SOCIAL COMPLEXITY AND TECHNOLOGICAL CHOICE: THE BAY AREA RAPID TRANSIT SYSTEM

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The growth of large metropolitan areas and public reliance on the private automobile have combined to produce what has been called a transportation "problem"—congestion due to inadequate facilities for the movement of people. In recent years, the federal and many state governments have evidenced a growing interest in funding major transportation programs. This development, in addition to recent fuel shortages, suggests that public transit will be an important policy concern for at least the remainder of this decade.

The policy choice, then, is not whether to invest in mass transportation, for this is almost a foregone conclusion. Rather, the choice is what type of transit system seems warranted and represents a sensible investment in a specific metropolitan area. Public discussions usually focus on variations of two basic technologies: buses and trains. Largely because of the discouraging performance of metropolitan bus operations since World War II, there is a resurgent interest in high-speed,

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fixed rail systems such as are now being implemented in Atlanta, San Francisco and Washington, D.C.[1]

Yet it is not clear whether the relative "failure" of bus systems can be attributed to features inherent in a bus technology or to the fact that, given a choice, most people will prefer to use private rather than public means of transportation. Assuming that gasoline supplies are available, can any package of positive inducements be arranged for public transit—whether buses or trains—that will be sufficient to lure people from the automobile? I submit that this is an open question and deserves far more serious attention than it has received.[2]

Let us assume, then, that the choice of metropolitan mass transportation investments is between buses and trains. Two factors should be considered in order to highlight more clearly the optimal choices available. First, we must understand the social context of decision-making; that is, what are the attributes of metropolitan areas, and what are the implications of those attributes for policy-making? Secondly, we must understand the role of technology in policy choice in order to determine whether investment in buses or trains really makes a difference. These variables—social complexity and technological choice—will be discussed in the context of the decision to build a rail rapid transit system in the San Francisco Bay Area.

I. Social Complexity

The social complexity of major metropolitan areas is not difficult to comprehend in the abstract. First, the number of actors and units to be accounted for is large and heterogeneous. Secondly, if we consider, as a single example, the numbers and types of governmental units, there is considerable differentiation and specialization in metropolitan areas. Finally, the degree of interdependence among these many actors

1. Leaders in approximately two dozen major metropolitan areas want to build or expand subway systems during the next decade. A reluctant national administration, through capital construction grants and operating subsidies, appears destined to assist in this effort. A powerful political lobbying effort composed of big-city mayors and suburban legislators is backing the push for transit funding. The former believe that subways will both improve mobility and reinvigorate central business districts; the latter view subways in terms of better commuting facilities, less highway construction, and a cleaner environment. *See* Lilley, *Mayors and White House Prepare for Battle over $40-Billion Subway Program*, 4 Nat'l J. 484 (1972).

2. For a summary of the results of two recent studies on this question see 76 Technology Rev., Oct.-Nov. 1973, at 66.

and units is substantial as is manifested, for instance, by the sectoral dislocations resulting from the recent fuel shortage.

What, if any, are the implications of this social complexity for the manner in which public policy issues are addressed? The complexities of social systems and our ability to understand those complexities are inversely related: the more of one, the less of the other. Public policy-making in complex social systems, then, is fraught with uncertainty, particularly in the matter of making choices. Under conditions of social complexity, the probability of making poor choices, and thus mistakes, increases sharply. Further, such mistakes may have serious consequences in terms of the social and political experiences of the affected publics.

As social complexity increases, with its resultant uncertainties, we become less able to predict future developments with accuracy. The less the certainty about the future, the greater the risks involved in decision-making. The prevalence of planning activities during the past decade can be understood as one method of attempting to cope with increased complexity and of trying to reduce the magnitude and seriousness of decision errors.

But is it possible to plan effectively for an uncertain future? If planning means understanding the relevant variables and relationships as well as the ability to control their effects, social complexity would seem to preclude the requisite knowledge and understanding. This situation presents a paradox. Since we may be unclear about the relationship between an action and its consequences, it would seem sensible to plan before acting. But if what we have said about social complexity is true, planning is also uncertain and hazardous. The dilemma arises from the need to act without complete information; and the fact that actions may have serious unanticipated and/or unintended consequences is a chilling reality for decision-makers.[3]

One way decision-makers have eased this burden of doubt is to look to "authorities." Under conditions of social complexity, experts—*i.e.*, individuals possessing "knowledge" and "information"—assume an increased importance in decision situations because they are considered

3. The significance of this argument should not be underestimated, for it flies in the face of the conventional wisdom that complexity necessitates planning. *See generally* ORGANIZED SOCIAL COMPLEXITY: CHALLENGE TO POLITICS AND POLICY (T. LaPorte ed. 1974). The relationship between complexity and planning is specifically addressed in the chapters by D. Metlay & J. Ruggie.

capable of understanding highly technical problems. We have come to believe that technical questions should be answered by technical experts, whom we tend to regard as "neutral" and "objective," and who are thought to render judgments (not opinions) on the basis of facts (not feelings).

Thus, social complexity and the rise of experts have produced a change in the character of the political arena. In folklore, if not in fact, a democracy's political process begins with citizens coming together to exercise their power to make choices about public issues. At one time, all voters actually could be assembled to discuss and make decisions about their lives in common, but today's metropolitan areas are inhabited by millions of persons. Even if it were still possible to convene citizens, it is doubtful whether they could render informed decisions in this highly complex and technological society. Instead of coming together to debate and make choices about public issues, contemporary Americans play a lesser role: either ratifying or rejecting proposals advanced in the name of "the public interest" and often formulated by technical experts chosen by political officials.

