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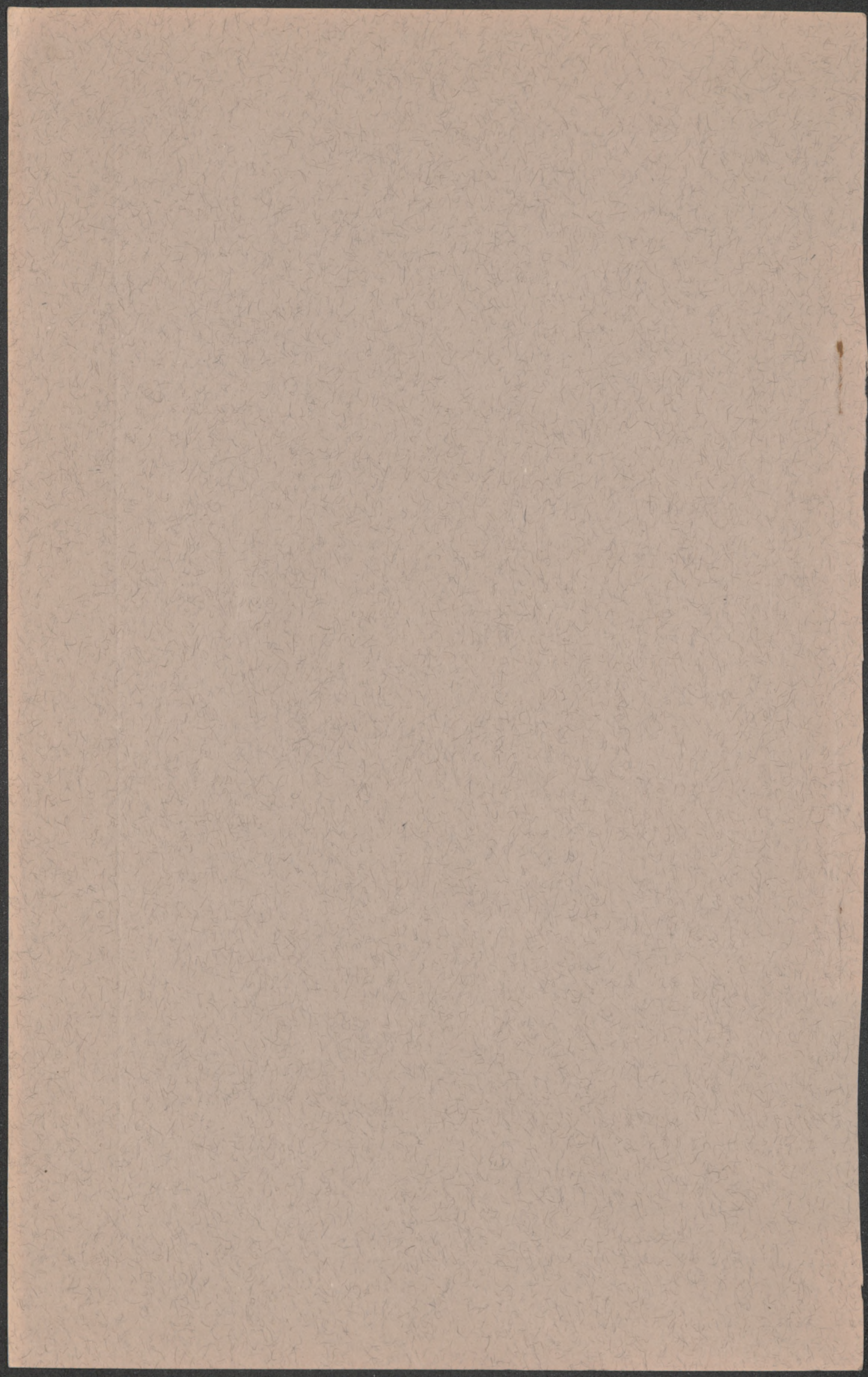
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PREPARED FOR THE
SUBCOMMITTEE ON SCIENCE, RESEARCH,
AND DEVELOPMENT
OF THE
COMMITTEE ON SCIENCE AND ASTRONAUTICS
U.S. HOUSE OF REPRESENTATIVES
NINETY-THIRD CONGRESS
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JULY 1973

Printed for the use of the Committee on Science and Astronautics



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A WORKING GLOSSARY

[REVISED—1973]

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LETTER OF TRANSMITTAL

HOUSE OF REPRESENTATIVES,
COMMITTEE ON SCIENCE AND ASTRONAUTICS,
Washington, D.C., July 20, 1973.

HON. OLIN E. TEAGUE,
*Chairman, Committee on Science and Astronautics,
House of Representatives, Washington, D.C.*

DEAR MR. CHAIRMAN: I am transmitting herewith a revised edition of "Science Policy—A Working Glossary." This glossary was originally printed in April 1972. Since that time the supply has been exhausted, the demand remains high, and the revised edition has been expanded by almost 50 percent partly as a result of inputs and suggestions from all parts of the country and partly due to changing terminology.

I commend this document to you and am sure that all members of the committee will find it useful.

Sincerely yours,

JOHN W. DAVIS,
Chairman, Subcommittee on Science, Research and Development.

(III)

LETTER OF TRANSMITTAL

TO THE BOARD OF DIRECTORS
OF THE UNITED STATES DEPARTMENT OF AGRICULTURE
WASHINGTON, D. C.
JANUARY 1, 1900

SIR: I have the honor to acknowledge the receipt of your letter of the 29th ultimo, in relation to the report of the Commissioner of the General Land Office, dated June 1, 1899, in relation to the land owned by the United States in the State of California, and to inform you that the same has been forwarded to the proper authorities for their consideration.

I am, Sir, very respectfully,
Yours very truly,
J. H. HARRIS
Commissioner of the General Land Office

LETTER OF SUBMITTAL

THE LIBRARY OF CONGRESS,
CONGRESSIONAL RESEARCH SERVICE,
Washington, D.C., June 22, 1973.

Hon. JOHN W. DAVIS,
*Chairman, Subcommittee on Science, Research and Development,
Committee on Science and Astronautics, U.S. House of Repre-
sentatives, Washington, D.C.*

DEAR MR. CHAIRMAN: I am pleased to submit this revised glossary for science policy in response to your request. As I indicated in my letter to you of March 23, 1972, we have titled the paper a "working" glossary in recognition of the fact that the terminology in this field is changing dynamically. Many definitions in this revision have indeed been modified, and new terms have been added.

The glossary was prepared under the direction of Dr. Franklin P. Huddle of the Science Policy Research Division, assisted by William C. Boesman and Paul F. Rothberg of that Division.

It is suggested that correspondence recommending amplification or correction of the glossary be addressed to Dr. Huddle so that we can continue to consolidate the comments and, if you judge it desirable, update the work from time to time.

Sincerely,

LESTER S. JAYSON,
Director, Congressional Research Service, Library of Congress.

SCIENCE POLICY: A WORKING GLOSSARY

INTRODUCTION

The purpose of this Glossary is to facilitate communication between the Congress and persons engaged in the study of science policy. Some of the terms taken up here are used in various contexts to mean widely different things; writers in different countries or in different disciplines sometimes use different words for the same subject. There are socially important distinctions between such terms as, for example, Cost/Benefit Analysis and Risk/Benefit Analysis. The word Model has a different meaning in the expression Model Statute or Late Model Television Set from its meaning in the Forrester Dynamic Model of World Interactions.

Whether in congressional hearings, agency reports, professional symposia, or elsewhere, it is useful that the terms expressed in the discussion of issues of science policy communicate meaning according to generally accepted standards.

Debate over the meanings of words is usually fruitless. It recalls the classic example cited by S. I. Hayakawa of the two families which ceased speaking to each other over the issue of whether unemployment benefits *were* insurance payments or *were merely called* insurance payments.

Given a set of usable standard definitions, the analysis can proceed to substantive issues. The definitions presented in the following pages will not accord with the usage of all students of science policy. However, the definitions are available to be cited, or to help clarify alternative meanings.

The point is that science policy is a lively art, a field of study undergoing rapid development. Its flexibility of language reflects this tendency toward change. The standard meanings proposed in the Glossary can at least serve as peg points, useful to characterize the present State-of-the-Art, and perhaps later on to measure how far the changes have gone when the Glossary is reviewed in a year or two hence.

It is also important to identify meanings covered by several significantly different words—reflecting different disciplines or different contexts—and to discuss these. Every scientific discipline tends to develop its own special vocabulary. When practitioners of the different disciplines come together to consider mutual problems of science policy, they bring into use their own special languages. One man's "Homeostasis" is another man's "Steady State." Analogies like these are rarely precise, but they do enable interdisciplinary communication when their degree of interchangeability is mutually understood.

The Rise of Science Policy

Since 1950, national policy in the United States has been to support scientific research as a beneficial activity for public purposes. The assumption on which this policy is based is that the discovery and disclosure by scientists of the facts of nature broaden the options available for the application of technology to achieve public purposes. As more facts become known, their technological application enables man to improve or restore his environment, and thus to enhance the compatibility of man's relationship with the environment.

As resources of the public have been increasingly applied for this purpose, the powerful effects of the policy have become evident. These effects have become a major consideration of national policy. Intended results of scientific discovery have been achieved in countless directions. But not all aspects of the man/environment relationship have been equally well served. There have been technological lags, the march to obsolescence of entrenched technologies, and the appearance of technologies clearly dysfunctional in their intended purposes. Moreover, the effects of any given technology are invariably mixed, with some benefits accompanied by some economic, social, or physical environmental costs. The growing power of technology operates to increase the magnitude of both benefits and costs.

The formulation and implementation of national science policy involves management of the resources employed in the discovery and use of scientific information to enhance man's compatibility with his environment, and the use of the innovations that emerge from this process to produce maximum social benefits at minimum social costs. The problem of translating this twofold proposition into operational policies and procedures, and of designing institutional arrangements to implement them, turns out to be enormously complex. This is the problem of science policy. The problem is of interest not only to scientists but to political decisionmakers and the general public. If the issues of science policy must be discussed in scientific or technical terms, then it becomes important that these terms are carefully defined in language meaningful to the public.

Scope and Limitations of the Glossary

The title "A Working Glossary * * *" was selected to reflect not only the purpose of the collection but also its limitations. It is manifestly not the last word on the subject. It is open to correction or amplification. Suggestions received while the Glossary was in preparation generally have been incorporated in it; if these involved adding a new and conflicting definition, this was done. However, the register is not closed but will be open for the further posting of corrections and amplification.

Not all words selected for treatment are of equal currency. The selection was perforce arbitrary. Some inclusions may have been unnecessary; some omissions unfortunate. More terms were suggested for definition than could be included, but no decision on such matters should be regarded as final in a "Working Glossary."

A word of explanation may be helpful as to the criteria used in the selection of terms to be included in the Glossary. One of the most im-

portant of these was the assignment—for science policy purposes—of a special meaning to a term in wide general usage. Another was the existence of controversy as to which of several meanings of a policy term was the precise one. A third was the observation that change was taking place in the meaning of a policy word in frequent usage.

A few terms have been added that characterize institutional developments involving technology (e.g., Agri-business, Multinational Corporation). Also, a number of terms are included that refer to emerging technologies of potential political importance (Cable Television, Magnetohydrodynamics) or to areas of technology that might warrant legislative attention (Catalysis, Corrosion, Tribology).

Considerable correspondence was received by CRS in comment on the first issuance of the Glossary. Many suggestions were offered for additional terms to be included. The procedure followed was to attempt a Trade-off (q.v.) between satisfying all critics and applying the indicated criteria. If the result does not constitute an optimization, at least—hopefully—it will “Satisfice.”

There is always a tendency to approach the subject of definition from a context which makes difficult the exclusion of the author's bias. In the study *Technical Information for Congress*, the observation was made that no person is free of bias. In defining terms, bias is virtually unavoidable. One way to try to escape it is by offering as little information as possible under each term—in effect, striving for the least common denominator. This reduces bias at the cost of reducing information content. Another approach was attempted here: a preliminary draft was submitted to more than a hundred persons engaged in science policy studies, inviting them to review it, suggest changes or alternative wordings, and to help achieve balanced treatments. Their help is gratefully acknowledged. If bias still remains, the fault is the author's but the remedy remains open: the identification by correspondence of opportunities for further refinement.

It was presumed that for items on which no comments were received the definitions were free of bias or else represented a consensual bias of those consulted. In the latter case, it is hoped that the wider dissemination of the Glossary will stimulate a further response and yield further emendation toward objectivity and balance.

General Acknowledgment of Contributions

Acknowledgment is accordingly made of the help given by associates in the Science Policy Research Division, the Environmental Policy Division, and others in the Congressional Research Service; by staff members in the National Science Foundation and the Department of Commerce. Persons not in the Government service whose important contributions are acknowledged are: Philip Berano, Albert Biderman, S. L. Blum, Marvin Cetron, E. Q. Daddario, Joel Goldhar, Harold Green, George Kudravetz, Hans Landsberg, Harold Linstone, Gordon McBride, John McHale, Jay Mendell, Bryan Noton, Chauncey Starr, and Carlos Stern. Imperfections, of course, remain the responsibility of the author.

Additional Comment on the Revised Edition

Many helpful comments have been received by the Science Policy Research Division in response to the first publication of the Glossary.

These have been considered in preparing the present revision. Additional definitions are largely the work of Mr. Boesman. In addition, an appendix by Mr. Rothberg presents a selected list of acronyms and abbreviations frequently encountered in science policy literature.

Particular acknowledgment is due to the Federation of Materials Societies for many detailed suggestions incorporated in the revision. In addition, thanks are expressed to Professor Derek J. deSolla Price of Yale University for his recommendations on the future dissemination of the publication.

SCIENCE POLICY: A WORKING GLOSSARY

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ADAPTATION

A structural or functional (behavioral) modification of a system, usually self-directed, in response to a change in the external stresses operating on the system.

ADVERSARY PROCESS

A debate, legal contest, or other confrontation, in which decision is obtained or sought by the verbal interchanges of proponents of opposing positions in the presence of a neutral decisionmaker.

AGRIBUSINESS

The business of agriculture, as opposed to its science or practice. The essence of agribusiness is that it is capital-intensive. Productivity per man-hour is enormous; productivity per acre is not very impressive, although it is subject to constant improvement. Extensive use is made of energy materials (fertilizers, powered equipment, and aircraft). Farm units are very large. Management is often corporate, rather than family. It may consist of the initial development of agricultural land through the distribution of agricultural products in retail trade. Agribusiness may require knowledge of:

- Land surveys and purchases;

- Development of irrigation systems;

- Use of chemical fertilizers;

- Governmental development of agricultural infrastructure, like roads, water and sewerage systems, and rural electrification;

- Establishment or use of transportation systems for agricultural products;

- Establishment or use of governmental and/or private financial structures, like grant systems, agricultural or export credit institutions, and loan guarantee programs;

- Establishment or use of distribution systems, like production or retail cooperatives, farmers' markets, and elevators and storage facilities;

- General business skills, like marketing, office management, bookkeeping, and legal services; and

- Government assistance programs, like the Department of Agriculture's Extension Service, Farmers Home Administration, Banks for Cooperatives, and Office of Economic Opportunity rural development programs.

AGRO-INDUSTRIAL COMPLEX

A nucleus of complementary industrial and agricultural enterprises structured around a source of cheap, abundant energy, like nuclear

energy. An agro-industrial complex combines the ideas of synergism and economy of scale and might consist of:

A nuclear power station of 1,000 to 2,000 megawatts;

A plant to desalinate sea water at a rate of 1.3 to 3.8 million cubic meters per day;

A cultivable area of several thousand hectares capable of feeding several million persons on the basis of 2,500 calories per person per day; and

A certain number of industrial plants producing nitrate and phosphate fertilizers, aluminum, caustic soda, chlorine, and other products.

Agro-industrial complexes might have their greatest use in undeveloped regions, particularly desert regions near the sea.

ALGORITHM

A symbolic or quantitative expression of a relationship between or among different elements; a set of stepwise directions for attacking a problem. More generally, a complete system of numbers, including zero.

ALTERNATIVE(S)

See Option(s). One of several possible courses of action, expedients, methods, or contrivances considered to offer the same approximate outcome or effect.

AMBIENCE (noun)

The surroundings or environment of a place or thing. Used in experimental research to indicate, e.g., the temperature, humidity, pressure, gases, and radiation in the space surrounding the object of an experiment. (See Background.)

AMBIENT (adjective)

Completely surrounding.

ANALYSIS

The action of taking something apart and examining its components. The very extent of the use of the term may seem to deprive the word of much of its meaning. It is employed in a great many different senses, and in many combinations. The meaning seems to depend somewhat on the discipline connected with its use. Thus, the chemist makes an Analysis when he discovers the quantity and quality of ingredients in something. The biologist and botanist use Analysis to signify the operation of classifying a specimen. The psychiatrist uses it to mean the treatment or cure of aberrant psychic behavior. The physician interprets the word in terms of what happens in the laboratory of pathology. The mathematician uses it in a variety of ways, for example: (1) as a technique of proving a theorem by assuming the truth of the theorem and then searching out the consequences; (2) since integral and differential calculus are commonly used in searching out these con-

sequences, he tends to regard any application of calculus as a form of analysis; (3) still more loosely, he regards any problem amenable to mathematical solution as "subject to analysis;" and most loosely of all, (4) analysis becomes the establishment of—or search for—any kind of quantitative relationship.

The notion that *analysis* is an identifiable and describable process independent of the discipline involved or the item being analyzed is suggested by the large number of compound words hyphenated with it. For example:

Value-
Failure-
Cost-effectiveness-
Operations-
Systems-
Stress-
Reliability-
Maintainability-
Etc.

According to Merriam-Webster the word means to "resolve into its elements." (Separation of "anything, whether an object of the senses or of the intellect, into constituent parts or elements.") Also, any statement or table exhibiting the results is "an analysis." The verb *to analyze* has as synonyms the following: *separation, resolution, dissection, reduction*.

There is a tendency to expand the scope of Analysis to qualitative as well as quantitative factors (see Policy Analysis). In this sense, Analysis can be qualitative if it retains such other characteristics as order and logic, explicitness or replicability, definable scope and internal consistency.

APPLIED RESEARCH

See Research, Applied.

BACKGROUND

Phenomena forming the natural Ambience (q.v.) of experimental research or ordinary situations. For example, the noise of natural electromagnetic radiation from solar activity is received on radio receiving sets as background, and naturally occurring terrestrial radioactivity is detected as background radiation on geiger counters set to detect large deposits of radioactive materials.

Toxic materials like mercury and arsenic may form part of the naturally occurring chemical background of the human environment. Chemical pollution from factory effluents, chemical fertilizer runoffs, and defoliants would add to this background toxicity.

In general, the background of any social, economic, environmental, political, psychological, scientific, or technological situation includes those phenomena which would distort the understanding or evaluation of the experimental or experiential situation unless the phenomena were known and accounted for in the experiment or experience. They are the situational elements in relation to which a particular vector under consideration is to be evaluated or measured. Before this evaluation or measurement can be made, the background must first be determined.

BACKLASH

A countervailing movement in response to, and in the opposite direction from, some specific social or technological trend.

BASELINE

A standard. A reference point on some significant parameter against which changes over time can be measured. E.g., analysis of the solute content in a particular stream on a specific day of the year, so that by measuring it on the same day in subsequent years a trend can be established.

BASIC RESEARCH

See Research, Basic.

BENEFIT/COST ANALYSIS

See Cost/Benefit Analysis.

BENEFIT/RISK ANALYSIS

See Risk/Benefit Analysis.

BRAIN DRAIN

This is journalistic jargon for the movement of persons with scientific or technological knowledge, skills, or experience from one country (or State or locality) to another. The attraction of the destination jurisdiction can be relative—a competition among countries or localities to retain scholars; it can be political—the effect of extending or denying political or intellectual freedom to scientists; it can be the result of comparative economic opportunity—as in a rich versus a poor country; there are many other possible causes. A related expression, “Reverse Brain Drain,” has been used to refer to the outflow of scientists and technologists from a country that had previously attracted them.

BRAINSTORM (verb)

To engage in the process of Brainstorming (q.v.).

BRAINSTORMING (noun)

Loosely, any unstructured analysis of a problem or issue. Originally a procedure designed by Osborn, it is now defined in Webster's Third New International Dictionary as follows:

To practice a conference technique by which a group attempts to find a solution for a specific problem by amassing all the ideas spontaneously contributed by its members.

Osborn sets forth the four basics of brainstorming as:

Criticism is ruled out. Adverse judgments of ideas must be withheld until later. (This is the deferment-of-judgment principle.)

"Free-wheeling" is welcomed. The wilder the idea, the better. It is easier to tame down than to think up.

Quantity is wanted. The greater the number of ideas, the more the likelihood of useful ideas.

Combination and improvement are sought. In addition to contributing ideas of their own, participants should suggest how others can be turned into better ideas, or how two or more ideas can be joined into still another idea.¹

CABLE TELEVISION (CATV)

A system of receiving, transmitting, and more recently originating (cablecasting) television signals for the use of system subscribers (generally households). CATV generally transmits, by coaxial cable, signals from local television (and perhaps radio) stations and stations in distant cities, according to the "carriage" rules of the Federal Communications Commission (F.C.C.). In addition to commercial broadcast stations, CATV may carry programs of local public interest and government proceedings on closed circuit channels, and may be required to provide a cablecasting channel and public access channels for local expression. CATV may also provide closed circuit channels to local school systems and to municipal service organizations, like police and fire departments.

Most recently installed CATV systems provide 12 channels, with 20 or 40 channels likely to become common. The broadcasting industry has also proposed the extensive development of two-way (duplex) CATV systems enabling subscribers to initiate communications with stores, banks, and opinion and voting polls. The comprehensive, two-way use of cable systems for such numerous services has been called the "wired-city concept."

At present, CATV is largely a system for television entertainment; it generally costs subscribers from \$5 to \$15 per month, plus small installation charges. Its development in the major television markets has been somewhat restricted by F.C.C. rules governing the carriage of broadcast signals.

Initially, CATV was thought to affect adversely the development of UHF stations. To the contrary, some studies subsequently indicated that CATV extends the markets of the, generally, weaker UHF stations.

CATV also has implications for pay television (PTV). Opponents of PTV claim that CATV is the first step toward PTV which, it is also claimed, will damage "free" commercial TV.

CATALYSIS

Catalysis is a mechanism by which the rate of a chemical reaction is promoted by some particular mediating substance, called a "catalyst," which remains in its initial form when the reaction is completed. The catalyst allows the starting substances of a chemical process to react to form the products of the reaction at a faster rate than when the

¹ Alex F. Osborn, *Applied Imagination: Principles and Procedures of Creative Problem-Solving*, third revised edition (New York: Charles Scribner's Sons, 1963), p. 156.

catalyst is absent. Catalysis as an important technology offers opportunities to improve environmental quality using such devices as catalytic converters attached to automobile exhausts, to increase energy supplies using fuel cells and coal gasification, and to enhance industrial productivity with improved and new catalytic reactions for industrial applications.

In common usage, the word "catalyst" refers to any element in a situation that facilitates change. For instance, in the United States, public opinion can serve as the catalyst to motivate the Congress to institute a new law or to change an existing law.

CATV

See Cable Television.

CITIZEN PARTICIPATION

Involvement of the public in decisionmaking. At least three different forms of such an involvement can be distinguished: (1) participation in the selection of the decisionmakers, i.e., exercise of the right to vote; (2) involvement in the deliberations of the decisionmakers by communications and representations of interest in a desired outcome, or as to the methodology to be employed in the making of the decisions; and (3) public participation in the decision itself (sometimes called "direct democracy") by plebiscite, public convention, or other means.

CLOSED CYCLE

A concept involving a flow of material through a system that does not discharge wastes but returns the flow to become input into the system. It is a hypothetical concept, as loss is probably unavoidable in even the most carefully designed and managed system. However, it is to be distinguished from energy cycles, in which the second law of thermodynamics applies, and in which the loss through entropy is generally calculable.

COMMUNICATION(S) (AND COMMUNICATION THEORY)

Communication is an essential element of all systems. In simplest form a communication is any transmission of meaning, by signs, signals, or symbols, between persons or stations. Communication takes many forms and employs many media.

Communication theory (cybernetics) focuses on the relationship between communication and control. It refers specifically to the regulative processes of physical, biological, and behavioral systems, with a special emphasis on Feedback (q.v.). Feedback, which tells the system how to adapt itself to changing situations, enables control of a system on the basis of actual performance rather than expected performance. Negative feedback reverses the direction of the main system; positive feedback amplifies or intensifies the work of the main system.

Information theory is another complex aspect of communication theory. It proposes to measure the effect of operations by which a particular selection is made from a range of possibilities. It is related to probability theory in that the measure of selectivity is a function of the probability of achieving the same result by chance.

COMMUNICATION, SCIENTIFIC

With the increase in the support and activity in the worldwide scientific community, there has been increased attention given to the problems and science policies for improved information handling and communication.²

CONSENSUS FORECASTING

See Delphi Technique.

CONSERVATION

This is a broad term generally conveying the idea of foregoing present benefits to reserve them for the future. Among the shades of meaning encompassed by the term are: Preservation of natural beauty in an unspoiled condition, frugal use of a scarce and critical material, prevention of needless consumption or waste of any resource, reservation of supplies of a resource for allocation among essential uses, accumulation or protection of reserves of a resource to ensure its future availability, and the concept of (maximum) "sustained yield" of resources like forests. Compare Steady State.

CONSTRAINT

A limiting condition to be satisfied in the design or operation of a system. For example, the total cost may be a constraint; another might be the percentage of system life consumed in down-time. Physical size or weight constraints may be required. Compatibility of a system with other systems may impose constraints. Sometimes it is not easy to distinguish between constraints and design objectives. For example, for a corporation to operate at a profit is sometimes considered an objective and sometimes a necessary constraint.

CORROSION

Corrosion is the deterioration of a metallic or nonmetallic material caused by a chemical interaction with its environment. The major materials subject to corrosion are metals, but corrosion of nonmetals, like the weathering of timber or concrete, is also important. Broad types of corrosion reactions involving metals are: (1) corrosion by electrolyte solutions, like the corrosion of zinc in hydrochloric acid; (2) corrosion by dry gaseous environments (usually at high temperatures); (3) corrosion by solvents, like liquid metals; and (4) the failure of metals under prolonged stress, through stress corrosion cracking.

Economic losses directly or indirectly attributable to corrosion are estimated to be some \$15 to \$20 billion a year. Corrosion problems are a limiting factor in the progress of areas like the exploration of the oceans and the development of better refining operations and chemical processing methods. Half of the current losses from corrosion could be prevented by full application of known technology. Anodic protec-

² S. Passman, *Scientific and Technological Communication* (Elmsford, N.Y.: Pergamon Press, 1969).

tion or cathodic protection, inhibitors, material selection, and the appropriate design of structures are methods used to control corrosion.

COST/BENEFIT ANALYSIS

(Compare Risk/Benefit Analysis)

The relation between social benefits and social costs associated with the operations of a technical system under study. The benefits and costs include direct and indirect effects. Monetary equivalents are sometimes assigned to the non-materialistic values for the purposes of comparison and to clarify the relationships between benefits and costs.

A respondent offers the following amplification:

Cost benefit analysis deals with decisions of two kinds: (a) engineering or building, and (b) policy. In either case, alternatives are defined and compared in terms of their cost and payoff. Type (a) refers to choices of weapons system designs, for example, and type (b) to [departmental] policy decisions. This definition could be referenced to [Cost Effectiveness] since historically cost-effectiveness analysis preceded cost-benefit analysis. In the military area, in which cost-effectiveness analysis originated, the payoff was defined in terms of effectiveness of the military system. In the civilian area, "effectiveness" is replaced by "benefit." Admittedly, benefits in social systems are even more difficult to define than effectiveness in military systems.

