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Multiple Perspectives: Concept, Applications, and User Guidelines

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The evolution of the multiple perspective approach and its range of applications over the past decade are reviewed. The traditional technical perspective of systems analysis is augmented with organizational and personal perspectives. The three types of perspectives have inherently different characteristics and properties. The applications show that each perspective yields insights on a system that are not attainable with the others. The organizational and personal perspectives also focus more attention on problems of implementation. The concept is serving as an effective and practical vehicle to overcome the limitations of systems analysis in dealing with complex real-world situations.

KEY WORDS: multiple perspectives; technical perspective; organizational perspectives; personal perspectives; applications; user guidelines

1. INTRODUCTION

The multiple perspective approach, advanced to help the systems practitioner bridge the gap between analysis and action, between model and real world, is now a decade old. This paper takes a look at its evolution to date.

In the United States "systems analysis" was a term first heard in the late 1940s; it was used at Bell Telephone Laboratories and Hughes Aircraft Company for the preliminary design of complex telephone and radar systems. The RAND Corporation, aerospace industry, and Defense Department were early leaders in the development of systems analysis. By 1961 there was an Assistant Secretary of Defense for Systems Analysis and a group of

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RAND alumni made the subject *de rigueur* in Washington. By 1967 an article on "The Road to 1977" in the business magazine *Fortune* announced,

> The further advance of this new style [systems analysis] is the most significant prediction that can be made about the next ten years. By 1977 this new way of dealing with the future will be recognized as a salient American characteristic. (Ways, 1967)

The work of MIT's Jay Forrester in the 1960s reflects this euphoria: starting with the system dynamics concept in electrical engineering (Forrester, 1968), he applied it to the corporation as "industrial dynamics," to the city as "urban dynamics," and to the globe as "world dynamics." Global modeling became a popular activity among analysts in the 1970s. However, this decade also saw the rise of articulate criticism, for example, Hoos (1972), Berlinski (1976), and Churchman (1977) in the United States and Adams (1972) in England. In the federal government and industry, systems analysis was muted. A 1980 IIASA seminar recognized a need for "Rethinking the Process of Systems Analysis." Here we read,

> Hard systems analysis, tied to technical rationality, cannot cope adequately with the multi-valued complexities of the real world. (Checkland, 1984, p. 57)

In recent years *Fortune* has featured articles implying a very different path than "The Road to 1977":

> December 27, 1982: "The Real World Strikes Back: Corporate Strategists Under Fire"
> December 21, 1987: "Goodbye, Corporate Staff"—meaning "planners, economists, . . . futurologists, other analysts, and deep thinkers"

Operations research, management science, and strategic planning groups have witnessed cutbacks and reassignment of personnel (*Business Week*, Sept. 17, 1984). Thus the pendulum has swung.

For the practitioner the starting point is almost always a functional, real-world entity perceived to be complex (also described by him as messy, wicked, or ill structured). This "system" may involve either nature, man, society, technology, or some combination of them. We stress that "complexity" and "order" are properties of the observer—who is himself part of the system being observed (Von Foerster, 1977). Decision making about this system, implementation of such decisions, and operational management of the system are common objectives for the practitioner. He proceeds by creating a substitute system—an idealized construct or conceptual model that is perceived to be simpler than the complex real-world system, yet appropriate for understanding it.

2. THE TRADITIONAL PERSPECTIVE

Science and technology represent the most successful "religion" of modern times. From Galileo to the Apollo lunar landing, from Darwin to recombinant DNA, its methods have yielded dazzling triumphs and they also serve as paradigms for systems analysis. This world view is typified by the following characteristics:

- We define "problems" by abstraction from the world around us, with the implicit assumption that such problems can be "solved."

  But in the living world a solution nearly always creates new problems; we shift problems rather than solve them. Public-health measures have cut the death rate drastically; however, they have also contributed to a global population explosion and, indirectly, to starvation. Problem-solving becomes a never-ending process. Furthermore, we are not concerned with problems, but with perceptions of problems (Checkland, 1981, pp. 238–241). And these perceptions are subject to frequent change.

- We seek the "best" or optimal solution.

  Cost-benefit analysis and linear programming are typical of this search. But in the real world complex living systems strive to maximize their options rather than confine them by selecting the best one. They seek to minimize the cost of failure rather than the likelihood of failure. They recognize that "we learn more from our failures than from our successes." Ecological systems sacrifice efficiency for resilience; they trade avoidance of failure for the ability to survive failure, the *fail-safe* strategy of the engineer for a *safe-fail* strategy.

- Reductionism is the norm; a real-world system is transformed into an intellectual construct using a very limited number of variables with the relationships among them often linearized.

  As Berlinski (1976, pp. 131–132) put it, complexity begets nonlinearity—but linear theory is where the theorems have been. The analyst has been caught between two unpalatable choices; solving linear, irrelevant problems and struggling unsuccessfully with nonlinear, relevant ones. Forecasting is feasible with the former but may be severely limited with the latter, as suggested by the work on macroscopic indeterminacy (Prigogine *et al.*, 1977) and chaos (Gleick, 1987).

- Reliance is placed on data and models, and combinations thereof, as the only legitimate modes of inquiry.

The analysts' emphasis on certain types of models easily leads to a kind of "groupthink." For example, as system dynamics has proliferated and the number of modelers has multiplied, conferences, papers, and books have created a community. Shared interest and mutual reinforcement increasingly focus attention on baroque model improvements and compulsive extensions. In its most extreme form modeling becomes an end rather than a means ("the Pygmalion complex," i.e., the modeler falls in love with his model). A look beyond the realm of traditional science and engineering opens our eyes: there are other important modes of inquiry; indeed, the lawyer and the executive make effective use of them.