Political choices, however, are still, as always, far too important to be left to the experts, upon whose recommendations the electorate can only register either approval or disapproval. We do need expert advice, but we should use it only where appropriate (*i.e.*, in situations requiring a substantial assembly of facts and objective data). Most essential decisions, however, are based more on subjective attitudes and preferences ("values") than on facts per se. And where personal beliefs are concerned, the expert's opinion is no more valid than the layman's. In short, experts should help to provide background for policy choices, not formulate them.

Thus far, the social complexity of a metropolitan area as well as its practical and ethical implications for decision-makers has been noted. This has led to a growing concern for planning (which may be less possible than has been imagined) and a reliance on authoritative experts to assist in the pursuit of more effective planning. One consequence for the political arena may be that the citizen will be "displaced," as it were, in the decision process. With this background, it is now possible to consider the role of technology in the policy-making process, particularly as it concerns decisions about mass transportation systems.

II. Technology as a Strategic Element in Policy Choice

Technology, like expertise, is generally regarded as a neutral, apolitical instrument. Choosing among alternative technologies is thought to result from a thorough and objective analysis. In considering the choice between buses and trains, for example, we tend to focus on the respective technologies as if, in themselves, they represent better or worse solutions to the metropolitan transportation problem. This focus on technological solutions, however, often obscures other important considerations.

The essential function of a transportation system is to link points distributed in geographic space, thereby providing a means for conveying people from one place to another. As such, there is little intrinsic value in a transportation facility; rather, it is a means to an end, an instrument by which other, nontransportation purposes may be served.[4] This suggests that the choice from among a set of alternative technologies, all of which are roughly equal in their capacity to deliver a transportation service, is deliberate rather than accidental.

The choice of technology, then, is purposive and is determined in large part by executive perceptions of the problem to be solved and how best to remedy it. Confusion arises because arguments for or against particular transportation facilities are presented as if better transportation were the principal or primary objective. Yet, as we noted above, transportation is not an end in itself. Buses and trains may be presented as alternative solutions to a problem, but the problem they address may have little to do with transportation. Because of the interrelationships between transportation and land use, the issue—and the preference for one or the other technology—often has to do with the future pattern of metropolitan development.

Proposals for transportation systems can thus be understood as responses to, or methods of coping with, an uncertain future. Two basic strategies are involved, and the adoption of either strategy depends upon whether decision-makers prefer to keep future options open or closed.

The first strategy, an incremental one, is embodied in a tech-

4. M. Webber & S. Angel, The Social Context for Transport Policy (reprinted from a compilation of papers prepared for the Panel on Science and Technology, Committee on Science and Astronautics, U.S. House of Representatives, 1969). (Also available as Reprint No. 48, Institute of Urban and Regional Development, University of California, Berkeley.)

nology that is capable of adapting or adjusting to a changing future. The decision-maker who adopts this strategy seeks, above all, to hedge his bets. Lacking a commitment to a specific vision of the future, he attempts to maximize the chance of being able to respond to whatever possibilities the future may hold. Tactically, the decision-maker endeavors to avoid irreversible choices in order to minimize the risks of being wrong. The more a new technology lends itself to incremental change, the better. The more costly a decision error is perceived to be, the greater the preference for an adaptive technology.

The second strategy is comprehensive or synoptic and finds expression in a prescriptive technology. The decision-maker who adopts this strategy seeks to minimize the vagaries of an uncertain future by placing all the eggs in one technological basket, as it were. In this instance the decision-maker has a specific vision of the future and seeks, through technological choice, to realize it. As contrasted with the adaptive, adjustive technology, which can respond to a changing future, the prescriptive technology so dominates and overwhelms the future that other possibilities are almost precluded. Given a preference for an ordered future, a decision-maker will opt for an inflexible technology, one that shapes developments rather than responds to them. Whereas the incremental strategy dictates flexibility precisely because the costs of error are high, the comprehensive strategy dictates rigidity in order to make error irrelevant if it should arise.

The fundamental trade-off is the extent to which the technology can be modified. The incremental strategy-adaptive technology serves the present and is capable of responding to future requirements as long as the future does not differ drastically from the present. Because a flexible technology can, in principle, be adjusted to meet changing circumstances, the technology serves as a built-in mechanism for reducing social and political conflict, particularly in the present and probably in the future.

The comprehensive strategy-prescriptive technology, on the other hand, requires an investment of present resources so that the future pattern of metropolitan development may be shaped and, hopefully, served. The technology may thus serve as an instrument for preventing unwanted patterns of development, or at least for constraining them. Because an inflexible technology cannot respond to altered circumstances (*i.e.*, a future different from that envisioned by those who planned it), this technology has a potential for generating conflict not only in the present, but in the future as well.

Hence, the choice between alternative technologies depends upon how decision-makers regard an uncertain future. Technology, of course, is not determinative; it alone does not cause things to happen or not to happen. The immediate consequence of choosing between technologies, however, is to encourage some possibilities while discouraging others. A flexible technology (buses) can be adjusted to fit a range of possible futures; an inflexible technology (trains) cannot be so adjusted. In sum, the selection of a prescriptive technology is a fundamental gamble that the future will accommodate the technology rather than that the technology will accommodate the future.

