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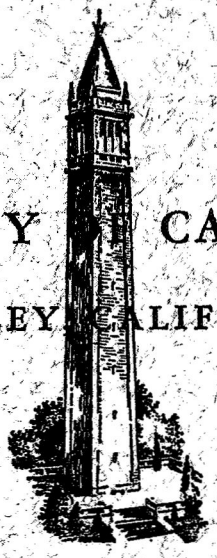

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by

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A CRITIQUE ON THE APPLICATION OF SYSTEMS ANALYSIS TO SOCIAL PROBLEMS

by Ida R. Hoos*

To refer to systems analysis as the cynosure of our time is, surely, nowhere so appropriate as in the context of meetings of the American Astronautical Society. In its meaning as the North Star, Cynosure guides and directs; in its figurative sense, cynosure is a center of interest. Systems analysis qualifies in both respects. Within recent years, systems analysis, developed to a high degree of sophistication in aerospace companies and in space-related ventures, has certainly attracted considerable attention; its potential applications are being explored for every possible social, technological, industrial, and governmental purpose. Hailed by some as the most valuable "spinoff" of the national space endeavor, systems analysis is regarded as the vehicle which will convey scientific and technological advance directly into current channels for mankind's present utility and benefit. In California, where five major problem areas have been subjected to systematic analysis by engineers from Aerojet-General, Lockheed, North American Aviation, and Space-General, we have had the unique opportunity to observe at first hand the dynamics of this new phenomenon.

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Basic to the case study now in progress are such interrelated questions as these: Does the technical capability derived from the national program of space exploration have relevance to the solution of problems confronting terrestrial society? To what extent are social problems amenable to solution by quantitative methods? Can systems analysis be applied with equal efficacy to such disparate matters as, for example, mass transportation and social welfare? What inferences can be drawn from observation of the California experience that will be meaningful in carrying the quantitative techniques of systems analysis, simulation, and model-building into other large and complex problem areas, e.g., labor force adjustment, education, community health services?

Definitive answers to these questions are premature at this early stage of the research. But in the application of these methods we are already learning a great deal about the nature of the problems generated by our scientific age and about the social and political environment in which they exist and must be addressed. The reasons for and the process by which public agencies utilize outside experts from aerospace provide the framework in which the California experience is unfolding and occupy the first portion of this paper. The second part deals with the government-industry interaction and its professional and bureaucratic correlates. These may well be the prime determinants of the outcome of the analyses and are discernible from the framing of the request for proposals, throughout the study itself, and in the evaluation and implementation phases.

Because the aerospace industry, anxious to diversify its product output, and the government, aspiring to utilize technical competencies and also to mount innovative attacks on troublesome problems, are exhibiting a growing tendency toward a proliferation of such contractual

arrangements, observation of the evolving California experience will serve to point up some of the areas for confidence or for caveat. As anyone who has undergone analysis (whether of psyche or system) can attest, the process is not without strain and stress. And only time will determine the allocation of the costs and benefits, as between doctor and patient!

Prolegomena

Systems analysis has gained ubiquitous acceptance from county to Congress as a nostrum for a vast array of societal ailments almost before it has been satisfactorily defined. Indeed, faced with that task, one is tempted to emulate Gertrude Stein's "rose is a rose is a rose" and suggest that systems analysis is the analysis of systems. This would be no less accurate and not a bit more confusing than the gallimaufry of terms, systems design, systems study, systems engineering, used interchangeably to describe what is in essence an approach, a philosophy, or a way of addressing a given problem. E. S. Quade stated in a RAND Corporation lecture that system analysis eludes firm definition, because "it is still largely a form of art," in which there are neither fixed rules nor universally accepted principles.[1] In an authoritative article on the related subjects of cost-benefit analysis, systems analysis, and program budgeting, Aaron Wildavsky made the cogent observation that one should not be surprised at the absence of a definition, for, he contends, "creativity, daring, and nerve" are the basic features of the

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[1] E. S. Quade, Analysis for Military Decision (Chicago, 1964), p. 153.

practice of these arts.[2] Notable here because of the "scientific" attributes imputed to systems analysis is the lack of precision that is usually associated with scientific methodology.

A brief review of the genealogy and current conception of the systems approach will have to serve as orientation in place of the definition. The origin can be traced to operations research (O.R.), a quantitative technique "with roots as old as science and the management function."[3] Specifically, O.R. emerged during World War II as a useful method for solving tactical and strategic problems of a military nature, with optimization of resource allocation the prime goal. After the war, the business and industrial community and the government rapidly adopted the approach; subsequent refinements emerged in the specific techniques of linear and quadratic programming, Monte Carlo method, queuing, and game theory, further definition of which concepts is not necessary in this context. Suffice it to say that there is a vast literature on the subject for the interested reader.

