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ABSTRACT

Education's investment in technology is massive. There is growing interest in something called technology assessment, or the evaluation of the environmental consequences (usually second order consequences) of human activities and actions. The investigators conducted a study of the literature of technology assessment to determine the applicability of the theory and methodology of technology assessment to education. Five topics are included in the report of the study. First, a description of the multiple definitions of technology assessment is given. Second, a discussion of the stated and implicit purposes of technology assessments is offered. Third, the assumptions upon which technology assessments are based are explicated. Fourth, the methodology being proposed is examined. Finally, the possible consequences that might occur from educator use of technology assessment are described. (Author)

EVALUATING SECOND ORDER CONSEQUENCES:

TECHNOLOGY ASSESSMENT AND EDUCATION

by

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Technology has become an inexorable part of our culture, with ramifications affecting all aspects of our society. Education has not been immune from this trend. Never before have teachers, learners, and administrators had more hardware, software, courseware, and instructional development strategies available to them. Technology has been able to solve significant problems, both inside and outside education, but there is a growing awareness that, in solving these problems, technology also produces unanticipated side effects. A movement for technology assessment, the evaluation of consequences that may flow from human activities and actions, has emerged in order to reduce the probability of being surprised by such side effects.

The technology assessment movement has generally occurred outside the context of education, and those supporting the movement believe that by anticipating the second order consequences of technology, interventions may be instigated that enhance those side effects which are beneficial, while avoiding those side effects which are detrimental. In this essay, we attempt to review those aspects of technology assessment that seem particularly relevant to education. We first explore the origins, meaning, and methodology of technology assessment and then examine its purposes, assumptions, and potential consequences.

We raise questions about technology assessment that educators may soon be forced to confront. We assume the idea of technology assessment has a place in education, a place that may be sought by educators or thrust upon them. And although the questions we raise are anchored to the concept of technology assessment, we suspect they may also pertain to many other kinds of evaluation.

Origins

The term technology assessment emerged during hearings by the House Subcommittee on Science and Astronautics which were initiated in 1965. The hearings were conducted in order to determine ways of improving science-technology policy and occurred in times marked by increasing concern for environmental degradation and the appearance of a burgeoning literature on the consequences of technology. Much of this literature hypothesized general effects of technology such as its creating a more diverse, transient, and novel environment (Toffler, 1970); producing shifts in human values (Mesthene, 1968); raising the complexity and uncertainty of social institutions (La Porte, 1971); generating an ethos of planning (Taviss, 1968); modifying the nature of religious symbolism (Cox, 1971); and causing increased pressure for intellectual pursuits and the centralization of research and development (Bell, 1964). In addition, some of this literature postulated a number of negative effects, such as technology's helping to create large, unresponsive bureaucracies (Fromm, 1968), accelerate the rate of social change beyond the limits of human endurance (Toffler, 1970), and establish conditions which make a "tyranny of experts" possible (Douglas, 1970). Some of these hypothesized negative outcomes have been criticized (Chazar, 1969; Lakoff, 1966).

It is not our purpose here to recount the history of technology assessment. That has been done elsewhere (Hahn & Chalk, 1972; Kransberg, 1969). It is our purpose to point out that technology assessment 1) has increased in popularity, as evidenced by the recent establishment of an International Association for Technology Assessment and the creation of an Office of Technology Assessment for the Cong ss of the United States, and 2) technology assessment has emerged in a social melieu that is not exactly congenial to technology. The social context of technology assessment has been summed up succinctly by a panel of the National Academy of Science which has stated:

> Whereas a few years ago, for example, the idea of a supersonic transport seemed to many the obvious fulfillment of man's airborne destiny, today some who might once have greeted the SST with unbounded enthusiasm are asking whether it is truly a sign of progress to fly from Watts to Harlem in two hours, vibrating millions of ears and windows in between.
>
> (National Academy of Science, 1969, p.1).

Knowledge of the origins of technology assessment is important because, as shall be discussed later, there is a danger that technology assessment may devolve into technology harassment, a gener_l emotional reaction to creating new human capacities (Green, 1972). Technology assessments, like other evaluations, may inevitably unearth problems and failures in whatever is being evaluated, and may often provoke political responses that are overreactive and irrational (House, 1973).

Some of the things that may be evaluated in technology assessments are educational programs and products. For one thing, a number of educators are beginning to urge appraisal of side effects in education. They have advocated evaluation of potential untoward side effects of measurement procedures (Miller, 1970), curriculum materials (Travers, 1973), and the techniques used to create such materials (Locatis, 1973). They have argued that educational evaluations should examine both expected and unexpected outcomes (Stake, 1967), and that the avowed goals of educational programs should at times be ignored to enable evaluators to focus more fully on the entire spectrum of consequences educational programs produce (Scriven, 1973). In addition, a number of individuals, largely outside the field of education, believe that many aspects of education are appropriate to technology assessment. For example, a panel of the National Academy of Engineers (1969) chose educational television and computer assisted instruction as variables for investigation in an early pilot technology assessments study.

The origins of technology assessment, then, suggest a number of critical questions for educators. Is technology assessment a backlash to the creation of new human capacities or is it an attempt to improve human tools? To what extent might technology assessment simply confirm the apprehensions or misapprehensions people have about technology, either through the conduct of assessments or the use of assessment results? What procedures might be instituted to inhibit such tendencies? And how might technology assessment affect the development of new and relatively unsophisticated technologies like the technology of education? Such questions have greater urgency when one considers that, as a result of its hearings, Congress has funded its recently established Office of Technology Assessment for the next five years (Hahn & Chalk, 1972), and that Senator Edward Kennedy, Chairman of the Office's governing board, has mentioned the consequences of behavior modification, a concept central to education, as a potential priority area for investigation by this Office (Congress gears up, 1973).

Meaning

An examination of technology assessment's meaning is essential to being able to come to grips with the many questions the concept presents. Determining the meaning of technology assessment is not easy. First, technology assessment is a relatively new and, hence, uncommon term. It first appeared in 1966 (Huddle, 1970). Second, discrepent definitions of the term occassionally appear in assessment literature. Technology assessment is at times confused with technological forecasting, technology transfer, advanced planning, and other activities (Strasser, 1971). Finally, many of the key terms used in more common definitions have recently acquired new meanings.

Technology assessment is most usually referred to as the identification and evaluation of the effects which might result from the introduction of a technological application into the environment (see, for example, Black, 1971; Coates, 1971; Mayo, 1971). Basically, this means assessing the consequences of human activities and actions. The justification for this conclusion is derived from changes in meanings associated with key concepts in technology assessment definitions. These concepts are technology, environment, and evaluation. As shall be shown, each of the concepts is extremely broad.