III. The San Francisco Bay Area Rapid Transit (BART) System

In view of the current national attention being accorded mass transit systems, it seems particularly appropriate to elaborate on the impact of technology on the decision process. Having provided a theoretical framework for analysis, let us turn our attention to the decision to build a fixed-rail rapid transit system in the San Francisco Bay Area. The 792 million dollar BART bond election of November 1962 is the largest local bond issue ever approved in the United States. It amounted to thirteen times the total transit indebtedness in the state at that time, or a sum twice as large as the total of all other general obligation bond debts in the three counties comprising the rapid transit district. Although BART was, at the time of the 1962 decision, a strictly local project, the federal government will now pay 80% of the capital construction costs of future mass transit projects.[5] Furthermore, now that BART is "on stage," we have much to learn that can be applied to other proposals still "in the wings," especially with respect to fashioning our future.

A. *Early Planning Efforts*

Various proposals for rapid transit planning in the Bay Area have been aired since the turn of the century. Most of the planning activity prior to World War II focused primarily on subway systems for San Francisco's downtown business district. The voters of San Francisco evidently did not share the enthusiasm of the City's civic leaders for they voted down a subway proposal in November 1939.

During World War II, San Francisco Congressman Richard J. Welch voiced his concern about the strategic importance of traffic movement

5. Act of August 13, 1973, § 301(a), 87 Stat. 296.

to national security. This prompted the federal government to create an Army-Navy Board in 1946 to study the need for additional Bay crossings. Although the Board did not agree with Welch on the immediate need for new facilities, it did recommend a completely integrated rapid transit system with a subaqueous tube between San Francisco and Oakland. While the implications of that study were not immediately obvious, the context of the discussion on Bay Area rapid transit had undergone a shift of major importance: a local concern voiced by local elites had become a regional concern supported by national authorities.

B. *The Goal: To Preserve San Francisco's Preeminence*

San Francisco's civic leaders were convinced that if nothing were done to prevent it, their city would decay for many of the same reasons that other major American cities were decaying. Expanding networks of high-speed public roadways enabled people to move out of central cities into suburban areas. Furthermore, as low-density suburbs emerged, retail business and light industry began to leave the urban core to take advantage of new markets and lower costs. Unless these apparent shifts were arrested, prominent San Franciscans foresaw a decline in the City's status as the cultural and economic "capitol" of the West.

These civic leaders were convinced that the basic problem was the inadequate transportation facilities. During peak commuting hours, for example, traffic congestion was steadily increasing at the six principal gateways to San Francisco. If the problem of traffic congestion could be solved, one of San Francisco's major problems—the shift of consumer buying patterns away from the central city and toward the suburbs—would be solved as well.

Given the objective of preserving the status of San Francisco within the region and the understanding that one way to do this was by improving access to the city, the topographic constraints made the answer seem obvious: a system of rail transit. Since the points of entry were subject to periodic blockage, the accepted solution was a high-speed, high-capacity transportation system that could operate on its own exclusive right-of-way. But the impetus for rapid transit did not seem to arise primarily from a concern for better transportation to serve the region, but rather from a desire to rejuvenate the downtown retail business and financial districts of San Francisco.

C. *1951: A Study Commission Is Formed*

In 1949 the California Legislature authorized the various local governments in the San Francisco Bay Area to form a rapid transit district.[6] Although many civic leaders were convinced that rapid transit was necessary, the large number of local jurisdictions that were to be considered, as well as the lack of public consensus on the need for rapid transit, made the immediate formation of a rapid transit district impractical.

When it became apparent that such a district would not be created without further study, the legislation was amended, and the San Francisco Bay Area Rapid Transit Commission was established.[7] The 26-member Commission was charged with the investigation and study of rapid transit problems in the nine Bay Area counties and with the development of a coordinated rapid transit master plan.

The Commission retained the firm of Parsons, Brinckerhoff, Hall and Macdonald (PBHM) in November 1953. PBHM was a New York firm of engineering consultants whose founder was chiefly responsible for the development and construction of New York City's subway system. A broad range of studies, conducted under the aegis of the prime contractor, culminated in a coordinated rapid transit plan that was submitted to the Commission and then to the legislature in early 1956.[8] That report, *Regional Rapid Transit,* is the basic source document for rapid transit planning in the Bay Area and merits close scrutiny. What questions were asked? How were the answers formulated?

D. *The Issue Posed: Automobile Congestion vs. Regional Rapid Transit*

The Commission posed four basic questions for the consultants: (1) is an interurban rapid transit system needed for the Bay Area? (2) if so, what areas should rapid transit serve and along what routes should it be constructed? (3) what type of rapid transit facility would best meet the Bay Area's needs? and (4) is the cost justified?