Another respondent suggests that the term Cost/Benefit Analysis signifies "a decision-making tool especially useful in obtaining a first ranking of large public projects in terms of their priority for implementation. There has been an increasing attempt to widen the scope of both cost and benefit to include effects that have no obvious market valuations."

COST/EFFECTIVENESS (ALSO, COST/EFFECTIVENESS ANALYSIS)

This is a term widely used in systems analysis, and has been carried over into budgeting analysis. It signifies the ratio, over an explicit and finite time-span (such as product life in service), of cost in dollars and other tangible values to Effectiveness (q.v.) It should be noted that Cost/Effectiveness as an analytical expression is useful in dealing with tangible costs and measurable performance characteristics. Its application to programs with unpredictable results (such as scientific research projects) can lead to the undervaluing of the project. Experimental programs are not amenable to such analyses, except after the fact.

A definition used by the Research Analysis Corporation emphasizes the concept of precision:

[Cost-Effectiveness Analysis is the] quantitative examination of alternative prospective systems for the purpose of identifying the preferred system and its associated equip-

ment, organizations, etc. The examination aims at finding more precise answers to a question and not at justifying a conclusion. The analytical process includes trade-offs among alternatives, design of additional alternatives, and the measurement of the effectiveness and cost of the alternatives.³

COST OUT

In Program Analysis (q.v.), an early step in the assigning of monetary costs to the various program inputs required.

CREATIVITY

A capacity for novel association as, for example, of ideas, principles, phenomena, or artifacts to produce a useful or purposeful result.

CRITERION (plural CRITERIA)

A Standard (q.v.) or an explicit measure by which to evaluate any thing or activity. Criteria may be quantitative or qualitative and objective or subjective. In Effectiveness analysis, criteria are the elements to be measured to determine costs and benefits. In Policy Analysis, criteria are separate considerations employed to eliminate alternative options, or to establish priorities or preferences among options.

CROSS IMPACT MATRIX ANALYSIS

This is a method of correlation based on the assumption that every event under consideration can be assigned a probability of occurrence. By analysis, on the basis of estimated interdependency among the different events considered, an adjusted probability estimate of each event can be produced. For discussion of the technique, see:

T. J. Gordon and H. Hayward, "Initial Experiments with the Cross-Impact Matrix Method of Forecasting," *Futures*, Vol. 1, No. 2 (December 1968), pages 100-116.

Howard Johnson, "Some Computational Aspects of Cross-Impact Matrix Forecasting," *Futures*, Vol. 2, No. 2 (June 1970), pages 123-131.

Richard Rochberg, "Information Theory, Cross-Impact Matrices, and Pivotal Events," *Technological Forecasting and Social Change*, Vol. 2, No. 1 (1970), pages 53-60.

T. J. Gordon, "Cross-Impact Matrices," *Futures*, Vol. 1, No. 6 (December 1969), pages 527-531.

R. Rochberg, et al., *The Use of Cross-Impact Matrices for Forecasting and Planning* (Middletown, Conn.: Institute for the Future, April 1970).

Selwyn Enzer, et al., *Futures Research as an Aid to Government Planning in Canada*, Report R-22, (Middletown, Conn.: Institute for the Future, August 1971).

³ I. Heymont, O. Bryk, H. Linstone, and J. Surmeier, "Guide for Reviewers of Studies Containing Cost-Effectiveness Analysis," Economics and Costing Department Study 63.2 (McLean, Va.: Research Analysis Corp., October 1965).

A different technique with a similiar name, Cross-Support Analysis (also called "Decision Impact Analysis"), is described as a method "to aid in technological forecasting by the study and operational analysis of the effect of making and implementing complex decisions which affect and are affected by a large number of factors." For an illustration of this technique, see Christine A. Ralph, "The Beginnings, of Cross-Support Analysis (DIAMA) as Applied to the Fishing Industry," in Marvin J. Cetron and Christine A. Ralph, *Industrial Applications of Technological Forecasting* (New York: Wiley-Interscience, 1971), page 274.

CROSS-SECTIONAL DATA

See Longitudinal Data.

CULTURAL LAG

This term implies a comparison. It may refer, alternatively, to the fields of intellectual activity in a country that are relatively less developed than are other fields, or to a country in which the fields of intellectual activity are generally less developed than in other countries.

CYBERNETICS

See Communication(s) (and Communication Theory).

DATA BASE (ALSO, DATA BANK)

A collection of factual information, particularly when deposited in the memory core of a computer ("stored"), organized or structured by categories pertinent to a problem area, and accessible to be called out or consulted.

DECISION THEORY

Even when all extraneous variables are held as closely under control as possible—as in an elegant scientific experiment—the finding is still probabilistic. See Science. In the management of social programs, control of variables is much more partial. Accordingly, in choosing among Options (q.v.) in program management, the manager or decisionmaker always makes his decision on the basis of partial and incomplete information. Decision Theory is the term applied to the array of mathematical and other logical tools and procedures of Systems Analysis (q.v.) that may help to focus the issue and give guidance toward a rational decision under these conditions. The goal of a "good" decision, under this theory, is to maximize the probability of favorable outcome.

DELPHI METHOD (ALSO, CONSENSUS FORECASTING)

This is a term referring to one type of procedure, developed by Messrs. Dalke and Helmer of the Rand Corporation, for the forecasting of time-related future events. It has been most commonly employed in the estimating of the probable time of achievement of specific technological or social goals. The technique involves the repeated

("iterative") consulting with numbers of informed persons as to their best judgment as to when a specified event is likely to occur (i.e., when it *will* occur, not when it *should*), and providing them with systematic reports as to the totality of judgments rendered by the group. The responses of all participants are assembled and returned to the participants, inviting them to reconsider and to offer any defense they may have for an estimate that seems out of line with others made by the group. This information, and revised estimates, may then be circulated to the participants for further analysis and so on. The procedure can vary considerably, but its primary utility is that it produces a well-considered consensus of the intuitions of a plurality of informed witnesses without injecting the bias of leadership influence, face-to-face confrontation, or group dynamics. Respondents as individuals are expected to clarify their own thinking, and the final decisions—according to the theory, at least—will tend to converge by narrowing the range of estimates in response to the most convincing arguments.

DEVELOPED/DEVELOPING/UNDEVELOPED NATIONS

These are conceptual terms and encompass many characteristics. They are always relative, in the sense that no nation is fully developed or totally undeveloped, and rarely are all factors of development being developed at the same rate. The state of being "developed" has reference generally to such factors as gross national product (GNP), education, level of technological development, industrial productivity, industrial infrastructure, health and welfare provisions, agricultural productivity, level of exploitation of available resources, and the like.

DEVELOPMENT

Loosely, any intensification in the use of technology, whether to raise the economic level of a geographic region, or to provide concrete means of improving the performance of a function or program. As distinguished from Research (q.v.), Development is the employment of available information in the construction of a piece of operating hardware or a useful process, physical or social. In the usage of science policy, Development signifies the systematic use of the knowledge and understanding gained from scientific research directed toward the production of useful materials, devices, or methods, including design and construction of prototypes and demonstration of processes.

DIFFUSION (OF TECHNOLOGY) (ALSO, DIFFUSION OF INNOVATION)

Some persons distinguish between the first application of a new technology (i.e., the transfer of technology from the applied research phase to application) and subsequent, more general application of it. The term, Diffusion, is commonly applied to the transfer of a new technology from the first commercial use to a number of competing users.

DISCOUNTING

Introduction of the economic factor of the future cost of capital, to be charged against realized future income produced by a proposed in-

vestment of the capital. For investments yielding returns in the very long range future, the discount can be a major percentage of the total investment.

ECOLOGY

The biologist Haeckel coined the term "ecology" about 1870 by combining the Greek roots *oikos* (house) and *logos* (study); literally, the term means the study of organisms "at home." Odum, in *The Fundamentals of Ecology*, states:

Usually ecology is defined as the study of the relation of organisms or groups of organisms to their environment, of the science of the interrelations between living organisms and their environment. Because ecology is concerned especially with the biology of *groups* of organisms and with *functional* processes on the lands, in the oceans and in fresh waters, it is more in keeping with the modern emphasis, to define ecology as the study of the structure and function of nature (it being understood that mankind is a part of nature). In the long run the best definition for a broad-subject field is probably the shortest and least technical one, as, for example, "the science of the living environment," or simply "environmental biology."

Laymen frequently use the word to refer to the environment itself, rather than to refer to its study. In this loose usage "ecologist" may be anyone interested in or concerned about the environment, rather than a biological scientist. Thus, in a letter to *Science* magazine, July 14, 1972, Bruce L. Welch of Johns Hopkins University asked: "What is an ecologist? One who has graduated from a curriculum bearing the name 'ecology'? A member of a professional 'ecological society'? Or one who holds the point of view that an organism's interactions with its environment are important, and who seeks to rigorously define the natural rules by which these interactions are determined?"

ECONOMETRICS

The application of statistical and mathematical techniques in solving problems as well as in testing and demonstrating theories relating to matters of economics.

ECONOMIC INDICATORS

Statistical series reflecting changes in the national economy over time. Examples include: gross national product, wholesale price index, unemployment level (aggregated and disaggregated by categories), disposable income, new capital formation, etc. An important impetus was given to the use of Economic Indicators by enactment of the Employment Act of 1946, Public Law 79-304, 60 Stat. 33, approved February 20, 1946. This measure declared it to be the "continuing policy and responsibility of the Federal Government" to manage its affairs to "promote maximum employment, production, and purchas-

ing power." To coordinate this effort, there was created a Council of Economic Advisers, one of whose functions was (sec. 4(c) (2) :

—to gather timely and authoritative information concerning economic developments and economic trends, both current and prospective, to analyze and interpret such information * * * for the purpose of determining whether such developments and trends are interfering, or are likely to interfere, with the achievement of [the indicated policy], and to compile and submit to the President studies relating to such developments and trends.

See also Social Indicators.

ECOSYSTEM

The ecosystem, the basic functional unit in ecology, is "any area of nature that includes living organisms and nonliving substances interacting to produce an exchange of materials between the living and nonliving parts." (Odum, *Fundamentals of Ecology*.) An example of an ecosystem is a lake.

An ecosystem is conveniently described in terms of four constituents: "(1) abiotic substances, basic organic and inorganic compounds of the environment; (2) producers, autotrophic organisms, largely green plants, which are able to manufacture food from simple inorganic substances; (3) consumers (or macroconsumers), heterotrophic organisms, chiefly animals, which ingest other organisms or particulate organic matter; (4) decomposers (micro-consumers, saprobes or saprophytes), heterotrophic organisms, chiefly bacteria and fungi, which break down the complex compounds of dead protoplasm, absorb some of the decomposition products, and release simple substances usable by the producers."

EFFECTIVENESS

In systems analysis, the term Effectiveness is an aggregative expression intended to encompass all performance qualities of a system that the customer judges—or is likely to judge—as relevant. The term describes a condition in which the system or program possessing it has been designed to satisfy at some pre-determined level all criteria selected as relevant. The term does not imply perfection but essential adequacy in all significant categories of performance. An Effective design will result from the total of design decisions among Options (q.v.), selecting the optimal Trade-Off (q.v.) at each decision point, to satisfy all conceivably relevant internal and external criteria, quantitative and qualitative, tangible and intangible, of performance and environmental compatibility. The concept includes such obvious criteria as cost, efficiency, and reliability. It also involves total life (or "Life Cycle") cost, maintainability, maintenance of state-of-the-art modernity, manufacturability, training, compatibility with expected operating environment, recycle or scrap value, and such other criteria as the design engineer and the customer consider relevant.

The term has carried over into wide use of budgetary and analysis purposes, such as in Cost/Effectiveness (q.v.).

EFFICIENCY

A concept of mechanics: output divided by input. (The higher the efficiency of a system, the closer Efficiency is to unity; it is always expressed as a percentage less than one.)

The term Efficiency is also used more loosely to indicate an input-output relationship of incommensurables. Viz., an increase in output without an increase in input, or maintained level of output with reduced level of input indicates increased "Efficiency" even though neither term is quantifiable. Still more loosely, the term is sometimes used to refer to increased output per unit of time with a given set of factors of production.

ELECTROMAGNETIC SPECTRUM

The electromagnetic spectrum is the full continuum of radiant energy which is transmitted through space or materials in the form of electromagnetic waves, either from natural (terrestrial or extraterrestrial) or man-made sources. Although electromagnetic radiation is generally treated as being in wave form, it may also be treated as consisting of discrete particles or quanta, like photons of light.

The full range of electromagnetic radiation extends from cosmic photons with a Frequency (q.v.) of 10^{23} Hz (Hertz) and a wavelength of 3×10^{-15} meters through commutated direct current with a frequency of 1 Hz and a wavelength of 3×10^{18} meters to direct current supplied by batteries with zero frequency and infinite wavelength. The electromagnetic spectrum includes, starting from the high frequency end, gamma rays, X-rays, ultraviolet radiation, the spectrum of visible light, infrared radiation, microwaves, radar, television, FM radio, shortwave radio, AM radio, longwave radio, and induction heating radiation.

Sources of electromagnetic radiation include extraterrestrial sources, radioactive nuclei, inner atomic shells, atoms in sparks and arcs, hot bodies, electronic devices, rotation machinery, and batteries.

EMPIRICAL (adjective)

Based upon experience or experiment alone, without using science or theory; *a posteriori* (from effect to cause), based upon actual observation or experimental data; opposed to *a priori* (from cause to effect), based upon reasoning processes (theory) independently of actual observation or experimental data.

EMPIRICISM (noun)

A method based extensively or entirely upon experience or experiment with little or no reliance upon science or theory. Sometimes called "Edisonian" research because the famous inventor Thomas Alva Edison relied heavily on "cut and try" experimental methods. Empiricism

bears some relation also to the philosophic term "pragmatism"—i.e., "that which proves effective" as against "that which is supported by theory or hypotheses."

ENERGY

Energy is the capacity to do work. It involves a force acting over a distance to move a mass or overcome a resistance. Energy takes chemical, mechanical, electrical, thermal, nuclear, radiant, and gravitational forms. A spring can be compressed to store mechanical energy and do work as it returns to its relaxed shape or position; a charge of gunpowder has chemical energy and does work by burning explosively. A mass may possess energy by the nature of its physical position (potential energy) or by the nature of its motion (kinetic energy). Scientists use different units to quantify its various forms. Physicists use joules, ergs, and electron volts; biologists use calories; and engineers use British thermal units and kilowatt-hours. Quantities of energy are mathematically equated to each other by conversion equations like: 1 joule=10 million ergs; 4.184 joules=1 calorie; and 1.34 horsepower-hours=1 kilowatt-hour.

Energy tends to change from one form to another, usually winding up as heat. (Cf. Energy Conversion.)

ENERGY CONVERSION

Energy (q.v.) exists in a number of forms and is capable of being changed from one form to another in many ways.

The burning of coal to convert chemical energy to heat, the use of solar energy to provide electricity to heat or cool a house, and the cellular metabolism of food to provide a living body with calories are examples of energy conversion. In any energy process, some of the energy is converted to heat or light or is otherwise lost to the system. Consequently, after conversion, the remaining energy can do less work than previously. In this sense, the transformation of energy from one form to another is never 100 percent efficient.

Einstein's famous formula $E=mc^2$ equates energy with mass "m" and the speed of light "c". According to this equation, if one kilogram of matter is entirely converted into electrical energy, it yields 25 billion kilowatt-hours of electricity.

ENGINEERING

The profession in which a knowledge of the mathematical and natural sciences gained by study, experience, and practice is applied with judgment to develop ways to utilize economically the materials and forces of nature for the benefit of mankind.⁴ It is possible that this definition is too severe in excluding the contributions to engineering design of psychology and anthropology (human factors engineering), biology and medical research (bioengineering), and the long lists of specialized disciplines required for systems engineering.

⁴ Definition supplied by Engineers Council for Professional Development.

ENTROPY

Entropy is an abstract concept of the process of loss in the relative order or arrangement of the constituent elements of a system. It is "measured" in terms of the energy flows or the arrangement of molecules in the system. A highly ordered structure, like a pure crystal, has low entropy. The random molecular arrangement of a gas has high entropy.

In the systems concept, the purpose of the system is to preserve low entropy, in other words to maintain stability by adapting to change in external or internal stresses, without loss of its operational character.

ENVIRONMENT

This term refers to the total set of things, influences, conditions, and forces in relation to some referent. One may speak of the environment within some space or volume (organism, city, ocean, etc.) or of the environment surrounding some locus (organism, hill, planet, etc.).

The most common usage of the term is in a biological or, more broadly, a natural science sense in reference to the total surroundings of the earth: air, land, water, flora and fauna (including man), radiation from space, and so on. These surroundings include both active and passive elements. Occasionally the term is used by laymen in a sense differentiating the so-called natural environment from man and his activities, as in the expression "man's destruction of the environment."

The concept of "environment" has proved so meaningful that the word has become incorporated into the jargon of many disciplines with slightly altered references. For example: Businessmen may speak of the "business environment," referring to the totality of social, economic, political, and technological forces within which their business is conducted. Systems analysts use the term to refer to all relevant elements or forces external to and impacting on a system and also to all relevant elements or forces within a system that impact on components of it.

ENVIRONMENTAL IMPACT STATEMENT(S) (ALSO, IMPACT STATEMENT(S), 102 STATEMENT(S), 102 REPORT(S))

An analysis of the environmental implications of actions by agencies of the Federal Government; such analysis are prepared by Federal agencies pursuant to Section 102 of the National Environmental Policy Act of 1969 (NEPA) (Public Law 91-190, approved Jan. 1, 1970). Section 102 requires all Federal agencies to interpret and administer all policies, regulations, and laws in accordance with NEPA, to utilize "a systematic, interdisciplinary approach . . . in planning and in decision-making which may have an impact on man's environment, and to—

include in every recommendation or report on proposals for legislation and other major Federal actions significantly affecting the quality of the human environment, a detailed statement by the responsible official on—

- (i) the environmental impact of the proposed action,
- (ii) any adverse environmental effects which cannot be avoided should the proposal be implemented,
- (iii) alternatives to the proposed action,
- (iv) the relationship between local short-term uses of man's environment and the maintenance and enhancement of long-term productivity, and
- (v) any irreversible and irretrievable commitments of resources which would be involved in the proposed action should it be implemented.

The Council on Environmental Quality (CEQ) is responsible for overseeing the process of drawing up 102 Statements and for reviewing them. Pursuant to Executive Order 11514, the CEQ has established Guidelines on Environmental Impact Statements (36 Fed. Reg. 7724-7729, April 23, 1971); and it has overseen the issuance of the procedures used by Federal agencies to implement Section 102 (36 Fed. Reg. 23666, Dec. 11, 1971). Revised Proposed Guidelines for the Preparation of Environmental Impact Statements were published in the *Federal Register* (10856-10866, May 2, 1973).

In early 1972 some ten reports per day were being received by the CEQ, about half from the Department of Transportation concerning airports and highways. The CEQ checks the reports for compliance with NEPA, identifies problem areas for possible correction, and monitors significant or controversial actions.

Through the 102 Statements, NEPA is established as an information mechanism: it requires systematic comprehensive consideration of environmental implications of actions, evaluation of alternatives, and the development of in-house expertise. The requirements of NEPA, including in particular the adequacy of the 102 Statements, have been upheld by the courts.

These statements are circulated in draft form to other agencies for comment, and also are made public. A catalog of 102 Statements is prepared monthly by the CEQ and is called the "102 Monitor."

EXTERNALITIES (ALSO, EXTERNAL EFFECTS)

This term can be defined in at least three ways: as an economic term, as an element of communications theory, or as a factor relating to social systems. Economically speaking, externalities are costs or benefits not taken into account in a transaction or system of transactions. In this usage, the right of an industry to pollute a stream (i.e., a "free good") when it is not charged against the cost of doing business would be an Externality. In Communications Theory, an Externality is an aspect of the operation of a system that generates no Feedback (q.v.). As applied to social systems, an Externality is an aspect of changed environmental stress that has not been perceived or has not motivated an adaptive adjustment of the organism or social system.

FACSIMILE (FACSIMILE TRANSMISSION)

The transmission of a fixed image, like a photograph, handwriting, map, or drawing, by wire or radio. Most facsimile equipment in the

United States today is used for telegrams, but other uses are increasing rapidly, including business document transmission, weather charts, newspaper photographs, railroad waybills, and cloud-cover photographs from signals sent by satellites.

For black and white transmission, an image is divided into small areas (each typically .01 x .01 inch) and each area is then transmitted as an electrical signal according to its degree of shading from white to black. Color facsimile transmission is now possible using multiple transmissions representing different colors.

FEEDBACK

"The control of a machine on the basis of its *actual* performance rather than its expected performance is known as feedback, and involves sensory members which are actuated by motor members and perform the function of tell-tales or monitors—that is, elements which indicate a performance. It is the function of these mechanisms to control the mechanical tendency toward disorganization; in other words, to produce a temporary and local reversal of the normal direction of entropy."⁵

The concept of Feedback is extended by Wiener to human and information systems, as well as to mechanical systems. He writes:

It is my thesis that the physical functioning of the living individual and the operation of some of the newer communication machines are precisely parallel in their analogous attempts to control entropy through feedback. Both of them have sensory receptors as one state in their cycle of operation; that is, in both of them there exists a special apparatus for collecting information from the outer world at low energy levels, and for making it available in the operation of the individual or of the machine. In both cases these external messages are not taken neat, but through the internal transforming powers of the apparatus, whether it be alive or dead. The information is then turned into a new form available for the further stages of performance. In both the animal and the machine this performance is made to be effective on the outer world. In both of them, their *performed* action on the outer world, and not merely their *intended* action, is reported back to the central regulatory apparatus.⁶

Elsewhere, Wiener relates Feedback to learning:

* * * *Feedback*, the property of being able to adjust future conduct by past performance. Feedback may be as simple as that of the common reflex, or it may be a higher order feedback, in which past experience is used not only to regulate specific movements, but also whole policies of behavior.

Such a policy-feedback may, and often does, appear to be what we know under one aspect as a conditioned reflex, and under another as learning.⁷

⁵ Norbert Wiener, *The Human Use of Human Beings, Cybernetics and Society*, (Garden City, N.Y.: Doubleday & Co., Inc., 1954), pp. 24–25.

⁶ Ibid., pp. 26–27.

⁷ Ibid., p. 33.

Positive feedback amplifies, enhances, or stimulates the performance of a machine or system. Negative feedback dampens, diminishes, or discourages the performance or adaptive response of a machine or system.

FOOD CHAINS

The transfer of food energy from the source in plants through a series of organisms with repeated eating and being eaten is referred to as the *food chain*. At each transfer a large proportion, 80 to 90 per cent, of the potential energy is lost as heat. Therefore, the number of steps or "links" in a sequence is limited, usually to four or five. The shorter the food chain (or the nearer the organism to the beginning of the chain), the greater the available energy. Food chains are of two basic types: the *grazing food chain*, which, starting from a green plant base, goes to grazing herbivores (i.e., organisms eating living plants) and on to carnivores (i.e., animal eaters); and the *detritus food chain*, which goes from dead organic matter into microorganisms and then to detritus-feeding organisms (detritivores) and their predators. Food chains are not isolated sequences but are interconnected with one another.⁸

Toxic substances may be introduced into foods through various forms of environmental pollution and transferred to humans through the links of the food chain. Examples include mercury in swordfish; pesticides and herbicides in fruits, vegetables, and grains; and radioactive fallout in milk.

FORECAST (ALSO, FORECASTING)

See also Futures Research, Prediction.

Loosely, Forecast is synonymous with Prediction. However, it is properly distinguished from it in that a Forecast is a probabilistic statement at a relatively high confidence level that a specified event will occur by a specified future point in time or within some specified time period. A respondent offers the following list of methodological types of Forecasting: probabilistic forecasting, Delphi techniques, gaming, cross impact analysis, scenario building, extrapolation techniques, contextual mapping, precursive analysis, brainstorming, statistical models, expert panels, relevance trees, network analysis, historical analogy, operation models, individual 'expert' forecasting, simulation, and causal modeling.

FORECASTING, EXPLORATORY

This general approach to technology forecasting starts from a base of accumulated knowledge in relevant areas in order to project future technological parameters or functional capabilities or both.

FUTURES RESEARCH (ALSO, FUTURISM, FORECASTING, FUTURIST)

See Forecast, and Delphi Technique.

Futures Research encompasses various attempts to develop systematic methodologies to identify future Options (q.v.) or alternatives, or

⁸ Eugene P. Odum, *Fundamentals of Ecology*, third edition (Philadelphia: W. B. Saunders Co., 1971), p. 63.

to narrow probabilities of time estimates. See James Bright, ed., *Technological Forecasting for Industry and Government* (Englewood Cliffs, N.J.: Prentice-Hall, Inc., 1968); and Cetron and Ralph, *Industrial Applications of Technological Forecasting*, *ibid.*

GAME THEORY

Game theory can be defined as the application of mathematical analysis to abstract models of conflict situations. Models can consist of parlor games or situations from the behavioral sciences, including economics, sociology, and political science. Parlor games are generally in "extensive" form, that is, they are specified by a set of rules and are terminated after a finite number of moves. Models from the behavioral sciences are generally in "normalized" form, that is, they are specified by a set of pure strategies which could be followed by suitably-instructed neutral observers. Pure strategies are complete lists of choices of legal moves covering all possible responses to legal opposing moves. Due to the enormous number of pure strategies possible in even a relatively simple model, applications of game theory to real-life situations have been severely limited by computational difficulties. However, game theory nonetheless has provided a means for analyzing many problems long of interest to philosophers and behavioral scientists. Of primary interest has been the concept of the welfare state, the theory of monopoly, the concept of the maximum good for the maximum number, and oligipolistic competition.

GENETIC ENGINEERING

The change of undesirable genes to more desirable forms by a process of directed mutation (or) the prospect of being able to insert, deliberately, specific factors (genes) into the genetic material, (or) the direct manipulation of the genetic message by changing, subtracting, or adding to the instructions received by the cell.⁹ Many discussions of this topic have included such subjects as eugenics, artificial insemination, "test-tube" babies, cloning, counseling, medical genetics, and euthenics.

GLOBAL EFFECTS

Changes in the climate, habitability, fauna and flora, ocean, atmosphere, land masses, or other large element of the Earth, resulting from human activities. The concept of Global Effects as a subject warranting study emerged from three contemporary developments: (1) the recognition of the Earth as a "spaceship" possessing finite resources and complex natural relationships on which man depends; (2) the increasing power of man's technology; and (3) the increasing rate of diffusion of this technology. Fears have been expressed "of both imminent and potential global environmental catastrophes."

⁹ These three definitions, in the order given, appear in: (1) Donald Huisinck, "Should Man Control His Genetic Future?", *Zygon*, vol. 42 (February 1969), p. 189; (2) Gordon Rattray Taylor, *The Biological Time Bomb* (New York: New American Library, 1968), p. 159; and (3) I. Michael Lerner, *Heredity, Evolution, and Society* (San Francisco: W. H. Freeman & Co., 1968), p. 273.

Theories and speculations of the global effects of pollution have included assertions that the buildup of CO_2 from fossil fuel combustion might warm up the planet and cause the polar ice to melt, thus raising the sea level several hundred feet and submerging coastal cities.

