ON THE MANAGEMENT OF TECHNOLOGY: OLD AND NEW PERSPECTIVES, PART II

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SYNOPSIS

Part I of this paper appeared in the last edition of DYNAMICA and dealt with a presentation and critique of some commonly used paradigms and perspectives in the problems relating to the management of technology.

In this section of the paper the need for simultaneous, multiple perspectives is introduced and this philosophy is developed through a discussion of currently available methods, including the work of the author.

1. MULTIPLE PERSPECTIVES

It has been shown that the technical perspective, so successful in addressing purely technical problems, is very inadequate in dealing with sociotechnical and other problems. It is well suited to design a highly sophisticated technological system but ill suited to deal with the assessment or implementation. In this technology management phase the system can no longer be viewed as a purely technological one. Organizations and individuals play important roles and it is suggested that other perspectives with different paradigms must augment the technical perspective. In other words, multiple perspectives are needed.

Let us first make clear what we do *not* mean by multiple perspectives:

First, we refer to the use of multiple models *simultaneously*, not sequentially. The latter use is exemplified by the Copernican and Ptolemaic models, one replacing the other as the "correct" view of the world. Religions, like early science, depended strongly on *one* Weltanschauung as a base for authority. The fear of unsettling alternative views is reflected in inquisitions, witch hunts, ostracism by colleagues, and other techniques of persecution.

Second, we do not imply that a technological aspect must be viewed by a technological perspective (Fig 1(a)) and an organizational aspect by an organizational perspective. The technological, social, and individual aspects are interrelated