The problem was defined by the consultants as automobile congestion. Stating the need for both local and interurban express transpor-

6. San Francisco Bay Area Rapid Transit Act, ch. 1239, § 4, [1949] Cal. Stats. 2173 (repealed 1957).

7. Ch. 1760 [1951] Cal. Stats. 4187.

8. PARSONS, BRINCKERHOFF, HALL & MACDONALD, REGIONAL RAPID TRANSIT: A REPORT TO THE SAN FRANCISCO BAY AREA RAPID TRANSIT COMMISSION, 1953-55 (1956).

tation, the consultants noted that although the Bay Area depended upon mass transit, transit patronage was declining. The basic alternatives facing Bay Area citizens were starkly stated as

> whether to accept the stagnation and decline of interurban transit and to prepare for drastic decentralization and repatterning of its urban centers to meet the avalanche of automobiles that will result—or whether to reinvigorate interurban transit so as to sustain the daily flow of workers, shoppers, and visitors on which the vitality of these urban centers depends.[9]

The conclusion reached by the consultants was that transit must be reinvigorated:

> We on our part are convinced that the prosperity of the entire Bay Area will depend upon the preservation and enhancement of its urban centers and subcenters. Sustaining these as concentrations of employment, commerce, and culture will depend on the reinvigoration of interurban transit.[10]

The consultants then proceeded to develop a comprehensive plan for regional rapid transit, a plan "fundamentally directed at curing traffic congestion."[11] After describing briefly some of the highlights of the comprehensive plan, the consultants observed:

> The ultimate decision on whether or not to provide rapid transit will be a matter of policy; it should rest upon the basic decision of the Bay Area citizens as to the type of region they wish it to be.
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> . . . .
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> . . . The Bay Area is still young enough for its over-all urban development to be purposefully molded into a desired pattern, according to the long-range needs and aspirations of its people. The decisions made daily by individuals, business firms, and legislative bodies will largely determine what form the urban expansion will take; and among the most critical of these decisions are those concerned with transportation services. . . .
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> . . . *It is imperative, therefore, that the design of the rapid transit portion of the transportation system be based upon a recognition of its effects on future urbanization. The plan for future regional development forms the foundation for the design of the rapid transit system.*[12]

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9. *Id.* at 1.

10. *Id.*

11. *Id.*

12. *Id.* at 2, 18 (emphasis added).

E. *The Preferred Pattern: Centralization and Nucleation*

The consultants then addressed alternative patterns of future urban organization, which, tersely stated, were centralization or decentralization of commercial activities:

> An effort can be made to encourage the development of large, nucleated, high-intensity business districts in appropriate locations. Or an alternative effort can be made to encourage the dispersion of new business establishments in much smaller districts or in scattered, isolated locations entirely outside business districts. *To a great degree, this choice is a matter of public policy.* . . . The development of nucleated centers and subcenters is possible only if these are served by a high-capacity transportation system integrating freeways and rapid transit. To depend on highways alone is inevitably to choose the alternative of dispersion.[13]

Because the consultants believed the alternative of nucleated centers (high-density, high-intensity) to be the clearly preferable choice, they did not address other alternatives.

The consultants recognized that transit planning should follow rather than precede choices on alternative regional futures. Nevertheless, they did not fully discuss various possible conceptions of regional development. In fact, they assumed the desired pattern of future development was a "given":

> The general concept of the region's future organization is that [of] a system of centers of varying levels of activity, market size, and specialization. . . . By providing high speed transit service between residential communities and the concentrated business centers, the maximum degree of choice of living place and working place is opened to the population. Only in this way can the desires of the people to live in low-density, suburban residences be economically accommodated.[14]

Finally, although the total cost of implementing the comprehensive regional rapid transit plan was to be high (1.545 billion dollars), the consultants endorsed it without qualification:

> The essence of the story is that without rapid transit the region will ultimately pay many times its cost in additional hours of travel time, in the additional cost of trucking goods over highways congested by automobiles, in diminished revenues from

13. *Id.* (emphasis added).
14. *Id.* at 20.

> property depreciated by congestion or swallowed by automobile facilities, and in the premium costs of urban freeways and parking garages. *We do not doubt that the Bay Area Citizens can afford rapid transit; we question seriously whether they can afford NOT to have it.*[15]

F. *1957: BART—To Build an Interurban Railroad*

The task of the Commission ended with the submission of its report to the legislature. In early 1957, Senator John F. McCarthy of Marin County, whose previous efforts on behalf of rapid transit led to the creation of the Commission, sponsored a Commission-drafted bill to create a rapid transit district. In June 1957, the legislature created BART.

Regional Rapid Transit (1956) provided the groundwork for the *Composite Report* (1962), the second major document guiding the development of rail rapid transit in the Bay Area.[16] Both were prepared by PBHM, and, not surprisingly, both were based upon the same assumptions. Thus, the 1962 planning report, like the 1956 feasibility study, defined the problem as existing and future automobile congestion:

> The continuing increase of highway traffic congestion threatens the future growth and well-being of the San Francisco Bay Area. The central cities of San Francisco and Oakland particularly are vulnerable.
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> . . . .
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> . . . The crux of the Bay Area's congestion problem is the growing use of automobiles and the declining use of public transit, especially during the peak travel hours.[17]

Despite the emphasis on congestion in central cities, however, BART was not intended to be an *urban* transit but rather a *regional* and interurban railroad. As its routes and the distance between stations indicate, "[t]he regional rapid transit system transports people between outlying suburban areas and the central core areas."[18] In other words, BART was primarily intended for people who had a choice between the private automobile and public transit.

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15. *Id.* at 3 (emphasis in original).

