

1) Uncertainties regarding the future state of the environment...
 2) Uncertainties regarding the future intentions of those responsible for choices of action in related fields of activity...
 3) Uncertainties regarding the appropriate value judgments upon which to make planning choices...
 These lead to feelings of need for: 1) more research regarding environmental characteristics; 2) more coordination and 3) more policy guidance...
 None of these needs for uncertainty reduction can be met adequately in the long-range planning situation. However, as Schon and others have shown, rational man has not become a situation-shaping and usually avoid becoming involved in them. Lindblom [4] writes in support of the political and logical rationality of incrementalism: "noncommittal policy proposals are typically unprepared in their consequences." Uncertainty is avoided by ignoring the issues that lead to uncertainty, or by gradually translating an uncertain situation into a risk situation. Much of the ritualized rationality that characterizes high strategy in the nuclear age, especially with regard to thinking the unthinkable, typifies these responses but either is an inadequate response to the problems of long-range planning or a very problematic nature. Organizations arranged so that they could deal with uncertainty would be ones in which the members are trained enough by each other and by their relevant consequences to propose goals and means for reaching them, which are original, tentative, and subject to revision as the organization environment moved into that future—a future in part invented by their actions and in part imposed by the actions of others. We find little evidence that men who have become successful by defining themselves to themselves and to others as rational and pragmatic are able to live openly and continuously with uncertainty. We find no evidence that we know how to design organizations that can work effectively in an explicit context of uncertainty.

4. Turbulent Environment
 Emery and Trist [5] have conceived of and examined the concept of the "turbulent environment." This is the task-relevant external environment for an organization. The characteristics are such that much that happens within it is significant for the organization is not the result of actions taken by the organization. Essentially, it is an environment full of unanticipated amplifiers and attenuators. The authors give reasons for arguing that this is the present and anticipated environment for organizations in highly developed, complex, technological societies. If they are right, then internal differentiation of organizations to match their environments will be extremely difficult and never more than temporarily so phase. It also means that feedback from that environment will hit the organization with formidable, probably overwhelming, regulatory requirements for adjusting means and ends at the time, much less in an anticipatory manner. Both of these issues will be discussed, and clearly turbulence increases uncertainty with the consequences mentioned above.

1) Uncertainties in knowledge regarding the environment relevant to the planning task...
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Redefinition of Internal and External Functional and Operational Boundaries

Cyberneticists working from their theoretical perspectives, organizational theorists such as Miller, Rice, and Thompson, and planning theorists such as Lawrence and Lorsch all stress that organizations must be differentiated internally to reflect their relevant external environment. Moreover, in order that the overall organizational goals can be pursued, the organization must integrate these differentiated activities. But one thing is clear from both literature and the field: the existing intra- and interorganizational differentiation and integration of agencies "serving" the public interest are appallingly mismatched to that public interest. The new technologies of data banks, social indicators, simulation, etc., could permit greater apposite differentiation and integration than has ever been possible. Futurist studies could help delineate patterns of differentiation and integration that might be more responsive to the developing situation than those derived from the past. But when these technologies, which are all a part of long-range planning technology, are applied for purposes of establishing new differentiations and integrations, they are profoundly threatening to preferred and stable views of: 1) what is important "out there"; 2) internal empires and status; and 3) definitions of self in terms of skills (see what follows) and one's internal and external utility. For these reasons, very few persons will be prepared to give up the rewards of present boundary arrangements in order to try to cope better with a problematic future, or even to become embroiled in problematic redefinition of present operational and functional boundaries.

New Skills

Use of long-range planning technology depends on acquiring new skills in interpreting data, reorganizing personal perspectives, coping with turbulence and error, living with uncertainty, task-oriented interpersonal relationships, sentient relationships, and in future orientations. A crucial psychological usefulness of organizations is the protection they afford their members from being overwhelmed by the environment. But all aspects of long-range planning require those involved to enlarge their skills at coping with greater personal and societal complexity and turmoil. To the extent programs and perspectives will need revision, everybody in the organization must have these skills. However, not everybody in existing organizations can learn, or cares to learn them. From top to bottom, the easier situation is to avoid the challenge and disruption by avoiding long-range planning.