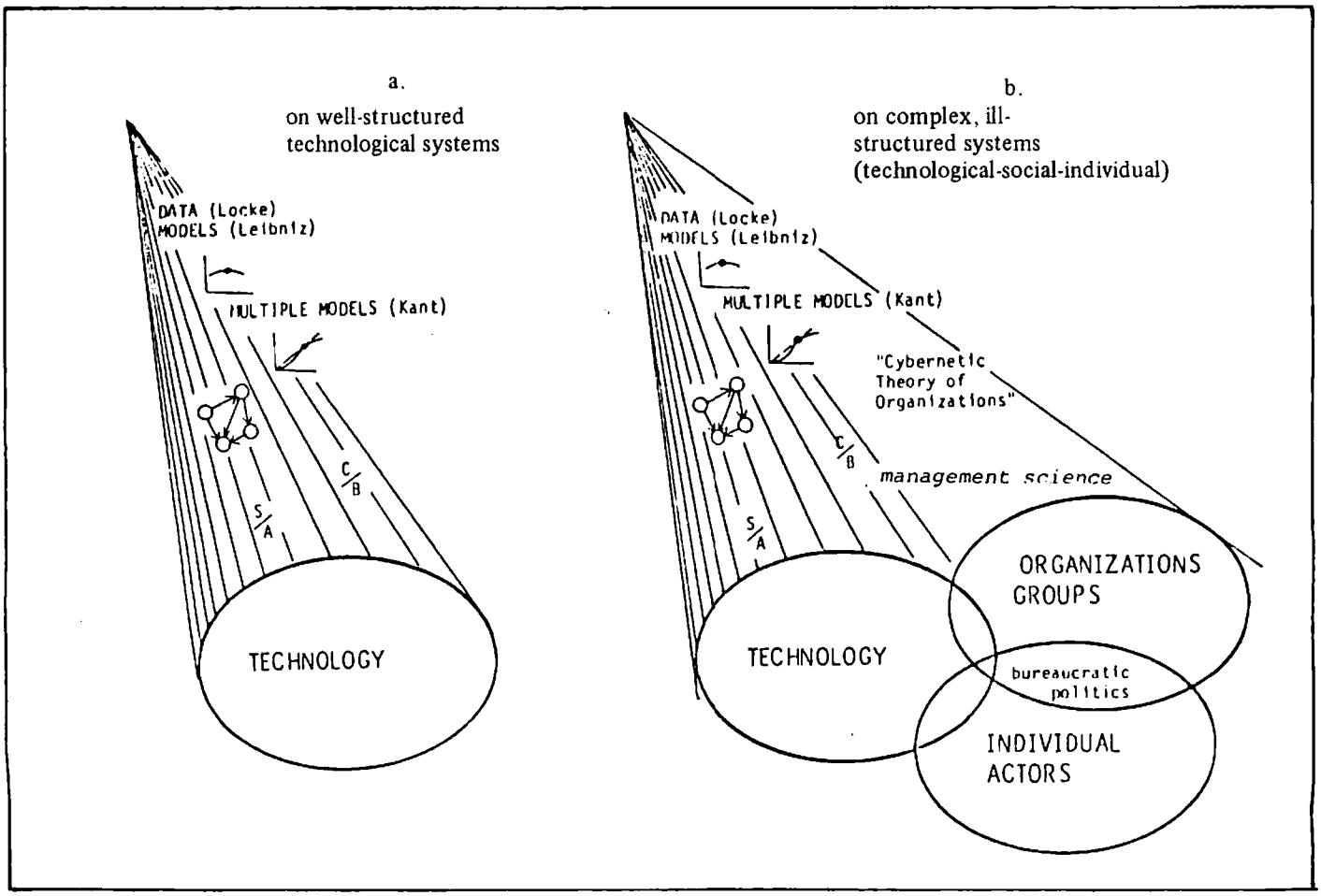

Figure 1: The Technical Perspective

and it is the hypothesis of this paper that multiple perspectives should be considered in looking at all aspects. Acceptance of multiple models simultaneously requires a considerable degree of intellectual sophistication or maturity. In mathematics the nineteenth century challenged us with the Euclidean, Riemannian, and Lobachevskian geometries – while physics offered the wave and particle theories as simultaneously valid. Anthropologists have used the triad of culture, society, and personality.[1] In the social sciences Etzioni bases his model of "mixed scanning" on political and systems approaches to decision making.[2] Multiple perspectives are most familiar to the trial lawyer (he expects each witness to bring forth a different perspective) and have also been used as literary devices. "Rashomon" is a classic example.

1.1 Allison's Models

Table 1 suggests the origins of Allison's Models. Both Models I and II could be built on a solid base of 1950's and 1960's scholarship. The RAND "school" and its disciples produced a plethora of rational actor guidelines and case studies, e.g., Dror[3] and Quade[4]. The organizational process model was drawn largely from the Simon-March school of organizational decision making.[5,6] Many of Allison's propositions are taken from Cyert and March.[7] Their research is a response to the dominant assumption in economics that the activity of business firms is solely a function of market dynamics. They present an alternative "process-oriented" theory where the internal structure of the firm plays an equally significant role. Similar to Allison's questioning of the assumption of rational choice in foreign policy making. Cyert and March challenge the axiom that profit is the only motive behind business decisions. Instead, they argue that goals are reached through bargaining and compromise between the major sub-units within the organization. Maximization of profit is only one consideration. In the prevailing economic theories of the firm (and Allison Model I), decision makers are assumed to have complete information about alternatives. Cyert and March, in contrast, posit a process of problem solving characterized by incomplete information and biased toward dominant perspectives within the organization.

The foundations of Allison's first two conceptual models (I and II) are stronger than those of the third. Organizations are easier to analyse than individuals and permit more ready generalisation, hence, propositions. Allison in his afterword notes that "Model III tells a fascinating story, but is enormously complex. The information requirements are often overwhelming".[8] The use of a "rational actor" model and an "organizational process" model for a case study of a 1962 presidential crisis is self-evident considering the strong counter currents of the time. Rationality was the hallmark of "the best and the brightest", the whiz kids brought in by Secretary of Defence McNamara to the dismay of the apparatchik dominated by career civil servants, true "organization men". In the five years prior to the formation of the Harvard May Group[8], Models I and II were, so to speak, in public

