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November 1970

Program of Policy Studies in Science and Technology
The George Washington University
Washington, D.C.

Monograph No. 5

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Revision of paper presented at the
Engineering Foundation Research Conference
Andover, New Hampshire, August 1969

Program of Policy Studies in Science and Technology
The George Washington University
Washington, D. C.
established under NASA Research Grant NGL 09-010-030

Monograph No. 5

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INTRODUCTION

A few years ago Bertrand de Jouvenel offered the following comment concerning the trend of professional group dominance in the management of social affairs:

> There can be no civilization unless society affords ample credit to men of thought. As their character changes, so does society. In the history of European civilization it is easy to observe, first, a long era during which the men of thought were all men of God, clerics; then a gradual emergence of the men of law, who finally became the most favored and dominant type of intellectual. As we can tie great changes in political ideas and institutions to this displacement, we therefore have good reason to predict great changes from the supersession of the jurist by the scientist as the most favored and dominant type of intellectual.[1]

It would appear that de Jouvenel associates professional dominance with superior intellectual equipment (concepts of inquiry, techniques of analysis, and modes of institutional decision-making) for dealing with the crucial public problems of the particular era. Rather than approaching this matter by asking whether lawyers or scientists are more relevant

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[1] Bertrand de Jouvenel, "The Political Consequences of the Rise of Science," Bulletin of the Atomic Scientists, (December 1963), p. 2.

Compare this statement by Emmanuel G. Mesthene in "The Impacts of Science on Public Policy," 27 Pub. Adm. Rev. 97, 99-100 (1967):

> "The scientists' view of the world changes - as did everybody else's - following the explosion of the first atomic bomb. But their view of science by and large remained the same. They still saw it as an end. Since science had demonstrated its impact on the wider world, many of them seemed to say, the wider world had now to embrace the values and methods of science, and abandon its ancient irrational ways, on pain of instant extinction. Science was thus transformed from an end-in-itself into the end or goal of all wisdom. All problems tended to be seen as scientific problems and scientists, it seemed to follow, were ipso facto the best solvers of all problems. This fixing on science as principally an end can thus inhibit understanding of the relationship of science as means to procedures and ends other than its own."

to the technology assessment function, it would seem more useful to examine the utility of various analytical techniques which can or must be brought into operation for technology assessment purposes.

Tentative and simplified definitions of a few recurring terms at this point will be helpful in the subsequent discussion. Technology Assessment refers to the identification of the effects (direct and derivative--immediate, intermediate and long-term) and the evaluation of the social desirability or undesirability of such effects as related to particular technological applications. Mechanism or Entity (such as a Congressional committee or the OST or a Special Study Group) refers to the organizational unit conducting the assessment. Process refers to the operational procedures (adversarial system, panel discussion, research study results, etc.) utilized by the assessment mechanism.

In order to simplify the subsequent analysis, the identification of the effects of a technological application and the measurement of their magnitude, intensity, and persistence will be referred to as the Effects Phase, and the evaluation of the social desirability or undesirability of such effects will be referred to as the Evaluative Phase of technology assessment. In the following sections, brief attention will be given to the concepts of Technology Assessment, Scientific Method, and Adversarial System.

I. Technology Assessment

The foregoing definition of technology assessment is broad. It is probably safe to assert that the decision process associated with every substantial technological project involves, to some degree, technology assessment. This would include considerations of feasibility where relevant to a particular application. Feasibility is not necessarily yes or no. There can be degrees of operational impact which will determine different types or levels of effects. Further, assessments directed toward prospective or potential applications may be made before the question of technical feasibility has been completely explored. In such instances, feasibility is assumed and the assessment is, of course, provisional.

Perhaps the most significant aspect of the concept of technology assessment as herein defined is that it is, and is meant to be, consistent with the notion of Total Impact Assessments, i.e., the identification of all social impacts of a particular application rather than selected impacts.[2] Presumably the ultimate objective of the technology assessment function is to obtain total impact assessments. However, the process of attaining such assessments is complex and difficult in most assessment systems dealing with particular applications. Technology assessment must

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[2]See discussion of Total Impact Assessments by Louis H. Mayo, "The Management of Technology Assessment," in Technology Assessment--The Proceedings of a Seminar Series (publication of the Program of Policy Studies in Science and Technology, The George Washington University, July 1969). In the cited article, Total Impact Assessments are referred to as Total Problem Assessments.

usually be considered within a time frame spanning years. Most technologies develop gradually. Hence, the social implications may not be immediately perceived. The social impacts become more evident through time. The means of evaluating the consequences may change through time. As applications increase and the technology affects a larger segment of participants, the larger becomes the number of interest groups involved as operators or as receivers of benefits or absorbers of costs. As participants increase, the number of assessment sub-systems (assessment mechanisms and assessment processes) increases. Such assessment sub-systems will normally be concerned with one special aspect of the problem. Only a few will give attention to the larger social sub-system affected by the application or pattern of similar applications.[3]

There are various reasons why assessments by particular sub-systems are truncated. The authority to deal with given aspects of a problem may not be with the mechanism; or the sub-system may have a capability for dealing with only a special aspect of the problem; or the data may not be available to make a useful assessment at a given point in time even within its special area of competence. All of the essential elements for a fully adequate assessment (one analyzing all of the variable interactions within the total social sub-system) can be brought into focus only at certain points in time. Hence, assessments are almost necessarily incremental and

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[3]See, for example, Gordon J. F. MacDonald, "Science and Space Policy: How Does It Get Planned?", Bulletin of the Atomic Scientists, May, 1967, p. 2, for a detailed discussion of the bifurcation of space policy planning.

cumulative with only periodic complete assessments being made or even feasible.

A most useful study could be made on the strengths and weaknesses of various assessment sub-systems. For example, a court case usually deals with an after-the-fact situation and declares rights and duties flowing from a technological application with respect to some highly restricted issue. It is basically reactive as contrasted with a prospective assessment. Initiation is not within the control of the court. The problem definition or scope of the assessment is largely determined by the issue in contention. Information is selected and limited by relevance to the specific issue. In other words, the range of alternatives that can be considered is usually extremely narrow.[4]

Executive departments and agencies usually have their scope of authority and responsibilities spelled out by statute. Such authority may be a narrow mandate for a special type of R&D with respect to a given technology. It may be reasonably broad as where the mandate calls for the administration of a given technology, such as broadcast communications, in the "public interest." Further, the rule-making and policy-declaring authority of regulatory agencies provides a projective dimension to the assessment function. Of all the permanent governmental entities, Congress, it would seem, has the broadest authority and flexibility to make inquiries

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[4]See, for example, Brotherhood of Locomotive Firemen & Engineers v. Chicago, Rock Island & Pacific Railroad Co., 89 S. Ct. 323, 330, (1968), citing and quoting from the Bibb case, 359 U.S., at 524, that:

> "If there are alternative ways of solving a problem, we do not sit to determine which of them is best suited to achieve a valid state objective. Policy decisions are for the state legislature, absent federal entry into the field."

and assessments. The charter of special ad hoc study groups can vary from an inquiry into a specific issue to a total impact assessment.

Illustrations of approximate Total Impact Assessments of a technological application are the following:

- Considerations Affecting Steam Power Plant Site Locations: A Report Sponsored by the Energy Policy Staff, Office of Science and Technology, December 1968.
- Civil Aviation Research and Development: An Assessment of Federal Involvement: Summary Report by the Aeronautics and Space Engineering Board of the National Academy of Engineering, August 1968.
- A 10-Year National Highway Program: Report of the President's Advisory Committee on a National Highway Program, January 1955.

The above reports place primary focus on a technological application. An alternative approach which also involves technology assessment is to start with a "social problem," however conceptualized, and utilize Special Purpose or Total Impact Assessments relevant to such problems.[5] Most projects tend to be organized in terms of perceived social problems of which technological applications may be the primary source or only one of many sources of adverse social impacts; or the primary means, or only one of various alternative means, of remedying a deficiency or of improving the performance of an activity designed to achieve specified social objectives. If the problem is formulated in terms of removing or reducing an

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[5]See discussion of the concepts of the "social problem" approach to assessment and Special Purpose Assessments in Mayo, The Relationahip of Technology Assessment to Environmental Management, Staff Discussion Paper #206 of the Program of Policy Studies in Science and Technology, The George Washington University (December 1969).

adverse effect of one or more technological applications (for example, jet aircraft noise), then only partial special purpose assessments related to such effects will be required.[6] But if a technology is being considered as a means of solving a social problem (introduction of the electric-powered auto to alleviate air pollution) or of attaining a social objective, then a total impact assessment would be advisable.

Some assessment processes are cumulative through time but in the aggregate may provide rough approximations of a total impact assessment, as for example, the long sequence of assessments of the various social aspects of the Supersonic Transport.[7]

The basic purpose of technology assessment is to provide enlightenment, i.e., data and analyses upon which rational social action decisions can be made. The outcome of an assessment is information (in the sense of a policy analysis) as distinguished from the outcome of an authoritative action decision which directly affects the allocation of resources, the conferring of benefits and the imposition of costs. While these two phases of the overall political decision process are conceptually distinguishable, the relation in some instances is extremely close. Further, the assessment phase has as its very purpose the influencing of the action

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[6]Another illustration would be the statutory functions of the National Transportation Safety Board which is concerned with the application of only one impact of transportation technology, namely, safety. See Public Law 89-670, 89th Cong., H.R. 15963, October 15, 1966. An Act to establish a Department of Transportation, and for other purposes, Sec. 5. See also National Transportation Safety Board Annual Report to Congress (1967).

[7]For one reference to this continuing review see the Wash. Evening Star of February 7, 1969, A9, col. 1.

decision phase, and this becomes readily apparent when the assessment carries with it, either explicitly or implicitly through the assessment outcome, a recommendation as to the preferred action to be taken.

The assessment phase can easily be distinguished from the decision phase where separate entities perform the two functions as in the recent National Academy of Sciences review of approximately 4,000 pre-1962 drugs for "effectiveness."[8] This evaluation provided information support for subsequent Food and Drug Administration decisions as to whether to order the removal of certain "ineffective" drugs from the market.[9] However, since our attention here is directed to assessments involving Government decisions on technological applications, the Ultimate Assessment Forum will coincide with the Political/Power Arena, that is, the same entity will perform the final assessment that makes the authoritative, official decision.

Technology Assessment as an enlightenment function is necessarily concerned with sources of information and techniques of inquiry: recognized research results, basic causal relationships, judgments of people with special competence in the subject under examination, and all of the operations associated with the scientific method, i.e., systematic observations, controlled experimentations, etc. The decisional arena reflects those authoritative determinations of legal rights and duties or other distributions of benefits and costs. Excluding naked, arbitrary exercise of power,

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[8] National Academy of Sciences, Drug Efficacy Study, (July 1969).

[9] See Morton Mintz in the Wash. Post, May 14, 1969, A3, Col. 5; Judith Randal, Wash. Evening Star, May 16, 1969, H11, col. 6; and Judith Randal, Wash. Evening Star, June 5, 1969, A14, col. 3; with reference to the combination antibiotic, Panalba.

we ordinarily associate with the decisional arena certain processes such as negotiation, bargaining, adjudication, arbitration, legislative procedures, rulemaking, and executive action. Since our present concern is with the assessment forum, thought patterns, information generating and organizing functions, and decisional processes (institutionalized or informal) must be evaluated in terms of their effectiveness as techniques of inquiry and the extent to which they contribute to the informational outcome of the assessment process.

II. Scientific Method

"Science," like "law," and "scientific method," like "legal process," have been given innumerable formulations.[10] The following selected extracts may provide suggestions as to how science, the purpose of science, and

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[10] John Zinman, "Undoctrinaire Inspections," in Science, Nov. 7, 1969, in connection with a review of Medawar, Induction and Intuition in Scientific Thought, (1969), and Pantin and Thorpe, The Relations Between the Sciences, (1968), states:

> "Writings about science remind one of the old joke about the international essay competition on the subject of elephants. The Englishman wrote 'Elephants I Have Shot'; the American wrote 'Bigger and Better Elephants'; the Frenchman wrote 'L'Elephant et Ses Amours'; the Pole wrote 'The Elephant and the Polish Question.' The experimental physicists tell us that the aim of science is to reduce the universe to mathematics; 'It's all done by mirrors,' complain the logicians; 'Don't stop me; buy one!' is the theme of the technologists; the psychiatric interpretation seems to be 'Look what a lovely mess I've made!'; and some of our more doctrinaire sociologists embroider the slogan 'Give him the money, Barney!' Science is so elephantine that one tends to see it only from the standpoint of one's own particular experience and interest."

"Science" and "scientific method" have been described in a multiplicity of ways. "Science as the exemplification of authority and objectivity" is advanced by Professor Donald Fleming, "Big Science Under Fire," The Atlantic, Sept. 1970, pp. 96-99:

> "Science exalts the principle of intellectual authority, always aims at authoritative pronouncements and tolerates dissent only because it promises to reconstitute the authority of science on firmer foundations. Authorities can always be overthrown, but never the pursuit of authority as the chief end of science. By no accident, one of the highest compliments that can be paid to a scientist is to say that he is one of the great authorities in his field.
>
> "At any given moment there is, and must be in every science, a prevailing orthodoxy, jealously guarded against unauthoritative intrusions and yielding only to a new orthodoxy. Divisions of opinion prolonged as a mere form of self-expression, dissent as a way of life and badge of integrity, are intolerable to scientists, who cannot rest till they achieve a new stability, a new consensus dissolving controversies. Fresh controversies will

scientific method can most usefully be viewed with reference to the technology assessment function. According to Richard B. Braithwaite:

> A scientific hypothesis is a general proposition about all the things of a certain sort. It is an empirical proposition in the sense that it is testable by experience; experience is relevant to the question as to whether or not the hypothesis is true, i.e., as to whether or not it is a scientific law.[11]

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arise, but the basic thrust of science is toward an ungrudging though continually retreating unanimity."

Raymond M. Wilmotte states in "Engineering Truth in Competitive Environments," IEEE Spectrum, May 1970, pp. 45-46, that "In broad terms, the constant questioning--the delving into uncertainties in a continuous and systematic way--may be said to be the scientific process." Gerard Piel in Science in the Cause of Man (1961) states:

> "The rational method offers no absolutes and no blueprints prepared in advance to tell us what we want to live for. But science does broaden and secure the ground on which men can make their choice. It has shown in the triumphs of technology that human life is not fated to be nasty, brutish, and short. In our increasingly complete and connected knowledge of the cosmos, we have an ever clearer understanding of ourselves and our place in nature. We see that the perfected man, that idea of the eighteenth century enlightenment, is the ultimate produce of the cosmic process as it is known to modern science."

And further, p. 79;

> "Wherever they have taken root, the two movements of science and democracy have mutually sustained each other by their close correspondence in motive and objective. As democracy substitutes persuasion for force in the relations of men, so science established observation and reason in the place of authority as the foundations of knowledge. In democracy, the government is open at all times to change and improvement by the governed. In science, every hypothesis is provisional, every finding tentative, and no work lays claim on final truth. Science and democracy are open-ended; they set no limits to human knowledge and experience. The autocrat and dogmatist are enemies of both."

11 Richard B. Braithwaite, Scientific Explanation: A Study of the Function of Theory, Probability, and Law in Science (1955), p. 2. Ernest Nagel in The Structure of Science: Problems in the Logic of Scientific Explanation (1961), p. 12 states:

> "Implicit in the contrasts between modern science and common sense already noted is the important difference that derives from the deliberate policy of science to expose its cognitive claims to the repeated challenge of critically probative observa-

Further, he in turn defines a "scientific law" as a "proposition asserting a universal connexion between properties."[12] More relevant for present purposes is the statement:

> For the most important fact about our acceptance of a scientific law is that of enabling us to make reliable predictions, and this predictive function of a scientific law would be ignored if the function of the law were taken as being purely descriptive.[13]

With respect to the subject matter of science, Charles R. DeCarlo asserts that:

> We must remember that the essence of scientific rationalism is a belief in objective scientific truth. The "real" properties of the world are those which can be quantified, measured, and made susceptible to mathematical formulation . . .In scientific rationalism the subjective world of feelings, values, and the many qualitative aspects of life not susceptible to measurement or mathematical manipulation is considered a separate and "imperfect" aspect of the human mind.[14]

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tional data, procured under carefully controlled conditions." Gordon Tullock in The Organization of Inquiry (1966), p. 66, states:

> "In the view of scientific method which I learned from Popper, the method by which we reach our hypothesis is less important than the question of whether the hypothesis is true, and this latter question can be answered only by testing it. . .Efforts to prove that we can reach conclusions about general laws by induction from specific instance have always failed. . .The crucial problem of science is not: Was this proposed law derived according to proper procedures? but: Is it true? This question can be most readily answered by testing it."

See also Zinman, supra note 10, quoting Medawar:

> "The scientific method is a potentiation of common sense exercised with a specially firm determination not to persist in error if any exertion of hand or mind can deliver us from it."

[12] Braithwaite, op. cit., supra, n. 11, p. 9.

[13] Ibid., p. 348.

[14] Charles R. DeCarlo, "Perspectives on Technology" in Technology and Social Change, (Eli Ginzberg, ed. 1964), pp. 8-11.

The Report on Technical Information for Congress[15] moves close to the scientific method with a number of statements similar to the following:

> Scientific decision-making tends to be imposed by the method of science--rather than arrived at by group dynamics. It is structured in terms of the measurable data of experiment and observation. The decision is delayed until a working or useful consensus is possible from the available data. Until the consensus is firm, the method requires that the information-gathering process continue.[16]

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[15] U.S. Congress, House, Committee on Science and Astronautics, Technical Information for Congress, Report to the Subcommittee on Science, Research, and Development of the Committee on Science and Astronautics, House of Representatives, 91st Cong., 1st sess., prepared by the Science Policy Research Division, Legislative Reference Service, Library of Congress (Washington, D.C.: Government Printing Office) April, 1969. This Report will hereinafter be cited as Technical Information for Congress.

[16] Ibid., p. 475. Zinman, supra, n. 10, states relative to the standard of "objectivity,"

> "This is an unattainable standard of proof. The fact is that science is a purely human pursuit, and the best we can achieve is systematic inter-subjectivity or 'consensibility'--an agreement that 'thus it is' between well-informed minds."

See also Ernest Nagel, supra, note 11, p. 13:

> "The practice of scientific method is the persistent critique of arguments, in the light of tried canons for judging the reliability of the procedures by which evidential data are obtained, and for assessing the probative force of the evidence on which conclusions are based. As estimated by standards prescribed by those canons, a given hypothesis may be strongly supported by stated evidence. But this fact does not guarantee the truth of the hypothesis, even if the evidential statements are admitted to be true--unless, contrary to standards usually assumed for observational data in the empirical sciences, the degree of support is that which the premises of a valid deductive argument give to its conclusion. Accordingly, the difference between the cognitive claims of science and common sense, which stems from the fact that the former are the products of scientific method, does not connote that the former are invariably true. It does imply that, while common-sense beliefs are usually accepted without a critical evaluation of the evidence available, the evidence for the conclusions of science conforms to standards such that a significant proportion of conclusions supported by similarly structured evidence remains in good agreement with additional factual data when fresh data are obtained."

In his treatise on Political Theory Arnold Brecht undertakes to describe the method of scientific inquiry as consisting of several identifiable phases or operations. He says:

> In every inquiry--and that means inquiry within the social as well as the natural sciences--Scientific Method concentrates on the following "scientific actions," "scientific operations," or "steps of scientific procedure."
>
> 1. Observation of what can be observed, and tentative acceptance or nonacceptance of the observation as sufficiently exact.
> 2. Description of what has been observed, and tentative acceptance or nonacceptance of the description as correct and adequate.
> 3. Measurement of what can be measured; this being merely a particular type of observation and description, but one sufficiently distinct and important to merit separate listing.
> 4. Acceptance or nonacceptance (tentative) as facts or reality of the results of observation, description, and measurement.
> 5. Inductive generalization (tentative) of accepted individual facts (No. 4), offered as a "factual hypothesis."
> 6. Explanation (tentative) of accepted individual facts (No. 4), or of inductively reached factual generalizations (No. 5), in terms of relations, especially causal relations, offered as a "theoretical hypothesis."
> 7. Logical deductive reasoning from inductively reached factual generalizations (No. 5), or hypothetical explanations (No. 6), so as to make explicit what is implied in them regarding previously accepted facts (No. 4), factual generalizations (No. 5), and hypothetical explanations (No. 6).
> 8. Testing by further observations (Nos. 1-4), the tentative acceptance of observations, reports, and measurements as properly made (Nos. 1-3), and of their results as facts (No. 4), or tentative expectations as warranted (No. 7).
> 9. Correcting the tentative acceptance of observations, etc., and of their results (Nos. 1-4) of inductive generalizations (No. 5) and hypothetical explanations (No. 6), whenever they are incompatible with other accepted observations, generalizations, or explanations; or correcting the previously accepted contributions.
> 10. Predicting events or conditions to be expected as a consequence of past, present, or future events or conditions, or of any possible constellation of such, in order either
> (a) to test factual or theoretical hypoteheses (Nos. 5 and 6), this being identical with steps 7 and 8; or

(b) to supply a scientific contribution to the practical process of choosing between several possible alternatives of action.

11. Nonacceptance (elimination from acceptable prepositions) of all statements not obtained or confirmed in the manner here described, especially of "a-priori" prepositions, except when "immanent in Scientific Method" or offered merely as "tentative assumptions" or "working hypotheses" (Chapter II, Sections 5 and 6).[17]

It is to be noted that the foregoing operations defining scientific method are by no means exclusively limited to the analytical procedures of professional scientists and engineers. The crudest designed trial and error approach has some reference to operations of hypothesizing, experimenting, observing, and testing of empirical results against the hypothesis. Such a method is surely far removed from authoritative assertions of first principles, whether theological or political, to be taken on faith alone.