Operations research is generally considered applicable when there are clearcut objectives and where alternatives can be assessed quantitatively. With respect to the systems approach, however, there is no consensus regarding objectives. Some authorities maintain that an identifiable and identified objective is a sine qua non; others regard uncertainty about objectives as the quintessence of systems analysis. In fact, learning about objectives is construed

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[2]Aaron Wildavsky, "The Political Economy of Efficiency: Cost-Benefit Analysis, Systems Analysis, and Program Budgeting," Public Administration Review, Vol. XXVI, No. 4, December, 1966, pp. 292-311.

[3]C. West Churchman, Russell L. Ackoff, and E. Leonard Arnoff, Introduction to Operations Research (New York, 1957), p. 3.

as the very purpose of this kind of endeavor by Charles J. Hitch, acclaimed as the father of this method. He stated in a RAND paper that that organization had never undertaken a major system study at the beginning of which satisfactory objectives could be defined.[4]

Objectives, whether implicit or explicit, proximate or ultimate, defined by client or analyst, are certainly important when the system involved is in the realm of public affairs. The objectives play a strongly determining role in the focus of the study, the parameters set for it, the variables identified as pertinent, and the interfaces taken as significant. In the emphasis on the total system and its internal, interrelated web of interrelationships, there is such strong interaction between means and ends that the end is frequently the controlling factor. What the analyst regards as the system's objective often molds and certainly weights his conceptions and can influence so seemingly quantitative an operation as cost/benefit comparison. Whose cost becomes whose benefit is not a matter of indisputable accounting but rather an issue for interpretation within a given framework. And in this matter, the analyst's role is crucial, for not only does he make this interpretation, but he can also have biased the direction of the study through his selection of the alternatives to be examined, the variables to be included in the model, and the goal that he perceives as desirable.

Whichever school of thought with respect to objective one favors, there is agreement that systems analysis concerns itself with alternatives involved in the decision-making process and that

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[4]Charles J. Hitch, On the Choice of Objectives in Systems Studies (Santa Monica, The RAND Corporation, 1960), p. 19.

the model is a useful method of examining them. The model, a description of relationships between the alternatives, is an abstraction, designed to simulate reality and to serve as a base for testing hypotheses, especially those comparing the costs and effectiveness of various possible courses of action. Boguslaw sets forth some of the conditions for constructing a complete model of a real system by means of a mathematical model; he stresses the need "to determine that the range of situations in which action can occur has been accurately predicted, that the various states of the system have been accurately predicted, and that there exist analytic or mathematical techniques which can provide solutions to models constructed."[5] These conditions can be met in designing missiles and rockets, but not in the realm of social affairs where the multiplicity of unquantifiable and, perhaps, unidentifiable variables makes prediction at best a statistical exercise, useful only with certain specified constraints but far from adequate as a complete model of a real system.

The aerospace industry, as a major factor in the national defense and space effort, may certainly claim a conspicuous degree of experience and success in the development of technically complex systems. It has also demonstrated the capability of managing such systems. But it must be noted that the concept <u>system</u> applies only in its broadest sense to both space hardware and social problems. The inputs are vastly different, as are the controls and the objectives. In the physical system, such, for example, as a radar network, the components are tangible, the outputs identifiable. In the social sphere, the crucial elements often defy definition and are outside the purlieu of statistical rules; the test of the effectiveness of a social system is to a large

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[5]Robert Boguslaw, <u>The New Utopians</u> (Englewood Cliffs, 1965), p. 53.

extent a reflection of our values and not amenable to mathematical measure. Whether, where, and with what modifications a viable transfer of systems analysis techniques from the arena of military and space to that of public affairs can be achieved is far from certain. The California experience has provided valuable insights into the problems and the process of such a transfer and may well serve as a guide to future applications.

Aerospace Experts and Government Affairs

For the administration of the State of California to have sought to extend its capability by invoking the technical competence of its aerospace industry was a manifestation of considerable innovativeness, a phenomenon considered rare in bureaucratic circles. To be sure, agencies at all levels of government from city to federal have used consultants on special assignments, and private firms have performed all manner of services for public agencies. But it is one thing to enter into a contract with a company to train a few thousand Job Corpsmen in a given period and quite another to ask an industry how to cope with crime in our society in six months. Actually, this was one of the original four subject areas chosen for systems analysis, the others having been waste management, mass transportation, and information storage and retrieval. Subsequently, social welfare was added, with the contractor's due date of late March, 1967 for a nine-month study.