Equally foreboding has been the warning of the possibility that particles emitted into the air from industrial, energy, and transportation processes might prevent some sunlight from reaching the Earth's surface, thus lowering global temperature and beginning a new ice age. The U.S. Government has virtually eliminated the use of DDT, largely because of its adverse effects on the reproductive capabilities of birds, and because of its accumulation in other species, including man. Serious questions have been raised about the effects on ocean and terrestrial ecosystems of systematically discharging into the environment such toxic materials as heavy metals, oil, and radioactive substances; or of such nutrients as phosphorus which can overenrich lakes and coastal waters.¹⁰

GOALS, NATIONAL

In general, these are outcomes, options, conditions, or relationships of large or national scope, held socially desirable by a consensus of persons, by groups, influential spokesmen, or political decisionmakers. They may be formalized, informal, or tacit. There are many mechanisms by which national goals are proposed, considered, and promulgated; there are also many ways by which they are modified, superseded, abandoned, or reduced in force.¹¹

National goals may be formulated of different scope or character. For example, there are philosophical goals that state a nation's values or formal governmental purposes (such as liberty, welfare, tranquility, and security). There are social goals, expressing aspirations for improvement in a social function (such as literacy, or living standards), or the correction of social defects (such as crime rates or ill health). Political or legislative goals may take the form of formal statements of desired public objectives issued in legislative form by a law-making body (such as the "Finding of the Congress that. . ."). Agency goals are expressed initially in the form of legislation—the organic acts creating departments and agencies of government and defining their missions; these are interpreted administratively as expanded mission statements and communications to the public. Pursuant to the agency goals are program goals, and at a still finer-grain level of specificity are project goals.

National goals can provide a frame of reference to establish priorities to which science policy can respond in the allocation of resources, and program selection and emphasis. See "Science, Growth, and Society, A New Perspective," Report of the Secretary-General's Ad Hoc

¹⁰ Report of the Study of Critical Environmental Problems (SCEP). *Man's Impact on the Global Environment, Assessment and Recommendations for Action, Report of the Study of Critical Environmental Problems*—SCEP (Cambridge, Mass.: Massachusetts Institute of Technology, 1970), p. 4.

¹¹ For a general discussion of national goals, see the Report of the National Goals Staff: "Toward Balanced Growth: Quantity with Quality" (Washington, D.C., U.S. Government Printing Office, July 4, 1970). See also: Franklin P. Huddle, "The Evolution and Dynamics of National Goals in the United States," Committee on Interior and Insular Affairs, U.S. Senate, 92d Cong., 1st sess. (Washington, D.C., U.S. Government Printing Office, Aug. 6, 1971). For a methodology of "Costing Out" national goals, see Leonard Lecht, "Goals, Priorities, and Dollars" (New York: The Free Press, 1966).

Group on New Concepts of Science Policy—the “Brooks Report” (Paris: Organisation for Cooperation and Development, March 28, 1971).

HARDWARE

Originally, tools and other household, farm, and repair items. With the advent of the computer, the term has come to mean the computer itself and its associated equipment, like control consoles, memory units, key-sort and card-punch equipment, tape recording and drive equipment, print-out units, and telecommunications terminal and transmission equipment. Computer hardware is distinguished from the programming procedures used to operate it. These are called “Software” (q.v.).

HEURISTIC (adjective)

According to Webster's Third New International Dictionary, “Heuristic” refers to an approach “valuable for stimulating or conducting empirical [q.v.] research but unproved or incapable of proof—often used of arguments, methods, or constructs that assume or postulate what remains to be proven or that lead a person to find out for himself.”

HEURISTICS (noun)

The study of the mental processes and stages involved in solving problems, including the perception of the problem, obtaining relevant information, a passive period of waiting for insight, and the solution of the problem, or insight.

HOLISTIC (adjective)

An approach to research, analysis, or other activities characterized by an emphasis on completeness or wholeness; opposed to the atomistic approach. It is related to the synergistic approach with its emphasis on the organic or functional relationship of the whole to its parts, and on the whole as being greater than the sum of its parts.

See Synergistic Effect(s).

HOMEOSTASIS

In biological usage, the term refers to a tendency of organisms to maintain uniformity or stability. For example, the human body normally maintains its internal temperature at about 98.6° F. The term has been applied by analogy to the maintenance by any system of a steady state condition of dynamic equilibrium.

IMPACT (AS IN IMPACT ANALYSIS, TECHNOLOGICAL IMPACT, ETC.)

For one formal statement of the scope of this term, see Environmental Impact Statements. However, the term is far from precise in most usages. The recognition of impacts tends to be a progressive, repetitive process because the impacts on man and his environment from any given technology, process, or system appear to be almost limitless. Some impacts are quantifiable, and some not. Various kinds

of impact can have varying degrees of directness or remoteness as between cause and effect. (A classic example of remoteness is the illustration of the light sensitivity of silver salts as a cause of divorce—in which the chain of causality encompasses the Hollywood subculture.) The concept of Technology Assessment (q.v.) is the analysis of “total impact.”

IMPACT STATEMENT(S)

See Environmental Impact Statements.

INCREMENTAL (adjective)

Refers to any relatively small, usually positive, change in anything that can be quantified, like a change in temperature caused by a change in applied heat, or a change in demand caused by a change in supply.

In the jargon of public policy analysis, governmental decisionmaking apparently based on little else than a decision to make small yearly across-the-board increases in existing programs is often termed “incrementalism,” and is sometimes also disparagingly referred to as the “art of muddling through.” However, many social processes show general trends over long periods of time, as, for example, the “secular” trend in reduced purchasing power of any national currency. Incremental adjustments are normally made in response to such secular trends as a matter of course.

Moreover, in any complex social process involving a long learning period (for one example, see Technology Assessment), incremental improvement is inherent and instant perfection improbable.

INDIRECT EFFECTS

See Side Effects.

INFORMATION

See Communication(s) (and Communication Theory).

INFRASTRUCTURE

Supporting elements. Usually applied in connection with some category of social, economic, or cultural activity. For example, a nation’s scientific Infrastructure might be said to include arrangements for financial support of scientific research, basic scientific educational institutions, the manufacture of precision measuring instruments, the management and dissemination of scientific data and information, the organization of scientific societies, and arrangements for interpreting to the public the meaning of scientific achievements.

A nation’s technological infrastructure depends on many supporting conditions, including availability of capital, technical knowledge, favorable governmental structure, entrepreneurial attitude, effective distribution and marketing system, transportation, communications, health services and facilities, education, and many more.¹²

¹² See: U.S. Congress, House, Committee on Foreign Affairs, *The Evolution of International Technology*. Prepared for the Subcommittee on National Security Policy and Scientific Developments by the Science Policy Research and Foreign Affairs Divisions, Legislative Reference Service, Library of Congress (Washington, D.C.: U.S. Government Printing Office, December 1970); pp. 35–41. [Committee Print.]

INNOVATION ¹³

Compare Invention.

Innovation is a term used to signify either the product of a complex series of activities, or the process itself. It includes (1) a perception of a problem or opportunity, perhaps using Exploratory Forecasting (see Forecasting, Exploratory); (2) a "first conception" or invention of an original idea; (3) a succession of interwoven steps of research, development, engineering, design, market analysis, and management decisionmaking; and (4) a "first realization" or "culmination" when an industrially successful thing—a product, industrial procedure, or technique—is first used in an economic, industrial, or social context (vertical transfer of technology), and perhaps also the adoption of the process or manufacture of the product by others in competition (diffusion or lateral transfer of technology).

Although sometimes used to signify the process itself, the word is also used as a modifier, in the term "innovative process."

Innovation, according to one view, should not be confused with: (1) scientific discovery, although relevant discoveries may be incorporated in an innovation; (2) invention, although an invention frequently provides the initial concept leading to an innovation; or (3) marginal improvement in an existing product, process, or technique. However, how much more than marginal an innovation ought to be to qualify as a true innovation is hard to determine.

Many inventions or new scientific or technological ideas do not go through the entire complex of activities from conception to culmination; many are abandoned at intermediate steps. Only those that go through the entire process and emerge as new and useful commercial products, processes, or techniques can be accurately termed innovations.

See also Technology Transfer.

INTERDISCIPLINARY RESEARCH

See Research, Interdisciplinary.

INVENTION

Compare Innovation.

The conception of a new product or process. A respondent suggests: "A spontaneous creative act on the part of an individual." However, the spontaneous creative act might conceivably be performed by a group working in concert; moreover, the act has been known to occur more or less simultaneously with remote inventors, as in the classic instance of aluminum reduction. In any event, the concept of a "flash of insight" appears to be involved. A respondent suggests reference to Fred Scher, "Invention and Innovation in the Watt-Boulton Steam-Engine Venture," *Technology and Culture* (Spring, 1965), as an illustration of the invention-innovation process.

Inventions can range from the novel combination of known elements to the conception of an altogether novel principle. However, the term is not commonly applied to the creation of a large system (such as satellite communications systems or air defense systems) although these may incorporate applications of a number of inventions.

¹³ Adapted from *Science, Technology, and Innovation*, prepared for the National Science Foundation (Columbus: Battelle Memorial Institute, 1973).

IRREVERSIBILITY

A one-way process, or alternatively a process that can be reversed only with great difficulty. An illustration is the comment by Oscar Wilde on viewing Niagara Falls. He agreed that it was a remarkable sight, but that it would be even more remarkable if it went the other way. An example of irreversibility in the physical world would be a wet chemical reaction in which one of the products was removed from the solution, as either a precipitate or a gas.

One concept of irreversibility relates it to Entropy (q.v.). Every closed system tends to run down. In this sense, irreversibility is a quality inherent in nature.

In the narrower sense of social use of technology, irreversibility is found in the growing commitment or dependency of a social system or subsystem on a particular artifact or assortment of technological artifacts—pesticides, automobiles, telephones, drugs, vaccination, etc. Other irreversible effects are those related to the consumption of fossil fuels, or the extraction and use of minerals from concentrations in nature that result in their unrecoverable dispersal. For example, the making of graphite from petroleum, or the use of cobalt salts to make paint driers. Although irreversible effects are inherent in nature, the rate at which they occur is partially determined by human decisions.

The concept of irreversibility may depend primarily on the factor of time. For example, a catastrophic, large-scale generation of radioactivity might cause a train of events that could not be reversed in time to prevent permanent damage to man's environment.

One respondent comments: "Most situations that one would judge to be irreversible are so not because of physical barriers but owing to the magnitude of cost attached to reversal. This is particularly true of the commitment of social systems to given technologies."

LEAD TIME

Lead time is the time between two implicitly or explicitly designated events, the second one generally being an objective or goal. In research and development, lead time usually refers to the time between the beginning of a project, like the commitment of funds to develop an airplane, and the project's successful completion, which may be when a successful prototype flies or when new planes are in mass production. However, the term has come to be applied widely to any preparatory period, decision sequence, or time lag between signal and response. In concept, the term derives from an analogy with sports—the throwing of a ball to "lead" the running receiver, or aiming a shotgun in advance of a flying bird. The PERT (q.v.) concept links the sequence of events in a process with time lines, with the length of each line indicative of the length of time (lead time) required to complete or prepare for the event that follows it.

LONGITUDINAL DATA

Longitudinal data are data about a specific population over an extended period of time, generally months or years, in which the researcher returns at intervals to collect identical kinds of data from

the same population under study. The term is frequently applied to data collected for social science research, including statistics of individual and family incomes, educational levels, places of residence, religious affiliations, jobs, attitudes, and political and other beliefs. The term may be contrasted with "cross-sectional data," which are data for different groups at one time. Longitudinal data collection, when feasible, is superior in information product to cross-sectional data collection. It represents a more advanced procedure, particularly in the social sciences.

When longitudinal data cannot be collected for a specific population over an extended period of time because of time or financial constraints or the dispersion of the population under study, data-gathering procedures may be applied to different, but hopefully comparable, populations at different times (the cross-sectional approach) to approximate longitudinal data collection. However, the inappropriate use of cross-sectional data to approximate longitudinal data may invalidate research, or at least render it relatively useless because of the assumptions introduced to qualify its inappropriate use.

LUDDITE (ALSO, NEO-LUDDITE, AND TECHNOPHOBIC)
(ANTONYM: TECHNOPHILE)

According to the 11th Edition of the Encyclopaedia Britannica, Ned Ludd, a "person of weak intellect," in Leicestershire, England, had been tormented by boys in his village, had pursued them into a house, and, when they escaped, had vented his wrath on several frames used in making hosiery. Thereafter in the community, when mischief was done to such equipment it was blamed—more or less facetiously—on "Ludd." Then, in 1811, a series of organized economically-inspired riots broke out in and around Nottingham. The rioters concentrated their attention against new textile machinery which they feared would generate technological unemployment. The riots spread and worsened through 1816. They were terminated by a combination of repressive measures plus returning prosperity. The term "Luddites" was given to these rioters. It became generalized to include any organized movement against labor-saving machinery, in much the same fashion as the term "saboteur" (originally referring to a worker who threw a wooden shoe or sabot into the machinery) has been generalized to mean any form of politically motivated destruction.

The term Neo-Luddite, however, refers to a quite different motivation for hostility to technological innovation. In general, it applies to those opposed to technology on value grounds, rather than for economic reasons. According to this point of view, opposition to technology is a moral position; economic determinism has been found inadequate to regulate the production and adoption of good technology while restraining the bad, or—according to another view—there are so many technological innovations that society is increasingly incapable of adjusting to them.

MAGNETOHYDRODYNAMICS (MHD)

MHD is a technology under development to produce electric energy in commercial quantity by burning coal or other fuels to obtain a very

hot ionized gas (cf. Plasma) which is then passed directly through a magnetic field to generate electricity. Some experts suggest that MHD can be developed to a stage at which it would surpass current methods of generating electricity in thermal efficiency, operating costs, and environmental effects.

MANAGEMENT ENGINEERING

The application of scientific and technological principles and training, operations research, and associated disciplines, to the maintenance of a high level of productivity at minimum cost in industrial enterprises. It includes such approaches as analytical study, application of improved methods and systems and operating procedures, quantity and quality measurements and controls, safety measures, and personnel administration.

MATERIAL (noun)

The difficulty in defining this word is in determining what to exclude. One common meaning is: "A solid substance having a certain degree of permanence and intended either alone or combined with other objects, for well-specified uses." This definition is defective on many counts; it excludes liquids and gases, in which forms many useful industrial materials appear. Another defect is in the implicit assumption that a material must have present utility. The implication of this assumption is that a substance may be converted by technology from a non-material to a material, and then later be converted back into a non-material again. Another awkward complication is presented by the notion that a substance ceases to be a material when it is changed by processing.

For public policy purposes, Title II of Public Law 91-512, the Resource Recovery Act of 1970 (Title II bearing the separate title of "National Materials Policy Act of 1970"), defines (section 205) materials as "natural resources intended to be utilized by industry for the production of goods, with the exclusion of food." The exclusion of food in this case is arbitrary and functional, rather than logical.

It is suggested that in the modern sense of addressing the "Materials Cycle" (q.v.) it is necessary to use a definition as all-encompassing as possible. Thus, materials are stuff that things are made of or with, or could be. It includes both materials as they occur in nature and in their useful forms; it encompasses both materials in the (relatively) pure form and in their infinity of combination. Converting a substance or combination of substances into a useful shape does not take away its existence as a material; a razor blade is also a piece of stainless steel, a piece of material, whether it is in use or after it has been discarded. It is of no matter whether the material is in the form of a solid, a liquid, or a gas, it is still a material. Wood, when cut into lumber or pulped to make paper, or disintegrated into sawdust, does not lose its character as a "material."

MATERIALS CYCLE

All materials employed by man move in a "total materials cycle." From the earth and its atmosphere man takes ores, hydrocarbons,

wood, oxygen, and other substances in crude form and extracts, refines, purifies, and converts them into simple metals, chemicals, and other basic raw materials. He modifies these raw materials to form alloys, ceramics, electronic materials, polymers, composites, and other compositions to meet performance requirements and from them makes shapes or parts for assembly into products. When its useful life is ended, the product returns to the earth as waste; or it may be dismantled to recover basic materials that reenter the cycle.

Implicit in the operation of the total materials cycle are strong three-way interactions among materials, the environment, and energy supply and demand. The condition of the environment depends in large degree on how carefully man moves materials through the cycle, at each stage of which impacts occur. As materials traverse the cycle they may represent an investment of energy in the sense that the energy expended to extract a metal from ore, or to reduce aluminum from its oxide, need not be expended again if the metal is recycled.

MATERIALS MANAGEMENT

Materials management is the application of scientific and technological principles and training to achieve the optimal usage of materials resources. It is a broad concept, not only because of the scope of the meaning of materials (see Material), but also because it encompasses all aspects of materials extraction, processing, utilization, marketing, disposal, and reuse. It thus includes such concepts as Resource Recovery (q.v.) and Recycling (q.v.), which represent specific management approaches to materials conservation and use. Traditionally considered more narrowly as the manipulation of materials by business and industry, it has come to include also the effect of materials use on society and the consequence of such use. Thus, it relies heavily upon the application of System(s) Analysis (q.v.) to achieve an optimal mix of various scientific, technological, economic, social, ethical, and political factors which impinge on the development and use of material resources for the good of society as a whole. Increasingly, a primary objective of materials management is the achievement, insofar as practicable, of a Closed Cycle (q.v.) for materials to ensure that maximum benefit is obtained from materials at minimum overall cost.

MATERIALS POLICY, NATIONAL

The identification of those aspects of the total Materials Cycle (q.v.) for which concerted national actions will probably serve the public interest, and the prescription of what these actions should be. Title II of the Resource Recovery Act of 1970 (Public Law 91-512, approved October 27, 1970) is entitled the National Materials Policy Act of 1970. Its purpose is to "enhance environmental quality and conserve materials by developing a national materials policy to utilize present resources and technology more efficiently, to anticipate the future materials requirements of the Nation and the world, and to make recommendations on the supply, use, recovery, and disposal of materials." The Act created the National Commission on Materials Policy to make a full and complete investigation and study for the purpose

of developing a national materials policy; the report of the Commission was directed to be made to the Congress and the President by June 30, 1973.

MISSION

A single large operation or task, or a continuing specific function. Examples of missions might include the construction of a number of housing units, capture of a hill, development of a prototype fast breeder reactor, maintenance of national air superiority, achievement of improved pollution control or automobile safety. A distinction may be made between an agency of government performing a continuous or repetitive function such as budgetary control or revenue administration, and an agency responsible for carrying out some one of the missions listed. The latter might be called a "Mission Agency" but probably not the former. Mission Research is a term with several possible alternative meanings: it encompasses exploratory research, applied research, and supporting research to advance the general capability of a Mission Agency to perform; and also research of these types in support of a specific task or mission as more narrowly defined. It is with respect to the latter type that the study, Project Hindsight, was addressed.

MODEL

As used in science policy literature, the word signifies a simplified description of a process, or system, or the interaction of either with its environment. Usually a model is expressed in quantitative terms so that it can be exercised mathematically. A nonmathematical model is sometimes called a Paradigm (q.v.).

With respect to the science policy meaning of the word, a respondent notes: "An important thing about the model is that you try to walk the very fine line between shoving in too much detail (and then you can't use the model in practice) and leaving out essential details (in which case it will lead you astray)."

There are also two older meanings of the word Model: (1) a typical unit (e.g., late-model automobile), and (2) a reduced-scale structure to test performance or other characteristics of a design before going to full-scale prototype construction. From the second meaning is also derived the idea of a "scale model"—a reduced-size simulation of a structure that may or may not be operational.

MONITORING

An activity that evaluates on a continuous or periodic basis the Feedback (q.v.) from an operation against established criteria.

MULTIDISCIPLINARY RESEARCH

See Research, Interdisciplinary.

MULTINATIONAL CORPORATION

Although there is no agreed definition of the term "multinational corporation," it may be defined simply as a business enterprise conducting transnational operations in two or more countries.

Some authorities define it as a company whose foreign sales have reached a ratio of, say, 25% (or some other share) of total sales. Some find the definition in organization; i.e., a company that has global product divisions rather than an international division. Others look to the distribution of ownership or to the nationality mix of managers or directors as the determining characteristic. Professor Raymond Vernon of Harvard University, an authority on the multinational corporation, regards it as a company that attempts to carry out its activities on an international scale, as though there were no national boundaries, on the basis of a common strategy directed from a corporate center. According to Vernon, affiliates are locked together in an integrated process and their policies are determined by the corporate center in terms of decisions relating to production, plant location, product mix, marketing, financing, etc. Mr. Jacques Maisonrouge, President of IBM World Trade Corporation, characterizes the multinational corporation as one that: (a) operates in many countries; (b) carries out research, development and manufacturing in those countries; (c) has a multinational management; and (d) has multinational stock ownership.¹⁴

Some reasons often given for U.S. firms becoming multinational corporations are:

- To cut the shipping time for products with short shelf lives;
- To manufacture to special market requirements (smaller appliances, differing electrical requirements, and the like);
- To be as close as possible to the customer to adapt to his needs and provide fast service;
- To meet a government's purchasing policies by being within the country's borders;
- To avoid the problems imposed by frequent strikes at U.S. ports;
- To keep foreign firms so busy competing locally that they cannot effectively launch export campaigns aimed at the U.S.;
- To be close to raw materials sources; and
- To meet foreign "minimum local content" requirements.¹⁵

The number of U.S. multinational corporations ranges from 75 to more than 3,000, depending upon how they are defined. "The Harvard School of Business Administration in its studies of U.S. multinational corporations, which comprise about two-thirds of the world's total, has taken the firms listed in the Fortune group of the 500 largest firms and selected those having equity interests of 25 percent or more in manufacturing enterprises located in six or more foreign countries. The 187 firms that qualified under this definition were studied extensively and account for about three-fourths of all U.S. foreign direct investments. Among these are such familiar names as General Motors, Chrysler, Ford, Singer, ESSO, and ITT. In addition, about another 100 foreign firms comprise the major multinationals based in other countries, including such companies as Nestle, Shell, and Unilever (Lever Brothers).

¹⁴ U.S. Department of Commerce, *The Multinational Corp.: Studies on U.S. Foreign Investment* (Washington: U.S. Govt. Print. Off., March 1972), p. 7.

¹⁵ Reported in *Industry Week*, Jan. 8, 1973, p. 23.

"Multinational corporations are among the world's giant firms; annual sales of at least \$100 million are considered a minimum size for a multinational.¹⁶

According to 1970 figures, General Motors ranks 23, Standard Oil (N.J.) ranks 27, and Ford Motors ranks 29 in a listing of countries and multinational corporations by the corporations' gross annual sales and the countries' gross national products.¹⁷

NATIONAL MATERIALS POLICY

See Materials Policy, National.

NEGATIVE FEEDBACK

See Feedback.

NEO-LUDDITE

See Luddite.

NIH (not invented here) SYNDROME

The "not invented here" syndrome is alleged to be a characteristic of research and development. Its major symptom is a lack of interest by professionals in new ideas which have originated outside of their establishment, or perhaps even in another division of their establishment.

The NIH syndrome may be considered an organizational pathology, prevalent at both the research and management levels, which impedes communication (q.v.), innovation (q.v.), and technology transfer (q.v.). It is caused by a conviction, based on institutional pride or confidence, that "if it were any good we would have thought of it first."

NOISE POLLUTION

Pollution may be defined as any deleterious and unacceptable substance or effect which cannot be assimilated or recycled by a system.¹⁸

Noise is a specific example of an effect which may be deleterious and unacceptable to many persons, depending upon its level. Noise is measured in decibels (dB), which is a logarithmic measure of sound energy used because of the nature of human response to sound, that is, a sound with ten times the energy of another is perceived by humans as being twice, not ten times, as loud.

On the decibel scale, zero is an arbitrary level corresponding to the threshold of hearing for the average person. A rise of ten decibels corresponds to a tenfold increase in sound energy level, which is perceived as a doubling in loudness. The following table lists some typical sounds and their decibel values.¹⁹

¹⁶ Janet Bancroft, *The Multinational Corp.: A Background Survey*, C.R.S. Report 72-244-F (Washington: Library of Congress, Dec. 20, 1972), pp. 1-2.

¹⁷ Lester R. Brown, "The Multinationals and the Nation-State," *Vista*, vol. 8, June 1973, pp. 50-51.

¹⁸ Paul Sarnoff, *The New York Times Encyclopedic Dictionary of the Environment* (New York: Quadrangle Books, 1971), p. 234.

¹⁹ Migdon Segal, *Noise Control Legislation* (Revised) CRS Report 72-190-SP (Washington: Library of Congress, Aug. 29, 1972), p. 2.

	<i>dB</i>
House party, 4-piece rock band.....	115
Pneumatic hammer, 6 ft away.....	108
Walking near a helicopter.....	104
Outside, jet taking off at airport.....	102
Train stopping in station.....	100
Pushing a power lawn mower.....	96
At a seat in subway, windows open.....	95
Inside a jet airplane on take-off.....	94
Screaming child.....	92
Sports car running in street.....	86
Garbage truck, 200 ft away.....	85
Inside a city bus.....	85
Traffic at a residential intersection.....	82
Large office.....	60

Long-term exposure to noise levels above 80 dB may cause hearing impairment; at about 130 to 140 dB, noise will become painful.

Noise pollution can be abated by quieting the source itself, enclosing the source, isolating or damping vibrations caused by the source, absorbing the noise in soundproofing materials, and protecting persons with ear protection devices.

NORMATIVE

This important adjective encompasses all values, value orientations, and value-motivated activities. In contradistinction to the scientific method, which aspires to be value-free, any normative procedure or activity concentrates on the assigning of social values. It is the distinction made by Hume between "is" and "ought". Thus, normative forecasting of technology represents an attempt to identify what kinds of innovation will be needed (i.e., what society will desire or ought to have) by some future date. Normative analysis attempts to determine what is good or bad; science characterizes what happens and why.

NORMATIVE FORECASTING

This is a form of forecasting in which the starting point is not the question of feasibility but rather a determination as to what option might be of social value at some future time. Thus—

When the forecast is "needs oriented", it is termed "normative." In the normative forecast, goals, needs, objectives, or desires are specified, and the forecast works backward to the present to see what capabilities now exist or could be extrapolated to meet future goals. In some cases the goal may even force technology. Indeed, the remoteness of the goals and the priority they have may well determine how many concurrent approaches are pursued to meet the goal.²⁰

The author adds: "Normative forecasting probably should be called 'goal oriented planning'." On this last point, a respondent comments: "Actually, it is difficult to imagine planning that is not goal-oriented."

²⁰ Bright, *Technical Forecasting for Government and Industry*, *op. cit.*, p. 165. See especially Marvin J. Cetron and Thomas I. Monahan, "An Evaluation and Appraisal of Various Approaches to Technological Forecasting," in this text.

OBJECTIVE (adjective)

Rational and unbiased; conducted, as research and analysis, in conformance with the canons of the scientific method (cf. Research). Not contaminated by normative values or emotional associations. An advantage commonly ascribed to Objective knowledge is that it is cumulative, and can be integrated into structures of rational association. No such claim is made for subjective knowledge.

OBJECTIVE (noun)

An end or goal toward which efforts are directed.

OBLIGATIONS

Commitments assumed by an agency under an authorization to be supported by a future appropriation.

OPERATIONS RESEARCH

"An experimental and applied science [q.v.] devoted to observing, understanding, and predicting the behavior of purposeful man-machine systems."²¹ The discipline of Operations Research is inherently pragmatic; its techniques are specific to the environment, the problem, and the use of the product. However, the method is that of Science (q.v.). A distinction can be made between Operations Research and Technology Assessment (q.v.) in that the former seeks to achieve Optimization (q.v.) of the measurable parameters of the system, while the latter consists of an evaluation of all consequences, to the extent feasible, in order to formulate public policy concerning the management and control of the system to satisfy broad criteria of the public interest. Characteristically, Operations Research relies extensively upon quantitative mathematic methods.

A tendency is noted to confuse Operations Research as the generalized use of quantitative methods of analysis with the specific use of some methodology enjoying a particular vogue. For example, linear program(m)ing, game theory, and queuing theory are all leading candidates. However, Operations Research encompasses all of these and many others besides.