In this effort to examine the relevance of scientific method to technology assessment, we are concerned with the capacity of this method of inquiry to provide information on such matters as: 1) The existence, or probability of existence, of given phenomena or causal relationships; and 2) The probability that certain events or effects will occur under given conditions in the future, as with the introduction of a particular technological application.

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17 Arnold Brecht, Political Theory (1959), pp. 28-29.

III. Adversarial System

Expressions such as "adversarial system," "adversary process," and "advocacy" tend to convey an image of an argument or a contest. Advocacy is often defined as "pleading for" a person or position.[18] Some undoubtedly equate advocacy with rhetoric or "the art of influencing the thought or conduct of one's hearers."[19] In his article on "Concealed Rhetoric in Scientistic Sociology" Richard M. Weaver states:

> Rhetoric is anciently and properly defined as the art of persuasion. We may deduce from this that it is essentially concerned with producing movement, which may take the form of a change of attitude or the adoption of a course of action, or both.[20]

In this brief statement there is little to suggest that advocacy or the adversarial system is or might be a method of inquiry as well as a technique of influencing a decision outcome.

There is a great deal more to the adversarial system than rhetoric, however. In a recent treatise on the former, William A. Blaser commences his analysis with a discussion of the adjudicatory model of the adversarial system. Clearly, the assumption is entertained that, from the presentation of rival claims prepared independently by the interested parties, the "true" facts will emerge and that the "correct" rule will be applied.[21]

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[18] The American College Dictionary.

[19] Ibid.

[20] Essay in Scientism and Values (Schoeck and Wiggins, Eds., 1960), pp. 83-84. "This means that rhetoric, consciously employed, is never innocent of intention, but always has as its object the exerting of some kind of compulsion." Ibid.

[21] Blaser, Pretrail Discovery and the Adversary System (1968), p. 4.

He makes the following points:

> The adversary system's method of investigating the facts of a case is conditioned by the system's ultimate aim of exploring disputes thoroughly, enabling all parties to present their claims in their own words, and settling the disputes decisively without violence.[22]
>
> The adversary system distinguishes between the roles of advocate and judge because, it is assumed, one inhibits performance of the other.[23]
>
> The adversary system assumes that public respect for the courts is necessary and depends on judicial neutrality.[24]

Additional assumptions relative to the adjudicatory model of the adversarial system pertain more directly to the development of relevant information:

> The adversary system places the burden on the parties and competitive relationship motivates each to find all the law and facts.[25]
>
> The adversary system gives each party the full responsibility and opportunity to reveal defects in the rival's arguments.[26]
>
> By separating the partisan advocate from the judge of the law and facts, the adversary system tries to ensure that the decision-maker suspends judgment until all the arguments and proofs have been presented.[27]

Blaser advances a further proposition concerning cases of first impression for which there is no settled precedent that "the adversaries do not merely urge the court to adopt whatever well-defined but competing legal principles

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[22] Ibid., p. 13.

[23] Ibid., p. 4.

[24] Ibid., p. 5.

[25] Ibid.

[26] Ibid., p. 4.

[27] Ibid.

can apply to the facts most advantageously to themselves, but their arguments and mutual criticisms help the court develop new and more clear principles of law for that class of cases."[28]

The assumptions made about the advantages of the adversarial system as a technique of inquiry are somewhat blunted by actual practices. As Blaser says, "Since the parties in a fight seek victory rather than truth for its own sake, their presentations may confuse rather than help the court."[29] For example, expert testimony is often shaped to partisan ends. Further, "While the trier of facts wishes to know everything that is pertinent, a partisan who discovers harmful information is motivated to conceal it from the adversary and from the court."[30] While the practice of concealment is to some extent considered to be in accord with the "rules of the game" in an adversary decisional arena such as a court or a regulatory agency adjudication where the primary objective of the advocate participant is to prevail, such practice could seriously hamper the assessment process where the objective is to assemble complete information on a given application.[31]

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[28] Ibid., p. 13.

[29] Ibid., p. 6.

[30] Ibid., p. 7.

[31] See generally on the adversarial system, E. Barrett Prettyman, "Some Observations Concerning Appellate Advocacy," 39 Va. L.R. 285 (1953) wherein Judge Prettyman discusses both brief writing and oral argument and quotes John W. Davis on oral argument techniques, at 299, as follows:

> "'The statement of the facts is not merely a part of the argument, it is more often than not the argument itself. . .'
>
> "'Always "go for the jugular vein".' By that is meant that upon oral argument the lawyer should pick the nub of the case and go for it. '. . .(T)he quintessence of the advocate's art'

In an authoritative decisional arena, advocacy has as its objective the presentation of claims or demands that the decision or outcome allocates values, i.e., rights and duties, benefits and costs, in designated ways. But advocacy in the sense of attempting to influence outcomes is also employed as a strategy in assessment forums. While the assessment process culminates in an informational outcome as contrasted with a binding value allocation, it nevertheless involves a decision or determination as to the outcome which distinguishes such processes from a mere "bull session." Advocacy in the assessment forum is directed toward gaining recognition for certain types of effects of a technological application and toward persuading the assessment entity to apply evaluative criteria to such effects (socially desirable or undesirable and the magnitude thereof) so as to reflect the participant's preferences.

Mr. Davis calls the ability to pick one single point and drive it home as the only worthy topic in the case. If you are superbly courageous, you can concede impossible and even dubious points."

Arthur S. Miller, in "Drawing the Indictment," Saturday Review, Aug. 3, 1968, pp. 39-40, summarizes the adversary system thus:

"The adversary system, in sum, is based on two premises: first, that the lawyers and judges are competent in the matters dealt with, and second, that the system can provide enough of the right type of data to make viable decisions."

Professor Miller believes that both assumptions are incorrect with regard to courts as they are presently constituted. See infra p. 81 of this paper.

See also, on the adversarial system, Milton Katz, The Relevance of International Adjudication, (1968) chap. 2.

IV. Similarities and Differences

We can probably agree that scientific method is aimed primarily toward enlightenment, i.e., the production of knowledge, while an adversarial system is directed primarily toward power, i.e., the assertion of claims and the influencing of decision outcomes.[32] But the adversarial system clearly includes an enlightenment component. The adversarial system not only attempts to shape the outcome directly (as with mere rhetoric), but is supported to some degree by the organization of relevant information including both factual events and appropriate rules or criteria of decision. For example, when applied in the ultimate political decision arena where the issue involves a technological application, the adversarial system subsumes the assessment function.

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[32] To draw on a social science example rather than a technological application, consider the following observation in the review by David M. Schneider of Rainwater & Yancy, "The Moynihan Report and the Politics of Controversy," Bulletin of the Atomic Scientists, March 1968, pp. 20-21:

> "But the major problem remains, this time fairly and well put by the authors: 'The central issue raised by the Moynihan Report for the government social science relationship is that of the political use of social science findings.' That is, the Moynihan Report is not basically a research report or a technical document; it is a polemic which makes use of social science techniques and findings to convince others. It was designed as a persuasive document because Moynihan felt that the social science data he could bring to bear would have a persuasive effect. '. . .the rhetoric of persuasion is generally considerably simpler than the rhetoric of scholarly or research discourse. The suitable criteria for evaluating a persuasive document are not that all its i's are dotted and all its t's are crossed but that it selects some crucial issues and presents them in such a way as not to belie a fuller and more balanced intellectual discussion of them. It is our view that the Moynihan Report does not violate this standard although we recognize that some other social scientists would disagree.'"

This close interaction between enlightenment and power has prompted some interesting analyses of the differences and similarities between scientific method and legal process including the adversarial system. However, the identification of scientific method with verifiable or potentially verificable empirical relationships, that is, with accurate description of phenomena and the prediction of events under given conditions, has convinced some observers that a sharp distinction should be drawn vis-a-vis legal process: That scientific method represents a dispassionate search for the "truth" whereas adversarial system reflects a passionate "urge-to-win"--to impose a position, to achieve a preferred value or resource distribution.[33] Consider, for example, the informational limitations of advocacy as illustrated in Professor Mason's description of one of Chief Justice Marshall's opinions:

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[33]Raymond M. Wilmotte in "Engineering Truth in Competitive Environments," IEEE Spectrum, May 1970, p. 45, advances the thesis that "the success of decisions in both public affairs and industry depends today on the correct assessment of technical uncertainties" and that in "an atmosphere of adversary confrontation, the efforts to hide them can prove the source of much harm." He states further:

> "The mental attitude of the individual who sees that there is a gap in the truth when uncertainties are not expressed is altogether different from the attitude attending the process of finding the truth by the legal process of adversary confrontation, for that method in effect eliminates the voluntary disclosure of uncertainties. Scientists are inherently unsympathetic with this legal process, at least on technical matters." Ibid., p. 46.

Wilmotte seems to be saying that the adversary process tends to add confusion to factual determinations, particularly where the "uncertainties" as to facts are significant. His references are to the factual/effects phase rather than to the value or social preference phases of the assessment-decision process. He feels that areas of uncertainty can and should be reduced in order to enlighten and clarify rather than to confuse. He asserts that "No scientific or engineering study should be considered complete without an 'uncertainty analysis'. No system or component is really understood by its designer until he has carried out such an analysis." Ibid., p. 47. He finds the "adversary confrontation" designed not to "reach

> By minimizing the complexity of the question he had gratuitously set for himself, the Chief Justice ruled out the technical agglutinative approach. He chose to fuse the ingredients Judge Cardozo singled out as necessary for a persuasive opinion--overtones of sincerity and fire, the mnemonic power of alliteration and anthesis, the terseness and tang of the proverb and the maxim. "Neglect the help of these allies," Cardozo warns, "and it (the opinion) may never win its way." Such qualities make for an opinion at once both 'magisterial' and 'imperative.' Such an opinion 'eschews ornament.' It is meager in illustration and analogy. If it argues, it does so with the downward rush and overwhelming conviction of the syllogism, seldom with tentative gropings toward the inductive apprehension of a truth imperfectly discerned.[34]

Contrast the foregoing technique of persuasion with the following description of the scientific mode of presentation:

> The natural scientists have won an enviable reputation for modesty in this respect: they seldom allow their desire for results to carry them beyond a statement of what is known or seriously probable. This often calls for a great deal of qualification, so that cautious qualification has become the hallmark of the scientific method.[35]

A striking if somewhat crude contrast of adversarial system and the scientific approach is that offered by the late Judge Jerome Frank in his book Courts on Trial (1949):

> Our mode of trials is commonly known as "contentious" or "adversary." It is based on what I would call the "fight"

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a conclusion, but to prove one." He adds, "One can generalize from the example of the ABM that whenever the purpose of a technical presentation is to 'sell' rather than to communicate something, and competition exists, the foundation for a process of adversary confrontation is established." Ibid.

[34] Mason, The Supreme Court: Palladium of Freedom (1962), p. 86.

[35] Weaver, supra, n. 20, p. 91.

> theory, a theory which derives from the origin of trials as substitutes for private out-of-court brawls.[36]
>
> In short, the lawyer aims at victory, at winning in the fight, not at aiding the court to discover the facts. He does not want the trial court to reach a sound educated guess, if it is likely to be contrary to his client's interest. Our present trial method is thus the equivalent of throwing pepper in the eyes of a surgeon when he is performing an operation.[37]

Judge Frank characterizes the "fight theory" of justice as "a sort of legal laissez-faire," that whereas classical economic theory postulated "economic man," the adversary system postulates "litiguous man."[38] Several statements in the Report on Technical Information for Congress also attempt to draw a sharp distinction between scientific and legal-political processes, as for example:

> Scientific truth is established by objective demonstration and confirmed by replication; political truth is established by consensual agreement, usually after an "adversary contest."[39]

John Dewey's specific attention to the process of problem solving as reflected in the adversarial system and its relationship to scientific method is illustrated by the following passages:

> As a matter of fact, men do not begin thinking with premises. They begin with some complicated and confused case, apparently admitting of alternative modes of treatment and solution. Premises only gradually emerge from analysis of the total

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[36] Frank, Courts on Trial (1949), p. 80.

[37] Ibid., p. 85.

[38] Ibid., p. 92.

[39] Technical Information for Congress (1969), supra, n. 15, p. 5.

> situation. The problem is not to draw a conclusion from given premises; that can best be done by a piece of inanimate machinery by fingering a keyboard. The problem is to find statements, of general principle and of particular fact, which are worthy to serve as premises. As a matter of actual fact, we generally begin with some vague anticipation of a conclusion (or at least of alternative conclusions), and then we look around for principles and data which will substantiate it or which will enable us to choose intelligently between rival conclusions. No lawyer ever thought out the case of a client in terms of the syllogism. He begins with a conclusion which he intends to reach, favorable to his client of course, and then analyzes the facts of the situation to find material out of which to construct a favorable statement of facts, to form a minor premise.[40]

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[40] Dewey, "Logical Method and Law," 10 Cornell L.Q. 17, 22-23 (1924); reprinted in Cohen and Cohen, Readings in Jurisprudence and Legal Philosophy (1951), pp. 553-554.

Making a determination and then searching for the "authority" to support the conclusion as is reflected in the story about Chief Justice Marshall: "Judgment for the plaintiff; Mr. Justice Story will furnish the authorities," would seem the antithesis of the scientific method. But the pronouncement of Marshall does not necessarily represent his process of reasoning. Chancellor Kent, in explaining how he arrived at a judicial decision, noted that he first made himself "master of the facts" and then:

> "I saw where justice lay, and the moral sense decided the court half the time. I then sat down to search the authorities . . .I might once in a while be embarrassed by a technical rule, but I almost always found principles suited to my view of the case." [Extracts taken from Jerome Frank, "What Courts Do In Fact," 26 Ill. L.R. 645 (1932), reprinted in Cohen and Cohen, Readings in Jurisprudence and Legal Philosophy (1951), pp. 474-476.]

Dewey's attitude toward the lawyer's approach to information gathering and organization would seem to be shared with Gordon Tullock in The Organization of Inquiry (1966), pp. 58-59:

> "So far, I have discussed science and inquiry as though they were the same thing. In one of the general uses of inquiry, this is true, but in other meanings of this term they are different. Investigations may be started which are not motivated by either curiosity about reality or the desire to make practical use of knowledge of the real world, but by some other motive. A lawyer building up a brief for his client, for example, may be much more intelligent, more learned, and more ingenious in his research methods than most scientists, but his investigation is not scientific because he is not searching for the truth. He looks for an argument, based on factual information to be sure, which he thinks will persuade. In fact, in the Anglo-adversary type of legal proceedings, he is prohibited from expressing his personal opinion on this point to the court."

> I do not for a moment set up this procedure as a model of scientific method; it is too precommitted to the establishment of a particular and partisan conclusion to serve as such a model.[41]

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[41] Ibid. But does the focus on a predisposed, partisan conclusion necessarily preclude characterization of such techniques of data collection and organization as utilized in the famous "Brandeis Brief" in support of the normative standard of "reasonable" in Muller v. Oregon, 208 U.S. 412 (1907), as scientific?

> "In the fall of 1907 the owner of the Grand Laundry in Portland, Oregon, Curt Muller, decided to appeal a ruling against him by the Oregon Supreme Court. Some months previously Muller had been convicted by a lower court of having forced a Mrs. Elmer Gotcher, one of his employees, to work longer than the ten hours a day permitted by the Oregon law governing women workers in factories and laundries. He was fined $10 for the offense. The Portland laundry incident might have had little importance, except that since the 1905 ruling by the United States Supreme Court in the case of Lochner v. New York, which struck down a ten-hour limit for men working in bakeries, employers had been encouraged to challenge every law restricting hours of work. The Portland laundry owners, employers of women, wanted a clear test.
>
> "From his study of the Lochner decision of 1905 and others involving the clash between Fourteenth Amendment liberty of the property-owner and state legislation designed to protect the weak, Brandeis recognized the kernel of his task: to convince the Supreme Court that the Oregon legislature had acted reasonably in passing its ten-hour statute. The Court had made it clear that it would tolerate protective laws that curbed the employer in the free enjoyment of his property only if such laws were reasonably calculated to promote the social good. The words reasonable and reasonably ran like a thread through one Court decision after another.
>
> "Brandeis immediately put Josephine Goldmark to work pulling together evidence to prove the reasonableness of a law designed to curb the physical and social evils to women attendant upon excessive hours of toil. This evidence was to be from physicians, health inspectors, social workers, and industrial experts rather than from legalists. Medical libraries were combed for documentation; when this was assembled and edited, Brandeis submitted 101 pages of citations from experts in a dozen countries, all bearing on the physical requirements of women for a decent amount to (sic) rest if they were both to work and to fulfill their functions as mothers. Some of his testimony dated back fifty years, and much of it revealed greater official concern with working women's health in the Old World than in America. Brandeis' brief showed that every reliable nonjuridicial authority in Western Europe and North America knew that excessively long hours of work are harder on women than on men; and further, that because women bear children, the physical well-being of humanity requires that their working hours be limited. One citation after another proved that long hours of work led to

Despite the fact that many efforts have been made to distinguish scientific method and legal process, similarities can also be found. All decisional sub-systems within society and especially those which are closely related to a recognized discipline or profession, are necessarily concerned with particular subject matter, thought processes, and institutionalized or customary decisional procedures. While given professional groups tend to specialize in certain types of subject matter, thought processes, analytical frameworks, and customary modes of reaching outcomes, such elements are not necessarily the exclusive province of such professions. Science is the subject matter of politicians as well as scientists. Inductive, deductive, trend, alternative, and goal-value thinking are engaged in by all professional groups to some degree. Further, all such groups are exposed to some extent to the various institutionalized or customary modes of outcome determination. One should not be surprised,

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breakdowns in women's health and morals--to illness, to alcoholism and to prostitution." [A. L. Todd, Justice on Trial (1964), pp. 57-58.]

"But Brandeis' triumph in Muller v. Oregon consisted of much more than success in arguing a case on the basis of actual conditions of industrial life. One reason the case is considered to be a landmark in constitutional adjudication is that the Supreme Court accepted the brief filed by Brandeis as an entirely appropriate means for buttressing the legal argument in behalf of what would be called today welfare legislation. 'The Muller case is epoch-making,' Felix Frankfurter wrote in 1916, 'not because of its decision, but because of the authoritative recognition by the Supreme Court that the way in which Mr. Brandeis presented the case. . .laid down a new technique for counsel charged with the responsibility of arguing such constitutional questions and an obligation upon courts to insist upon such method of argument before deciding the issue." [Konefsky, The Legacy of Holmes and Brandeis (1956), pp. 88-89.]

therefore, that many thinkers have found a degree of correspondence between scientific method and legal process, including the adversarial system.[42]

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[42] The philosophical movement of "analytical or logical positivism," including its jurisprudential aspects, grew out of the application of the methods used in the natural sciences to the study of social and legal process. See Bodenheimer, Jurisprudence (1962), p. 89.

F. S. Cohen, in "Field Theory and Judicial Logic," 59 Yale L.J. 238 (1950), reprinted in Cohen and Cohen, Readings in Jurisprudence and Legal Philosophy (1951), p. 580, quotes from Einstein and Infeld, The Evolution of Physics (1938), p. 259:

> "A new concept appears in physics, the most important invention since Newton's time: the field. It needed great scientific imagination to realize that it is not the charges nor the particles but the field in the space between the charges and the particles which is essential for the description of physical phenomena."

In the discussion which follows Felix Cohen states:

> "Must we not say that the truth of any assertion is a matter of degree, that from certain angles the sentence may give light and that at other angles it may obscure more light than it gives? The angle or perspective and the context are part of the meaning of any proposition, and therefore a part of whatever it is that is true or false.
>
> "The location of words in a context is essential to their meaning and truth. The fallacy of simple location in physical space-time has finally been superseded in physics. We now realize that the Copernican view that the earth moves around the sun and the older Ptolemaic view that the sun moves around the earth can both be true, and that for practical though not aesthetic or religious purposes the Ptolemaic and Copernican astronomics may be used interchangeably. We realize that Euclidean and non-Euclidean geometrics can both be true. What is a straight line in one system may be an ellipse in another system, just as a penny may be round in one perspective, oval in a second, and rectangular in a third.
>
> "A prosecuting attorney who assumes that policemen are accurate and impartial observers of traffic speeds will arrive at one estimate of the speed of a defendant charged with reckless driving. The defendant's attorney, if he assumes that his client is an honest man and that policemen on the witness stand generally exaggerate in order to build up an impressive record of convictions, will arrive at another estimate. If each honestly gives his views the court will have the benefit of synoptic vision. Appreciation of the importance of such synoptic vision is a distinguishing mark of liberal civilization. To the anthropologist, the tolerance that is institutionalized in a judicial system geared to hear two sides in every case represents a major step in man's liberation from the tyranny of word-magic. If we do not feel that we have to annihilate those who say things we do not believe or, what is generally more irritating,

Morris Cohen, for example, in his writings strongly supported the "hypothetico-deductive" method, asserting that, like science, law is based upon a relatively few primary principles from which particularized legal rules are derived.[43] The resemblance found by Morris Cohen would certainly be rejected by others who might select a different aspect of legal process to examine or who might start from assumptions or conclusions about legal process which differ radically from those of Cohen. Holmes at times seemed scornful of the application of a formal logical approach to legal process

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say things we do believe but say them in strange ways or in unfamiliar accents, we are able to conserve our energy for more useful purposes. Energy so conserved may produce science, art, baseball, and various other substitutes for indiscriminate individualistic slaughter.

"The ancient wisdom of our common law recognized that men are bound to differ in their views of fact and law, not because some are honest and others dishonest, but because each of us operates in a value-charged field which gives shape and color to whatever we see. The proposition that no man should be a judge of his own cause embodies the ancient wisdom that only a many perspectived view of the world can relieve us of the endless anarchy of one-eyed vision." Ibid., pp. 583-584.