Technology

The term technology describes the class of factors or independent variables and causes whose consequences are to be evaluated in technology assessments (Black, 1971). Technology concerns machines, but also includes techniques (Toffler, 1970; Ellul, 1964), and, broadly conceived, may be considered the organization of knowledge to achieve practical purposes (Mesthene, 1970), human skill (Odum, 1970), and a systematic way of altering the environment (National Academy of Engineers, 1969). Some kinds of technology may primarily alter the physical environment, while others may primarily induce social change. The latter may include such things as national health insurance programs, simulations and games, and group therapy and counseling (Strasser, 1971; Farson, 1967). The development of educational and instructional systems may also be considered technology. Most recent definitions of technology, such as those presented above, are woven together by a common thread in that they all imply human activities and actions and, when taken together, indicate the term technology has environmental and ecological connotations.

Environment

The term environment describes the kinds of consequences or dependent variables and effects that are estimated in technology assessments. Environment may be considered an aggregate of conditions or influences and may consist of things created by nature or artifacts made by man (Simon, 1969). In addition to having natural and artificial components, environment may have physical and social components. Like technology, environment is a very inclusive concept. It means that technology assessment is not only concerned with evaluating the impacts of human actions on nature, but also ascertaining the effects of these actions upon man's artifacts, including his social systems and culture.

Obviously, all evaluations appraise environmental consequences of one kind or another. The difference between technology assessment and other forms of evaluation is the scope of effects examined. Most evaluations focus exclusively on primary environmental effects or the specific goals an action is designed to accomplish. Technology assessments also explore such primary effects but, in addition, investigate the second order consequences that may result from either attaining primary goals or using different strategies to implement primary outcomes. To use an educational example, a typical evaluation of an individualized curriculum may focus only on learner achievement of and attitude toward subject matter. A technology assessment might also examine whether learning or failing to learn the subject matter produces desirable or undesirable effects on the community or whether the individualized approach inadvertantly cuts human interaction below desired levels and impairs learner social skills.

Evaluation

Evaluation is the third key concept in definitions of technology assessment and refers to the process by which estimates of consequences are obtained. Evaluation attempts to appraise worth, describe a program or state of conditions, document how well objectives have been met, and provide useful information to decision makers (Grotelueschen & Gooler, 1972). Evaluation may be viewed as a descriptive process that entails documenting an existing or postulated state of affairs. It may also be considered a process of making judgments related to the desirability of these existing or postulated conditions (Scriven, 1967). To obtain judgments of worth, criteria which various publics use in appraising the value of independent and dependent variables must be determined, standards (the maximum and/or minimum level of performance on a given criterion deemed acceptable to these publics) must be set, and indicators or phenomena representing reality that can be measured or estimated to determine whether standards have been met must be specified (Gooler, 1971).

Technology assessment, then, is an evaluative process that not only entails investigating cause and effect, but also concerns making judgments about the desirability of the potential effects identified (Black, 1971; Mayo, 1971). Further, in technology assessments, as in other forms of evaluation, causality is usually ascribed to specific programs, projects and products, rather than to generalizable principles or scientific laws. The latter are more appropriately within the domain of research (Glass & Worthen, 1972; Weiss, 1972; Stake, 1969). The general process for exploring and judging causality in technology assessments is presented in Figure 1.

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1. Define the assessment task, including scope of inquiry, major problems, and ground rules.

2. Describe relevant features of technologies supportive to and competitive with the major technology to be assessed, as well as the major technology.

3. Develop state-of-society assumptions regarding major non-technological factors influencing the application of the relevant technologies.

4. Identify impact areas, ascertaining those societal characteristics that will be most influenced by the application of the assessed technology.

5. Make preliminary impact analysis by tracing and integrating the process by which the assessed technology makes its societal influence felt.

6. Identify possible action options by analyzing various programs for obtaining maximum public advantage from the assessed technology.

7. Complete impact analysis with an analysis of the degree to which each action option would alter the specific societal impacts of the assessed technology.

Figure 1. The general technology assessment process (Kirchner & Lagerson, 1972).

At least two additional points can be made about technology assessment as an evaluative process. First, like other evaluations, technology assessment is intended to influence policy concerning human activity, but is usually not considered a direct control of human actions. Controls result from decision making and political processes, and for technology include the development of technological fixes, such as pollution control devices, or the inauguration of social interventions (Weinberg, 1969). The latter includes changing the criteria and standards by which technology is judged (Eberhard, 1969) by educating individuals who administer technology to behave differently (Haggerty, 1970), broadening existing legal concepts to set new court precedents (Katz, 1969), exerting political and economic pressures (Nader, 1972), altering existing government policy arenas that ultimately make decisions about technology (Wheeler, 1970), enacting new laws (e.g., the Clean Air Act), and establishing new regulatory agencies (e.g., the Environmental Protection Agency). Second, unlike other kinds of evaluations, technology assessment also frequently entails appraising effects before they actually occur. This is because second order consequences often take longer to materialize than primary effects. Thus, the improved efficiency engendered by a new agricultural device may be evident immediately, while its effects on harvesting patterns and the lives of farm workers may evolve more slowly. The selected summary of second order effects of computer assisted instruction shown in Figure 2 have not yet occurred, but were postulated by a panel of experts on the basis of certain assumed future conditions.

Impacts On:

Institutions of higher education:

Increased cost	F̸LC
Improved instruction	FL̸C
Physical plant modification	FLC
Closer ties between schools	FL̸C
Destructuring of curriculum	FL̸¢
Extended day, week, and year	FL¢
Need for more TV channels	F̸LC
Standardization and centralization	FLC
Improved continuing education	FLC
Coping with poorly prepared students	FL̸C

Students:

"Impersonal" education	F̸L̸¢
Individualized instruction	FL̸C
Aid for minority-group students	FL̸C
Student-instructor relationship	FL̸¢

Faculty:

Modification of instructor's role	FL̸C
New copyright protection	F̸LC

Industry:

Industry-controlled education	FLC
Development of industries and products	FL̸C

Note: F=Favorable; F̸=Unfavorable; L=Likely; L̸=Unlikely; C=Controllable; ¢=Uncontrollable; ?=Unknown

Figure 2. Excerpts from Impacts and Characteristics of Strategy No. 1 (National Academy of Engineers, 1969, p.44).

The meaning of technology assessment, like its origins, also suggests crucial questions for educators. Most of these relate to technology assessment's interface with decision making and its efficacy as an instrument for prognosticating future effects. These questions will recur in greater detail in later discussions of technology assessment's assumptions, but at a general level include: To what extent do decisions evolve during an evaluation process? Do assessment results and processes "educate" decision makers and others who administer technology? Can assessments be structured to favor results that promote certain goals? And can the domains of evaluation and decision making be neatly demarcated?

Methodology

Technology assessment methodology is presently in rudimentary stages of development and ranges from general assessment guidelines to more specific statistical techniques. This discussion is restricted to general guidelines and factors influencing their application.