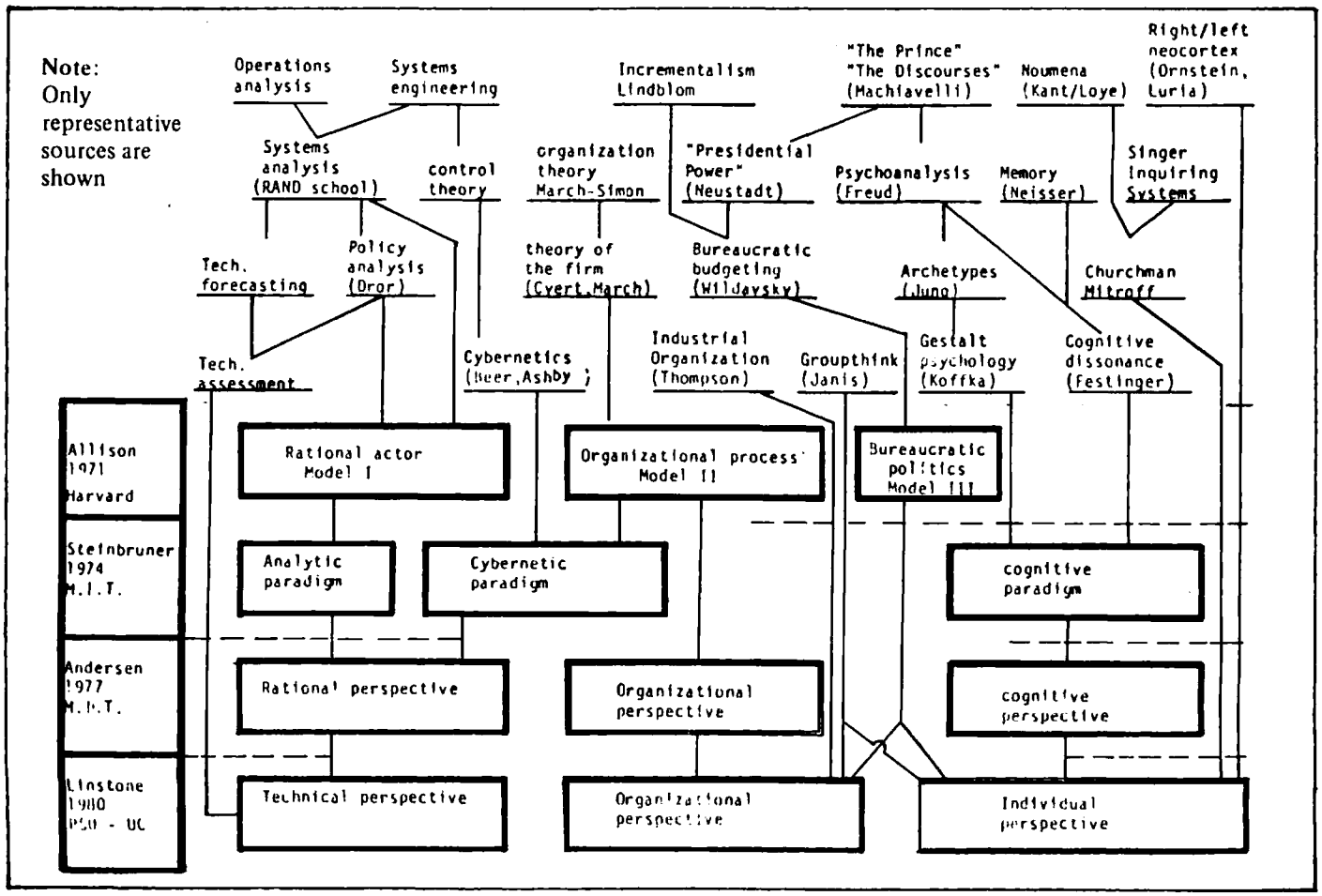

Table 1: A Comparison of the Multiple Perspectives and their Sources

	Rational actor	Organizational Process	Bureaucratic Politics
Basic Unit of Analysis	Action as choice of total system	Action as organizational output in framework of present capabilities and constraints	Action as political resultant (bargaining, compromise)
Organizing concepts	Unitary decisions maker (e.g., government) One set of goals (e.g., national) Problem as seen by unitary decision-maker Solution a steady-state choice among alternatives Action a rational choice based on goals/objectives, alternatives/options, consequences, and value maximizing selection	Constellation of loosely allied units topped by leaders Problems factored; power fractionated Parochial priorities Goals are constraints defining acceptable performance of organization Sequential attention to goals Standard operating procedures (SOP) Programs and repertoires Avoidance of uncertainty Problem-directed search Central co-ordination and control	Players ("where you stand depends on where you sit") Parochial priorities and perceptions Goals include personal interests Players' impact based on relative power Action channels structure the game Rules sanction some tactics (bargaining, coalitions, bluff) but not others
Dominant Inference pattern	Action are maximizing means to achieve ends	Behavior of organization at time t similar to $t-1$, $t+1$ similar to t	Action resultant of bargaining game among individuals, groups
General propositions	Likelihood of any actions results from a combination of relevant values and objectives, perceived alternative courses of action, estimates of various sets of consequences, and net valuation of each set of consequences Increase in costs of an alternative reduces likelihood of its selection Decrease in costs of an alternative increases likelihood of its selection	Standard routines: program is a cluster of SOP's a satisfying rather than maximizing (first acceptable rather than best alternative) Long-range planning institutionalized then disregarded Incremental change Trade-offs neglected Organizational health implies growth, inperialism Administrative feasibility a major dimension Directed change possible when organization is in crisis	Peculiar preferences and stands of individual players Styles of play vary Face of issue differs from seat to seat Focus on immediate decision rather than on doctrine Views: Looking down – options Looking sideways – commitment Looking up – show of confidence Frequent misperception Misexpectations Miscommunications

Table 2: Allison's Three Models

Source: G.T. Allison, *Essence of Decision*, Little, Brown & Co., Boston, 1971

confrontation all over Washington. Model III subsequently signified the recognition that two models could not encompass all the crucial aspects of the decision-making process. The main descriptors of the Allison models are shown in Table 2. Allison himself stressed that his Models II and III are not the only alternative conceptual models. He specifically mentions a Model IV based on Steinvruner's cognitive processes of individuals.[8]

1.2 Steinbruner's Perspectives

Steinbruner's "The Cybernetic Theory of Decision"[9] is based on his M.I.T. doctoral dissertation. Like Allison he is concerned with dimensions of political analysis and, like Allison, he defines three perspectives with separate paradigms. They are termed rational or analytic, cybernetic, and cognitive; Table 3 summarizes the characteristics.

The *analytic* paradigm refers to the operations research/systems analysis process of evaluating alternatives and determining preferred decisions by suitable measures. Often a model is the means by which casual learning takes place.

The *cybernetic* paradigm sees the systems engineering concept of the servomechanism or automatic feedback as a fundamentally different basis for decision making. Instead of casual learning we have learning through error-control. Presumably organizations function largely in this mode, with decision mechanisms screening out information which the established set of responses are not programmed to accept, i.e., standard operating procedures. While a strictly cybernetic view of organizations undoubtedly has some value, it appears to us that these definitions create considerable problems. Both are "systems" views and this approach severely clouds the organizational perspective. Cybernetics was defined by Ashby as "the study of systems that are open to energy, but closed to information and control; systems that are information-tight".[10] Is this an appropriate definition of organizations? Few systems people would agree that cause-controlled systems and error-controlled systems justify the description "separate paradigms".

The *cognitive* paradigm rests on cognitive psychology, specifically three claims:

(1) there are regularities in the decision process which have to do with the structure as opposed to the content of cognitive operations.