43 See M.R. Cohen, "Law and Scientific Method," in Law and the Social Order (1933), pp. 192-197; reprinted in Cohen and Cohen, Readings in Jurisprudence and Legal Philosophy (1951). Citations are to pages in Cohen and Cohen. Representative comments include:

"The method of beginning with hypotheses and deducing conclusions, and then comparing these conclusions with the factual world, seems to be still the essence of sound scientific method." p. 563.

"A deductive system that enables us to derive many legal rules from a few principles makes the law more certain, so that people can better know their rights." p. 564.

"A suggestive parallel can be drawn between the functions of the law and of natural science. Both facilitate transactions by increasing our reliance on the future." p. 542.

"(S)cientific jurisprudence endeavors to analyze all laws as combinations of a few recurrent simple elements." p. 549.

as when he stated that "The life of the law has not been logic: it has been experience."[44] While this assertion would seem sharply at odds with Cohen's, Holmes might be said to have moved very close to the scientific spirit of inquiry by emphasizing the empirical approach and the predictive function: "The prophecies of what the court will do in fact, and nothing more pretentious, are what I mean by the law."[45] Clearly, "science," "legal process," or even "science of law" can be defined, interpreted, and analyzed in a multiplicity of ways, and whether similarities or differences are found depends largely upon the aspect of the concept or process examined.[46]

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[44] Holmes, The Common Law (1881); reprinted in Cohen and Cohen, Readings in Jurisprudence and Legal Philosophy (1951), p. 530.

[45] Holmes, The Path of the Law from Collected Legal Papers (1920); reprinted in Cohen and Cohen, Readings in Jurisprudence and Legal Philosophy (1951), pp. 416-417.

[46] See the interesting introduction to the article by Barbara J. Shapiro, "Law and Science in Seventeenth-Century England," 21 Stan. L. R. 727 (1969):

> "It is a remarkable trick of the English language, and of the historical development of legal thought, that the phrase 'law and science' stands in such sharp contradistinction to the phrase 'legal science.' Nineteenth and early 20th-century lawyers, seeking to carve out an intellectually legitimate and autonomous discipline of law, used the term legal science not to suggest that the law was part of modern scientific culture, but precisely the opposite. They meant that law was a science just as chemistry was a science, and was thus entitled to independent existence. This reasoning rested on an obsolete definition of a science as any systematically organized body of knowledge and on a failure to acknowledge that what made chemistry or physics a science was not its autonomously organized knowledge but the fact that it shared with other sciences a particular method of investigation and a particular mode of stating results.

And consider the statement of Frederick K. Beutel in Experimental Juris-

Many observers who have given careful attention to the interacting roles of scientific method and the adversarial system in the making of socio-political decisions usually attempt to assign different tasks to these

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prudence (1957), pp. 18-19, on the "Essence of Experimental Jurisprudence":

> "A science of law based on a rigorous application of the scientific method should be devoted to the study of the phenomenon of law-making, the effect of law upon society and the efficiency of laws in accomplishing the purposes for which they came into existence. It is immaterial whether or not all of political science, part of each of sociology, economics, philosophy and many of the other social sciences are included within its ken. The line between the 'sciences,' like the definition of law, is little more than a quibble which can be left to the pundits, bureaucrats and administrators; to the scientist, the nature of its subject matter, the methods which it uses and the results which it achieves, rather than its definition, are fundamental."

Suggestions that an approach to problem solving which involves

- Specification of goals,
- Description of contextual conditions and influential trends,
- Invention of alternative courses of action to achieve such goals,
- Appraisal of the outcomes and consequences of alternative courses of action, and
- Cost-benefit evaluations of the consequences of such outcomes in terms of specified goal-objectives,

is a "scientific approach," seems to push the scientific label a bit too far. This is certainly a rational approach to problem analysis if we consider rational to be the application of relevant facts and analyses to specific standards of judgment or consider rational problem-solving to be the selection of satisfactory means to achieve specific objectives. But the types of thinking represented by the components of this decisional model certainly existed long before the Western Scientific Tradition got its momentum. There is nothing distinctively scientific in this approach. It represents alternative thinking which has always been reflected in legislative and policy processes. See Mayo & Jones, "Legal-Policy Decision Process: Alternative Thinking and the Predictive Function," 33 Geo.Wash. L.R. 318 (1964). Nevertheless, modern science has contributed to the more effective utilization of this decisional process. Its empirical, inductive procedures have provided more comprehensive data on the real world and have assisted in better defining the gap between what exists and our aspirations. It has improved our techniques of trend thinking and prediction. It has provided improved means of measuring impacts of given policies, projects, practices and applications and has therefore given us a better grasp of how to move from where we are to where we want to be. The approach to problem analysis noted above, however, obviously involves both "factual" and "evaluative" components so interrelated as to provide a systematic or rational model for social problem solving. Such intellectual tasks as goal

two methods of inquiry or to suggest limits on the applicability of scientific method or of legal process. Judge Lee Loevinger in "Law and Science as Rival Systems" comments as follows:

> The fundamental point that lawyers, as well as scientists, must understand is that both the dialectic method of law and the empiric method of science are merely means of gathering and helping to organize data, and that data may answer some simple specific questions, but they do not provide answers to problems, particularly of the kind with which law and government deal.[47]
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> The dialectic method of law is essentially clinical in the sense that it is best adapted to investigation and determination of the "facts" of individual cases and it is not well adapted to the investigation of mass or social problems. Legal procedures tend to break down under the influx of large numbers of cases. . .and simply have no means of coping with large populations or broad social investigations.[48]
>
> What science has to offer law in this generation, and probably in several succeeding ones, is knowledge of how to gather, analyze, and test data. . .[49]

Loevinger offers as a summary statement:

> The difference in the legal and scientific modes of securing data is, as has often been observed, at least partially a

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clarification, model construction of factor-variable interrelationships, and alternative invention, are involved. It is not surprising, therefore, that similar approaches have been suggested as means by which both science and scientists can effectively relate to the social-political process. See, e.g., Robert S. Morison, "Science and Social Attitudes," Science, July 11, 1969, pp. 150 and 165; Don K. Price, "Purists and Politicians," Science, January 3, 1969, pp. 25 and 31; and Gordon F. White, "Broader Bases for Choice: The Next Key Move," in H. Jarreted, Perspectives on Conservation: Essays on America's Natural Resources (1958), pp. 206, 216-225.

[47] Lee Loevinger, "Law and Science as Rival Systems," 19 U. of Fla. L.R. 530, 541-542 (1967).

[48] Ibid.

[49] Ibid., p. 544.

> function of the different tasks performed by law and science. While science seeks to analyze and predict phenomena, law seeks to classify and control conduct. In the most simple and elementary terms it may be said that the function of science is descriptive and law is prescriptive. The essential legal function of prescribing norms is not and cannot be scientific in any sense which the contemporary scientific community would recognize as scientific.[50]

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[50] Ibid., p. 535. A professor of rhetoric puts the matter simply: "The difference is that science is a partial universe of discourse, which is concerned only with facts and the relationships among them. Rhetoric is concerned with a wider realm, since it must include both the scientific occurrence and the axiological ordering of these facts. For the rhetorician the tendency of the statement is the primary thing, because it indicates his position or point of view in his universe of discourse. Rhetorical presentation always carries perspective. The scientific inquirer, on the other hand, is merely noting things as they exist in empirical conjunction. He is not passing judgment on them because his presentment, as long as it remains scientific, is not supposed to be anything more than classificatory." Weaver, supra, n. 20, p. 85.

Distinctions between "law" and "science" become somewhat less clear when one shifts from the physical sciences to the behavioral sciences. Consider the following extract from Gordon & Temerlin, "Forensic Psychology: The Judge and the Jury," 52 Judicature, No. 8, March 1969, p. 333:

> "Psychology and the Law often stand juxtaposed. The Law is basically rational and deductive; Psychology is basically experimental and inductive. The Law assumes a volunteeristic source of man's actions and couches its concepts in such absolute terms as guilty or innocent, defendant or plaintiff, sane or insane. Psychology assumes a deterministic basis for man's actions and shrouds its concepts in relativistic and probabilistic terms. The Law, for the most part, seeks answers in legal theory and precedent; Psychology seeks to solve its problems by future research. Yet, one overriding commonality emerges. Both Psychology and the Law are concerned with human behavior: one to study it and aid in its actualization, the other to codify rules for the protection of men and to guide men's behavior toward one another."

For an interesting comparative professional analysis see June L. Tapp, "Psychology and the Law: The Dilemma," American Bar Foundation, 1969, No. 2, Reprinted from Psychology Today, February 1969.

V. Sources of Factual Uncertainty: The Effects Phase

Both the concept of technology assessment and the practices associated with it afford an unusual opportunity to examine the constant interplay between efforts to abstract or differentiate science and scientific method from the other data organization and decisional procedures on the one hand, and on the other to integrate science and scientific method into broader community decisional processes. Such considerations as the allocation of decision-making competence among professional groups, the meaning of a scientific-technical question, and the limits of scientific method as a mode of inquiry suggest differentiation. What is the relevance of these notions to the technology assessment function, particularly to the effects phase?

In a recent article entitled "Educating for the Scientific Age," Dean Don K. Price states that if scientists would communicate to the layman what they really think about the political significance of science

> . . .they would lead him to see that the driving force of great science is not the accumulation of random facts in the hope of making material profit, but the search of a disciplined mind for the underlying principles by which man can understand some aspect of the universe. They would make it plain to him that the general problems with which he --the citizen--is most concerned are not going to be solved by any one of these several approaches to knowledge. Indeed, the more important the question is to the citizen, the less likely it is that any one science can solve it, the more necessary it is that many sciences be brought to bear on its solution, and the more immediate action on it must be guided by a type of responsible judgment that cannot be determined by scientific procedures.[51]

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[51] Don K. Price, "Educating for the Scientific Age," Bulletin of the Atomic Scientists, October 1968, pp. 26-31.

This statement suggests the need for the blending of various sources of information and thought patterns in the analysis of major socio-political issues involving a scientific or technological component. Dean Price goes on to say, however:

> (P)ower is not simply decided upon equally among the sovereign people. Subject to ultimate checks, it is distributed on the basis of various types of competence.[52]

And further:

> You cannot settle its (science's) big problems by majority vote. Nor can you settle them either by compromise in a committee, or by the exercise of executive power.[53]

Similarly, the Report on Technical Information for Congress states:

> Scientists do not decide a scientific question by voting on it; they decide by reaching a consensus.[54]

These quotes convey explicitly enough the thought that there are certain types of issues or questions which must be decided by certain types of competence. Equivalences, or even rough correspondence, between methodologies are apparently rejected. Or more narrowly, it is asserted that certain problems, scientific or technical, can be determined only by the application of scientific method. Application of the adversarial system simply will not do.

If so, however, it is essential that a "scientific question" or "technical issue" be given a workable definition. Is such a question or issue one that only qualified scientists, engineers, pharmacologists, etc., can answer? If so, why? If a scientific or technical question is one that

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[52] Ibid. [53] Ibid.

[54] Technical Information for Congress (1969), p. 480.

can be answered only by "scientific information," then we are told by the Report on Technical Information for Congress that "Scientific testimony tends to be factual, descriptive, quantitative, and circumstantial,"[55] as contrasted with "political testimony" which "tends to be value-oriented and group-preference-oriented."[56] Hence, is a "scientific-technical" question one which pertains exclusively to specified scientific subjects (the natural sciences and physical sciences), requires no consideration of values in its outcome, and can be determined by the recognized operations of the scientific method? Was the termination by the Department of Agriculture on July 4, 1969, of permission for radiation treatment to preserve bacon, following a finding by the FDA that more data would be necessary on possible health hazards, such a question?[57] Did the panels of the National Academy of Sciences studying the "efficacy" of various drugs deal with a clear scientific question? The Report on Drug Efficacy states that while the panels were not specifically requested to reevaluate the "safety" of the drugs, that "in the assessment of efficacy, safety cannot be ignored."[58]

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[55] Ibid., p. 475.

[56] Ibid.

[57] U.S. Department of Agriculture Notice 2052-69, July 2, 1969.

[58] NAS Drug Efficacy Study, July 1969. The Report states at p. 9:

"However, in the assessment of efficacy, safety cannot be ignored. Every therapeutic or prophylactic judgment of a drug involves a balancing of benefit and risk. Whenever the risk factor seemed to prejudice the use of the drug for a given indication or when inadequate emphasis on risk is made in the labeling, the panels have drawn attention to these situations and have indicated the extent to which they have influenced their ratings."

But does not the determination of "safety" transcend a purely scientific-technical issue?[59]

What if the definition of a scientific or technical issue were made more inclusive by omitting the limitation of natural or physical science subject matter but restricting such questions to those which are assumed to be value free and for which the outcome can be determined (or conditions permitting, should be determined) by the operations of scientific method? This broadened concept of a scientific-technical issue could be construed to encompass the entire effects identification phase of the technology assessment process. This task is to identify all effects of a technological application, i.e., the effects of existing applications and the prediction of effects of prospective applications. But the important point is that the performance of this total effects analysis would not be limited to

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[59] For an example of a frequent type of criticism, particularly the lack of relevant representation, see Green, A New Technological Era: A View from the Law, (Program of Policy Studies Monograph No. 1, 1968) wherein the author, in discussing the National Council on Radiation Protection and Measurements (NCRP), states:

> "It is apparent that the NCRP, in adopting radiation protection standards which are arrived at through the balancing of social values, and which are more or less automatically incorporated into government regulations and used as standards by the courts for determining whether a plaintiff's exposure to radiation caused harm, is performing a legislative function. As such it is an unrepresentative body, since it consists only of scientists and engineers, without representation from other disciplines (e.g., law, psychiatry, theology, economics, etc.) and other societal interests. There is, moreover, the further problem that the NCRP has no political accountability of the kind that should be incident to law-making bodies." (p. 7)

That the evaluation of food additives and drugs can move into ramifications far beyond the "efficacy" and "safety" aspects, consider the controversy over the Cyclamate Ban and the marketing of combination antibiotics. See "Ban on Cyclamates Is Ridiculed," Wash. Post, Nov. 1, 1969, F1, col. 5; William Hines, "Was Cyclamate Ban Really Necessary?" Wash. Evening Star, Nov. 2, 1969; and "U.S. Orders Recall of Antibiotics," Wash. Post, Dec. 6, 1969, A2, col. 3.

scientists or engineers. It would involve the application of scientific method by all those disciplines and professions required to cover the full spectrum of social impacts.

Even should the definition of a scientific-technical issue be limited to that which pertains to the natural and physical sciences, is value free, and for which the outcome can be determined by scientific method, have we then isolated a segment of the area of inquiry which is clearly restricted to scientists and engineers as a professional group? The answer seems to be--not necessarily. Relevant to this point is the following extract from the Report on Technical Information for Congress:

> Scientists sometimes disagree as to the facts; when this happens, the matter is resolved by the accumulation of more facts to confirm or refute--to make the weight of the evidence adequately conclusive in one direction or another. Scientists frequently disagree as to the correct interpretation of the facts; when this happens, the matter is resolved by further review of the rigorousness with which the data were collected, the examination of the data by additional scientists, and perhaps the accumulation of more data or a finer sensitivity and precision of observation of data.[60]

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[60] Technical Information for Congress (1969), p. 475.
Consider the seemingly endless dispute as to the effects of fluoridation. Frederick J. Stare, Daniel Bernstein, Constantine Hampers, and James Dunning, in "Fluoridation and 'New Facts'," Saturday Review, May 3, 1969, p. 57, state:

> "If water fluoridated at a concentration of 1ppm can, by moving through an artificial kidney, cripples the body it enters within a year, it is time to discover whether water fluoridated at a concentration of 1ppm can reasonably be expected to cripple the bodies of severe kidney disease victims who drink the water daily for ten to twenty or more years.
>
> "This quotation is from John Lear's latest attempt (SR, March 1) to raise what he considers the agonizing specter of fluoridation. The first word in the quote, 'If,' is a very significant if. Many physicians and scientists, eminently qualified and respected by their peers, have been working for more than twenty years to find out if fluoridated water, either natural or controlled, is harmful in any way to any individual, any age, either sex, in any state of health or illness. The answer continues to be a clear, emphatic

Surely, this is the approach to take. It is fully consistent with the scientific method. But what if the further accumulation of evidence leads only to inconclusiveness--at least up to the time when determination one way or the other must be made? The Report states with respect to Project Mohole:

> Finally, with evidence of disagreement among scientists as to the feasibility of the project and as to the scientific merit of the expressed objective, the Congress terminated its funding and the project was dropped.[61]

'No.' It is not harmful. It is even possible that fluoride at 1ppm in dialysis for uremic patients may be beneficial to their bones, rather than detrimental, as alleged by Mr. Lear. It is true that there are still a few scientists and physicians who question the safety and even the efficacy of fluoridation, but, generally, they are scientists whose reasoning is suspect or who are unqualified to judge the issue because they are unaware of the facts. (Incidentally, there are still a few scientists and physicians opposed to the pasteurization of milk, to immunization against poliomyelitis, and to almost any generally accepted health procedure, including vaccination against smallpox.)"

Harvey M. Sapolsky in "Science, Voters, and the Fluoridation Controversy," Science, Vol. CLXII, Oct. 25, 1968, p. 427, hypothesizes that the dispute over fluoridation among scientific experts, with technical arguments offered by both sides, is the major reason for overwhelming public rejection of fluoridation in referenda. He argues that this rejection is not due to middle and lower class alienation from science and technology but to confusion and fear generated by the debate. Most people start with an uninformed but favorable attitude toward fluoridation. After hearing all the arguments pro and con, the public, unqualified to judge which experts are right, decides not to take the risk and votes against fluoridation, knowing it can wait while other communities experiment further.

Another area of disagreement among scientific experts on a "technical" issue is whether or not the estrogen hormones in birth control pills can cause cancer. An article entitled "Pill's Link to Cancer is Disputed," Wash. Post, Jan. 16, 1970, p. 1, col. 3, begins, "Two eminent medical scientists yesterday argued before a Senate subcommittee whether birth control pills cause cancer." The article indicates that evidence on both sides is inconclusive and both proponents and opponents may have been prejudiced by their prior good or bad results, or by complete lack of experience, with the pill.

61 Technical Information for Congress (1969), p. 490.

If some scientific-technical issues cannot be resolved conclusively by scientific method with respect to existing technological applications, it is evident that a far greater potential for differences of opinion may exist as to the impact of prospective applications. To quote from the Report again with respect to the Test Ban Treaty:

Technical Differences of Opinion

> A recurring problem is the situation in which witnesses with outstanding technical qualifications take opposite sides on a technical issue. Members of Congress experience an understandable sense of frustration when they find themselves obliged, as in the Test Ban Treaty case, to decide on a complex technical matter that ranged outstanding scientists against each other. The problem in that case was that the two sets of scientists favored two conflicting hypotheses. Those opposed to the treaty supported the hypothesis that further scientific investigation would reveal phenomena that would enable development of a workable defense against ballistic missiles. Those favoring the treaty supported the hypothesis that the technical problem of overcoming a defensive technology was inherently much simpler and less costly than designing a defense--and that therefore the offense would always keep well ahead of the defense. While there may be many non-scientific reasons for a bias in a technical witness, there are many occasions on which the witnesses disagree over unproved--and sometimes unprovable--scientific judgment. In such cases, the disagreement itself is illuminating. (Italics added.)[62]

Donald A. Strickland summarized the problem in discussing the failure of the 1958 Geneva Conference of Experts to agree on the scientific requirements for test-ban detection:

> The distinction between "political" and "technical" matters is virtually meaningless when it comes to analyzing a conference such as this. Politics has no fixed subject-matter; it changes from week to week, embracing genetics, markets, and weaponry one week, public education, budgets, and boundaries the next, and so on. The crucial distinction

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[62] Ibid., p. 509.

> ought to be between controverted and noncontroverted matters. Matters controverted only within the scientific community remain scientific disputes, unless they exceed the professional subject-matter and affect the organization of science or alter the relations of science and other institutions: then we speak of the "politics of science." Ordinarily, however, politics is the process of working through those controversies which are the business of the whole community taken as a natural aggregate, without regard to the division of labor within the community or the exclusiveness of particular institutions or the esoteric reputations of individual members. Hence political matters, which may or may not have a large scientific component, are a) controverted b) throughout (i.e., within the interested circles of the leadership and citizenry of) the whole community.
>
> By this view, there could be no such thing as a non-political conference on technical questions where the relevant technical applications are to international affairs and are widely controverted in advance of the conference, unless the conferees are completely indifferent to the on-going controversy.[63]

This problem has led to various proposals for the creation of institutions which are less interested in on-going controversies in order to give a more "scientific judgment" on the disputed questions. It is in this context that the proposal by Arthur Kantrowitz for an Institution of Scientific Judgment might be considered.[64] Since we usually associate scientific method with increased predictive ability, it may come as a surprise to read Kantrowitz' statement that: "Of all the frightening aspects of technology, the most frightening is its unpredictability."[65] He sees as one of our most pressing needs "a mechanism for the democratic control of a rapidly advancing technology,"[66] pointing out that many public or "mixed" decisions involve

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[63] Donald A. Strickland, "Scientists as Negotiators: The 1958 Geneva Conference of Experts," 8 Midwest Journal of Political Science 372, 380 (1964).

[64] See Arthur Kantrowitz, "Proposal for an Institution for Scientific Judgment," Science, May 12, 1967, pp. 763-764; and Arthur Kantrowitz, "The Test," Technology Review, May, 1969, p. 45. Citations are to the latter article.

[65] Ibid. [66] Ibid., p. 46.

scientific components "so new that no unanimity has been achieved in the scientific community."[67] Historical examples of such "mixed decisions" include:

> The World War II decision to build an atom bomb; the German decision (a blunder, I think) to build ballistic missiles during World War II; the U.S. decision not to use our ballistic missile capabilities to launch a satellite until after the Russians had beat us to it; the current decision to direct our primary space effort toward beating the Russians to the Moon.[68]

He states that "these decisions all involved technologies new enough so that debatable extrapolation of hard scientific fact was required,"[69] and that many such decisions "must be made before unanimity exists in the scientific community."[70] In view of this situation he proposes an Institution for Scientific Judgment which would:

1) Separate the scientific from the political and moral components of a mixed decision.