Feedback

The *sine qua non* of long-range planning is the capability to evaluate continuously the relevance of the goals sought and the means used for seeking them and, on that basis, to revise continuously both the goals and means as appropriate [6]. The organization must seek information in the environment and must act on it. However, if the environment is turbulent, its characteristics are not generated

exclusively or primarily by its interaction with the specified organization. Thus the feedback is very likely to indicate that things are either going differently than intended or are mystifyingly indeterminate as far as assessing the impact of the organization on the environment from the perspectives of the long-range task with which it is coping. Not only must the organization be structurally differentiated and integrated to deal with such discomforting turbulence and evidences of inadequacy but, to do so effectively would seem to require a profound shift in values. Instead of being a threat to those "responsible," open "error embracing" must become the necessary way to go about societal learning through the revision of on-going plans. Political man and rational man avoid error acknowledgment like sin—which, indeed, it smacks of in our society. In the existing way of doing things, a rational and skilled man has, by definition, the good judgment to choose his risks correctly. In terms of conventional wisdom, he does his very best to avoid getting mixed up with uncertain situations. But in the open-system cybernetic philosophy treats error as a natural property of such systems to be detected *after the act* rather than to be anticipated. Indeed, the capacity to adjust depends on effective use of error. But we do not now have an error-embracing ethos, nor do we know how to design organizations that have a capability for continuing re-differentiation and reintegration as a function of what the feedback from the environment requires.

Technological Inadequacy

Since concepts and data for selecting among them are relatively primitive as regards our understanding of the societal processes that would be the subject of social long-range planning, it follows that our computer-based simulations, data bank content, social indicator selection and interpretation methods, and methodologies for futures conjecturing are also primitive. As a result, potential users feel justified in rejecting long-range planning on these grounds alone, whatever else motivates them. But this means that the incentives, resources, and opportunities needed to improve the technology by evolving it in its natural setting, in the library, or in the laboratory are comparatively few. This situation constitutes a self-fulfilling prophecy for those in public organizations who say long-range planning will not work. (As I have said elsewhere, I do not think long-range planning would work well under the best of operational circumstances for a long time to come. But this way, it will not work at all!)

In sum, organizations that should apply long-range planning technology and philosophy in public interest areas to enable anticipated future states to guide present actions must live with the personal and organizational threats inherent in: acting in uncertainty; acquiring new skills; living with frequent boundary re-differentiations and re-integrations that would upset present statuses and senses of self; and embracing the errors that inevitably will be produced in part by the planning technology itself and in part by the feedback from a turbulent environment. These problems and processes would repeat themselves endlessly.

that we will stay ahead of entropy. I believe this is a strategically naive hope. One can "step-out" in all the approved ways a rich multiple-option society provides. One can seek a revolution, but I have yet to see a model of a complex society that overcomes the theoretical and practical problems posed here which apparently have no ideological limitations. One can look for shortcuts for long-range planning and for the organizational development processes that provide its functional equivalents. That is what we are now looking into. Let me mention some directions of our work.

Crisis and disaster appear to be the occasions affording the greatest opportunities for basic structural and personal changes in organizations. Social and ecological crises and disasters are inevitable, probably in increasing numbers. What about contingency planning of programs that the leader designing organizational changes to be instituted in fluid, crisis situations? The problem here aside from our pathetic design capability limitations is that contingency planning of this sort on a sufficient scale to matter probably depends on acknowledging publicly before the fact that one has no real capacity for avoiding the crisis. Otherwise the planning effort will be too tepid. The needed skills are scarce and hard to recruit. But acknowledging incapacity has obvious problems for the agencies for foundations or private social service organizations that would take this step. What's more, the contingency plan, by the very fact that they are too disruptive of conventional rewards to be instituted under every-day circumstances, will be politically controversial and, thereby, vociferously rejected in conventional political quarters.

There is one hopeful (?) social psychological factor that may operate here: As the calamities increase, it may be easier for leaders to acknowledge error and incompetence simply because many of them will be perceived as having been incompetent in that way, the whole error-prone planning learning philosophy regarding long-range planning might be more implementable because it will be obvious to us simply do not know what works. But the more typical psychological response in crises is to seek leaders who comfort by insisting they have the answer.

Another approach is to see whether the planning process can be "retained-out" to other parts of the society that are functionally better able to accomplish them. For example, corporations or think-tank could do the radical imagining. Advocates and critics groups could do their own scanning of the environment and force the feedback on the responsible agencies. Law could act as regulator, in Victor's sense, maintaining the system to what it is going in the right direction [7]. But the structures that would accomplish this in the public interest do not now exist even in theory. Much less in a necessary inter-organizational system within the organizational and inter-organizational world.

There is, in principle, another way to view these problems and that is to try to discover a theory that makes possible the needed organizational design and its implementation which would encourage and permit long-range planning. Throughout the study I have been haunted by a piece of

I have outlined the requirements to be met within one or two paragraphs and have not discussed here the obvious problems of inter-organizational collision and competition and the effects of those on the above delineated internal requirements. It is no wonder long-range planning is so thoroughly resisted.