16. PARSONS, BRINCKERHOFF, TUDOR, BECHTEL *et al.*, THE COMPOSITE REPORT: BAY AREA RAPID TRANSIT, MAY 1962.

17. *Id.* at 76.

18. *Id.* at 16.

Although rapid transit was justified in terms of its ability to relieve traffic congestion, the specific benefits of BART—listed in the order they appear in the *Composite Report*—were only secondarily concerned with transportation. Those benefits were: (1) to preserve and enhance urban centers and subcenters; (2) to increase property values; (3) to help prevent urban sprawl; (4) to improve employment conditions by attracting industry; (5) to improve access to social, cultural and recreational opportunities; (6) to increase the efficiency of transportation expenditures by reducing the requirements for additional automobile-related facilities; and (7) to provide low-cost transportation.[19] This list of benefits suggests that BART was to be a tool for shaping the future growth of the region instead of a way of relieving urban traffic congestion.

IV. The Politics of Expertise

The foregoing distillation of some major ideas in the feasibility and planning studies upon which BART is based raises some disturbing questions about the politics of professionals. It appears that all the principals agreed upon the desirability of rail rapid transit before the first study of the Bay Area's transportation requirements was undertaken. It seemed only natural, then, to retain the services of a consulting firm with an established reputation in that field. This having been done, it is not surprising that a rail system was, in fact, recommended.

Our traditional understanding of professional judgments is that they are based on an impartial assessment of alternative possibilities. In the planning and feasibility studies for BART, however, no other transportation modality was evaluated. Accordingly, it appears that the role of the experts was to design, merchandise and implement a particular type of transit system rather than to discover what future pattern of regional development was desired by the citizens of the Bay Area and then to design the transit facility best suited to meet those expressed desires. According to our conventional definition of professionalism, this type of behavior is surprising. Moreover, the question of the constituencies or clients to whom professionals respond is in doubt.

The consultants were fully aware that the recommendation of a

19. *Id.* at 82-83.

transportation system was not the primary question. Indeed, they explicitly recognized that the selection of a transportation system was a technical consideration dependent upon a prior political choice, made by the public, as to the preferred patterns of regional development. Yet, by rendering a technical judgment about what *they* understood to be the most desirable pattern of development, the experts acted politically to predetermine what was in "the public interest."

Furthermore, as *transportation* experts they made a judgment about land use objectives, a field in which they had little or no claim to expertise. Thus, BART's managers and their consultants arrogated to themselves what was properly a public and political decision. By presenting only one view of one technology they effectively limited the choice to rail rapid transit or nothing, instead of providing an informational background of alternative possibilities to serve as the basis for public choice.

Unquestionably, BART was presented to the public as a remedy for transportation ills, and it seems reasonable to assume that citizens understood BART in terms of its alleged transportation benefits (*e.g.*, congestion relief). The documentary record, however, suggests that the transportation benefits were of secondary importance. The planners and promoters of BART understood their mission mainly in terms of land use and economic benefits; that is, the revitalization of downtown business districts.[20]

V. The Politics of Technology

The fact that BART planners did not seriously explore either alternative technologies or different patterns of future regional development prior to their recommendation of rail transit implies a definite political strategy.[21] Bus systems, for example, operate on public roadways that usually precede the formation of a transit district and that

20. By calling attention to the "hidden agenda" of the Bay Area's rapid transit enthusiasts, it is not meant to suggest that this phenomenon is unique to BART. Indeed, America's transportation history is replete with such examples. California's freeway system, for instance, was also sold on a partial basis. The U.S. Interstate Highway System was publicly advocated for defense purposes while actually being intended to stabilize the postwar economy, to give jobs to contractors, and to help truckers profit from long freight hauls. Thus, BART followed a well-established tradition.

21. *See* S. Zwerling, Mass Transit and the Politics of Technology ch. 2 (1974).

are amenable to a variety of uses. Moreover, bus service can be inaugurated, expanded, contracted or shifted in a short time and at a relatively low cost. Although a bus system may be highly integrated, its component parts are not highly interdependent, *i.e.*, the ability of one bus to operate is not fundamentally contingent upon the operation of other buses.[22] A bus system, because of its flexible technology, is able to react without a great deal of prior planning activity. Its capacity for incremental adjustment permits immediate action and the feedback from such action to substitute for long-range planning. Assuming that the bus company takes feedback seriously and attempts to adjust services accordingly, it is able to use action as a substitute form of planning.

BART, on the other hand, has had to acquire property prior to constructing an essentially single-purpose facility and then to engage in a long-term construction phase. This means that the "start-up" time is much longer in the case of a train system; for instance, the period from the capitalization of BART to its actual operation as a passenger-carrying facility was ten years. Not only is the time-lag between decision and operation considerable, but any subsequent alteration of the basic physical system is very expensive. Furthermore, since BART is both highly integrated and interdependent, a malfunction in one part of the system may affect the operation of the entire system. This makes redundancy a desirable feature in certain technologies,[23] as we have learned from studies of the human body and the Apollo space program. Finally, the implementation of an inflexible technology requires a considerable investment in planning prior to the actual operation of the system. For BART, then, preoperational planning constitutes a form of action.