2) Separate the judge from the advocate.

3) Provide for publication of the scientific judgment.

The similarity of this decisional model to the traditional formal adjudicatory model of the adversarial system is striking. He states the rising importance of the scientific judicial function as follows:

> "Scientists are traditionally advocates, and in small-scale science judicial functions have never had an importance comparable with that of advocacy. An experiment can always overturn anyone's judgment on a scientific question. However, the judicial function becomes important in large-scale science and technology when we must anticipate the results of experiments which cannot be performed without the expenditure of great amounts of money or time."[71]

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[67] Ibid. [68] Ibid., p. 47. [69] Ibid. [70] Ibid. [71] Ibid., p. 48.

Significantly, Kantrowitz asserts that the need for such an Institute stems not only from the lack of unanimity on the feasibility of new technologies and associated technical questions but, in addition, the "need for an alternative source of scientific judgment which shall forego taking any moral or political stands and seek to achieve the greatest possible objectivity."[72] Kantrowitz maintains that "it is not possible for scientists to have deeply held moral and political views about a question and simultaneously maintain complete objectivity concerning the scientific components,"[73] a situation which he seems to feel is prevalent today.[74]

Some troublesome thoughts arise, however, from the Kantrowitz proposal. If such a high degree of potential exists for disagreement among

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[72] Ibid. [73] Ibid.

[74] There would seem to be a growing tendency to recognize that "scientific detachment" is a luxury of the past and that scientists and their activities are inevitably and properly "involved" with the whole of the social process. See the following note from the Princeton Alumni Weekly of October 21, 1969, p. 11:

"THE LIMITS OF TRUTH

'Biological problems have attracted the attention not only of scientists and philosophers but also of leading religious thinkers and scholars. Dr. Paul Ramsey, Professor of Religion and the author of a number of distinguished books on the moral and ethical questions of our time has taken the ethical questions raised by bioscience and medical advances as the subject of his most recent work. Tentatively entitled, Covenants Among Men: Explorations in Medical Ethics, the book treats such contemporary problems as organ transplants, genetic control, and abortion. Dr. Ramsey agrees that many scientists now feel there may be moral limits to obtaining certain truths. 'Scientists once may have had naive notions about how increasing knowledge inevitably leads to progress, but in that case they only shared the optimism of all mankind. The attitude often typed as "moral neutrality" really rests on this optimistic view of progress. Rather than being uncommitted, these people are deeply committed--to the notion that progress can solve all the problems it causes. In this they are more guilty of working under a false premise than of

scientists and engineers on purely scientific-technical issues so that an adversarial system providing for an essentially binding outcome is considered necessary, then what of the potential areas of uncertainty which will exist with respect to the social, economic, or political feasibility of a proposed technological application or of the vast range of strictly non-scientific, non-technical implications of such an application? For example, if the Institution for Scientific Judgment were employed in support of the analysis of the proposal to increase the size and weight of motor freight carriers, it would decide, perhaps, the increased wear and tear on the highways and the extent of additional highway maintenance which would be required, or possibly the additional increase, if any, in air pollution and environmental noise.[75] But to what extent would it have any relevance to the identification of the following types of effects?

- The distribution of benefits in terms of such factors as lower shipping costs, greater diversity of services, and production and distribution options;

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abdicating moral responsibility.'

"He adds that a scientist is responsible for directing public concern and warning the public about the consequences of research. 'Chemical and biological weapons are a very difficult moral problem,' he says, 'largely because of the question of deterrence. Biological weapons are wrong if their justification is in use. But you have to consider the possibility of their being necessary as a deterrent." Dr. Ramsey feels that the biological scientist belongs in the thick of moral questions and ethical problems, because, as he puts it, 'Science floats upon a sea of ethics. It requires of the scientist the moral qualities of courage, honesty, and openness to criticism. So in a period of time when everything, including those virtues, is being called into question, the scientist, as he is a man and a citizen as well as a scientist, is deeply involved.'"

[75] See discussion of Highway/Motor Freight Carrier technology assessment by Mayo, "The Management of Technology Assessment," in Technology Assessment - The Proceedings of a Seminar Series. Program of Policy Studies publication, Kasper, ed., July 1969.

- Living patterns and population distribution;
- Employment opportunities or employment displacement;
- New business opportunities;
- Harm to existing economic interests;
- Encouragement ot technological innovation, as for example, containerization methods of transport;
- Traffic congestion;
- Traffic accident frequency;
- National defense capabilities;
- Comfort, convenience, and enjoyment by the private, auto user-traveler;
- Effect on other modes of freight transportation.

Clearly the prediction of any of the above effects which might flow from an appreciable increase in motor freight carrier size and weight transcends the definition of a scientific-technical issue as one that is limited to the natural or physical sciences. On the other hand, the objective is to deal with such effects in terms of what will happen rather than what should happen, that is, in measurable predictions insofar as feasible. Therefore, the recognized operations of scientific method will clearly be applicable. But this method will be tailored to the special requirements of various professional groups who will be involved in this prediction of effects, not solely to scientists and engineers. In sum, it would appear that the function of the Institute as proposed by Kantrowitz would be of severely limited utility in the total assessment process, or even with respect to the effects phase only.

To the extent that the concept of a scientific or technical question is useful it can probably best be considered as an issue involving the

subject matter of the natural or physical sciences, value free, with the outcome susceptible of determination by scientific method. This definition tends, therefore, to equate scientific-technical issue with the competence of the scientific and engineering professions. The requirements of technology assessment far exceed the scope of scientific-technical issue as thus defined, however, even in connection with the effects phase. This phase of assessment involves the entire social process. We are concerned not merely with the feasibility of an application to perform a given task but with the effects of such application on participants, values and institutions of society. While the recognized operations of scientific method would be the appropriate means of making such identifications, at least to the limits of their utility in particular instances, these operations would be applied by representatives of those disciplines and professions with specialized skills in all sectors of social impacts. A further element should be noted at this point, namely, that while the actual operation of the effects phase is concerned with the identification of effects, value considerations are necessarily introduced in deciding which effects have relevance for identification and subsequent measurement in the first place. In other words the indices by which effects are identified and measured as to probability, magnitude, intensity, and persistence, reflect social values. But while indices reflect social values, the outcomes of the procedure for identifying the effects of a given application are not (or should not be) value or preference statements but factual findings of existing effects, or predicted effects of prospective applications, independent of any value judgment made on such effects, i.e., whether socially desirable or undesirable.

To the extent that we are willing to accept the hypothesis of Jacob Bronowski that "the side effects of technical innovation are more influential than the direct effects, and that they spread out in a civilization to transform its behavior, its outlook, and its moral ethic"[76] (citing the Hollywood industrial-cultural complex as an outgrowth of the photographic film industry and a radically changed middle class moral code as the result of the mass-produced private automobile), then the scope of alternative social consequences opened up is indeed wide. In this exercise of predicting remote social consequences which might evolve from the confluence of one or more technologies with other social variables, the operations of scientific method assume greatly diminished status as techniques of inquiry. While in the present state of the art model construction of complex interacting social sub-systems and their application to computer simulation may provide many useful insights, a certain amount of random speculation may also be rewarding.[77]

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[76] Jacob Bronowski, "What We Can't Know," Saturday Review, July 5, 1969, pp. 44-45.

[77] Among other techniques which might be employed would be the Delphi Method. See Dalkey, "The Delphi Method: An Experimental Study of Group Opinion," RAND publication, June 1969.

VI. Goal Objective Conflicts: The Evaluative Phase

The effects phase, which more broadly involves the identification of effects of existing applications and the measurement of their magnitude, intensity and persistence, and/or the prediction of the effects of prospective applications, is generally amenable to the techniques of inquiry reflected in scientific method: observation, experiment, hypothesis, testing, model construction, prediction, and so forth. But even in the effects phase of the assessment process it has been shown that these techniques lead us just so far. For example, it has been noted that scientists and engineers sometimes differ on scientific-technical issues or draw different inferences from the same set of data or work with alternative hypotheses designed to analyze the same data and related issues. Further, diminishing reliance can be placed on scientific method as the analysis moves from the area of existing effects to prospective effects and from direct effects to indirect or "side-effects."

Hence, even in the effects phase of the assessment process we must push far beyond the limits of conclusive demonstration by scientific method. If these types of limitations are recognized on the applicability of scientific method in this phase, it is perfectly clear that scientific method has little if anything to offer in the selection or positing of value preferences and social goals, i.e., the social impact-evaluation phase of the technology assessment process. As the Report on Technical Information for Congress puts it:

> The formal limits of the scientific method are that it can describe relationships and outcomes of given conditions, but

> cannot make value judgments about these relationships and outcomes.[78]

The limitations on scientific method can be translated into terms of uncertainty as to facts or causal relationships and differences of perspectives as to socially desirable goals. That pervasive differences do exist as to the priority ordering of social values is too evident to require elaboration. One example will suffice. Lee C. White, the past Chairman of the Federal Power Commission has pointed out the need to "harmonize" the requirements for more electrical generating plants and transmission lines and natural gas pipelines to meet increasing energy demands with the rising concern for the nation's environmental quality.[79] He has noted that "increasing pressures are preventing things from being done in power,"[80] as for example, restrictions on fuel which can be used by electrical generating plants in some cities, communities which prohibit the construction of new plants, and conservationists who oppose new transmission lines and hydro-electric dams.[81] Indicating that we may be faced

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[78] Technical Information for Congress 12 (1969). De Jouvenel agrees, as cited by Philip C. Ritterbush, reviewing The Art of Conjecture by Bertrand de Jouvenel, in Bulletin of the Atomic Scientists, Nov., 1967, p. 34, and warns "against a mindless extension of forecasting practices from narrow technical problems where they may be applied, almost automatically, to more complex social and political realms where there must be a premium on wisdom and sophisticated insight. Only through profound insight into the political process and the transformation of ideas can we progress to sound estimates of social change on a large scale. Thus planning is not for technocrats but for humanists deeply respectful of the human condition and its social manifestations."

Cf. the discussion of the scientific study of consumer wants in Harold Demsetz, "The Technostructure, Forty-Six Years Later," a review of Galbraith, "The New Industrial State," 77 Yale L.J. 802, 809-810 (1968).

[79] See Wash. Post, May 18, 1969, E1, cols. 1 and 3.

[80] Ibid. [81] Ibid.

with an inadequate power supply, he states: "We have grown up in this country assuming there will be energy at the flick of a switch. I doubt that the public or the press will tolerate a situation where we do not have adequate generating or transmission capacity. I am certain that political office-holders will not."[82] But he also expresses sympathy with those concerned with environmental and aesthetic values saying: "My pitch is that we have to develop an apparatus where those things can be resolved."[83] He notes that important considerations in this connection are the long lead times required to build new facilities, the irreversibility of such decisions, and lack of public appreciation of these factors. Yet, he expresses the need to bring the public into the decision-making process.

If then, neither the resolution of conflicting values, nor the identification and measurement of total social effects of a technological application, nor even a consensus among responsible scientists on some strictly scientific-technical issues can be assured through the operations of scientific method, what are the alternative techniques available for arriving at the necessary outcomes?[84] It is, no doubt, disturbing to the

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[82] Ibid.

[83] Ibid.

[84] The Report on Managing the Environment of the Subcommittee on Science, Research, and Development of the House Committee on Science and Astronautics (1968) is literally crammed with instances, explicit or implicit, which go to the uncertainty of "scientific fact" and of probable future effects, as well as to the problem of the existing differences of opinion relative to environmental standards. See in particular:

"6. A New Approach to Hazard Evaluation (p. 22).

"7. The Intent of the Congress in Criteria and Standards (pp. 22-25)."

Michael D. Regan put it succinctly in "R & D: Suggestions for an Allocations Framework," 27 Pub. Adm. Rev. 104, 109 (1967):

> ". . .(N)othing but the vaguest predictions can be made as to the ultimate effect of halving or doubling the basic research budget in a given year. . .That is to say, there is no scientific method

scientist or engineer to suggest that a scientific-technical issue might be decided by "vote," using this term in the generic sense to include various modes of registering opinions and preferences. Certainly such an issue should be determined by scientific method. But as Kantrowitz states and many examples support, some such questions have not or cannot be determined by scientific operations in the time a decision requiring such information must be made. Then what? Kantrowitz suggests the adjudicatory procedure with advocates and judge, i.e., the formal adversarial system.

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for constructing a scientific budget."
See also Lee A. DuBridge, "Science Serves Society," 164 Science, June 1969, pp. 1137, 1139:

"Priorities in Science

This matter of what we call the priorities of various fields of pure or applied science is one of the most difficult and confusing questions which we face. What do we mean by priorities? And even when we decide on priorities, how do we interpret this in terms of private or government effort or budget allocations? To illustrate the difficulty, let me take a concrete case. What do we mean, let us say, when we talk about the relative priority of microbiology compared to high energy physics. (You may choose any two fields you wish.) Do we mean one field has greater importance? If so, importance to whom or to what purpose? Social importance? Importance to human life? To our economy? To the advance of our culture? To the cultivation of the human spirit? Or to satisfying the basic urge of human beings to know and to understand? Or to the welfare of scientists? If we confine attention to any one of these goals, we still face a dilemma. Do we mean immediate or long-range importance? Do we mean the specifically foreseeable importance of the results to be attained or to the long-range effects which might be anticipated or imagined? And how does one even foresee or predict the long- or short-range results and applications of basic investigations? We can all think of too many cases of totally unexpected results of research and their wholly unexpected and unforeseeable impact to have any confidence in anyone's prediction that one field of research will surely lead to beneficial results and another one will not."

Must we necessarily conclude then that the less the experience, and the less the empirical data relevant to the prediction of feasibility, operations, and effects of a prospective application, the greater the necessity of relying upon procedures other than scientific method for such predictions? If the relevant scientific data is less than conclusive, why not then rely upon the trained or conditioned intuition of the experts in the general field? If there is little or no experience, however, then no "experts" will exist.[85] While such situations will vary with respect to the data available, if a decision must be made before the necessary

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[85] The feasibility as well as the probable use and social consequences of the atomic bomb seem to have been the focus of intense controversy. See review of "Lawrence and Oppenheimer" (Nuel Pharr Davis, 1968) by Thomas O'Toole, Wash. Post, Sept. 29, 1968, Book World Section, p. 1, wherein the reviewer states:

> "By the time Lawrence won the Nobel Prize in 1939 for his invention of the cyclotron, Berkeley was the physics center of the United States. So it came as no surprise when Lawrence and Oppenheimer were tapped for the two toughest scientific wartime tasks, Lawrence to find a way to make enough fissionable uranium for a bomb, Oppenheimer to carry the uranium to atomic explosion. Neither one had an inkling of what lay ahead. 'The bomb will never be dropped on people,' said Lawrence, the more warlike of the two. 'As soon as we get it, we'll use it only to dictate terms of peace.'
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> "At first, Oppenheimer worried that he could not explode a bomb, then that Enrico Fermi was right in predicting the explosion would burn up the atmosphere. When he finally made it go off without igniting the sky there were men who felt that nobody but Oppenheimer could have done it. 'It was not that his decisions were always correct,' Los Alamos Director Norris Bradbury told Davis. 'But they always opened up a course of action where none had been apparent.'
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> "Lawrence had none of Oppenheimer's self-doubts about his own project, which is one reason why it failed in the end. The super-salesman had convinced Washington that the way to make fissile uranium was through electromagnetic separation, a pet idea of Lawrence's that turned out to be time-consuming, expensive and impractical. By the time Oppenheimer was ready to explode his bomb, the uranium for it was being made by gas-diffusion and not by Lawrence."

experience can be gained, then clearly, non-scientific procedures must be resorted to, and it would seem appropriate that such decisional authority should be shared by representatives of those community groups likely to be affected by the proposed application.

Scientific method persuades through disinterested demonstration.[86] As the capability of scientific method to produce such disinterested demonstration diminishes in a given assessment context, the role of advocacy for expressing participant claims and interests increases.[87] This shifting accommodation is exhibited in many forms and has been addressed or described in various ways.

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[86] "The scientific method is clearly a different and distinguishable approach to data gathering, although it is not nearly so clear as was once thought that there is any specific and unique technique that is entitled to be known as 'the scientific method.' Science is like law in that it is a mode of securing agreement among different individuals with respect to certain kinds of questions and problems. The strength of science derives from its objective and demonstrative, and therefore highly persuasive, techniques. The limitation of science is that it is not applicable to all kinds of questions and problems. Essentially, the scientific method is applicable only to questions of the kind commonly characterized as those involving issues of 'fact.'" Lee Loevinger, "Law and Science and Rival Systems," 19 Univ. of Fla. L.R., 530, 534 (1966-67).

[87] Roscoe Drummond identifies adversary process as growing out of uncertainty of knowledge and judgment of values (also "uncertain" in a scientific sense!), Wash. Post, Oct. 21, 1967, A13, col. 3. See also infra p. 98.

VII. The Process of Technology Assessment

The assumption underlying technology assessment as expressed herein (the identification and measurement of the effects and the evaluation of the social desirability or undesirability of such effects as related to particular technological applications) is that such effects will be determined by the most reliable scientific means available and that the social benefits and costs will be deliberately and systematically determined by evaluation of such effects against explicit social norms, representing insofar as practicable, consensus social values. The previous discussion has, however, already demonstrated that differences arise among qualified scientists and technicians with respect to the identification of the effects of given applications, particularly those which might flow from proposed applications. Serious difficulties also arise in tracing identifiable effects back to the primary cause, especially where there are multiple possible sources of the effect.[88] It is also obvious that there exists no single consensus scheme of social values, certainly not when general value categories are reduced to operational criteria reflecting basic values. Furthermore, basic values, such as national security on the one hand and freedom of expression on the other, come into conflict in many

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[88] Situations of this sort are infinite. With respect to one important social decision context see "Causality Assessment--Medical vs. Legal," Trial Magazine, June/July 1969, p. 59, concerning "the principles involved in medical-legal assessments of causal connection between an injury, illness, disability or death and factors of legal import (as being) crucial to many litigated cases in a host of legal areas, particularly workmen's compensation and tort actions."

decisional contexts, and the measure of the benefit of one against the detriment to the other is often difficult to determine. Consider as a further illustration computer technology, which may vastly increase the efficiency of records-keeping and the disbursing of social benefits but may concurrently present a potential for the invasion of personal privacy.

Thus far in this paper an attempt has been made to show that progression through a simplified effects phase/evaluation phase model of the assessment process inescapably produces situations of uncertainty as to facts, differences of opinion over effects which should be considered, and the social value to be given such effects. These conditions encourage resort to techniques of inquiry other than or in addition to scientific method, as for example, some variation of the adversarial system. In many actual assessment forums these conditions of uncertainty and disagreement are aggravated as when the prescribed process of assessment involves situations wherein factual components are hopelessly entangled with normative judgments. In this connection, consider the 1968 Congressional enactment of S. 611, an amendment to the Federal Aviation Act of 1958, entitled "Control and Abatement of Aircraft Noise and Sonic Boom."[89] This section directed the FAA to prescribe standards for the abatement of aircraft noise. That jet aircraft noise is an adverse effect flowing from the application of jet transport technology is a matter of public notice. Several special-purpose assessments have been made of jet aircraft noise in order to determine with some precision the degree and character of its adverse effects on special segments of the population under various

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[89]Public Law 90-411, 90th Cong., H.R. 3400, July 21, 1968, 82 Stat. 395.

conditions. Such adverse effects by definition create a social problem. The alleviation of this problem may be viewed as one of reducing engine noise, devising noise abating take-off and landing techniques, or of land use management. S. 611 is addressed to the abatement of noise at the source, i.e., the reduction of engine noise through engine design, the use of acoustical nacelles, etc. Hence, the process leading to a prescription by the FAA of maximum noise standards involved a technology assessment which included the technical question of the feasibility of reducing jet engine noise within what period of time by how many decibels. Clearly, however, the use of a new engine design to abate noise will have multiple implications and effects, particularly economic. Section 611 states in part:

Control and Abatement of
Aircraft Noise and Sonic Boom

> Sec. 611 (a) In order to afford present and future relief and protection to the public from unnecessary aircraft noise and sonic boom, the Administrator of the Federal Aviation Administration, after consultation with the Secretary of Transportation, shall prescribe and amend standards for the measurement of aircraft noise and sonic boom and shall prescribe and amend such rules and regulations as he may find necessary to provide for the control and abatement of aircraft noise and sonic boom, (including the application of such standards, rules and regulations in the issuance, amendment, modification, suspension, or revocation of any certificate authorized by this title).
> (b) In prescribing and amending standards, rules, and regulations under this section, the Administrator shall--
>
> (1) consider relevant available data relating to aircraft noise and sonic boom, including the results of research, development, testing, and evaluation activities conducted pursuant to this Act and the Department of Transportation Act;
> (2) consult with such Federal, State, and interstate agencies as he deems appropriate;
> (3) consider whether any proposed standard, rule, or regulation is consistent with the highest degree of safety in air commerce or air transportation in the public interest;

(4) consider whether any proposed standard, rule, or regulation is economically reasonable, technologically practicable, and appropriate for the particular type of aircraft, aircraft engine, appliance, or certificate to which it will apply; and
(5) consider the extent to which such standard, rule or regulation will contribute to carrying out the purposes of this section.

Attention is invited to the fact that this statutory authority not only defines with some degree of specificity those information sources which should be drawn upon in order to assure an adequate information base for the assessment but further prescribes the criteria by which the assessment is to be made in determining the standards which should be set in order to abate "unnecessary aircraft noise." Note that the assessment required here cannot rely entirely upon scientific-technological evidence. Even what would be "technologically practicable" is unlikely to be supported by a consensus among those informed on jet engine R&D, particularly with respect to what can be done within given periods of time.[90] But more troublesome questions arise with respect to the meaning of the non-technological criteria such as "unnecessary aircraft noise."[91] How does one

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[90] See NASA Release 69/21 of January 30, 1969, concerning contracts for the design, fabrication, and testing of experimental quiet jet engines.