Review of the reasons underlying the State's action in turning to its aerospace industry in this fashion may provide some interesting clues as to the future of this trend toward what has been called "government by contract." It may even contain some

guidelines by which both parties to the contractual arrangement could improve their relationship and, thus, further the chances for its continuation. If one is willing to concede that systems analysis is a form of technological spinoff, then technological utilization may be regarded as a primary motive. This is especially significant in light of Ralph E. Lapp's dictum that "technological possibilities are irresistible to man."[6] They contain an imperative and will be put to use. An obvious corollary here is the government's interest in finding promising directions for diversification for its aerospace and defense-oriented industries, as well as avenues for redeployment of technical talent.

Another reason for adoption of systems analysis has been the appeal of "revolutionary new concepts," especially in view of the growing complexity of program planning and management in public administration. Social problems persist and new ones emerge as technological and scientific advances create a higher order of challenges to society. Crime rates soar; urban blight spreads; the air, water, and land are becoming polluted to an awesome degree. Impatient with traditional approaches, which seem inadequate and ineffectual, we seek new tools and techniques. Perhaps, as Edmund P. Brown, then governor, suggested, the know-how that would put a man on the moon would help Dad get to work on time! The fresh look, by a different kind of experts, unfettered by doctrinnaire constraints, had sufficient promise so that California's four pilot studies could be instituted with only a modicum of obstruction. Not insignificant in the attractiveness of this methodology is the element of magic derived from its relationship with dramatic and spectacular space ventures.

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[6] Ralph E. Lapp, The New Priesthood (New York, 1965), p. 67.

Nor is this association fortuitous. To convince the State of their superiority over competitors, the companies which responded devoted considerable portions of their proposals to a detailed enumeration of their NASA and Air Force contracts, as well as their particular contributions to Mercury, Ranger, Mariner, and Gemini missions.

It is, however, never made clear whether the personnel assigned to the systems study have been anything but a highly programmed component of an enormous and structured enterprise. In the contract with the State, they are given a degree of autonomy which certainly did not exist in their customary work lives. Nor does there seem to be evidence in all cases that they were selected on the basis of outstanding qualifications, either with respect to standard engineering tasks or the new fields under exploration. Indeed, we have observed that an interesting assortment of ad hoc titles blossoms, depending on the subject to be studied. In a five-man team, for example, there might be a project leader, and the others would find themselves designated "chief of socio-economic studies," "demography specialist,"--in areas with which the extent of their knowledge was at best derived from an undergraduate minor.

Similarly attractive to decision-makers is the strongly "scientific" flavor of systems analysis. The layman is predisposed to regard "mathematical precision" as a term that brooks no internal division. (Mathematicians, of course, know better!) Impressed with the infallibility of figures and formulas, and usually reluctant to display ignorance by asking questions, many a public administrator has found himself acting out a new role in the age-old drama of "The Emperor's New Clothes." Particularly unassailable are techniques

that harness the powers of the computer. Most lay persons, unacquainted with higher forms of mathematics, are unable to understand their applications, let alone distinguish between what is valid and what is not. But when a computer has turned out the calculations, the average citizen is cowed into acquiescence. Among the cognoscenti, GIGO used to be the acronym for Garbage In, Garbage Out. That it now stands for Garbage In, Gospel Out is a commentary on public acceptance attitudes.

Although I seem to be betraying a bias here, I really do not mean to denigrate all quantitative techniques. I simply want to point out that they are awfully impressive, that they are not infallible, and that they may not be as universally appropriate as their purveyors would like to suggest. Unless the mathematically-stated solution ultimately comes to grips with the social reality, the administrator is bound to be left with a pile of plastic-encased volumes full of tables, charts, and calculations, the price for which he is going to have to pay to a disenchanted public. And this could discredit systems analysis before it has been put to fair test in the arena of public affairs. It could also ultimately undermine confidence and damage the relationship that both government and industry are striving to foster and improve.

The first task facing public officials who have decided that systems analysis might be useful is that of formulating a request for proposal that conveys to the prospective contractor the essence of the problem and the objectives of the system. The balance between over-specificity and over-generality is extremely delicate, and one not yet mastered by government staff. If the terms are set forth in great detail, the response is likely to be an item-by-item play-back which

precludes the very innovativeness and imagination sought for. If the phrasing is general, the contractors fail to perceive the dimensions of the job and respond in vague terms that elude proper evaluation for the start.

