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Redundancy in Public Transit

Vol. I:
On the Idea of an
Integrated Transit System

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vacuum behind; and civic leaders, like Nature herself, abhorred that prospect. And so it was that American governments went into the transit business.

It is not self-evident why civic leaders were so quick to socialize the industry. In part they were concerned about persons who would have no alternative means of transport if bus lines and other transit services were to close down. Few people expected that average household incomes would ever permit widespread auto ownership; indeed, it wasn't until the end of the Korean War that the trend to nearly universal car ownership became self-evident. But even then, children, old persons, and other carless persons would be stranded, and so something of a crisis in social equity might ensue. Moreover, it has been widely understood, if only intuitively, that easy accessibility is an integral attribute of a high living-standard. Businessmen have always understood that access to their shops and factories is essential to the success of their businesses. And motorists, discomforted by traffic congestion, were wary lest decline of public transit services would lead to increased competition for space on local streets and highways. Besides, in a more generalized sense, it was vaguely understood that the civic life of the metropolitan area depended upon continued free mobility.

In Volume IV of this report, Seymour Adler traces the history of Bay Area transportation policy as it evolved in the post-war years. He portrays a lively rivalry among the various districts of the metropolitan region, each seeking to gain advantage over its neighbor. Competition for

improved accessibility became as spirited among the Bay Area's consortia of municipal governments and civic leaders as it had previously been in the traditional contest for factories and other tax sources. In some degree transport was seen as an instrument for maintaining and enhancing the economic foundations of each municipality or district within the metropolitan area. But it was apparently far more. It became in itself a symbol of civic betterment--of civic attainment--and a source of civic pride.

In part, as Adler's report documents it, the Alameda-Contra Costa Transit District (AC Transit) was initially perceived as a necessary means of filling the gap left by the departure of National City Lines. The State Legislature gave its blessing to the East Bay's bid for a new and independent governmental agency at just about the time discussions were underway for a regional transportation organization of some kind and at just about the time the rail-transit organization was being designed. Under the crisis circumstances attached to the demise of Key System (National City's rail and bus lines) something had to be done. And so AC Transit was created, seen by many as a stop-gap move until some larger, more integrative, regionwide establishment could be created.

But it was also seen by East Bay leaders as their own medium for fostering development of the East Bay. The East Bay-West Bay rivalry has old and deep roots. AC was but one manifestation of efforts by Oakland and neighboring groups to proclaim their independence of San Francisco and to attract business and industry to their own turf. Oakland's new entrepreneurial spirit was manifested in the same era in a series of comparably dramatic moves: they built a large colosseum and auditorium and attracted major-league baseball and football teams to go with them; they

INTRODUCTION AND SUMMARY

The San Francisco Bay Area may be most generously endowed with public transport services of any metropolitan area anywhere. It has cable cars, trolley cars, and subway cars, both modern-light and modern-heavy rail. It has traditional local buses, luxury express buses, and specialized subscription buses. Besides all this there are governmentally sponsored car and van pools; there are taxis and a rare but viable jitney service; and there are high-speed ferries, an old-fashioned suburban railroad, and soon even a local helicopter. That smorgasbord is offered by some thirty-five organizations, not counting the numerous taxi, jitney, and specialized van and bus operators. All but four of those outfits are now governmental agencies, most of them operating autonomously, almost as though they were private firms openly competing with each other in an unregulated market.

Thirty-five separate public organizations serving the same metropolitan area may sound like a lot. (By comparison, there are at least 117 comparable transportation agencies throughout California, and that too does not count the numerous taxi and other private paratransit operators.) And to further compound the picture, those thirty-five transit agencies operate in a metropolitan setting comprising 1,063 of the 4,971 separate governments in California.

None of this happened by design. No one ever intended that there should be so many transit operators in the Bay Area. Surely no one ever

intended that they should openly compete with each other, as AC Transit and BART clearly do on their transbay routes. Instead, most of these agencies were created in response to local crises or when predecessor private operators threatened bankruptcy or when local civic leaders sensed that the quality of access was dangerously deficient and sought some plausible remedy.

The transit industry in the Bay Area evolved in just about the same happenchance way it developed everywhere else. The early streetcar and ferry operators were private entrepreneurs who saw transit as a business opportunity, whether as adjunct to real-estate development or as straight common carrier. In typical fashion, each town, each district had its own locally franchised operator who offered his services in direct competition with others, some running in parallel on the same streets. In time some rivals lost out, then sold out to the competition, as the rough-and-tumble of the market place determined which would survive and which would die. The successful ones gradually upgraded their service, shifting from primitive to improved technology that offered greater reliability, comfort, safety, and efficiency. Over time, too, all of them confronted massive competition from automobiles, especially after World War II when California auto-ownership ratios exploded to surpass all others by huge margins.

Although the degree of competition with autos here was greater than in eastern metropolitan areas, the effect was essentially the same everywhere in the country. Private transit operators one after the other were driven into the red. Some nationwide operators, National City Lines most notably, found themselves in the straits of buggy-whip makers before them, drummed out of the industry by the popular new motor cars. They would leave a

built an international airport, one of the world's first and largest container ports, and simultaneously undertook major slum clearance, redevelopment, and downtown-reconstruction programs, while launching one of the nation's first anti-poverty campaigns. In the mid-fifties and early sixties, Oakland and the East Bay boosters were on the make, staking out their claims for Bay Area leadership and openly competing against the traditional hegemony of San Francisco. In some instances, most notably in the Oakland container port developments, they were dramatically successful; there they effectively took the business away from San Francisco to become the dominant port in Northern California.

They were also remarkably successful in the transit business. Once AC had gotten its charter and had gotten a claim on property tax revenues, it was able to attain a degree of fiscal and managerial vitality that was rare in local transit and far exceeded the styles of stodgy old Key System. Under imaginative and spirited management, it quickly acquired new equipment, established new lines, and in short order turned a decrepit transit system into a spit-and-polish operation. It was one of the first in the country to reverse the downward trend in transit riding, and it did so long before federal subsidies had changed the fiscal climate for urban transit in America.

It seems, in retrospect, that AC managed to be created and then to thrive as an independent operator as a consequence of a fortuitous sequence of historical accidents. Key System was brought down just when the big debates were underway on the appropriate governmental organization for Bay Area transportation. Despite strong sentiment for a regionwide unitary agency of some kind, no resolution was in sight; and so a short-run

solution seemed expedient. Opposition from otherwise influential West Bay voices was blunted, because the BART bond election was then in the offing. No one dared risk alienating East Bay transit leaders lest they turn cool to BART, for without enthusiastic East Bay support, all hope for BART would have been lost. Besides, all this was happening just when Oakland and her neighbors were being most entrepreneurial and successful, just when they seemed to be shedding their habitual inferiority complex and flexing their political muscles. Had Key's departure been delayed a few years--say, until BART had become a viable agency--a powerful argument would have been made in Sacramento to place the related services into a single, regional agency; and that argument would likely have prevailed. Bay Area leaders have long-standing and firm ideological leanings to regionalism, and they probably share the widespread belief that efficiency is best found through controls exercised by central management.

Much of the case for unification had indeed been made at the time AC Transit's charter was being formulated in the State Legislature. A leading proponent, Robert Nisbet, had testified that he saw AC's role as integral with larger regional transit operations, and he anticipated AC becoming a feeder system to BART when the rapid rail system later became operational. In effect, he was suggesting, it would be possible to create a unified regional system, even if AC and BART were to be structured as separate special districts. Besides, BART had its mission cut out for it in the decade ahead, for it was about to confront the monumental task of building a 71-mile system de novo. Neither BART promoters nor anyone else was eager to burden it with running a bus system at the same time.

And so it was that AC was initially to operate buses along the East

Bay and between the East Bay and San Francisco, providing bus service where
the old Key System buses and electric suburban railroad had previously
operated. Many people expected that, later on, AC express service to San
Francisco and to downtown Oakland would become unnecessary--that AC would
then retreat, becoming a feeder-line to BART and providing only local ser-
vice within the East Bay. That must have seemed a highly rational and
efficient plan to legislators and others. But, as things happened, it
didn't work out that way.

BART was confronted with construction, equipment, and financial diffi-
culties that delayed its transbay opening until Fall, 1974, some five-to-
six years after its originally planned inauguration. By that time AC was
well established. It had a refurbished terminal building in San Francisco
and a firmly habituated clientele. It was also well-established as a suc-
cessful and admired East Bay institution with loyal and influential sup-
porters within political and business leadership circles. And besides,
even after it opened, BART was so beleaguered by equipment failures that it
was not able to carry the full load of transbay passengers anyway. BART
management was probably just as happy to leave things as they were. Had
its equipment worked as expected and had the system proved able to provide
reliable service, BART's management might have made a move long ago toward
forcing AC to eliminate transbay bus service or to effect an organizational
merger. As things have worked out, however, AC and BART have maintained
their independence and have dealt with each other as peers--as autonomous
governmental agencies directly competing for the same passengers, the same
revenues, the same subsidies, the same political support.

They run along parallel routes in both the East Bay and across the

Bay. AC operates express buses from several East Bay locations across the Bay Bridge to the bus terminal in downtown San Francisco. BART's lines merge into the transbay tube and then thread under Market Street in the center of the San Francisco business district. Where their routes are roughly parallel, their running times and fares are approximately the same. Their equipment differs, of course, but except for differences in operational reliability, they closely approximate each other in service characteristics and standards. When BART's equipment is finally fixed to match design standards, they will be even closer akin in service qualities. What then should be the organizational relations between AC and BART? Ought they then to be organizationally merged, or should the parallel bus lines be eliminated in some other way?

The present structure of two independent public agencies offering directly duplicative services flies directly in the face of long-standing doctrine. Legislators, congressmen, and professors of public administration have long condemned duplication in government as wasteful. Their conditioned response is clear when they discover that two governmental organizations are doing pretty much the same thing. One or the other must stop what it is doing, or the two organizations must be merged, effectively placed under central management which will prohibit the wastefulness and inefficiency.

In Volume III of this report Jonathan Bendor compares the experiences of the Bay Area transit agencies with those of Washington, D.C. The contrast is sharp. Washington's transit history had somewhat resembled those

of other American metropolitan areas; like the others it had gone through the era of private bus operators, followed by a govermental heir that sought to establish high service standards. It departed from national norms when it built a modern rail transit system just about when the Bay Area did, but Washington's strategy differed markedly from the Bay Area's. With more lead time and somewhat different timing, Washington's old bus systems and its new rail rapid transit system were assigned to the same agency. In the interests of efficiency and in accord with standing doctrine, bus and rail services were to be integrated into a unified transit system that would provide coordinated service efficiently. Buses would serve as feeders to trains. Parallel, and hence wasteful, routes would be eliminated. Thus, together they would function smoothly, passengers flowing easily from one to the other in quite the way materials flow through a factory that enjoys central management and central control.

Bendor's interviews with WMATA officials reveal a rather different outcome, however. It seems that METRORAIL dominates WMATA, which was created for the specific task of building and then operating the new rapid-rail system. From the start top management was primarily oriented to making the rail system work well. METRORAIL was the newsworthy system, the one that had everyone's attention and held the greatest interest to riders and public officials alike. Like BART, it represented a bold new innovation in public transit in America. By contrast, the buses were old fashioned, dull, prosaic, low status, and passe. Management hired some bus men, then pretty much ignored them, so they had few resources, could command little attention in the front office, and, unlike AC, never enjoyed the autonomy that would have permitted them to rebuild the bus division into a polished operation. They were told to eliminate lines that might

compete with METRORAIL, to install new feeder lines, and to make do with whatever they had in hand. Interviewees reported that the bus was neglected after METRORAIL became operational, and, as a result of cutbacks, the bus system deteriorated from even its prior low stature.

At the same time the quality of AC's bus service, under otherwise similar circumstances, was being vastly improved. AC folk appear to be devoted to bus service. They have by now built a proud and effective cadre of drivers, maintenance workers, and central management that in turn has created one of the most effective and efficient bus operations in the country. The extensive interviews that Bendor and Donald Chisholm have conducted with AC personnel persistently reveal an organization with high morale, devotion to service, and confidence in their capacity to do their individual and collective jobs superbly.

All very well for AC. But what about the public that supports that duplicative service? Is it not a waste of public resources when BART could serve many AC passengers, thus saving the costs of providing parallel and essentially equal service?

In the pages that follow here, we examine that proposition in detail. Our conclusions in turn are emphatic--that the present arrangement is by far the best of the various alternative organizational structures that have been suggested. AC and BART provide back-up service for each other such that each is able to serve the other's passengers when labor disputes or equipment failures compel service reduction or shutdown. That kind of fail-safe redundancy has already saved Bay Area transit service several

times in the years since BART began operating, and it will undoubtedly continue to do so in future years, long after BART's equipment has been put to right and its reliability has been established.

Our investigations reveal a remarkable degree of coordination between the two operating agencies, most of it informal and none of it centrally planned. The kinds of cooperation and the depths of their efforts to coordinate their services is all the more remarkable for the fact that there are virtually no line-authorities compelling it. Dispatchers at AC and at BART maintain cordial and informal relations, such that they help each other whenever trouble arises. Maintenance people are mutually helpful. Information gets transferred easily; interorganizational operating problems are handled with dispatch; communication is frequent; and cooperative action is fostered. Without any central managerial controls, without unitary command, without formal coordination machinery, BART and AC are at least as well coordinated as WMATA's buses and trains.

The overall effect of redundancy in the Bay Area transit system is far greater reliability in the over-all system than would be probable under unitary control. Through several strikes, a devastating fire in the tube, and frequent train failures, back-up service has been maintained. The effect of redundancy in the Bay Area transit system is stable transit service.