[91] A suggestion of the difficulties that can arise with the use of a standard such as "unnecessary aircraft noise" is considered in Wollan, "Controlling the Potential Hazards of Government-sponsored Technology," 36 Geo. Wash. L.R. 1105, 1118, 1122 (1968) (Program of Policy Studies Reprint No. 2) wherein noise emission standards with reference to the SST might have been that which was "tolerable to the community," or that equivalent to "existing sub-sonic jets," or "Start with the kind of plane you need, then drive the numbers (noise level) as low as you can possibly get them." Ibid., p. 1124.

Hugh Folk in The Role of Technology Assessment in Public Policy, December 1969, p. 6, sharply criticizes the present standard-setting process as inherently unfair to the public, who suffer from its inadequacies:

". . .it is inevitable that experienced experts will usually be

establish what "the highest degree of safety in. . .air transportation in the public interest" means? What is "economically reasonable"? Surely much more goes into this assessment than scientific and engineering judgment. The degree of harmful noise, physical or psychological, to various segments of the population, the economic costs of abatement at various levels, and the transportation inconvenience which might be involved in the abatement program are the more obvious of a complex of factors (conditions, predictions, and norms) which must be taken into account. When such elements of uncertainty exist, sharp differences of opinion inevitably arise since some segments of society benefit and others suffer. Why should we reasonably expect that such matters be determined without resort to some form of adversarial system and the opportunity for affected participants to state their positions? The evolution of this standards-setting process has thus far disclosed sharp differences of opinion among those participants affected.[92]

> drawn from the interests involved in a problem. In many instances the experts will have created the problem. The ASEB [Aeronautics and Space Engineering Board of the National Academy of Engineering] appears to be incapable of entertaining an idea injurious to air transport. Just as automobile executives and engineers could not generate any interest in automotive safety, so these men cannot generate any interest in quiet. They perceive the problem in terms of 'tolerable noise,' as does the Federal Aviation Agency (which is well represented on the panel) which establishes standards slightly below that at which people complain vigorously, and thus keeps the public sullen but not mutinous."

[92]The conflict concerning aircraft noise abatement standards between the Air Transport Association representing the nation's airlines, and the Airport Operators Council International is discussed in the "FAA to Issue Rules on Muffling Noise of Airliners," N.Y. Times, July 27, 1969, p. 66, col 1. See also Release of the Airport Operators Council International, May 20,

Decision points abound through the full process of technology assessment.[93] In the initiating phase, for example, a mission-oriented agency will frequently have to select from among various potential technological projects those which will be recommended for authorization and budgetary support. The Office of Management and Budget has the recurring problem of deciding which proposals must be rejected, modified, or terminated as with the DOD Manned Orbiting Laboratory project. Relevant Congressional committees have the continuing task of deciding which of numerous proposed projects are timely or substantial enough for attention, and from among such projects those which necessitate a hearing. Even an essentially independent assessing mechanism has the decision of setting its agenda as to what technological applications should be analyzed.[94] Hence, decision

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1969, concerning a communication of this organization to the FAA relative to noise abatement standards.

Cf. the statement of Micheal D. Reagan, supra n. 84, at 107; regarding the related area of SST development:

> "Whether an SST is worth building at all is thus a question partly subject to quantitative analysis of costs and potential market and savings to airline customers through decreased travel time, but at least equally a matter of politics: who wants it how badly."

[93] See Chart A, Provisional Schematic of the Technology Assessment Function in Mayo, "The Management of Technology Assessment," Technology Assessment--The Proceedings of a Seminar Series (1969) (Program of Policy Studies publication), which suggests decision points in the assessment process.

[94] One example of the operation of the adversarial system in the initiation phase is the decision of the National Academy of Sciences not to undertake a "scientific study" of "hereditary aspects of our national human quality problems." In response to a resolution to have the Academy "determine the relative importance of environment and heredity as causes of social problems and as causes of racial differences in behavioral traits," the Academy voted not to undertake the study. Reasons given were that "none of the current methods can produce unambiguous results," that it was "not clear that major social decisions depend on such information," and,

points involving elements of uncertainty (alternative interpretations of the situation or issue presented, and differences of opinion as to what judgment to make or action to take) are inextricably part of the technology assessment function.

One type of assessment decision of paramount importance to appraisals of continuously developing technologies (such as Highway/Motor Freight Carrier applications) which are subjected to a sequence of assessments through time, is the scope of the social sub-system (social interactions and effects) which should be taken into account with a given assessment. Is it, for instance, sufficient to consider only the extent of physical wear and tear on the highway when the proposal is made to increase the maximum size and weight limits of motor freight carriers? In such cases one would need to know which factors have been adequately considered in past assessments and which are the more critical undetermined effects which should be examined in the current assessment. Our methods for making such decisions are ad hoc and unsystematic at best, even at the Congressional level. It is a slight exaggeration at most to state that we have neither the assessment systems nor the informational base to support rational

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according to NAS President Frederick Seitz, "that it is essentially impossible to do good research in this field as long as there are such great social inequities. And such research is also so easily misunderstood in these times." (NAS News Report, June/July 1969, p. 11.)

At the opposite or terminal end of the R&D process are such decisions as that made by the Army for disposal of "nerve gas," including the "safe transport" of such toxic substances across country to ocean dumping grounds. Public and Congressional concern brought about the formation of National Academy of Sciences Panel "to assess Army plans for disposing of obsolete chemical warfare agents." Clearly, there were many aspects of this question, even those seemingly technical or scientific, upon which uncertainty existed. See N.Y. Times, June 29, 1969, 12E, col. 1.

decisions in such assessment contexts at this time, as the treatment of Senate bill S. 3658 during the 90th Congress persuasively demonstrated. The lack of an adequate assessment data base encourages unnecessary contentiousness and controversy as demonstrated by the propaganda embroilment between the AAA and the trucking interests during the House consideration of this proposal.[95] In other words, areas of potential agreement were in all probability eliminated by an inadequate process of assessment.

The technology assessment function is a pervasive one. As previously noted, the variety of assessment sub-systems is vast, differing in objectives, authority, composition, capability, and processes of assessment. It should be evident that most assessment forums involved with technological applications of any appreciable social consequence will be faced with situations of uncertainty in various factual dimensions such as feasibility and effects and with differing attitudes toward the preferred ordering of social values. The opportunity to introduce (or even require) some variation of the adversarial system as an extension to, and as a complementary technique of inquiry to, scientific method for a complete assessment seems clear enough. While there may be certain types of questions which should be addressed through the operations of scientific method there are others which should be addressed through the processes of full public discussion or through some variation of the adversarial system in assessment forums representative of segments of the public in some manner affected

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[95] See Mayo, supra, n. 93. A serious lack of assessment information in connection with the Santa Barbara oil blowout seems to have precipitated intensely conflicting viewpoints concerning this type of technological hazard. See "Offshore Oil: Channel Blowout Points Up Information Gap," Science, May 2, 1969, p. 530.

by an application.[96] Between these polar positions are innumerable and varying situations wherein some combination of these two modes of assessment and other techniques of inquiry are invoked. Modified forms of the adversarial system which provide for the utilization of scientific method and other techniques more substantial than sheer rhetoric are frequently employed. After all, the ultimate objective is to obtain the fullest possible relevant factual information and the optimum clarification of the social values involved.

In sum, it seems crucial to recognize that technology assessment is a process of evaluation and that an appreciation of this process is indispensable if the appropriate roles of scientific method and of the adversary process in technology assessment are to be understood. It is suggested here that a viable, effective, reliable technology assessment process can frequently, if not always, apply the adversary process to advantage. This process of evaluation can be shown by an Assessment Schematic having the

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[96] While uncertainty as to facts is considered in this paper to be a condition producing, or likely to produce, conflict and hence the introduction of some variation of the adversarial system into technology assessment, this does not necessarily mean that in specific instances with respect to particular facts, the resolution of the dispute through adversarial procedures or by other means will contribute appreciably or at all to the adequacy of the assessment.

See Department of Commerce Release of September 24, 1969, p. 5, address by Assistant Secretary of Commerce for Science and Technology, Myron Tribus, in connection with the effects of uncertainty in decision making. "(F)requently, incomplete information about the facts is sufficient for making meaningful decisions."

Even use of the scientific method may be part of an adversary system broadly conceived, through the functioning of scientific pluralism, although this can not occur with large-scale projects. See Joseph D. Cooper, "More Problems of Instant Medicine," Saturday Review, June 3, 1968, pp. 56, 61; or the statement of Arthur Kantrowitz, supra, n. 71.

following components:

1) Identification of Participants

2) Perspectives of Participants

3) Resources of Participants

4) Influential Contextual Conditions and Trends

5) Applicable Assessment Forums

6) Strategies of Participants

7) Alternative Outcomes

8) Social Impacts of Alternative Outcomes

By analyzing the assessment of a given technological application in this manner, a confident grasp of the process can be achieved.[97]

In most significant technological applications a variety of participants will be involved. Such applications will have social benefits and social costs. It would seem a notorious fact that participants will almost invariably have different perspectives with respect to the application, that is, they will seek special objectives, have different expectations,

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[97] On this general approach to the analysis of legal-policy issues see Harold D. Lasswell, "Toward Continuing Appraisal of the Impact of Law on Society," 21 Rutgers L.R. 645 (1967).

The many-faceted debate over the merits of the ABM would seem to provide an excellent illustration of the relevance (and operations within each) of these basic categories (Participants, Perspectives, Resources, Conditions and Trends, Situations, Strategies, Outcomes, and Effects). Surely, few techniques of persuasion were overlooked by the contending participants in what, up to the final Congressional vote, should have been basically a technology assessment.

See "ABM Debate: Pressures Grow as the Issue Becomes Partisan," N.Y. Times, June 29, 1969, E2, col. 6. See also "ABM Debate: Both Sides are Going to the People," N.Y. Times, April 6, 1969, E2, col. 5.

The ABM controversy would provide excellent case study material for an inquiry into the assessment process, including limits on the adversarial system as a mode of information production and goal clarification and the nature of the claims/demands/pressures, relevant or irrelevant to the social merits of the ABM, brought to bear upon the critical assessment/decisional entity, the Senate. See N.Y. Times, July 20, 1969, E2, col. 6.

and varying alignments with other participants. Expectations, for example, will vary with the resources of the participant, influential trends or other conditioning factors, and the character of the assessment forum. Demands can be characterized in terms of the degree to which they are inclusive (embracing a large scope of identifications with the demands of the other participants), or according to the degree to which they are exclusive (narrowly partisan). The popular image probably associates the demands of the supposedly non-partisan scholar as representing the most inclusive of interests in that his efforts are directed toward discovering "truth" for the benefit of all mankind, whereas lawyer-client partisanship is considered to be the most exclusive since the paramount goal is to gain an outcome favorable to the client.[98] Resources may be based on power such as formal authority, or on prestige and reputation, or on economic resources, or on the degree of enlightenment that can be brought to bear upon the assessment,[99] or in terms of skill in the presentation of claims, or in

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[98] See Frampton, "Scientific Eclat and Technological Change: Some Implications for Legal Education," 63 Mich. L.R. 1423, 1426 (1965):

> "(T)individual client receives from the lawyer-advocate a capability for disinterested analysis and skillful articulation focused so as to illuminate in the particular conflict every facet of the client's asserted but challenged interests that supports a common interest. If that client's interests prevail on balance, society is ultimately served and the client is incidentally satisfied."

[99] Consider the following statement by Daniel Bell in "The Balance of Knowledge and Power," Technology Review, June 1969, p. 39:

> "The crucial point about knowledge today is that it is a strategic resource; and, as with all resources, the question becomes, Who will control it, who will make the necessary decisions about allocations?"

See also the statement of Lynton Caldwell in "Managing the Scientific Super-Culture: The Task of Educational Preparation," 27 Pub. Adm. Rev. 128 (1967):

> "The challenge to this generation is a consequence of the unprecedented explosion of knowledge and of the means of its transmission. . . Knowledge was always power, but it was not always the central and controlling force in society. Today it is."

terms of the congruence of the participant's position with that of a broad community consensus on proper standards of rectitude. The participant will devise alternative strategies and select the one which seems best to apply his resources to the desired outcome in the particular forum. Forums will differ as to objectives, authority, composition, capability, and assessment procedures.

Perspectives of participants are critical. The disinterested scientist may have as his objective a deliberate, unbiased total impact assessment of a given application. Yet he may still insist that a given methodology is the appropriate one for the particular assessment and differ with his colleagues on what the most productive and reliable sources of information might be, including the qualifications and potential contributions of prospective participants. Dr. James B. Conant in his book Modern Science and Modern Man was not this charitable. He states:

> The notion that a scientist is a cool, impartial, detached individual is, of course, absurd. The vehemence of conviction, the pride of authorship burn as fiercely among scientists as among any creative workers. Indeed, if they did not, there would be no advance in science. But this emotional attachment to one's point of view is particularly insidious in science because it is so easy for the proponent of a project to clothe his convictions in technical language.[100]

On the other hand, it is conceivable that the most ardent advocate will be more interested in a given instance in maintaining the continuity and effective working procedures of the assessment entity than he will be in pressing to the extreme for an outcome which maximizes his demands. This

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[100] Conant, Modern Science and Modern Man (1952), p. 114.

will, of course, depend upon his perception of both the partisan stake and the public stake in an outcome other than the one most immediately favorable to him or his "client."

Nor can the perspective of the assessing entity itself be overlooked. Considerable bias may be shown toward some techniques of inquiry rather than others. This will, of course, differ with the assessing entity or the forum situation. Some assessment entities may wish to rely on supposedly disinterested studies, outside experts, and the experience of the assessing entity members. Others will be more disposed, for reasons of institutionalized procedures or because of a strong belief that enlightenment results from the conflict of contending views, to favor a vigorous adversary proceeding. But on occasion it may be difficult to obtain adverse witnesses.[101] Where the assessing entity has considerable discretion in its choice of information sources it may simply ask: what information from what sources should be sought over and above the informational resources of the entity itself?[102] The assessing entity will or-

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[101] See, for example, Luther J. Carter, "Planetary Exploration: How to Get by the Budget Cutters?", 158 Science 1025, 1027-8 (1967), on the difficulty Congressional committees experience in finding non-NASA scientific witnesses relating to NASA's budget requests.

[102] See Technical Information for Congress (1969), p. 518:

"MODES OF INFORMATION GATHERING

An unlimited number of different kinds of situations, processes, and devices can be conceived of as useful for congressional information gathering. It is likely that the quality of information received is influenced by the situation, and that different witnesses respond best to different situations. Two hypotheses are suggested by observations drawn from the present case

narily have knowledge of and accept consensus views on many aspects of the assessment process by the equivalent of judicial or official notice.[103]

A significant example of a contemporary application with high-level social implications is that of electric power generation by nuclear energy. It is anticipated that over the next twenty years approximately 250 new power installations will have to be built across the nation in order to provide for expanding energy demands.[104] Energy requirements approximately double every decade. About one-third of the new plants will be fossil-fueled, the remainder nuclear-fueled. This total investment has been estimated at $80 billion. The social impacts, including environmental dangers which might arise with the operation of such plants, have

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study. One is that adversary proceedings tend to be more illuminating and produce more information than do consensus presentations. Another possibly useful hypothesis is that the more different modes of information gathering that are used, the more complete and satisfactory will be the information secured. Unfortunately, none of the cases (with the possible exception of the Salk vaccine and panel discussion) illustrates a deliberate attempt to structure an adversary proceeding. A valuable inadvertent instance, however, occurred in the drug testimony reported in the thalidomide case. The concluding case, concerning criteria for water resources projects, illustrates best the hypothesis as to the benefits of a variety of modes of information gathering."

[103] This creates certain risks. As Kenneth J. Gergen put it in "Lost in the Shuffle: A Political Case History," 158 Science 896 (1967), reviewing Rainwater and Yancey, "The Moynihan Report and the Politics of Controversy":

". . . (M)akers of public policy may be prone to distort, deny, defend against, selectively perceive, and misinterpret both scientifically established fact and theory in order to maintain vested interests. If science stands in the way of programs or positions to which one is emotionally and socially committed, science is likely to be the loser. The negligible impact that the findings linking cigarette smoking to cancer have had on cigarette sales in the United States demonstrates that such recalcitrance is not limited to the policy-making domain."

[104] See generally the Wash. Post, Jan. 5, 1969, A7, Col. 1.

been given much careful attention by the Atomic Energy Commission and other assessment entities, including a recent study by the Office of Science and Technology in cooperation with other Government agencies. Nevertheless, proposals to construct new nuclear power plants continue to create sharp controversy.[105] While we have substantial consensus knowledge of the performance characteristics and relationship between nuclear power plants and their environmental impacts, and the Atomic Energy Commission has investigated radiation hazards and adopted presumably adequate radiation safety standards, areas of uncertainty as to long-term impacts remain and provide a basis for serious disagreements. Hearings conducted by the Atomic Energy Commission on applications for construction permits for such plants offer excellent illustrations of the differing perspectives of the various participants involved.

A recent public hearing by an Atomic Energy Commission Safety and Licensing Board on the application for a construction permit to the Baltimore Gas and Electric Company to install a $387 million nuclear-powered plant

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105 See Editorial, Wash. Post, May 8, 1969, A18, col. 1.
Relevant to the complex of conflicting interests which may be involved in the nuclear power plant controversy, consider extracts from "Minnesota Fights AEC on A-Plant," Wash. Post, Oct. 11, 1969, A3, col. 1, wherein it is stated that:

> "The Nixon administration is facing a difficult new decision--whether to back the state of Minnesota and its Republican governor in setting far tougher anti-pollution rules for nuclear power plants than the Federal government requires. Minnesota, in trying to do so, is throwing a big scare into the U.S. Atomic Energy Commission and the entire power industry. . .Whether they compromise or not, this issue has aroused environmentalists--and foes of pollution, man's distortion of nature and what is considered 'the careless atom'--like almost no issue before it in this part of the country."

on the shores of the Chesapeake Bay in Calvert County, Maryland, provides a vivid illustration of the assessment process in operation and the interests represented. Several influential participants were involved: the Utility, the Atomic Energy Commission, other Government agencies (Weather Bureau, Army Coastal Engineering Research Center, the Geological Survey, the Coast and Geodetic Survey, and the Fish and Wildlife Service), the State of Maryland represented by the Public Service Commission and Board of Water Resources, a group of scientists from Johns Hopkins University and, of course, the press.[106] While all the participants addressed the same forum situation, the perspectives, resources, and strategies of each differed. Two controlling conditions, perhaps better characterized as trends, existed: the rapidly increasing need for sufficient electrical energy to supply two million additional consumers of the Utility and the growing sensitiveness of segments of the public to the quality of the social and natural environment. These two conditions roughly reflected the basic value conflict. In contested cases, evidence is presented by representatives of the applicant, the AEC regulatory staff, and by witnesses called by the intervenors.[107] Brief attention will be given to four of the participants in terms of the Assessment Process.

The Atomic Energy Commission has split and potentially divergent responsibilities with respect to nuclear power implementation, and hence multidimensional perspectives. In this connection Professor Harold P. Green

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[106] Wash. Post, April 19, 1969, A9, col. 1.

[107] See Harold P. Green, "Safety Determinations in Nuclear Power Licensing: A Critical View," 43 Notre Dame Lawyer 633, 642 (1968) (Reprint No. 1, Program of Policy Studies in Science and Technology, The George Washington University.)

states:

> (T)he regulatory program is administered by the very same agency that is responsible for, committed to, and under very great political pressures to speed development of nuclear power. Although the licensing and regulatory activities of the AEC are totally separated from the AEC's operational and promotional functions below the level of the Commission itself, the five-man Commission is responsible equally for both phases of the overall atomic energy program.[108]

And further:

> (H)earings usually take place only after the prestige of the ACRS (Advisory Committee on Reactor Safeguards) is in support of issuance of the permit and the AEC regulatory staff is committed to the position that safety standards have been met.[109]

> (T)he locus of regulation within the AEC creates some bias in favor of technological advance and getting more power reactors in operation faster.[110]

While some may disagree with Professor Green's analysis of the AEC's reactor licensing procedures, it is clear that the Commission does have a prime promotional interest in nuclear power applications.[111] This places the Commission in close association with the Utility. Hence, if either the ACRS or the AEC regulatory staff is not satisfied with the safety aspects of the application, "the applicant will in all likelihood withdraw its application."[112] Of course, the resources of the AEC are extraordinary when measured in the combined terms of formal authority, prestige, technical

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[108] Ibid., p. 649. [109] Ibid., p. 642. [110] Ibid., p. 651.

[111] In this connection see speech by James T. Ramey, Commissioner, U.S. Atomic Energy Commission, "AEC's Role in National Electric Power Policy," before Federal Bar Association, Washington, D. C., October 16, 1967. AEC Release of October 23, 1967, No. IN-827.

[112] See Green, supra, n. 107, p. 642.

expertise, and a constantly accumulating experience.