Suggested general technology assessment guidelines are currently a conglomeration of prescripts resulting from 1) theoretical technology assessment discussions, 2) analyses of previous government evaluations of technology policy alternatives, 3) reflections upon the methods employed and problems encountered in pilot assessments conducted to date, and 4) related writings on the evaluation of social programs. Pilot assessments have been particularly helpful in extending assessment methodology and have involved evaluating the second order consequences of such diverse variables as orographic snowpack augmentation (Weisbecker, 1972), enzyme food additives (Strasser, 1972), supersonic transports (Chatham, 1971), subsonic aircraft noise abatement procedures, multiphasic health services, and computer assisted instruction (National Academy of Engineers, 1969).

The same general assessment guidelines may be applied in both technology initiated and problem initiated assessments. In technology initiated assessments, evaluators begin with a contemplated action, such as widespread utilization computer assisted instruction, and trace its impacts on a spectrum of problem areas, such as educational expense and student unrest. In problem initiated assessments, evaluators begin with one or two problem areas (e.g., raising education costs and student disaffection) and trace the impacts of one or more strategies for solving the problems. Problem initiated assessments are preferable to technology initiated assessments because the latter easily become unwieldy, since a bewildering array of problem areas typically may be affected by any given action. The focus of problem initiated assessments is easier to establish, as the problem area becomes the benchmark for appraising several problem solutions in light of their secondary effects (National Academy of Engineers, 1969). Problem initiated assessments also have the merit of allowing evaluators to explore alternative actions, rather than focus on one option.

Guidelines

General technology assessment guidelines are essentially of two genres: those that pertain to the construction of a technology assessment system with appropriate agencies and organizations; and those that relate to the conduct of individual assessments. Guidelines related to assessment systems are summarized in Figure 3, while guidelines for individual assessments are summarized in Figure 4. To elaborate upon each of these guidelines is beyond the scope of this document. Instead, our intention is to describe some of the general organizations that have been proposed for establishing an assessment system and expand upon a single guideline related to individual assessments in order to indicate the multitude of considerations incorporated into each summary guideline statement presented.

1. Provide for continuous evaluation (Bauer, 1964; Gross, 1964).
2. Anticipate new developments (Jungk, 1969).
3. Decentralize assessment activities, while also coordinating information flow (Mayo, 1970b; National Academy of Science, 1969; National Academy of Public Administration).
4. Provide for self-renewal (National Academy of Science, 1969).
5. Permit broad participation (National Academy of Science, 1969; Carrol, 1971; Mayo, 1970b; Coates, 1971).
6. Locate the assessment system, especially its coordinating component, near loci of power, while insulating it from political pressures (National Academy of Science, 1969; National Academy of Engineers, 1969; Mayo, 1970b; Kantrowitz, 1967).
7. Provide timely data (United States House of Representatives, 1971).

Figure 3. Guidelines for appraising-constructing assessment systems and information networks.

1. Use a broad range of criteria (National Academy of Engineers, 1969; National Academy of Science, 1969; Jones, E.M., 1970).
2. Utilize adversary proceedings (Mayo, 1970a; National Academy of Science, 1969; Kantrowitz, 1967; Coates, 1971).
3. Assemble multidisciplinary teams (Black, 1971; Coates, 1971; National Academy of Engineers, 1969).
4. Use existing empirical data and scientific theories (National Academy of Science, 1969; National Academy of Engineers, 1969).
5. Conduct experiments (Cambell, 1969; Rivilin, 1971).
6. Structure assessments so as to separate multiple issues and variables (Huddle, 1971).
7. Estimate priorities (National Academy of Engineers, 1969).
8. Examine in detail the inherent characteristics of an action being assessed (Jones, M.V., 1972).
9. Explore a broad range of potential consequences (Mayo, 1971; Black, 1971).
10. Investigate support systems (Jones, M.V., 1972).
11. Explore possible abuses (National Academy of Science, 1969).
12. Calculate the magnitude of the action or activity being assessed (Jones, M.V., 1972).
13. Estimate the controllability of hypothesized adverse effects, (Jones, M.V., 1972).
14. Indicate the amount of uncertainty associated with each hypothesized impact (Jones, M.V., 1972).

Figure 4. Guidelines for appraising-conducting individual assessments.

Guidelines for a technology assessment system have been articulated in a number of proposals for assessment organizations in both government and the private sector. Suggested government assessment agencies include the newly established Office of Technology Assessment, to serve the Congress of the United States, and a technology assessment mechanism for the executive branch. The latter has not been adopted, but would have government bureaus evaluate consequences of programs within their purview and forward these evaluations to the Council on Environmental Quality, which would review assessments and institute interventions under certain conditions (National Academy of Public Administration, 1970). Proposed assessment organizations for the private sector include 1) Civilian Assessment Agencies that would be modeled after the Better Business Bureau and would be empowered to bring lawsuits against those who may be engaged in technological abuse (Mottur, 1972), 2) quasi independent institutes like RAND that would conduct independent studies and issue reports (Mottur, 1972; Kantrowitz, 1967), and 3) Corporate Cassandras or counter commercial development staffs within businesses that would assess corporate objectives in terms of long range social responsibilities as well as short term profits (Keifer, 1971). It has been suggested that both public and private technology assessment organizations might utilize inputs from proposed social indicators (Mondale, 1973). Social indicators would provide evidence as to the quality of life, just as economic indicators provide evidence of prosperity (Bauer, 1964; Panel on Social Indicators, 1969).

As for guidelines pertaining to conducting individual assessments, one states that a broad range of criteria should be applied when appraising the consequences of action options, criteria that should go beyond economic benefits and encompass factors related to the quality of life (National Academy of Engineers, 1969). Several strategies have been suggested to ensure a broad range of criteria are applied. These mainly concern broadening participation in the assessment process. Since different publics have different values, having many publics participate in a technology assessment is one way to increase the chance that multiple criteria are utilized (National Academy of Science, 1969). It may be desirable to select participants on the basis of 1) their having different perceptions of the desirability of the consequences of action options (Jones, E.M., 1970); 2) the different kinds of information contributions they may make (Jones, E.M., 1970); and 3) whether they represent groups both immediately and remotely affected by the actions being appraised (National Academy of Science, 1969). It may also be desirable to select participants whose function is to represent unborn generations in order to reinforce long range perspectives (Jones, E.M., 1970).

Application

Assessment guidelines may be applied in many ways. Some assessments may employ all the guidelines, while others may utilize only a few. Factors affecting guideline use pertain to either practical constraints or philosophical perspectives. Some practical constraints affecting guideline application are the time, money, and talent of evaluators. Broad participation, for example, may be desirable, but evaluators may lack the time and money required to assemble a sufficient number of participants. Some philosophical perspectives affecting guideline application are evaluator beliefs as to the purposes and assumptions of the assessment process. Some evaluators, for example, may believe the public has little to contribute to assessment outcomes and may apply the participation guideline in a way that only involves experts. Other evaluators may shy away from applying another guideline, the use of adversary proceedings, because they believe the techniques of impartial, scientific inquiry will yield more rational, effective results.