Simultaneously, despite high-quality train service, AC continues to carry large volumes of passengers on its transbay lines that are directly competitive with the tube-rail service. However similar the service qualities, about equal numbers of transbay peak passengers are still choosing train and bus, suggesting that passengers' perceptions of service qualities

must differ and that equal numbers of peak-hour passengers prefer the bus to the train. If the two governmental districts were to be merged, such that they maintained a single set of accounts, there is little doubt that transbay bus lines would be quick to go. With huge capital investment sunk in the tube and with potential excess capacity there, seemingly rational central managers would undoubtedly try to cut their operating costs by pushing as many passengers to the transbay rail line as they could. Their first impulse would likely be to reduce costs by eliminating all redundancy, i.e., by eliminating the bus. That was the tendency in Washington. It might also be the response in the Bay Area.

The initial effect would be to deprive many transbay transit peak-hour patrons of their preferred mode. A secondary effect would be to expand available road space on the bridge for autos and thus to encourage some bus riders to become auto users. A telling effect would be reduced reliability of transbay transit service, for loss of redundancy in the system would be equivalent to loss of the fail-safe back-up.

Our inquiries have led us to the unambiguous conclusion that, however accidental the origins, the Bay Area did it right. Parallel and competitive organizations have provided the Bay Area with higher quality and more reliable transit service than it might otherwise have enjoyed. If it hadn't happened through historical accident, this kind of multiorganizational system should have been invented. If it had happened by design, it would have been an act of genius.

But aren't the costs of maintaining and operating two systems inordi-
nately high? Couldn't economies be realized in this, a declining-cost
industry that promises increasing returns to scale? Isn't it an untoward
luxury for the Bay Area to be carrying redundant and parallel transit sys-
tems, especially on the transbay route? The intuitive answers to all those
questions are all yes.

In Volume II of this report, Philip Viton presents his simulation
model of the BART-AC system and his startling findings. Drawing on the
large amount of work completed in recent years by University of California
transport economists, Viton has simulated the as-if conditions of competi-
tion between BART and AC. The demand side of the model is based on our
knowledge of Bay Area travelers' modal preferences and their travel pat-
terns in time and space, all derived from numerous traveler surveys and
from operators' records. The supply side is based on studies of BART's and
AC's actual operating costs. When the models are placed in conjunction, a
striking and surprising picture emerges. Viton concludes that, if both
BART and AC were to operate as though they were profit maximizers, each
seeking to increase its revenues and to reduce its costs, they would deli-
berately offer a variety of different services. By differentiating the
qualities and prices of transit service, each would attract more riders
than it presently serves--some passengers buying low-quality services at
low prices, others choosing luxury services at high prices. Because they
would then be meeting the travel preferences of many who now use automo-
biles, transit riding would rise dramatically. The overall effect, he con-
cludes, is that both BART and AC could then operate in the black--that the
subsidies they now require could be eliminated.

The key to that seeming magic is more and more-effective competition
than they now practice. The ideologic paradox that insists upon competi-
tion in the private sector and monopoly in the public sector appears to
have been misleading. Congress and the courts have long insisted that,
wherever technologically possible, nongovernmental single suppliers of
goods or services be broken up into competing organizations. The conse-
quences of litigation under the Clayton and Sherman acts in such industries
as oil and aluminum demonstrates the effectiveness of that policy. But on
the public-sector side, we have followed an opposite doctrine.

Viton's simulation of the Bay Area transit industry suggests that pub-
lic policy should be requiring these two governmental agencies to compete
as forcefully as if they were private firms instead. The benefits would
redound to the communities of travelers who would then be better served.
They would redound, too, to the larger communities of taxpayers who would
be relieved of the burden of subsidizing transit riders. It seems clear
that middle- and upper-income travelers are prepared to pay higher fares
for present or superior service, and there is thus no clear justification
for a public subsidy to them. Lower-income travelers would probably accept
slower, more circuitous, or less comfortable service at lower fares. In
net, if Viton is right and if presently standardized transit services were
to be differentiated and fitted to wants and abilities to pay, there would
be more transit riders. In turn, the promised economies of scale would be
realized by profit-making transit operators, albeit publicly owned.

Are we likely to follow that route? Probably not. The Metropolitan

Transportation Commission is now emerging as a major force in the Bay Area transit scene. Although it is not clear to us what roles the commissioners and their officers foresee, there is no doubt that they look toward much greater involvement in the future. Some have speculated that MTC might become the parent of BART, AC, and the dozens of other publicly owned transit operators in the region. That model would convert MTC into the unified transport agency long craved by many Bay Area regionalists. Were that to happen, the initial impulses might parallel those in Washington. Alternatively, MTC might become a regulatory commission, similar to those that oversee electric-power companies or those that control rates, routes, and schedules in railroading and broadcasting. Whether as proprietor or as regulator, the intuitive response might parallel MWATA's: to save operating costs, they might choose to cut out the transbay bus service.

Our review of past, present, and potential relations between AC and BART indicate that would be a serious mistake. Rather than more regulation, rather than cut-backs, rather than more monopoly, the policy instead should be to encourage each operator to do what it does best, to differentiate its product and its fare schedule, and to expand its patronage however it can.

The region is fortunate to have so many government companies offering similar services, for customers are assured more reliable service, they enjoy a wider variety of service types and qualities, and they enjoy the opportunity of choosing for themselves from among the array of service modes on the market. Despite the public-spirited service-orientation of both BART's and AC's staffs, it is likely that the quality of service each offers is enhanced by the competition for riders that maintains the lively

rivalry between them. It would be a pity on all those counts if the competition were to be reduced or eliminated.

New York City recently permitted private bus lines to operate alongside its publicly dominated system, and those private lines are turning in handsome profits to their owners. By happenchance, the Bay Area has some of those same redundancies in its transit system; the big difference is that all parts of ours are losing money. Let them operate more like profit-seeking competitive business firms, we believe, and they too can get out of the red and perform their public-service responsibilities more effectively.

MULTIORGANIZATIONAL COORDINATION IN THE BAY AREA TRANSIT SYSTEM

About twenty-five years ago, Wingo and Perloff noted that "what is normally called 'the transportation system' simply has evolved from the unsystematic accumulation of public projects and policies." In their view, this piecemeal evolution, while it appeared to possess some self-corrective properties, failed to attend "to critical inter-connections between parts of the system and between the system and the basic processes of the city. It may cope with specific problems as they arise, but in the end conse- quences for the total fabric of urban life are haphazard, capricious, and upredictable."[1]

Twenty-five years later, David Jones, substituting the Bay Area for the city, tells us, "that transportation development has occurred in a policy-making vacuum filled by the project-by-project ad hocery [sic] of competing technologies. . . . Even BART, the region's multi-billion

investment in rapid transit, was conceived, planned, and built as a pro-
ject, and not as a service component of a larger system."[2] Jones observes
that project-by-project development has produced an extensive but ill-
coordinated network of services and facilities, that the region's transit
networks (and highway routes) display significant gaps where controversies
have stalled development and where competing interests of independent jur-
isdictions frustrate coordination and connectivity, and that the "jealous
rivalry" of these jurisdictions has produced a diffusion of transportation
responsibilities to the point where "the Bay Area is an extreme case of
jurisdictional fragmentation."[3]

The problem seems to be quite clear: there are too many autonomous
transit actors in the region. In fact, there are many. There are BART and
AC Transit, SamTrans, Santa Clara, Muni, Golden Gate; there are Southern
Pacific, Greyhound, and additional private bus carriers in Palo Alto, San
Mateo, and San Jose; there are private taxis and jitneys, and public van-
pools. There are MTC, CalTrans, and PUC. And there are more than 100 city
departments with transportation as a prime function, the bulk of which
serve transportation exclusively. Not only is the cast of characters very
large, but their roles vary as do their organizational structures, the
scope of their authority, and their sources of funding. Some are single
mode, others multimode; some are operators, others regulators and coordina-
tors; some are private, most are public. And of the latter, some rely on
property levies, others on sales taxes, while all look to the state and
federal governments for general and special purpose support. Taken as a
whole, they appear to be a collection of discrete entities without any
shape or form. Bay Area transit appears to be a far cry from the
"integrated multi-modal transportation system" that Wingo, Perloff, and

Jones desire. Indeed, Jones describes it as "chaotic and irrational."[4]

Multiorganizational Suboptimality and the Problem of Coordination

To large numbers of planners, and to practitioners of public adminis-
tration and management science, a plurality of agencies in the same policy
space has traditionally been seen to be a problem. Such is the preoccupa-
tion with "integrated and coordinated systems" that the mere fact of mul-
tiorganization is deemed a serious weakness. Multiorganizational sectors,
as it is usually put, breed severe problems of coordination. Each unit
pursues its own policy, even to the point of system incompatibility. In
the aggregate, they enable an easy buck-passing of responsibility. They
are costly and uneconomic, and they entail waste through duplication and
overlap. The technical term for this condition is "multiorganizational
suboptimality." Its primary property is said to be the lack of coordina-
tion.[5] Implicit in this concept is a systemic model that envisions one
interlocking network, the elements of which, however varied and complex,
are so ordered as to perform with high reliability, zero redundancy, rein-
forcing consistency, and maximum efficiency. Against this perspective, the
multiorganizational character of Bay Area transit is easily judged to be
chaotic and irrational. Nor is it difficult to see why "inadequate organi-
zation" is taken to be a major reason for the "unsatisfactory level of ser-
vice and economic problems" of transit operators.[6] It seems to be a truism
that a single consolidated agency is superior to several that are function-
ally similar. So, all agencies having to do with national defense are
grouped together in a Department of Defense; all having to do with tran-
sportation are merged into a single Department of Transportation; those

concerned with energy now comprise a unitary Department of Energy; all having to do with education are now consolidated in a new agency. The federal government sets the pattern.

It is, however, a curiosity that the concept of multiorganizational suboptimality is applied primarily, if not exclusively, to the public sector. If we extend the concept's implications, the corrective lies in a monopoly which is vertically integrated, centrally controlled, and entirely unitary. That is, the key to coordination is hierarchy.

The curiosity stems from the economic cast of the term, for it is rarely applied to the private sector--the multiorganizational complex par excellence. In fact, consolidations and mergers of similar business organizations are frequently judged in restraint of trade and in violation of law; the most optimal organization, according to the principle, the monopoly, is patently illegal.[7] Moreover, the regulatory controls and coordinating properties of the market, extolled in classical economic theory and writ large in the system, are typically ignored with public organizations. With but few exceptions,[8] those who see natural market forces operating as a profound coordinating mechanism abandon this view when it comes to the public administration. One justification holds that, because public agencies specialize in necessary services that cannot be sold for dollars at a per unit rate, market constraints do not apply. Accordingly, they can be controlled only by pervasive regulatory programs that group similar and functionally related activities under one center of authority and responsibility.

Yet to accept the fact that the single most important distinction between a public and private organization is that the former is nonprofit

and operates in a "grants economy," does not necessarily entail the conclusion that the way to efficient and effective performance is through hierarchy. All too often the assumed virtues and economies of vertical coordination schemes, and of efforts to "stream-line" multiorganizational sectors by eliminating duplication and overlap, are terribly exaggerated. In fact, they have more to do with bureaucratic politics than with effective performances.[9] Even when not, however, experience teaches that such efforts do not work too well and, as in the case of PPB, often do more harm than good.

Over the last forty years, the American scene has witnessed massive efforts to coordinate and integrate public agencies on all levels of government. The push really began in 1939 with Roosevelt's Committee on Administrative Management, accelerating in the post-war years through the Hoover Commission and its counterparts in virtually every state and major locality--and continues to date. In all this time, "reorganizers" have been "hunting" for the system that would eliminate duplication, prevent overlap, provide policy integration, and insure operational coordination--at a cost of hundreds of millions. But hunting, we need to emphasize, stands in sharp contrast to learning, to steady and continuous adaptations in structure that occur as direct responses to experience, or as the result of careful experimentation. Rather it refers to the propensity of organizations "to oscillate from one organizational form to another" even in the fact of "generally stable environmental conditions."[10] It appears to be a common feature of public and private administration to assume that problems can be solved and difficulties removed by some structural reform. Our history, thus, is replete with radical reorganizations that shuffle and merge agencies, redistribute authority and jurisdiction, and provide comprehensive coordinating schemes which range from outright consolidation to

central control systems like PPB. The latter, presumed to be a profound management reform, served only to centralize the system even more.[11]

We should say something about counter-moves. From time to time the folly of undue centralization becomes evident and we do observe shifts to decentralization in the search for effective performance. This happens with cyclical regularity; and the continuous variety of New Federalisms (each administration seems to pay lip service to its own version), regionalisms, and locally centered programs are periodically proclaimed, often taking the form of revitalization movements that are quite congenial to the public opinion. The American political tradition is, after all, pluralist in character and multiorganizational in form. It is built on federalism, localism and home rule, and the Tenth Amendment. Moreover, the justification for decentralization seems to make good sense: it increases public participation, strengthens local capacities to govern and administer, stimulates both entrepreneurial and innovative action, and allows decisions to be made at the point where they can be made best--at that point where spill-over effects are negligible. But we are soon instructed that they are not negligible: that society has grown so complex, its parts so interdependent, as to have rendered precise functional, and therefore, territorial categorization well-nigh impossible. And this means that for any policy space, the number of relevant actors not only increases, but they are locked into states of tight mutual interdependencies. Transportation of any type is now to be seen as tightly coupled to land use, housing, taxation, conservation, community and industrial development, energy, public health, and more. Faced with such complexity, and with the consequent enlargement of the multiorganizational domain, the pendulum swings back. A "new agenda" is called for--an agenda of "purposive and coordinate

actions." The idea is, once again, to avoid "fragmentary and disjointed" approaches.[12]

To achieve this, however, requires a reduction in the number of auto-nomous actors--a consolidation of such actors into a lesser number of organizations, to the point of unity. The latter, of course, is the ideal, permitting a single control that is totally integrative. But reductions of this kind in the span of policy and operational control serve to increase the number of levels through which a decision issue must pass;[13] or, alter-natively, the effort to coordinate produces a tightly centralized system, a longer chain of command, and a sharply peaked hierarchy. Despite several decades of debate over decentralized and centralized systems, the clear thrust of our effort has been toward greater central control--Watergate to the contrary notwithstanding.