These differences between buses and trains imply that the politics of incrementalism are different than the politics of prescription. A bus system, by making no assumptions about future regional development, is able to follow a physically decentralized, socially heteroge-

22. A bus facility epitomizes Simon's notion of a "nearly decomposable" system, *i.e.*, although the system itself is characterized by a high degree of complexity, if one part of the system fails, the effects would hardly be noticeable in terms of the system's ability to operate. The issue is not interdependence per se, but rather what the consequences are for the interdependent system should the component parts fail. *See* H. SIMON, THE SCIENCES OF THE ARTIFICIAL 84-118 (1969).

23. *See generally* Landau, *Redundancy, Rationality, and the Problem of Duplication and Overlap*, 29 PUB. AD. REV., July-Aug. 1969, at 346.

neous pattern of development. In fact, it may increase the likelihood of such development. Buses follow development rather than force it; hence, decisions about future growth remain relatively open and mutable. Finally, because of the inherent capability for adaptation and adjustment in a flexible technology, a bus system, by responding to feedback, may serve as a mechanism for reducing social conflict.

Implicit in the choice of a rail system, on the other hand, is a judgment about what constitutes a desirable future in terms of land use and development. Because a rail technology tends to force rather than to follow development, the implementation of a rail system is, in effect, an attempt to bring about a pre-vision of the future by deterring other possibilities. Since growth is intended to occur at certain preselected nucleated centers, the developmental objective, if realized, would tend toward centralization and social homogeneity. Once the rails and stations are set along a particular route, the extent to which BART, as a technological system, can respond to the transportation requirements of a different future is extremely limited. To the extent that the future is different, an inflexible technology may serve as a mechanism for generating social conflict.

To recapitulate, the choice of technology can be understood as a response to uncertainty. Decision-makers operating under conditions of social complexity may use technology as a means of either shaping the future or allowing the future to evolve. A bus system does not rely on a specific pattern of development for its success, but rather on a technology capable of adapting to developments. Because of its inherent flexibility, a bus system seems better able to cope with a future that cannot be known. On the other hand, BART is perceived to be a system of the future even though it is an inflexible technology that cannot be adjusted to a future different from the one envisioned by those who planned it. The irony is that a bus technology is strictly a system of the present while BART, in a curious sort of way, may be a system of the future on its way to becoming a system anchored in the past.

VI. Social Complexity, Conflict and Technology

Increasing social complexity suggests that an organization's external social and institutional environment becomes increasingly problematic.[24] If survival can be posited as a minimum objective for

24. *See generally* J. Thompson, Organizations in Action (1967).

an organization, this implies a degree of adaptation and responsiveness to the social milieu of which the organization is a part. Furthermore, it seems reasonable to assume that the greater the social complexity, the greater the potential for social conflict. Since organizational leaders probably prefer not to generate conflict, it is possible to consider the implications of technological choice for creating or reducing social conflict.[25]

The relationship between technological choice and social conflict can be understood as a function of expectations versus outcomes, costs, types of facilities, scales of construction, and lengths of installation periods. In general, the greater the potential of a proposed project for disrupting existing community life, the greater the expected resistance to, and conflict associated with, the implementation of the project.

Bus systems are based upon a well-understood and conventional technology. Because buses are neither new nor exciting, people know basically what to expect from them. Even the well-managed bus systems receive little publicity. A decision to opt for bus transit involves a relatively low capital investment cost. Furthermore, since buses usually operate on nonexclusive facilities (public roadways), virtually no construction activity is required. Therefore, the time-lag between the decision to implement and the actual operation is relatively short. Along with these inherent advantages, bus systems accrue an additional benefit due to their capacity for adaptation. Since bus drivers are in continuous interaction with the organization's service environment, management is in a position to receive almost instantaneous feedback. To the extent that the organization receives and responds to feedback from those it serves, technology may be used as a means of reducing social conflict.

On the basis of technologically innovative considerations alone, an advanced rail system such as BART can be expected to engender more social conflict than would a bus system. Hailed as a technological breakthrough, BART generated great expectations of future benefits. Promoted as the "solution" to problems of congestion and mobility in the Bay Area, BART has attracted considerable national attention.

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25. This is not to assert that technological choice, in and of itself, is responsible for the presence or absence of conflict. Assuming a conflict exists, however, does a particular technology tend to exacerbate or ameliorate the conflict?

The greater the gap between expected and actual performance, the greater the potential for conflict.

Rail technologies are also different from bus technologies in terms of their requirements. The initial capital cost is high because trains operate on single-purpose rather than multi-purpose facilities; therefore, considerable construction activity is required. It follows that there is a relatively longer time-lag involved in the implementation of a rail system. Finally, since a rail technology is inflexible, its managers are limited in the extent to which they can respond to negative feedback. In short, we can expect train systems to engender more social conflict than bus systems.

Unfortunately, the management of BART has experienced considerable conflict with many elements in its external social and institutional environment, thereby confirming predictions in this regard. Prior to the initiation of revenue service operations in September 1972, the organization had weathered a variety of storms. Among them were conflicts with several Bay Area cities and counties over the overall plan and proposed facilities, with California's legislature over financing, with labor unions over employment practices, and with the general public over various other issues.[26]

Criticism of BART has not abated since the beginning of passenger service.[27] For example, teenagers quickly discovered how to produce their own transit "tickets," thereby duping the sophisticated equipment produced by IBM. Despite the substandard quality of the transit cars provided by the Rohr Corporation, BART's managers, after perfunctory complaints, awarded that firm an additional contract. Safety and signalling equipment produced by Westinghouse has been challenged as less adequate than that of conventional railroads, but BART executives have resisted the pressure to change suppliers. A labor strike that lasted for approximately one month shut down transit operations entirely.