- Quantitative analyses drive out qualitative analyses.

  We confuse dollars spent with effectiveness (for example, in national defense matters), because money is easier to count. We produce masses of numerical trend extrapolations but shy away from probing the underlying assumptions. We find comfort in the six-figure precision of output data, although it masks the real uncertainties.

- The conviction persists that the analyst is an objective observer and that truth is observer-invariant.

  In the complex real world virtually everything interacts with everything, and this includes the observer. Without the observer there are no descriptions; the observer's faculty of describing enters, by necessity, into his description.

- The individual may be considered as a type but rarely as a unique person.

  Complexity has been defined as the ability to hold conflicting world views at the same time and to benefit therefrom, to see the world globally *and* in terms of unique individuals (Churchman, 1977). Abstraction and generalization are not a substitute for specific case studies.

- Time moves linearly at a universally accepted pace, with no consideration of differential time perceptions, planning horizons, and psychological discount rates.

  Recent experiments demonstrate how humans apply a discount rate to their own past and thus distort the integration of their own experience, that is, their subjective probability. Recent events are overstressed in comparison to more remote ones. Similarly, we look at the future as if through the wrong end of a telescope: distant crises and opportunities appear smaller than they actually are, so they are ignored.

Such discounting of the future drastically affects the choice among alternatives in decision making. It particularly downgrades research and development with its long-term payoff in favor of short-term investments.

The characteristics discussed here suffice to explain the traditional perspective of the engineer and scientist; we label it the *technical* or T perspective.

If this perspective is not adequate, how do we proceed? For me the first clue was derived from my own long experience in industry (1947–1970), where I was able to observe the decision-making process of top executives in large corporations. The second was the seminal work of Graham Allison (1971), *Essence of Decision*. Beginning with a graduate seminar I presented at the University of Washington in 1977 and the preparation of our first National Science Foundation grant in 1978, these clues evolved into the approach discussed in the next Section.

Among the authors who have contributed significantly to the development of the multiple perspective concept, we must mention particularly Steinbruner (1974) and Andersen (1977). Other relevant writings are cited in Section 3; for many additional references see Linstone (1984).

3. THE MULTIPLE PERSPECTIVE CONCEPT

Consider the following two examples.

- Forrester's industrial dynamics provides important insights about an enterprise, particularly its materiel and money flows. Machiavelli also provides valuable insights about organizations and how to control them (cf. Jay, 1968). Both are looking at organizations, but from very different angles. Each perspective presents insights not obtainable with the other. Morgan (1986) views organizations using various "metaphors"—organizations as machines, as living systems, as cultures, as political systems—and finds each a valuable way of thinking about these complex systems.

- A corporate executive must make a decision on a new line of business. He has a detailed cost-benefit analysis from his technical staff developing the "optimal" alternative. But he does not make his decision solely on the basis of this report. He talks to various department heads to determine whether there is strong support or opposition. Over the weekend he plays golf with an old friend who runs a company in a different field. Valuing his partner's judgment he bounces the ideas off him. And he has his own intuition and experience upon

which to draw. Then he decides. He has integrated in his mind—without a weighting formula—several different, probably conflicting, perspectives: technical, organizational, and personal.

We also find it desirable, indeed essential, to call on several perspectives in addressing real-world systems which are complex, which deal with people as well as artifacts (Allison, 1971; Linstone, 1981, 1984, 1985). We emphasize that we are augmenting, not replacing, the T perspective. Specifically, we draw on three types:

T, the technical perspective (see Section 1);
O, the organizational or societal perspective; and
P, the personal or individual perspective.

The different perspectives force us to distinguish *how* we are looking from *what* we are looking at. We see the system through different filters. The perspectives do not represent different mathematical models but very different sets of underlying assumptions, axioms, or paradigms. Table I summarizes the features of these distinct world views. There are usually several O and P perspectives appropriate in any one situation, reflecting the relevant organizational and individual actors $O_1, O_2, O_3, \ldots, P_1, P_2, P_3, \ldots$.

The following points are stressed:

- Any complex problem may be viewed from any perspective. For example, an organizational decision may be seen from a T perspective, as decision analysis does; technology may be viewed from a P perspective, as Florman (1976) does.
- As O and P differ in key characteristics or paradigms from T, they inexorably move us beyond those associated with science and engineering. Experimental design and validation of hypotheses are *intraparadigmatic*: they operate within the framework of a perspective. They cannot prove that any model gives the "correct" representation of reality; they cannot give assurance that the variables chosen are sufficiently inclusive or appropriate.
- We cannot prove that a set of perspectives is the "right" set any more than an executive can prove he listened to the right input before making his decision. We cannot derive the "proper" weighting in integrating perspectives any more than a jury can in integrating the testimony of different witnesses.
- Two perspectives may reinforce each other or cancel each other out; they frequently "cross-cue" each other.
- Taken together, the multiple perspectives constitute a Singerian inquiring system (Churchman, 1971). As such it is pragmatic and includes application of all other inquiring systems, for example, data and model based or dialectic, as needed.