Yet it is quite clear that mergers, consolidations, and concentrations of authority at the apex have not yielded any more effective or significant improvements in performance. It remains a notorious fact that large cen-tralized bureaucracies are sluggish, inflexible, resistant, and unrespon-sive. They do not learn easily or quickly; their repertoire of response is rigid. Nor are they especially powerful coordinating agents. We fre-quently forget that many of our bureaucracies came into existence as sys-tems designed to coordinate the array of lesser organizations that now con-stitute their parts. Ostensibly intended, even designed, to meld a mul-tiorganizational sector into an integrated entity whose programs are "pur-posive and coordinate," agencies like the Department of Health, Education, and Welfare, and Transportation, constitute conglomerates that have yet to exhibit the virtues of vertical integration. The recent organization of

the Department of Energy, for example, formally abolished several indepen-
dent agencies by transforming them into discrete subunits. Where the prob-
lem was once considered to be multiorganizational suboptimality, it is now
suboptimization of the various parts. The old problems of coordination
remain, and additional problems have been generated by the fact that DOE
must now interact with all other departments concerned with such matters as
health, safety, environment, defense, and transportation, to name only a
few. To manage coordination at this order of magnitude, we could do what
John Lindsay did in New York and create super-agencies, but the history of
this episode is sufficient to compel extreme caution. Nor has the NYC MTA
fared any better. Created in 1967 to ease the financial pressure on the
New York City transportation system, the Metropolitan Transportation
Authority took jurisdiction over the subway, the city's bus lines, the
commmuter rail services, and the Triboro Bridge and Tunnel Authority. The
revenues of the Triboro were to be used to offset deficits, and the cen-
tralized management system was to integrate a previously disjointed system.
Thirteen years have elapsed and "operations, long-term planning, budgeting
and policy coordination are still largely in the hands of the individual
agencies which were brought together in the consolidation." Indeed, MTA
still "lacks even the information for managerial supervision."[14]

When we turn to the Washington METRO, a system that we have studied
directly, a similar story emerges. METRO absorbed the bus systems in 1973
when they were in rather run-down condition. The obvious purpose of the
consolidation was to improve the character of the lines and to provide
effective coordination of bus and rapid transit. Neither occurred. In
fact, under the "consolidated" organization chart, there was no bus divi-
sion and no real representation of surface-transit experience or expertise

at the executive level of the agency. In 1975, a METRO Board consultant urged that the managerial capacity of the bus mode be strengthened--a proposal that was easily resisted by the General Manager. To 1976, bus transportation suffered from systematic bias, neglect, and inadequate improvement. One would have expected that, at the very least, the problem of routing would have been assigned priority, but it was not; and route structures remained Byzantine. Moreover, the low priority assigned buses within the organization generated hostility and antagonism among bus personnel who were convinced that their mode was deemed by management to be of no consequence. The selection of a new General Manager and the creation of an Office of Bus Service under its own director have tended to ease tension, but recent internal conflict over the assignment of security forces between modes suggest that intermodal conflict persists.

At this writing, consolidated WMATA is not an integrated system, and its two modes are not smoothly coordinated. Perhaps they will never be. The General Manager has observed that "there is a quantum difference between bus and train in all respects. The differences are too big--they are almost of different centuries." In any case, economies of scale, so frequently advanced to justify merger, have not yet materialized--nor is it likely that they will. Service coordination is not any better than that achieved by the independent managements of AC and BART--if it is that good; and an integrated fare structure--once developed--has collapsed and is not likely to be reestablished. The Washington area presents, as the General Manager puts it, a "Balkanization of the fare structure"--an appropriate metaphor since the fare structure is, at root, a political question.[15]

Even when attention has been limited to a single-function agency,

efforts to design or engineer coordination have not been notably success-
ful. To enhance integrative management, national and state departments
have gone from performance to program budgeting, to PPB, PERT, CPM, MBO,
and all manner of information and control systems. The fact that they con-
tinue to "hunt," to shift from one device to another, one reorganization
after another, is ample indication that the appropriate design eludes them.
But the effects are fairly clear: the constant disruption of known pat-
terns of response, the unsettling of informal modes of conduct, the inten-
sification of internal conflict, the spread of cynicism--all of which tend
to destabilize an organization. If there is now a substantial public opin-
ion which is unfavorably disposed to the public bureaucracy, it is in part
due to the fact that the "hunters" have repeatedly missed their target.

Horizontal Linkage and Natural Coordination

Recall now that Bay Area transit has been described as chaotic and
irrational: a fragmented system. When terms of this kind are used, great
care must be exercised because their subjective connotations can lead to a
priori judgments that are not only incorrect, but restrict vision. That
is, the problems posed may be artifacts of the model employed, and the
judgments involved no more than a function of the language used--a language
that elevates holistic or systemic orientations to the point where they
become the only normative standard. It bears notice that while "frag-
mented" is presented as a descriptive term, its normative connotations are
quite negative. To say that something is fragmented is to say that it is
broken, in bits and pieces, disconnected, incomplete, disjointed--terms
that presuppose a unity that has been fractured. In this context,
"integration" appears to be the obvious remedy. It brings together the

broken pieces, the disconnected and disjointed parts, and renders them entire--one symmetrical and harmonious whole, as it were.

It is, therefore, no accident that appraisals of situations tend to be made against the standard of fully integrated systems. The model is there, not only in systems theory, but far more fundamentally in the language we speak.

Suppose, however, that we were to characterize the Bay Area transit space as constituting a loosely-coupled organizational domain--as a flat organizational system in which each member is tied to the others by horizontal linkages, not by hierarchy. Or suppose that we describe it as a confederation in which a number of organizations administer portions of a common task environment. In neither case would the subjective connotations of the terms employed constrain us, as "fragmented" does, and we would not reflexively assume that it is a system in need of correction, repair, or integration. We would see problems only when malfunctions arise--and it would not necessarily follow that correction lies in formal integration. There are systems which are deliberately partitioned and/or decentralized in order to improve peformance. In the military, a command structure, this happens quite frequently.

Our central point, thus, is that a multiorganizational domain should not automatically be regarded as problematic. Such domains may be quite effective overall, exhibiting weakness only on certain dimensions--and these may be more nuisance than trauma. If there are serious problems, it does not necessarily follow that solutions are to be found in formal coordinating schemes. Indeed, we are beginning to learn that formal control and coordinating devices are not all that significant in establishing

effective, even efficient, performance.[16] An entrepreneurial and innovative spirit, flexible response capacities, error-detecting and error-correcting procedures, stable informalities, bargaining, respect for norms of reciprocity,[17] and certain types of redundancies, including slack, may contribute far more to effective performance than the most sophisticated formal coordinating devices.

The latter have only limited utility: they work when the task environment is fixed, known, and unchanging--equivalent to a "closed set of variables." Under this circumstance, standardized routines and coordinating schedules can specify all operations required in advance. If the situation is a closed set, the entire organizational complex will perform as planned. Trouble arises on several counts, however. First, because formal coordinating systems have great power when deployed properly, they are frequently applied to situations marked by contingency, variability, and emergency. Here, the rigidities of standardized procedures and coordinating routines prevent flexible responses to unpredicted stimuli--and the organizational system suffers visibly. The more variable the task environment, the more prone to uncertainty, the more are such formal systems vulnerable.[18] Second, such routines tend to take on a life of their own, producing the well-known "organizational paradox"--the transformation of means into ends. Also known as "displacement of goals," the organization ceases to be task-oriented and evaluates its activities in terms of adherence to rules.[19] That is, its responses are not informed by the problems that arise, but by the routines in force. Third, when formal coordinating offices are established, they are invested with authority to control the behavior of subordinate units and to intervene directly in their internal and external operations. But in most cases they do not possess the knowledge necessary

to coordinate. Victor Thompson refers to this phenomenon as "the gap between the authority to decide and the capacity to decide." All too often, the creation of such offices is not based on the recognition that coordination and integration require a great deal of technical and organizational knowledge. The consequence is that fiat substitutes for expertise, serving only to compound difficulties by disrupting intra-organizational and inter-organizational relationships--as WMATA demonstrates.[20]

For these reasons, it is a major error to assume that coordination can be had only by means of formal arrangements. Harold Seidman, after a quarter of a century as an official of the U.S. Bureau of the Budget, observes that the results of such arrangements are "generally inconclusive." And then he adds, "True coordination sometimes may be obtained only by going outside the formal process."[21] This consideration is critical to our understanding of modern organizations. Far more often then not, formal arrangements are not necessary because in the natural course of events, in the daily performance of tasks, actors who are not officially required to make contact with each other do consult, do negotiate differences, and do work out cooperative arrangements. In fact, the larger and more complex the system, the more are official channels bypassed and horizontal channels employed.

These are not designed. They develop naturally, on the basis of need. They are derived from the everyday process of mutual adjustment that are exhibited by all large-scale systems, public and private.[22] Such organizations, marked by large numbers of functionally differentiated components, create interdependencies that are so great as to demand channel capacity and message-transmission rates beyond the scope of their formal structure.

This, coupled to the propensity of components to compete for scarce resources, a factor that breeds internal conflict, frequently overwhelms official channels and produces "switchboard overload." Official decision-making is slow, costly, and often located at the wrong choice point. To deal with their problems in timely fashion, components are forced to develop informal (unofficial) and unscheduled communication and decision channels. Departments and subdivisions engage in lateral negotiation, adjust their actions on the basis of mutual self-interest, and frequently displace authority by consensus. When, therefore, it is said that in the Bay Area transit systems "consensus rather than policy emerges,"[23] this statement reveals a gross underestimate of the facilitating and coordinating properties of horizontal networks. We come back to Harold Seidman:

> By overemphasizing coordinating machinery, we have created the false impression that most Federal activities are uncoordinated. This is by no means the case. Without informal or so-called "lateral" coordination, which takes place at almost every stage in the development and execution of national programs and at every level within the Federal structure, the Government would probably grind to a halt. Skilled bureaucrats develop their own informational networks. Managers who are motivated by a desire to get something done find ways and means of bridging the jurisdictional gaps . . . . Coordination does not necessarily require imposition of authority from the top.[24]

Coordination and Bay Area Transit: Informalities

We have referred to Bay Area transit as a flat organizational system, whose member units are only loosely coupled. Coupling refers to degree of causation: in tightly coupled organizations, formal bureaucracy, e.g., authority constitutes the prime causal factor. Hierarchy means that every superior is able to determine the behavior of a subordinate. Every superior is, therefore, the primary causal factor controlling the actions of those under his jurisdiction.

A loosely coupled organization lies on the other end of the scale. Hierarchy is minimized as a causal factor. Roles and definitions of tasks are not set by any single authority but by the components themselves. Interaction and communication occur not as a consequence of instruction or regulation, but on the basis of need. Written communication is kept to a minimum and is frequently discouraged. Roles are continuously redefined on the basis of experience, and tasks are generally established by negotiation. Parties to the bargain are determined by the character of the issue, not by the organization chart.[25]

Because such systems are flat, there is no one "center of authority," and they appear to be messy. And they do impose strains--especially upon the organizational actors. Since the system is not strictly determined, the place of each actor is uncertain. In sharp contrast to a tightly coupled system, risk displaces certainty, and there is considerable hazard in "navigating the system". Loosely coupled systems are no place for those who require the security of complete predictability.

But they have many virtues. They tend to be flexible, adaptive, creative, and quite congenial to innovation. The cost of novelty is much higher in a tightly coupled organization because of its disruptive effect upon routines. Loosely coupled systems are pragmatic, goal-searching, and problem-oriented; and they detect and correct errors more easily than do hierarchical organizations. Their most striking property, however, is that they are self-organizing and self-regulating, the stimuli for which are not the _a priori_ demands of planners, but _the effects of experience_.

Against the canons of classical management theory, they appear to be uncoordinated; but, to use Seidman's words, this is a false impression.

They are, to be sure, flat and therefore cannot and do not coordinate by hierarchy. But they are marked by extensive lateral coordination which occurs at virtually every level of activity--producing an overall system of rugged stability that is quite resistant to serious disruption. The behavior characterizing Bay Area transit is a clear illustration of these relations.

In the course of our research, we interviewed, in person, over one hundred transit officials engaged in Bay Area transit operations, and an additional twenty-five by telephone. All major carriers were represented, as well as the Metropolitan Transportation Commission. Personnel included general managers, assistants to general managers, directors of planning, scheduling, station operations, program review, research, and maintenance, as well as members of their staffs. Those we interviewed ranged from middle-level management to the top, including board members of the various transit properties, county supervisors, councilmen, city transportation department personnel, and other city officials. On the record, a core of about ten to twelve persons emerge as critical contact nodes, each serving as a frequently used channel of communication. Respected for their knowledge of "how to get things done," they have been endowed with an "aristocratic suffrage," independent of the formal positions they occupy. They are found in all major Bay Area agencies, but are quite prominent in BART, AC Transit, and Golden Gate. The genesis of these informalities may be personal friendships, "old boy networks," professional ties, common or shared perspectives, prior employment in the same agency, etc. But they are sustained by their capacity to ease difficulty.

We learn "how the system works" in a straightforward manner. Respondents state: when I have a serious problem or I want to get something done, I contact $\underline{A}$ at BART, $\underline{B}$ at AC Transit, $\underline{C}$ at Golden Gate, $\underline{D}$ at SamTrans, $\underline{E}$ at MTC, etc. Or, they state, "in my own organization I see $\underline{Y}$ when I want to get certain things done." These letters represent persons, not officials; i.e., there are times when the letters refer to the appropriate formal officer, but more often than not, they do not. Informal access points are not equivalent to formal positions.