In the procedure which accompanies the letting of contracts such as those we are here concerned with, government officials are hard put to distinguish between the merchandise and the merchandising, between the capacity to do the job and the expert salesmanship of the corporate image. So highly developed is the technique of responding to requests for proposals that it in itself has become the specialty of some consulting firms. Under contract, they will put together for the aspiring competitor a very professional-looking document, replete with overlap maps, flow diagrams, and curricula vitae, on any subject, from a transportation network in Pakistan to a welfare system in Indianapolis. Company representatives then present the proposal with finesse. Small wonder that the bemused client expects a miracle; the tendency to oversell cannot but lead to disappointment. Even if systems analysts had Rumpelstiltskin to help them, they could not possibly deliver the gold their client has been led to expect!

In all business matters, fulfillment of the written contract discharges the obligation of the respective parties. This is a relatively simple matter when tangible products are involved. Whether ratchets or rockets, if they meet the standards of quality and performance, they are accepted. In the case of the systems study, although no such specifications and norms are available, the ethics of the marketplace still prevail. The contract is fulfilled when the deadline is met by delivery of the systems study.

This is usually voluminously illustrated by charts, tables, and flow diagrams, most of which may be familiar to the public official but bewildering in juxtaposition. Frequently, the relation of the "technical" portion of the report to the task at hand is not made explicit, and there is ground for reasonable doubt as to its relevance or necessity. It is even possible that fancy mathematical techniques have been used as window dressing to disguise a possibly poor analysis, as Quade has suggested.

If there are uneasy feelings of mission unaccomplished, contractor and client express them differently: The contractor emphasizes the "first cut" aspects, the "rough approximation." Iteration, better information, and greater refinement through subsequent sensitivity analysis will, he avers, result if a follow-on contract is awarded his company. The client, disturbed by this serialized solution of exacerbating problems, is somewhat less sanguine about this "Perils of Pauline" approach. But his disappointment has been eclipsed because of the political nature of the entire endeavor.

With no pejorative intent, it must be noted that political considerations, which permeated every facet of the State of California's experience, will likewise affect all other government-industry ventures of this type. It is important, therefore, that they be examined and their impacts traced throughout the process. Here, we must pause to explain that we are referring not only to partisan politics, but also to what Wildavsky[7] has called policy politics, related to the selection of policy to be adopted, and system politics, which have to do with decision-making structures. From the point of view of simple party

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[7]Wildavsky, op. cit., p. 304.

politics, the very notion of invoking space magic to solve terrestrial problems apparently has vote-getting potential, and it has been used by Republicans and Democrats alike. It seems to be providing a vehicle on which many can ride, whether on the high road to Congress or on country backroads. The leverage is derived from the novelty, the promise of "scientific" solutions, and the quest for innovation in solving earthly problems, in other words, the need to hitch those stars to our wagon!

Far more crucial in the long run, however, are the other types of political implications. First and foremost, the systems approach legitimates governmental planning and defuses it of socialistic connotations. This methodology also enables the government planner to examine questions implicit in many of the problems but never before openly addressed in the political and bureaucratic context. Another use of the technique is demonstrated as it becomes a tool to accomplish certain ends or as a strategic weapon against bureaucratic inertia or sabotage. With it, the astute tactician can make an end run around the Establishment and achieve a desired goal. By providing "scientific" justification, the system can help him evade traditional checks and balances and alter others. In many instances, a case for new and different jurisdictional boundaries and units can be made on a logical, rational basis; thus, what would otherwise be a highly-charged political matter becomes neutralized. It should be interjected here, however, that a recommendation, no matter how logical or rational, that archaic or inappropriate political entities give way in favor of new functional forms of authority, will be given short shrift by such bodies of vested interest. Consequently, we

must again emphasize that in the realm of public affairs, implementation within the realities of the political system must be recognized as a crucial factor. The systems study may in the long run prove to be a handy mechanism for the graceful non-solution of politically-grating problems. All along, we have been making the assumption that someone wants a particular problem to be solved. Perhaps a better case can be made for the contrary hypothesis. By turning the matter over to outside experts, the public official escapes the accusation of procrastination.