Table I. Characteristics of the Three Perspectives[a]

	Technical (T)	Organizational (O)	Personal (P)
Goal	Problem solving, product	Action, stability, process	Power, influence, prestige
Mode of inquiry	Modeling, data, analysis	Consensual and adversary	Intuition, learning, experience
Ethical basis	Rationality	Justice, fairness	Morality
Planning horizon	Far	Intermediate	Short, with important exceptions
Other characteristics	Cause and effect	Agenda (problem of the moment)	Challenge and response
	Problem simplified, idealized	Problem delegated and factored	Hierarchy of individual needs
	Need for validation, replicability	Political sensitivity, loyalties	Filter out inconsistent images
	Claim of objectivity	Reasonableness	Need for beliefs
	Optimization (seek best solution)	Satisficing (first acceptable solution)	Cope only with a few alternatives
	Quantification	Incremental change	Fear of change
	Trade-offs	Standard operating procedures	Leaders and followers
	Use of averages, probabilities	Compromise and bargaining	Creativity and vision by the few
	Uncertainties noted (on one hand . . .)	Avoid uncertainties	Need for certainty
Communication	Technical report, briefing	Language differs for insiders, public	Personality important

[a]Ref. Linstone (1984, 1985).

- In real-life situations problem management consists of three activities: (a) finding paths, (b) decisions, and (c) implementation. The T perspective focuses most strongly on a and least on c; hence the "gap" between analysis and action. But implementation depends first and foremost on the use of human resources, and that means O and P become crucial as we move from a to c.

Indeed the concept addresses the weaknesses in systems analysis seen by Tomlinson and Kiss (1984, p. xi):

> One . . . assumption was that the "hard" part of a problem—which could be expressed in mathematical terms—could usefully be isolated from the human and organizational elements which could thus be eliminated from the analysis. Another false assumption was that implementation was an entirely separate activity from the analysis itself.

Checkland (1981) proposed a seven-stage procedure to the T-focused problem solver or analyst, which can relate directly to our concept. He insists that the systems practitioner formulate his T model only after examining, in stages 1 and 2, the "problem situation" in the real-world setting in which it is anchored. In this way he can build up the "richest possible," i.e., multiple perspective, picture. After his "systems thinking" has developed conceptual models (stages 3 and 4), he descends once more into the real world (stage 5). Presumably, nonsystems people will have considered other, more O- and P-oriented, means to move from stage 1 to stage 5. Stages 5 and 6 then involve cross-cuing, integration, and political bargaining among the relevant real-world actors and their perspectives, leading to stage 7—action to improve the problem situation.

In sum, the justification for the use of multiple perspectives is basically twofold:

(1) *each perspective yields insights not obtainable with the others,* and
(2) *the O and P perspectives are essential in bridging the gap between analysis and action.*

A spectrum of sociotechnical systems in the private and public sector has been subjected to multiple perspective scrutiny in recent years. It includes military system decisions, corporate policy decisions, education planning technology and forecasting and assessment, health-care planning, regional development, and trade deficits. We limit ourselves to selected illustrations which highlight various aspects of the T, O, and P perspectives.

4. APPLICATIONS

4.1. Strategic Planning and Decision Making—the American Experience

In his survey of strategic management in 25 major U.S. corporations Halal (1980) found that

> skillful executives do not rely primarily upon the outcome of formal planning . . . . The decision maker continually gathers opinions, pieces of data, new ideas, etc., through exchanges with persons that are trusted and respected.

Peters and Waterman (1982), in their analysis of 43 particularly well-run U.S. corporations, similarly stressed that success is correlated to the ability to go beyond the "rational" model, in other words, the T perspective. A more recent survey by *Business Week* (Sept. 17, 1984) similarly attributed the failure of the majority of strategic plans to number-crunching professional planners:

> The quantitative, formula-matrix approaches to strategic planning developed . . . in the 1960s are out of favor . . . [Mead's former chief strategic officer says:] "The old process was just too mechanized. The real world is just too complicated for

> that." [The vice-president for corporate planning at Westinghouse adds:] "The notion that an effective strategy can be constructed by someone in an ivory tower is totally bankrupt." (pp. 63–64)

The results of these three surveys all point directly to the inadequacy of the T perspective. Intuition, a facet of the P perspective, is well appreciated by top executives (Rowan, 1979):

R. P. Jensen, chairman of General Cable Corp.:

> On each decision, the mathematical analysis only got me to the point where my intuition had to take over.

J. Fetzer, chairman of Fetzer Broadcasting Co.:

> Walk through an office, and intuition tells you if things are going well.

R. Siu (1978), management consultant:

> Effective CEO's . . . are aware that rationality and the scientific method provide critical inputs to only one of three questions overarching key decisions. These are: (a) Does it add up? (b) Does it sound OK? and (c) Does it feel right? Logic and science contribute primarily to the first question, less to the second, and even less to the third.

The personal perspective has historically played a key role in U.S. enterprises, being instrumental in entrepreneurship and leadership. Current business writings (Main, 1987) place renewed attention in the latter.

> What's required now . . . are not merely managers, but *leaders* . . . . The new paragon is an executive who can envision a future for his organization and inspire colleagues to join him in building that future . . . . Corporate America has always maintained at least a nodding interest in the subject of leadership, but recently the exigencies of global competition, deregulation, and accelerating technological change have whipped that interest into an anxious search for new answers to old questions: Can leadership be taught? How do you spot potential leaders? And what, precisely, sets leaders apart from everyday managers?