While this is a natural process, arising out of need, it occurs with considerable thought beforehand. The primary assumption involved, made explicit by one respondent, is that "formal communication and commitment follows informal communication." Hence, the creation of informal channels is a matter of "conscious cultivation" and "explicit strategies." One respondent referred to "portals" which provide him with entry points. In this case, his preference is to establish a single portal for each operator. This permits an economy of communication; but, more importantly, confining contact to one portal over a period of time enables an easier development of reciprocity, and we are able "to more easily keep track of the balance of favors owed."[26] Another respondent prefers two portals in each agency, and a third develops them on a functional basis.[27]

Whatever the mode, informalities are serious business. There are specialists in informal channels, there are specialized channels, and there are primary and secondary channels, the latter serving as a redundant back-up. Moreover, these channels give rise to alliances, with respect to which norms of reciprocity are scrupulously followed, so that network members frequently aid and defend each other. $\underline{A}$ wants to get a proposal

through his own management. He calls B, an informal contact in another agency. B, in turn, calls an appropriate access point in A and presents A his own--thus reinforcing the original proposal. In telling of such incidents, B emphasizes that his counterparts frequently do the same for him.[28] Or, if this is too abstract, "Muni tried to negotiate an end-run around us [BART] concerning the "X" program. An AC staffer learned of this and informed me." Through use of other informal channels, Muni was stopped.[29]

Despite the fact that several Bay Area operators compete with each other, these channels are used to solve problems, secure coordination, promote cooperative relationships, exchange and transmit information, and ease decision-making. They serve most importantly at the operational levels, cutting red-tape, saving time, and providing problem-centered organizational interfaces. Here are some representative illustrations.

1. AC Transit feeds BART at the San Leandro station. There exists a contract between BART and the city of San Leandro which guarantees that separate lanes for buses and cars will be maintained in the station area. Denying buses the use of car lanes, however, creates serious difficultis for AC Transit. To change this situation, a laborious and time-consuming contract renegotiation would be required. The problem was resolved in the following manner: An AC official contacted the BART station manager to discuss the problem. The station manager passed the problem to a BART official who maintains strong ties to both the AC officer and Transportation Engineer of San Leandro. The BART official arranged for all parties to meet at the station to consider the problem. A simple agreement was reached; the San Leandro engineer would simply ignore the contract terms

and allow both the bus and car lanes to be mixed.[30]

2. A senior staffer at AC, whom we shall designate as S, maintains a continuing and close tie with a senior staffer at BART, whom we shall refer to as C. Both operate "in fairly unconventional ways" and bypass official channels easily. They originally got to know each other through their official tasks in connection with the contract express service that AC runs for BART. Over time, they have established a mutual trust which, as Kenneth Arrow once put it, is the prime lubricant of formal organizations. The $S-C$ channel is of major importance to both AC's and BART's operations.

For AC to establish a new service route by request takes some three months. Requests are routed to the Office of Scheduling, then referred to AC Planning for study, and then back to Scheduling. In late August '79, C called S to inquire about the possibility of a new route in Martinez. S immediately invited C to join him in a test of the proposed route. Securing a bus, they made a run to check out the availability of stops, potential traffic problems, the ability of an AC bus to negotiate hills and curves, etc. Both decided that the route was feasible. On the same day, they met with the Public Works Director of Martinez and fixed the route. S then presented the request to the Director of Scheduling, along with the necessary technical support. The new service route was established in less than five weeks.

The $S-C$ channel works frequently and successfully. BART requested an AC-route change in Walnut Creek, involving an extension. The entire matter was worked out informally and then placed in formal channels. In another case, BART sought a reciprocal transfer agreement with East Contra Costa Transit on the BART express bus lines (run by AC under contract). C worked

through S and both secured ECC Transit agreement. The object here was to eliminate the need for transfer customers to pay twice. No exchange of funds between the operators (AC, BART, ECC) was required, because the direction of transfers was balanced and the number involved was quite small. C took the informal agreement back to BART for Board approval; AC also accepted it on the basis of S's efforts. What might have been a sticky conflict was dispatched quite easily.[31]

3. S has known D for many years. Because one works for AC Transit and the other for Golden Gate, there is very little operational interface, if any. But they maintain close ties and frequently communicate on matters of general transit policy and development. The connection between them is firm. At one point, Golden Gate became interested in purchasing some special buses that AC had cut down for use on narrow streets and tight curves. This experiment had proven to be eminently successful from both an engineering and an operating perspective. D wrote to the appropriate AC official, offering either to buy or rent their buses. Weeks passed with no reply, and D finally called S. S contacted the appropriate AC official, who indicated that it was an extremely difficult question to decide. A check of the files indicated that there had been no response to D, the AC official apparently employing a strategy of avoidance. S then built a case for Golden Gate which also demonstrated advantage to AC, since the buses were not used by AC on weekends. Taking the matter to the General Manager, he secured agreement to rent the buses to Golden Gate on the weekends. The technical details were ironed out easily, and the cut-down buses are used by Golden Gate on their Mt. Tamalpais runs.[32]

4. D is an actor who carries an "aristocratic suffrage" by virtue of

his experience and expertise in transit, and his personal integrity. He is consulted frequently and serves as a node in the unofficial communication system of Bay Area transit. He came to Golden Gate from AC Transit when its enabling legislation was being enacted. He brought with him several AC employees who formed the core of the staff that established bus operations. Not surprisingly, operations and maintenance procedures of Golden Gate and AC are quite similar -- and quite effective insofar as bus life and operating time are concerned. In fact, SamTrans procedures are also similar because it too relied on D's advice when getting underway, the consultations again unofficial. Bus operational procedures in the Bay Area are, thus, rather similar, a condition which derives from a system of informal exchange that quickly diffuses information.

Both Muni and Golden Gate use GM buses. Muni's buses were very noisy; in contrast, Golden Gate's are quiet. D's contact at Muni called to inquire about this difference, asking what, if anything, Muni could do to lower noise levels. The Muni contact was then instructed to "replace the belt-driven cooling fans with thermostatically controlled, hydraulically driven fans." The former ran continuously, the latter only as needed.

5. Or, again, AC and Golden Gate use the same type of oversized articulated buses,--all of which suffered problems with their back-door mechanisms. Mechanics at AC found a way to solve the problem, and the information was passed to Golden Gate through another informal channel-- B-T. In the spirit of reciprocity, Golden Gate, through the same informal channel, informed AC of significant savings involved in replacing a single 400-amp battery with four one-hundred amp batteries.

What is striking here is that Golden Gate has very little operational interface with other transit actors and, therefore, very few interorganizational problems. Yet many of its personnel recognize the critical role that informal channels play and spend time developing and maintaining such channels. The payoff is not deemed to be immediate, rather "in the expectation of some kind of return down the line." This attitude is shared by staff throughout the Bay Area, most notably at BART, AC Transit, and MTC. The net effect is the creation of an unofficial (informal) system of communication which transfers technological innovation, problem-solving techniques, and information very rapidly—far more rapidly than do official channels, since neither clearance nor deference to the chain of command is involved. Additionally, strict adherence to norms of reciprocity required to build such channels creates a reservoir of goodwill that works to reduce conflict in the entire system. When, for example, AC was struck in 1977, the President of the Amalgamated Transit Workers Union prevailed upon D, a rather high official at Golden Gate, to act as intermediary between the union and AC. With both sides placing trust in D, his role in the settlement, one week later, was of some consequence.[33]

6. AC Transit and BART are direct competitors in the Bay Area. While AC feeds BART and runs express buses for BART under contract, its transbay routes parallel the BART line—a situation that has generated considerable acrimony on both sides. Yet AC and BART have developed a rather unique co-operative arrangement to cover emergencies. The system of coordination is entirely informal and unofficial—and capable of effective operation under the most severe test, the transbay tube fire.

In the Bay Area, there has been a noticeable shift of staff personnel from one transit agency to another over the last years.[34] Movements of this kind are by no means uncommon and are to be found in virtually all functionally similar areas, both public and private. They are, however, frequently regarded as uneconomical, and as disruptive of the stability sought by professional personnel administrators.   Yet there can be significant benefits, for such personnel carry with them a knowledge of the operating procedures, the decision-premises, the critical actors in their former agencies, and the difficulties they confront--knowledge which enables them more easily to predict the reactions of these agencies to various problems and proposals. Because of prior association, they are also able to make unofficial contact with former associates on matters of common interest.

The Director of Scheduling at BART was originally employed at AC Transit.   Shortly after asssuming his new post, it became apparent to him that BART did not possess any back-up in the event of emergency. In his view, the easiest and most effective way to provide for this was to arrange a "bus-bridge" with AC. In the event of a BART break-down, AC buses would carry BART passengers. Securing the assent of BART's General Manager, he approached the operations manager at AC. An emergency procedure was agreed upon.   The procedure is simple: once BART determines that an emergency exists, its central dispatcher notifies the AC dispatcher and requests a bus-bridge; AC routes the requisite buses to the locations identified by BART. Payment for this service also follows a simple procedure: AC charges BART the cost of running the buses as against their sitting in the yard. There may be a small overhead charge, and AC will also charge for overtime if that is required.

The novelty of this system is that the agreement is <u>oral</u>. Both parties to the original negotiation deliberately established an oral agreement in order to bypass their respective legal departments. Lawyers would unnecessarily complicate the situation; their agreements would be unduly formal and restrictive and, thus, might impair the flexibility required in the operation of an emergency bus-bridge. Moreover, both felt that they were part of a "professional operations fraternity" and could trust each other.[35] At the present writing, no written contract exists, the oral agreement forged on the basis of informal ties stands, and the bus-bridge is a critical factor in the system, competition to the contrary notwithstanding. The full significance of this system of coordination emerged most clearly in the BART transbay tube fire.

The fire occurred on January 17, 1979. A train bound for Daly City caught fire about a mile from the San Francisco side of the tube. At 7:45 p.m., the BART dispatcher requested a bus-bridge between the MacArthur BART station (Oakland) and the Transbay Terminal in San Francisco. As it happened, the request arrived at AC just as one shift was going off duty, permitting AC to dispatch a rather large number of buses (some 35) to the cross-the-bridge shuttle.

When the original agreement was made, however, BART anticipated that the worst possible shutdown of any portion of the system would last for no more than several hours. Moveover, none of its scenarios contemplated the complete closing of the transbay tube. In AC's perspective, maintaining a bus-bridge for BART for any extended period was not an easy task. Proposition 13 had resulted in a material reduction of its driver force, and it simply did not have enough buses to run the bridge for more than several

hours. On the night of the fire, thus, it was luck and the heroic stretching of its rolling stock and driver force that enabled AC to carry the load. But when officials realized that the tube would be closed the next day, and perhaps for several days (no one then foresaw a closing of close to two months), AC instructed BART that it could provide only 10 buses for the next morning's run from MacArthur to the Transbay Terminal. BART was left with no option but to secure assistance elsewhere.

During the summer of 1977, when BART suffered a wildcat strike, the Director of Scheduling at BART had contacted a number of private lines (Franciscan, Great Western, Scenic Tours, Falcon) to arrange for bus service on those routes not overlapped by any of the major public bus lines. The private lines were not part of the Bay Area transit informal network, and it is interesting to observe that the Director of Scheduling at BART had to search the Yellow Pages to find their numbers, some of which (the Greyhound night number) were not even listed. Once contracted for, however, the Director of Scheduling at BART was in no position to coordinate the dispatching of buses. But it is to the point of this study that the drivers organized on their own, established a radio communication link, and themselves coordinated the spacing and rotation of their buses.

The day after the tube fire, BART's Director of Scheduling again contacted private bus operators (Falcon, Franciscan, Eastshore, Greyhound, Bay Bus, Cal/Nevada Tours, Guiton, Trailways, Peerless, Scenic, and one owner-operated bus), employing them on a daily basis. When, after a few days, it became clear that the crisis would be prolonged, an AC colleague informed the Director of Scheduling at BART that AC would be willing to assume the task of chartering buses for BART. (Immediately after the fire, AC had

assigned dispatchers to coordinate the transbay bus-bridge in both direc-
tions.) Because of its prior experience and bus expertise, AC urged that it
could charter private buses more effectively and less expensively. The
Director of Scheduling at BART agreed.

The task was assigned to AC's manager of charter services on January
24--one week after the fire--with rather wide discretionary authority over
the number of buses to be chartered and their cost. Unlike BART, AC knew
all the private bus carriers, was familiar with their decision makers, and
most importantly, was in a position to apply "yardstick regulation" to the
problem of cost--which immediately resulted in substantial savings for
BART. Greyhound, for example, had been charging about $380 per bus per
day; Peerless about $400. But AC's standard price was $270-280 per day.
AC immediately cut Greyhound from 40 to 20 buses per day and cancelled
Peerless.

Additionally, AC's dispatchers at the MacArthur station routed all
chartered buses so as to ease traffic flow. They also checked each private
coach at both the MacArthur station and the Transbay Terminal to insure
that the loads contracted for were in fact being carried. This amounted to
300 busloads in the AM and PM peak periods, a total of some 12,000
passengers.

There's another interesting chapter in this story. As part of its own
bus-bridge arrangement with BART, AC had been running 7-11 buses per day,
using its articulated coaches because of their greater capacity. But it
also added well over twenty buses on its own transbay routes--some
prescheduled, others assigned on need, in direct consequence of the tube
closure. BART incurred no financial obligation for these runs, which

reduced the number of buses that BART would otherwise have had to charter.