Assessment methodology, then, also poses a number of questions for educators. These questions cluster about how guidelines may be applied to enhance the adequacy and effectiveness of the assessment process, rather than how guidelines may be applied to produce objective assessment products. Purely objective outcomes are unlikely, but interventions can be made to ensure outcomes are as objective as possible (Mayo, 1971). But what constitutes an adequate assessment? How might assessments be structured to produce more objective results? What conditions enhance an assessment's effectiveness in evoking responses from decision makers? And in what way do various perceptions of technology assessment's purposes and assumptions influence the application of assessment guidelines and the nature and use of assessment results?

Purposes

Answers to some of the questions regarding assessment methodology are suggested by technology assessment's purposes. However, many more questions become manifest when these purposes are explored. At least three reasons for conducting technology assessments are given in assessment literature. These are that technology assessments will promote ecology, accountability, and rationality. Although these different purposes can be complimentary, they are not always compatible.

Ecology

According to the precepts of ecology, man is part of the ecosystem comprised of interacting subsystems that attempt to maintain a steady state of equilibrium. Furthermore, man, like all species, is affected by perturbations in the ecosystem's steady state. Since all species have limits of adaptive tolerance, man must seek harmony with his environment and avoid actions which jeopardize its equilibrium. As man is able to affect his environment in more powerful ways, due to his increasing numbers and cumulative nature of his knowledge and skill, it becomes more important for him to receive both positive and negative feedback (Odum, 1971). The danger of destroying the steady state beyond the limits of human adaptability pertains to man's relationships with his social as well as physical environment. Toffler (1970), for example, has hypothesized limits to human endurance of social and technological change and presents evidence which suggests mental and physical disorders occur when these limits are exceeded.

The achievement of ecological balance as a reason for conducting technology assessments is evidenced by the frequent appearance of key ecology terms in assessment literature. Thus, Congressman Emillio Daddario, the man attributed with coining the term technology assessment, and the man who oversaw early Congressional inquiries into its feasibility, has written about technology assessment in the context of avoiding catastrophic departures from the steady state and the need to balance competition and cooperation among individuals and nations (Daddario, 1971). Franklin P. Huddle, a participant in many of these inquiries, has discussed technology assessment in terms of man's compatability with the environment and the need to attain more or less dynamism in the steady state at any given time (Huddle, 1970). Moreover, it would appear that the concept of technology assessment is itself an embodiment of key ecological concepts. The very idea of evaluating second order consequences gives tacit recognition to interconnecting relationships and interactive effects and would appear to be a precondition for avoiding actions which may destroy environmental harmony. Seen in this way, technology assessment, and perhaps other kinds of evaluations, may be viewed as homeostatic feedback mechanisms that input data which regulate the rate and direction of human growth.

Accountability

The notion of accountability essentially means that public and private decision makers should be more responsible to the people they serve. The simple economic relationship between buyer and vendor may be viewed as a paradigm for accountability. This paradigm involves: 1) disclosure of information concerning a product or service being sold, 2) testing of product or service performance, and 3) redress in the event of false disclosure or poor performance (Glass, 1972).

The attainment of accountability as a reason for conducting technology assessments is also evidenced by the frequent appearance of accountability concepts in assessment literature. Repeated references are made to the importance of disclosure, testing, and redress in writings on technology assessment. The National Academy of Science (1969), for example, has stressed the need for conflict inspiration rather than conflict resolution in evaluating action options and has urged creation of mechanisms for alerting all interests that decisions affecting them are about to be made. Kantrowitz (1967) has advocated the publication of scientific judgments, and the general use of litigation on tort liability has been suggested as a way of seeking public redress for private technological abuse (Katz, 1969). The latter notion has been extended in an aforementioned proposal for Civilian Assessment Agencies that would initiate appropriate lawsuits (Mottur, 1972). Further, when attempts are made to extend participation and employ adversary proceedings, the process of technology assessment may itself be an instrument for accountability. When these guidelines are employed, technology assessments become a means of letting decision makers know how the public feels about the consequences of contemplated activities and actions that have already been undertaken.

In addition, broad participation and adversary proceedings are ways to thwart the power of vested interests, extend the criteria for making technological choice, and input judgment data into the assessment process (National Academy of Science, 1969).

Rationality

Rationality has been called the quality of being rational, which, in turn, implies the ability to reason logically and draw conclusions from inferences. Rationality has also been called the habit of taking into account all relevant evidence in arriving at a belief. This means that facts and probabilities should be ascertained by objective methods, methods which would lead any two careful people to the same result (Russell, 1961). Rationality, then, may be said to be characterized by attempts to obtain evidence objectively, reason logically, and draw inferences from data. This includes checking the reliability and validity of information and the compatibility of conclusions with evidence prior to inaugurating a course of action.

As is the case with ecology and accountability, extending rationality is also advanced as a reason for conducting technology assessments. Thus, Huddle (1970) has called technology assessment a rational approach to managing technology; and the introduction to Technology Assessment: Understanding the Social Consequences of Technological Applications, a collection of papers from an early seminar on technology assessment, specifically mentions the promotion of more rational policy as an assessment purpose (Kasper, 1972). In addition, assessment methodology exudes many characteristics of rationality. In the general technology assessment process (Figure 2), attempts are made to gather empirical evidence about technology and society, explore alternatives, and logically infer relationships.

Although ecology, accountability, and rationality have all been suggested as purposes for technology assessment, this does not mean that any given assessment will simultaneously serve all these purposes. Some assessments may serve certain purposes more than others, depending on evaluator beliefs. For example, some evaluators may believe in accountability and, therefore, structure evaluations so as not to confront ecological issues if their constituents prefer economic growth to environmental balance. Other evaluators may believe broadening participation is the best way to weaken the irrational influence of vested interests, while still other evaluators may believe in restricting participation because they fear the inclusion of uneducated and unknowledgable individuals may impair rationality. Questions emerging from such potential conflicts in purpose include: How will different decision maker and evaluator perceptions of technology assessment's purposes affect the use of assessment results and the structuring of assessment processes? Will certain guidelines, like broad participation and adversary proceedings, produce results that favor certain purposes? Will evaluator perceptions of purpose bias them in applying guidelines and structuring assessments or in attending to data they collect? And how can assessments be structured to best serve the conflicting purposes that are characteristic of a democratic, pluralistic society?