(2) the full human mental apparatus is engaged in the simplest of operations such as direct, immediate perception,

Analytic Paradigm	Cybernetic Paradigm	Cognitive Paradigm
Analytic evaluation of alternative outcomes	Uncertainty reduction by routinization	Much information processing is done without conscious direction
Models used for casual learning	Servomechanism or feedback control	Inferential memory, consistency, reality, simplicity, and stability as basis for mental information processing
Decision based on optimal choice	Learning through automatic error-control	Structure of cognitive operations has regularities bearing on decision process
Decision maker makes assessment of relative values	Problem fractionalization	Strong beliefs exist despite uncertainty
New information added as in Bayesian statistics	Decision-making by recipe rather than blueprint	Strong reliance on negative logic
Collective decision making assumes equivalence with theoretical individual	Survival or perpetuation a decision criterion (not optimization or satisficing)	Thought patterns: grooved thinking, uncommitted thinking, and theoretical thinking

Table 3: Steinbruner Perspectives

(3) most of what happens in the human mind is not accessible to direct, conscious experience. In other words, a great deal of information processing is conducted independently of conscious direction.

Inferential memory, consistency, reality, simplicity, and stability provide the basis of this paradigm.:

inferential memory – an overall structure in operationalizing the memory

consistency – a tendency to keep internal belief relationships consistent with one another (and filter out inconsistent ones)

reality – the human mind is in contact with its environment (Freud's reality principle)

simplicity – cognitive inference mechanisms work to keep the structure of belief as simple as possible

stability – cognitive inference mechanisms resist change in the core structure of beliefs

Cognitive thinking is taken to follow one of three patterns:

grooved thinking – routinized by tradition and experience, akin to the cybernetic process

uncommitted thinking – adoption of generalized concepts embeded in larger, theoretical belief structures: these are associated with a sponsor; sequential adoption of different belief structures, i.e., oscillation among them ("he was of the mind of the last person he talked to")

Rational Perspective	Organizational Perspective	Cognitive Perspective
• Alternatives specified	• Multiple actors, parochial interest	• Limited information processing capability
• Consequences assessed	• Goals as constraints ("don't go above")	• Tendency to filter out inconsistent images
• Goals or objectives	• Sequential attention to goals	• Store and recall information consistent with past experience
• Choice (often by optomization)	• SOP's	• Focus on simplistic hypotheses rather than scan
• Decisions collective (single actor)	• Decomposable environments	• Small peer group reinforcement
• Problem bounded	• Problem directed search	• Reality socially constructed (Merleau-Ponty)
	• Importance of information channeling	
	• Short run actions and corrections based on feed-back	
	• No prediction of long term consequences	
	• Limited flexibility	
Role of Mathematical Models (e.g., system dynamics) in Perspective		
• highlight problem definition	• focus attention on long term goals	• expand information processing capabilities
• evaluate consequences of alternative policies	• ignore sequence of goal attention	• aid formation of images and analysis (structural) models
• explicitly present tradeoffs	• provide guidelines for problem directed search	• counteract simple extrapolations
• forum for collective decisions	• aid organizing information processing	• force casual hypotheses and then clarify trade-off
	• ignore short-run feedback	
	• aid development of inter-agency policies	
	• tend to develop infeasible policies	

Table 4: Andersen's Three Perspectives

	TECHNICAL (1)	ORGANIZATIONAL (0)	INDIVIDUAL (P)
WELT – ANSCHAUUNG	Science-technology	organization	psychology-behaviour
CHARACTER– ISTICS	Cause-effect Objective Problem solving Analysis Prediction Optimization Use of averages, probabilities Trade-offs Complete rationality Left neocortex	cause-effect & challenge-response objective & subjective problem avoidance/delegation analysis & synthesis action/implementation Satisficing Standard operating procedures Parochial priorities factoring/fractionating problems incremental change recognition of partial unpredictability left and eight neocortex	challenge-response subjective game-in-process for most intuition fear of change and unknown creativity and vision by few partial rationality inner world/self Maslow hierarchy of needs learning power/influence/dominance left & right neocortex
PREFERRED INQUIRING SYSTEM	Lockean-data Leibnizian-model Kantian-multimodel	Hegelian-dialectic Singerian-pragmatic	intuition-noumena Merleau-Ponty-negotiated reality
TIME CONCEPT	Technological time Zero discounting	Social time Moderate discounting	Biological time High discounting