The Utility had as its objective the need to provide adequate services to its consumers as well as to improve the economic position of the Company. Its resources were substantial, including its position as a source of an indispensable public service, its financial standing, its initial investment in the project which included planning, research and development, and site excavation, and its experience in electric power generating activities. The generally recognized need for additional electric power was a condition clearly in its favor. This factcr took on additional significance in view of the close identification of the Utility and the AEC in furtherance of this same purpose. The strategy of the Utility was simply to translate its resources as noted into arguments in support of the construction while minimizing the alleged environmental dangers asserted by opponents. Professor Green describes the general context here presented as follows:

> Each reactor should be recognized as the immense potential risk it is. It should be recognized that whether or not "undue risk" to the health and safety of the public exists can never be a matter of all black or all white. Further, it should be recognized that the degree of risk that the public is called upon to assume is basically a function of the utility's economics. In many instances, the risk can be reduced by selection of a more remote site. In every instance, the risk can be reduced through incorporation of additional, though costly, engineering safeguards.[113]

This rationale leads to the plausible conclusion that the Utility was interested in making the minimum economic outlay compatible with the

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[113] Ibid., p. 655.

requirement of avoiding "undue risk."[114]

The State of Maryland found itself in an extremely uncomfortable position of attempting to reconcile a wide diversity of conflicting demands. Not only did the Maryland-based Utility insist on the plant, but its construction was vigorously urged by many Calvert County economic development groups who envisaged an additional $2.5 million annually in tax revenues.[115] On the other hand, three State departments--Health, Water Resources, and Chesapeake Bay Affairs--urged further research on potential effects on the Bay before approval of the construction permit.[116] In order to extricate himself from this knotty situation, Governor Mandel appointed a 17-member commission to study the potential air and water pollution that might result from nuclear-fueled plants.[117] While it was suggested that the study panel's report could result in the State's refusing an operating permit to the Utility, a newspaper report stated:

> The Panel chosen. . .consists mainly of businessmen, industrialists, academicians and state officials. It includes no one associated with any private conservation group. Eaton (the Chairman of the Governor's Science

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[114] See continuing half-page ads in the Wash. Post and Wash. Evening Star during summer and fall of 1969 by the Baltimore Gas and Electric Company, extolling the virtues of Calvert Cliffs and nuclear power. One ad appeared in the Wash. Star on October 7, 1969, D8. A news story in the Wash. Post, October 16, 1969, B7, col. 2, quotes a vice-president of the Baltimore Gas and Electric Company to the effect that the Company had spent $151,000 through September 30, 1969, to offset criticism and to attempt to allay public fears about Calvert Cliffs nuclear plant.

[115] See Wash. Evening Star, May 13, 1969, B1, col. 3.

[116] Ibid.

[117] Wash. Evening Star, July 10, 1969, B2, col. 2.

> Resources Advisory Board) said that conservationists had been excluded because he felt "they would prejudge this matter."[118]

In the meantime Baltimore Gas and Electric was granted a provisional construction permit by the AEC for the proposed plant.[119]

But differing perspectives in the Calvert Cliffs hearing were not limited to the foregoing participants. The first paragraph of a Washington Evening Star story on the hearings reads:

> Scientific experts are bombarding an Atomic Energy Commission panel with conflicting testimony on potential hazards of a proposed nuclear power plant on the Chesapeake Bay.[120]

The scientific witnesses called by the Baltimore Gas and Electric Company testified that the operation of the plant would pose "no undue risk to the health and safety of the public."[121] But a report prepared by seven scientists at Johns Hopkins University for the Chesapeake Bay Protection Association found that the plant would be a "health and environmental hazard to this and succeeding generations."[122] While the Johns Hopkins scientists felt that radiation emitted from the plant would create a risk of genetic deformities in the offspring of seafood eaters, a scientific consultant to the Utility insisted that "it would require an individual to eat a million and a half pounds of fish a year"[123] from the

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[118] Wash. Post, July 11, 1969, C4, col. 1.

[119] Wash. Evening Star, July 1, 1969, B5.

[120] Wash. Evening Star, May 13, 1969, B1, col. 3.

[121] Ibid. [122] Ibid.

[123] Wash. Post, May 14, 1969, D1, col. 1.

waters of the Chesapeake Bay in order to raise the chances for developing cancer or other diseases. A Washington Post reporter covering this testimony stated that "much of what both sides contended about long-range radiation hazards admittedly was theoretical and the need for more facts was emphasized."[124]

Provisions for public hearings as in the Atomic Energy Commission licensing procedures are, of course, a recognition that diversity of perspectives do or may exist in technology assessments. Surely some variation of adversarial procedures is to be expected in such hearings, however energetic the effort to mute their contentious quality.[125]

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[124] Ibid.

[125] To the effect that public reaction to the threat by nuclear power plants to despoil the environment will grow in intensity see Wash. Post, October 29, 1969, A6, col. 1; see also Victor Cohn, "Public Fights A-Power" in the Wash. Post, October 19, 1969, B1, col. 1; see also editorial on "Energy for Man and Environmental Protection" in Science, October 31, 1969.

For an interesting discussion of a notorious case wherein there was an intense interplay of conflicting interests see Andrew Hacker, "Pressure Politics in Pennsylvania: The Truckers vs. The Railroads," in The Uses of Power (Weston, ed. 1962), p. 323. The manner in which various participants made use of the so-called "Maryland Road Test" data concerning damage of heavy motor carriers to highways is illuminating.

The various interests represented in the DDT controversy are reflected in the California proposal to prohibit the use of DDT in the state after December 31, 1971. See "Hot Battle Over DDT Looms in California," the Wash. Post, July 20, 1969, F3, col. 1. This bill was defeated in the Assembly after numerous witnesses representing the state's $4.5 billion agriculture industry said "it could not survive a cost-price squeeze without use of DDT." Wash. Post, July 30, 1969, A2, col. 5. See also Wash. Post, May 4, 1969, B1, "DDT: Boon to Man--Or Bane to Our Environment?"

Concern over nuclear device testing is presented in "Rumbles Over Atomic Tests in Nevada," N.Y. Times, April 6, 1969, E12, col. 1, and "About 355 of 'Those Things' Have Exploded in Nevada," N.Y. Times Magazine, July 27, 1969, p. 6.

The continuing conflict over the supersonic transport is reflected in "SST: A Controversial Project Moves Inexorably Ahead," N.Y. Times, September 28, 1969, 8E, col. 6.

Consider among innumerable articles on the ABM controversy, the review

VIII. Adequacy of Assessment Performance

It would seem that the outcome of an assessment in support of the final authoritative decision (as contrasted with the limited appraisals of the various assessing mechanisms constituting the relevant assessment system) should be a comprehensive and explicit appraisal of the social impacts of the technological application involved. The previous discussion has attempted to emphasize, however, that in the actual process of assessment, outcomes based wholly or approximately on quantifiable factors are seldom obtainable. Further, participants in the process have differing perspectives and utilize various strategies depending upon their resources and the character of the forum to influence the outcome of the assessment. Even a supposedly impartial assessment entity, designed to provide the decision arena with a comprehensive evaluation of the impacts of the

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in the Book Review Section of the N.Y. Times of June 29, 1969, p. 3, by J.P. Ruina, of the book, ABM: An Evaluation of the Decision to Deploy an Antiballistic Missile System (Chayes and Wiesner, eds. 1969).

Controversy has raged and will probably continue with respect to the notion of a "national data bank." See "National Data Bank: Its Advocates Try to Erase 'Big Brother' Image," Science, January 10, 1969, p. 160.

The effects of fluoridation has been a matter of dispute among scientists and physicians for years. See "Fluoridation and 'New Facts,'" in the Saturday Review, May 3, 1969, p. 57. This long-standing controversy over fluoridation provides an excellent case study in the operation of the technology assessment process. See Wollan, "Controlling the Potential Hazards of Government-sponsored Technology," 36 Geo. Wash. L.R. 1105, 1125 (1968) (Program of Policy Studies in Science and Technology, Reprint No. 2). See also Joshua Lederberg, "Revived Controversy Over Fluoridation Points Up Our Basic Lack of Knowledge," Wash. Post, March 15, 1969, A11, col. 1.

Even gun control can be seen as a problem of technology assessment--and a highly controversial one at that. See Joshua Lederberg, "New Civil Hazards Agency Could Regulate Gun Sales," Wash. Post, April 20, 1968, A13, col. 5.

application on the social sub-system posited for examination, would likely be only one of multiple participants in the ultimate decision arena, as for example, in a regulatory agency rule-making procedure or in a Congressional hearing. It should be expected that the perspective of such an entity would differ from that of other participants and that any special influence it might exert on the final decision would result from its respect position gained through the full disclosure of its decisional processes, the thoroughness of its analyses, and the dependability of its assessment outcomes.

Assuming the foregoing situation, it does not seem advisable to characterize the preferred assessment outcome as "objective" in the sense that this term might denote the attainment of a demonstrably conclusive "right answer" to an assessment outcome. It would seem more appropriate, and accurate, to think in terms of the Adequacy of the Process of assessment rather than in terms of the Objectivity of the Outcome. The notion of adequacy can be reduced to various component operations which are to some extent susceptible to measurement. Of course, certain qualitative elements will always shape one's appraisal of the adequacy of particular assessments, as for instance, the confidence in the membership of the assessing entity or the performance reputation of the entity itself based on previous experience. Further, it seems necessary to recognize that the outcome of an assessment will not be a "neutral" product. The whole purpose of an assessment outcome is to provide an input into subsequent action decisions. However, a characteristic of an adequate assessment would be absence of a predisposition on the part of the assessing entity as to the

outcome of the assessment.[126]

The adequacy of an assessment can be expressed in terms of the Information Selection Operations and the Decisional Procedural Operations of the assessment entity. The following criteria have relevance to Information Selection:[127]

1) Availability and timeliness of data

2) Economy of data (cost of obtaining as related to value)

3) Dependability (accuracy, reliability)

4) Comprehensiveness (contextuality, systematic)

5) Openness (opportunity for participation)

The adequacy of the application of such information to the assessment process can be measured in terms of the attention to and quality of analysis of the following operations in the Decisional Phase:[128]

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[126] This problem is important for Arthur Kantrowitz's "Proposal for an Institution for Scientific Judgment," supra, n. 64.

> ". . .(T)here is no solution of the problem, discussed above, of combining the highest level of expertise with lack of prejudice except the solution arrived at centuries ago in the similar legal problem. If one insists only on expertise in advocates and expects them to marshall the arguments for one side of a question, one can call on the services of people who have gone most deeply into a particular subject and who have in the course of this work arrived at a point of view. Such advocates, in addition to presenting their side of the case, can be very useful in criticizing the cases made by opposing advocates. The requirements of the judges, on the other hand, is simply that they must clearly understand the rules of scientific evidence, have no intellectual or other commitments regarding the matters before them, and, finally, have the mature judgment needed to weigh the evidence presented."

[127] See Jones, Systems Approaches to Multi-Variable Socioeconomic Problems: An Appraisal, (Staff Discussion Paper 103, Program of Policy Studies in Science and Technology, The George Washington University, 1968), pp. 23-24.

[128] See Mayo and Jones, "Legal-Policy Decision Process: Alternative

1) Specification of the social objectives to be achieved by the proposed technological application

2) Controlling Contextual Factors:

- Objectives and authority of the assessment forum
- Demands of participants
- Resources available
- Relevant institutional framework
- Customary practices in the social context
- Influential trends affecting the implementation of the proposed application

3) Consideration of alternative proposals designed to achieve the same or similar social objectives

4) The projection of the probable outcomes of each alternative proposal

5) The prediction of specific consequences of each outcome

6) Cost/Benefit assessments of the alternative proposals in terms of an explicit scheme of social norms

These criteria, or a similar scheme of criteria of adequacy more suitable for particular types of assessment contexts, can be applied to the performance evaluation of 1) a specific assessment, taking into account the various constraints which may limit the scope of the assessment; or to the evaluation of the adequacy of 2) a Total Impact Assessment, whether performed at a given point in time by one assessment entity or by an aggregate of assessment entities through a period of time.

Thinking and the Predictive Function," 33 Geo. Wash. L.R. 320, 349, 351 (1964).

IX. Applicability of Adversarial System to Technology Assessment

As a general proposition it can be stated that any methodology, procedure or technique which increases the adequacy of the identification of effects (scope, intensity, and persistence) of a technological application and which clarifies the social norms against which the desirability or undesirability of such effects can be measured has a legitimate function in the technology assessment process.[129] The utility of any mode of inquiry can therefore be measured by the degree to which it contributes to the execution of the operations encompassed in the concept of Adequacy.

Scientific method is indispensable as one means of producing relevant data; but as a method of inquiry it clearly does not satisfy all of the data requirements for the technology assessment process as defined herein. While the operations of scientific method are essential in establishing cause and effect or probability relationships and in projecting trends, even in contributing to the data required in comparing alternative projects, it has relatively little direct contribution to goal clarification. One must not dismiss, however, the contribution that scientific operations do

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[129] The following statement of Dean Don K. Price in The Scientific Estate (1965) p. 272f would seem of relevance in this connection:

> "Though science has given mankind greater certainty of knowledge, it has gained that certainty by renouncing the concern for purpose that must remain at the heart of politics and administration--in both practice and their theory. . .
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> . . . . . .
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> The case for the mutual independence of the several disciplines does not depend mainly on the objective validity of the ways by which they acquire and verify knowledge. It depends even more on the political value of maintaining free competition and free mutual criticism in the search for truth."

make in the appraisal of impacts of existing applications. Such data is relevant to goal clarification in the sense that it forces reexamination of posited goals to determine if the means employed are in fact achieving the goals sought or if goals supposedly sought are the objectives actually desired after the implications of such objectives are made explicit by scientific investigation of effects, thus, in effect, contributing to the selection, as well as clarification of goals.[130]

As scientific method reaches its limits of utility, some variation of the adversarial system will usually be introduced. But the Formal Adjudicatory Model of adversarial system is not a wholly satisfactory model of the technology assessment process either, even though it combines both factual determination and normative resolution.[131] Yet there

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[130]Consider this statement of Emmanuel G. Mesthene, supra, n. 1, p. 101:

> "We used to scorn the mind of the military man as rigid, yet he has proved remarkably flexible. In less than twenty years, he has learned that science, which began by giving him new means to his old ends, has ended by giving him a new set of ends. Science has changed his old business from soldiering to a much broader concern with national security affairs.
> . . .To turn to science as a means is to take the first step toward changing one's ends. The question is not whether the ends will change, but when and how, and the manager's principal attention--whether he is managing a business, a government, or an international negotiation--must be on the first signs of change in the ends he thought he was heading for when he began."

[131]See with reference to the general point, Harold L. Korn, "Law, Fact and Science in the Courts," 66 Columbia L.R. 1080 (1966):

> "CONCLUSION
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> "Adjudication faces an institutional setting for 'fact-determination' that seems on its face at war with the kind of aspirations that science can entertain in pursuit of the truth. Built into the system is an extreme tolerance for low-accuracy results. A mere 'preponderance' of the evidence--probability greater than fifty percent--normally suffices to establish a fact as true for the purpose of the litigation, and latitude exists to

are characteristics of the adversarial system such as the motivation engendered in the participants to present the full data to support a position and to carefully scrutinize the positions of other participants which definitely can contribute to the satisfaction of the various operations set forth in the Adequacy Performance Model suggested. Hence, the objective must be to utilize scientific method, the adversarial system and other modes of inquiry to the greatest degree possible in order to optimize the criteria of adequacy.

That adversarial system in some form will probably be introduced into the assessment process is evident.[132] However, the inevitability of adversarial practices in certain assessment forums is not necessarily conclusive

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> sustain jury verdicts that are erroneous in the eyes of the court even under this broadly permissive criterion. Much pertinent data is excluded because of policies that the law deems paramount to ascertainment of the truth in adjudication, or under rules designed to screen uneducated nineteenth century juries from evidence that they might overvalue. The evidence that is admissible is gathered and presented in an adversary setting under the result-oriented aegis of the parties; and the tribunal is supposed to base its decision (apart from matters which may be 'judicially noticed') solely on the evidence so produced by the parties of its own."
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> "It is an important question to what extent this institutional setting properly imposes limits on the goals that may meaningfully be pursued in seeking improved technical decision-making. To some extent the justifications for so structuring the traditional trial process may be unconvincing as applied to scientific and technical issues." (Ibid., p. 1115.)
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> "However they are viewed, it is clear that inherent limitations of the judicial process require that the major stresses of scientific and technological advance be borne by legislative and administrative innovation." (Ibid., p. 1116.)

[132] A strong impression of the "inevitability" of the assertion of partisan claims in various technology assessment forums is provided by

of the desirability of such practices, at least in the manner in which the adversarial system is sometimes employed by particular participants. With respect to the technology assessment process, adversarial system must be appraised in terms of its utility as a mode of inquiry which contributes to the operations of the Adequacy Performance Model. Professor Arthur S. Miller advances a cogent criticism of the adversary system as it operates in the judicial system:

> That deficiency of "ad hocery"--former Bureau of the Budget Director Charles Schultze's term--may be seen quite clearly in the lawyers' desire to judicialize human affairs. They not only view the adversary system of litigation (which deliberately casts witnesses in partisan roles and expects them to be partial in their testimony) as a proper method of settling disputes, but tend to look on it as the sine qua non of any situation. But litigation does not suffice when the problems, in Aristotle's classification, concern distributive justice rather than corrective justice. As government moves ever more into a system of planning, the adversary system simply will not cope with the needs.
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> There is, furthermore, nothing in the intellectual equipment of the usual judge to make him knowledgeable about many of the problems now brought before courts and those "quasi-courts," the administrative agencies. The same may be said for the average lawyer. (Administrators, on the other hand, are supposed by definition to be endowed with technical expertise, a notion that has been badly oversold in this country.) As a consequence, judges cannot base wise decisions on the information brought to them by contending litigants. Accordingly in the past they have tended to abdicate decisional responsibility to administrators--just as legislators have.
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> The adversary system, in sum, is based on two premises: first, that the lawyers and judges are competent in the matters dealt

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Wollan, The Process of Setting Safety Standards in the Courts, Congress, and Administrative Agencies, Part III-Summary and Conclusions, (Program of Policy Studies Staff Discussion Paper 204, 1968). Conversely, the probability of attaining "rigorous objectivity" in the assessment function is minimized.

> with, and second, that the system can provide enough of the right type of data to make viable decisions. Neither idea is valid.[133]

It is clear that adversarial system is discouraged in certain assessment forums or by particular assessment entities. In other words, adversarial system is not viewed as a positive mode of inquiry for the purposes of certain assessment entities. This seems to be the case with the National Transportation Safety Board. This Board is an unusual type of assessment entity, the Department of Transportation Act specifically stating that in the exercise of its function the Board is charged with a continuing review of the safety situation with respect to all modes of

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[133] Arthur S. Miller, supra, n. 31, p. 40. These criticisms focus on the competency of the advocates and decision-makers to resolve scientific and technological questions. Even in regard to traditional courts Miller, ibid., p. 42, acknowledges that:

> "At the very least they could study the problem of making judges and other legal decision-makers more competent. One way to accomplish this would be for panels of experts to be made available to the judges. This is done in Great Britain, with respect to the Restrictive Practices Court (a court that deals with Britain's counterpart of the antitrust laws); there economists are on the staffs of the judges. Further, judges and administrators dealing with scientific-technological issues should have available personnel who could forecast the impact of projected decisions."

Cf. the statement of Arthur Kantrowitz, supra, n. 126.

More difficult to cope with is the view that people, particularly educated people such as scientists and engineers, should be able to cooperate to their mutual benefit in achieving common goals rather than competing for individual benefit and individual goals.

Perhaps this is a consequence of the affluence of science over the past 30 years. But as Representative Emilio Q. Daddario (D-Conn.) pointed out in "Congress faces Space Policy," Bulletin of the Atomic Scientists, May 1967, p. 11, at 15, in reference to DOD and NASA cooperation in space ". . .if the budget squeeze became tight enough, some individuals normally willing to recognize complementary spheres might become more partisan."

transportation.[134] The Act further states that the Board, in the exercise of its functions, powers, and duties, shall be ". . .independent of the Secretary and other offices and officers of the Department." Section 5(b) of the Act prescribes that the Board shall have responsibility for determining cause or probable cause and reporting the facts, conditions, and circumstances of accidents investigated under authority transferred to the Secretary of Transportation.[135] Reports and recommendations of the Board, as well as special studies, must be made public. The Board is concerned with obtaining the fullest possible information. It is not concerned with authoritative determinations of placing fault or assessing legal liability. Its findings are not admissible in court. In order to obtain the most candid and uninhibited evidence feasible it has discouraged adversarial procedure.[136] Nevertheless, the Board does attempt to establish probable

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[134]Public Law 89-670, 89th Cong., H.R. 15963, October 15, 1966, 80 Stat. 931, An Act to Establish a Department of Transportation, and for other purposes. See Section 5: National Transportation Safety Board. See also Annual Report to Congress, 1967, of the National Transportation Safety Board.

[135]The Board is authorized, for example, to:

"Make recommendations to the Secretary concerning rules, regulations, and procedures for the conduct of accident investigations.

"Initiate on its own motion, or conduct rail, highway, or pipeline accident investigations as the Board deems necessary or appropriate.

"Conduct special studies on matters pertaining to safety in transportation and the prevention of accidents.

"Make recommendations to the Secretary which will, in its opinion, tend to prevent transportation accidents and promote transportation safety. "

See Annual Report to Congress,1967 of the National Transportation Safety Board, p. 2.

[136]This is the impression gained by the writer in discussing investigatory procedures with persons cognizant of the Board's operations. See

cause and this finding is obviously related to fault and liability. Here the accident has occurred. Liability for certain parties and remedies for others potentially exists. The Board's recommendations have been generally accepted; thus, its assessments effectively control official decisions. Various participants, therefore, have a stake in its findings or may think they do. This encourages a self interest, partisan approach which may inhibit full disclosure of facts. But in such circumstances, why should it be expected that the adversarial system would not creep into the factual investigations by the Board? One might further ask: Why shouldn't such procedures be accommodated to some degree at least?

Another assessment context in which an attempt has been made to de-emphasize adversarial procedures is discussed by Professor Harold P. Green in his article: "Safety Determinations in Nuclear Power Licensing: A Critical View."[137] In the author's view the public or affected segments of

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Charles Yarborough in the "Crash Inquiry Innovation," Wash. Evening Star, October 28, 1969, A9, col. 6, wherein it is stated that in the investigation of the Indianapolis mid-air collision tragedy "the NTSB will not only sit as a full membership but that another procedural precedent will be departed from: Witnesses, heretofore subject to questioning by batteries of technical experts, will be interrogated only by Board Members."