The trend toward problem solution by systems analysis seems likely to continue especially because of the peculiar political benefits that may accrue to the client. The object lesson already drawn from the systems studies completed is that regardless of their intrinsic worth, they have substantial political usefulness, and there is a great deal of protection, as well as likely advantage, to be gained from taking the initiative where they are concerned. In other words, the agency that asks to have its system analyzed is in much safer position vis-à-vis both its power position and perceived goals than the one subjected to this kind of investigation by order of some higher-up level. In the final analysis, it is the "customer" that must live with the results and recommendations of the outside experts. If his conception of his own organizational objectives is substantiated or enhanced, he can reap the benefit. If, on the other hand, the study yields negative results, he can assign an inhouse task force to evaluate it and classify the findings under the heading of State Secret. Herein, then, lie cogent reasons why calling for an analytic study of his system would attract both the ambitious bureaucrat and the conscientious administrator desirous of improving his

service to the public. For better or for worse, the systems approach has utility. Moreover, as a trial balloon, there is no more satisfactory device. If the outcome flies, the client claims credit for farsighted statesmanship; if it is shot down, the client gets the message without too many bruises. Bolstered by such a multiplicity of potential uses, the self-perpetuating propensities of the trend toward more systems reach colossal proportions.

Just as political considerations ensure the continuation of this kind of approach to governmental affairs, so also do they provide it with a protective cloak. Once completed and the property of the public agency, the study takes on a kind of unassailable quality. Any criticism of it impugns the judgment of the officials who advocated the study and allocated the contract. The whole affair, therefore, becomes a politically sensitive matter. Consequently, quite irrespective of its evaluation by expert practitioners and professionals outside or inhouse, the study is publicly proclaimed to be "objective," "insightful," etc., with all other criticism silenced or ignored. It is important, whatever the situation to the contrary notwithstanding, that everyone come out looking good. The degree to which this political shield hampers reliable, unbiased review is, of course, aggravated by the present undeveloped state of the art, for, as Quade has emphasized, there exists no universally accepted set of ideas on what constitutes a good analysis.[8] If, then, the professional practitioner criticizes, he is accused of parochial myopia; if a political foe, of jealousy or partisanship. Fellow-analysts are inclined to be exceedingly chary in their comments, for there is a good deal of sum

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[8] E. S. Quade, op. cit., p. 149.

quod eris in this business, i.e., "another time 'round I could be on the griddle"! Indeed, the mobility patterns and deportment of the new occupational category of information technologists suggest that their loyalties lie more with their fraternity than with either their current employer or client.[9] Consultant to the government on one project and staff-member of the contractor on the next, these young men pursue an existence characterized by commensality, whichever side of the table they happen to be occupying.

The Epistemology of Information Technology

The rationale for inviting systems engineers into the arena of public affairs stems from the assumption that their capability in managing large-scale, complicated projects can be applied to large-scale, complicated social problems. This hypothesis will probably never be entirely proved or disapproved because of the hydra-headed nature of social problems and also because a diagnosis, no more so than a remedy, is not a cure, especially in situations in which there are so many political overtones. Space Age magic may be invoked, but implementation of good programs is what is decisive, and that must be accomplished in the framework of 19th century institutions, to say nothing of the restless flow of action and reaction in the political tides. Ultimately, we may be able to put such considerations into clearer focus, especially as we learn more about the uses of the systems study as a maneuvering device. Of immediate interest are the professional and bureaucratic correlates of the applications of systems analysis, that is, what happens to the people and institutions

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[9]Robert V. Head, "Real-Time Programming in the Sixties: A Study in Business Alienation," Computers and Automation (October, 1965), p. 23.

involved in this experiment in technological transfer.

From the point of view of the sociologist, the fact that tensions arise and conflicts occur is neither a surprise nor necessarily destructive of the effort. The defense mechanisms ordinarily activated by encroachment on one's professional preserves are intensified by the enormous differences in orientation and commitment between the systems engineers and the practitioners in the particular field, especially if the latter are social scientists. One of the most dramatic examples of this divergence can be seen in the use and interpretation of data, which are, of course, the very heart of all systems designs.

There seems to be universal agreement that computer technology can contribute to servicing the needs of public agencies for information systems that will expedite and improve management and policy decision-making. For the technologist, this is a mandate to automate the entire operation along the lines of a speedy postal service. With memory capacity and rapidity of transmission prime objectives, he is inclined to include every bit of available data, however irrelevant, in case it might be useful some day. All too frequently, however, the systems engineer fails to distinguish between intelligence systems, which generate data about individuals qua individuals, and statistical information systems, which deal with characteristics of aggregates or populations.[10] Since his approach to a study does not mean learning about the system but merely handling it, there is evidence of a lack of dis-

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[10]Edgar S. Dunn, Jr., "The Idea of a National Data Center and the Issue of Personal Privacy," The American Statistician, Vol. 21, No. 1 (February, 1967), p. 23.

crimination about what constitutes necessary and sufficient data for its optimum functioning. Indeed, it is from this very question that the need arises to articulate what the system's objectives are and whether they really should be furthered. Perhaps an allocation of resources in some other direction altogether would better serve society's needs. These matters are generally outside the realm of technical rationality and require an understanding of the conceptual framework of the system.