Table 5: Linstone Perspectives

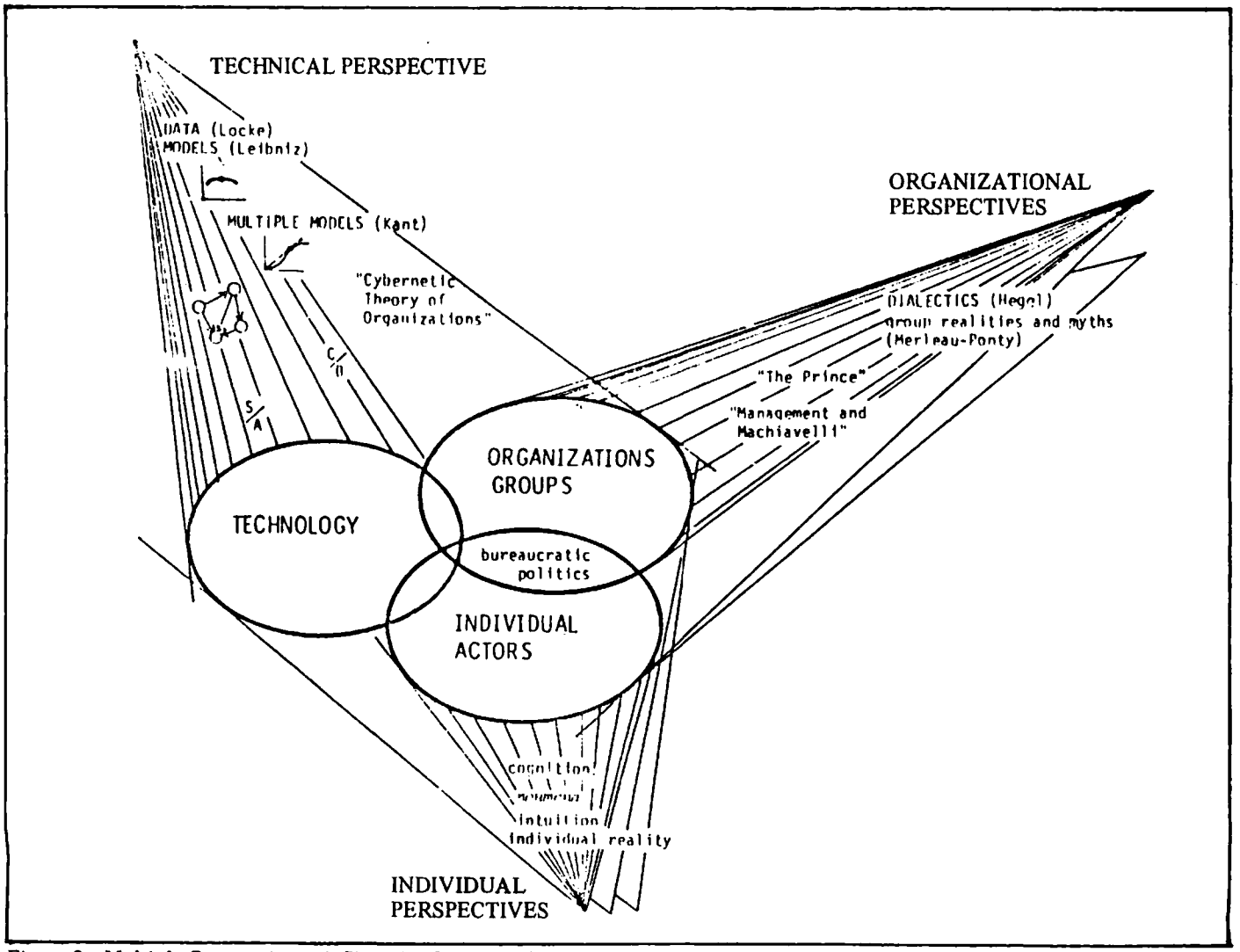

Figure 2: Multiple Perspectives: A Singerian Inquiring System

theoretical thinking – adoption of very abstract and extensive belief structures which are internally consistent and stable over time; theological faith in one world view ("the Communist conspiracy")

This paradigm is quite distinct from Allison's Model III, bureaucratic politics. To summarize, Steinbruner's first paradigm bases the decision on whatever information is available to build a model of critical relationships, the second paradigm controls uncertainty by mechanistic feedback and decision rules, the third rests on a belief structure in the human mind.

1.3 Andersen's Perspectives

Allison's book appeared in 1971 and has been widely used at Havard and M.I.T. In 1974 Massachusetts began to implement a comprehensive policy reform of special education ("Chapter 766"). A system dynamics simulation was constructed as an element of this effort. Andersen's work[11] like Steinbruner's an M.I.T. PhD dissertation, examines the impact of that model on the decision-making process using a "rational", "organizational", and "cognitive" perspective. The central features of the Andersen perspectives are summarized in Table 4. He appears to take his *rational* perspective directly from Allison's Model I, his *organizational* perspective similarly from Allison's Model II, and his *cognitive* perspective from Steinbruner's cognitive paradigm. As Andersen writes,

> *"there was some question concerning what the third perspective should be. The most active candidates for the third slot were a bureaucratic politics model as articulated by Allison, a purely political model, or a form of a cognitive model. The details of the case study helped to make this choice".*

A comparison of Tables 2 and 4 show the difference in the Third Perspective, Allison is concerned with bargaining, Andersen with learning and mental decision processes. Allison focuses on governmental action as a resultant of compromise, perceptions, styles of play, personal goals, and rules of the game. Anderson deals with the individual's limited information processing capability, inferential memory, focusing rather than scanning as a basis for choice, and small group interactions leading to a shared reality.

1.4 Linstone's Perspectives

Building on the work of Allison, Steinbruner, and Anderson, we are currently experimenting with the application of our own version of these multiple perspectives in the area of technology assessment.[12] Table 5 describes our perspectives in summary form and Fig. 2 related these multiple perspectives to Fig. 1.