As defined by Lord Rothschild, Operational Research is "the application of objective and quantitative criteria to decision-making previously tackled by experience, intuition, or prejudice. Called operations research in the U.S.A." It is, he notes, a subdivision of Applied Research (see Research, Applied).

OPTIMIZATION

A system concept under which significant properties are identified as desirable or undesirable, and a determination made as to what quantitative level of each represents the best balance of total performance under a given set of constraints.

²¹ "Operations Research," *The Journal of the Operations Research Society of America*, vol. 19, No. 5 (September 1971), p. 1138.

OPTION(S)

A choice among alternatives. In Technology Assessment, Policy Analysis, and PPBS (q.v.) such options are characterized as fully as possible in quantitative terms—as to their costs and benefits, including important second-order consequences—in order to establish a basis to aid in making rational management decisions.

A respondent suggests that too much stress may here be put on the quantitative aspect of option analysis. Some technical issues defy quantification, such as for example, how much resources to devote to basic research or how to allocate between two claimant disciplines. Moreover, options may involve normative values that are not subject to quantification at all, yet may be brought into the assessment process, such as for example, impairment of scenic values, public apprehension of physical hazard, or convenience of the consumer.

OPTION ANALYSIS

Both terms of this title are separately defined. Together, they refer to one of the functional elements of Program Evaluation or of Futures Research and Policy Analysis (q.v.) by which the comparative merit of an alternative way of achieving a program objective can be determined and the alternative assigned the requisite resources. The analysis can be of a single alternative, or a comparison of several.

PARADIGM

A set of relationships like a model, but more abstract and less quantitatively defined than a model. Thomas Kuhn defines paradigms as “universally recognized scientific achievements that for a time provide model problems and solutions to a community of practitioners.”²² Ayres defines it as “a structured set of axioms, assumptions, concepts, hypotheses, models, and theories, e.g., Newtonian physics or Marxist economics.”²³

PARAMETER(S) (also, Parametric)

A quantity or characteristic having fixed values for a particular subject for separately indicated cases or conditions. For example, the strength or resistance to failure of a given material (one parameter) will vary according to temperature (another parameter). The information can be presented in the form of a table or a curve.

Mathematically speaking, parameters are those factors, generally variables, which together represent or approximate the nature, functioning, or behavior of a system. For example, parameters which completely define a straight line in a Cartesian system are distance along the x-axis, distance along the y-axis, and the point at which the line crosses the y-axis.

Parameters are generally quantifiable and, when quantified, subject to mathematical formulation. However, the term may be loosely

²² Thomas S. Kuhn, *The Structure of Scientific Revolutions* (Chicago: The University of Chicago Press, 1962), p. x.

²³ Robert U. Ayres, *Technological Forecasting and Long-Range Planning* (New York: McGraw-Hill Book Co., 1969), p. xiii.

applied to factors which are not readily subject to mathematical operations. For example, parameters required to predict the outcomes of elections may include numbers of registered voters, party affiliations, past voter turn-outs, voter attitudes, expected impacts or major issues, and expected impacts of major interest groups, several of which are non-exclusive and non-quantifiable.

When parameters are quantifiable, or at least subject to analysis in qualitative form (like "popular" or "unpopular" candidates or "important" or "unimportant" issues), but not reducible to mathematical formulation (that is, not reducible to a statement of equality or nonequality), they may be analyzed in other ways. Such "Parametric" analyses include rank orderings, frequency distributions, graphic analyses, Cross Impact Matrix Analyses (q.v.), Algorithms (q.v.), Delphi Methods (q.v.), and heuristic modeling.

For a discussion of analysis conducted on the basis of unquantifiable parameters, but known mathematical relationships, see Parametric Analysis.

PARAMETRIC ANALYSIS

An analysis conducted with assumed instead of expected or actual values. Such an analysis attempts to answer the hypothetical question: if the values of the parameters were as assumed, what would the results be? Parametric analyses are used, in the absence of data from experiments or other sources, to examine a problem, to identify sensitive parameters, and to obtain reasonable approximations (on the high and low side) of final results. In a parametric analysis, a range of values for each parameter is assumed which will bracket the expected values for that parameter, and a solution is obtained to the problem for each set of assumed parametric values.²⁴

See also Sensitivity Analysis.

PEER REVIEW

A procedure customarily employed by Basic Scientists. It entails the formal examination of papers, reports, or findings of one scientist by others working in the same field (and presumed of comparable competence in the field) before they are accepted for publication, announced in journals, or presented at scientific meetings. (However, on occasion the presentation at scientific meetings is regarded as a form of Peer Review.) The same arrangement is used by the National Science Foundation to evaluate proposed research projects before allocating funds to support such projects.

PERT (PROGRAM EVALUATION AND REVIEW TECHNIQUE)

Various systems of management control and planning, amenable to computer application, for concentrating on critical elements in the design and construction of large structures or systems. The concept involves the identification of significant actions or accomplishments, the identification of actions that must precede these, the estimating

²⁴ Heymont, et al., "Guide for Reviewers of Studies Containing Cost-Effectiveness Analysis."

of the time required to accomplish each, and the presentation of this information graphically (PERT chart) and as a computer print-out. The scheme strengthens management in numerous ways, such as by enabling flexible scheduling, identification of long leadtime items or tasks, and calling attention to problems needing correction. It speeds the process by showing the "critical path" to completion, and identifying the sequence of events that must take place so that management attention can be focused on them. A related technique, stressing this feature is CPM (critical path method). Another, stressing the economic aspect, is known as "PERT-Cost Method".

PLASMA

Plasmas, often called the fourth state of matter, are highly ionized gases which are formed at very high temperatures (over 5,500°C.). They are composed of nearly equal numbers of positively charged nuclei and electrons. Plasmas are important because (1) most of the matter in the universe is in the plasma state, (2) they are the fundamental media of Magnetohydrodynamics (q.v.), and (3) they are part of a many gas discharge and ultra-high temperature processes, and controlled nuclear fusion.

The word "plasma" also refers to the liquid part of blood or lymph, as distinguished from the corpuscles. It can be separated from the rest of the blood by centrifugation.

POLICY (Collective Noun, also POLICIES)

A general course or method of operation adopted or proposed for the achievement or maintenance of a condition or (less frequently) the winning of an objective. The term is customarily employed with respect to social, public, administrative, and business institutions, and particularly to characterize the general principles guiding the operational decisions of their principal executives, to achieve coherence and consistency of management.

"Policy means . . . intelligently directed action toward consciously determined goals—as distinct from aimless drift and blind faith."²⁵

A respondent suggests that an administrative hierarchy of procedure should be identified. It begins with Policy (as defined above), leading to Program, ("an ordered set of interrelated actions"). Program, in turn, may be further subdivided into Projects or tasks, each contributing coherently to a Program in support of a Policy.

POLICY ANALYSIS

Cf. Policy Science(s) and Analysis. See also Normative. Generally, the analysis of policy calls for an investigation of cause and effect relations of policy alternatives in order to identify at the earliest possible point in time the preferred broad course of action to be taken by an agency toward its mission.

²⁵ "Resources for Freedom." A Report to the President by the President's Materials Policy Commission (Washington D.C. : U.S. Government Printing Office, June 1952), p. 17; (The Paley Commission).

Viewing Policy as the complex of principles that govern action toward given ends, Policy Analysis includes such matters as the examination of the adjudication of laws, statements of leaders, agency documents, legislation and laws, and position papers from the private sector, for the purposes of evaluating goals, means, processes, objectives, achievements, and intentions; it seeks from this analysis to formulate guidance for management of government programs, use of resources, and control of human behavior. The analysis of policy encompasses: conflicts among policies, internal consistencies, impacts on society and its environment, political consequences, problems of administrative implementation, institutional and organizational aspects, problems of coordination, determining of relative priorities, timetables for action in programming, and evaluation and overview requirements.

Yehezkel Dror has defined Policy Analysis as "an approach and methodology for design and identification of preferable alternatives in respect to complex policy issues. Policy analysis provides heuristic aid to better policymaking, without any presumption to provide optimization algorithms."²⁶

POLICY SCIENCE(S)

(In this usage, Science(s) is the noun and Policy the adjective.)

Both Science and Policy are separately defined (q.v.). In general, Policy Sciences can be derived from the coupling of these two definitions. However, the term is relatively new, and subject to considerable interpretation. It appears mainly to encompass (1) an understanding of the process by which are evolved broad principles useful in institutional problem-solving activities, and (2) the kinds of knowledge (both scientific disciplines and value systems) useful in the application of the process to particular conditions, circumstances, or problems. According to Lasswell,²⁷ "The policy sciences may be conceived as knowledge of the policy process and of the relevance of knowledge in the process." Later on in this reference, he explains that the field is "contextual" and "problem-oriented." It appears also to be an attempt to introduce normative values into the decision process in a systematic way.²⁸

POLLUTION

The concept of Pollution involves changes affecting the quality of life or resources. Usually, the term implies a judgment of degradation.

²⁶ Yehezkel Dror, *Ventures in Policy Sciences* (New York: American Elsevier Publishing Co., Inc., 1971), p. 3.

²⁷ Harold D. Lasswell, "The Emerging Conception of the Policy Sciences," *Policy Sciences*, vol. 1, No. 1 (Spring 1970), p. 3.

²⁸ According to E. S. Quade:

During the past thirty years, almost a revolution has occurred in basic thinking about the nature of policy and how it is, or should be, made. The philosophies, procedures, techniques, and tools of the management and decision sciences—operations research, systems analysis, simulation, "war" gaming, game theory, policy analysis, program budgeting, and linear programming, to name a few—are accepted in business, in industry, in defense, have started to penetrate the domestic political scene, and are even reaching into foreign affairs, that last bastion of the pure intuitionists. But, in those areas where policy is made for the public, this revolution is having heavy going and may soon run against a stop: the need, from one point of view, to bring the knowledge and procedures embedded in the "soft" or behavioral sciences into systems engineering and aerospace technology and, from the other, to introduce the quantitative methods of systems analysis and operations research into the normal approaches by social and political sciences.

* * * Hence the policy sciences—an interdisciplinary activity that attempts to blend the decision with the behavioral sciences. "Why Policy Sciences," *Ibid.*, p. 1.

The President's Science Advisory Committee in its report *Restoring the Quality of Our Environment* (1965), stressed pollution as the undesirable consequences of man's activities: "Environmental pollution is the unfavorable alteration of our surroundings wholly or largely as a by-product of man's actions, through direct or indirect effects of changes in energy patterns, radiation levels, chemical and physical constitution and abundances of organisms."

The National Academy of Science's report *Waste Management and Control* (1966), also defined pollution as change having undesirable consequences: "Pollution is the undesirable change in the physical, chemical or biological characteristics of our air, land, and water that may or will harmfully affect human life or that of other desirable species, our industrial processes, living conditions, and cultural assets; or that may or will waste or deteriorate our raw material resources."

The Federal Water Pollution Control Act Amendments of 1972 (Public Law 92-500), however, defined pollution as any man-induced change and did not imply a judgment on the change: "The term 'pollution' means the man-made or man-induced alteration of the natural chemical, physical, biological, and radiological integrity of water"—or land or air.

The PSAC and Senate definitions refer to man-caused changes, while the NAS definition includes any undesirable change; the PSAC and NAS definitions refer to "unfavorable" and "undesirable" changes, while the Senate definition refers to all man-made changes. All three see pollution as being alterations, but they differ in how they evaluate those changes and in what aspects the changes are pollution. What is a pollutant and pollution depends to some extent on one's point of view: heat can be a water pollutant or a source of warmed irrigation water; solid wastes can be viewed as a disposal problem or as source of raw materials. Clearly, the concept of pollution is affected by the perceiver's view of the potential pollutant and what benefits and damages it may cause. These variations make the judgments on pollution variable over time, among societies.

Different disciplines view pollution from their own perspectives. To a biologist, pollution is likely to be changes affecting the lives of organisms. To a sociologist, pollution may be a behavioral issue. To an economist, pollution is a problem in the allocation of costs.

Because of these variations, the student of science policy will need to indicate, when he speaks of pollution, whether he is distinguishing man-made from natural pollution and the degree to which he is basing his definition on a value judgment.

POPULATION SCIENCE

Population research comprises studies of the nature, determinants, and consequences of population characteristics and dynamics and the development of basic data and methods for such population analyses. Physical, biological, psychological, cultural, social, economic, geographic, historical, and political factors may all be included in population studies. Operationally useful subdivisions of the field are:

- a. Systematic *description* of population characteristics and dynamics including fertility, mortality, and migration; of geographic

distribution and socio-economic composition; and of various correlates of different demographic rates.

b. Studies of the biological, psychological, social, and environmental *determinants* of population characteristics and dynamics, and of the effects of efforts to influence demographic rates.

c. Studies of the *consequences* of population characteristics and dynamics, at both personal and societal levels, with attention to technical, industrial, economic, political, psychological, social, environmental, educational, health, and related factors.²⁹

Population science encompasses demography which may be defined as the statistical study of populations. Demography includes the study of population composition in terms of categories like births, deaths, migrations, age, sex, social status, ethnicity, income levels, marriage, divorce, illegitimacy, labor force, motivations, and survival rates.

POSITIVE FEEDBACK

See Feedback.

PPBS (PLANNING-PROGRAMMING-BUDGETING SYSTEM)

PPBS, a management system, was first introduced in the Department of Defense in the early 1960's. Conceptually, PPBS integrates planning, programming, and budgeting into an organization's decision-making process. Decisions on programs based on carefully articulated plans are made in light of the required resources. To arrive at these decisions plans are needed to translate agency goals into specific objectives, and programs are framed for each alternative method of achieving these objectives. Then budgets must reflect the total cost of each alternative. Decision-makers remain cognizant of these phases while judging effectiveness of performance versus cost.

Implicit in PPBS is the use of analytical tools, the first of which, operations research, grew out of problems arising during World War II. Operations research became a valuable tool in the war to solve tactical problems such as improving the effectiveness of anti-submarine and bombing operations. Systems engineering, cost-effectiveness analysis (or cost-benefit analysis), and the synthetic/analytic approach known as "systems analysis" were tools and techniques which closely followed behind the development of operations research.³⁰

PPBS is a means, therefore, of analyzing both policy and the implementation of policy, a consideration of available alternatives and the resources that would be required by each. It is a means of resource allocations on a national scale, by overcoming the problems presented by the fact that requirements for programs are relative, clear criteria are wanting, and information as to the costs and benefits of alternatives is rarely available. Any individual program can plausibly demand resources beyond reasonable expectation of capacity to provide.

Herein lies the need for a new approach. While this allocation proc-

²⁹ Office of Science and Technology, Executive Office of the President, *The Federal Program in Population Research*, pts. I and II. Report to the Ad Hoc Group on Population Research (Washington, D.C.: U.S. Government Printing Office, 1969), pp. 1101-1102.

³⁰ Robert L. Chartrand and Dennis W. Brezina, "The Planning-Programming-Budgeting System: An Annotated Bibliography," Multilith No. SP 114, Science Policy Research Division, Congressional Research Service, Library of Congress (Washington, D.C.: U.S. Government Printing Office, 1966), p. 1.

ess is essentially a political one, it can be illuminated by the continuous assembling and analyzing of statistical data on the nature and capability of the economy and the objectives and needs of the Nation.

Program budgeting [i.e., PPBS] provides such an approach. It focuses on the decision-making process, particularly on the problems of data and analysis. Its first effort is simply the rational ordering of inputs and outputs, in which the initial emphasis is on the identifiable outputs—major objectives of Government processes. It then attempts to order the inputs—Government activities produced by manpower, material, real estate—so that comparisons among wide ranges of alternatives are feasible and meaningful.

[PPBS] starts with the structuring of the problem and ends with analysis of the data. Among the analytical tools, cost-benefit or cost-utility analysis that compares benefit or utility (outputs) with resources or costs (inputs) is a most prominent one. Since the objective is to improve the decision making that occurs in real life, and not in the philosopher's fancy, [PPBS] pays special attention to questions of organization and administration, and the politics and pressures of the workaday world.³¹

"... The contribution of comprehensive planning, programming, and budgeting system is . . . in the conceptually simple yet operationally difficult task of (1) identifying the over-riding objectives of the organization; (2) developing an array of feasible alternatives for achieving them; (3) systematically choosing from among the alternatives; and (4) converting the results into operational decisions."³² According to this author, the basic concepts of PPBS are as follows:

Planning.—The study of objectives, of alternative ways of achieving objectives, of future environments, and of contingencies and how to respond to them. The purpose of planning is to explore alternatives, to stimulate ideas about tradeoffs and management strategies, to identify problems, to formulate theories, and, of course, to generate data.

Programming.—A method or system of describing activities according to objectives or "outputs" . . . and of relating these objectives to the costs or "inputs" needed to produce the outputs.

Budgeting.—The activity through which funds are requested, appropriated, apportioned, and accounted for.³³

Jay Mendell writes:

Planning is the broad process of setting objectives and goals for the Department of Defense and its component parts, taking into account the current and projected world environment. These objectives and goals must, of course, be made in concert with national objectives. Generally, planning is concerned with what we want to do and can reasonably hope to achieve, whereas *programming* is the much more specific process of allocating resources among alternatives and appraising

³¹ David Novick, ed., *Program Budgeting * * * Program Analysis and the Federal Budget* (Washington, D.C.: U.S. Government Printing Office, 1965), pp. xi-xii.

³² Statement of Murray L. Weidenbaum, Assistant Secretary of the Treasury of Economic Policy, June 2, 1970. In U.S. Congress, Joint Economic Committee, *Changing National Priorities*, Hearings before the Subcommittee on Economy in Government of the * * * June 2, 1970, pt. I. 91st Cong., 1st sess. (Washington, D.C.: U.S. Government Printing Office, 1970), p. 66.

³³ *Ibid.*, p. 64.

the benefits from alternative programs. Programming sets the level of effort and computes the consequent benefits in relative or absolute terms. *Budgeting* reckons the costs of programs. Thus budgeting concentrates on resource inputs, and programming on military outputs. The objective of PPBS is to link programming and budgeting like Siamese twins.

Later in his description he adds: “* * * The PPB System is premised on the assumption that when the Services compete for programs in the annual defense program *a decision can be made among alternatives on a rational basis, which includes a strong dose of systems analysis.*”³⁴

PREDICTION

Loosely, synonymous with Forecast (q.v.). Properly distinguished from it in that Prediction is a declaration (a non-probabilistic statement at an absolute confidence level) that some specified event will occur at a specified future point in time, or within some time period.

PRIORITIES

Any systematic methodology to put first things first. It is the systematic application of pertinent criteria to a set of Options (q.v.) in order to rank the options in a rational order of preference as claimants for a limiting resource. The limiting resource can be time, management attention, dollars, manpower, or other. The implication of a priority system is that not all programs can be undertaken at once, or with the same degree of completeness or expenditure of resources, and that therefore the resources must be reserved (allocated) in accordance with a set of rationally-determined preferences.

A distinction should be made between program priorities and normative priorities. In the former, the limiting resource is material and quantitative; in the latter it may be a finding based on social attitudes. Ultimately, of course, physical limitations will prevail, even if they are insufficiently appreciated by society. Thus—

Calling for a reallocation of national priorities is now a standard theme in the rhetoric of both the establishment and the student activists. What is often forgotten is that the term “priority” implies a choice. To have more of one thing, we must give up something else. If we could achieve all our objectives simultaneously, there would be no need to set priorities, no need to make difficult choices. Reallocating national priorities, therefore, is a double-edged concept—it not only involves a decision about what we want most, it also involves a decision about what we want least.³⁵

Much of the discussion in the area of Science Policy revolves around the issues of how much money should be provided for supporting research and development and how the total pie should be divided

³⁴ Materials supplied in correspondence.

³⁵ Statement of Charles L. Schultze, senior fellow, the Brookings Institution, and Professor of Economics, University of Maryland, June 1, 1970, before the Subcommittee on Economy in Government, Joint Economic Committee, *Changing National Priorities*, pt. 1, p. 2.

amongst the various disciplines and subject areas of science and technology. The search for improved criteria and an improved methodology to apply to this allocation problem is an important area of science policy research. (See A. Weinberg, *Minerva*. Vols. I (Winter 1963), and III (Autumn 1964).)

PROBLEM ASSESSMENT

This term is used by the RANN Program of the National Science Foundation to signify an institutional operation that "defines and analyzes national issues in a total context to synthesize existing knowledge and identify specific opportunities for research to beneficially enlighten the decision-making process."

PROCUREMENT

In its simplest form, Procurement is the buying of something. However, this process has become enormously ramified, as conducted by the Federal Government, especially when the item to be bought is a large, complicated, and costly structure that does not exist when it is ordered. The complexity of the procurement process is illustrated by the Procurement Regulation of the Department of Defense, running to several thick volumes, incorporating the many instructions of the Congress on policies, constraints, and operational procedures. There are also large procedural manuals, specifying hundreds of required reports, procedures, and functions, issued by agencies responsible for the procurement of large systems. These deal with such related matters as inspection, quality control, documentation, cost analysis, configuration management, training programs, maintainability, and the like.

PRODUCT EFFECTIVENESS

A general or staff engineering function, especially in large aerospace and systems-oriented corporations, intended to optimize the Effectiveness (q.v.) of large systems. It encompasses such elements as design effectiveness, availability, reliability, value engineering, quality control, safety, maintainability, and the like. (Cf. Procurement.)

PROGRAM (noun)

A set of actions to implement an agency's mission, or a major part of the mission; also, a pattern of instructions to a computer.

PROGRAM (verb)

To formulate the plan of actions for an agency, or the instructions to a computer.

PROGRAM ANALYSIS

A loose term which includes Cost/Benefit Analysis, Risk/Benefit Analysis, Cost/Effectiveness, PERT, PPBS, Policy Analysis, Systems Analysis, and Operations Research (q.v.). See also Program and Analysis.

PROGRAM EVALUATION

As used interchangeably with the term "social program evaluation," denotes three types of social sciences research employed in Federal agencies. Based on a scheme first identified by Wholey, et al.,³⁶ they are:

(1) Assessment of program impact, to determine the "overall effectiveness of programs in meeting their objectives [and] to examine the validity of the objectives chosen to solve the problems to which the program is addressed. [This kind of evaluation provides] information for use in the policy formulation process. Ideally this evaluation takes the form of a comparison between a control group and an experimental group, with measurement before and after treatment in conformity with a rigorous research design. An example of this kind of evaluation * * * is the evaluation of the impact of HEW programs on migrant and seasonable farmworkers."

(2) Program strategy evaluation, to: "inform program managers of the relative effectiveness of different techniques or methods that can be used in producing desired results. [It] depends on definition and measurement of the appropriate environmental process, and output variables selected on the basis of suitable analytical models. The evaluation of the Follow-Through Program is an example * * *."

(3) Project evaluation, to assess the "effectiveness of a specific mechanism that has been designed to accomplish program objectives. [It] is often conducted as part of the administration of the program and is frequently performed by the agencies or by the project managers * * *." ³⁷

PUBLIC INTEREST

Until recently, public interest could be defined as "something in which the public, the community at large, has some pecuniary interest, or some interest by which their legal rights or liabilities are affected. It did not mean anything so narrow as mere curiosity, or as the interests of the particular localities, which may be affected by the matters in question." ³⁸

Since the early 1960's, however, the concept of the public interest has been given a broader, less well-defined meaning which includes (1) the public's *general* interest in such things as consumerism and environmentalism and (2) a rationale for an expansion of the Government's influence in business and private affairs, particularly through the quasi-judicial powers of administrative agencies.

"Public interest" law firms and interest groups, like Ralph Nader's organizations and John Gardner's Common Cause, are an outgrowth of this movement.

See also Citizen Participation.

PUBLIC TECHNOLOGY

See Technology, Public.

³⁶ Joseph S. Wholey, et al. *Federal Evaluation Policy: Analyzing the Effects of Public Programs* (Washington, D.C.: The Urban Institute, 1970).

³⁷ Laurence E. Lynn, Jr. "Notes from HEW" *Evaluation* (Fall 1972): p. 24.

³⁸ *State v. Crockett*, 86 Oklahoma 124, 206, pp. 816, 817 as defined in *Black's Law Dictionary*, revised 4th edition (St. Paul, Minn.: West Publishing Co., 1968).

QUALITY OF LIFE

This term is perhaps indefinable. Nevertheless, it enjoys considerable currency in the modern world. Presidents Eisenhower, Johnson, and Nixon addressed themselves to the meaning of the term in formal messages to the Congress. Accordingly, some discussion of its possible range of meanings may be helpful, without in any way purporting to represent a formal definition.

The term appears to be compounded of opposites: Concern for the present versus concern for the future; normative values versus physical or material considerations; a dynamic balance of conflict and cooperation; hope and gratification; freedom and responsibility. The attitude of the individual appears to have great importance: It involves a conviction that life has meaning and purpose, that the efforts of the individual have efficacy, and also that the individual is not alone but belongs to a group with shared hopes, beliefs, and efforts.

Below the level of abstraction implied in the previous paragraph are a collection of considerations expressed by President Johnson in his message of January 4, 1965, the "Great Society" message. The items he proposed were education, health, urban improvement, beauty rather than pollution of the environment, uplifting of lagging economic regions, elimination of crime, expanded political participation, encouragement of art and literature, and prevention of waste. Implicit, of course, in this statement was the preservation of peace abroad. Indeed, the general thrust of the concept of Quality of Life seems to imply aspects of personal and community existence which are in addition to the "primal" (C.P. Snow) values of food, clothing, shelter, and security.

A review of U.S. national goals over the years since the founding of the Republic suggests that there is a tendency for the people of this country to focus on some one general goal—usually the correction of a deficiency or blunting of a perceived threat. Examples are: Win a war, end a depression, or reduce environmental pollution. Concerted efforts toward this goal perhaps satisfy many of the conditions generalized in the second paragraph above.

It is evident that no list of national objectives or qualities would be equally pertinent for all individuals or groups of society. Moreover, the more detailed the itemization of desired qualities, the less the agreement as to their priorities. Ultimately, the quest for a definition of Quality of Life appears to resolve into a determination by each individual for himself. In this context the phrase "pursuit of happiness" in the Declaration of Independence is pertinent. There may be some degree of consensus that there is such a thing as "Quality of Life" but no agreement as to how it is to be defined.³⁹

QUICK FIX (ALSO, TECHNOLOGICAL QUICK FIX)

A prompt engineering action to correct a defect in a system, employing "off-the-shelf" hardware or designs already available, or an already-established alternative process not requiring validation.

³⁹ See Huddle, "The Evolution and Dynamics of National Goals in the United States," *op. cit.*

RANN (RESEARCH APPLIED TO NATIONAL NEEDS)

A program of the National Science Foundation "to bring important new resources to the national effort to improve the quality of life." (q.v.) The program consists of support for a variety of problem-oriented research projects, including weather modification, earthquake engineering, a variety of advanced technology applications, environmental systems studies, and social systems studies. Criteria of acceptable projects are: *importance* (potential or actual significance and urgency to the nation), *payoff* (high domestic economic and social benefits), *leverage* (role of science and technology is significant), *readiness* (timely), *capability* (organizational resources available), *Need for Federal Action* (market incentive inoperative), and *Unique Position of NSF*.⁴⁰

RDT&E (RESEARCH, DEVELOPMENT, TESTING, AND ENGINEERING)

An abbreviation used primarily in the management of the development of military hardware; it covers the spectrum of basic research, applied research, and development—including the design and development of prototypes. It extends from initial determination of a strategic requirement for a system with defined performance capabilities to the operational deployment of the system. A respondent supplies five definitions for terms that he suggests constitute the component elements of RDT&E, as follows:

Research: Defense research is scientific study and experimentation directed toward increasing knowledge and understanding in * * * fields * * * related to long-term national security needs. It provides fundamental knowledge for the solution of identified military problems. It also provides part of the base for subsequent exploratory and advanced developments in Defense-related technologies and of new or improved military functional capabilities * * *.