The tube fire reveals a situation in which two direct competitors collaborated on an entirely informal basis to ease the effect of a gross trauma to BART and Bay Area transit. Relying almost entirely on unofficial channels, agreements were worked out, communication was swift, and problems were dealt with as they arose and on the basis of mutual trust. The trust extends even to cash outlays. When AC assumed the task of chartering private buses for BART, coach operators billed AC on a weekly basis. AC checked and approved the invoices, which were then sent to BART for approval. BART would then release money to AC which paid the operators. For its own services, AC followed the procedures employed in charging BART for express services, i.e., the actual cost to AC. BART paid AC with little or no discussion, auditing AC invoices after payment.[36]

We should also add that the bus-bridge is only half of the AC-BART mutual support system. Although there has not been any occasion for use, BART will provide a "train-bridge" for AC passengers on the transbay route in the event that access to the Bay Bridge is impaired. This arrangement is also informal, and the financial procedures to be followed are of the same character as those employed with the bus-bridge.

Other Informal Agreements

Bilateral informal agreements of this kind extend beyond BART and AC. BART and MUNI have similar arrangements to support each other under emergency conditions. Muni will supply a bus-bridge, BART a train-bridge. Fortunately, no emergency has yet occurred, but both have agreed to follow the pattern set by AC and BART should the need arise. Again, nothing

exists in written contractual form. Similarly, there is a bus-bridge arrangement between Harbor Carriers (which provides ferry service between Tiburon and San Francisco) and Golden Gate; and SamTrans buses can and do operate in the Santa Clara territory to provide back-up service in the event of a Southern Pacific commuter-service breakdown.

Finally, the flexibility afforded by informal channels can be seen in the following case. In late May 1979, BART service was suspended because of a venting failure in the transbay tube. AC was unable to provide a bus-bridge despite the fact that the breakdown occurred on a Saturday. BART's head of scheduling, however, maintained a "portal" at Golden Gate. A telephone call on that Saturday produced ten Golden Gate buses for a period of five hours.[37] Golden Gate then billed BART at regular charter rates. This was the first such arrangement between BART and Golden Gate, effected easily and with dispatch. We should note, however, that had the request come during peak hours, Golden Gate would not have been able to comply because of a lack of reserve capacity. This is the reason Golden Gate did not participate in the tube fire bus-bridge.

The situations we have described illustrate a transportation complex that possesses a high capacity for self-organization and for coordinated and flexible responses to felt need. While it reveals no "center of authority", no formal control mechanisms, its highly developed informalities sustain a rich and rugged system of horizontal linkages that allow coordinate action when and where required. The organizational structure of Bay Area transit is marked by an extensive array of lateral channels that tie into every level of operational authority, producing high overall systemic reliability and high systemic capacity to resist disruption. It was

this loosely coupled multiorganizational system that stabilized and main-tained effective public transportation for the two months when one of its major carriers was crippled--and for the several months when it was struck.

It should not, however, be assumed that the self-organizing properties of the system are exhausted by route changes, technological transfer, bus-bridges, and other emergency procedures. Nor should it be assumed that the interorganizational agreements are exclusively informal. Bay Area opera-tors have also engineered bilateral formal arrangements to order and coor-dinate a variety of routine operations. While other systems have resorted to authority, the Bay Area system has also relied on contract as means of solving problems.

Coordination and Bay Area Transit: Formal Arrangements

1. Intercarrier transfers

If passengers are to "transfer" easily, several conditions must be met. Transit lines involved must be in close proximity, preferably using the same stops. Headways of the relevant lines must be fairly closely matched to reduce waiting time. And the transfer between lines must be either free or discounted. In an ideal world, a passenger would have to pay only one fare for one trip, regardless of how many times he changes carriers. In the following section we describe the efforts made by the six Bay Area public transit operations to address these factors.

Early in BART's operating history, BART and AC agreed to share the costs of an intersystem transfer on a fifty-fifty basis. This division was not based on a careful cost accounting, rather, it seemed reasonable and

was acceptable to both parties. The system, in process now, works as follows. A passenger boards an AC bus, pays a normal fare, and rides to a BART station. He then pays a normal BART fare and rides to his destination. On the return, he again pays a normal BART fare, but upon leaving the BART station he receives a free transfer to an AC bus, good for several hours, and can use it at bus stops adjoining the BART station. About 15,000-20,000[38] of these free transfers are issued on an average weekday, and they allow for a fifty percent discount on bus trips to and from BART stations.[39]

BART has a similar transfer arrangement with Muni. Transfer-issuing machines are set up so that the passenger pays the fare and receives two transfers. The first transfer allows the passenger to take a Muni bus away from the BART station, and the second allows him to return within twenty-four hours. About 25,000 of these transfers are purchased by BART riders weekly.[40]

Before BART became operational, a BART-Muni coordination project was undertaken with the aim of more closely aligning the Muni lines with the BART stations. Although not all of the project's recommendations were adopted by Muni, a number of significant route changes were made. The changes were less substantial than those made by AC, but then fewer changes were needed, given Muni's grid-pattern of lines. As part of its Five-Year Plan, Muni's planning staff has recommended additional changes that would increase the number of Muni lines touching a BART station at some point. Because BART does not run on a fixed schedule, it is not possible for Muni buses to "meet" the trains. Muni, however, runs its buses with even closer headways than AC Transit, reducing waiting time even more when trains are

running on time. These arrangements make transfers between BART and Muni simple, and other route and headway changes now contemplated will make the transfer process even easier.

BART and Muni are now debating the use of a Muni Fastpass on BART. If agreed to, holders of Muni Fastpasses will be able to use them both on Muni buses and BART trains. BART wants a surcharge of $4 to $6 on the Muni Fastpass, which currently costs $16.00, for the Muni rider to use BART. Muni is opposed to the surcharge. However, it is not clear that BART machines can accept the Muni pass. And, as one Muni staffer commented, "If the technical details can be resolved, the financial arrangements will fall into place." It is probable that an agreement is not far off.[41]

Throughout the Bay Area there is a sensitivity on the part of all carriers to the financial burden borne by passengers. Bilateral negotiation over transfers is, thus, a common feature of the system and does produce tangible results. There exists a transfer agreement between BART and Sam-Trans; another involves AC, BART, and the East Contra Costa County Transit District. Muni has a commitment to a transfer arrangement with Southern Pacific, and Golden Gate and Muni are executing a federally funded demonstration project involving free transfers from Golden Gate ferries to Muni lines at the ferry building in San Francisco. Other transfer problems are now before the Services and Tariffs Committee of the Regional Transit Association--a free transfer system between SamTrans, Santa Clara, and Southern Pacific at Palo Alto, between BART and Santa Clara, and between AC and Santa Clara in the effort to establish a Fremont Transit Center.

On many routes, however, the lack of a transfer system does not present serious problems either because carriers do not articulate or

because the number of passengers is small. Where problems have existed, however, negotiations have been undertaken in a spirit of mutual benefit, which has extended to passengers. While each carrier obviously seeks a favorable resolution of transfer problems and transfer financing, none has been blind to the constraints which bind other operators in their jurisdictions.

2. Interagency Contracting

Formal contracts have been used by all of the Bay Area operators to solve any number of problems and constitute a device by means of which agencies coordinate with each other, to their mutual benefit. We have already alluded to several of these--including Golden Gate's rental of six cut-down AC buses. But we want to note here that BART contracted with Greyhound to keep its service to the Concord area until such time as BART is capable of carrying the load. In like manner, SamTrans contracted with Southern Pacific. In these cases, the contract is used to enable private carriers to maintain an unprofitable though useful line until such time as a public carrier can take over.[43] Potential gaps in the transit system are prevented in this manner, and existing gaps are closed.

Marin County Transit District is supposed to provide local service. Though supported by property tax levies, it has no fleet of its own. But it provides service by contracting with Golden Gate, on a cost basis. Golden Gate runs 235 commute buses during peak hours and forty-eight local service buses on weekdays--on routes and in areas selected by the Marin District. By a similar arrangement, AC Transit provides service for the East Contra Costa County Transit District. SamTrans, a relatively new addition to Bay Area public transit, does not have sufficient resources to

build a fleet of buses large enough to service its area. It therefore contracts with Greyhound, which operates a large share of the commute service in SamTrans jurisdiction.

In the case of AC and BART, the fact that they are direct competitors on the transbay route, and the fact that AC had consistently refused to transform itself into a feeder system for BART, have not prevented either from entering into contracts to solve the feeder problem. This situation is illustrative of what can be arranged by contract. Early in BART's history it became clear that BART service could be greatly improved by bus feeders from areas lying outside AC's district. A contract was negotiated between the two in late 1974 and has since been renewed. Using Federal capital assistance money, BART provided AC with sufficient funds to acquire thirty-six buses. These are used on routes established by BART and AC jointly; as are service levels, fare structures, and marketing programs. The lines carry about 5000 passengers daily, half of whom do not ride BART. Single-zone fare is 25 cents, and the longest trip costs 50 cents. There are free reciprocal transfers between these buses and local lines in Walnut Creek, Concord, Livermore, Pleasanton, and the East and West Contra Costa County Transit districts--the transfers good for single-fare zones. AC bears the responsibilities that are characteristic of bus operators-- installation and maintenance of bus stop signs, benches, etc., and the provision of service on a standardized basis. BART pays for the direct labor costs involved, and for bus maintenance and service--but only for that proportion of mileage covered by the specified service.[44]

BART is also engaged in an analogous negotiation with Muni. Both share a number of subway stations in San Francisco. Muni rail operates

from the upper level, BART on the lower level. BART built and owns these along with two stations that it does not use. Under an interim agreement now in force, BART maintains the right-of-way and the stations. The interim agreement satisfies for the moment, because BART is not fully operational. Negotiations, however, have been underway to cover the long term and involve payment schedules, union membership and representation, and such routine operating issues as security, personnel duties, and responsibilities.[45]

Coordination by contract occurs frequently in the Bay Area. By contracting with each other, operators ease interorganizational problems, close gaps, and provide more effective service--as when SamTrans and Golden Gate, restricted by police code from entering the downtown San Francisco area, are able, by agreement with Muni, to run buses over designated routes; or when Golden Gate, by agreement with Muni, is permitted to run a Christmas season "Shoppers' Special" for its passengers. Apart from operational benefits, however, there are other values in administration by contract. Operators meet as equals, work out mutually beneficial accords, find areas of mutual interest and agreement, and thus reduce conflict. Operators are able to retain their autonomy, to maintain their options, and take initiative on the basis of need. And, as against a formally integrated agency, contract administration minimizes hierarchy and its attendant problems of clearance, and permits each carrier a much wider repertoire of response. They can act, not in response to authority and rule, but in response to experience.

More Formal Multiagency Coordination: The Regional Transit Association

The Regional Transit Association (RTA) was formed in 1975 following establishment of the Metropolitan Transportation Commission. The driving force behind RTA was Albert Bingham, then General Manager of AC Transit.

Three factors seem to have encouraged operators to join RTA. It offered a vehicle by which they might jointly oppose the then vague but perceived threat of the Metropolitan Transportation Commission. It was a medium through which they might undertake regionally oriented activities to forestall and/or preempt intervention by MTC. RTA would allow joint issuance of press releases, giving the appearance, if not the substance, of a regional transit entity. RTA achieved relatively little at first. It fell into disuse after about one year, only to be revived in early 1977.

In its revised form, RTA plays rather important roles. It provides a regular forum where top transit personnel get to know each other. It promotes development and maintenance of informal relationships, which then provide a favorable setting for discussions of regional problems, for exchange of information on problems affecting each operator, and for joint efforts to confront common problems. RTA also provides an economical vehicle for MTC to communicate its views on particular issues and to communicate information relevant to all operators.

RTA operates under a joint-powers agreement among the six major operators. It is run by a Board of Control comprising the six general managers. It has no staff of its own. There are, however, eight standing committees composed of staff from the relevant divisions in each agency: Maintenance, Joint Procurement, Management Systems, Public Information, Services and Tariffs, Personnel, Training and Affirmative Action, and Operations. The

Board of Control and the committees meet about once a month, members rotat-
ing as hosts. MTC provides staff assistance and thereby gains an appreci-
able involvement and influence. Memberships on the Board of Control and
the committees have remains fairly stable over RTA's life, thus enhancing
potential for success.

If RTA performed no function other than to promote the development and
continued maintenance of contacts, all the time and expense so far invested
would have been justified. The reasons are apparent. RTA has opened up
new lines of communication, particularly in maintenance, procurement, and
management. Unlike operations staffs, who have occasion in the course of
their work to meet and deal with counterparts in other transit agencies,
personnel in these three specialties have little opportunity for such con-
tact. Along with this, RTA is familiarizing each carrier's staff with the
work of its counterparts. For example, during its first series of meet-
ings, the maintenance committee was given a tour of the maintenance facili-
ties at each agency.

RTA affords an institutionalized forum for discussion of regional as
opposed to operator-specific problems. Such discussions serve as socializ-
ing media. They make regional considerations legitimate topics of concern
instead of utopian or unrealistic dreams, and they increase awareness of
advantages associated with cooperative efforts and lay the basis for future
cooperation. Apart from such latencies, RTA does yield direct and tangible
benefits t the various operators. The exchange of expertise and technical
information is stimulated and facilitated; and members participate in a
wide range of multi-lateral cooperative efforts.

A careful reading of RTA history indicates that much of the first year of its reincarnation was spent establishing routines and procedures. For example, the Management Systems Committee tried three times during its first six months to come up with a viable set of purposes and objectives. The Joint Procurement Committee attempted to develop a joint-bid procedure that all parties could agree to. While these took time, much valuable information changed hands. The Management Systems Subcommittee on Data Processing, informed of the programming practices of all carriers, established conventions for file-naming and data-organization. The Maintenance Committee and the Operations Committee toured each other's shops, transferred their experiences, and shared their operating procedures in the interest of "consistency in the region." Prior to RTA, exchanges were routed through informal channels. With RTA, a regularized system of information transfer, interorganizational consultation, and mutual aid came into existence.