Some examples will serve to concretize these ideas. Consider first the case of guayule, a potential substitute for natural rubber (hevea). The guayule plant grows wild in northern Mexico and could be planted in the southwestern U.S. Table 6 samples the points brought forth by each of the three perspectives in assessing this technology.

Many other examples come to mind:

Organizational perspective

Energy – Key roles played not only by OPEC but by the Seven Sisters (major oil companies) who have, according to Blair[13], exercised near perfect control of supply and marketing, frequently proving stronger than national governments and international governmental organizations

Apollo lunar landing project – the search for missions by the U.S. Air Force and U.S. Army placed significant pressure on propelling the project toward a decision

Aircraft safety – the relation between the Federal Aviation Administration and aircraft manufacturers affects enforcement of National Transportation Safety Board recommendations

Naval ship design – the decommissioning in 1869 of the "Wampanoag", a superb new U.S. naval vessel proven superior to all existing ships in its sea trials; as Morison[14] notes, the Naval Board

> *"Officers were saying that the "Wampanoag" was a destructive energy in their society. Setting the extraordinary force of her engines against the weight of their way of life, they had a sudden insight into the nature of machinery. They perceived that a machine, any machine, if left to itself, tends to establish its own conditions, to*

Technical Perspective

- Tests have shown guayule to be a satisfactory substitute for heavea in automobile and aircraft tires (the primary use of natural rubber)
- In view of the 300% price increase of natural rubber since 1972, guayule is becoming competitive
- Guayule development can meet 100% of the projected natural rubber shortfall by 1991
- Yield per acre is expected to double between 1985 and 200

Organisational Perspective

- Mexico has had a long history of interest in guayule (wild natural growth, a research institute in Saltillo, a pilot processing plant) but relations with U.S. appear somewhat strained
- Research is not the key issue; rather, production start-up raises the question of assumption of financial risk between the tire and rubber companies and the government (Federal and California)
- The Dept. of Agriculture has not been aggressive; the Guayule Commission may become the lead group but has not done much to date; national security considerations may be decisive (Asian turbulence: Iran, Afghanistan, others?)
- Inbreeding appears to be a problem in tire and rubber industry management

Individual Perspective

- Ed Flynn ("Mr. Guayule Rubber News") is a determined promoter
- Effective leadership of, and cooperation between, Alex Mercure, Chairman of Federal Guayule Commission, and Isi Siddiqui of the Calif. Dept. of Food and Agriculture may spark implementation action
- Rep. George Brown (Dem., Calif.) has been a most effective advocate in The Congress and has been joined more recently by Sen. Peter Domenici (Rep., N.M.). Texas is lacking a strong Congressional supporter.

Table 6: Examples of the Use Multiple Perspectives on the Guayule/Heavea Substitution

create its own environment and draw men into it. Since a machine, any machine, is designed to do only a part of what a whole man can do, it tends to wear down those parts of a man that are not included in the design.

"I respect their awareness that they had a problem".

Army rifle – McNaughter[15] has chronicled the convoluted history of the struggle to replace the M-14 by the superior M-16 semi-automatic rifle. In this case the resistance of the Army Staff was broken by McNamara and the Vietnam experience.

Individual Perspectives

Apollo lunar landing project – the positions and ambitions of Senators Lyndon Johnson and John F. Kennedy, as well as the negative stand of President Eisenhower, were crucial factors in activating the program.

Soviet bureaucracy – Voinovich[16] gives this description in his fictional format:

"The only ideology (Ivanko the bureaucrat) worships is the maximum satisfaction of his personal needs; and his needs are infinite and in conflict with his resources, which, no matter how great, are always limited. His practical activity is directed at constant expansion of these resources."

Downsizing of automobiles – according to Kraft[17] Henry Ford II's actions, (e.g., playing off engineers against financial executives, firing Iacocca) placed the company in a disadvantageous position with regard to "downsizing".

New drugs – MER/29, an anticholesterol drug, was approved by the Food and Drug Administration (FDA) on the basis of falsified data (e.g., suppression of data on recognised harmful effects) in the New Drug Application–the key instrument–provided, according to Fine[18], by a laboratory head in a department of the drug manufacturer. Thalidomide was not approved by the FDA despite heavy industry pressure, owing to the strong will of one FDA individual, Dr. Frances Kelsey, to resist inadequate data

Auto safety – the role of Ralph Nader[19] during his early struggles was a lonely battle of an individual against giant corporations

For other examples, see 20,21.

2. WHY RAISE THE SUBJECT NOW?

It is ironic that the answer to this question lies largely with the success of technology. Public health technology has fueled the global population growth and telecommunications has opened the eyes of billions of people to the potential for material wealth. Technology management on a finite earth, crowded with human beings and increasingly suffused with technology, becomes continually more challenging. In this final section we address two importance facets in looking at the future management of technology.

2.1 New Technology

2.1.1 The Challenge of Technological Substitution

In a world of constrained growth periodic severe resource shortages must be anticipated. In this section we discuss the role of technology in alleviating dislocations. The concept is an old one: the substitution of one resource by another through the use of technology.

a. Energy

Access to surplus energy has been the overriding means enabling human societies to expand and advance from primitive to highly sophisticated levels. Early hunting and food-gathering tribes were necessarily small and obtained their energy (food and basic materials) from animals and wild plants. These sources were often dispersed, partly mobile, seasonal, and unpredictable. The advent of agriculture resulted in a more reliable and abundant energy supply (and food surpluses) and dramatically increased the earth's carrying capacity. Correspondingly, social organizations became more complex. Industrialization was galvanized by fossil fuels, permitting a further jump in carrying capacity, creating wealth and higher levels of social system sophistication.