Exploratory Development: Includes all effort directed toward the solution of specific military problems, short of major development projects, with a view to developing and evaluating the technical feasibility of proposed solutions and determining their parameters. This type of effort may vary from fairly fundamental applied research to quite sophisticated breadboard hardware, study and programming, and planning efforts.

Advanced Development: Includes all projects that have moved into the development of hardware for experimental test [to provide] proof of suitability of equipment, rather than the development of hardware for service use.

Engineering Development: Includes development programs in which the item is being engineered for service use but has not yet been approved for procurement or operation [but which] are initiated only in response to an approved military need.

Operational System Development: Includes R&D efforts directed toward the development, engineering, and testing of

⁴⁰ National Sciences Foundation, *Justification of Estimates of Appropriations, fiscal year 1972* (Washington, D.C.: U.S. Government Printing Office, 1971), pp. D-17 to D-19.

systems, support programs, vehicles, and weapons that have been approved for production and service employment.

RECYCLING

In its most narrow sense, recycling of materials means the rescue of materials from disposal and their subsequent reuse in essentially the same form. Thus, the recycling of paper means the collection of wastepaper and the reprocessing of the recovered pulp into new paper; the recycling of glass bottles means the collection of used bottles and their reprocessing into new bottles. In practice, however, this narrow sense of the definition has been enlarged to include several additional meanings. One such meaning is reuse: stationery, for example, may be reused for additional writing, as in using the reverse side for scratch paper, or may be used for another purpose unrelated to writing, as when incorporated into building materials like insulation and hardboard. Another meaning concerns conversion of a waste material from its existing form into another form which is then useful, as in converting wastepaper to protein or compost. Still another meaning concerns the use of a material so as to consume its substance entirely, as in burning wastepaper for fuel. Strictly speaking, reuse, conversion, and consumption do not represent recycling, but all have popularly come to be included within the term. Thus, in the broadest sense, recycling is the creative management of a waste material so as to obtain the maximum additional value from it, in contrast with disposing of the material as solid waste at additional cost.

Cf. Material Management.

RESEARCH

Loosely, any gathering of information. More precisely, the gathering, ordering, and analysis of information on a systematic basis in accordance with predetermined criteria. Scientific Research is Research conducted in accordance with the scientific method. It is systematic, intensive study directed toward fuller scientific knowledge or understanding of the subject studied. Research is customarily distinguished from Development in that research is concerned with the acquisition of knowledge while development is concerned with the systematic use of scientific knowledge directed toward the production of useful materials, devices, systems, or methods, including the design and improvement of prototypes and processes.

According to the National Science Foundation, Research is "systematic, intensive study directed toward fuller scientific knowledge of the subject studied."

In an article in *Nature* ("Forty-five Varieties of Research (and Development)," Oct. 13, 1972), Lord Rothschild cites "the number of different sorts of research and development there seemed to be and the confusion they caused, at any rate in the minds of some people." In his article he proposes "to help to remove the confusion." Then he presents a tabulation of 45 terms, of which six refer to "pure research," 33 to "applied research," two to "development," and five to "miscellaneous." In his analysis of these terms, he suggests that all research should be divided into two categories, of "pure" and "applied" research. His analysis of applied research is discussed in this Glossary under Research, Applied.

Rothschild identifies five synonyms for "pure research" as follows: basic science, fundamental research, pure basic research, basic research, and absolutely pure research. However, he urges the use of Pure Research as the preferred form. This he defines as "research done solely to increase knowledge, without any practical application in view."

Under "miscellaneous," Rothschild includes as terms for definition: self-chosen research, curiosity-oriented research, speculative research, and general research (surcharge). The first two terms are, he says, synonymous and too broad in scope to be useful. The second two are partial synonyms and have a specialized institutional significance which he judges not very useful. (They have to do with "research which may be pure or applied and which is not directly concerned with an applied research programme, though done by the same research group, organization, or laboratory.")

RESEARCH, APPLIED

Systematic application of information, systematically acquired and validated. In particular, Applied Research is the practical application of such knowledge or understanding for the purpose of meeting a recognized need to develop a capability, employing the methods and data of Science (q.v.). It is distinguished from Development (q.v.) in that it does not extend to the design or construction of working processes or hardware.

As used by the National Science Foundation, the term means:

[Research directed] toward practical application of knowledge—it covers 'research projects' which represent investigations directed to discovery of new scientific knowledge and which have specific commercial objectives with respect to either products or processes. By this definition, applied research in industry differs from basic research chiefly in terms of objectives of the reporting company.⁴¹

For a useful collection of essays on the subject, see *Applied Science and Technological Progress*, Report to the Committee on Science and Astronautics, U.S. House of Representatives, by the National Academy of Sciences, June 1967.

In his article (c.f. Research) on "Forty-five Varieties of Research (and Development)," Lord Rothschild identifies 33 different terms for Applied Research. He presents them in an introductory list, and then proceeds to evaluate them out of consideration.⁴² Those that remain, all subsumed under "Applied Research" are defined as follows:

Strategic Research. Research undertaken to generate specific applied programs.

⁴¹ National Science Foundation, *National Pattern of R. & D. Resources, 1953-71*, NSF 70-46 (1971), pp. 24-25.

⁴² His list includes: absolutely applied research, commissioned research, mission-oriented research, objective-oriented research and development, orientated [U.S. oriented] research, product-oriented research, tactical science, target research, applied (project) research, applied (operational) [U.S. operations] research, short-term "troubleshooting" research, exploratory research, product research, process research, method of operation research, operational [U.S. operations] research, strategic research, objective basic research, basic strategic research, target basic research, targeted basic research, basic applied research, applied basic research, strategic applied research, oriented-strategic research, and underlying research.

Product Research. A subdivision of applied research whose objective is a new or improved product.

Process Research. A subdivision of applied research whose objective is a new or improved process.

Operational Research. The application of objective and quantitative criteria to decisionmaking previously tackled by experience, intuition, or prejudice. Called operations research in the U.S.A. A subdivision of Applied Research.

RESEARCH, BASIC

The systematic acquisition and validation of structured information or knowledge about the universe, employing for the purpose the methods and assumptions of Science (q.v.). In particular, Basic Research is directed toward a fuller knowledge or understanding of the subject under study, rather than toward the practical application of the knowledge or understanding. One view of this activity stresses that its motivation is curiosity about nature, leading the practitioner "to proceed along sophisticated disciplinary lines as delineated by peer judgment as to the frontier problem areas." Moreover, "open and free dissemination of the results of such inquiries is an international tradition of the [basic] scientific community."

According to the National Science Foundation, "the definition of basic research stresses that it is directed toward increases of knowledge in science with * * * the primary aim of the investigator * * * a fuller knowledge or understanding of the subject under study, rather than a practical application thereof." NSF also notes that some research conducted by private industry may represent "original investigations for the advancement of scientific knowledge * * * which do not have specific commercial objectives, although they may be in fields of present or potential interest to the reporting company." This concept appears to relate to the discussion in the Glossary under "Research, Fundamental."

For a useful collection of essays bearing on Basic Science, see *Basic Research and National Goals*. Report to the Committee on Science and Astronautics, U.S. House of Representatives, by the National Academy of Sciences (March 1965).

RESEARCH, EXPLORATORY

This category of investigation may be thought of as an intermediate stage between basic and applied research. Administratively, exploratory research is defined as "the early stages of research in areas not yet well enough defined or understood to merit full programmatic support."⁴³

RESEARCH, FUNDAMENTAL

"The search for new knowledge in a broad but definite scientific field without reference to specific applications."

⁴³ National Science Foundation, "Exploratory Research and Problem Assessment (ERPA)," mimeograph, p. 3.

Typically it involves inquiries—frequently multidisciplinary—into such natural phenomena as elasticity of polymers, catalysts, nuclear particle attraction, or the detonation process. Fundamental research is not—like so called “pure” research—the pursuit of knowledge for its own sake. Fundamental research seeks knowledge which will hopefully benefit someone someday. But the specific nature of its eventual application is not known at the time the research is performed.⁴⁴

In many cases, Fundamental Research cannot be distinguished from Applied Research, (see Research, Applied) except by reference to the institution which conducts it.

RESEARCH, INTERDISCIPLINARY

Broadly, scientific research directed toward an objective or mission, involving practitioners of a number of relevant scientific disciplines. Various characteristics that distinguish Interdisciplinary Research from traditional single-discipline research include: multiplicity of disciplines, use of tools or findings of several disciplines, mission orientation, and organizational setting.⁴⁵ These may be discussed as follows:

a. *Disciplinary mix*: Donald J. Cunningham defines interdisciplinary research as research done jointly by social scientists with other scientists: “research which is conducted by a mixture of investigators gathered both from the disciplines of the physical and social sciences.”⁴⁶ Another definition is: when investigation incorporates the finding tools and techniques of several disciplines, and particularly when it makes conceptual patterns and analyses pertaining to several branches of knowledge.⁴⁷ The distinction between single discipline and interdisciplinary research is lost when research using the techniques of several disciplines becomes institutionalized as a new scientific specialty,⁴⁸ such as biochemistry, astrophysics, urban affairs, or science policy. Indicators of institutionalization of interdisciplinary research as a new scientific speciality include its publication of specialized journals, and the formation of scientific societies and teaching departments.

b. *Applied or problem-oriented*: Interdisciplinary research is generally applied and problem oriented—designed to provide a solution or alternative solutions to important and complex problems at the interface of society and technology.

c. *Organization setting*: A variety of organizational forms characterize the conduct of interdisciplinary research. These differ from the units in which single discipline research is

⁴⁴ James Brian Quin and Robert M. Cavanaugh, “Fundamental Research Can Be Planned,” *Harvard Business Review* (January-February 1964), p. 112.

⁴⁵ Based on: U.S. Congress, House, Committee on Science and Astronautics, “Interdisciplinary Research—An Exploration of Public Policy Issues,” Science Policy Research Division, Legislative Reference Service, Library of Congress, 91st Cong., 2d sess. (Washington, D.C.: U.S. Government Printing Office, 1970), 106 p.

⁴⁶ Dr. D. J. Cunningham, *Federal Support and Stimulation of Interdisciplinary Research in Universities* (Oxford, Ohio: Miami University, October 1969), p. 3.

⁴⁷ Pierre de Bie, “The Concept of Problem-Focused Research,” *International Social Science Journal*, vol. XX, No. 2 (1968), pp. 204–07.

⁴⁸ Warren O. Hagstrom, *The Scientific Community* (New York, Basic Books, Inc., 1965), p. 149.

generally conducted. Typical of these organizations unique to the conduct of interdisciplinary research are: a university, interdisciplinary research problem institute; a non-profit non-academic research institute, frequently located close to both universities and industrial centers; Federal laboratory; social scientists teaching or working in professional schools, such as law, medicine, engineering, etc.; and a university interdisciplinary department or an *ad hoc* public policy advisory group established to assess research needs or particular social problems cutting across disciplinary lines.

An attempt is sometimes made to reserve the use of the term "Interdisciplinary" to combinations of the physical sciences (E.g. "Interdisciplinary Laboratories" sponsored by the Advanced Research Projects Agency). According to this view, the definition given above would apply to the term Multidisciplinary Research.

RESEARCH MANAGEMENT

Research management includes the dynamic process of planning, organizing, leading, performing, administering, coordinating, and evaluating (1) scientific study; (2) experimentation; and, (3) for organizations in applied research, development, and production, the translation of that basic knowledge into new products, processes, and techniques.

"Different applications of the management process of planning, organizing, leading, doing, administering, coordinating and evaluating exist within many companies, according to the "basicness" or "purity" of the research and development. If the research is basic or "pure," the management process is applied to the basic research least, with more freedom, relief from routine, less punching of time clocks, more confidence in his professional ability, more participation in matters in which he is concerned, more choice of projects or tasks by him—and, in general, more democratic management and administration. The manager was found to apply fewer or less drastic controls because of the uncertainty involved, the relative lack of knowing where basic research is going (or how to do it), the greater degree of creativity involved, and the administrator's inability to tell the scientist what to do.

"The objective of basic research is more vague. The methods are less clearly defined, so that control cannot be as rigorously established. As research becomes applied to development and production, the objective can often be defined more clearly. In applied research, the goals of the new scientific knowledge are related more to the specific commercial objectives with respect to either products or processes. The greater the relation to the specific products or process that can be made, the more objective and exacting can be the management and administration—especially the control, organization, the planning, the goals, and purposes.

"The management of development, then, is even more objective in translating research findings or other general scientific knowledge into products or processes. Development can be managed, administered and

controlled more definitely than basic or applied research. And thus, as the results of development go into production, definite products are produced and more definite planning and control can be managed.”⁴⁹

RESEARCH, MISSION-ORIENTED (OR, MISSION-ORIENTED SCIENCE)

Loosely, any Applied Research (see Research, Applied) although it may also be used to cover certain basic research activities (or activities in “Fundamental Science”) deemed pertinent. The term is particularly associated with scientific research to provide information or capabilities needed to support the development of a system or to support a program. In other words, “Mission-Oriented” signifies that the research is directed and constrained by the goals and rules of some organizational entity and its mission.

According to one respondent, the term “fast-transit research” is sometimes used in Europe as synonymous with Mission Oriented Research, implying that the results of the research should be rapidly applicable to improve the efficiency of civil or military systems.

RESEARCH, PURE

Loosely, a term synonymous with Basic Research or Fundamental Research (see Research, Basic and Research, Fundamental). There is a tendency to associate the term Pure Research with the exclusive intent to expand knowledge and understanding of the physical universe.

RESOURCE RECOVERY

A concept signifying the recovery, for additional use, of resources already utilized at least once. The term Resource (q.v.) is generally taken to include all kinds of material resources as well as energy resources which, if not recovered, would go to waste. Included, for example, is the conversion of municipal solid waste to useful purposes, as well as the thermal use of heated waste water effluent from nuclear power plants for the heating of offices and homes. Impetus was given to the concept by passage of the Resource Recovery Act of 1970 (Public Law 91-512) which aimed at shifting national solid waste management activities from disposal to recovery and reuse. Closely related is the concept of Resource Conservation (q.v.), defined as the judicious use of resources to avoid their waste and prevent their premature depletion. Included within the concept is the more restricted concept of Recycling (q.v.). See also Materials Management.

RESOURCE(S)

In general, resources encompass all means or potential means toward ends or potential ends. They can include physical inputs, people (and their levels of training), information, institutional arrangements, available financial assets and credit, etc.

In comment on this term, one respondent suggested that attention should be called to the variety of ways in which resources are categor-

⁴⁹ J. E. Walters, *Research Management: Principles and Practice* (Washington, D.C.: Spartan Books, 1965), pp. 6-7 and 15-16.

ized: as exploitable and potential, economic or uneconomic under a given level of technological capability, and as tangible and intangible (e.g., scenery). The concept of extractable value versus free good (e.g., air) is also involved in the term.

RESOURCES, ALLOCATION OF (ALSO FEDERAL SUPPORT OF SCIENCE)

See Priorities.

RISK ANALYSIS

A respondent contributes the following comment on this term:

This term is now becoming quite well established and an even more specialized term, "technological risk analysis" is used by the Department of Defense. The emphasis on risk analysis is due largely to the problem of overruns which have plagued large systems such as the C-5A and the F-111. The most important aspects in any commercial risk analysis involves two uncertainties: (a) market, and (b) cost of development and production. This kind of analysis is basically an effort or attempt to take specific account of these uncertainties rather than use "best estimates." In most cases, these uncertainties are in the form of subjective probability distributions. The outputs of such studies are probability distributions of quantities such as discounted cash flow return on investment, net present value, and net income. Thus, risk analysis provides the executive with answers to questions such as the following: What is the chance of loss on a project and what is the likelihood of achieving a 15% return on investment?

A related concept is "engineering risk," which is the degree of probability that a given design of a system, incorporating a number of components, will be effective. The design problem is to find the optimum trade-off between the use of proved components (thus inviting the risk of early obsolescence) and the use of wholly new and unproved components (thus inviting the risk of unreliability).

RISK/BENEFIT ANALYSIS (ALSO, BENEFIT/RISK ANALYSIS)

That portion of Cost/Benefit Analysis which pertains to the social costs of public health impacts of technology—such as deaths, disability, and discomfort. These elements of public risk are usually presented in mortality and morbidity statistics, but are most conveniently used in Risk/Benefit Analysis in the monetary terms of equivalent social costs.

A respondent notes: There has not always been an adequately comprehensive vantage point from which to consider the issues: very often, the risks are borne from a separate group from those for whom the benefits may accrue (i.e., the costs may be "external" to the undertaking). Furthermore, the risks are not always apparent "*a priori*."

SATISFICE (verb)

This is an activity of "administrative man" who looks for a course of action that is adequate, reasonably satisfactory, or "good enough."

It may be contrasted with "maximize," an activity of "economic man" who selects the best alternative from among those available. Examples of satisficing criteria familiar to businessmen are "share of the market," "adequate profit," and "fair price." A significant aspect of satisficing behavior is that administrative man, because he satisfices rather than maximizes, can make his choices without first examining all possible behavioral alternatives and without ascertaining that these are in fact all the alternatives.⁵⁰

SCENARIO

The order or sequence of events, scenes, or situations. A methodology has been developed for analyzing alternative futures as "scenarios," by which a set of interacting forces (social, economic, political, technological, etc.) is assumed, characterized, and worked out in narrative form to a logical outcome. The purpose of the technique is to give a realistic, tangible illustration of the probable consequences of different policy options or goals. The term Scenario originated with the motion picture industry, to signify the story outline combined with descriptions of the kinds of pictures needed to help tell the story.

SCIENCE

This is a term for a broad area of human activity based on the unifying assumption of the universal relationship of effects to causes. It is aimed at discovering, characterizing, organizing, and explaining facts and relationships according to principles of systematic and logical thought. Characteristic of science is the method of developing and testing of hypotheses through empirical observation (inductive-deductive reasoning), the validation of findings through replication, the construction of orderly taxonomies of related information, and reliance on quantitative measurements employing accepted standards. Within the taxonomies of each scientific discipline, the scientific effort seeks to achieve progressively finer grain of detailed understanding; externally, each discipline of science seeks to establish relationships among classes of phenomena.⁵¹

The term Science is loosely applied to encompass not only the activity itself but also the community of practitioners of science (Scientists), who are also governed by the rules and constraints (cannons) of science. The term also embraces the products of science, in the form of discovered factual information, laws, concepts, inventions, and even novel artifacts relying on scientific discoveries for their inception.⁵²

As science encompasses both basic and applied activities, the practitioners of both categories of science are called Scientists. This combination of meanings should present no difficulty, however, as the

⁵⁰ From Herbert A. Simon, *Administrative Behavior* (New York: The Free Press, 1957), pp. xxiv and xxv.

⁵¹ Louise B. Young and William J. Trainor, eds., "Science and Public Policy," prepared by American Foundation for Continuing Education at Syracuse University (Dobbs Ferry, N.Y.: Oceana Publications, Inc., 1971), pp. 3-48.

⁵² Authorities to be consulted on various aspects of the subject would include C. P. Snow, *The Two Cultures, and a Second Look* (New York: Cambridge University Press, 1964), 100 p., describing the interface between the scientific community and the non-scientific community; Robert Merton in Bernard Barber and Walter Hirsch, eds., *The Sociology of Science* (New York: The Free Press of Glencoe, 1962), an investigation into the scientific sub-culture.

shades of distinction between them in practice tend to be very fuzzy. On occasion, it is said, the workers in the same laboratory use the same equipment to perform the same operations at different times for different purposes, one of which is "basic research" and the other "applied research."

Science is sometimes described as a "value-free" activity, to suggest that it is normatively neutral in purpose and that the results of scientific discovery can be used for good or bad purposes. However, the canons of science are themselves normative values—for example, belief in the efficacy of rationality, respect for precise and careful procedure, and insistence on the free interchange of information.⁵³

SCIENCE, APPLIED

See Research, Applied.

SCIENCE, BASIC

See Research, Basic.

SCIENCE(S), BEHAVIORAL

See Science(s), Social.

SCIENCE, FUNDAMENTAL

There is a tendency to associate the term Fundamental Science with integrative principles that shed light on several different scientific disciplines, thereby opening the way to many new discoveries in each. See also, Research, Fundamental.

SCIENCE INFRASTRUCTURE

The institutions necessary for the support of scientific research but which neither perform research nor control it. They include the industries producing instruments, the institutions establishing scientific standards, the institutions and other arrangements for documentation, exchange of scientific communications, interpersonal contacts among scientists, and for the training of technical support personnel in skills required in the laboratory, such as glass-blowing, electronic circuitry, instrument calibration, and the like.

SCIENCE, INTERNATIONAL (ALSO, INTERNATIONAL SCIENTIFIC INTERACTIONS)

As science and technology have become increasingly important to nations, the international issues have become highly significant. Furthermore, worldwide cooperation, beginning with the International Geophysical Year (1957) has provided opportunities for interaction and cooperation, and cost-sharing, which have been highly productive.

⁵³ For an attempt to couple normative values with national science policy, see Robert W. Lamson, "Framework of Categories for Science Policy Analysis and Technology Assessment," Office of Planning and Policy Studies, National Science Foundation, mimeograph (November 1969).

Both governmental (United Nations, Organisation for Economic Cooperation and Development, etc.) and non-governmental (International Council of Scientific Unions, Committee on Space Research, etc.) organizations have provided mechanisms for cooperation. The organizational structure, personnel, activities, and results of this general field are loosely subsumed under the term "International Science."

SCIENCE(S), LIFE

The term Life Sciences encompasses a composite of highly specialized sub-unit scientific disciplines for the study and control of living organisms. "Molecule to man" in scope, it confronts questions and problems of life in: origin, heredity, evolution, structure and development; materials and their transformation processes; behavior, environment, and disease. A meaning increasingly influencing investigators in the Life Sciences, whether or not they designate themselves as "Ecologists" (see Ecology), is the interdependency of the living world; thus, problem solving in areas concerning food, population, renewable resources, health, and disease, involves understanding across the entire spectrum of living things.

The historical characteristics assigned to the term "Life" had to do with the readily visible properties of growth, structure, reproduction, mutation, and motility. However, since the advent of the electron microscope and molecular biology, living matter is now known to require an extremely complex intracellular organization and a very large number of chemical processes. Although living organisms are more than the sum of their parts, the phenomenon of life is now understood in terms of the same chemical laws that govern and characterize the non-living physical universe. It is here (i.e., the Chemistry of Life) that the revolution in biology is taking place, and where life scientists expect to achieve the next generation of advances in the quality of life for man and his fellow creatures.

Another revolution, just beginning in the life sciences, is the conservation of those environments and resources essential to the "chemistry of life." In matters of this type the life scientist (psychologist and sociologist) must deal with the behavior of man himself. The problem which confronts workers in these disciplines is that, among man's resources, humankind is the least manageable of all.

SCIENCE(S), NATURAL

Includes Physical Science(s) and Life Science(s) (see Science(s), Physical and Science(s), Life), but is generally taken to exclude the Behavioral or Social Sciences (see Science(s), Behavioral and Science(s), Social).

SCIENCE(S), PHYSICAL

According to Merriam-Webster, Second Edition: "Any of the sciences included under the head of pure physics, or of the allied sciences, as chemistry, mineralogy, petrology, geology, astronomy, meteorology, etc." In essence, it encompasses the sciences dealing with inanimate matter, energy, and their related phenomena. It excludes the Behavioral or Social, and Life Sciences (q.v.).

However, according to a communication from a staff member of the National Science Foundation, the disciplines of mineralogy, geology, and meteorology are more properly Environmental Sciences rather than Physical Sciences. According to this view either they should be deleted from the definition or the term to be defined should read "Science(s), Physical and Environmental."

SCIENCE POLICY

(In this usage, Policy is the noun and Science the adjective.)

The Brooks Report (cited below) observes that "Science policy is generally conceived of as a deliberate and coherent basis for national decisions influencing the investment, institutional structure, creativity, and utilization of scientific research." Its scope encompasses "the natural sciences (presumably including the life sciences), the social sciences, and technology."

In this Glossary, both Science and Policy are separately defined (q.v.). In general, Science Policy can be derived from the coupling of these two definitions. However, by usage, the term Science Policy has come to embrace, at the level of national government, two different social functions: (1) the political process affecting the activity of organizations engaged in science or in the training of scientists, and (2) the political decisions that select particular scientific activities for public support by virtue of their perceived potential contributions toward social or political goals. Both deal with the political process as a form of influence or control on the conduct of scientific activities.

According to the Brooks Study:

In the first place, science policy means policy for the development of technology, as well as policy for science as ordinarily understood. It is concerned with the allocation of resources for scientific research and technical development. It includes government encouragement of science and technology as the roots of strategy for industrial development and economic growth; but it also includes the use of science in connection with problems of the public sector. Because of the close association of basic research with higher education, this aspect of science policy is difficult to separate from overall educational policy and from technical manpower policy.

But science policy does not comprise only policy for science—that is, for the creation of an environment in which science can flourish and choices can be made among scientific and technological projects and fields; it also comprises science for policy—affecting the ways in which scientific and technical considerations bear on important political decisions and policy choices in areas that are not themselves mainly scientific, such as foreign affairs or urban planning. Indeed, some observers have even questioned whether it makes sense to conceive of science policy as a distinct and separate area of policy. Nevertheless, science, including the social sciences, penetrates deeply into almost every aspect of the government function, as indicated by the growing percentage of technical specialists in the upper levels of the civil service. It requires consideration in its entirety as a set of means to

other goals, having some coherence within itself across the functions that it serves.⁵⁴

With the increasing significance of science and technology for public interests and goals, there has arisen a large number of institutes, associations, and university programs investigating and publishing on this theme. (See D. Schooler, *Science, Scientists, and Public Policy*, New York, The Free Press, 1971.) Also, with the large sums provided to the scientific enterprise by the "public patron," there has been increasing attention to various aspects of science and government with regard to the methods of support, areas of support, institutions for support, etc. Both the legislative and executive branches of Government have been searching for answers to the various issues involved, and recently State and local government attention has been drawn to the issues. See U.S. Cong., House, Comm. on Science and Astronautics, *National Science Policy*, (H. Con. Res. 666), Hearings before the Subcomm. on Science, Research, and Development, 91st Cong., 1st sess. (Washington, U.S. Government Printing Office, 1970).

SCIENCE(S), SOCIAL (ALSO, BEHAVIORAL SCIENCE(S))

"The objectives of basic and applied behavioral and social science are essentially the same as those of other sciences: the scientific method is used to establish a body of fact and theory, demonstrable and communicable, that contributes to knowledge and understanding that will permit man to manage his affairs with greater rationality."⁵⁵ The object of study is human behavior; differentiations are usually drawn along the following lines:

The unit of analysis in behavioral science is the individual. The unit of analysis in social science is aggregates of individuals in formal and informal social groupings and institutions.

While biological scientists examine animate physiological and environmental factors which may effect changes in patterns of individual behavior, behavioral scientists (e.g., psychologists, anthropologists, and psychiatrists) focus upon inanimate mental factors or real or perceived environmental or social factors which cause patterns of behavior in the individual and groupings of individuals as a consequence of social, cultural, economic, or political arrangements, beliefs, traditions, institutions and opportunities. Such social sciences include economics, sociology, political science and history.

SCIENTIFIC METHOD

See Science.

SCIENTIFIC PROOF

In the conduct of Science (q.v.), the product sought is knowledge. The problem is how to validate what is known. The convention adopted

⁵⁴ "Science, Growth, and Society," OECD, op. cit., pp. 37-38.