Assumptions

Many assumptions are embedded in the idea of evaluating second-order effects. Two assumptions, however, are particularly prominant. One is the assumption that man has some capacity to prognosticate the future. Another is that assessment results can affect policy. Both of these assumptions are afflicted with a number of limitations. Although these constraints are not always evident in assessment literature, they are suggested in related writings on future forecasts and the influence of information on decision making. They also raise questions pertaining to the use of adversary proceedings in evaluation.

Forecasts

The assumption that man can make reasonable forecasts of the future is important to technology assessment, since second order consequences often take longer to manifest themselves than primary outcomes. Forecasts of such consequences are not predictions, but are conjectures about possible future conditions. In recent years, a number of forecasting tools have been devised, including the Delphi and Cross Impact Matrix (Sandow, 1970). Despite their provision for diminishing the influence of personalities and their attempts to be systematic, the results of these and other forecasting techniques are often limited (Weaver, 1972; Folk, M., 1970). These limitations apply to technology assessment, especially when technology assessment concerns the evaluation of contemplated future actions instead of appraisal of existing activities.

Perhaps the most stringent limitation of forecasts is that the quality of results depends upon the quality of information originally input into the forecasting process. Since much of this information is human conjecture, the results of forecasts depend upon who has participated. Different participants will produce different forecasts. The problem is that there is no way of identifying individuals with "superior" forecasting powers (Weaver, 1970). Further, all information based on human judgments becomes more tenuous when related to increasing expanses of future time (National Academy of Engineers, 1969).

A second limitation is that forecasting techniques do not predict (Tanenbaum, 1970; Wolfson, 1969). It is impossible to say with certainty that a forecast is an accurate portrayal of the future. However, forecasting tools can assist planners in clarifying their thinking by making them aware of alternatives and by alerting them to possible occurrences that may affect their plans. Thus, although the outputs of Delphi and other forecasting techniques are often difficult to substantiate as accurate estimates of the future, these processes may assist individuals in thinking about the future in more complex ways and, therefore, may be useful pedagogical devices (Weaver, 1972).

The limitations of forecasting tools have implications for technology assessment. First, like other forecasting methodologies, technology assessments cannot predict, but can generate conjectures of future conditions that may be useful in planning. Second, technology assessments will only be as good as the judgments and data input of participants. Third, technology assessments will become more questionable as they move beyond postulating primary outcomes and immediate side effects to hypothesizing more remote consequences.

Influence of Information

The assumption that decision makers will be affected by evaluative information is important to technology assessment because such evaluations are intended to yield data on secondary consequences that may modify decisions that would otherwise be based solely on the ability of a given activity to implement primary goals. The assumption that decision makers will be influenced by such information entails making additional assumptions as to how adequate and objective assessments may be and the degree to which policy formation may be considered a rational process. If rationality is characterized by seeking and attending to objective and perhaps dissonant information before acting (Lane & Sears, 1964), then much of the literature on public opinion and bureaucratic behavior indicates there may be critical limits to rationality in the policy process (Lindblom, 1968) and to the influence of assessment results.

One limitation to rationality is that any given individual's collection of knowledge is a balance between the need to know and the need not to find out. Lane and Sears (1964) have suggested people need to know or not know for irrational reasons, and this affects the information they avoid and seek. Thus, individuals may seek information to use as an aggressive weapon against others, improve their self esteem, or selectively reinforce a preconceived ideological framework. They may avoid information that raises ambiguity of situations above tolerable levels, challenges biases or satisfaction with the *status quo*, or contains threatening or objectionable stimuli. Such information approach-avoidance behavior is important, because people often form opinions first and then seek supportive data.

Although the generalizations above may hold true for the general public, Lane and Sears have noted the generalizations may not necessarily be true for decision makers. For one thing, individuals of higher socioeconomic status tend to have better mental health, and it is likely more of these people have decision making power. For another, decision makers, unlike most people in society, have responsibility for both having opinions and acting on the basis of these beliefs. Decision makers, therefore, are probably under more pressure to be well informed. Still, many of the information approach-avoidance factors may operate in decision making situations, especially when one considers certain tendencies in bureaucratic behavior.

Demand and acceptance of information by bureaucracies and organizational decision makers is influenced by their perceptions of 1) the need for the data; 2) the benefits of having the data as opposed to its acquisition costs; 3) the relevancy of the data to organizational goals; and 4) the extent to which the data conforms to their biases and advances their vested interests (Downs, 1967). Another factor influencing decision maker acceptance of information is decision maker perceptions of the information source (Lane and Sears, 1964). All of these factors indicate there are not only limits to the influence assessments may have, but also suggest the assessment process itself may be subject to several constraints, especially when assessments produce data dissonant with decision maker beliefs. Individuals may take a variety of actions to reduce this dissonance. They may change their opinions, distort the data, or derogate the information source (Lane and Sears, 1964).

The problem of rationality is further confounded by the fact that the decision to inaugurate an assessment is likely to be political; i.e., inspired or affected by vested interests, and that individuals participating in assessments may fear reprisals from powerful interest groups and be sensitive to the biases of the decision makers they are to serve (Folk, H., 1972). Cyert and March (1965) have pointed out a tendency for experts to have their judgments about uncertain savings and costs colored by their perceptions of decision maker attitudes and predilections. Research on special government commissions indicates those commissions often tend to ignore information unfavorable to the individuals to whom their reports are addressed (Lipsky & Olsen, 1968). In addition, it is almost inevitable that experts who participate in assessments will be drawn from interests involved in a problem and that many times these experts will have created the problem. Such a condition potentially introduces bias and further limits rationality of assessments (Folk, H., 1972).

Adversary Evaluation

Limitations to the effects of information on decisions are associated with two different schools of thought concerning the conduct of assessments. The first school would erect barriers against political contamination by stressing the conduct of impartial inquiry by experts in what would be an essentially "scientific" approach. The second would incorporate political considerations into the assessment process by broadening participation and employing adversary proceedings in what would be an essentially "legal" approach.

There is little evidence that indicates what applications of assessment guidelines, and hence which approach, improves the adequacy and effectiveness of assessments. One study suggests adversary proceedings produce evaluations that tend to be judged as more adequate by experts (Kourilsky, 1973). In addition, one author, after analyzing scientific and legal modes of inquiry, has concluded that more aspects of issues tend to be examined in legal, adversary proceedings, and that such proceedings include increased efforts to avoid bias (Allen, 1972). The author of the analysis cites the Jensen controversy as an example of what may happen to individuals who fail to follow prevailing popular scientific zietgiests. Coleman (1972), however, has cited the same example as evidence that adversary proceedings are an inherent component of scientific inquiry. Perhaps formal adversary proceedings may enhance the adequacy of assessments, if used at the beginning of the assessment process, to identify issues and points of contention, and at the end of the assessment process to provide quality control.