The strong difference in Japanese and American approaches to strategic planning can be traced to cultural traits which inform the O and P perspectives. The Japanese have tended to submerge the personal to the societal view; the American, the societal to the personal view. Japan's Ministry of International Trade and Industry (MITI) undertakes to do long range planning for entire industry sectors, while there is no equivalent concern in the United States with collective long-range industrial policy and strategy. On the other hand, the relative strength of the P perspective in the United States is reflected in its individual creativity output or basic research dominance: 135 U.S. Nobel Prizes in science compared to 4 for Japan.

4.2. Risk Evaluation and Management

Management is always concerned with risks. We consider here only two types, physical risk and political risk.

Table II shows how the three perspectives illuminate different views of physical risk. The T perspective undertakes probabilistic calculations and draws up fault trees; the O perspective deals with standard operating procedures and threats to organizational integrity; the P perspective perceives personal fears and images of horror. Not surprisingly, there is a dramatic difference among actuarial, societal, and personally perceived risk rankings. According to a recent survey, the typical individual views the risk of auto

Table II. Risk Concerns Seen in Perspectives[a]

Technical (T)	Organizational (O)	Personal (P)
One definition of risk for all	Definition customized to organization or group	Individualized definition
Compartmentalizing risk by discipline	Compartmentalizing risk by organizational slot	Time for consequences to materialize (discounting of long-term effects)
Probabilistic analysis; expected value calculations	Compatibility with standard operating procedures (SOP)	Age of individual
Statistical inference	Avoidance of blame; ability to diffuse responsibility	Perceived horrors (cancer, AIDS, Hiroshima)
Actuarial analysis	Inertia; warnings ignored	Fears based on personal experience
Fault trees	Fear exposure by media; attempt stonewalling	Influenced by media coverage of risk (*China Syndrome*)
Margin of safety design; fail-safe principle	Financial consequences	Economic cost (job loss, opportunity for gain)
Quantitative life valuations, cost-benefit	Impact on organiz. power	Freedom to take voluntary risks
Validation and replicability of analysis	Threat to product line	Salvation; excommunication
Failure to grasp "normal accidents" (Perrow, 1984)	Litigious societal ethic	Peer conformity pressure
Intolerance of "nonscientific" risk views	Reliance on experts, precedent	Peer esteem (exhibit courage, manliness)

[a] Ref. Bowonder and Linstone (1987).

accidents as equal to those of nuclear power, while the actual annual mortality rate of the former is over 500 times that of the latter. Strokes kill 85% more people than do accidents, yet people estimate that accidents take 25 times as many lives as strokes (Slovic *et al.*, 1981)

The accidents at Three Mile Island (nuclear power plant), Chernobyl (nuclear power plant), and Bhopal (chemical plant) all involve complex systems and have the characteristics of "normal accidents" (Perrow, 1984), each a very improbable combination of technical and human errors. At Three Mile Island the President's Commission (Kemeny, 1979) concluded that

> . . . the fundamental problems are people-related problems and not equipment problems . . . wherever we looked, we found problems with the human beings who operate the plant, with the management that runs the key organization, and with the agency that is charged with assuring the safety of nuclear power plants.

At Chernobyl a mishap on April 26, 1986, led to a partial core meltdown. While Westerners have pointed to technical flaws in the reactor design, the Soviet report to the International Atomic Energy Agency focused on a series of human errors, mistakes that violated safety regulations and, in some cases, common sense (*Washington Post*, Aug. 22, 1986). Andronik Petrosyants, head of the State Committee for the Use of Atomic Energy, said,

> For almost 12 hours the reactor was functioning with the emergency cooling system switched off . . . . It is quite possible that the [previous] smooth operations brought on complacency and that this led to irresponsibility, negligence, lack of discipline and caused grave consequences.

Valeri Legasov, first deputy director of the principal Soviet atomic research institute, added,

> If at least one violation of the six would be removed, the accident would not have happened. The engineers psychologically did not believe that such a sequence of improper actions would be committed. Such a sequence of human actions was so unlikely that the engineers did not include [it] in the project. Is that human or technical?

A recent multiple perspective examination of the Bhopal disaster is also illuminating (Bowonder and Linstone, 1987). On December 2–3, 1984, a catastrophic leak of methyl isocyanate (MIC) occurred at the Union Carbide plant in Bhopal, India. As in the Three Mile Island and Chernobyl nuclear cases, we are dealing here with a system involving (a) man + machine, as well as (b) an event characterized by the combination of very low probability + severe consequence. It is apparent in each of these risk situations that the engineers' standard T-type analysis is quite inadequate.

Each perspective applied draws forth insights which contribute to an understanding of the problem situation and development of possible actions. The technical perspective classifies the causal factors. The corporate

perspective informs us about the proprietary aspects (inadequate dissemination of information on the toxicity and clinical treatment of exposure to MIC) and "stonewalling" as the standard initial corporate reaction to a disaster. The personal perspectives show the importance of an effectively trained leader—a neighboring plant suffered no losses because the manager, a former brigadier in the Indian army, efficiently evacuated the workers upon detection of the leak.

Cross-cutting of the perspectives exhibits their interactiveness. For example, the safety audit (T) and the financial priorities of the company (O) affect the correction of problems. Most importantly, the perspectives lead us to a reconsideration of actions in the treatment of risk. Examples arising from each perspective.

T: Try to make the system "safe-fail" by decoupling of subsystems so that an accident can be bounded or limited to one subsystem.

O: Partially customize the system to the local culture for increased safety (revise instruction manuals, resulting in equivalence in practice rather than merely literal equivalence in language).