[137]Harold P. Green, "Safety Determinations in Nuclear Power Licensing: A Critical View," 43 Notre Dame Lawyer 633 (1968) (Reprint No. 1, Program of Policy Studies in Science and Technology, George Washington University.)

Perhaps some scientists and engineers would find the following extract from Felix S. Cohen, op. cit. supra, n. 42, congenial to their temperament. In addressing the topic of The Paradoxes of Judicial Logic, he asks: Are Lawyers Liars? and states in part:

> "How the edifice of justice can be supported by the efforts of liars at the bar and ex-liars on the bench is one of the paradoxes of legal logic which the man in the street has never solved. The bitter sketch of 'Two Lawyers' by Daumier still expresses the accepted public view of the legal profession. So, too, does the oft-told

the public do not have an adequate opportunity to review the considerations that go into the licensing process nor to contest the determinations made.[138] One of his more pungent statements for our present analysis relates to the Atomic Safety and Licensing Boards of three members, two of whom must be technically qualified members of "recognized caliber and stature in the nuclear field":[139]

> Clearly, therefore, the boards do not base their determinations solely upon the evidence within the four corners of the record. The evidence is weighed and assessed in terms of the knowledge, experience, and biases of the expert members of the board. Moreover, the hearing procedures themselves have been significantly de-judicialized on the theory that "trial-type" proceedings are not appropriate for the development of scientific and technical information concerning safety and also to accommodate the procedures to the temperaments of the scientists and engineers who testify and sit on the boards.[140]

A major implication of the foregoing is that concerted efforts have been made to limit adversarial proceedings in nuclear power licensing, no doubt with the best of intentions since this process is viewed by nuclear specialists and enthusiasts as essentially a scientific-technical matter. The Price-Anderson Act of 1957 provided that a mandatory hearing be held on every application for a license for a nuclear power reactor,[141]

> story of Satan's refusal to mend the party wall between Heaven and Hell when it was his turn to do so, of St. Peter's fruitless protests and threats to bring suit, and of Satan's crushing comeback: 'Where do you think you will find a lawyer?'"

[138] Green, supra, n. 107, pp. 652-653. [139] Ibid., p. 643.

[140] Ibid. Social scientists are apparently more willing to accept the analogy of a trial to critical reviews of their efforts. See, for example, Carl Stover, "Industry, Technology, and Metropolitan problems," 27 Pub. Adm. Rev. 112, 114 (1967).

[141] Green, supra, n. 107, p. 639.

thereby amending the 1954 Act which required only that a hearing be granted at the request "of any person whose interest may be affected," no hearing being required in the absence of such request.[142] The 1957 Amendment was interpreted to require a mandatory hearing at the construction permit stage, the operating license stage, and on any significant amendment to the application at either stage. This approach apparently led to a multitude of hearings, most of which were uncontested.[143] Professor Green states:

> In view of the practice of informal discussion and collaboration between the regulatory staff and the applicant, safety issues were generally resolved before the hearing so that the role of both parties typically was to build a record supporting issuance of the construction permit, license, or amendment. The entire multi-hearing procedure not only invited intervention, but also was in many respects an exercise in time-consuming, expensive futility which was particularly irritating to scientists and engineers, who had little patience for the lawyer's role and the legalistic aspects of these proceedings.[144]

It would appear, therefore, that adversarial proceedings such as reflected in non-essential public hearings can get in the way of adequate as well as efficient assessments. By a 1962 Amendment to the 1954 Act the requirement for a mandatory hearing remained but only at the construction permit stage. "The AEC is, however, required to give thirty days notice of its intent to issue an operating license or an amendment, and it must grant a hearing at the request of any intervenor whose interest may be affected."[145]

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[142] Ibid., p. 637.

[143] Ibid., p. 639.

[144] Ibid., pp. 639-640.

[145] Ibid., p. 640.

The effort to restrain non-productive adversarial intervention can be appreciated. This attitude hardly resolves the complex of issues involved, however, Safety or the criterion of "undue hazard" applied in nuclear power licensing is not merely a scientific-technical issue; social risks and benefits are involved in such judgments. A consensus position on such matters, if potentially attainable, would seem desirable, but an imposed consensus, whether it pertains to factual interpretations and predictions or to social objectives, is not only unfair to the affected public but is an inherently dangerous procedure--both technologically and politically.[146] Further, the problem here is not limited simply to determining the best techniques for the promotion of public enlightenment. It also involves the allocation of professional influence over economic and political decision-making. Put another way, the greater the universe of issues that are categorized as scientific-technical, the greater the decision-making power of the scientist and engineer. The consequent jostling for positions of influence as between professional groups or organized societal interests would not seem destined for early demise.

Efforts persist, however, to moderate the public's feelings of dissatisfaction with decisions based on highly conflicting assessments, particularly where serious threats to health are concerned. During the Calvert Cliffs nuclear power hearings, the Washington Post, noting that all such hearings have been controversial, suggested that:

> The least the country can ask, in venturing into a new field of this kind which may vitally affect the environment, is that

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[146] See discussion by Green, ibid., p. 652.

> a competent and disinterested public body take a careful look at all the available facts before the leap is taken. The location of such plants ought to be a major issue before a Council on Environmental Quality.[147]

The obvious abuses of the adversarial system in practice such as concealment of relevant information, introduction of frivolous claims, the distortion of factual data to suit partisan ends, the exaggeration of benefits or of potential dangers, the divisive efforts which prevent consensus on matters where potential and legitimate consensus would serve the public interest, and so forth, should not blind us to the contributions such a system can make in support of more adequate technology assessments.[148] The advantages may be looked at broadly in terms of the pressing need for public participation in major technological decisions. For example, Professor H. L. Nieberg states in his article on "The Tech-Fix and the City":

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[147] Wash. Post Editorial, May 8, 1969.

[148] See John Platt, "How Men Can Shape Their Future" in the Bulletin of the World Future Society, June 1970, p. 9:

> "Several features stand out as requirements for satisfactory group decision-making in the groups and cities and countries of the world ahead. The first is that all social decisions from now on must be participatory. Every individual or sub-group must have as large a share as is practically attainable in the decisions that affect its destiny. . .
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> . . . . . .
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> Better maps may not only bridge divergent pictures of reality but may even do something toward bridging divergent self-interests. If one route can be shown to be clearly more promising than another in terms of total social costs in reaching a generally agreed-upon goal, then that total social advantage can be partly used to give compensating personal advantages to groups whose interests are damaged by taking that route. Thus, we compensate landowners displaced by a highway, or workers displaced by automation. It is only when the total advantage is uncertain that the disputes rage on. Much wider use of this principle of preassessment and compensation would help many of our needed social changes to go faster and with less disruption."

> The problem is not how to control science and technology. The problem is to recognize which interest groups are exerting preponderant influence and for what purposes--in order that we may seek the time-honored correctives of pluralism--namely visible public accounting and counter-prevailing power. If there is, as Admiral Rickover frequently asserts, an antithesis between blind technology and individual liberty, it is an antithesis between coalitions of narrow group interests able to allocate natural resources toward ends not shared by other large groups. Our theme, therefore, is the need to assimilate the gothic mysteries of science and technology to ordinary political analysis, common-sense political judgment, and plain English. Obviously, the nation cannot deny itself the aid of augmented science and technology in facing the serious problems of the day. But neither can it blindly accept all those claims made in the name of science and technology as inexorable natural forces. Scientific and technical change are far from unstoppable and automatic, but are rather the result of, and responsive to, public policy. The interested public can gain access and predict consequences in this, at least as well as in any, area of policy choice; and all areas are complicated, highly specialized, and jargonized.[149]

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[149] H. L. Nieburg, "The Tech-Fix and the City," in the Quality of Urban Life, Vol. III, Urban Affairs Annual Review, (Sage Publications, 1969) pp. 211, 240.

On the growing intensity of the general public interest in major technological projects, see guest editorial of Eugene B. Skolnikoff of MIT, "Public Challenge of Government Action," in Science, May 2, 1969.

See "Arms and the Scientists: A Long Dialogue Continues," Science, March 28, 1969, p. 1436.

> "The national debate on Sentinel is the first example I know of a military system being a matter of public debate not confined to a small group of experts or advocates of a special cause.--Professor Jack P. Ruina of MIT, a former top Pentagon weapons adviser, at recent Senate ABM hearings.
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> "David E. Lilienthal, first chairman of the Atomic Energy Commission, made this point in a recent CBS public affairs program when he contrasted the ABM debate with conditions prevailing two decades ago when the decision to develop the hydrogen bomb was made. Lilienthal, who opposed development of the H-bomb, commented on the decision and its effect on the arms race. 'Well, it's easy,' said Lilienthal, 'to look back and say you were right, but now we're going through another cycle. . .'
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> . . . . . .
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> 'Now we're having a public debate about another issue of this kind, and it's casting a lot of light on public policy. The H-bomb should have been discussed that way.'
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> "Certainly there is a new freedom in discussion of weaponry in comparison with the early postwar period, when the military

It must be kept in mind that we are not necessarily concerned with desirable and undesirable social impacts but with which impacts represent positive social values which should prevail in specific assessment contexts. We desire both a pest-free agriculture and a pollution-free environment. How is one to determine what distribution or adjustments are to be made between two social values at a given point in time or during a projected period of time? Certain segments of the public stand to gain benefits and

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secrecy lid was kept clamped down with wartime tightness. But it is unclear to what extent more open discussion has actually affected key strategic decisions or the process by which they are made."

The adversarial system would seem to be consistent with the implementation of the notion of "social justice" as proposed by Kenneth E. Boulding, "Social Justice in Social Dynamics," in Social Justice (Richard B. Brandt, ed., 1962):

> "I propose to approach the problem of social justice as an economist and social scientist in a manner somewhat different from that which is customary among the philosophers. The philosopher treats the concept of justice as essentially a normative concept. He is concerned with abstract notions of what is right, good, and just. He is concerned with what ought to be, not necessarily with what is. These normative discussions are important and I would not for a moment wish to decry their value. There is, however, another point of view from which the problem of social justice can be examined. This might be called the positive or operational point of view in which social justice --or at least the image of social justice as it exists in the minds of the members of society--is an essential variable in determining the dynamic processes and the evolution of that society." (p. 73.)
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> "The perception of divergence between the perceived real value and the ideal value of any important psychological variable--that is, of any variable which is strongly related to utility or general satisfaction--may be labeled discontent. In this sense, discontent can be regarded as the prime mover of man to action provided that his image of cause and effect permits him to believe himself capable of such action as to reduce the divergence between the perceived real and the ideal. We may notice a point here, the importance of which will be clearer later. The divergence between the real and the ideal may be reduced by acting so as to manipulate the real. But it may also be reduced by adjusting the ideal. This is the way of renunciation--of wanting what you get, rather than getting what you want. It is traditionally associated with Eastern philosophies, and if adopted it is a powerful deterrent to rapid change." (p. 78.)

other segments of the public stand to be deprived of benefits or to bear additional social-economic costs as a result of these decisions. The adversarial system offers the indispensable means by which the relevant values are clarified and the probable benefits and costs are estimated for the enlightenment of the ultimate decision-maker.

No doubt some observers and participants view the adversarial system as a most serious threat to the achievement of adequate assessment outcomes. But if one begins with that criterion of the Adequacy Model which refers to the comprehensiveness and openness of assessment information, then the adversarial system as a method of inquiry is to be encouraged rather than inhibited. Even the most casual inquiry into the various existing technology assessment systems which have relevance to particular applications will show a tremendous fragmentation of assessment entities and their associated processes of assessment. Improved coordinating mechanisms to serve the purpose of assuring that all such assessment subsystems contribute their inputs to support Total Impact Assessments is perhaps the really crucial need at this particular time. Participation needs to be encouraged rather than hindered. Broadened participation will in turn, no doubt, contribute to additional areas of factual disagreement and to different judgments on the social worth of the application under consideration. This will encourage further resort to adversarial type proceedings. But why not? Advocates for potentially affected participants usually introduce a flow of intelligence respecting the relationship of the parties they represent to the assessment situation which would not

otherwise be available.[150] Not only do we have our long historical judicial tradition to support this proposition but the more contemporary practices of administrative agencies of sending proposed rules to potentially affected parties for comment often taps an extremely useful source of data and appraisals.

Some commentators feel that a well-structured and vigorous adversary system is the crucial technique for technology assessment.[151] This notion

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[150] Consider this statement of Gordon F. White:

> "The kind of analysis the nation needs would present estimates of the consequences of each of the politically practicable lines of public action. Thereby, the political process of choice would be sharpened rather than curbed, and governmental intervention seen in perspective with the alternatives.
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> . . . . . .
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> "Agency consolidation, policy formulation, Congressional reorganization, and interagency co-ordination may, indeed, help reduce friction and reconcile operating methods. But they are less basic than an agency or procedure to focus attention upon the choices and effect of public action. Even with such a mechanism we could expect continued conflict, divergence, and pluralism of approach. As Norman Wengert has stated, we should welcome such indecision and friction so far as they reflect searching and experimenting with promising lines of action. We should be dissatisfied only when the choices are not made from the full range that could be marshalled with our potentially available stock of knowledge and skills.
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> . . . . . .
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> "Whether or not the federal government recognizes a greatly refined appraisal process as an aid to decision-making, nonfederal agencies will be needed for that purpose, to double on a small scale for such action in its absence, or to give it competition in its functioning." Supra, n. 46, pp. 224-25.

[151] Consider the following extract from Dennis W. Brezina, The Role of Crusader-Triggered Controversy in Technology Assessment: An Analysis of the Mass Media Response to Silent Spring and Unsafe at Any Speed, Staff Discussion Paper 203, (Program of Policy Studies in Science and Technology, The George Washington University, April 1968):

> "The process of technology assessment in the case of pesticides and auto safety had previously consisted of an unemotional and sporadic debate which centered on highly technical issues of interest primarily to a small circle of experts, and which,

is based on the assumption that new technologies have a momentum expressly and energetically promoted by the proponents of specific applications, that such proposals invariably emphasize, even exaggerate, the benefits to be derived from such applications and minimize the social costs. If this situation is assumed as the general context of technology assessment, then the obvious means for gaining a Total Impact Assessment

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therefore, was largely beyond the understanding of the public. The appearance of the two crusaders and their upsetting books signaled a shift in the tempo and the substance of the previously low-keyed and intermittent debate, for value judgments were injected and simplifications were made in such a way that the issues became meaningful to the public. This popularization phase evoked an emotional response which raised the debate to a controversial pitch. At this time the political implications of the issues became apparent to the public and the Congress and enough interest and pressure was generated to allow Congress to take action. In this way the books served to move the issues from the technical plane to the political arena, where the policy makers could decide on future courses of action before the partially resolved issues gravitated back to the technical public. This movement from expert to crusading critic, to public, to policy maker, and then back to expert, in general describes the pesticide and auto safety controversies.

"In terms of the democratic process, one is persuaded that the public's involvement was to a great extent due to the efforts of Rachael Carson and Ralph Nader. Whether public and congressional interest could have developed without these crusaders is a matter of conjecture. That the technology assessment process did proceed in this fashion in these two cases suggests that other controversies over technological programs might occur in the same fashion in the future. For example, crusader-triggered controversies might enter into the process of assessing the anti-ballistic missile or the supersonic transport, which are two technological programs as yet not explained to the public in any systematic way that points out both their strengths and weaknesses. In any event it is not clear how public and congressional involvement in the assessment of technology can be assured unless some controversy develops. If controversy is, therefore, necessary, then Silent Spring and Unsafe at Any Speed are elements of an emerging tradition of social criticism evolving in response to the scientific-technological revolution. This new form of social criticism has tended to illustrate that public and congressional involvement, even though episodic, can be a viable and influential part of the assessment and application of technology." (Italics added.)

of the application--a full analysis of the prospective impacts and social implications--is to confront the proponents in the assessment forum with countervailing facts, interpretations, and evaluations of social consequences. Professor Green, in the article previously referred to, has proposed that a "devil's advocate"[152] arrangement be introduced into the nuclear reactor licensing procedure. In support of this proposal he states:

> What is required is a scheme that would require and facilitate the public articulation, in language which the public can understand, of the nature of the risks, the steps taken to minimize them, and the degree of risk that remains. This would permit a meaningful balancing of costs against benefits and the focusing of public attention on the policy questions.[153]

In his book on Modern Science and Modern Man, Dr. James B. Conant gives special attention to adversary-type proceedings:

> There is a fairly common fallacy that if you are dealing with scientific and technical matters, judgment of values rarely, if ever, enters in. Facts speak for themselves in science, we are often told. Anyone who is familiar with the course of scientific research and development knows this is nonsense. What is true is that the area of debate is fairly definitely circumscribed. . .(T)his does not mean that what is proposed is not controversial; it means simply that the number of people qualified to take part in the controversy is highly limited.[154]
>
> (Therefore) it is necessary to explore ways and means of balancing the biases of experts whenever their opinions are of prime importance in the making of decisions.[155]

Dr. Conant suggested that "if the Department of Defense would gradually introduce a quasi-judicial system of review which provided forced opposition to new projects, the taxpayer's money would be more wisely spent."[156]

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[152] See Green, supra, n. 107, p. 656.

[153] Ibid., p. 655.

[154] Conant, Modern Science and Modern Man (Doubleday Anchor Book, 1954, originally published in 1952), p. 113.

[155] Ibid., pp. 114-115.

[156] Ibid., p. 117.

He further suggested a referee or judge to hear arguments and added:

> With opposing briefs, arguments and cross-questioning many facets of the problem, many prejudices of the witnesses would be brought out into the open. The forced opposition is the important point.[157]

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[157] Ibid., pp. 117-118. Apparently, some such procedure was adopted. The N.Y. Times Editorial of July 6, 1969, 8E, col. 1, commented, in connection with Pentagon programs, that "the influence of the Joint Chiefs of Staff. . .has been rising sharply within the Administration" and added:

> "The danger in the current trend. . .is the elimination of checks and balances. The decisions Mr. McNamara made were partly right and partly wrong. But the adversary process he employed, which forced the Joint Chiefs to justify their proposals to civilian experts, was eminently sound. Nowhere else--neither in the Pentagon, nor in the Budget Bureau review, nor in the Congressional hearings, nor in National Security Council and White House studies--does such a thoroughly competent cross-examination occur."

See also Harold Demsetz, "The Technostructure, Forty-six Years Later," reviewing Galbraith, The New Industrial State, 77 Yale L. J. 802, 811-812, for a concise description of the assessment system within the Pentagon between weapons systems and between bidders on a particular weapons system. Because of the requirement for secrecy, an open forum of any real utility would be rather difficult to obtain.

Congress,of course, does on occasion serve as a more or less open assessment forum. The B-70 controversy as well as ABM involved searching examination of the Pentagon's position--whether one agreed with the ultimate outcome of these controversies or not. See Michael Harrington, "The Social-Industrial Complex," Harper's Magazine, November, 1967, p. 55, for a description of the adversary nature of such controversies and of new social programs before Congress, which points up the danger in the present relative lack of capacity of any group which does not stand to make a profit from a favorable outcome to challenge such presentations.

> "Each element in the defense sector--particular industries, branches of the service, 'independent' associations for the Army, Air Corps (sic), Navy, and Marines, and even trade unions--has its own special interest (profit for the companies, prestige and power for the officers, jobs for labor). And each one lobbies for strategies which are determined, not by any objective analysis of the needs of the nation, but by its own stake in the decision. The debate over the B-70 bomber during the Kennedy Administration was a classic case in point. A powerful section of the military-industrial complex, led by the Air Force and aiming to serve purposes of its own, mounted a determined campaign against the Administration in favor of proposals which had been rejected by three Secretaries of Defense under Eisenhower and by Secretary McNamara under Kennedy."

Dr. James R. Killiam, Jr., Chairman of the MIT Corporation and the first White House Science Adviser, proposed in testimony before the Senate Subcommittee on Internal Organization and Disarmament in March 1969, that the U.S. establish a new policy review group. He proposed a task force which could channel public debate on weapons issues by making an "independent, comprehensive study in depth of our weapons technology and of the factors which bear upon the decisions the nation must make." His proposal would seemingly introduce a new, reputable, moderating participant into such controversies which could contain the vehemence and bring a more effective adversarial procedure into being.

> Their special value would be that they would be dependent conclusions reached by a group of competent citizens who were free of organizational loyalties. By virtue of this freedom such a commission could also provide some reassurance to the growing number of citizens who are concerned about the "military-industrial complex" and its alleged influence.[158]

"Something like this pattern is beginning to emerge within the social-industrial complex. 'Business,' to quote the Wall Street Journal once more, 'is turning into an important force for pushing embattled domestic proposals through Congress.' An executive of the Department of Housing and Urban Development is quoted as saying, 'Each agency has gradually developed a list of firms interested in its field. . .We know how to turn them on. . .' . . .(A)s the experience of the military-industrial complex demonstrates, such procedures lead straight to private alliances between self-interested executives and ambitious bureaucrats. This trend is already quite developed in the cities industry--where, for instance, real-estate men support rent subsidies as a means of attacking public-housing. . ." (p. 57.)
As Lynton Caldwell put it, supra, n. 99, at 128, "American administration of science and technology is not irresponsible; nevertheless it may be argued that it is not sufficiently responsible."