The implications of advanced information technology are serious because the systems engineer has a different conception of data from that of the professional in the given field. The former approaches data as an inanimate entity, to be manipulated and programmed for the efficient functioning of the system. The latter views data as standing for the human lives they represent, the men and women for whom the system should function optimally, even if this means putting them outside its bounds or terminating its operation. The handling of a system's information requires an understanding of its theoretical and operational framework, far exceeding the adoption of its phraseology or jargon. Lack of the proper professional orientation is a severe handicap in the design of a proper electronic data-processing system, but it is disaster in construction of a meaningful model of the total system. Ludicrous naïveté and an almost incredible measure of latter-day Columbusism result when significant inputs are overlooked, irrelevancies included, important variables neglected, and simplistic conclusions reached. Quade[11] regards as one of the "pitfalls in systems analysis" the temptation to become more interested in the model than in the real world

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[11]Quade, op. cit., pp. 309, 311.

and the possibility of forcing complex problems into analytically tractable shape. We have seen this not only in failure to address the important questions raised in the study, but also in the real possibility that the data have been misinterpreted, weighted inappropriately, or distorted by Procrustean treatment.

The reification and deification of data which prevail in the quantitative approach could well be one of its most serious hazards to a democratic society. On this score, Thomas A. Cowan[12] has commented, ". . . it is a prime policy matter to determine what data shall be preserved, and among those that are preserved, which it is politic in any instance to suffer to be recalled. Data-retrieval experts make the blithe assumption that data are, ipso facto, good." His recommendation for "creative unlearning" or purposeful forgetting comes from his experience in the practice and philosophy of law and is all the more à propos in view of the potential dangers to individual privacy inherent in the capability for the electronic matching and coordination of large masses of information.

Already in fairly advanced stages of development is a national information system, which will provide an instant check on any American, with complete details on his birth, color, religious and political affiliation, school grades, employment, criminal or military record, credit rating, and medical history. Even if a man's past contained nothing like a mental illness or a conviction to render his present and future a Sisyphean struggle, he could be tabbed by the system as a potential member of some designated "risk"

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[12]Thomas A. Cowan, "Decision Theory in Law, Science, and Technology," Science, Vol. 140 (June 7, 1963), p. 1070.

population, e.g., criminal or welfare, and as such become the object of unwarranted and unwelcome official attention. Recent historical events in this country and abroad provide little reassurance of perpetual benevolent intent on the part of all future governments under all possible situations of duress,--war, witch hunts, and the like. There are no electronic locks against the invasion of personal privacy, and laws offer discouragingly little protection. Observes one sociologist, "The potential for evil, for official and unofficial blackmail, for the harassment of political minorities is virtually unlimited. One must realize that whatever safeguards may be proposed in the initial justification could later be removed by a powerful president or a stampeded congress. Also the safeguards probably would be circumvented on or off the record by our undercover agencies."[13]

For the information specialist to be concerned exclusively with data is evidence of a trained incapacity reprehensible only because we have been led to believe that he will think in terms of total systems. Actually, he is no more culpable than the public official and the social scientist. The bureaucrat trained not to rock the boat is not likely to generate ideas for coping with the complex management problems of a rapidly changing society; nor is the professional who has been forced so far out on the limb of his specialty that he has lost touch with the roots of his discipline. As for the social scientist, development of a science of society has been his primary goal, and he has deliberately avoided value-laden issues. If, therefore, the technologist seems to have rushed in where others have feared or neglected to tread, perhaps he should not be blamed.

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[13]H. Taylor Buckner, Letter to the Editor, The American Sociologist, Vol. 2, No. 1, February, 1967, p. 25.

It is a commentary on our society that this phenomenon is occurring, and, as was pointed out earlier, there are many political and economic forces perpetuating it.