But what about multiorganizational coordination aimed at fitting individual agencies to the needs of the larger transit system? The greatest successes in multilateral coordination have occurred where all participants stand to gain, and where none stands to lose. Financial savings through joint procurement is one such instance. And successes have come where members have not had to spend resources over and above routine operating costs. Where, for example, a joint-advertising program involving member contributions of over $20,000 was haggled over intensively, a software and hardware inventory which required only donations of staff time was dealt with easily. Other successes have come where members have not had to change their central operating procedures, where no procedures had been developed prior to RTA involvement, and where individual operators were not

required to surrender organizational autonomy. In the joint-procurement program, no operator was required to purchase through the joint bids; they were available for use at the discretion of each operator. None of this is surprising. RTA successes have occurred in situations where benefits were expected with little or no costs attached.

What of the tangible coordination activities of RTA to date? They have occurred across a spectrum of activities. The joint-procurement effort led to joint bids on air filters, oil seals, batteries, lamps and lights, and diesel fuel. There have been joint-training seminars in technical and supervisory areas in both operations and maintenance. In management systems an inventory of hardware, software, and staff was prepared, and efforts were made to standardize computer concepts and procedures. An extensive joint-research and marketing program with a $650,000 budget was designed and is now being implemented. This project is especially significant because it was the first time RTA members spent their own funds on RTA activities without guarantee of tangible benefits. The Services and Tariffs Committee has considered many problems associated with a formally "fragmented" public transit system, i.e., different fare structures, overlapping services, and noncoordination of bus schedules between operators. The committee has prepared a detailed report on a regional fare structure, discussing types of service, recommending fare standards, and comparing current fares. It developed joint-run procedures for issuing a Bay Area Discount Card for the Elderly and Handicapped, as well as a joint training film for drivers. Further, it identified seven specific projects for more examination and remedial action:

a. The sale of Muni Fastpasses at SP depots and the possibility of joint-use tickets;

b. Muni-Golden Gate Ferry transfer demonstration project;

c. Market and Seventh Street interfares of Muni, BART, Greyhound, and Golden Gate;

d. Transit Center in Fremont with intersystem transfers

e. BART-SamTrans intersystem transfers;

f. Bus transfer facility at the Palo Alto SP station;

g. BART-Muni Fastpass.

Some of these are bilateral projects already underway but which RTA showed an explicit interest in resolving.

Although we have pointed to a number of concrete examples of coordination on multilateral bases through the RTA committees, it should be clear that a great many issues remain to be examined and resolved. It is typical of any new organization, especially one comprised of several independent organizations, to spend a great deal of time in its early years establishing procedures and setting its agenda. Once these matters are fairly well decided, the organization can move to the resolution of substantive issues.

Monthly meetings of RTA's Board of Control permit MTC to keep abreast of the activities and views of top transit officials in the Bay Area, and they allow MTC to communicate its views to the same people. The Board serves as a institutionalized forum for information exchange. This role has been enhanced by the Transit Operator's Coordinating Council (TOCC) created by state law in 1978. Following meetings of RTA's Board of Control, members change hats and reconvene as members of TOCC. TOCC is chaired by the Executive Director of MTC (who sits by as an observer/participant during RTA meetings). These meetings enable an

economical and reliable transmission of information, augmenting the infor-
mal channels which exist, and the usual process of agency-to-agency commun-
ication.

The Metropolitan Transportation Commission

MTC was created by the state legislature and is charged, among other
things, with coordinating and overseeing development and maintenance of
public transit in the nine Bay Area counties. It has no analog anywhere
else in Calfornia. It is an eighteen-member commission appointed by for-
mula from personnel of other government entities in the Bay Area, with an
Executive Director and staff. In 1972 when MTC came into existence, it had
more commissioners than staff members. MTC now has about one hundred pro-
fessionals and support personnel.

Much of MTC's early activity was devoted to establishing itself as a
legitimate authority in Bay Area transit. Early critics missed this point
when they decried its lack of effectiveness in coordinating Bay Area tran-
sit. It takes time for a new organization to establish its legitimacy,
particularly when it is perceived as a threat. Three other conditions had
to be met as well: to recruit a staff of professionals who knew what they
were doing and who would be respected by their peers; to develop entry into
the informal Bay Area transit network; to obtain or develop the means to
influence operators' behavior. Moreover, much of MTC's early activity was
focused on the preparation of a mandatory regional transportation plan.

We believe that the Metropolitan Transportation Commission will play
an increasingly large role in Bay Area transit. MTC currently works to
insure that expenditure of funds and public transit operations meet

guidelines established by UMTA, the State of California, and MTC itself. It is also increasingly assuming the role of mediator and/or arbitrator in conflicts that arise between operators, particularly where MTC goals are at stake. For example, both Golden Gate and Marin Transit District (MTD) compete for the same funds. If Golden Gate gets the money it goes into trunk-line service. If MTD gets it, it goes into local service. MTC has become the adjudicator for conflicts like this.

MTC also influences state transit legislation, particularly as it affects the nine Bay Area counties. It represents a regionwide interest as compared with the interests of specific operators or groups. Conversely, through TOCC, MTC provides an information service about pending transit legislation and its probable impacts on operators—timely information any single operator could not easily find on its own. We expect MTC to play the role of "protector" of Bay Area transit operators against outside threats, either from state or federal governments.

MTC also provides another point of entry for interested parties to the politics of the transit system. It allows for a representation of interests which is not available either at the level of the transit operator or other government agencies, and it also provides an appeals channel or back-up forum for those who may have been unsuccessful before transit organizations.

MTC is able to perform such functions because of changes it itself introduced, and those brought about by the California Legislature, the Federal government, and by such "outside" factors as Proposition 13. Each year the amount of money that flows through MTC to the operators has increased both in absolute terms and as a proportion of the operators'

budget. As UMTA and state funds increase relative to fare box or local revenues, MTC's power to affect operating procedures in the transit agencies is strengthened. Every dollar that flows through MTC has conditions attached, directly and potentially. For the three counties served by BART, twenty-five percent of the half-cent sales tax collected is given to MTC to be used as a discretionary fund. One such condition placed on the redistribution of these funds is that one-third of the operating costs of the operators must be met through the fare box. AC, BART, and Muni have met this requirement and have drawn on the fund. And this is but a small part of the overall picture. By offering monetary inducements, MTC can stimulate programs that would not otherwise be attempted, and can influence existing programs and operations. Operators now tend to modify their grant proposals to conform to MTC guidelines--a practice which strengthens MTC even as it moderates potential conflict.

Two other mechanisms serve to enhance MTC influence. First, MTC has provided the necessary staff work for RTA staff committees. MTC thus keeps abreast of RTA activities and participates in the development of RTA policy. Second, in addition to the influence MTC exerts in the grant-application and approval process, its reporting requirements permit it a continuing voice in determining how the monies are spent. The typical transit operator in the Bay Area has about twenty separate reports to submit for MTC approval annually. The number seems likely to grow.

Two external factors have combined to strengthen MTC's influence further. Rising gasoline prices have induced some motorists to shift to public transit. The operators have had increasingly fewer reserves of equipment and personnel, so MTC's equipment grants are more important than

ever. At the same time, operators are seeking to update and enlarge their fleets, thus increasing reliance on MTC monies. Simultaneously, there has been a substantial erosion of the local tax base owing to Proposition 13. The impact is clear--a sharp shift from local funding to state and federal sources. The latter funds pass through MTC; the former do not. Clearly MTC's position has been strengthened by both Proposition 13 and the energy crisis.

The patterns of behavior we have outlined for the individual operators, RTA, and MTC are well established now. They imply a division of labor in which issues of coordination which are most appropriately addressed bilaterally will continue to be worked out between pairs of operators, either on their own initiatives or at the urging of RTA or MTC. RTA addresses issues that are best dealt with multilaterally, while MTC acts as the representative of regional interests and the goals mandated by the state and Federal governments. But if issues are not resolved throught the efforts of individual operators, they are likely to be picked up by RTA or MTC. We believe this means that very few problems of coordination will remain unrecognized and unaddressed. What falls through the cracks at one level is likely to be picked up at another level. And this carries us to the theory of system reliability.

The Theory of System Reliability

That duplication and overlap are wasteful is a cardinal doctrine in public administration. It is also widely held in the Bay Area. If Ford and General Motors duplicate each other, if TWA and United Airlines provided a choice of channel, this is perfectly fine. But if AC and BART

duplicate each other on the transbay route, also providing a choice of channel, then it is assumed that something is wrong. Arguments which could be used against Ford and GM, or TWA and UA, are then advanced to instruct that the transit system is wasteful because organizations, services, equipment--even jurisdiction are duplicated. Accordingly, the instruction continues, capital equipment, labor force, and management services are underutilized (or in excess of what would be required by a single integrative entity), and the total passenger load could be carried with less equipment and personnel and at lower cost, were we to eliminate duplication.

Indeed, even in anticipation of the possibility of duplication, there arise proposals for the creation of one transit authority to amalgamate and coordinate the entire system--as the Stanford Research Institute urged in the early 1950s. Although this proposal was never acted on, as BART moved closer to an operational stage, serious consideration was given to the "problem" of duplication, especially as regards BART and AC. The key issue was how the two could be coordinated. Several efforts were undertaken in this regard: the Northern California Transit Demonstration Project, 1965-67, and two studies--one in 1972, the other in 1974. It is important to observe that in all three, coordination meant the elimination of duplication. AC was to be transformed into a feeder, routes were to be both redirected and abandoned, transfers arranged--all to produce one integrated network.

While AC did make numerous changes better to mesh with BART, it maintained its competitive position with BART, holding to the principle that the rider should have a market choice. Given BART's technical and

organizational difficulties, there is no public demand at the present time for merger, consolidation, and the consequent elimination of the transbay bus route. But the issue is there and, though dormant, is not dead. On the contrary, for BART it is very much alive. On the day before the tube fire, a high BART official at a meeting which included AC officials, pressed AC to cut services that parallel BART--notably on the transbay routes.[46] The tube fire created an embarrassment which may, however, be no more than momentary. For with the passage of Proposition 13, we are bound to see an increase in demands for merger. A high official at Golden Gate states that AC and BART should be merged now, for "the dollar will push it into happening--the heyday is over."[47]

The issue, however, is not restricted to BART-AC transbay routes. Duplication and overlap may be observed on several routes, and involve several operators. Muni buses parallel BART from downtown San Francisco to Daly City; BART Daly City-San Francisco overlaps SamTrans on portions of this segment, as it does with SP commuter lines on another segment; Sam-Trans and Southern Pacific from San Mateo to San Francisco also duplicate each other. We can find a considerable amount of duplication and overlap in the total system and sometimes within one organization. Golden Gate buses from Marin to San Francisco do in fact duplicate Golden Gate ferries from Larkspur and Sausalito to San Francisco.

On the surface, this appears to be messy and wasteful, even anarchic. The fact is, however, that Bay Area operators are responsive to market conditions. Riders of public carriers are able to express their preferences and adjust to their needs by choosing between carriers. The carriers, in turn, adjust their service levels on the basis of demand. Over time, the

load carried by each operator has stabilized, the shares roughly constant even upon absolute increases of passengers. Passenger load shares are now fairly well balanced.

AC and BART are again illustrative. Shortly before BART became operational, AC forecast a one-third drop in patronage on the transbay route, which turned out to be correct. Over the next year, it cut service incrementally in adjusting to demand to a total of 70 buses. These, and their drivers, were assigned to the AC-BART contract-express service and, additionally, were used to expand local services. The distribution of load has now stabilized, and both enjoy higher patronage than in 1974. But, as has been clearly demonstrated by the tube fire, the AC strike, and the BART strike, neither carrier has sufficient capacity to absorb all the others' passengers. The presence of both, however, and their reserve capacities, lessen the impact of trauma on the entire system. That reserve is crucial.

What would have happened had the recommendations of early coordination/integration studies been followed--had AC Transit been transformed into a BART feeder exclusively? Before BART began operations, AC used about 245 of a total fleet of 700 buses for peak transbay service. If all transbay service had been eliminated, these buses and their drivers would also have been eliminated. For even with AC feeders in operation, local service could not have absorbed the transbay equipment. Such service did not show any rise in patronage once BART started to operate. The cost of a reduced AC transbay capacity is to be seen in the BART tube fire and the subsequent strike. A considerable reserve capacity would have been lost to the system.

This factor, cardinal to questions of system reliability, is invariably ignored. It is clear that the reserve capacity of the operators is, when aggregated, far greater than the reserve capcity of any single transit entity. Yet in pressing for merger in the interest of systemic integration, those who advance such proposals rarely raise the issue of reliability. Nor do they evidence any doubt that duplication and overlap can be eliminated. Hence the confidence with which reorganization proposals are continually offered. And to object to them seems to defy common sense and conventional wisdom.

Yet it can be fairly asserted that any such reorganization will fail. For the plain fact is that no effort as yet has been able to produce an organizational system unmarked by either "malady." In the last forty years, massive attempts have been made on both the federal and state levels, in multi-functional agencies, in single-function agencies, through the process of radical reorganization, and through incremental continuous effort. And the result is clear: duplication and overlap are as conspicuous today as they have ever been--if not more so.[48]

There are reasons for this:

1. In an organizational system, it is extremely difficult, virtually impossible, to establish precise, mutually exclusive categories. It is an arduous task in analytic domains, as, e.g., in formal logic, where there is no empirical content. When we try to establish such categories in an empirical and operational area, experience defies such classification. In formal organizations, departments, offices, and positions are the equivalent of categories. Our attempts to render these precise and mutually exclusive fail in the face of the language we are obliged to use--

which itself is ambiguous. Anyone familiar with the tortuous tasks of position classification should be well aware of this fact. Moreover, human actors are nonlinear and multidimensional: they are "variable" actors who constantly, even inadvertently, spill-over across categories. Such categories are continuously assaulted by the task domain itself, for experience thrusts upon organization demands which differ from their departmental arrangements. Nor can such arrangements be protected from random events which bear grave, even traumatic consequences--so many of which are either unanticipated or underestimated. And finally, the system of departmentalization (or categorization) is often more a function of organizational politics, the demands of client groups, and the pressures of funding agencies than it is of careful planning.