158 Quoted in Technology Review, May 1969, p. 72.

Dr. Killiam added that "it is important for the policy-maker and the public to have the benefit of listening to contending points of view on complex technical and strategic proposals such as Sentinel."[159]

The need for, and opportunity to employ, adversarial system exists to the extent that scientific method cannot supply the data to satisfy the operational criteria of adequacy of assessment. But the need for information and evaluations through methods of inquiry other than scientific method does not necessarily mean that adversarial system can be employed or, if permitted, to what extent. Multiple assessment entities and their associated forums exist which differ in objectives, degree of specific official authority, composition of membership, character and scope of subject matter treated, capability to assemble and analyze data relevant to its objectives, statutory or customary decisional processes, and reputation, including respect status, among participants. These factors plus the general disposition of the assessment entity will determine the extent to which the adversary system may be applicable. Some assessment entities will or purport to be non-partisan seekers after the "truth" and stress unbiased, inclusive claims. At the other extreme, adversarial proceedings will not only be expected by the assessing entity but be required as in courts or in regulatory agency and Congressional hearings. The assessing entity may, through time, indicate clearly what types of information and techniques of presentation it tends to rely upon.[160]

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[159] Ibid.

[160] Various types of communications links between information sources and the Congress are noted in Technical Information for Congress (1969), p. 510.

The following tentative hypothesis is offered for the purpose of providing a summary statement of the theme developed herein and for the further purpose of provoking continued critical appraisals of the role of adversarial proceedings in the technology assessment process:

- The greater the uncertainty as to relevant data and effects of technological applications,
- The greater the divergence of preferred social values among the participants,
- The greater the perceived stakes in the authoritative decision to be based, at least in part, on the assessment outcome,
- The greater the probable influence of the assessment on the ultimate authoritative decision,
- The greater the acceptability to the assessment entity of adversarial proceedings,
- # The more likely are the participants to resort to adversarial techniques of data development and outcome persuasion.[161]

The contribution of adversarial system to an assessment will, of course, be measured by the extent to which it satisfies the criteria of adequacy.

There is a very obvious and substantial reason why adversarial techniques will be imposed upon assessment processes such as the National Transportation Safety Board hearings and the Atomic Energy Commission licensing procedure. Suc procedures necessarily tend to become adversarial because real interests and values are at stake. While this will depend upon a number of factors,

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[161] While the variables noted may tend to be the more influential regarding the likely resort to adversarial techniques, a wide range of factors which may exist in numerous combinations would be relevant to the testing of the hypothesis. See Program of Policy Studies in Science and Technology, Chart: Process of Technology Assessment/Application, December 1969.

including the assessment forum and the influence that the assessment outcome is likely to have on the authoritative decision, one may appropriately ask: why shouldn't participants having a stake in the ultimate allocation of benefits and costs employ every legitimate means of protecting and advancing their interests?[162] While "impartial assessment sub-systems" can usefully provide independent (more or less) standards of judgment by which partisan claims can be appraised, it is unlikely that our social values and our assessment-decision procedures can or should preclude partisan participants. Further, as set forth previously, there would seem to be a potential gain from the standpoint of improving the adequacy of the assessment process by such partisan participation. In other words, an adversarial system tailored to the assessment process not only reinforces a fundamental political principle[163]

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[162] A recent National Academy of Sciences panel report, "Behavioral Science or Electioneering?" reprinted in part in the Saturday Review, November 1, 1969, p. 65, states:

> "If there is to be any substantial increase in social experimentation, the public must have a voice in what is permitted. This is a matter not simply of public acceptance of scientific methods of gaining information, but, more importantly, of public participation in decisions that affect the utilization of scientific knowledge. This is true for such classic social problems as poverty and crime; it could be even more important where the products of science and technology may stimulate fundamental changes in human affairs."

[163] The late Judge Learned Hand stated in the Associated Press Case, 52 F. Supp. 362, 372 (1943):

> "(N)either exclusively, nor even primarily, are the interests of the newspaper industry conclusive; for that industry serves one of the most vital of all general interests: the dissemination of news from as many different sources and with as many facets and colors as is possible. That interest is closely akin to, if indeed it is not the same as, the interest protected by the First Amendment; it presupposes that right conclusions are more likely to be gathered out of a multitude of tongues than through any kind of authoritarian selection. To many this is, and always will be, folly; but we have staked upon it our all."

but also serves as a valuable mode of inquiry.[164]

Yet it would seem clearly desirable to attempt to identify those areas of agreement or consensus relevant to the assessment, particularly

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[164] This "theme was sounded on April 14 by Dr. Kenneth S. Pitzer, then President of Stanford University, a former research director for the AEC and a recent chairman of the President's Scientific Advisory Committee. Urging a testing delay in central Nevada and Alaska until independent scientists could study the possible effects, Pitzer said:

> 'The problem in this case is not that the risk is completely ignored; rather, that it has been examined primarily in closed circles with the effective judgment rendered by officials committed to the test program. This sort of problem should be considered by an impartial judge and jury. I believe the risk that a damaging earthquake might be triggered deserves a much more substantial public hearing. Then Congressmen, Governors, and other responsible public officials, as well as the interested public, can form their own judgment, balancing this and any other risks against the need for tests or the extra costs of moving to a (safer) location.'"

Gladwyn Hill, "About 355 of 'Those Things' Have Exploded in Nevada," N.Y. Times Magazine, July 27, 1969, p. 36.

Consider also the following extract from a talk by Representative Emilio Q. Daddario (D-Conn.) at Washington University in St. Louis on February 12, 1969, quoted in Science, March 15, 1969, p. 1183:

> "Let's take one example--the 200 BEV accelerator proposed for Weston, Illinois.
>
> "You may be, and probably are, much interested in the 'policy' machinations which resulted in a decision to go forward with this highly publicized, highly expensive bit of 'big science.' I am, too. But I must confess I do not know what they were.
>
> "What rationale is behind the priority given to the accelerator? (Not that given to the facility itself.) Who was most responsible? The National Academy of Sciences? The Congress? The Atomic Energy Commission? The National Science Foundation? The Office of Science and Technology and the Federal Council? The President's Science Advisory Committee? Or was it the remnants of the old World War II MIT-Los Alamos axis whose guiding lights are sometimes alleged to have been dominating U.S. science ever since? What logic actually governed the selection of the site? And, in this case, did an 'in-group' make the recommendation; if so, was its real advice followed?
>
> "These are questions on which we have all read much and speculated much. Certainly, they are questions of policy. Just as certainly, very few know the answers, and I sometimes wonder if anyone knows them all.
>
> "But the point here is to suggest that many of the important

the technical aspects, as early in the assessment process as practicable. In other words, it would seem highly desirable that to the extent a potential consensus exists, it should be formulated and stipulated in order to restrict the areas of uncertainty and difference as much as possible. This will prevent those aspects of the assessment which are determinable and can be agreed to from being distorted by subsequent conflicting assertions, interpretations, and partisan claims. Perhaps in some situations the most adequate assessments can be made at an early phase of the development of a new technological application before interests in the application have become consolidated as by investments or by the assignment of program authority. But this also means that relatively little will be known at this stage about the impact of the operations. This is another variation of the eternal dilemma of whether information is to be sought from those who are essentially unbiased and therefore probably only superficially informed or whether advice is to be sought from those who have studied the problem in depth and have in the course of this process in some way become committed or identified with a particular application or interest.[165]

There are, however, difficulties with the foregoing hypothesis that the potential for consensus is greatest at the earliest phases of a proposed technological application. Surely, disputes are to be expected on every conceivable factual and normative issue in the assessment of existing

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details of federally assisted scientific endeavor in this country are decided without being responsible to any policy, formal, or informal. . ."

[165] Cf. the statement of Arthur Kantrowitz, supra, n. 126.

applications where stakes are already consolidated. But even in the case of developed technologies where an assessment is simply for a new project resembling many existing applications, the early phases of the assessment process may present the best opportunities for resolution of differences. Put another way, as the assessment process approaches the final assessment forum and the ultimate authoritative decision, the more likely that partisan claims of participants will be vigorously pressed. But again, reservations arise. The procedural closeness to the ultimate arena may not identify the most crucial forum, i.e., that assessment forum which will have the greatest influence on the ultimate allocation of costs and benefits. For example, the hearing on the initial construction permit for a nuclear reactor may be a far more critical assessment point than a subsequent hearing, by request, just prior to the granting of the final permit. Hence, one can expect, within procedural limitations, that the adversarial system will be employed with maximum vigor and expertise in what is perceived to be the critical assessment forum.[166]

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[166]Limitations on adversarial techniques, however, may severely cripple the public's right to participate in decisions which vitally concern it. See for example "Maryland A-Plant: Boon or a Menace?" Wash. Post, Aug. 26, 1970, p. 1, col. 1, wherein it is stated:

> "Dr. Edward P. Radford, professor of environmental medicine at Johns Hopkins University, is among the scores of people who have criticized the events in the decision-making process.
>
> "He notes that in May of 1969, the AEC began hearings on Baltimore Gas and Electric's application for a construction permit.
>
> "Although opponents regarded this as the key hearing in blocking the plant, the AEC pointed out that the law governing such proceedings prohibited presentation of testimony regarding the choice of plant location, thermal effects on marine life in the Bay, power line location and the relationship between the size of the plant and the actual power needs of the area to be served.
>
> "Testimony was therefore limited strictly to matters regarding actual plant construction."

To the extent the above situation does or will pertain, it raises a most difficult and critical question concerning the role and the efficacy of existing or proposed "neutral" or "unbiased" or "non-partisan" assessment entities. If, as the tentatively advanced hypothesis suggests, the most vigorous partisan demands will be made (or attempt to be made) in the most critical or influential assessment forums, what is the implication of this assumption for the role of a supposedly impartial assessment entity? Of course, the answer might differ somewhat with the structure of the assessment system for different technological applications, with the stage of the assessment process as the assessment moves from proposal to recommendation to ultimate authorization, or even with particular operations of the Adequacy Performance Model. But the crux of the matter is that partisan claims will be focused on the more influential assessment forums;[167] and the more influential the assessment outcomes of a given assessment entity on the final authoritative decision, the greater the

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[167] Consider Lynton Caldwell's statement, supra, n. 99, pp. 128-29:

> "The locus of responsibility for this kind of policy guidance is obviously. . .a function of the Congress, the President, and the Supreme Court. But the knowledge required for policy decisions in the new age of science cannot possibly be developed at this level. . .(P)ublic policy making must be sought at those levels in the structure of decision where the knowledge is. . . (T)he technological bias of our social attitudes and administrative programs make it easy for technical judgments to become social decisions without adequate appraisal of the implied consequences."

See also M. Harrington, supra, n. 157.

This is partly compensated for by deliberately structuring institutions around these people to protect them from their own lack of knowledge --although these institutions are by no means sufficiently knowledgable.

> "But even with a President and a Vice-President who are firmly on record as advocates, the program is not automatically guaranteed clear sailing in the executive branch. The Executive Office of the President is not an open door to budget suppliants in NASA and

effort that will be brought to bear to impose partisan demands on the assessment process (forum proceedings) of such entity.[168] In the Congressional hearing (assessment forum) certain possibilities seem apparent. If a given Congressional committee or sub-committee should tend to rely primarily upon the analysis and recommendations of a particular "impartial" assessment entity, then interested participants would surely make every effort to be heard and to influence the assessment outcomes of such entity. At the other extreme, the "impartial" assessment entity might be viewed by the committee or sub-committee as "just another witness," in which case the entity would enter the Congressional assessment forum as a partisan participant, although with a different perspective from the usual interest-oriented witnesses. In the latter situation the adversarial proceeding would focus at the Congressional hearing level rather than in the forum of the "impartial" assessment entity. But it is simply a matter of at what level and to what extent the adversarial system enters the assessment

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> Defense or other agencies who have space plans to push. Of course their requests are heard. But these requests are screened for the President by a variety of institutional safeguards whose very purpose is to protect a President from his own enthusiasms and from the persuasiveness of a particular subordinate official. The Bureau of the Budget is a professional "no" agency; otherwise the limit to federal expenditures would be almost impossible to fix short of disaster.
>
> ". . .The consequence is that it is most difficult to establish new forward commitments in the executive branch. The desire is there, perhaps, but the realities of total national needs are a strong constraint." Rep. Daddario, supra, n. 133, p. 16.

Of course, Congress cannot rely on such a "no" agency since it doesn't have one--except itself.

168 The pressures that can be brought to bear upon the ultimate assessment/decision entity is well illustrated in the fluoridation controversy. See Wollan, "Controlling the Potential Hazards of Government-Sponsored Technology," 36 Geo. Wash. L.R. 1105, 1125, 1130 (1968) (Reprint No. 2, Program of Policy Studies in Science and Technology, July 1968.)

process. Partisan claims will be made or, at least, heavy pressure will be brought to bear to have them heard. Hence, the "impartial" assessment entity in all probability cannot escape the adversarial procedure.[169] Either its own assessment process will have to provide for adversarial procedures or it will have to enter the Congressional assessment forum as one of multiple participants in an adversarial assessment context. It may, nevertheless, be plausibly maintained that while the conventional partisan inputs to the Congressional assessment forum are indispensable, there is clearly further need for one or more "disinterested, public-interest-oriented" assessment entities which can provide the Congress with a full spectrum of prospective impacts of proposed technological applications. Yet it would seem most unlikely that in our political system such an "unbiased" assessment entity could operate as a

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[169] Without positing a particular model of an assessment arrangement it is not feasible to identify the specific difficulties or issues which would arise with respect to concept, prescribed functions, organization and operations. Assuming the possibility of the establishment of a more highly institutionalized and centralized assessment function than now exists, surely past experience with official entities such as courts and the regulatory agencies would be suggestive in identifying the types of issues which might arise. In this connection such articles as that of A. Everette MacIntyre, "The Status of Regulatory Independence," 29 Fed. Bar Jou. 1 (1969), would be useful. And on the further assumption that the new assessors would have objectives similar to those of Federal Trail Examiners in the technologically oriented regulatory agencies and would be confronted with conceptual and operational questions with which such examiners have had to contend, careful attention to John W. Macy's article, "The APA and the Hearing Examiner: Products of a Viable Political Society," 27 Fed. Bar Jou. 351 (1967) would seem warranted.

And in terms of process and the relationship of scientific or technical "facts" to decisional criteria, the article of Harold L. Korn, "Law, Fact, and Science in the Courts," 66 Col. L.R. 1080 (1966) is highly relevant. This article treats in major subheadings: I. Transmitting Technical Information; II. Applying the Scientific Knowledge to Decision of the Legal Issue; and III. Scientific Knowledge as Law or Fact.

decisive assessment instrumentality in isolation from partisan claims.[170] In any event, the shifting interaction in the assessment process between the inputs of adversarial system on the one hand and the inputs of a supposedly disinterested public interest-oriented assessment entity on the other, is deserving of continuing careful examination.[171]

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[170] Hugh Folk, in a paper entitled The Role of Technology Assessment in Public Policy, pp. 4-5, 9, 10, delivered at the AAAS Meeting on December 29, 1969, addresses this point in the following fashion:

> "No matter how objective an assessment might be, it will become embroiled in political controversy if the matter is important.
>
> . . . . . .
>
> "It would seem to me wise to accept as a political fact that any assessment of an interesting problem is likely to be embroiled in controversy. Those who wish to engage in such exciting activities should look to their flanks. When they prepare assessments they should employ 'no men,' devil's advocates, and experts on 'the intentions of the enemy.'
>
> ". . .if technology policy is to be forged in the fire of political controversy, then a responsible technological opposition must constitute itself. These counter assessors must separate themselves from the closed, coopted, scientific and technological elite that pretends to be above or beyond politics and ally with those political interests and politicians whose objectives are consonant with survival, prosperity, and liberty as the counter-assessors perceive these goals. They must train themselves in the skills, the arts, and even the wiles of the assessment process."

[171] See discussion of the "notion of 'Independence' of the Assessment Function" in the Statement of Professor Louis H. Mayo, "Some Legal, Jurisdictional, and Operational Implications of a Congressional Technology Assessment Component" before the Subcommittee on Science, Research and Development of the House Committee on Science and Astronautics, December 2, 1969. (Staff Discussion Paper 207, Program of Policy Studies in Science and Technology, December 1969.)

Experience with agencies established to protect or promote the "public interest" rather than a special partisan segment of the public, has been something less than an overwhelming success.

An editorial concerning the resort of citizens to the courts rather than to the regulatory agencies, "Back to Caveat Emptor," N.Y. Times, August 24, 1969, E12, Col. 2, states in part--after referring to a study of the Food and Drug Administration which cautioned that exaggerated faith in the FDA "should be dispelled to the greatest extent possible,"--

> "So it should, and the candor of the study is admirable. But where does it leave the consumer? If he believes the findings--and there is no slightest reason for him to doubt them--he may well

Perhaps those who find the adversarial system in conflict with the notion of "demonstrated truths," with a sensitivity toward precision, and with a dispassionate approach to assessment, look forward to a beautiful future wherein sophisticated techniques of automatic data processing, mathematical modeling, systems analysis, and computer simulation will eliminate the need for adversarial system and obliterate the advocates, particularly the lawyers. But perhaps one shouldn't bet on it.

As the Participant-Computer merges into an operational entity, we shall probably see a somewhat modified form of the adversary system composed

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feel that the nation is fast returning to the rule of caveat emptor that existed before the coming of the regulatory agencies. If he reads Louis M. Kohlmeier's newly published book, 'The Regulators,' he will be sure of it. For the author documents the already familiar thesis that these agencies, set up to protect the public against special interests, tend to forget the public and come to identify themselves with the interests they are supposed to be watching.

"It is understandable, then, that many citizens are concluding that their best resource against damage and deception is the law."

Morton Mintz, in "A Speech Portends Change of Climate," Wash. Post, February 7, 1969, A22, col. 5, writes that:

"The other day, in a talk warning about the location of large nuclear power plants licensed by the Atomic Energy Commission, Senator Edmund Muskie (D-Maine) recognized that 'Government itself develops vested interests which become more concerned with self-perpetuation than with social values. Sometimes economic interests and Government agency interests become so intertwined that the public cannot distinguish between the two.'"

Further, in News and Comment, Science, 29 August, 1969, p. 881, Morton Mintz states:

"It will be recalled that the commissioner, Dr. Herber B. Ley, Jr., said the conflict over the combination anti-biotics was 'between commercial and therapeutic goals.' If he is correct, the Panalba case reaches a great question of our time: In a struggle between public interest and special interest in which the stakes are needless exploitation, injury, and even death to helpless patients, can American institutions function reliably to protect the public?"

of computer-advocates.[172] The model or models employed will differ; the values introduced into the computer as social benefits and costs will differ; thus the outcomes will certainly differ as will the combinations of consequences flowing from such outcomes. While automatic data processing and simulation may lead to the establishment of a greater degree of certainty about some factual situations and relationships, the capability of the computer to vastly broaden the number of alternatives that can be considered with respect to both the effects phase and the normative phase of technology assessment may generate an increasingly greater number of discrepancies, areas of uncertainty, and potential points for disagreement. Advocacy may not yet have reached its hey-day.

Hence, with reference back to de Jouvenel, it seems highly probable that adversarial system has a most promising future in technology assess-

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[172] That new modes of decision-making, designed to reduce uncertainty and clarify options, will be employed is clearly indicated by Daniel Bell, in "The Balance of Knowledge and Power," Technology Review, June 1969, pp. 39-40:

> "In the post-industrial society, there will be new modes of decision-making based on 'intellectual technology.' If technology is defined not just as machines but as a rationalistic attempt at problem solving, using machines, then the new intellectual technology--systems analysis, simulation, decision theory, linear programming, stochastic models--based on the computer will become increasingly important in the analysis of problems and the laying down of alternative solutions."

For a less optimistic view, see Ida R. Hoos, "Automation, Systems Engineering, and Public Administration: Observations and Reflections on the California Experience," 26 Pub. Adm. Rev. 311 (1966).

ment and other phases of the public decision-making process, whether the advocacy is performed by the "ascendant technologist" or the "obsolescent lawyer." [173]

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[173]See Jones, Advocacy in Technology Assessment, Staff Discussion Paper 209, Program of Policy Studies in Science and Technology, November 1970.

STANDARD TITLE PAGE FOR TECHNICAL REPORTS	1. Report No. GWPS-M 5	2. Govt. Accession No.	3. Recipient's Catalog No.

4. Title and Subtitle

Scientific Method, Adversarial System, and Technology Assessment

5. Report Date April 1970

6. Performing Organization Code

7. Author(s) Louis H. MAYO

8. Performing Organization Rept. No.

9. Performing Organization Name and Address

Program of Policy Studies in Science & Technology
The George Washington University
Washington, D. C. 20006

10. Project/Task/Work Unit No.

11. Contract/Grant No. NASA NGL 09-010-030

12. Sponsoring Agency Name and Address

National Aeronautics & Space Administration
400 Maryland Avenue, S.W.
Washington, D. C.

13. Type of Report & Period Covered

14. Sponsoring Agency Code

15. Supplementary Notes

16. Abstracts The purpose of this paper is to examine scientific method and adversarial system as techniques of inquiry in the process of technology assessment. Scientific method is an obvious mode of inquiry with respect to the factual and predictive elements of technology assessment and may have some degree of usefulness even in determining existing and emerging patterns of social interests. But what utility, if any, does scientific method have in the selection and ordering of social values or goals? On the other hand, adversarial system, or advocacy in the broad sense, will be utilized in the assessment forum for the purpose of gaining recognition for certain types of effects of given technological applications and persuading the assessment entity to apply evaluative criteria to such effects (in terms of magnitude and social desirability) which will reflect the advocate-participant's preferences. In general, this paper advances the thesis that situations of uncertainty as to facts and differences in social value preferences among participants affected by prospective assessment outcomes will inevitably lead to and involve the adversarial system as a technique of inquiry in the process of technology assessment.

17. Key Words and Document Analysis. 17a. Descriptors

17b. Identifiers/Open-Ended Terms

17c. COSATI Field/Group

18. Distribution Statement	19. Security Class (This Report)	21. No. of Pages
Releasable to public without limitation. Initial distribution from Program of Policy Studies; all subsequent copies only from Clearinghouse.	UNCLASSIFIED	114
	20. Security Class (This Page) UNCLASSIFIED	22. Price $3.00