It would be premature to set forth conclusions on the California experience at this time. Nonetheless, because the process of technology utilization is of vital importance for all time, it might be worthwhile to report certain observations, especially if one subscribes to the notion that social research can, and, in some instances, should be of an on-line, real time nature. Current findings, above all those in a new and significant endeavor, should be meaningfully incorporated as it progresses. For this reason, I shall cast in empirical terms this summary of points made earlier.

Social Dimensions of the Problems

In the quest for new areas of applicability for system methods, we are learning a great deal about the nature of social problems and about the environment in which they exist. Of particular interest here is the increasing realization that even when the issue appears superficially to be one of conventional engineering, human and social values are at its roots. A corollary to this is the observation that when the problems impinge on our social, economic, and political environments, even technological matters require an orientation far exceeding that of engineering alone. In transportation, for example, movement of people and goods turns out not to be just a matter of miles of freeways or location of airports but the value structure of the society--how many acres of recreation land it is willing to relinquish to rights-of-way, how willing it is to accept some mode other than the present one-man-

one-car, which clogs highways and fouls the air. Supersonic jets the size of a football field, for example, are not only regarded as a necessary form of transportation but are a matter of national pride. A system that would truly enhance the life style of the society would have to take into account many factors--land usage, noise, air pollution, etc. And, because man lives in a closed ecological system, delicately balanced and allowing only limited options, he would have to select those which he regards as desirable and for which he is willing to pay the social costs, present and future.

One of the engineers involved in the crime study made the point that in a society where a comprehensive system of electronic surveillance is already a reality, man is going to have to put a price on his values and fight to have them included in the system. Otherwise, they will be ignored. If detection of crime is the prime objective of the system, we may all find electrodes concealed in our vitamin pills! Value judgments, likewise, are central to the welfare system, which is the very expression of a country's values. Our sick and aged receive public assistance because we accept them as a social responsibility. The very definition of dependency and the functions of the welfare system are related to our social philosophy, and this reflects a historical, political, and moral frame of reference.

In the waste management study, it was clear that the problem was not simply one of disposal of unwanted products. A total waste management system is a complex network of technical interrelationships and critical aesthetic, geographical, economic, political, jurisdictional, and administrative considerations. Here, criteria, standards, and regulations of environmental quality are crucial. With the skies not spacious enough for all the debris and the seas not deep

enough to swallow the fissionable wastes of this nuclear age, it is readily apparent that the design of the system will also have to take into account a broad range of uncertainties that run the gamut from people's choice of fuels to their way of dealing with international tensions.

To apply technical rationality to situations in which the crucial variants are social and political has resulted in inadequate and inappropriate models which will be of little use as sources of prediction or program-planning. The observed tendency to rely on information technology to define the system violates and distorts the facts so that pertinent variables have been obscured or overlooked. As demonstrated so far, systems engineering will require great modification and refinement before we can put much stock in its public problem-solving propensities.

Comparative analysis of the California experience reveals a marked disparity of quality among the respective studies. This may be attributed in part to the subject matter of the respective studies and how far removed the practitioners were from concepts familiar to them. For example, in waste management, sanitary engineers could address certain aspects of the problem with confidence; in mass transportation, highway engineers were able to draw upon some relevant experience. Cast in the framework of long-term, over-all social betterment, however, even these matters took on broader dimensions. Another factor in the quality is, of course, the performance of the particular teams. This suggests that along with the technique, the technicians, too, are on trial, and that their performance in the arena of public affairs may either substantiate or jeopardize the aerospace industry's early claim to

prowess. The industry cannot expect to transfer its expertness unless it applies the same rigor with respect to personnel qualifications and performance checks that prevail within its other operations. It is a safe bet that the design of an XB-70 will not be entrusted to a group of ornithologists even though some of them may have taken courses in aerodynamics.

The differences between appropriately-assigned people and the "pick-up crew" showed in their respective approaches to the subject matter and in their attitudes toward and relationship with the professionals in the given field. Apparently assuming that they had ready-made solutions to fit neatly, albeit loosely, over any assortment of social problems, the information technicians mistook their own ignorance for objectivity, and never knew when they were retreading worn ruts and rehashing disproven hypotheses. Conclusions emerged in the form of naïve clichés and mantic generalizations, cloaked in systems jargon to convey an impression of precision and conceptual validity. Many recommendations and predictions turned out to be commonplace or common sense, derived from lay preconceptions about the problems, and neither drawn from nor substantiated by the systems analysis performed.