Although the outcome is more symbolic than substantive, BART's managers were encouraged to end their formal association with the

26. Several of the earlier conflicts are elaborated in ZWERLING, *supra* note 21, at chs. 2-3.

27. A recent report prepared by California's legislative analyst questioned the administrative and technical competence of BART's management, directors, engineers and engineering consultants. *See generally* A. POST, INVESTIGATION OF THE OPERATIONS OF THE BAY AREA RAPID TRANSIT DISTRICT WITH PARTICULAR REFERENCE TO SAFETY AND CONTRACT ADMINISTRATION (1972).

engineering consulting firm of Parsons, Brinckerhoff, Tudor & Bechtel. In addition, by running afoul of the state legislature and the Public Utilities Commission, the BART system is still not fully operational and will not be until at least September 1974, six years behind schedule. Despite its restricted service schedule (weekdays only), BART managers conceded early this year that the cost of providing service is already higher than had been expected to operate trains seven days and nights a week throughout the three-county system. Moreover, they publicly announced that without state or federal aid, BART faced the prospect of closing down by early 1975. It appears that conflict is endemic to BART.[28]

VII. Some Lessons from BART

The BART experience is generally instructive about the relationships among complexity, planning, technology and politics. In terms of planning, it seems to me that the studies upon which the BART system was based lacked both substance and penetration. Having accepted their clients' definition and diagnosis of "the problem," the consultants created a huge analytic apparatus to justify the conclusions that their clients had already reached, *i.e.*, that an interurban rail system should be built. Admittedly, *within the boundaries of the task as defined,* the consultants' work was creditable; yet unless one accepts such a narrow perspective as exemplary of professional responsibility, the boundaries were not valid. The major effects of the BART system will be external; it will shape the future of the region. Yet there was little analysis of these consequences. Instead, the BART proposal was presented to citizens as a tool for relieving automobile congestion while the principal instigators viewed BART as a tool for shaping land-use development in the Bay Area for the economic gain of downtown business interests.[29]

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28. While the BART managers may be criticized for their inability to manage conflict or to learn from it, there is a more important lesson to be extracted. It seems quite likely that, if the public chooses a prescriptive technological solution, those who are responsible for implementing that choice cannot afford to engage in public debate about how that decision is to be executed. That is, it can be argued that in order to implement the technology at all, the technological core must be carefully buffered from all unnecessary uncertainties. While this may not be an obvious consequence of selecting a prescriptive technology, its implications should be understood by both public officials and voters.

29. In a presentation to the Bay Area Chapter of the American Society for Public Administration on March 8, 1972, BART's Assistant General Manager, L.A.

If this interpretation seems plausible, then technology can be understood as an independent variable in political decision-making. The significance of the distinction between adaptive and prescriptive technologies is that, while the technologies themselves are value-neutral, the ends toward which they are directed are value-laden. As such, the comparison between buses and trains is based not so much on their relative effectiveness as transportation systems, but rather on their relative capacities for shaping the future. Rapid transit planners may have believed they were *forecasting* the future transportation requirements of the Bay Area for the next thirty years and then recommending the best way to meet them. In fact, they were *legislating* an image of the future that *they* assumed to be desirable; a future with nucleated centers and subcenters. These planners imagined themselves to be predicting a Bay Area to be served by BART, but BART is likely to create the very Bay Area they thought they were predicting. The planners and promoters of BART, then, were in the business of *enforcing* a particular future as much as serving the future. By so doing they preempted the public interest.

VIII. The Transportation Problem Reconsidered

For various reasons, Americans have failed to understand that the primary issue is not so much how to solve problems, but rather how to choose the fundamental problems we wish to solve.[30] With respect to public transit service, for example, we know how to supply transportation facilities; the expertise and technical capability are available. The difficulty is that we are not involved in the debate about what should be done. Deciding what should be done is a political matter; once this has been determined, the issue becomes how to accomplish the specific objectives, and that is a technical matter. Yet the BART experience constitutes an example of the contrary—political decision-making in technological clothing.

Furthermore, with respect to providing transportation facilities, the human dynamics of a large metropolitan area suggest that the problem

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Kimball, stated that the primary purpose of rapid transit was indeed to shape the future growth and development of the Bay Area. During a subsequent question-and-answer period I asked Mr. Kimball whether this was the basis upon which BART was presented to the public. He declined to respond to the question.

30. Drucker, *What We Can Learn from Japanese Management*, 48 Harv. Bus. Rev., Mar.-Apr. 1971, at 110.

of service is a continually changing one. In a very real sense, then, the transportation "problem" is not really a problem at all; no matter how much *know-how* we may acquire about providing transit systems, we lack the *know-what* regarding future service requirements. Consequently, the problem is not amenable to any final solution; rather, the demand for service is an evolving problem to be dealt with —democratically, if possible, given our political norms and heritage.

Implicit in this understanding is the notion that there is no single definition of what constitutes good public transit service, although most people probably have some idea of what might be better (or worse) service than they are currently receiving.[31] Not only does the definition of good service differ from person to person, but these individual definitions themselves change over time.[32] Viewed in this perspective, a transportation system that cannot adapt itself to changing demands for service would seem singularly inappropriate.