FACTS OF ORGANIZATIONAL TRANSFORMATION

It follows from the above discussion that a necessary precondition for long-range planning is organizational development. The personal and interpersonal skills and techniques needed to cope with the emotional and intellectual burdens of the change-over and the operating situation far exceed those that most people seem to possess, and certainly exceed those that organizations, particularly public agencies, reward. But these strengths and skills would also need to be linked to the appropriate structure of individual, task group, and functional arrangements. Finally, both people and structure would have to be matched to long-range planning technology per se. And all of these designs would have to be appropriate to the relevant environment, but not, of course, in a once-and-for-all sense since the environment and the technology, hence the people and the structure, would be changing.

Our review of the literature on organizational development techniques makes it clear that none of the current techniques available (1) to shift interpersonal skills and personal behavior, (2) to recommend some valuable structural change, or (3) to better relate some organizational tasks to throughput techniques, is adequate to the challenge posed here. What is more, there is no theory or technique that combines technical, interpersonal, and structural organizational change.

In the public sector, the situation is still more discouraging. Experience and theory make clear that organizational development takes years of deliberate effort. This time period must be dominated by champion at the top of the organization with sufficient control of resources and organizational boundaries to make possible the controlled redefining of the organizational change procedure. None of these requirements is met in government. Of special importance is one high in government organization can have sufficient control of organizational boundaries for a long enough period. There are congressional and court constraints available to those inside the organization that make the boundaries highly permeable and boundary control impossible. And these problems and limitations are common knowledge which further reduces the incentive to put real effort into organizational change.

If we like (1) we do not know how to design organizations in the public sector long-range planning and (2) even if we did know how to design them, we do not know how to deliberately get them transformed from what they are into the appropriate new forms. What then? One could hope

engineering history: There was a time when aerodynamists could design pretty good airplanes but the theories upon which the designs were based also said the honeybee could not fly. Today, they design better planes and can also demonstrate how the honeybee flies. Maybe society, and the organizations that comprise it, can be made to fly by different or additional principles than those we have discovered so far.

To my mind, the most promising approach here is to think about the possibility and feasibility of a complex society where organizational structures and the norms that legitimate them are designed to reward a different set of assumptions about the nature of man. It seems clear that it would have to be a definition that says it is natural for man to embrace error, live in uncertainty, live in nature, be trusting, and be as constructively and openly feelingful as he is now constructively rational. "Unnatural" as that definition of human nature seems to us, it is age old—Huxley has called it the *Perennial Philosophy*—and seems to be making sense today to a growing number of people (I think). Whether the occasional, tentatively successful, experiments that have matched "human nature" and organizational structure in this perspective can become the norm or even

become an important strand in the dialectic of societal change remains to be seen. But if our theory of man and his organizations cannot be replaced or radically revised, we are in terrible trouble. For national goals will depend on long-range planning for their realization and national goals as planning guides will be a necessary input to the planning process. The way things are, that process is inaccessible to us.

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A Framework for Science and Technology Policy

HARVEY BROOKS

Abstract—Science by itself has no impact on society. Its impact is mediated through the professions, all of which are concerned with design in some sense. Science and technology are both option-generating processes, and the options have a high mortality. It is only the application of technology in a replicative process that is option-choosing and commits us to its social consequences.

Social systems do not conform to traditional systems analysis. They do not have single objective functions. They exhibit conflicting and internally inconsistent goals. Systems analysis which aims to incorporate society as part of the system must incorporate these conflicts and inconsistencies as part of the analysis.

Paretian environmental analysis and Allison's models of governmental decision-making are described as illustrating how the concepts of systems analysis might be broadened to take into account the response of social groups and bureaucratic structures to technocratic plans.

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The author is with the Division of Engineering and Applied Physics, Harvard University, Cambridge, Mass.

If engineers are to bring systems thinking to bear on social problems, they must learn how to incorporate social and political theory into their analytical framework *ab initio*.

SCIENCE, TECHNOLOGY, AND THE APPLICATION OF TECHNOLOGY

THE RECENT popularity of such terms as "science policy" or "science and society" has led to a good deal of confusion in thinking about the relationships between science, technology, and society and the responsibilities of scientists and engineers and other technologists in these relationships. The term "impact of science on society" is an extreme shorthand expression for a process which is very complex and involves many elements besides science. By itself science has no impact except on man's thinking and the way he views himself in relation to the universe. Science is not action but thought, and thought which aspires