P: Give investigative reporters and "whistle-blowers" more protection in exposing poor practices, thus anticipating potential catastrophes.

In political risk forecasting for business generally, Ascher and Overholt (1983) move

> beyond a tradition of studying forecasting primarily as a series of discrete mathematical methods . . . . An exclusive emphasis on formal methods, particularly complex quantitative methods, will often prove self-defeating . . . We affirm the importance of studying forecasting in the context of the actual behavior of people and institutions rather than in a formalistic manner.

A clear distinction is drawn between the policy maker's "rational information needs" and his "political needs." The former refer to the meaning and content of the information, the degree of certainty, and the policy recommendations embedded in, or implied by, the information. The latter focus on the ability

- to be a convincing advocate of preferred policies, hence to have access to appropriate information;
- whenever possible to be correct, that is, to choose policies that produce positive results;
- when wrong, not to be disastrously so—thus, to make conservative decisions that avoid major risks even at the expense of foregoing certain opportunities;
- when wrong, to avoid adverse political repercussions for the policy maker;
- to maintain his decision-making discretion at all times.

It is evident how important a role is allotted to organizational loyalties (O). The authors are also convinced that long-range strategic thinking is qualitatively different from short-range tactical thinking, frequently to the extent of requiring different personalities (P) (Ascher and Overholt, 1983, pp. xi, xii, 45).

4.3. Energy Forecasting and Planning

A careful analysis of accuracy in academic, government, and industry forecasts of population, energy, and economic trends (Ascher, 1978) yields a clear and consistent pattern: the core assumptions underlying the forecast are the major determinant of forecast accuracy. They can be brought to the surface by multiple perspectives and prove to be far more crucial than the sophistication of the forecasting model used. A back-of-the-envelope model with good core assumptions is preferable to a sophisticated computer model with obsolete core assumptions. In other words, the methodology cannot "save" the forecast when the core assumptions are poor. An example of a poor core assumption is that used in the early ultimate petroleum reserve forcasts: no significant change in the technology of recovery.

A recent study (Sapp, 1987) used multiple perspectives to probe the energy demand forecasting process at Bonneville Power Administration in the Pacific Northwest region of the United States. Such analysis has provided a vital input used by utility agencies and companies for planning resource acquisitions and for financing decisions. Who is doing the forecasting proves as important as what is being forecast. The econometric models inevitably favored by the economists who constitute the forecasting group are very complex. Many core assumptions underpinning the models, particularly noneconomic ones, were accepted without question. For example, they assumed that there would be no major social and political discontinuities or structural changes over a 25-year period. Therefore, the long-term projections were inevitably biased by short-term trends. A 5% average annual rate of growth of regional electricity demand was accepted by all utilities in the region as realistic until the late 1970s. Major power supply shortages were anticipated in the mid-1980s on the basis of an assumed continuation of the regional economic boom experienced in the 1960s and early 1970s as well as continuation of old customer behavior patterns. Ascher calls this tendency "assumption drag" (Ascher, 1978). Uncertainties and possible surprise events were submerged in a sea of quantitative model output and "best estimates."

The decision to build the five nuclear power plants (The Washington Public Power Supply System) was based on such forecasts. The result was a

planning disaster: major changes in the forecasts due to altered assumptions could simply not be accommodated in the long lead-time construction program without enormous financial losses. Analysts were not accustomed by their background to maximize adaptability to unanticipated changes, that is, to disaster-avoidance planning. The P perspective also tells us that the leadership of the Bonneville Power Administration is a salient factor. One head administrator saw the impending power shortage as a technical problem; his successor saw it as a political problem; the third saw it as a business problem. Different foci lead to different solutions.

Today we see evidence of rejection of sophisticated strategic forecasting models and probabilistic analyses, accompanied by a shift to "planning under uncertainty." The inevitability of surprises is accepted and the combination of monitoring and short lead-time system responses reflects the new approach. For example, Southern California Edison Company (1988) now considers only system modules requiring a maximum of 2 years' lead time to provide for changes in energy needs.

The central nature of the O perspective for the decision process in energy facility siting has been illuminated in detail for four specific cases of liquified natural gas (LNG) projects—in the United States, Scotland, West Germany, and the Netherlands (Kunreuther *et al.*, 1983). The comparison shows very different institutionalized styles of risk handling that reflect cultural distinctions. The United Kingdom process was characterized by trust in experts and informal inspections as well as deference to top-down leadership. This consultative, consensual style contrasted with the American adversary, statutory bottom-up leadership style. In all cases two insights stand out: the siting decision process was political and it was sequential. The final outcome depended strongly on the actors' styles, their interactions, and the way the agenda was set.

The dialectric approach characteristic of the O perspective is also reflected in the history of energy resource forecasts in the United States (Wildavsky and Tenenbaum, 1981). The deep division between industrial interests and conservationists on oil and gas resources was already apparent in the early 1900s. In 1908 the U.S. geological Survey (USGS) forecast total U.S. oil resources between 10 and 24.5 billion barrels and indicated we would run out of oil between 1935 and 1943. Each side seized on these estimates to confirm its policy stand. Many forecasts have been made since then and, except for the World War I and II periods, each faction habitually accuses the other of manipulating the forecasts for its own purposes. Table III suggests the different O views on resource forecasts. It becomes clear that the forecasts are the servants of policies already determined or preferred rather than being prerequisites for policy formulation. The T-perspective quests for more accurate forecasts in this area are thus only of marginal relevance.