Social planners bear a heavy burden of responsibility to ensure that affected citizens are well informed about the broader social, political and economic ramifications of plans put forth for public ratification. The promoters of rapid transit in the Bay Area presented their proposal in such a circumscribed manner as to suggest that there were no such ramifications. While the voting public was persuaded that it was being given the opportunity to improve public transportation in the Bay Area, it was not also educated to the fact that, in addition, it was being asked to approve a particular pattern of development for the region. Narrow technical considerations appropriate to engineering decisions are not a sufficient basis for the significant political decision that BART really represented.

The development of technologies is a legitimate enterprise in our culture. Technocracy—or rule by technology—is not legitimate since it is inherently corrosive of the democratic process. BART is a product not only of technology, but of technocracy. It is now clear that BART's technocrats have implemented their political decision with greater competence than their engineering designs. The question is,

31. Homburger, *Fixed Facilities and Shifting Values,* 4 HIGH SPEED GROUND TRANSP. J., Jan. 1970, at 9.

32. Congestion and mobility, as twin facets of movement within metropolitan areas, do not necessarily require investing in new types of technologies. *See, e.g.,* Kain, *How to Improve Urban Transportation at Practically No Cost,* 20 PUB. POLICY, Summer 1972, at 335.

however, not whether the task of building BART was done in a technically competent manner; the point is that the prior task of deciding to build BART was done in a politically irresponsible manner and the subsequent implementation of that decision was removed from political influence.

IX. Toward the Future: Technology and Political Decision-Making

Having described and analyzed the decision process that led to BART, it would seem appropriate to conclude the essay at this point. I feel obliged, however, to address the question of whether and in what manner the process might have been different. What follows are some thoughts—both negative and positive—regarding the role of technology and political decision-making in the future.

Two separate, but related, themes have been discussed. The substantive theme was whether, under conditions of increasing social complexity, it makes sense to commit ourselves to technologies, such as BART, that are neither adaptable nor adjustable to a changing future. My belief is that it does not. Future possibilities and opportunities are simply beyond our comprehension. If we can agree that decisions ought to be made with a view toward expanding the range of diversity and choice available, it seems more sensible to make decisions on the basis of negative criteria. That is, while we may not be able to know precisely what our *substantive* preferences for the future are, we should be careful to assure ourselves the opportunity of making such choices. This suggests that irreversible choices are to be avoided.

The procedural theme ignored the substantive merits of a technological system such as BART and emphasized instead the process by which decisions were made. Democratic decision-making cannot be evaluated in terms of the wisdom of substantive choices. Rather, it is to be assessed in terms of the extent to which the process of choosing is open and public (rather than closed and private) and the extent to which the knowledge serving as the basis of choice is complete and fully disclosed.

Despite a tendency to blend the substantive with the procedural issue, the two are distinct. The substantive argument is that the experts have done well by persuading the public to accept large technological projects "in time" to avoid future problems. Even at the expense of political deception, the outcome is salutary. In view of the

recent fuel shortages, this argument is appealing, for despite cost overruns, project delays and system malfunctions, the public will benefit from BART. Perhaps this is so, but those agreeing with this perspective must also acknowledge that—in this case, at least—the end justified the means.

In my opinion, it matters not whether BART is the "right" decision; what matters is the process by which the decision was made. My preference for a flexible technology notwithstanding, I could not quarrel with a decision process that adhered to the aforementioned, admittedly idealistic, stipulations. My bias, then, is a procedural one.

If democratic values are worth preserving—as I think they are—what is required to safeguard political liberty is a process of technology assessment in the public interest. A functional equivalent of the environmental impact statements required by the National Environmental Policy Act of 1969[33] would suffice. The public should receive similar protection—a socio-political impact analysis—with respect to any proposal for investing in large-scale, complex technologies.

The purpose of a socio-political impact statement would be to explore and report the probable consequences of the proposed investment. It would help voters to understand the social and political values that would be served by the proposed investment, and those that would not be served. It would not be a statement for or against any particular technology. Instead it would be a report to the public about important indirect consequences of proposed investments in a technology.

The proposed socio-political impact analysis is neither a panacea nor a surrogate for involved citizen participation in public affairs.[34] As the BART experience has shown, however, technology can be used to legislate the future without full public consideration and/or disclosure of the consequences of that "legislative" act. If we regard this as undesirable, and if we wish to guard against this eventuality,

33. 42 U.S.C. § 4321 *et seq.* (1970).

34. A recent article suggests that simply requiring an assessment of consequences is not enough, at least not where the Federal Highway Administration is concerned. In an effort to learn more about the implementation of the National Environmental Policy Act, 76 final-draft impact statements required for proposed urban highway projects were analyzed. Sullivan & Montgomery, *Surveying Highway Impact*, 14 ENVIRONMENT, Nov. 1972, at 12. The carefully documented findings are not encouraging: "The impact statements surveyed contain arguments rather than findings, opinions rather than studies, and generalities rather than facts." *Id.* at 15.

careful analysis and public review of probable effects of proposed actions are essential. Although we presently lack adequate processes for exploring the policy implications of technology and technological change, the concept of socio-political impact studies, prepared in the public interest, may be a step in the right direction.

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