Toward professionals in the given field, some of the technologists displayed an attitude best characterized as intolerant. Evidence of this was seen in their bypassing recognized authorities, in their ignoring of advice from staff and resource people, and in their resentment of criticism. If the specialists whom the companies hired as consultants served in any capacity except that of captive yes men, the final reports seldom reflected it. However, the aerospace companies

were evidently pleased with the results, for they referred to them in subsequent responses to proposals as evidence of demonstrated capability. Public officials, on the other hand, have privately expressed relief if the treatment has not injured them too gravely.

Conclusion

There are positive lessons to be learned from the California experience, the value of which is eroded only if it cannot stand exposure to critical analysis. Short-run political considerations must not be allowed to impede recognition of all dimensions of this endeavor, for they could meaningfully influence long run benefits to society as a whole. What has been learned in the application of systems analysis to five problem areas has immediate significance for the aerospace industry and government, as well as for social scientists.

For the industry, maintenance of its comparatively advantageous position will become more difficult as competitors move into the field. Attracted by the prospect of federally-supported systems analyses at many levels of government and of all kinds of problems, a heterogeneous array of challengers has appeared. Management firms, computer manufacturers, electronics companies, "think tank" non-profiteers, and university-based entrepreneurs are flanked by teams of acronymic consultants ranging from Massachusetts' Route 128 to California's San Mateo Peninsula. Actually, the threat they pose is far less damaging than that inflicted by the industry upon itself by superficial fulfillment of contractual obligations. And, just as now individual companies bask in the charismatic glow of aerospace achievement, so will the entire industry suffer the opprobrium

invoked by certain of their fellows. Adverse reverberations could, consequently, prejudice the outcome of a fundamentally significant experiment in technology utilization and diversification.

Herein also lies a lesson for those public officials who found no political utility in their brief encounter but who, in fact, might be inclined to discredit the systems approach because of their own less than salubrious encounter. In a wider developmental spectrum, their first experience may turn out to have been merely an instance of poor workmanship,or, perhaps, faltering steps in a direction that could ultimately prove worthwhile. In the past decade, systems analysis has been tried in a variety of contexts and each time has undergone moderation and refinement. If sufficient viability can be maintained as new areas of usefulness are investigated, there may emerge methodological and conceptual mutations suitable to the tasks at hand. The philosophy underlying systems analysis does not rule out the economic, political, and social rationality that together must be taken into account in planned social progress. The fact that we do not yet know how to incorporate them in the system does not mean that they must or always will be excluded but, perhaps, that we must develop more sophistication.

Operations research, cost/benefit, systems analysis, and program budgeting form the intellectual technology which could possibly improve public decision-making. Public administrators have already learned, from their early experience with these techniques, that they themselves must either learn to articulate their objectives and conceptualize their problems or abdicate that vital responsibility to others certainly less familiar with and understandably less committed to their goals. To the extent that a model sets forth all pertinent

attainable aspects of the problem, takes into account its inner relationships, and grasps faithfully the outside factors impinging on it, much can be learned in the building and manipulation, provided that interpretations are made with seasoned judgment and orientation. The function of the government official appears clearly defined here. Intelligent participation in, rather than passive acquiescence to or smouldering resentment against, the process of systems analysis might, in the long run, have the beneficial feedback effect of improving both the methodology and the quality of public service.

There is an important role to be played in the process of social accounting and planning by professional persons, whether in the employ of government, industry, universities, or elsewhere. In every systems study, the close and constant involvement of individuals expert in the relevant disciplines is essential. Since, as has been emphasized, human and social values are at stake and must be safeguarded as old problem areas are subjected to new modes of treatment, there must be built into the process the active participation of competent behavioral scientists. This may run counter to this group's conception of themselves and their role, for, in their preoccupation with the development of a science of society, they have shown a predilection for a high level of abstraction and have thought mainly in theoretical terms. There is, despite its hazards, an urgent need for the responsible conduct, handling, and reporting of live research so that models of social systems will be adequate representations of the reality situation and not sketchy distortions that result by default.

Foremost among the contributions of the California experience to the advance of systems techniques in new areas is the discovery of the basically multi-faceted nature of every major problem facing the government planner. Reason would dictate, therefore, that conduct of analysis be assigned to a group representing many disciplines. This form of organization has been used with demonstrated success in the aerospace industry, operates in scientific laboratories throughout the country, and is growing in fields of bio-engineering and clinical automation in medicine. Progress, whether scientific, technological, or social, depends on knowledge on many fronts. There is a need for a creative synthesis arising from a genuine multi-disciplined effort directed to understanding the problems facing society. Paradoxically, systems analysis may be both the vehicle to and the end product of such a creative synthesis.