Table III. O Perspectives on Oil Reserve Forecasts[a]

	When prices are high	When prices are low
Industrialists favor	High forecasts "Major new supplies can be found if prices are high"	Low forecasts "Higher prices are needed to bring on more supplies"
Consumers favor	Low forecasts "Oil is no longer the solution"	High forecasts "No need to raise prices"
Conservationists favor	Low forecasts "High prices encourage overproduction"	Low Forecasts "Low prices encourage overconsumption

[a] Ref. Wildavsky and Tenenbaum (1981).

4.4. Military Systems Analysis

Ten years of experience with national defense needs analyses in the 1960s made clear to this systems analyst that the O perspectives lead to different priorities than does the T perspective:

> The gap between what is needed and what is marketable means that a "needs analysis" is, in fact, a mirage. (Project MIRAGE 85, 1970)

The "objective" T perspective takes into account King Richard's lament, "For want of a nail the shoe was lost . . . ," so that the priority list includes unglamorous items such as changes in training and maintenance procedures or communications equipment. However, a list based on both T and O emphasizes the more prestigious items in the firepower and vehicle areas—glamorous aircraft, ships, and space systems. These are important for the military–industrial complex, not only in terms of large new procurement contracts, but to military officers concerned with their own advancement ("you don't get three stars running a $30,000 program") and to morale of the forces in peacetime (Linstone, 1984, p. 339).

It is a lesson also observed by military historian Elting Morison (1966) in his discussion of the "advanced technology" destroyer built for the U.S. Navy during the Civil War and decommissioned almost at once when a Naval Board decided that this novel ship would be a destructive element in their society. Similarly, the history of the U.S. Army rifle from the Spencer Civil War weapon to the M-16 rifle controversy in the 1960s can be understood only if the O and P perspectives are drawn into the picture. The Army does not operate as the unitary decision maker usually assumed by the

systems analyst. The Ordnance establishment and the Infantry Board may be on opposite sides of the argument. And individuals such as Eugene Stoner and Robert McNamara, Generals MacArthur and Lemay, are found to play decisive roles in the decision process (Linstone, 1984, pp. 87–94).

4.5. Technology Assessment

The multiple perspective approach has been applied to three technology assessments sponsored by the National Science Foundation. Following are examples of the insights brought to the surface.

(1) Electronic Funds Transfer (1975–1980) (Linstone, 1984, p. 224)

T: The U.S. banking industry is technologically obsolete.
T/O: There is a mismatch between the technological and the managerial aspects of electronic funds transfer.
O: A vote by a Commission is the result of complex compromises by vested interest representatives and is revised only with great difficulty even if new information becomes available.
P: Computer crime has a promising future.

(2) Guayule Commercialization (Linstone, 1984, p. 259)

T: Tests have shown guayule to be a satisfactory natural rubber substitute for hevea in automobile and aircraft tire use.
O: The U.S. Department of Agriculture has not been aggressive. The Department of Defense and Federal Emergency Management Agency have a stronger interest.
P: Each actor sees the other's perceptions are distorted. Each therefore interprets a given act differently. The situation discourages intersectoral coalitions and encourages intrasectoral coalitions where perceptions are more similar and mutually comprehensible.

(3) On-Site Solid Waste Treatment (Linstone, 1984, p. 296)

O: Engineering schools and federal policies favor centralized systems.
P: There is a deeply ingrained "flush-and-that's-the-end-of-it" attitude. Homeowners dislike the maintenance required with on-site systems.

4.6. Cross-Cultural Systems Analysis

Following are two applications of multiple perspectives in cross-cultural settings.

(1) Environmental degradation in the Himalayas (Nepal)

Thompson and Warburton (1985) have studied this problem and drawn important conclusions about systems practice. They remind us that the classic development approach has been to sound the alarm and then tell the country what to do.

> It has not worked. It has not because it ignored (as if it were a mere detail of implementation) the deep political, economic and cultural structure . . . . What is needed is a more sensitive approach, an approach that places "mere details"—the institutions that constitute the deep structure—at the very center of the stage . . . . Though what we have done is applied systems analysis, it may not look like it. There is, we concede, a fair-sized break between the traditional single problem/single solution approach and the one we have developed here. There are many ways to characterize this break but perhaps the best is in terms of the shift it makes from *product thinking* to *process thinking*. The systems frame is no longer a model of the problem but simply an evaluative mechanism. When *the problem is to know what the problem is*, we need more than one perspective. The approach by way of plural institutions and divergent perceptions meets this need. It gives us problems and solutions that are multiple, but not infinite; certainties that are contradictory but not chaotic. (pp. 10, 17, 33)

Key O perspective conclusions: Top-down development is in the nature of a project, bottom-up development is in the nature of a process. The meshing of top-down and bottom-up requires constructive intervention at the "right" points of leverage.