History not only demonstrates the central role of energy but shows a long-term pattern of substitution which provides striking insights. The logistic curve very acurately portrays the rise and fall of primary energy sources. Fig. 3 shows the U.S. and the world patterns trans-

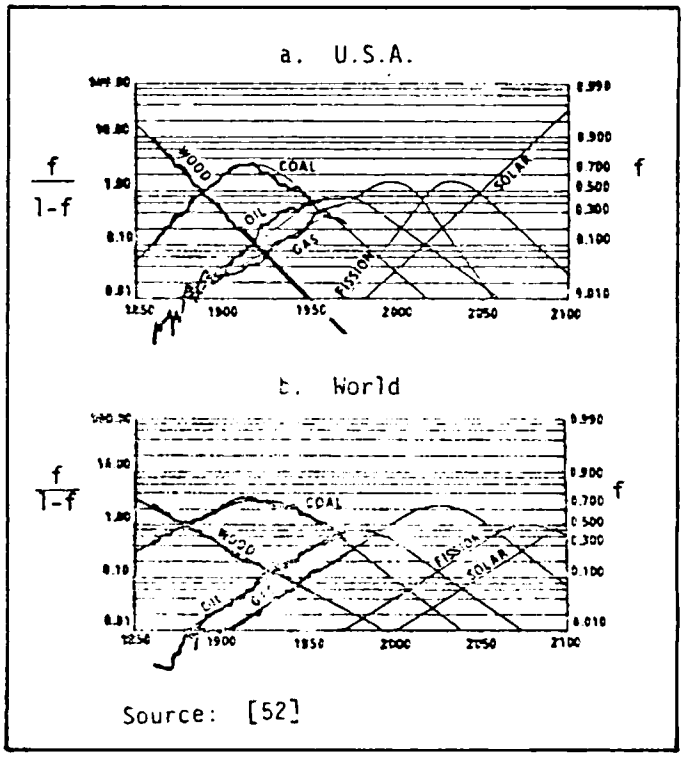

Figure 3: Energy Market Penetration History and Projection

lated into fraction f of energy consumption captured by each source.[22] The logistic structure matches the historical data from 1850 to 1970, suggesting

(1) a long lead time, 50 to 100 years, is required to move from 1% to maximum market penetration, and

(2) the pattern has a striking regularity.

There is no reason to assume that nuclear fission or solar energy will behave very differently. For example, if solar technologies were to provide 1% of world energy needs by 2000 and penetrate at a rate even somewhat faster than oil and gas, it would still require 100 years before they would supply more than 50% of the world's energy (Fig. 3).

It is clear that energy will remain a critical problem at least for the remainder of this century. There are obviously enormous policy dilemmas. Many nations' economies can be crippled if the substitution and conservation processes are not managed much more effectively. However, it will not remain a "front burner" priority indefinitely as the historical substitution process inexorably eliminates oil and gas, bringing us a solar and/or nuclear (fission breeder or fusion) era during the 21st century.

b. Materials

The primary resource crisis is the energy crisis: materials pose relatively little problem *if unlimited energy is assumed.* We draw this suprising finding from the realization that only 0.3% of the quantity and 14% of the value (excluding fossil fuels) of all non-rewardable resources are derived from resources in limited supply and that most of the uses of these limited materials are substitutable by materials in near-infinite supply (sand, stone, iron, aluminium, magnesium, etc.).[23] Of the major life-sustaining elements only phosphorus is not in near-infinite supply in the earth. But high grade resources are still available; the present resource-to-demand ratio is 500 years for world reserves.

Consider the case of mercury and suppose we had none. We could readily find substitutes for each use. The largest use (34%) is for caustic chlorine production. The diaphragm cell is an alternative that was already in wide use before mercury cells were introduced and still accounts for 70% of the U.S. production of caustic.[23] We know acceptable alternatives for all major uses except possibly high performance electric batteries. And in that case we could revert to standard miniaturized dry cells. Mercury in biocidal paints can be replaced by plastic and copper oxide paints. Further, functional substitutions are possible where a different mode of doing the task is developed.

There will be a stronger incentive to recycle. Energy use will increase as more work is required to produce substitute materials – possible 1½ to 2 times the current amount per unit of metal used.

However, while the long term prospects are good, the near term situation poses severe strains. Materials shortages loom in most nations over the next two generations. The rich, no less than the poor, will face stupendous management problems.

2.1.2 New Frontiers

Although it seems like ancient history, it was barely a decade ago that man accomplished what many consider his most glorious technological achievement – landing on the moon. Man is no longer confined to the earth and space colonization beckons us.