It is uncertain what effects adversary proceedings may have on acceptance of results. Such proceedings may generate a tendency to comply with whatever decision is eventually made because people may perceive the outcomes as more legitimate, since they have been given their "day in court." There is evidence people tend to accept decisions more when they believe they have had inputs into whatever decisions are made (Laswell and Kaplan, 1950).

There are at least three ways of examining the conflict over participation and adversary proceedings. One way is to note broad participation and adversary proceedings are probably unavoidable when evaluations involve politically hot issues. For example, groups adverse to findings of Presidential Riot Commissions have frequently conducted counter studies. In one instance, President Johnson disagreed with the results of his own commission and established a new commission to restudy the problem (Lipsky & Olson, 1968). Another way of examining the conflict is to note adversary proceedings can be as closed and one sided as expert inquiry. They may be <u>pro forma</u> activities designed to make people believe they have had input into decisions that have already been made. A final way of examining the conflict is to note that adversary and inquiry approaches are not necessarily incompatible.

The conduct of expert inquiry does not negate use of adversary proceedings, and utilization of adversary proceedings does not preclude inquiry by experts.

Questions emerging from technology assessment's assumptions, then, concern the extent to which technology assessment should be regarded as a predictive tool, planning aid or pedagogy, and ways in which the assessment methodology interacts with the adequacy and effectiveness of assessment results. The latter include: Is there a relationship between the adequacy of assessments and the acceptance of assessment findings? Will adversary proceedings increase the adequacy and effectiveness of assessments? If so, how and when should adversary evaluations be conducted? How might scientific and legal modes of inquiry be conjoined to maximize adequacy and acceptance? How can adversary proceedings be kept from becoming pro forma activities? And how can adversaries be equalized?

Consequences

Ironically, the evaluation of second order consequences may produce its own side effects. These have not been systematically investigated and have been mentioned only occassionally in hearings and studies which Congress has conducted and commissioned (Huddle, 1971; National Academy of Public Administration, 1970; National Academy of Engineers, 1969; National Academy of Science, 1969). A technology assessment of technology assessment is beyond the scope of this essay. However, a few speculations will be advanced, speculations which are exceedingly general, since the assessment system that may serve society is presently undefined. If technology assessments become commonplace, a number of political, economic, socio-cultural, and technological impacts might occur in both society and education.

Political Impacts

The political impacts of technology assessments will probably hinge on the extent to which participation is encouraged. Broadening participation may increase political conflicts over individual decisions, since the act of inviting various interests to participate may induce them to mobilize themselves into political forces. Although conflicts may increase over individual decisions, the resolution of these conflicts may promote long term stability, depending upon the authority originally ascribed decision makers and assessors by the general public (Laswell & Kaplan, 1950). On the other hand, restricting participation to experts may increase the danger experts would be captured by vested interests, depending upon the relationship between the experts and these interests. For example, there are limits to the extent to which independent organizations of experts like RAND can be co-opted by vested interests, since multiple and conflicting interests are often simultaneously served by these organizations (Downs, 1967). Regardless of the breadth of participation, assessments may increase the time required to arrive at decisions, although time requirements will probably be larger for assessments involving diverse groups.

Political impacts in education would probably be similar to those of society described above. In addition, if assessments in education predominate which stress participation and adversary proceedings, the political involvement such procedures may generate may weaken the influence of professional educators and cause control of education to devolve from existing power groups to other interests.

Economic Impacts

Assessments may directly or indirectly raise living costs. Pilot assessments funded by the National Science Foundation have cost between 150,000 and 250,000 dollars each (Coates, 1971). Such costs are likely to be borne directly by the public, since knowledge production involves forays into the unknown which often yield uncertain benefits, making private enterprise reluctant to risk such expense (Rosenberg, 1972). Even if private corporations undertook technology assessments, they would be unlikely to disclose findings that may help competitors, and would probably raise prices in order to pay assessment costs. Less direct increases in costs may accrue if legal sanctions are imposed on the basis of assessment outcomes. For example, pollution has not been considered a production cost. Fines and lawsuits may force companies and individuals to internalize what heretofore have been treated as external expenses, thereby increasing the costs of goods and services (Katz, 1969).

It is likely the costs of assessments would initially increase educational expense. Data derived from such evaluations, however, may prevent costly mistakes, reducing costs in the long run. Still, the high costs of assessments may only make them warranted for nationally developed curricula, like the Biological Science Study, or generalizable teaching strategies, like token economies, that may potentially affect a large audience. As for indirect costs, the notion of schools being responsible for primary outcomes is only beginning to be tested. Although it is conceivable that schools may eventually also be accountable for side effects, holding educators liable for side effects would probably be unreasonable and premature until educational technology has demonstrated its ability to first effectively produce primary outcomes.

Socio-Cultural Impacts

Widespread evaluation of second order consequences may eventually affect the ways individuals perceive themselves and their environmental relationships. The rate of change may be lowered in a society committed to take more time to think through consequences before initiating actions. Such a society may also become more conservative, depending on its tolerance for ambiguity. Consequences of contemplated actions are more difficult to determine than those of existing activities, and their appraisal may make individuals more aware of future uncertainties. Assessments may inadvertantly reinforce behaviors which tend to preserve the *status quo*, if assessments of future alternatives focus exclusively on costs while ignoring benefits, and if assessments of existing activities are not also conducted.

Technology assessments in education may affect educational goals. First, open assessments with broad participation may buttress the conception of education as a tool for transmitting social tradition, rather than an instrument for social change. Although some of the multiple publics served by education may expect education to function as a catalyst for change, it is questionable whether most publics would want their values and beliefs substantially altered in their children. Second, enhancing awareness of second order consequences may itself become an educational aim. Haggerty (1970), for example, has suggested training in social problems become a more integral component of the curricula of scientists and engineers. Postman and Weingartner (1971) have advanced a prospectus for a Ph.D. in Media Ecology, involving the study of media and its social effects. Black (1971) has suggested technology assessment is emerging as a generalist type of expertise that may become a discipline.

Technological Impacts

Technology assessment may have two consequences for technology in society and education. It may slow the rate at which innovations are introduced into the environment or redirect the development of these innovations. In the former circumstance, research and development of innovations may rapidly continue, but their introduction may be delayed until their consequences are evaluated. In the latter circumstance, assessments may either cause curtailment of development of innovations considered undesirable or trigger new development efforts in order to deter or modify any deleterious consequences that may be identified.

When the introduction of an innovation is delayed, society may be deprived of its benefits, while being saved the costs of its potential detrimental effects. Previous assessments of the Salk vaccine and Thalidamide indicate that the greater the public need for an innovation, the less likely its introduction will be delayed, and therefore, it is unlikely assessments will deprive society of an innovation's benefits. So great was public demand for the Salk vaccine, that its evaluation was haphazard and rushed, while the assessment of Thalidamide took longer, since its evaluators were under no such stress (Huddle, 1971). Such a tendency may induce purveyors of certain innovations to attempt artificially increasing public demand in order to influence the methodology and effects of technology assessments.