(2) Agricultural development of the Wei Bei region, Shaanxi Province, China

A joint project with the School of Management of Xi'an Jiaotong University (1985–1987) has focused on agricultural development of the Wei Bei area of Shaanxi Province (Linstone *et al.*, 1987). The T-focused analysis was determined to be necessary but not sufficient in addressing agricultural modernization and sideline enterprise development in Wei Bei. Sweeping in O and P perspectives, it became evident that realization of these goals requires an organizational process (O) at the lower levels which is not yet in hand, as well as personal abilities (P) in project managers and staff not likely to be acquired in academic settings. The partial decentralization now in progress places unaccustomed burdens on lower echelons of government (county, prefecture, township). The tradition of centralization has resulted in

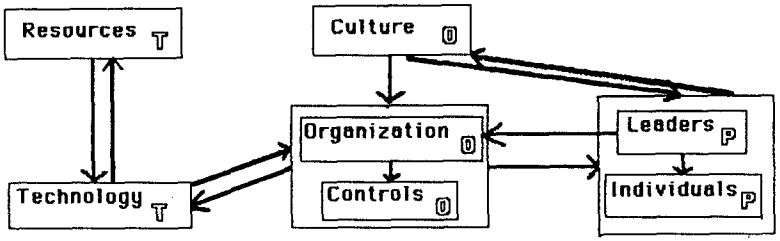

Fig. 1. Primary areas of perspective concern and cross-cuing in the China case (Linstone *et al.*, 1987).

an imbalance in information movement—vertically good, horizontally poor—and weaknesses in regional infrastructure and manpower skills to cope with modernization tasks. These tasks include high-value cash crops and animal husbandry, as well as diversification into profitable nonagricultural enterprises.

Figure 1 schematically shows the basic system categories (boxes) and the most obvious cross-impacts among them (arrows). The letter in each box shows the perspective likely to be of prime importance. Examples of factors in each box are as follows.

Resources—enormous human resources; minimal financial resources and education

Technology—reductionism and compartmentalization; considerable research but poor diffusion of output among institutions and to users

Culture—centrality of the *danwei* or group (until recently a person's existence apart from his *danwei* was barely recognized); reluctance to share information

Organization—redundancy at all levels due to history of centralization; stability the main concern of the vast bureaucracy; self-protection (no risk-taking)

Controls—strict controls on hiring, pricing, movement between countryside and city

Leaders—power pyramids common; blood ties important; many leaders at lower levels poorly qualified (little management experience)

Individuals—respect for authority; rote learning; uncritical acceptance of models; use of "back-door" or personal connections

Examples of cross-impact are as follows.

Leaders → culture

Mao Tsetung effected irrevocable changes in the culture.

Organization → individuals

Sudden policy shifts experienced in the past strengthen the peasants' desire to keep individual land plots for security.

Technology → organization and control
Information technology permits unprecedented centralization *and* decentralization.

Cross impacts are also seen in the "responsibility merry-go-round." Examples are as follows.

O → P: The governmental actors (O) in general blame the individuals (P)—the government is good but the problem is the people.

P → T: The farmer complains that the scientists and engineers propose impractical schemes based on unrealistic models and do not understand the local situation.

T → O: The analysts blame the rigidity and obsolescence of organizations.

In China O has historically tended to dominate T and P. Thus, more emphasis on T and P is obviously indicated. Indeed, the policies that propel the current transition should gradually realize just such an effect. In addition, the partial decentralization policy also implies a major reorientation of O on the part of the Chinese. Traditional concepts such as comprehensive planning, the hierarchy and power pyramid, and the cadre/peasant and city/countryside divisions need to be reassessed. The new policy necessitates greater organizational sophistication, flexibility, and self-regulation. So there is a challenge to all three perspective types.

Two other lessons stand out.

(1) In any cross-cultural situation the O and P perspectives bring to the surface subtle cultural distinctions. These affect the system in important ways. They are certainly masked in a T-type analysis and may even elude a Westerner's effort at O or P. After all, Westerners produce Westernized perspectives. Wherever possible, native Chinese should be fully involved in developing the O and P perspectives. It should be noted, however, that sensitive Western systems analysts have observed the effect of cultural differences on decision analysis and operations research, for example, the Chinese discomfort with the concept of uncertainty and the lack of skepticism about tools (Pollock and Chen, 1986; Bartholdi, 1986).

(2) Our work corroborates the system view of Thompson and Warburton (1985). Their own system characterization—"the problem is to know what the problem is" and "institutions rather than data constitute the facts"—fits the Wei Bei agricultural development case perfectly.

4.7. Further Comments

We have sampled the menu of application areas. As most decision making involves systems that are not purely technological in nature, the

spectrum of applicability of the multiple perspective concept is being steadily expanded. A very recent case is an examination of the U.S. trade deficit "crisis" using an "economic" (T) perspective, a "political" (O) perspective, and a "normalistic" (P) perspective. The fundamental premise is as follows:

> Perceptions of the trade deficit and its effect on decisions that lead to national trade policies can only be understood through the incorporation of economic, political, and moralistic arguments, where the compound explanation goes beyond that which can be obtained from any one of these separate fields of study . . . . To understand seemingly economic problems [one must] step outside the standard economic paradigm. (Udwadia and Agmon, 1988)

5. GUIDELINES FOR USERS

The multiple perspective concept is not simply another methodology to add to the analyst's tool kit. There is no six-step procedure, no formula to weight perspectives. Table I makes it clear that the O and P perspectives use inquiring modes and paradigms not natural to the T-trained engineer or economist—although quite familiar to managers, lawyers, politicians, bureaucrats, and even journalists. Our experience todate suggests some guidelines to assist in applying the concept. Those who are already effectively bridging the gap between analysis and action obviously do not have need for them. It is hoped that the guidelines will help the many others who are struggling to link theory with implementation in the real world.

5.1. T–O–P Balance

Strive consciously for a balance among T, O, and P perspectives. Either use an individual who exhibits a good balance of T, O, and P (an uncommon breed) or create a team with diverse backgrounds. We do not refer here to a philatelic mix, say, an engineer, an economist, and a computer systems analyst. They are all T-driven and concerned with model detail and precision. Instead of devoting roughly equal time to T, O, and P, they are likely to spend 90% of the available time on the T perspective, with which they are comfortable, and 10% on O and P, with which they are not. A better mix might be provided by an engineer, a lawyer, and a businessman.