⁵⁵ "The Behavioral and Social Sciences: Outlook and Needs." A Report by the Behavioral and Social Sciences Survey Committee under the auspices of the Committee on Science and Public Policy. National Academy of Sciences, and the Committee on Problems and Policy, Social Science Research Council (Washington, D.C.: National Academy of Sciences 1969), p. 20.

in the Scientific Method is to assume that all knowledge is probabilistic, so that certainty is never perfect. Scientific proof consists of the application of logical reasoning and quantitative factual evidence in order to reduce the probability of error as close to zero as possible.⁵⁶ Another way of stating this is that Scientific Proof attempts to marshal quantitative evidence in a logical demonstration to show the degree of certainty (e.g., by giving figures with an indication that they are accurate to plus or minus some numerical percent), and thus to indicate the degree of probability that a conclusion is valid. Replication of tests and verification of deduced effects of assumed principles raises the level of probability from hypotheses to "laws" of near certainty. Even so, it is a frequent event for laws to be overthrown or modified by further evidence.

SCIENTIST

See Science.

SECOND-ORDER EFFECTS (OR CONSEQUENCES)

See Side Effects.

SENSITIVITY ANALYSIS

An analytical procedure to identify particularly sensitive responses of a system to changes in specific inputs or other factors. According to the Research Analysis Corporation, it is defined as follows:

Repetition of an analysis with different quantitative values for cost or operational assumptions or estimates such as hit-kill probabilities, activity rates, or R&D costs, in order to determine their effects for the purposes of comparison with the results of the basic analysis. If a small change in an assumption results in a proportionately or greater change in the results, then the results are said to be sensitive to that assumption or parameter.⁵⁷

SERENDIPITY

According to Merriam-Webster, second edition, "The gift of finding valuable or agreeable things not sought for; a word coined by Walpole [Horace, Fourth Earl of Oxford] in allusion to a tale, *The Three Princes of Serendip*, who in their travels were always discovering, by chance or sagacity, things they did not seek."

The analogy with basic, pure, and fundamental research is obvious. However, there is no obvious reason why the analogy should not also be applicable as well to applied research in all its various forms.

⁵⁶ It is interesting to note the distinction between legal proof and Scientific Proof. Thus, a defendant can be convicted on testimony of a single individual witness, under conditions in which replication is impossible, even though the probability of human error of observation is high; but he cannot be convicted on the basis of a very high statistical probability that he conforms to the known facts about the criminal. The term "beyond peradventure of a doubt" is clearly unscientific.

⁵⁷ "Guide for Reviewers of Studies Containing Cost-Effectiveness Analysis," op. cit.

SIDE EFFECTS (ALSO SECONDARY EFFECTS, SECOND-ORDER CONSEQUENCES, INDIRECT EFFECTS) (FOR EFFECTS, IMPACTS IS SOMETIMES USED)

The purpose of all Technology (q.v.) is to improve the compatibility of man with his Environment (q.v.) in some explicit way.⁵⁸ However, it has been noted that technological innovations invariably produce other effects, unintended and often undesirable. These may be inherent in the innovation or they may result from its misuse. They may be immediate or long range, decisively important or minor, discrete or incremental or perhaps synergistic. They are usually related in impact to the extent of use of the technology from which the impact derives (cf. Diffusion of Technology).

Conceptually, the term involves two elements, an "effect" and the modifier suggesting that the effect in question is unmotivated and derivative.

From the comments received on this term, the impression is received that there exists some idea of an ordered structure of secondary effects (second-order, third-order, etc.) with time as perhaps another parameter. One respondent questioned, for example, the "merging of [Second-Order Effects] completely under Side Effects" and contended that the former "has a specific connotation involving cause-effect over time affecting increasingly abstract or complex levels of the culture" while Side Effects "can include specific and immediate effects, expected or not; usually, it just means they were unintended or deleterious." In the physical sciences, Second-Order Consequences conveys the idea of a chain of causality; thus, effect A produced by cause A becomes the cause of effect B which becomes the cause of effect C. In this sense, effect B is a secondary effect, and effect C is a tertiary effect. Also included in this concept is the idea that effect A may occur at once, but that effect B will occur later on, and effect C still later.

In the field of medicine and drugs, the term Side Effect means simply an unintended effect. Unfortunately for simplicity, the side effect of a drug developed for the treatment of Parkinson's disease may be discovered to affect male sexual activity and perhaps be prescribed for this effect, or a birth control pill may be prescribed as a hormonal treatment to correct skin blemishes. Thus, side effects are not necessarily undesired and, once characterized, may be converted into intended effects.

These are perhaps useful distinctions, but it is not clear that they are universally adhered to in Science Policy usage.

SIMULATION⁵⁹

Use of a model, generally mathematical, to represent a real system for the purpose of gathering information about how it responds to

⁵⁸ This is the view of the author of the Glossary. It is not universally held. One respondent took specific exception, holding that "the purpose is to satisfy man's needs or desires." Another nonconcurring respondent suggested that the "definition should point out that some side effects may be purely social consequences (e.g., the effect of the automobile on the family, sexual morality, and religion)."

⁵⁹ Adapted from information supplied by the Federal Simulation Center, Alexandria, Va.

changing conditions. Advantages of simulation are that (1) it is typically faster and cheaper to simulate reality than to exercise the real system and (2) simulation does not disturb the real system.

Normally, simulation is done on a digital computer because of the computer's speed and capacity to store information and instructions. However, simulation may be done by hand, with an analog computer, or by means of physical representation, the latter normally in miniature, like a wind tunnel.

Typical uses of simulation include aerospace systems; industrial and inventory systems; physiological, biological, psychological, and medical systems; many vehicular systems; political, economic, environmental, and social systems; physical science systems; and instructional systems.

SOCIAL AUDIT

Related to social accounting (cf. Social Indicators), but applied almost exclusively to social accounting in business firms. The general objectives of corporate social auditing are to identify, quantify in dollar terms, and draw up a balance sheet to measure the social responsibility of a corporation. According to Sethi, this information would be used to assist—

institutions and groups through political processes to assign relative weights and priorities to various elements of social responsibility, fix responsibility for overseeing performance, and assist existing and emerging * * * corporations to alter their *modus operandi* and goals to meet the new performance criteria thus established.⁶⁰

The resulting balance sheet would also be used to compare the relative social responsibility of several firms.

There is little consensus on the components of a social audit, but widespread agreement that there are significant conceptual, methodological, and (input and output) measurement obstacles to the development of such a social audit.⁶¹

Two types of audits are discussed in the literature. First, a process, management-oriented, and exclusively internal, which inventories the corporation's explicit socially motivated goals and activities and relates them to objective performance criteria to assist the corporation in developing new goals and programs to meet observed deficiencies.⁶² Fringe benefits given to employees for education might be included, for example.

A second type of audit, oriented to the external environment and usually publicly reported, would include those "activities that [a corporation] considers socially beneficial and that may be of interest to such groups as investors, consumers, public bodies, and the general public."⁶³ For instance, it might weigh the firm's tax contributions allocated for pollution control and its own pollution abatement efforts

⁶⁰ S. Prakash Sethi, "Getting a Handle on the Social Audit," *Business and Society Review/Innovation* (Winter 1972-73, No. 4), p. 33.

⁶¹ Raymond A. Bauer and Dan H. Fenn, Jr., *The Corporate Social Audit* (New York: Russell Sage Foundation, 1972), 102 p. (Occasional Publications Reviewing New Fields for Social Science Development, No. 5); and —, "What is a Corporate Social Audit?" *Harvard Business Review*, January-February 1973, pp. 37-48.

⁶² Bauer and Fenn, *ibid.*

⁶³ Sethi, *op. cit.*, p. 34.

in comparison with costs incurred by the community in eliminating pollution caused by the firm.

Various combinations of these two types of social audits are being explored.

SOCIAL COSTS

See Externalities (also, External Effects) and Risk/Benefit Analysis.

SOCIAL INDICATORS (ALSO, SOCIAL ACCOUNTING SYSTEM)

In a seminal work on this subject, Professor Raymond A. Bauer described Social Indicators operationally as "statistics, statistical series, and all other forms of evidence that enable us to assess where we stand and are going with respect to our values and goals, and to evaluate specific programs and determine their impact."⁶⁴

Subsequently, a definition prepared in the Department of Health, Education, and Welfare by M. Olson, emphasizing how social indicators would differ from currently collected statistics, read as follows:

A social indicator * * * may be defined to be a statistic of direct normative interest which facilitates concise, comprehensive and balanced judgments about the condition of major aspects of a society. It is in all cases a direct measure of welfare and is subject to the interpretation that, if it changes in the "right" direction, while other things remain equal, things have gotten better, or people are "better off." Thus statistics on the number of doctors or policemen could not be social indicators whereas figures on health or crime rates could be.⁶⁵

The H.E.W. definition has been criticized on two counts: first, on the basis that to provide social guidance on action programs, a social indicator system should measure both inputs and outputs—in other words, *both* quantity of medical care and qualitative health conditions should be dealt with; and second, that indicators should be developed with reference to a model or models of society itself.

Conceptually, Social Indicators would be used for policy and program guidance in a way similar to the use of reports of the Council of Economic Advisers. One legislative proposal to provide such a system calls for a Council of Social Advisers.

According to Kenneth C. Land of the Russell Sage Foundation, "three recurring claims for social indicators arising from the exigencies of public policy decisions are that social indicators can help (1) to evaluate specific programs, (2) to develop a balance sheet or system of social accounts, and (3) to set goals and priorities."

I propose [continues Land] that the term *social indicators* refer to social statistics that (1) are components in a social system model (including sociopsychological, economic, demographic, and ecological) or of some particular segment or process thereof, (2) can be collected and analyzed at various times and accumulated into a time-series, and (3) can be ag-

⁶⁴ Raymond A. Bauer, ed., *Social Indicators* (Cambridge, Mass.: M.I.T. Press, 1966), p. 1.

⁶⁵ U.S. Department of Health, Education, and Welfare, "Toward a Social Report" (Washington, D.C.: U.S. Government Printing Office, 1969).

gregated or disaggregated to levels appropriate to the specifications of the model. Social system model means conceptions of social processes, whether formulated verbally, logically, mathematically, or in computer simulation form. The important point is that the criterion for classifying a social statistic as a social indicator is its *information value* which derives from its empirically verified nexus in a conceptualization of a social process.⁶⁶

However, too much should not be expected of Social Indicators too soon. First, "the elusiveness of the concept * * * stems from the multitude of views about the relevance and purpose of developing and organizing statistics about the state of affairs of the country and its constituent parts." Second, "[some recent] literature in the social indicators field * * * testif[ies] not alone to the paucity of quantitative data on certain social conditions, but also to the lack of fit between the existing body of social statistics and the several purposes associated with the social indicators movement."⁶⁷

SOCIAL INVENTION

Generally, a social or behavioral science advance, breakthrough, finding, or new technique (cf. Technology) which the social science community judges both theoretically founded (i.e. the causes and effects of the finding can be determined and explained), and also empirically validated, and which applied social practitioners or policymakers can use to effect changes in social behavior. A recent study of 62 major advances in applied social science since 1900 identifies as "Social Inventions" in economics: social welfare function; understanding of economic propensities; employment and fiscal policy; game theory; national income accounting; operations research and systems analysis; theories of economic development; econometrics; and cost-benefit analysis (planned programming and budgeting). In psychology: psychoanalysis and depth psychology; learning theory; intelligence tests; conditioned reflexes; Gestalt psychology; projective tests; operant conditioning and learning; teaching machines; and scaling theory. In sociology and political science: sociometry and sociograms; factor analysis; large-scale sampling in social research; attitude survey and opinion polling; content analysis; multivariate analysis linked to social theory; computer simulation of social and political systems; conflict theory and variable sum games; stochastic models of social processes; and sociology of bureaucracy, culture, and values.⁶⁸

Another study, citing instances of major social science studies which have impacted on public policy, lists among others: studies of social

⁶⁶ Kenneth C. Land, "On the Definition of Social Indicators," *The American Sociologist*, vol. 6, No. 4 (November 1971), pp. 322-23.

⁶⁷ Dr. Henry David, Executive Secretary Division of Behavioral Sciences, National Academy of Sciences-National Research Council. "Social Indicators: Reverent and Irreverent Observations," prepared for the NATO Advanced Study Institute on Technology Assessment, La Garda, Italy, Sept. 18-29, 1972, draft version, p. 15.

⁶⁸ Karl W. Deutsch, John Platt, and Dieter Senghass, "Conditions Favoring Major Advances in Social Science," *Science* (Feb. 5, 1971), pp. 450-459. See also their expanded version of this study: "Major Advances in Social Sciences Since 1890: An Analysis of Conditions and Effects of Creativity," Communications 273 (Ann. Arbor: Mental Health Research Institute. The University of Michigan, May 1970), 98 pages.

security legislation contributing to passage of the Social Security Act of 1935; studies of legislative behavior which led to passage of the Legislative Reorganization Acts of 1946 and 1970; studies of minority group problems and problems of blacks in America which led to Supreme Court decisions on civil rights during the '50's; political science studies on deterrence impacting on policy formulation in the Defense Department; sociological and anthropological studies of cultural variation which underlay formation of the Peace Corps; sociological studies of the state of the humanities in society which provided the basis for passage of legislation on the National Foundation for the Arts and Humanities; and studies of impacts of television on society and culture which in large part stimulated formation of public broadcasting.⁶⁹

In the study, *Technical Information for Congress*, an illustrative sampling of important social inventions before 1945 is presented, as follows:

parliamentary procedure	retirement pensions
the Australian ballot	insurance
Federal-State grants-in-aid	mass public education
budgeting and accounting methods	institutional waste disposal
the census	public hygiene
Government corporations	statistical sampling and quality control
job and personnel classification	workmen's compensation and unemployment compensation
national income and product statistics	opinion polls
hospitals	institutional outpatient care
clinics	
work simplification surveys	

The relationship between these inventions of applied social science and the data, theories, and principles produced by basic research in the social sciences, is analogous to that in any other field of science. Invention has often come into being empirically, without benefit of, and in anticipation of, the development of fundamental theory. In the electric storage battery, for instance, the invention was empirical and the theory came later. So, also, with the wheel and the Code of Hammurabi. In many other cases, theory pointed the way to solution of a technological or social problem, such as Albert Einstein's theory of the equivalence of matter and energy that led to the discovery of nuclear energy, or the Pavlov and Skinner theories of conditioned response and reinforcement that led to the teaching machine. In other cases, refinement of understanding led to the correction of a misconception—such as the notion that metals failed by “crystallization,” that alcohol potations were a specific for snakebite, that insanity resulted from exposure to moonlight, or that criminal tendencies could be eradicated by severe enough punishment.⁷⁰

⁶⁹ James A. Hightower, “Some Social Science Studies and Projects Which Have Had an Effect on Public Policy.” A draft study prepared according to the instructions of the Senate Subcommittee on Government Research, Government and General Research Division, Legislative Reference Service, Library of Congress (July 7, 1969), 8 pages.

⁷⁰ “Technical Information for Congress,” Report to the Subcommittee on Science, Research and Development of the Committee on Science and Astronautics, 92d Cong., 1st sess., Science Policy Research Division, Congressional Research Service, Library of Congress (Washington, D.C., U.S. Government Printing Office, 1971). Revised Apr. 15, 1971.

SOFTWARE

Originally, dry goods—cloth and related materials. With the advent of the digital computer, the term has taken on a special meaning. The computer itself, its permanent and temporary memory banks, its consoles, readers, and linkages, were all “hardware.” To distinguish the programs telling the computer what to do, and the “language” to be used in communicating with the computer, these elements are referred to as “Software.”

See Hardware.

SPIN-OFF

A shorthand term for a sequence in which technology developed expressly for major (mainly aerospace) governmental purposes is then applied elsewhere with economic benefit. It is identical with the “horizontal” form of Technology Transfer (q.v.).

The encouragement of Spin-Off often requires some additional development and almost always requires a repackaging of information to make the innovation available in the new context. This effort is referred to as “technological utilization” (i.e., technology utilization). Such organizational arrangements as the State Technical Services Act and local technology utilization centers have sought to encourage and facilitate Spin-Off.

STANDARD(S)

Units, quantities, procedures, agreed to by consensus or imposed by decree, and available for reference in the reporting of scientific discoveries, in specifications and other procurement documents, and in international or other technical communications of all kinds.

In endeavoring to explain its mission, the National Bureau of Standards begins: “If men are to accomplish together anything useful they must, above all, be able to understand one another.” The Bureau then distinguishes between “the setting of fundamental standards and the practice of standardization as conducted in industry.”

The former [the Bureau continues] has to do with definitions, with specifying clearly and exactly what technical words mean, in a fundamental and scientific sense. The latter may be concerned with commercial definitions, but it is primarily involved with the task of agreeing on limiting ranges of sizes and forms which shall be manufactured in large numbers.^{70a}

A definition of “Standards” for industrial purposes is:

Standards are practicable, profit-provoking solutions to recurring problems. Established tentatively, they are couched in objective terms and are based on the consent of those affected. They facilitate and often promote general usage of the best thoughts and practices on the subject being standardized. Standardization is an evolutionary process whereby standards are established.

The source of this definition offers the further comment that:

A standard is the immediate consequence of the standardization process. It most often assumes the form of the printed docu-

^{70a} Foreword. Measures for Progress, A History of the National Bureau of Standards, U.S. Department of Commerce. (Washington, D.C.: U.S. Government Printing Office, 1966.)

ment. However, it may with equal validity be a physical object such as a gage. It may be a sound, on the order of the radio signal. . . . It may be spoken, engraved in copper, hacked out of stone, or put to music. If it was developed in accordance with the basic tenets of standardization . . . it is a standard.

These "basic tenets of standardization" are: the consensus principle, evolution, solutions to recurring problems, measurables rather than generalities, practicability, dynamism, objectivity, and profitability. Then the author goes on to classify industrial standards as follows: specification, nomenclature, dimensional standards, testing methods, ratings, standard practices, simplification, and safety.⁷¹

STATE-OF-THE-ART

A general term of applied science, engineering, and systems engineering. It refers to the level of useful development in some category of technology; it carries the implication that if design should call for performance requirements or a level of sophistication that exceeds the present stage of development it will invite a significantly increased level of engineering risk. Generally speaking, applied research has the purpose of advancing the State of the Art in the subject to which it is addressed, to reduce the engineering risk that might otherwise be involved.

STEADY STATE

Although it is axiomatic that all systems in the universe tend to run down, nevertheless this process can sometimes be arrested for limited periods of time. In the organization of systems, it is the function of Feedback (q.v.) to arrest this. Such a period of arrestment, although never absolute or infinitely extended, is termed a Steady State. It is an approximation, a general balance, with no evident radical (exponential) or persistent deviation.

If it is recognized that all systems and all components of systems are in a dynamic state, then they are all in a state of continuous change. Under such a concept, the term "Steady State" as applied to the total system, suggests that (in the words of one respondent) "the rates and types of changes are such that the overall macro pattern remains undisturbed against the background flux of micro-changes." (Compare Homeostasis, for a condition in which macro and micro are reversed from this condition.)

STOCHASTIC PROCESS

A concept of statistical probability. (In drawing blindfolded one bean from a container holding four black beans and eight white beans, the chances are two to one that the drawn bean will be white.) The Research Analysis Corporation defines the term as follows:

The statistical concept underlying the prediction of the condition of an element of a larger group when the probable average condition of the larger group is known. For example, assume that an armored division, under certain circumstances, has on the average a certain number of tanks deadlined for un-

⁷¹ Benjamin Melnitsky, *Profiting from Industrial Standardization* (New York: Conover-Mast Publications, Inc., 1953, pp. 1-14.

scheduled maintenance. The probability that any given tank under the same circumstances will be deadlined for unscheduled maintenance on a specific day is described by a stochastic process.

SUBOPTIMIZATION

Excessive attention to the quality of one component of a larger system to the detriment of total system performance. Literally, it means optimization of a subordinate part; but since all systems represent compromise of component quality toward total system performances, with limited total resources available for the whole, the devoting of excessive resources to one part takes away essential resources from others. For example, a school system that overemphasized (suboptimized for) automobile repair would degrade general educational quality of its graduates.

SYMBIOSIS (ALSO, SYMBIOTIC RELATIONSHIP)

Symbiosis is the living together of two species (plants or animals) for the benefit of one or both members. If one member cannot live without the other under natural conditions, the relationship is called "mutualism." The most common example of mutualism is the actual union of algae and fungi to form lichens, the crusty, gray-green plant found on rocks and trees. Another form of symbiosis is "commensalism," a rather lopsided arrangement in which one member benefits without harming the other. An example is birds feeding on the lice and ticks of grazing animals. Commensalism is very common in the ocean where sponges, shellfish, and burrowing worms support other forms of life almost without exception.

In a broader sense, the food chains in nature illustrate a kind of loose symbiosis: They illustrate how all parts of the world of nature are interwoven, with a never-ending process of dependency of one species upon another.

An analogous concept of symbiosis can be conceived of in industry, with various types of dependency of one industrial activity on another. For example, in the textile industry an associated industrial activity is that of the loom-fixing company. A more elaborate (though hypothetical) example might be an association between a cement plant and a paper mill, with dust from the former used as sizing by the latter and waste lignin from the latter used as an additive in the cement.

SYNERGISTIC EFFECTS

When two causes produce similar effects, but when applied together produce an effect significantly greater in magnitude than the sum of effects from the two causes taken separately, the intensification is called "Synergistic" and the phenomenon "Synergism." A contemporary example would be the physiological/psychological effect of ingesting alcohol and a tranquilizer drug together.

SYNOPTIC MEASUREMENTS

Sometimes a measurement of one factor or element in an experiment (physical, biological, social) yields no significant meaning but the

measurement—more or less in concert—of several elements or parameters can provide important insights. These are Synoptic Measurements; they contribute to interpretation of scientific events and influence research policy.

SYNTHESIS

Almost the antonym of Analysis (q.v.). Used in its basic “combining” sense, e.g., the assembly of often varied and diverse ideas, forces, or factors into one coherent and consistent whole.

SYSTEM

This term involves the idea of complex, interrelated elements or components working effectively together in harmony to yield a single desired result. A Rand Corporation research memorandum defines “system” as “a set of interrelated factors that are used together to produce an output.”⁷²

Most systems also involve communications from a central control point, governing the operation of subsystems and reporting back to the control point, at which operating decisions are made (so that the system possesses the capability of self-adjustment or self-correction). See Feedback.

According to one student: “A system is a set of objects with relationships between the objects and between their attributes.” He continues:

Objects are simply the parts or components of a system, and these parts are unlimited in variety. Systems may consist of atoms, stars, switches, springs, wires, bones, neurons, genes, gases, mathematical variables, equations, laws, and processes.

Attributes are properties of objects. For example, in the preceding cases the objects listed have (among others) the following attributes:

stars—temperature, distances from other stars

switches—speed of operation, state

springs—spring tension, displacement

wires—tensile strength, electrical resistance

Relationships tie the system together. In fact, the many kinds of relationships (causal, logical, random, etc.) make the notion of “system” useful.

For any given set of objects, it is impossible to say that no interrelationships exist since, for example, for a particular physical system, one could always consider as relationships the distances between pairs of the objects. The relationships to be considered in the context of a given set of objects depend on the problem at hand, important or interesting relationships being included trivial or unessential relationships excluded. The decision as to which relationships are important and which trivial is up to the person dealing with the problem. . . .⁷³

One simple and useful definition is: “. . . a goal-oriented enterprise.” (The definition continues):

⁷² Joseph A. Kershaw and Roland N. McKean, “Systems Analysis and Education.” Rand Research Memorandum RM-2473 (Oct. 30, 1959), p. 2.

⁷³ A. D. Hall, *A Methodology for Systems Engineering* (New York, Van Nostrand, 1962), p. 60.

It is characterized by formal procedures for defining goals, for identifying the tasks necessary to the achievement of these goals, for organizing to accomplish the tasks, for measuring one's success, and for revising the process as experience (data) dictates.⁷⁴

See also Systems Analysis.

SYSTEM(S) ANALYSIS (ALSO, SYSTEM(S) APPROACH)

The development of a system requires that a complete array of the relevant analytical methodologies (cf. Analysis) is brought to bear, each contributing its own individual methodology and serving its own particular purpose. The actions resulting from the products of these different analyses are harmonized to produce a coherent structure possessing Effectiveness (q.v.). The sum total of the process described is signified by the term System or Systems Analysis. According to one source—Systems Analysis is

* * * inquiry to aid a decision-maker [in choosing] a course of action by systematically investigating his proper objectives, comparing quantitatively where possible the costs, effectiveness, and risks associated with the alternative policies or strategies for achieving them, and formulating additional alternatives if those examined are found wanting. Systems analysis represents an approach to, or way of looking at, complex problems of choice under uncertainty, such as those associated with national security. In such problems, objectives are usually multiple, and possibly conflicting, and analysis designed to assist the decision-maker must necessarily involve a large element of judgment.⁷⁵

In characterizing the effectiveness of systems, main reliance is placed on quantitative data. Criteria of performance are expressed in numbers, as are cost, configuration, and maintenance data. Irrespective of the disciplines used in designing and developing a system, the facts extracted and used in the process of analysis will tend to be expressions of qualitative relationships.⁷⁶ See also Systems and Analysis.

Emphasis in Systems Analysis is on the total performance of the whole system, as measured in parameters judged of primary importance, toward the system goal or mission. However, it is inherent in the System concept that there be coherence internally within the system as well as balanced compatibility with the external environment.

Systems analysis is a part of a total methodology, or way of thinking about things, called the systems approach. The systems approach encompasses the awareness and treatment of:

Total system objectives and, more specifically, the performance measures (or standards, measures of effectiveness, or measures of merit) of the whole system;

The system's environment, the fixed constraints;

The resources of the system;

⁷⁴ However, this addition seems to confuse the idea of System with that of Systems Approach, and combines the two. (Source: James A. Mecklenburger and John A. Wilson, "Learning C.O.D.," *Saturday Review* (Sept. 18, 1971), p. 64.)

⁷⁵ E. S. Quade, ed., *Analysis for Military Decisions* (Chicago: Rand McNally, 1964), pp. 3-4.

⁷⁶ In comment on this point, one respondent suggested that the "realities of any given situation (under analysis) may push one to the point of having to deal qualitatively or parametrically with some portions of the analysis."

The components (or subsystems, missions, or submissions) of the system, their activities, goals, and measures of performance; and

The management of the system.⁷⁷

Systems analysis is a term which has become associated generally with the concept of using "scientific" methods for the solution of broad problems lying outside as well as within the confines of the physical sciences. A number of other terms, however, have also become associated with this concept; among them are operations research (OR), systems engineering, planning-programming-budgeting system (PPBS), cost-effectiveness analysis, and management science. Increasing usage of these terms in many aspects of government and business activity reflects a current trend toward the infusion of scientific methodology in decision-making and policy-making processes in a large number of diverse areas. Often certain of these terms are used interchangeably, while on other occasions definite distinctions are made between them. The scope and characteristics of the activities carried on under these names vary widely, and there is not complete agreement among practitioners as to their proper definitions and range of applicability. Nevertheless, the acknowledged effectiveness and increasing use of systems analysis and related techniques calls for greater general comprehension of its meaning.

TECHNIQUE

Wilkinson, in his translator's note to Ellul's *La Technique*, describes the scope of the title as the "organized ensemble of *all* individual techniques which have been used to secure any end whatsoever." Lasswell is quoted in this same source as defining [Technique] as "the ensemble of practices by which one uses available resources to achieve values." According to Merton's interpretation of Ellul, the French writer sees technique as "any complex of standardized means for attaining a predetermined result."⁷⁸ It seems impossible to distinguish Technique from Technology (q.v.).