2. If, however, we were able to excise all duplication and overlap, the result would be a system which is so highly specialized as to constitute a mass of virtually autonomous and irresponsible actors. In information theory, it is well-known that if there were no duplication or overlap in a transmitted message, there would be no way to detect an error. Similarly, if an organization were so precisely defined that all behavior fell into mutually exclusive categories, which is what the elimination of duplication and overlap means, then every actor would be engaging in work which only those in that class could understand and judge. Those outside the class (specialty) could not, for to be able to do so would mean that their functions and knowledge duplicate or overlap that class. This is why hierarchy itself must and does contain a considerable amount of duplication and overlap.

Now it may be said that the above paragraph pushes the argument to the

extreme, that, fundamentally, the question of duplication is a matter of degree--that what is wanted is the elimination of gross waste. To be sure. But the marked effect of "streamlining" efforts has been to push organizational systems toward precise definition in the hope of attaining optimality. Hence the extraordinary push to establish such devices as management-control systems. That they are rarely successful does not seem to slow the pace.[49] But they are dependent upon precise definition.

And this, interestingly enough, has exacerbated the conflict between the authority of incumbency (the authority of those who in virtue of their office may officially direct the organization) and the authority of the specialist (who alone is knowledgeable in his defined domain). Apart from the high cost of internal organizational conflict--clearly in evidence after the Washington METRO integration[50]--this again leads to an extensive and dangerous duplication. To protect against the specialist, incumbents enlarge their "staff" as a means of increasing their capacity to control. Thus, as duplication and overlap of line or operational departments is reduced, we observe sharp increases in the size of staffs which duplicate the line. While this phenomenon is somewhat characteristic of Bay Area transit operators, the most dramatic illustrations are to be seen in the growth of federal and gubernatorial executive staffs, which often appear as parallel bureaucracies.

3. If, again, we were able to excise all duplication and overlap, we would destroy all organizational informalities--which are, in effect, parallel information processing and communication channels. We have, we believe, already shown the vital importance of informal channels and networks to the Bay Area transit systems. While service redundancies are more

visible, it is the informal network which provides both an alternative to and a back-up for the formal lines of communication--which are often not reliable and usually very slow. Put succinctly, the informal network combined with formal lines of communication afford a redundancy of channels that makes the transmission of information far more reliable than it otherwise would be. Indeed, because the informal network arises out of need rather than design, it tends to be strongest where formal lines are weakest. It also facilitates cooperative arrangements that would be much more difficult to accomplish through formal channels alone. It should be apparent that informal systems are virtually indispensible in formal organizations.

4. And if, finally, we did succeed in removing duplication and overlap, in place of the "tight ship" anticipated, we would get a brittle system, incapable of coping with surprise or sustaining itself in the face of traumatic error and emergency. For such success would mean the elimination of all slack--and slack, as we have learned, constitutes a powerful reserve for any system.[51]

Because the concept of "slack" as a form of effective redundancy is not easily grasped, we introduce a case here. For an ordinary weekday in mid-1979, BART figured that 330 cars were required to carry its load at normal headways. In July 1979, because of labor difficulties, the number of usable cars fell to 185-195/day. Yet, BART was able to carry 90% of its usual load. This was accomplished by doubling headways on some lines, by removing two "extra" trains on the Concord-Daly City line, and by increasing the load factor to 2.5 passengers per seat. Despite the longer dwell time involved (because of the high load factor), 90% of the trains ran

within five minutes of schedule. BART ran about ten trains per line, each with fewer cars, and managed to meet its emergency until it ran short of control cars. The system broke down when the train operators staged a sick-out.

With slightly more than half of its cars available, BART managed to carry close to its usual passenger load. As a system, it remains as we show below, singularly vulnerable to technical error or equipment failure. But the fact that it possesses some slack provides a reserve that can be employed for certain kinds of emergencies.

Nor is there sufficient slack in the bus system. AC does not possess sufficient reserve to provide a back-up for BART for more than several hours at any time. During the tube-fire closure, it drew on its own slack to try to fill the gap. At that time, and later, during the strike, 100 private chartered buses were not enough. Even with present levels of duplication, there is not enough reserve in the system to provide effective back-up in the event of a major breakdown. This would appear academic but for the fact that major breakdowns, whether because of operational failure or labor strike, occur so frequently in the Bay Area. With the combination of Proposition 13 and an energy shortage, the problem promises to become more acute. As more and more people are pushed into public transit without appreciable increases in transit resources, the slack in the system is being eroded. And the consequences are not benign.

The removal of slack grinds an organization down to a subsistence level, so restricting its repertoire of response as to render it incapable of effective performance. It loses its capacity for innovation, for problem-solving, and for critical decision-making. One has to understand

that the absence of duplication and overlap in a system is a form of poverty, certainly not to be desired in and of itself. And yet it is made a principle. It is only in the world of public organization that surplus and reserves, that excess capital resources, are looked upon as waste. Who can imagine sustained and effective performance by a private corporation that has been stripped of all surplus? Just as surplus permits a private organization to handle unanticipated trauma, so too do public organizations--especially those that provide continuous services--require their own forms of reserves. And this is precisely what duplication and overlap provide. Both are aspects of the theory of redundancy, which is the heart of the theory of system reliability. It is only in the "world of frictionless systems" that one can propose the elimination of duplication and overlap. Only in that world can an organization work with zero redundancy.

A Reorganization of Bay Area Transit: Different Questions

Before engaging the theory of redundancy directly, let us contemplate a reorganization of the Bay Area transit complex in the direction of a unitary consolidation--one in which BART, AC, Muni, SamTrans, and Golden Gate were merged under one central directorate. This would be the course of action that logically derives from the concept of multiorganizational suboptimality, which instructs that separate units in an interdependent system act less effectively than if they were organized into a single entity.

In such an effort, however, the number of constraints involved, of both a technical and nontechnical character, is exceedingly large. On the technical side, which should present more decidable problems, our research

thus far indicates that the nature of the parameters engaged is of such order as to make precise and correct calculations difficult indeed. And this extends to engineering problems, headways, schedules, allocation of costs, and all manner of presumptively nonpolitical and objective factors, such as the effect of any single operator or combination of operators on the level of automobile traffic. The integration, e.g., of the six operators into one organization, would require a rationalization of schedules that would boggle the mind. It is nice to think that a single system would be able to standardize its operations, take advantage of economies of scale, and iron out the characteristic differences among operators--on the basis of calculable need. But the differences which exist are not a function of separate organizations. They arise because of variations in task domains. And there is no way to erase these. If we restrict ourselves to one illustration, standardizing buses, the point is made. Buses for use in San Francisco have low gearing to enable them to negotiate hills. Golden Gate uses a gearing which permits highway speeds, and AC sets bus gearing to permit both local service with frequent stops and express highway services. Because Golden Gate operates 80% long-haul service, its buses are air-conditioned, its seats are plush high-back recliners. Muni service is short-haul; its buses are not air-conditioned; its seating is a conventional local-service configuration. These only begin to list differences--composition of brake linings are another--which indicate that standardization and economies of scale are more easily proclaimed than realized.

On the nontechnical side, the problem becomes excruciating. The politics of a multicounty system, of numerous localities in the area; the wide array of interest groups; the diverse histories and traditions of the transit operators and the differences in their authority base, line of

accountability, structure of organization, modes of operation, and technology; along with such parties of direct interest as consumers, trade unions, businesses, banks, land holders, funding agencies, and more, are all factors that must be considered in designing the new system. The real problem, however, is to assign weights to these factors, to enable the identification of those factors that are critical. How much weight do we assign to the fact that any such reorganization upsets a transit complex that is generally stable and effective? How much to the fact that BART and buses are "quantum differences apart"--that "they are almost of different centuries"?

How much to the pattern of governance itself? Muni is governed by the San Francisco Public Utility Commission and the Board of Supervisors. It is a city agency. SamTrans and Santa Clara are under the control of county boards of directors--which are, in effect, the county boards of supervisors. Golden Gate, AC, and BART are special districts. BART covers three counties and has a Board of Directors elected on a geographic basis. AC covers parts of two counties, and its Board of Directors is elected partly geographically and partly at large. Golden Gate covers three counties, and its governing board is appointed by formula. If we are interested in rationalizing a system that is deemed by some to be "irrational," how do we "rationalize" the profound differences in interest that now exist? One need only examine Golden Gate to see the effects of a combination of divergent interest constituencies on the decision process: Marin and Sonoma representatives are perpetually at war with San Francisco, and board meetings are marked by bitter conflict, protracted debate, and divided votes.

And how much weight do we assign to the fact that a general

reorganization would reduce local access to decision-making centers? We enlarge on this point. In the city of Hayward, a Citizens' Transportation Consortium was set up after the first major gasoline crisis to try to produce an area transportation plan which would service the Hayward environs better. It also acts as a "watch dog," an access point to the City Council, and a channel of communication among citizens, operators, and the Council. It meets once a month, and both BART and AC are represented at its meetings. When BART wanted to transform Hayward into an unmanned station, the Consortium was activated into vigorous protest that led to a Council decision calling on BART to rescind its decision--which BART eventually did. The key point, however, is the fact that the Consortium and the Council, along with Hayward's Transportation Planner, were able to maintain continuous contact and easy access to BART officials. Moreover, Hayward's Consortium and its planner enjoy close relations with AC by means of well-developed informal channels. So close are these relations that twice Hayward functionaries "alerted AC that SamTrans had plans to encroach upon AC territory." When asked about the idea of "rationalizing the system," of consolidating and merging operators into an integrated network, the response was clear: such action would further remove the transit operation from the needs of the community; Hayward would lose access to its prime operators, as well as its leverage in dealing with them. Hayward actors were well aware of the advantages they accrued as a direct result of AC-BART competition, and they were not about to lose them.[52]

In the East Bay generally there has been built up an elaborate network of informal channels between cities and operators, and merger is uniformly opposed by city officials on the ground that access would be lost.[53] How much weight does one assign to the friction, to the rise in conflict level,

that usually arises as a result of rationalizing reorganizations.

Such calculations are rarely made, and, clearly, at the present stage of our knowledge, quantitative weights cannot be assigned. But such problems are real and exert powerful forces which cannot be minimized. They are, however, largely because of the inordinate propensity of designers to fix on those factors which can be quantified to the exclusion of others--a strategy which in no way helps to determine which of the numerous sets of constraints are vital. Actions of this kind are downright stupid, at best paradoxical. That is, they are self-subverting. Reorganizations of the most carefully engineered kind have foundered on the fact that the conflict levels they produce were so high as to guarantee their failure, PPB being the most recent case in point.

Even if our theories were capable of providing us with truly powerful measures, we would still have to proceed cautiously. And caution here means that the format or design that is used cannot be specified with exactitude. Precise definitions of task, role, office, jurisdiction, and function would be fruitless and dangerous. Nature is notorious for the uncertainties it generates. Or, as Simon Ramo once put it, there is noise in every system and in every task domain. The situations which confront public organizations may at times appear placid, but they often erupt into turbulence. And were we to design a system for Bay Area transit that actually eliminated duplication and overlap, it might gladden the rationalizers among us, but its tolerance margins would be so close as to court disaster. That is, in the face of error, even of a minor kind, they would suffer visible and serious damage--to the point where the integrity of major operational tasks would be at stake. But systems which possess slack,

which duplicate and overlap, possess the capacity to detect and correct error even while it is occurring, and thereby to reduce its effects.

Redundancy and System Failure

The preceding discussion may well be considered abstract, quite theoretical, and removed from reality. It may even be said that the argument makes sense but doesn't work in practice. Well, let us see. And to this purpose, we employ the testimony of Frank C. Herringer, then General Manager of BART. BART, as all of us know, was a space-age marvel that was so finely tuned as to eliminate virtually all duplication and overlap. Here is Herringer:

> The BART system was designed in a manner that makes it extremely intolerant of even minor equipment failures. For example, even a single brake failure on one train can have catastrophic impact on system performance because as designed, when braking capability is lost on one car in a ten-car train, the entire train must proceed at only 50 percent of normal speed, which in turn forces all following trains to slow down. Similarly, when an Automatic Train Control component fails, and the train must revert to manual control, the maximum safe speed is 25 m.p.h. compared to the scheduled 80 m.p.h. top speed. This substantial degradation in performance, combined with a track layout that provides for very few spur tracks on which to store "sick" trains and the existence of a complex merge of BART lines in Oakland which tends to exaggerate the effects of problems, means that a single equipment problem can and does cause delays throughout the system.
>
> It is this characteristic that most distinguished BART's performance from many of the older Eastern rail systems. The failure rate is probably not much worse than in New York, but the system as a whole is incredibly intolerant of failure.
>
> It seems clear that BART was designed with the assumption that nothing would ever fail--the inverse of Murphy's Law, which actually seems to be more applicable to BART than anywhere.[54]

Alas, however, Herringer didn't quite grasp the implications of his own remarks. Three days before this statement, in a meeting with the authors, one of the goals he emphasized was to eliminate duplication.