Assessments may be potentially more hazardous when they concern research and development activities. First, it is often impossible to identify the outcomes of research and development activities in advance. Discoveries may be made that have no apparent utility, only to be put to use later to attain desirable or undesirable social goals. Second, needs change. What is unwanted today may be a necessity tommorow. Finally, new discoveries may be made or new social strategies invented, as research and development proceeds, that may control hypothesized adverse effects. It may be important to distinguish between assessments related to the introduction of innovations into the social milieu and assessments concerning research and development, since prematurely applying evaluative criteria in the latter instance may inhibit experimentation required to solve the problems man confronts (Green, 1972). Solutions to these problems may require more experimentation, not less (Campbell, 1969).

Many unanswered questions remain concerning technology assessment's second order effects, questions which should be more easily resolvable as the concept is further defined. These questions concern the effects assessments may produce on the level of political conflict, time requirements in decision making, political control, costs, and the direction of research and development. They also concern the conditions under which assessments may be economically feasible, lead to preservation of the status quo, and create emotional reactions to experimentation and the creation of new human capacities.

Summary

We have attempted to transverse the concept of technology assessment and raise questions along the way. We have terminated our journey where it began, questioning the potential effects evaluating second order consequences will have on technology - especially on emerging technologies like the technology of education. As is probably evident, we have a certain ambivalence toward the concept. On the one hand, we are intrigued by the potential contributions of technology assessment to the improvement of decision making.

On the other hand, we are reluctant to approach the concept uncritically and are concerned about how assessments should be conducted and the effects assessments may produce. Hopefully, the questions we have raised will prompt others to research and explore the concept and increase the probability assessments are conducted in more effective and beneficial ways.

Bibliography

Allen, A. Scientific versus judicial fact finding in the United States. IEEE Transactions on Systems, Man, and Cybernetics, 1972, 2 (4), 548-550.

Bauer, R. Social indicators. Cambridge, Massachusetts: M.I.T. Press, 1964.

Bell, D. The post-industrial society. In E. Ginzberg (Ed.), Technology and social change. New York: Columbia University Press, 1964.

Black, G. Technology assessment--What should it be? Program of Policy Studies in Science and Technology (Staff Discussion Paper 211), Washington, D.C.: The George Washington University, June 1971.

Campbell, D.T. Reforms as experiments. American Psychologist, 1969, 24 (4), 409-429.

Carrol, J.D. Participatory technology. Science, 1971, 171 (3972), 647-653.

Chaszar, E. Science and technology in theories of social and political alienation. Program of Policy Studies in Science and Technology (Staff Discussion Paper 401), Washington, D.C.: The George Washington University, June, 1969.

Chatham, G. The supersonic transport. In Huddle, F., Technical information for congress. Washington, D.C.: United States Government Printing Office.

Coates, J.F. Technology assessment: The benefits...the costs...the consequences. The Futurist, 1971, 5, 225-231.

Coleman, J. Public policy and social science. Paper presented at the meeting of the American Association for the Advancement of Science, Washington, D.C., December 1972.

Congress gears up to assess technology. Business Week, 1973, 2262, 60-62.

Cox, H. The virgin and the dynamo revisited: An essay on the symbolism of technology. Soundings, 1970, 56, 125-145.

Cyert, R.M. & March, J.G. A behavioral theory of the firm. Englewood Cliffs, New Jersey: Prentice-Hall, 1963.

Daddario, E.Q. Priorities for the future. In 1971 Britannica yearbook of science and the future. New York: Encyclopedia Britannica, 1971.

Douglas, J.D. General introduction. In J.D. Douglas (Ed.), Freedom and tyranny: Social problems in a technological society. New York: Alfred A. Knopf, 1970.

Downs, A. Inside bureaucracy. Boston: Little, Brown and Company, 1967.

Eberhard, J.P. Man centered standards for technology. Technology Review, 1969, 71, 51-55.

Ellul, J. The technological society. New York: Vintage Books, 1964.

Farson, R.E. Emotional barriers to education. Psychology Today, 1967, 1 (5), 32-35.

Folk, H. The role of technology assessment in public policy. In A.H. Teich (Ed.), Technology and man's future. New York: St. Martin's Press, 1972.

Folk, M. A critical look at the cross impact matrix method. Educational Policy Research Center (Working Draft), Syracuse, New York: Syracuse University, April 1971.

Fromm, E. The revolution of hope: Toward a humanized technology. New York: Bantam Books, 1968.

Glass, G.V. The many faces of educational accountability. Phi Delta Kappan, 1972, 53, 636-639.

Glass, G.V. & Worthen, B.R. Educational evaluation and research: Similarities and differences. Curriculum Theory Network, 1971-1972, 8-9, 149-165.

Gooler, D.D. Some uneasy inquiries into accountability. In L.M. Lessinger & R.W. Tyler (Eds.), Accountability in education. Belmont, California: Wadsworth Publishers, 1971.

Green, L. Technology assessment or technology harassment: The attacks on science and technology. In R.G. Kasper (Ed.), Technology assessment: Understanding the social consequences of technological applications. New York: Praeger Publishers, 1972.

Gross, B.M. The state of the nation: Social system accounting. In R. Bauer (Ed.), Social indicators, Cambridge, Massachusetts: M.I.T. Press, 1964.

Grotelueshen, A.D. & Gooler, D.D. Evaluation in curriculum development. Curriculum Theory Network, 1971-1972, 8-9, 7-21.

Hahn, W.A. & Chalk, R.A. The technology assessment act of 1972. Washington, D.C.: Library of Congress, Congressional Research Service, February 6, 1972.

Haggerty, W.J. Educating technologists in desirable social policy and educating social scientists in technological capabilities. In J.C. Charlesworth & A.J. Eggers, Jr. (Eds.), Harmonizing technological developments and social policy in America. American Academy of Political and Social Science (Monograph 11), Philadelphia, Pennsylvania: American Academy of Political and Social Science, December 1970.

House, E. School evaluation: The politics and process. Berkeley, California: McCutchan Publishing Corporation, 1973.

Huddle, F.P. Government technology assessment: The role of the social sciences. Washington, D.C.: Library of Congress, Congressional Research Service, October 2, 1970.

Huddle, F.P. Technical information for Congress. Washington, D.C.: United States Government Printing Office, 1971.

Jones, E.M. Advocacy in technology assessment. Program of Policy Studies in Science and Technology (Staff Discussion Paper 209), Washington, D.C.: The George Washington University, November, 1970.

Jones, M.V. The methodology of technology assessment. The Futurist, 1972, 6, 19-21.

Jungk, R. Lookout institutions for shaping the environment. Futures, 1969, 1, 227-231.

Kantrowitz, A. Proposal for an institute of scientific judgment. Science, 1967, 156, 763-764.