TECHNOLOGICAL FIX (OR, T. QUICK FIX)

See Quick Fix.

The term "Technological Fix" was explored by Dr. Alvin M. Weinberg⁷⁹ as an innovation devised for the purpose of correcting a social defect. For example, a drug taken orally to prevent unwanted conception as a measure of population control. Emphasis of the concept is on first-order consequences of socially useful technology. The significance of the term is conditioned by the meaning attached to "technological." When the scope of the term is considered as sharply limited to mechanical contrivances, the "fix" becomes mechanical, although its social consequences can still be broad. As the scope of the term "Tech-

⁷⁷ C. West Churchman, *The Systems Approach* (New York: Dell Publishing Co., Inc., 1968), pp. 29-30 ff.

⁷⁸ Jacques Ellul, *The Technological Society*, translated from the French by John Wilkinson, with an introduction by Robert K. Merton, first American edition (New York: Knopf, 1964), p. vi.

⁷⁹ Alvin M. Weinberg, "Can Technology Replace Social Engineering?" *Bulletin of the Atomic Scientists* (December 1966).

nology" extends to the biological and social sciences, and to management techniques and financial controls, the meaning of the term "Technological Fix" begins to overlap with that of technology assessment and science policy generally.

TECHNOLOGICAL OBSOLESCENCE (ALSO, TECHNOLOGY OBSOLESCENCE)

A reduction in absolute or relative Cost/Effectiveness (q.v.) of a technological system, product, component, or input, caused by a change in the external circumstances surrounding it. (Historically, technological obsolescence has been associated most closely with economic criteria, but the term "Effectiveness" (q.v.), used in the definition, reflects here a broader scope of criteria.)

Obsolescence usually implies the appearance of a superseding item or operation economically or functionally superior. Various other forms of obsolescence are also possible: for example, a finding that a given technological artifact, process, or system has social or medical dysfunction, like the drugs heroin or thalidomide, or a recognition that environmental consequences may be commandingly adverse, as with some of the organic synthetic pesticides.

It is noteworthy that Assessment of Technological Obsolescence has not attracted attention as an appropriate subject for policy study to the extent that Technology Assessment has done, yet the Side Effects of such obsolescence can be serious. Examples are the economic decline of Appalachia as a consequence of the technological obsolescence of coal as principal fuel, the loss of agricultural productivity that could result from restrictive regulation of pesticides, and the disruptive effect on industry of premature or arbitrary regulation against air and water pollution.

A respondent comments: I would include also the impact on manpower when made obsolete by the waning of skills and the overtaking by new technical growth. In the past, the impact of automation has been of concern in this regard; more recently, the need for conversion and retraining has been of public interest in connection with scientific and engineering unemployment.

TECHNOLOGY

Compare Technique.

The term "Technology" in its earliest usage signified mechanical tools and implied machinery of various kinds. However, it has come to signify tools and their development and use in the broadest possible sense. It encompasses any systematic employment by man of the cause-and-effect relationship (cf. Science) or empirical (cut-and-try) methods to achieve some desired purpose. It is the opinion of the author of the Glossary that the purpose of all technology can be generalized as an attempt to modify in some intended and desired way the relationship or compatibility of man and his environment.

Accordingly, technology encompasses all basic and applied research, all Edisonian inquiry, all manufacture and use of products, all knowledge rationally applied to agriculture, biomedicine, applications of

sociology and other behavioral sciences, and any other rational human actions toward intended results.⁸⁰

It is hard to distinguish the boundary lines between basic and applied science and technology. The point is that both basic and applied science are a part of technology. Thus, basic science is an information function; and applied science is an information function with a useful purpose in mind; while technology is the development and social use of information. A great deal of technological innovation, over the years, came into being without the aid of science; and conversely, a great deal of the information uncovered by science has not found useful application but is still judged as potentially useful, or as the basis for useful understanding.

A distinction can be drawn between technology as a process and as a product. One author suggests: "Technology-as-process is those patterns of action by which man transforms knowledge of his environment into an instrument of control over that environment for the purpose of meeting human needs. Technology-as-product is understood as comprising the range of tools, machines, procedures, etc., produced as results of technological action."⁸¹

A respondent observes that the word "Technology" has very strong emotional connotations for some people, who read into it notions about "the Establishment," "Free Enterprise," "Excessive Rationality," "Big Business," "the Military-Industrial Complex," and others. He observes: "You can't overlook, in your Glossary, these secondary meanings."

An interesting trend in the meaning of Technology is revealed by a comparison of the definitions in the Merriam-Webster 2nd and 3rd editions. In the 2nd edition, the word is defined:

1. Industrial science; the science or systematic knowledge of the industrial arts, esp. of the more important manufactures, as spinning, weaving, metalurgy, etc.
2. Terminology used in arts, sciences, or the like.
3. Any practical art utilizing scientific knowlege, as horticulture or medicine; applied science contrasted with pure science.
4. *Anthropol.* Ethnotechnics.

Contrast this definition with that in the Merriam-Webster 3rd edition, which is as follows:

1. The terminology of a particular subject: technical language
2. a: the science of the application of knowledge to practical purposes: applied science (the great American achievement has been . . . less in science itself than in ---- and engineering—Max Lerner) b(1): the application of scientific knowledge to practical purposes in a particular field (studies are also made of polymeric materials to dental ---- —Report: Nat'l Bureau of Standards) (2): a technical method of achieving a practical purpose

⁸⁰ For a discussion of this definition, see: Franklin P. Huddle, "Government Technology Assessment: The Role of the Social Sciences," Science Policy Research Division, Legislative Reference Service, Library of Congress, Multilith No. 10-246 SP (Oct. 2, 1970).

⁸¹ S. R. Carpenter, "The Structure of Technological Action, Ph. D. dissertation, Boston University, 1971, p. 28. Italics in original not followed.

(a ---- for extracting petroleum from shale) 3: the totality of the means employed by a people to provide itself with the objects of material culture.

TECHNOLOGY ASSESSMENT

A generalized process for the generation of reliable, comprehensive information about the chain of technical, social, economic, environmental, and political consequences of the substantial use of a technology, to enable its effective social management by decisionmakers.

Initially advanced as an instrument to provide advice to political decisionmakers, the concept has been increasingly accepted as a policy service within corporate management of private businesses.

As originally conceived, in a bill introduced by Congressman Emilio Q. Daddario, in 1967, the process was described as—

* * * identifying the potentials of applied research and technology and promoting ways and means to accomplish their transfer into practical use, and identifying the undesirable by-products and side-effects of such applied research and technology in advance of their crystallization and informing the public of their potential in order that appropriate steps may be taken to eliminate or minimize them.

In the study, *Technical Information for Congress*, Technology Assessment was defined in the following passage:

Before, during, and after the building of a technological system, it is necessary to identify and study the consequences of its operation. The objective is to improve the management of the total technological society, including the minimizing of consequences which are unintended, unanticipated, and unwanted. Assessment includes forecasting and prediction, retroactive evaluation, and current monitoring and analysis. Measurements involve non-economic, subjective values as well as direct, tangible quantifications. Above all, assessment requires that catastrophic consequences of each proposed new technology be foreseen and avoided before the new technology becomes entrenched in the socioeconomic complex of human organization. Above all, irreversibly, adverse consequences need to be foreseen and avoided.⁸²

A study of Technology Assessment by the National Academy of Sciences⁸³ accepted the Daddario definition (above) but devoted many pages to an intensive examination of its implications, in terms both of the process required and the institutional mechanisms for its implementation.

A study of the subject by the National Academy of Engineering⁸⁴

⁸² "Technical Information for Congress," op. cit., p. 481.

⁸³ "Technology: Processes of Assessment and Choice." Report of the National Academy of Sciences to the Committee on Science and Astronautics. U.S. Congress. House, 89th Cong., 2d sess. (Washington, D.C.: U.S. Government Printing Office, 1969).

⁸⁴ "A Study of Technology Assessment." Report of the Committee on Public Engineering Policy, National Academy of Engineering to Committee on Science and Astronautics. U.S. Congress. House, 89th Cong., 2d sess. (Washington, D.C.: U.S. Government Printing Office, 1969), pp. 14-16.

distinguished two different kinds of Technology Assessment: problem-initiated and technology-initiated assessments. These were:

1. Assessments directed to the solution of identified problems of society which are usually amenable to systems analysis for their solution; and
2. Assessments to enable society to cope with the unfolding chain of cause-and-effect relationships stemming from a new technology.

It has been suggested that to these should be added two other kinds of Technology Assessment. These are:

1. Policy-oriented studies; and
2. Studies undertaken (usually in an academic environment) for the purpose of developing an assessment methodology, rather than as an input to decision-making.⁸⁵

The author of this glossary is not persuaded of the validity of these last two additions, however, because the first ought to be the product of all assessments, and the second yields no substantive assessment at all.

In the Report of the President's National Goals staff, a chapter was devoted to the subject of Technology Assessment. In it was presented a further definition, as follows:

A systematic planning or forecasting process that delineates options and costs, encompassing economic, environmental, and social considerations (both external and internal) and with special focus on technology-related "bad," as well as "good," effects.⁸⁶

Out of these definitions emerges a concept of a purposeful and iterative search for significant secondary consequences and side effects (the "total impact") of a technology; identifying affected parties; evaluating the social, environmental, and cultural impacts; considering feasible technological alternatives; and revealing constructive opportunities; with the intent of managing technology more effectively to achieve societal goals. The process is a neutral and objective structuring of information about tradeoffs, priorities, options, and alternatives, to promote effectiveness in management decisions in the control and use of technology—not only in the present but for an indeterminate future.

It is essential that the process not be confused with the decision process, but rather that it be recognized as an input to it. This point was elaborated in *Technical Information for Congress* in the passage—

⁸⁵ For a more detailed description, see "The Future of Technology Assessment in Policy Formulation" by Walter A. Hahn, in *Technology Assessment in a Dynamic Environment*, M. J. Cetron, B. Bartocha, and C. Ralph (eds.), New York, Gordon and Breach, (currently in press). Hahn offers the further explanation as follows: "Policy-oriented TA is of major interest to the legislative and, to some extent, executive branches of the several levels of government. Assessments to determine the impact of old, new, or proposed technological structures, products, or processes are more usually associated with industrial or government regulatory agencies. Problem- or issue-oriented TAs arise from the feeling that 'something is going wrong,' often articulated by industrial citizens, groups, or public-interest organizations. This has been referred to as 'people's technology assessment.' * * * Persons in academic and not-for-profit organizations emphasize the conceptual and methodological aspects of TA and push for the development of the techniques, quality assurance, and objectivity so necessary for the viability of TA."

⁸⁶ National Goals Research Staff, "Toward Balanced Growth," op. cit.

In the management of a political issue with substantial scientific or technological content, the political issue is always larger in scope than the scientific question within it. In principle, the scientific question needs to be dealt with first. It is important that the scientific question or issue be carefully framed so that the answer to it provides a useful and significant piece of evidence for guidance in the consideration of the broader political issue.⁸⁷

Moreover—

* * * Every technical decision that provides the underpinning for a major political decision should receive adequate professional consideration, and * * * the outcome and its justification need to be expressed in terms meaningful to those responsible for the political decision.⁸⁸

Accordingly, it is suggested that the process of Technology Assessment is one of three elements in the management of technology by society. The first is the process of science and technology, producing innovations as solutions to social problems and needs. These may be economically attractive, or may require public funding; either way, they may become candidate claimants for political decisionmaking. The second element is the assessment of these technologies as solutions. The third element is the political process by which the social benefits and costs are finally judged and appropriate public action decided upon. Technology Assessment, then, is the technological information input to the political decision process.⁸⁹

TECHNOLOGY FORECASTING

(Also called "Technological Forecasting," although this usage is suspect.) In general, Technology Forecasting signifies the estimating of probable availability or use of a technological innovation at some specified future point in time. According to Jantsch:⁹⁰

Technological forecasting is the probabilistic assessment, on a relatively high confidence level, of future technology transfer. *Exploratory technological forecasting* starts from today's assured basis of knowledge and is oriented towards the future, while *normative technological forecasting* first assesses future goals, needs, desires, missions, etc. and works backward to the present. (Gabor.) The subject of both types is a dynamic picture of a technology transfer process. Technological forecasting may be aided by anticipation and may "harden" to prediction.

TECHNOLOGY GAP

This is a shorthand expression referring to a perceived inequality in national level of technological potential or achievement, as evidenced

⁸⁷ See p. 506.

⁸⁸ See p. 516.

⁸⁹ One respondent questions this concept of technology assessment as a "pure" technical process aloof from the political decisionmaking process. He questions not only its feasibility but even its desirability.

⁹⁰ Erich Jantsch, *Technological Forecasting in Perspective* (Paris, Organisation for Economic Cooperation and Development, 1967), p. 15.

by national differences in such characteristics as percentage of gross national product allocated to scientific research, rate of investment in new capital formation, numbers of new products appearing on the national market, educational level attained by the population, character of exports and imports as "high" or "low" technology, etc. Various publications have offered strategies for closing the "gap" and others have addressed the question as to whether or not such a gap in fact existed or could be precisely characterized or measured. *The American Challenge*, by J. J. Servan-Schreiber, erects an elaborate thesis around the proposition that there is a gap, favoring the United States, and that it can be closed by positive and concerted action of European countries. The studies by Michael Boretsky, an economist with the U.S. Department of Commerce, advance the thesis that there has been a gap—favoring the United States—and that it is attributable to past U.S. efforts supportive of research and development leading to the simulating of innovations in "high technology" (q.v.), but that such an asserted superiority is short-lived and waning.

TECHNOLOGY, HIGH

A loosely defined and imprecise term that appears to carry the implication that some kinds of technological innovation involve a higher content of scientific input than others. While it is true that some technologies have been developed empirically, nevertheless it should also be recognized that all technological innovations are amenable to improvement by the systematic application of Science (q.v.). Perhaps the nearest approach to precision of a definition of High Technology would be: Hardware developments relying extensively or chiefly on recent discoveries of the Physical Sciences (q.v.) for their operational principle. Perhaps an equivalent term might be "Technology Intensive."

TECHNOLOGY INTENSIVE

See Technology, High.

TECHNOLOGY, PUBLIC

An aspect of Technology Transfer (q.v.) mainly concerned with the transfer of technology for solving some of the major problems of society, particularly urban living, including solid waste management; municipal services, like police, fire, and health; traffic systems; housing and construction; municipal management and information systems; and pollution control.

TECHNOLOGY TRANSFER

This complex and incompletely understood process involves Communication (q.v.) in which the message contains technological elements. The transfer can be vertical (i.e., successive transmissions of ideas cumulatively toward a complete design or process) or horizontal (from one user to another). Either kind of transfer can be intra-national or international.

An excellent example of the various stages of this process is presented by the development and deployment of the Pilkington float

glass process. The innovation was developed in England, based on an American patent (invention). The process was perfected and put to work first in England and then licensed to other producers in a number of foreign countries. It is not unlikely that some of these licensees will in due course introduce further improvements on the process, and that these in turn will be transferred back to the originating company.

THEORY

A principle or body of principles propounded to explain phenomena, generally based upon scientific reasoning and often supported by Empirical (q.v.) evidence. Theory, based mainly on *a priori* reasoning processes, may be contrasted with Empiricism (q.v.), which is based mainly on *a posteriori* observation and experimentation, although both theory and empiricism make use of both types of processes.

When a theory has been adequately tested and substantiated by scientific methods, and is generally considered "proven" by the scientific community, it may be termed a law, like Newton's laws of motion or the laws of thermodynamics. However, if a theory is still subject to some doubt or has not been substantiated, it would remain a theory in the parlance of science and technology. In this sense, there is a fine distinction between a law and a theory.

Often theory is treated loosely as being synonymous with hypothesis. More accurately, however, a theory is a more or less verified or established statement of known phenomena while a hypothesis tends toward conjecture. A continuum of less- to better-established principles might range from hypothesis through theory to law, with some overlapping of meanings from one word to another.

See Science.

THRESHOLD

The lowest level or concentration at which a particular phenomenon affects a system; also commonly, but erroneously, the lowest level or concentration at which a particular phenomenon can be detected. For example, the levels at which a human hears sound or feels pain are the threshold levels of sound and pain, respectively; the threshold of a change in a physical substance may be measured, for example, in terms of the boiling or freezing temperatures of the substance or by related changes in the Ambience (q.v.).

The determination of threshold levels may often be constrained by the limitations of detection devices. For example, some substances or radiation in any amounts may cause Toxicity (q.v.), particularly chronic poisoning. The apparent threshold of toxicity in such cases would be the level of detection registered by detection devices, rather than the actual, and perhaps much lower, threshold of toxicity caused by the first absorption of toxic substances or radiation by living tissues.

The concept of threshold presents problems in the regulation of some kinds of environmental insults. The threshold for acute toxicity is higher than the threshold for chronic toxicity. In the case of radiation, there are two conflicting concepts of threshold: one is that all radiation exposure, no matter how small, is injurious to exposed human tissue so that there is *no* threshold; and the other is that a threshold

exists which is determined by the rate at which the human organism is able to repair radiation damage.

TOXICITY (noun)

Toxicity, or poisonousness, has become an increasingly important subject as the environment has become more polluted. Toxins in the atmosphere, soil, and water in the form of fertilizers, pesticides, and herbicides, and industrial, vehicular, human, and animal wastes, as well as radiation, may poison humans directly or may be introduced into foods and transferred to humans through links in the Food Chain (q.v.). Poisoning may be acute or chronic depending upon the toxicity of the agent, the rate of intake of the poison, and the rate of onset and the duration of the symptoms.

Acute poisoning, typically, is characterized by rapid absorption of the offending material and the exposure is sudden and severe. For example, inhaling high levels of carbon monoxide or swallowing a large quantity of cyanide compound will produce acute poisoning. The death or survival of a victim through the critical period occurs suddenly. Generally, acute poisoning results from a single dose which is rapidly absorbed and damages one or more of the vital physiological processes. The development of cancer long after recovery from acute radiation damage is called a delayed acute effect.

Frequently repeated and extended exposures over a period of several hours or days, results in subacute effects, depending on the dose rate.

Chronic poisoning is concerned with the continued absorption over a long period of time of a harmful material in small doses; each dose, if taken alone, would barely be effective. Chronic poisoning is characterized by the harmful materials remaining in the tissues, continually injuring some body process. The rate of intake exceeds the rate of excretion or detoxification; thus chronic poisoning can also be produced by exposure to a harmful material which produces irreversible damage, so the injury accumulates, rather than the poison. The symptoms in chronic poisoning are usually different than those seen in acute poisoning by the same toxic agent.⁹¹

Not all individuals react in the same manner to the same amount of a harmful material. Such an atypical response to chemicals presents problems to those concerned with setting occupational and public health standards. To screen out hypersensitive individuals from exposed occupations or environments may involve the use of predictive tests.

The toxicity of substances is often expressed in terms of the Lethal Dose which is required to cause death in 50 percent of an exposed population (LD-50), usually within 30 days. An LD-50 level for humans

⁹¹ Julian B. Olishifski and Frank E. McElroy, *Fundamentals of Industrial Hygiene* (Chicago: National Safety Council, 1971), pp. 417-18.

is typically determined by subjecting a test population, like rats, to toxic substances and extrapolating the results to humans based upon the amount of lethal toxins given to, and the body weights of, the test population.

TRADE-OFF (noun, verb)

Foregoing some portion of one benefit in order to achieve some increased portion of another benefit; (or) foregoing some portion of a benefit in order to achieve a reduction in some portion of a cost; (or) accepting an increased portion of one cost in order to achieve a decrease in the portion of another cost. Other more complicated permutations of this concept can be suggested. The term is in wide usage.

TRAGEDY OF THE COMMONS

The principle that the maximization of private gain will, in some cases, not be regulated by a device like the "invisible hand" of Adam Smith, which typically serves as a natural self-regulator of economic activity.

The "Tragedy of the Commons" alludes to a situation in which each of several herdsmen seeks to maximize his gain by adding cattle to a common pasture. A herdsman could rationalize and justify his action in adding one animal to the commons on the basis that he would receive all the benefit of the additional animal while the detrimental effects of overgrazing caused by his action would be shared equally by all the herdsmen. In this type of situation, some form of governmental regulation might be required to prevent the economic ruin of those who share the commons. The principle of the Tragedy of the Commons is found in many societal problems, like environmental pollution and overpopulation, particularly those involving any "free" or common good or service, like air, water, procreation, and sometimes land.

This principle was first propounded by William Forster Lloyd in 1833. Professor Garrett Hardin of the University of California at Santa Barbara has recently expanded upon Lloyd's work and given the principle its name.⁹²

TRANSNATIONAL CORPORATION

See Multinational Corporation.

TREND EXTRAPOLATION

A form of forecasting in which the assumption is made that the rate of time-dependent change of a phenomenon will continue in the future at the same level as in the past. For example, electric power generating capacity in the United States has approximately doubled every decade since 1920. Trend extrapolation would predict that it will continue to double over each future decade. Such a simplistic approach, of course, ignores the fact that the rate of increase of electric power in its infancy was not this fast, and that future change may level off or even decrease. (Comments a respondent: [Trend Extrapolation] has the

⁹² Garrett Hardin, "The Tragedy of the Commons," *Science*, vol. 162, Dec. 13, 1968, pp. 1243-1248.

same problem as Delphi in the case of complex nonlinear feedback systems and can give highly misleading results for the same reason.) Graphically, the rate of change that begins slowly and increases to a sustained maximum rate before leveling out (becoming asymptotic to a horizontal line) is represented by an "S-Curve"; trend extrapolation, which cannot predict at what point in time (and for what reasons) the second knee in the S-Curve will be reached, simply ignores this subtlety by assuming that no knee exists. Similar difficulties are encountered in attempts to apply trend extrapolation to other phenomena exhibiting other forms of behavior.

TRIBOLOGY

The word "Tribology" was coined by a British committee in 1966 from the word "tribos," which means "rubbing" in classic Greek. It may be defined as the science and technology of the interaction of material surfaces in relative motion. It is concerned with every aspect of operating hardware and equipment in which the relative motion of surfaces is involved and thus covers a wide range of phenomena. Tribology encompasses, essentially as an integrated system, the many facets of friction, lubrication, wear, bearing phenomena, hydrodynamics, fluid mechanics, surface sciences, and many classical disciplines like chemistry and physics. Tribology constitutes an interdisciplinary approach to these fields and to related design and engineering problems.

VALUE(S)

Desired functions. They may be expressed in many ways. Economic values are expressed in monetary terms. Parts of systems are evaluated in relevant parametric numbers. Social values can sometimes be quantified. (Cf. Social Indicators and Externalities.) Normative (q.v.) values are general social, ethical, cultural, or esthetic "goods" not subject to quantification.

APPENDIX

Acronyms and Abbreviations of Organizations Frequently Appearing in Science Policy Literature.

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APPENDIX

Acronyms and Abbreviations of Organizations and Publications
and a Glossary of Policy Language

INTRODUCTION

The purpose of this Appendix is to provide a convenient reference to frequently used acronyms and abbreviations of organizations which appear in the literature of science policy. In most cases, the organic act creating the organization, and the purpose, and illustrative activities or programs of each organization are briefly described. The list is very selective. The short identifications of agencies are merely explanatory and do not define all their purposes, activities, or programs. The subsequent amendments to the organic legislation or other additional legislation that pertains to a particular organization are usually omitted.

INTRODUCTION

The purpose of this study is to provide a comprehensive overview of the current state of research on the effects of social media on mental health. The study will focus on the impact of social media on self-esteem, anxiety, and depression. The research will be conducted using a combination of qualitative and quantitative methods. The study will also explore the role of social media in the development of mental health disorders. The findings of the study will be used to inform the development of interventions to reduce the negative effects of social media on mental health.

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Organizations

Related to—

AAAS—American Association for the Advancement of Science.

AAAS was founded in 1848 to further the work and cooperation of scientists, and to improve the public understanding and the effectiveness of the role of science in promoting human welfare. The AAAS is involved in improving the quality of science education, a Foreign Scientists Program, and publishing scientific information.

AEC—Atomic Energy Commission

(also USAEC)----- U.S. Government

The AEC, created by the Atomic Energy Act of 1946, is responsible for developing atomic energy technology for defense and industrial uses and for regulations to ensure safe use of nuclear processes. Some of the activities that AEC is involved with are: procurement of adequate stocks of raw materials, development and storage of nuclear weapons, and technical support of U.S. efforts toward achieving international control of atomic energy.

AID—Agency for International Development

(also USAID)----- Department of State

The Agency for International Development (AID) was established by State Department Delegation of Authority 104 to encourage and support efforts by the developing countries to meet the fundamental needs of their people for sufficient food, good health, and employment. AID carries out development assistance programs overseas designed to promote the economic and social modernization of developing countries.

ANL—Argonne National Laboratory----- U.S. Atomic Energy
Commission

This major research center's program includes fundamental and applied research and engineering development. While the basic orientation of much of the Laboratory's effort has traditionally been reactor development, there has been increasing emphasis on high-energy physics.

ARS—Agricultural Research Service----Department of Agriculture

The ARS was established by the Secretary of Agriculture in 1953 to furnish the technology and knowledge that is necessary for the farmer to produce efficiently, conserve the environment, and meet the food and fiber needs of the country. Research is conducted in such fields as plant science, entomology, and soil sciences.

ARPA—Advanced Research Projects Agency-----See DARPA

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BIPM—International Bureau of Weights and Measures (Bureau International des Poids et Mesures).

BIPM was set up in 1875 for the establishment of international standards and of measurement scales of physical quantities. The Bureau's activities include research laboratories and consultative committees.

BNL—Brookhaven National Laboratory----- U.S. Atomic Energy Commission

BNL is a major U.S. Atomic Energy Commission research center. The principal areas of research activity are: physics, chemistry, biology, nuclear technology, and medical research.

CEA—Council of Economic Advisers----- Executive Office of the President

The Council of Economic Advisers was established by the Employment Act of 1946 to analyze the national economy; to advise the President on economic developments; to appraise the economic programs and policies of the government; to assist in the preparation of reports, and to recommend to the President policies for economic growth and stability.

CEQ—Council on Environmental Quality----- Executive Office of the President

The Council on Environmental Quality was established by the National Environmental Policy Act of 1969 to formulate and recommend national policies to promote the improvement of the quality of the environment. The Council develops and recommends to the President national policies which promote environmental quality, and performs a continuing analysis of changes or trends in the national environmental quality report to the Congress.

CERN—European Organisation for Nuclear Research (Organisation Européenne pour La Recherche Nucleaire).

CERN was set up in 1953 to provide for collaboration among its members in nuclear research. The original program of this organization was to do research on high energy particles and to organize and sponsor international cooperation in nuclear research. The main facilities at CERN are particle accelerators.

CIOMS—Council for International Organisations of Medical Sciences.

CIOMS was created in 1949 to facilitate exchanges of views and scientific information in the medical sciences. It employs four principal means: symposia, international congresses, assistance with the scientific programs of its members, and cooperation with UNESCO and WHO.

COMECON (CMEA)—Council for Mutual Economic Assistance-- Associated with Soviet Bloc

COMECON was established in 1949 to arrange for the exchange of economic, scientific, and technical aid and experience among the participating countries. There has been much interest in the joint development of raw materials, and of power and fuel resources by this organization.

COPEP—Committee on Public Engineering Policy—National Academy of Engineering

COPEP was established to provide advice and recommendations to the Federal Government on the social impacts of technology and its implications for public policy; and, more broadly, to address questions of national policy involving or affecting technology.