5.2. Choice of O and P Perspectives

There are as many O perspectives as there are affected or affecting organizations and interest groups. Within a company or agency each department has

its unique O perspective. You cannot include all; the choice is necessarily judgmental. Do not be surprised if perspectives are in conflict—this is, after all, the real world. The same cautions apply to the selection of P perspectives. Experience will make it apparent that the hierarchy or organization chart is not always a good guide; some key individuals in the decision process do not appear on the charts. An in-depth understanding of the organization will illuminate its myths, standard operating procedures, and actual decision process. The P perspectives pose the most difficult challenge; they lie at the deepest and least accessible level (corresponding to the persona layer in Freud's psychoarchaeological conception). Look particularly for individuals who are likely to act outside of an institutional role and would affect outcomes.

5.3. Use of Interviews for O and P

The T perspective is developed using traditional data- and model-based analysis. We have stressed that more of the same will not yield the O and P perspectives. Rather, they depend strongly on personal immersion, on digging below the surface, on really understanding what makes the actors "tick." Interviews are of great value in gaining O and P perspectives. But they require talent: the interviewer must be a good listener and sensitive to nuances and nonverbal communications. What is *not* said may be as important as what is said. Volunteered asides may be as significant as answers to questions. The effective interviewer recognizes that structured questionnaires or Delphi are no substitutes for such exchanges.

Language and cultural differences must be understood for the interviewing process. Our recent experience in China showed that the Chinese well understood what was being probed with O-type questions. Clearly the Chinese culture is bureaucratic and hierarchic, so that O games and strategies are known to all. Power relationships are enshrined in all kinds of slogans, such as "two down, one up" and "the pyramid of power." P perspectives presented more of a problem. We found that it was very important to keep pushing for concrete examples and anecdotes to flush out and interpret the often too general and spare answers.

Since interviews play such a central role in the multiple perspective approach, the quality of information generated by key interviewees is of major concern. All translation becomes interpretation, and this requires a sophisticated knowledge of the local culture. Since simple word-for-word translations are not possible and the Chinese language contains many untranslatable metaphors, similes, and allusions, very well trained and sophisticated interpreters are essential. Often an interviewee's apparently

peripheral response may bring forth valuable insights not anticipated by the questioner.

Detailed guidelines for interviewing are given by Linstone (1984).

5.4. Integration of Perspectives

The various perspectives may, and do, impact each other. Their interplay is the essence of the decision process, specifically, the negotiation and tradeoffs that lead to compromises. The question is often asked: Should the perspectives be integrated into one picture before submission to the decision makers or should the set of different perspectives be presented? In answer to this question, it is useful to call on the analogy of the trial courtroom. The jury hears the testimonies of the various witnesses (perspectives) *and* summations by the prosecutor and defense attorney. The jury can accept one or the other integrated version or use the original perspectives in arriving at its decision. The executive has similar options. We recommend displaying the different perspectives and possibly our own "prototype" integration. We must keep in mind that our cross-cuing and weighting of perspectives cannot simulate that of the decision maker. There is no way we can predict his mental process; indeed he or she often cannot articulate this crucial decision process even *a posteriori.* As President Kennedy (1963) wrote,

> The essence of ultimate decision remains impenetrable to the observer—often, indeed, to the decider himself . . . . There will always be the dark and tangled stretches in the decision making process—mysterious even to those who may be most intimately involved.

However, the presentation of the several perspectives encourages cross-cuing among them. For example, a manager's vision of the company's future (his P perspective) may become the organization's O perspective if he has the flair to engage others in sharing that vision. Such interplay also leads to consideration of important facets that are not captured by any one perspective. The willingness of a corporation or government to balance projects having only long-term payoff with those providing near-term payoff requires a conjunction of quite distinct perspectives.

5.5. Communication

The technical report or briefing is ideal for communicating the T perspective. The O perspective often involves a private insiders' language in combination with a hortatory one for the public. However, as any successful

artist, dramatist, and media producer knows, the personal level of the P perspective is the most effective of all. Even in the industrial world,

> we are more influenced by stories (vignettes that are whole and make sense in themselves) than by data (which are, by definition, utterly abstract). (Peters and Waterman, 1982)

It is hardly surprising to find that the T-type analyst is not the most persuasive scenario writer. Recognition that, to a degree, the medium is indeed the message, is the first step to the skillful communication of perspectives.

5.6. Implementation

The inherent process orientation of the O perspective virtually assures avoidance of a trap commonly encountered with the T perspective: walking away from problems of implementation, problems that focus on the role of human beings, both collectively and individually.

6. CONCLUSION

The multiple perspective concept constitutes an effective meta-inquiring system. Using a descriptive analogy, we could say that the T, O, and P perspectives together provide a three-dimensional view, rather than the traditional one-dimensional (T) view, of the real-world system.

The growing corpus of applications and the insights they have provided give us confidence that we are on the right track in dealing with complex sociotechnical systems. We cannot expect scientific validation. But the approach makes quite clear the reasons for the failures, more accurately the limitations, of traditional systems analysis and moves us successfully beyond them. The leap from the deeply ingrained analytic T perspective to multiple perspectives may initially require uncomfortable rethinking for many systems analysts. But it is well worth a strenuous effort.

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