Kasper, R.G. (Ed.), Technology assessment: Understanding the social consequences of technological applications. New York: Praeger Publishers, 1972.

Katz, M. The function of tort liability in technology assessment. University of Cincinnati Law Review, 1969, 38 (4), 587-662.

Kiefer, D.M. Assessing technology assessment. The Futurist, 1971, 5, 234-239.

Kirchner, E. & Lazerson, N. Technology assessment at the threshold. Innovation, 1972, 27, 14-27.

Kourilsky, M. An adversary model for evaluation. Paper presented at the meeting of the American Educational Research Association, New Orleans, February 1973.

Kransberg, M. Historical aspects of technology assessment. Program of Policy Studies in Science and Technology (Occasional Paper No. 4), Washington, D.C.: The George Washington University, August 1969.

Lakoff, S.A. The scientific establishment and American pluralism. In S.A. Lakoff (Ed.), Knowledge and power. New York: Free Press, 1966.

Lane, R.E. & Sears, D.O. Public opinion. Englewood Cliffs, New Jersey: Prentice-Hall, 1964.

LaPorte, T.R. The context of technology assessment: A changing perspective for public organization. Public Administration Review, 1971, 31 (1), 63-73.

Lasswell, H.D. & Kaplan, A. Power and society: A framework for political inquiry. New Haven, Massachusetts: Yale University Press, 1950.

Lindblom, C.E. The policy making process. Englewood Cliffs, New Jersey: Prentice-Hall, 1968.

Lipsky, M. & Olson, D.J. On the politics of presidential riot commissions. Paper presented at the annual meeting of the American Political Science Association, Washington, D.C., September 1968.

Locatis, C. Some uneasy inquiries into instructional development. Educational Technology, 1973, 8 (7), 46-50.

Mayo, L.H. Scientific method, adversarial system, and technology assessment. Program of Policy Studies in Science and Technology (Monograph 5), Washington, D.C.: The George Washington University, November 1970. (a)

Mayo, L.H. Commentary on paper by Dr. Seitz. In J.C. Charlesworth & A.J. Eggers, Jr. (Eds.), Harmonizing technological developments and social policy in America. American Academy of Political and Social Science (Monograph 11), Philadelphia, Pennsylvania: American Academy of Political and Social Science, December 1970. (b)

Mayo, L.H. The contextual approach to technology assessment: Implications for 'one-factor fix' solutions to complex social problems. Program of Policy Studies in Science and Technology (Monograph 9), Washington, D.C.: The George Washington University, April 1971.

Mesthene, E.G. How technology will shape the future. Science, 1968, 161 (3837), 135-143.

Mesthene, E.G. Technological change: Its impact on man and society. Cambridge, Massachusetts: Harvard University Press, 1970.

Miller, G. Assessment of psychotechnology. American Psychologist, 1970, 25 (11), 991-1001.

Mondale, W. A Bill, Full opportunity and national goals and priorities act. Senate bill 5.5, January 4, 1973.

Mottur, E.R. Technology assessment and citizen action. In R.G. Kasper (Ed.) Technology assessment: Understanding the social consequences of technological applications. New York: Praeger Publishers, 1972.

Nader, R. The scientist and his indentured professional societies. Bulletin of the Atomic Scientists, 1972, 28 (2), 43-46.

National Academy of Engineers, Committee on Public Engineering Policy. A study of technology assessment. Washington, D.C.: United States Government Printing Office, July 1969.

National Academy of Public Administration, Panel on Technology Assessment. A technology assessment system for the executive branch. Washington, D.C.: United States Government Printing Office, July 1970.

National Academy of Science, Committee on Science and Public Policy. Technology: Process of assessment and choice. Washington, D.C.: United States Government Printing Office, July 1969.

Odum, E.P. Fundamentals of ecology. Philadelphia, Pennsylvania: W.B. Saunders, 1971.

Panel on Social Indicators. Toward a social report. Washington, D.C.: United States Government Printing Office, 1969.

Postman, N. & Weingartner, C. The soft revolution. New York: Dell Publishing Company, 1971.

Rivlin, A.M. Systematic thinking for social action. Washington, D.C.: Brookings Institution, 1970.

Rosenberg, N. Technology and American economic growth. New York: Harper & Row, 1972.

Russell, B. Skeptical essays. New York: Barnes and Noble, 1960.

Sandow, S.A. The pedagogical structure of methods for thinking about the future. Educational Policy Research Center (Working Draft), Syracuse, New York: Syracuse University, September 1970.

Scriven, M. Pros and cons about goal free evaluation. Evaluation Comment, 1972, 3 (4), 1-4.

Scriven, M. The methodology of evaluation. In American Educational Research Association Monograph on Curriculum Evaluation, No. 1, Chicago: Rand McNally & Company, 1967.

Simon, H.A. The sciences of the artificial. Cambridge, Massachusetts: M.I.T. Press, 1969.

Stake, R.E. Generalizability of program evaluation: The need for limits. Educational Product Report, 1969, 2, 39-40.

Stake, R.E. Objectives, priorities, and other judgment data. Review of Educational Research, 1970, 40 (2), 181-212.

Strasser, G. What's in a name? The Futurist, 1971, 5, 240.

Strasser, G. Methodology for technology assessment: Experience in the United States. Paper presented at the Seminar on Technology Assessment, Organization for Economic Cooperation and Development, Paris, January 1972.

Tanenbaum, M. Technology assessment--II: Its effects on science and engineering. Research Management, 1970, 13, 427-434.

Taviss, I. The technological society: Some challenges for social science. Social Research, 1968, 35, 521-539.

Toffler, A. Future shock. New York: Bantam Books, 1970.

Travers, R.M.W. The smog of educational technology. Paper presented at the annual meeting of the American Educational Research Association, Chicago, April 6, 1972.

Weaver, W.T. Delphi, A critical review. Educational Policy Research Center (Research Report 7), Syracuse, New York: Syracuse University, February 1972.

Weaver, T. Future cognition: Contiguity in studies of human thought and the future. Educational Policy Research Center (Working Draft), Syracuse, New York: Syracuse University, April 1970.

Weinberg, A.M. Can technology replace social engineering? Bulletin of the Atomic Scientists, 1966, 22 (10), 4-8.

Weisbecker, L.W. Technology assessment of winter orographic snowpack augmentation in the upper Colorado River Basin: The impacts of snow enhancement. (Final Report, SRI Project EGU-1037) Menlo Park, California: Stanford Research Institute, May 1972.

Wheeler, H. Bringing science under law. In J. Cogley and D. McDonald (Eds.), The establishment and all that. Santa Barbara, California: Center for the Study of Democratic Institutions, 1970.

Wolfson, R.J. The evolution of our view of futures forecasting. Notes on the Future of Education, 1969, 1 (1), 5-7.