The other frontier is inner space. Jean Houston suggests that the human psyche is the new frontier:

> *"We use but a fraction of our capacities – perhaps 10% of our physical capacity and 5% of our mental potential . . . It is my belief, based on many kinds of evidence and 16 years of research in the field, that we can definitely give human beings the capacity to use much more of their potential than all but a few can use presently . . . Among the capacities contributing to such unblocking and unfolding are all of the sensory imageries, but also the uses of subjective time and the acceleration of thought processes, cross-sensing, self-regulation of pleasure and pain, and the establishment of voluntary control over some of the autonomic functions by means of biofeedback and autogenic training . . . To do these things . . . is to extend the frontier of inner space, which, unlike outer space, has inexhaustible resources."*

2.1.3 The Innovation Window

Economists such as Kuznets and Kondratieff have developed models to explain business cycles. Recently Mensch has found interesting relationships between technological innovations and the Kondratieff fifty year cycle model.[24] This "long wave" consists of the sequence prosperity – recession – depression-revival. Table 7 presents the scheme according to Van Duijn[25].

Mensch points out that *basic invention* occurs at a fairly steady pace while *basic innovation* experiences strong surges. For example, computers, radar, television, the atomic bomb, jet engines, and automatic automobile transmissions were basic innovations which clustered in a relatively brief time span – when the U.S. emerged from the depression and commenced its economic recovery. At such time there is a willingness to take risks and initiate major new capital investment. As the recovery continues and prosperity commences, the emphasis shifts to product improvement rather than basic innovation.

Prosperity reaches its peak and excess capacity leads to layoffs and recession. Fig. 4 illustrates this phenomenon. At the very least this model suggests the possibility of a particularly strong need for management of basic technological innovation in the 1985-1995 period.

Prosperity	Recession	Depression	Recovery
1783-1803	1815-1826	1826-1837	1837-1847
1847-1866	1866-1875	1875-1884	1884-1893
1893-1913	1921-1929	1929-1938	1938-1949
1949-1967	1967-1975		

Table 7: Kondratieff Cycles

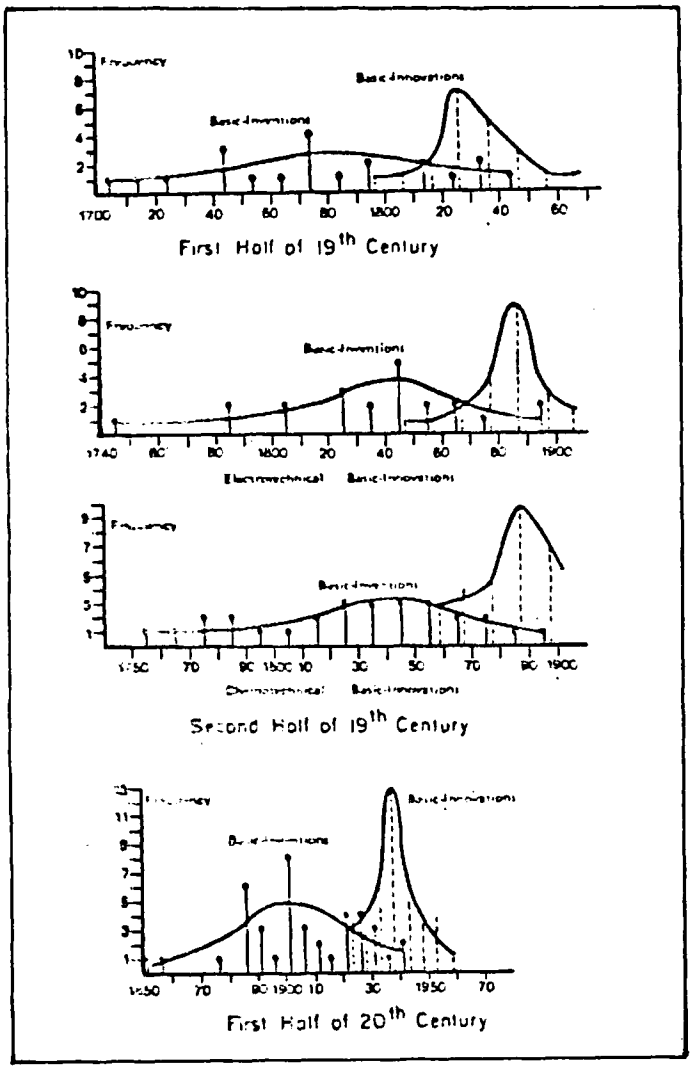

Figure 4: Frequency of Basic Inventions and Basic Innovations Corresponding to the Three Innovation Surges in the 19th and 20th Centuries
Source: Mensch[24]

2.2 Management of Technology as Ethics

Both Churchman[26] and Von Foerster[27] have raised ethical considerations relevant to the management of technology. Churchman considers any positive discount rate, as discussed in Part I of this paper[28] as "immoral". To him

> *"morality is what a future generation would ask us to do if they were here to ask us... My children are a lot more important than I am in my life and their children's children are still more important, and so on. The value of future generations keeps increasing, and becomes an amplifier rather than a diminisher."*

And Von Foerster reasons that

> *"Ethics is the conceptual machinery for computing morals. Morals are devices for managing behaviour. Ethics, therefore, is a general theory of management."*

The ethics of the old paradigm,[28] tended to see management in terms of proscriptions of constraints. The new ethic sees management in terms of imperatives such as "Act always so as to increase the number of choices."

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