COSPAR—Committee on Space Research----- ICSU

The Committee on Space Research was founded in 1958 to further the progress of scientific investigations which are carried out with the use of rockets or rocket-propelled vehicles. COSPAR is concerned with fundamental research and is not usually involved with technological problems such as propulsion, construction of rockets, guidance and control.

The purposes of this committee are achieved through the development of space research programs by the international community of scientists working through ICSU and its associated organizations.

COSPUP—Committee on Science and Public Policy--National Academy of Sciences

The Committee on Science and Public Policy (COSPUP) advises the Congress and agencies of the Government, upon request, and examines future needs of research in various scientific disciplines and the applications of science to critical national problems.

CRS—Congressional Research Service-----Library of Congress

This service for Congress was formally chartered as the Legislative Reference Service in the Legislative Reorganization Act of 1946; its duties were expanded and its name changed by the Legislative Reorganization Act of 1970. CRS provides research, analysis, reference, and other information services to the Congress. CRS responses to Committees and Members of Congress may involve the preparation of reports, making specialists available for consultations, and assembling and collating information.

CSG—Council of State Governments.

The Council of State Governments was founded in 1925 to develop and share information on administrative management among the States and in their relations with the Federal Government. This organization issues several publications and provides staff services to many affiliated groups.

DARPA—Defense Advanced Research Projects Agency—Department of Defense

Defense Advanced Research Projects Agency, on March 23, 1972, was made a separate agency of the Department of Defense. DARPA provides for the study and the development of advanced projects. It seeks to demonstrate the feasibility of advanced programs and then transfer them to an appropriate military service.

DDR&E—Directorate for Defense Research and Engineering—also
ODDR&E ----- Department of Defense

Overall research and development policy for the DOD is made by the Director of Defense Research and Engineering (DDRE). He is assisted by a considerable technical staff, by the Defense Advanced Re-

search Projects Agency (DARPA), the Weapons Systems Evaluation Group (WSEG), and the Defense Science Board (DSB).

DOD—Department of Defense-----U.S. Government

The DOD was established as an executive department of the Government by the National Security Act Amendments of 1949. The Department of Defense was created as a part of a comprehensive program designed to provide for the security of the United States through the establishment of integrated policies and procedures for the departments, agencies, and functions of the Government concerned with national security.

DOT—Department of Transportation----- U.S. Government

The Department of Transportation was established by the Department of Transportation Act of 1966 for the purpose of developing national transportation policies and programs conducive to the provision of fast, safe, efficient, and convenient transportation at the lowest cost consistent therewith. The Department also administers uniform time matters.

DSB—Defense Science Board----- Department of Defense

The mission of the Defense Science Board is to advise the Secretary of Defense and the Director of Defense Research and Engineering on overall research and engineering and to provide long-range guidance in these areas to the Department of Defense.

ELDO—European Launcher Development Organisation.

ELDO was established in 1962 to develop and construct space vehicle launchers and their equipment. This organization has been concerned with the following launcher vehicles: EUROPA 1, and ELDO-A.

EPA—Environmental Protection Agency----- U.S. Government

The Environmental Protection Agency (EPA) was established as an independent agency pursuant to Reorganization Plan 3 of 1970.

EPA was created to permit coordinated and effective governmental action to assure protection of the environment by the systematic abatement and control of pollution through a variety of research, monitoring, standard setting, and enforcement activities. EPA coordinates and supports research and anti-pollution activities.

EPA is involved in such activities as air and water quality protection, control of use of pesticides, and disposal of industrial and municipal wastes.

ESC—European Space Conference.

ECS was established in 1966 to develop a coordinated European space policy and watch over its implementation.

ESRO—European Space Research Organisation.

ESRO was established in 1962 to promote and provide for collaboration among European States in space technology and research. Some of the activities that ESRO has been concerned with are: launching of sounding rockets; putting small satellites into orbit; putting into orbit an astronomical observatory, and carrying out astronomical experiments.

FAO—Food and Agriculture Organisation----- United Nations

FAO was established in 1945 to improve the efficiency of the production and distribution of all food and agricultural products, to raise the levels of nutrition and standards of living of people, and to better the conditions of rural populations. Some of the activities that FAO is involved in are: the collection, analysis, and dissemination of technical and scientific information; the organization of international meetings; and the provision of technical assistance to developing countries.

FCC—Federal Communications Commission----- U.S. Government

The Federal Communications Commission was created by the Communications Act of 1934 to regulate interstate and foreign communications by wire and radio. Some illustrative areas of concern include: broadcasting, cable television, and safety and special radio services.

FCST—Federal Council for Science and

Technology ----- National Science Foundation

The Council was established by Executive Order 10807 in 1959 to promote better cooperation among Federal agencies, to facilitate resolution of common problems, to improve planning and management in science and technology, and to advise and assist the President regarding Federal programs affecting more than one agency.

FDA—Food and Drug Administration----- Department of Health
Education, and
Welfare

The name "Food and Drug Administration" was first provided by the Agriculture Appropriation Act of 1931, although similar law-enforcement functions had been carried on under different organizational titles since 1907.

FDA's activities are directed toward protecting the public health of the Nation. FDA is concerned with such matters as product safety, drugs, veterinary medicine, radiological health, and safety of foods.

FPC—Federal Power Commission----- U.S. Government

The FPC, originally operated under the Federal Water Power Act of 1920, regulates interstate aspects of the electric power and natural gas industries. Some of the Commission's activities include: issuing permits and licenses, and regulating rates and transactions in electric power and natural gas.

GAC—General Advisory Committee----- U.S. Atomic Energy
Commission

A statutory committee consisting of nine members appointed by the President, whose function is to advise the U.S. Atomic Energy Commission on scientific and technical matters relating to materials, production, and research and development.

GAO—General Accounting Office----- U.S. Congress

The General Accounting Office was created by the Budget and Accounting Act in 1921 to assist the Congress in providing legislative control over the receipt, disbursement, and application of public funds.

The primary purpose of these audits is to make for the Congress independent determinations of the way in which Government agencies are discharging their financial responsibilities.

HEW—Health, Education, and Welfare----- U.S. Government

The Department of Health, Education, and Welfare was created by Reorganization Plan 1 of 1953 to administer those agencies of the Government dealing with health, education, and social security.

HSMHA—Health Services and Mental
Health Administration----- Department of Health,
Education, and
Welfare

HSMHA was established as part of the Public Health Service in 1968 by the Secretary of HEW. HSMHA provides leadership to programs to improve general health services and mental health programs. It is responsible for development of health care and maintenance systems. HSMHA is divided into 15 major services such as maternal and child health, community health, and family planning.

IAEA—International Atomic Energy Agency----- United Nations

The International Atomic Energy Agency was established in 1956 to encourage and assist research on the development and use of atomic energy for peaceful uses. Some of the methods by which the Agency conducts its scientific programs include: maintaining mobile laboratories; undertaking research or providing research grants to scientific institutions; coordinating research programs; working on the development of health, safety, and waste management control and regulation codes; and holding international meetings.

ICSU—International Council of Scientific Unions.

ICSU was founded in 1931 to coordinate the activities of international scientific unions in the exact and natural sciences, and to serve as a coordinating center for national scientific organizations. Through the intermediary of the national adhering organizations, ICSU enters into relationships that promote scientific research.

ITU—International Telecommunications Union---- United Nations

ITU became a specialized agency under the United Nations in 1947. The purposes of ITU are (a) to maintain and extend international cooperation for improvement and rational use of telecommunication of all kinds; (b) to promote the development of technical facilities.

Its scientific objectives include the effective allocation of the radio-frequency spectrum and the adoption of standards for international telecommunications media. It also has technical assistance functions.

KAPL—Knolls Atomic Power Laboratory---- U.S. Atomic Energy
Commission

KAPL, established in 1946, is a power reactor development center, principally for Naval reactor programs.

LASL—Los Alamos Scientific Laboratory----- U.S. Atomic Energy
Commission

LASL was established in 1942 as a research center to engage in fundamental and applied research in weapons; later, other areas like

controlled fusion, reactor development, nuclear rocket propulsion, and direct energy conversion were added.

NAE—National Academy of Engineering.

The National Academy of Engineering was established on December 5, 1964, by the Council of the National Academy of Sciences, under the authority of its Act of Incorporation. NAE shares in the objectives and responsibilities of the NAS. It sponsors engineering programs aimed at meeting national needs, encouraging engineering research, and advising the Federal Government upon request in matters of engineering.

NAS—National Academy of Sciences.

The NAS was established by an act of Congress in 1863 with the purpose of the furtherance of science and its use for the general welfare. Although not a governmental agency, the Academy has long enjoyed close relations with the Federal Government. Its congressional charter of 1863 specifies that "... the Academy shall, whenever called upon by any department of the Government, investigate, examine, experiment, and report upon any subject of science or art ..."

NASA—National Aeronautics

and Space Administration----- U.S. Government

NASA was established by the National Aeronautics and Space Act of 1958. Three principal functions of NASA are: to conduct research on flight within and outside the earth's atmosphere; to do research on aeronautical and space vehicles; and to conduct activities required for the exploration of space. Some of the activities of NASA are: the conduct of manned and unmanned space flights, and the maintenance of research and flight centers.

NASC—National Aeronautics

and Space Council----- Executive Office of
the President

The National Aeronautics and Space Council was established by the National Aeronautics and Space Act of 1958. The functions of the Council are to advise and assist the President regarding policies, plans, and programs; to fix the responsibilities of the United States agencies engaged in aeronautical and space activities and to develop a comprehensive program of such activities. Reorganization Plan No. 1 of 1973 abolished NASC.

NASULGC—National Association of State Universities and Land-Grant Colleges.

The Association serves to bring the collective strength of its members to bear on pressing educational issues; it focuses public attention on research contributions that State universities and land-grant colleges have made. The activities of NASULGC include: commissions, publications, and councils.

NATO—North Atlantic Treaty Organization.

NATO was established in 1949 to coordinate the collective defense of its fifteen member nations. The scientific programs of NATO are directed toward promoting scientific and technical cooperation and

toward contributing to the security of the area by increasing the scientific potential of its members. Some of the methods employed by NATO to accomplish these goals are: research grants, advisory expert panels, and demonstrations of the applications of research.

NBS—National Bureau of Standards----- Department of Commerce

The National Bureau of Standards (NBS) was created by an act of Congress in 1901 to improve the Nation's science and technology and facilitate their effective application for public benefit. To this end, the Bureau conducts research and provides: a basis for the Nation's physical measurement system; scientific and technological services for industry and government; a technical basis for equity in trade; technical services to promote public safety; and technical information services.

NEA—Nuclear Energy Agency----- Organisation for Economic
Cooperation and Development

NEA was the new name assigned to the European Nuclear Energy Agency (ENEA) when this organization accepted Japan into its membership in 1972. NEA was set up to develop nuclear collaboration for peaceful uses among its members. The basic program of this organization is to promote the formation of joint undertakings, to formulate uniform legislation relating to nuclear energy, to coordinate research training, and to assess the role of nuclear energy in the future energy requirements of Europe.

NIH—National Institutes of Health----- Department of Health,
Education, and
Welfare

The National Institutes of Health (NIH) was established as an agency within the Public Health Service by the Secretary of HEW in 1968. The National Institutes of Health programs are designed to improve the health of the people of the United States. The NIH conducts and supports research in the causes, prevention, and cure of diseases of man; administers programs to meet the Nation's health manpower requirements; directs programs for the collection, dissemination, and exchange of information in medicine and health; and administers Federal standards and licensing activities for biological products sold in interstate commerce.

NIMH—National Institute of
Mental Health----- Department of Health,
Education, and
Welfare

The Institute provides for the improvement of mental health through the conduct and support of programs for the discovery and demonstration of new knowledge, and the inauguration, demonstration, and support of services to promote and sustain mental health, prevent mental illness, and treat and rehabilitate mentally ill persons. It also conducts and supports programs directed at such problems as alcoholism, narcotic addiction, drug abuse, suicide, crime, and problems of metropolitan areas.

NOAA—National Oceanic and Atmospheric

Administration ----- Department of Commerce

NOAA was formed on October 3, 1970 by Reorganization Plan 4 of 1970. Some of its missions are to study the global oceans; to assess, manage, use, and conserve the sea's resources; to study the physical environment; and to warn against impending environmental hazards. Some of its principal parts are: the National Weather Service, National Ocean Survey, and the Environmental Data Service.

NRC—National Research

Council ----- National Academy of Sciences and National Academy of Engineering

The Research Council was organized by the Academy in 1919, in response to a request from President Wilson, and operates in accordance with Executive Order 2859 of May 11, 1918, as amended by Executive Order 10668 of May 10, 1956. The National Research Council (NRC) was organized by the NAS to facilitate the participation of a broader representation of scientists and technologists in carrying out its objectives. The NRC has become, in effect, the principal operating agency for both the NAE and the NAS. The purpose of the Council is to stimulate research in the mathematical, physical, and biological sciences, and the application of these sciences with the object of increasing knowledge, of strengthening the national defense, and of contributing in other ways to the public welfare.

NSB—National Science Board----- National Science Foundation

The National Science Board consists of 24 members, each appointed by the President, with the advice and consent of the Senate. The Board's purpose is to establish policy for the National Science Foundation; more recently the Board has concerned itself with issues of national science policy. The Board reviews and approves all new programs to be launched by the National Science Foundation as well as any major changes in ongoing programs and reviews the formulation of the Foundation's annual budget requests.

NSF—National Science Foundation----- U.S. Government

The National Science Foundation was established by the National Science Foundation Act of 1950 to strengthen research and education in the sciences in the United States. A few of the activities that the Foundation is involved with include: the awarding of research grants and contracts; supporting research aimed at stimulating economic growth; and supporting major national and international science programs.

NTIS—National Technical Information

Service ----- Department of Commerce

NTIS was established in 1970 by the Secretary of Commerce by Department Organization Order 30-7A to improve public access to data files and scientific and technical reports produced by Federal agencies and their contractors.

It is the central point in the United States for the public sale of Government-funded research and development reports and other analyses.

The agency coordinates the publishing and technical inquiry functions of various Information Analysis Centers in the United States.

OAS—Organization of American States.

OAS was established in 1948 with the dual purpose of strengthening peace and security, and promoting the economic, social and cultural development of its members. To promote scientific as well as economic and social progress, OAS provides technical, educational and training assistance. It coordinates cooperative efforts among its member nations, and stimulates interest in research and training fellowships. OAS also coordinates its activities with the technical assistance programs of the U.S. and the U.N.

OECD—Organisation for Economic Cooperation and Development

OECD came into existence in 1961 to stimulate cooperation between member countries for economic growth, expanded world trade, and coordinated aid to less developed areas. In the scientific and technological fields the organization encourages research, promotes the development of resources, and promotes training. OECD has been involved in promoting the development and coordination of national science policies, in promoting international research, and in assisting with the scientific and educational problems of developing countries.

OEO—Office of Economic

Opportunity----- Executive Office of the President

The Office of Economic Opportunity was established by the Economic Opportunity Act of 1964 to strengthen, supplement, and coordinate efforts to further the policy of the United States to eliminate or mitigate poverty.

OMB—Office of Management and Budget----- Executive Office of the President

The Office of Management and Budget was established by the Reorganization Plan 2 of 1970 to aid the President in bringing about more efficient and economical conduct of Government service; to assist the President in the preparation of the budget and the formulation of the fiscal program of the Government; and to supervise and control the administration of the budget.

ONR—Office of Naval Research----- Department of Defense

The Office of Naval Research was established by act of Congress, 1946.

ONR plans and coordinates research programs; advises on findings and trends in research and development and disseminates such information; administers activities within or on behalf of the Navy relating to patent and copyright function; and executes contracts for the conducting of research.

ORNL—Oak Ridge National Laboratory----- U.S. Atomic Energy Commission

ORNL is a major U.S. Atomic Energy Commission research center. The fields of activity with which ORNL is most closely identified include: reactor development, chemical technology, controlled fusion, radioisotopes, and basic research.

OST—Office of Science and Technology----- Executive Office of
the President

The Office of Science and Technology was created by the Reorganization Plan 2 of 1962.

The Director of the Office of Science and Technology provides advice and assistance to the President with respect to developing policies and evaluating and coordinating programs to assure that science and technology are used most effectively in the interests of national security and general welfare.

This assignment is accomplished in four main ways:

1. Evaluation of major policies, plans, and programs of science and technology of the various agencies of the Federal Government;
2. Assessment of selected scientific and technical developments and programs;
3. Review, integration, and coordination of major Federal activities in science and technology; and
4. Assuring that close relations exist with the Nation's scientific and engineering communities.

Reorganization Plan No. 1 of 1973 abolished OST.

OTA—Office of Technology Assessment----- U.S. Congress

OTA was created by Public Law 92-484 in 1972 to provide early indications on the probable impacts of the application of technology. It is instructed to identify alternative technological methods of implementing programs and present findings of completed analyses to the appropriate legislative authorities.

PAHO—Pan American Health Organization--- Organization of
American States

PAHO was organized in 1958 on the foundations of other international organizations that had functioned from 1902 on. The purposes of this organization are to coordinate and to promote the efforts of the countries of the Western Hemisphere to lengthen life, combat disease, and improve the physical and mental health of the people.

The activities of PAHO related to science might be grouped into the following categories: development and improvement of health services, including assistance in planning and operation of special health projects; the eradication and control of communicable diseases; collection and dissemination of epidemiological information and health research; improvement of food, drug, and biologics control; and education and training assistance programs.

RAE—Royal Aircraft Establishment----- U.K. Ministry of Defense

The Royal Aircraft Establishment, founded in 1918, gives technical advice on aircraft and collaborates with industry in developing flying equipment. Research programs are discussed and agreed upon with the aerospace industry through joint research committees. The establishment's current activities include supersonics, vertical takeoff; rocketry and guided missiles, automatic control and space science.

SEATO—Southeast Asia Treaty Organization.

SEATO was created in 1954 with the basic provisions that member countries are to strengthen their free institutions, and to cooperate in the further development of economic measures, including technical

assistance. SEATO's activities include the furnishing of assistance in the form of medical research laboratories.

SIE—Science Information Exchange----- Smithsonian Institution

The mission of SIE is to assist the planning and management of research activities supported by Government and non-Government institutions by promoting the exchange of information that concerns current research in the prepublication stage. It helps program directors and administrators to avoid unwarranted duplication and to determine the most advantageous distribution of research funds. It informs individual investigators about others currently working on problems in their special fields.

SIPRI—Stockholm International Peace Research Institute.

SIPRI was set up in 1966 by the Swedish Parliament as a foundation to study problems of peace and conflict with particular attention to the areas of disarmament and arms regulations. Some of the projects of past concern are: "Arms Trade with the Third World" and the "SIPRI Yearbook of World Armaments and Disarmament."

SPR—Science Policy Research Division----- Library of Congress

SPR is a division of the CRS which handles inquiries on such subjects as: science policy, aviation and space technology, biological and medical issues, behavioral sciences, earth sciences, and other science and technology issues.

UNESCO—United Nations Educational, Scientific,
and Cultural Organisation----- United Nations

UNESCO was founded in 1945 as a U.N. satellite organization to encourage international cooperation in education, science, and culture. To attain this purpose, UNESCO advances the mutual knowledge and understanding of peoples and encourages international cooperation in all branches of intellectual activity. Science is a major part of the program. UNESCO coordinates research programs, aids nongovernmental international scientific organizations, and supports joint basic research programs.

UNITAR—United Nations Institute for Training
and Research----- United Nations

UNITAR was founded in 1963 for the purpose of enhancing the effectiveness of the United Nations in achieving its major objectives. This task is accomplished primarily by providing training, by conducting research, by maintaining peace and security, and by promoting economic and social development.

USAEC—United States Atomic Energy
Commission----- U.S. Government
(see AEC)

USAID—United States Agency for
International Development----- Department of State
(see AID)

WHO—World Health Organisation----- United Nations

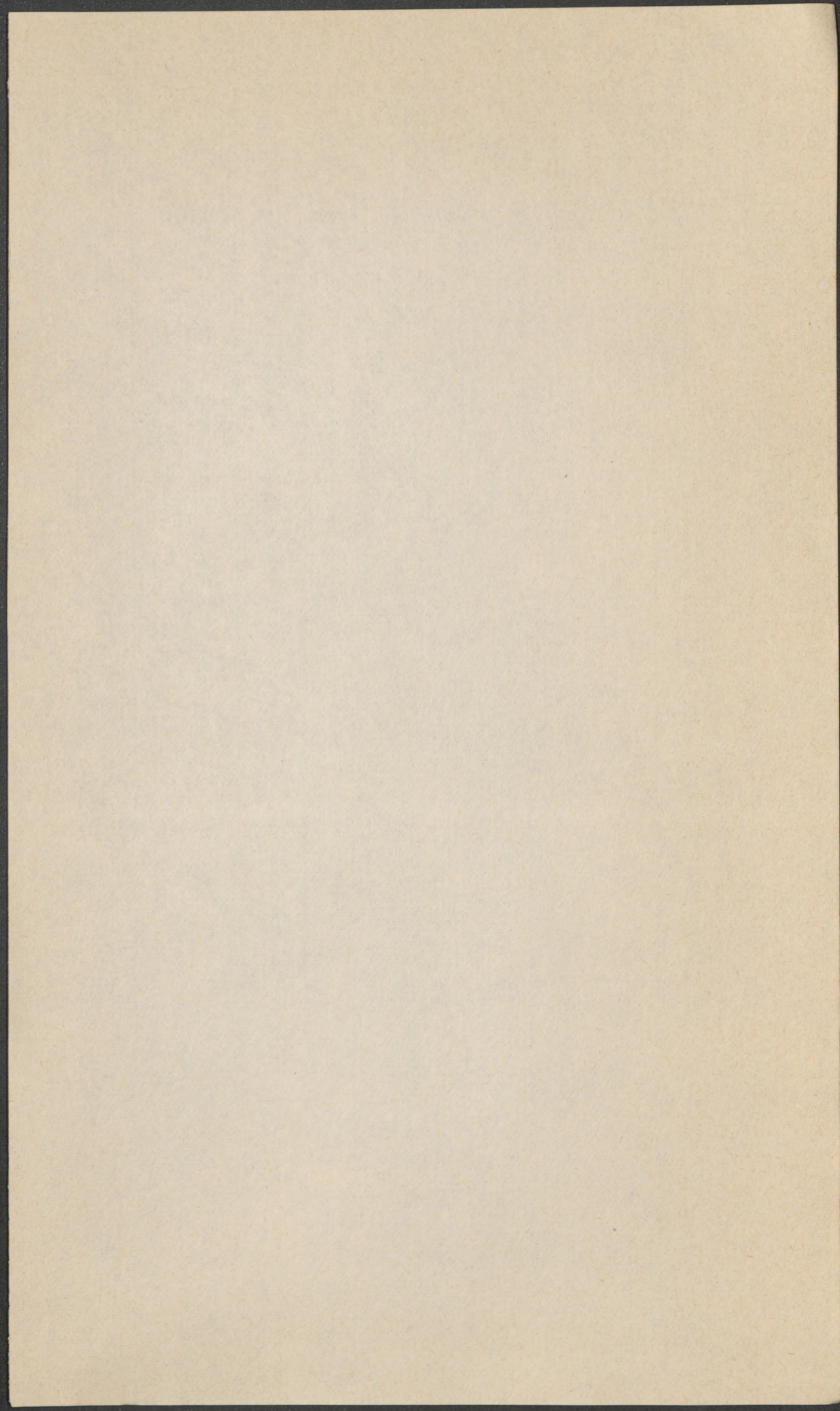
WHO became a specialized agency of the United Nations in 1948. It was created with the objective of attaining for all people the highest

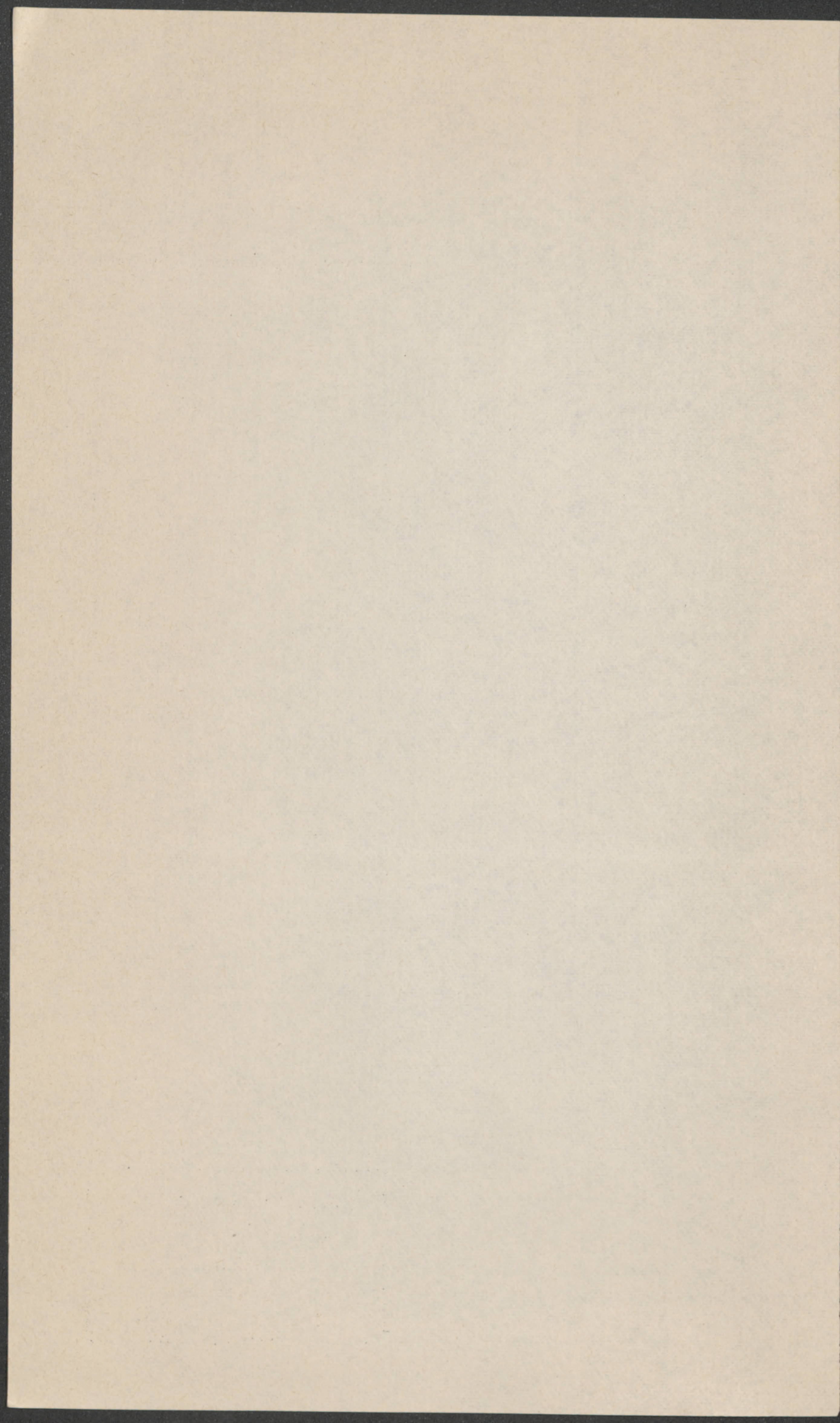
possible level of health. Some of the means WHO uses to carry out its objectives are: assisting governments in strengthening health services, furnishing technical assistance, advancing work to eradicate epidemic, endemic, and other types of disease, and promoting cooperation among groups which contribute to the advancement of health.

WMO—World Meteorological Organisation----- United Nations

WMO, responsible for promoting international cooperation in weather observation, came into being in 1950. Two major endeavors of the WMO have been to build up a worldwide network of stations for obtaining and transmitting meteorological data and to promote cooperation among national meteorological services.







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