The single, most crucial element to consider in thinking about organizations is the fact that they are not immune to error. No matter how carefully designed, how perfectly programmed, every one of its components--man, machine, or linkage--will at some time or other confound our expectations, and more often than we hope. The human being is variable. His behavior is a function of many forces, and it is folly to think, as Taylorism once proclaimed, that we can calculate his optimal values. He is a risky actor, and the best we can do is to speak of a "zone of indifference" or a "zone of acceptance" within which he will perform adequately. But we cannot, with any degree of precision, mark his limits. When we describe him, we do so approximately. We can't do all that much better with hardware. Every train, every motor, every change dispenser, every computer, and every transistor, gear, relay, brake, and turnstile "has some range within which it deviates from its optimal value." As do organizational units. Each carries its own range of potential surprise, and this "faithfulness" spreads across the entire system. There simply is no such thing as zero tolerance--a fact which escaped notice when BART laid its tracks or designed its braking system. It seems clear that the image which prevailed when BART was built was that of a decision-machine, the elements of which were to be so designed as to articulate unfailingly to attain the stated goals and objectives--including the 90-second headway. And this was to be done by using the least number of units that could possibly be employed in achieving these goals. Historically, zero redundancy has been the measure of optimality, and the picture which emerges is that of a perfectly

connected means-ends chain with not an excess link in it.

And that is why BART has had to have "several long term programs underway" to ease the problems caused by the original design; why it has had to develop "prototype" systems that allow a train operator (originally thought of as unnecessary duplication) to control the speed of the train when the automatic controls do not work; why it now considers adding a third track in Oakland; and why it needs to find additional spurs and cross-over tracks as well as storage sites in Daly City--where else can they park "problem trains," as Herringer put it? And this is also why BART, in 1973, designed a "back-up" system for basic train protection--only to find that additional safety measures were required, "including rewiring of the entire system to allow for safe stopping distances when there are wet tracks." Small wonder that both BART and the California Public Utilities Commission "do not yet believe that the automatic system that protects trains is sufficiently reliable. . . to ensure safety."[55] One wonders what the extent of belief is after the disaster of the tube fire.

Most organizations suffer from the assumption that the reliability and efficiency of a system is a function of the reliability and efficiency of its parts and linkages. To improve performances, therefore, they invest heavily in their components. Whether in the form of executive development and in-service training programs, the redesign of communication channels, management control and information systems, or updating and replacing machines, the investment is rarely criticized and never regarded as waste. Its warrant has been the classic maxim that a chain is no stronger than its weakest link.

Now it is true that this strategy produces improvements. Yet it is most doubtful that the risk of failure can be removed by perfecting parts. First, there is a limit beyond which a part cannot be improved and, second, no matter how carefully constructed, how much it is perfected, the chance that it wll fail cannot be ruled out. To ignore this fact may be a tolerable risk--for failure can be only of the order of nuisance. But in a complex system, where interdependent components are tightly coupled into means-ends chain, failure easily exceeds tolerable limits. In such systems, clearly exemplified by BART, there is a pronounced tendency for even minor errors to be so amplified along the length of the chain as to make the end result quite unacceptable. The failure, then, of a single part can means the failure of the entire system: as when the breakdown of a switching circuit in a power grid blacks out an entire region, or the breakdown of a single train brings every other train to a halt, or a slowdown at one point produces a progressing, increasing slowdown at every prior point. In complex and tightly coupled systems, the cost of error runs very high.

It is in this context that redundancy attains its power. It sets aside the doctrine which ties the reliability and efficiency of an organization to the reliability and efficiency of its parts, thereby approaching the pragmatics of organizational action much more realistically. That is, it accepts the inherent limitations of any system by treating any and all parts, regardless of their degrees of perfection, as fallible--as prone to error. And it does more. It upsets the time-honored notion that a chain is no stronger than its weakest link. In fact, the theory derives from the opposite question: "Is it possible to take a set of individual unreliable units and form them into a system with any arbitrarily high reliability?" Can we, in simple terms, build an organization that is stronger, more

reliable than any of its parts? The answer is affirmative: it can be done by adding sufficient redundancy. And the simplest forms of redundancy are duplication and overlap.

We demonstrate this in the case of duplication quite easily. Suppose we needed a channel or pathway that was immune to closure or breakdown. Suppose, too, that the chance of failure was 1 in 1000. Now we could perfect that channel to the point where the chance of failure was 1 in 2000--a 100% improvement. We might even go to 1 in 4000. But suppose, as an alternative strategy, we simply duplicated the pathway--i.e. provided a second channel, independent of the first. We now have two channels, each, we shall assume, rated at 1 in 1000. But we also have a reliability factor of 1 in 1,000,000--which is precisely the probability of the simultaneous failure of both channels. Readers will recall the first 1976 Ford-Carter debate when the audio system failed. ABC, which provided the channel, located the problem in a faulty one-dollar condenser. Later it stated that "it and the amplifier it served were considered so reliable no back-up system was required." When CBS televised the second debate, it provided two separate systems, one duplicating the other. We should also note, in the instance above, that if we add two duplicates, reliability would be increased to the point where the chance of failure would be one in one thousand million--or 1,000,000,000.

We show here how a chain can be made stronger than its strongest link; how, as the great Von Neumann put it, we can synthesize reliable organizations out of unstable components.[56] The theory of redundancy, which permits us to do so, is now a complicated set of formulations which, for the purposes of this paper, we do not dwell on. But there is one theorem,

exemplified in the illustration above, that we must stress: the probability of failure in a system decreases exponentially as redundancy is increased. Increasing reliability in this manner does raise the cost, but an immediate corollary of the theorem eases the problem, for it requires only arithmetic increases in redundancy to yield geometric increases in reliability.

The application of this formula depends upon the ability to construct a system so that it satisfies those conditions which permit the laws of probability to apply. In this case, it is the product rule for independent events; alternatively, the failure of parts must be random and statistically independent (unrelated). In practical terms this means that a system must be so arranged that when parts fail they do so unpredictably, and in such manner that they cannot and do not cause a breakdown in other parts-- as in the dual braking system of a car. If each such unit is not completely separate from the other, then redundancy is not only waste, it becomes a very dangerous condition. Redundant additions must be in parallel; they cannot be tied in series.

This is what we now have in the Bay Area--a network of independent operators who exhibit a redundancy of capacity, route, and linkage. And, as AC's strike, BART's tube-fire, and the BART's strike indicate, the whole system has been more reliable than any of its components. Transportation was not brought to a halt by the 1978 AC strike, the system was not destroyed by a two-and-a-half-month cessation of BART traffic through the tunnel, and the fact that BART did not run for months during the strike was compensated for by the other operators. Where one component has failed, others have taken over the load. Because of this redundancy, the system as a whole, in Herringer's idiom, has been incredibly tolerant of failure--

precisely the function of redundancy. For historical reasons, single-line, unitary arrangements in the form of hierarchical and centralized systems have not been permitted to develop in the Bay Area. In its place, we have a flat, loose-coupling of multiplexed (multiple lines in parallel) operators who so function as to provide extraordinary safety margins for the Bay Area transit system.

The question to be asked of this system is <u>not</u> whether <u>there</u> <u>is</u> <u>duplication</u>: <u>but</u> <u>whether</u> <u>there</u> <u>is</u> <u>enough</u> <u>duplication</u>. The Law of Redundancy is a law of <u>system</u> <u>reliability</u>. It does not fix on components, its focus is the entirety--the whole system. And this is what we are addressing. Our concern is whether Bay Area transit possesses sufficient inner strengths as to operate with some reasonable level of effectiveness, even when it suffers major and traumatic shocks. It suffered one during the long 1979 strike when BART, a major carrier, was incapacitated. Yet people got to work on time, did their shopping, and went about their business in, what was for them, a tolerable manner. The economic life of the region remained vital, even though injured. And the reason is that the system provided alternative pathways, back-ups, and shock reducers, much of which would be lost in a unified, integrated, and centralized system which is, by its nature, hooked in series. Had the Bay Area followed the model of the Washington METRO, a tube-fire or a major strike would have wreaked havoc on the entire system.

How Much is Enough?

In the last analysis, the question comes down to the kinds of trade-offs we wish to make between economic efficiency and organizational relia-bility. Can we appreciably improve the overall efficiency of the transit system without impairing its reliability? Except on the margins, we think not. Just as a discussion of formal integration cannot proceed without a consideration of organizational informalities, so it is dangerous to dis-cuss improvement of economic efficiency without taking account of its impact on reliability. In this era of public outcry for cutbacks in government spending--the so called "Proposition 13 mentality"--a position advocating the continuation of redundancy, let alone increases in it, is not easily defended. For the long-term vitality of the Bay Area transit system, however, we believe it is the only tenable one.

Unfortunately, although we can safely predict that increasing the level of redundancy in an organizational system will improve the reliabil-ity of that system in a general sense, we are unable to state with a high degree of confidence how much redundancy is enough. There are several rea-sons for this. Unlike the mechanical world, where the level of knowledge permits the types and frequency of failure to be predicted fairly accu-rately and appropriate back-up systems to be installed, the uncertainty involved in an organizational system is usually of a much higher order. It is simply much more difficult to pinpoint expected problems and identify the frequency with which they are likely to occur. The problem is exacer-bated by a lack of agreement about what level of reliability is desirable, or conversely, what rate of failure is acceptable.

What we can say is that the answers to how much and what kind of redundancy are enough depend upon trial and error (experience) and cannot be calculated a priori. A priori calculations depend upon subjective probability estimates of worst-case scenarios. We have seen that the BART estimates of how long the system might be shut down, of what it would need in the way of an AC busbridge, both based on a worst-case scenario of several hours, were invalidated by a tube-fire that would have left that part of the system closed for days even without the intervention of the Public Utility Commission. As it was, the tube remained closed for several months. Where, however, accurate probability values can be assigned to specific failures, back-up systems must be provided. And where they can't, bolstering organizational redundancy in the form of slack is certain to ameliorate the effects of unanticipated failure.

Should the Bay Area transit suppliers be merged into a unified and centrally managed enterprise? Clearly the answer is no. The level of service currently provided is excellent. Overall system reliability is probably as high as any in the nation. A multiplicity of operating agencies offering a multiplicity of services, especially where they do so along parallel routes, have created an outstanding public transit system. The experience of metropolitan areas elsewhere suggests that merger and centralized management would likely lead to lower tolerance of errors, loss of effective informal communication channels, lessened coordination, and much more red tape.

The present organization of transit services in the Bay Area appears messy and wasteful when viewed through the lenses of classical public administration doctrine. But it turns out to be remarkably adaptive,

stable, and effective; and it is duplication, informal channels, and direct competition that underlies its success. However well intentioned--whether in the name of efficiency or civic responsibility--to merge them into a single superagency would guarantee deterioration of one of the finest transit systems in the world.

FOOTNOTES

1. Lowdon Wingo, Jr. and Harvey S. Perloff. "The Washington Transportation Plan: Technics or Politics." Papers and Proceedings of the Regional Science Association, V.7, 1961, p. 249.

2. David W. Jones. The Politics of Metropolitan Transportation Planning and Programming. (Institute of Transportation Studies, University of California, Berkeley and Irvine, 1976), pp. 27-33.

3. Ibid, pp. 27-33.

4. Ibid, pp. 19-23.

5. Christopher C. Hood. The Limits of Administration. (John Wiley, New York, 1976), Ch. 4.

6. W. S. Homburger and V. Vuchic. "Federation of Transit Agencies as a Solution for Service Integration." Traffic Quarterly, V.24, No.3 (July, 1970), pp. 373-392.

7. Except when it is "affected with a public interest" and established as a public utility under state and/or federal regulation.

8. William A. Niskanen. Bureaucracy and Representative Government. (Aldine-Atherton, New York, 1971).

9. Martin Landau and Russell Stout. "To Manage is Not to Control." Public Administration Review, V. 39, No. 2 (March/April, 1979), pp. 148-156.

10. William T. Morris. Decentralization in Management Systems. (Ohio University Press, Columbus, 1968), p. 12.

11. Landau and Stout. "To Manage is Not to Control."

12. We simply cite this as typical: see David W. Jones, "Transportation in the Bay Area." Public Affairs Report. Institute of Governmental Studies,

13. Herbert A. Simon. Administrative Behavior. (Macmillan, New York, 1947), p. 26.

14. "Better Government as Less." Statement of Lyle C. Fitch before the Subcommittee on the City, Committee on Banking, Financial and Urban Affairs, U.S. House of Representatives (July, 25, 1979).

15. See Jonathan Bendor, Structure, Competition, and Reliability in Planning and Operations, Volume IV of Redundancy in Public Transit (Institute of Urban and Regional Development, University of California, Berkeley, 1980). Bendor's interviews numbers 8 and 12 are also source documents for this report.

16. Effective performance is measured by the discrepancy between expected outcome and actual outcome. Efficiency is a cost measure. Logically, any measure of efficiency which is not based on effective performance is spurious. True cost figures must be expressed in terms of the degree of effectiveness.

17. For an interesting and powerful discussion of these factors, see Charles E. Lindblom, Politics and Markets (Basic Books, New York, 1977).

18. James March and Herbert A. Simon. Organizations (J. Wiley and Sons, New York, 1958), pp. 158-161.

19. Landau and Stout. op.cit.

20. Bendor. op.cit., Chapter 5 and 6.

21. Harold Seidman. Politics, Position and Power (Oxford University Press, London, 1975, second edition), p. 196.

22. Victor Thompson. Bureaucracy and Innovation (University of Alabama Press, University, 1969), and David Braybrooke and Charles E. Lindblom. A Strategy of Decision (The Free Press, New York, 1970).

23. Jones. The Politics of Metropolitan Transportation Planning and Programming, op.cit. p. 35.

24. Seidman. Politics, Position and Power, p. 196.

25. Tom Burns and G. M. Stalker. The Management of Innovation (Tavistock, London, 1961).

26. Interview No. 8.

27. Interview Nos. 4 and 5.

28. Interview 8.

29. Interview No. 4.

30. Interview No. 8.

31. Interview Nos. 5 and 11.

32. Interview Nos. 11 and 13.

33. Interview No. 13.

34. Interview No. 2.

35. Intervew No. 44.

36. The discussion of the tube fire and its aftermath is based upon Memorandum no. 1 and Interviews nos. 36, 38-44.

37. Interview No. 47.

38. For example, on Tuesday, August 28, 1979, AC received 16,260 transfers from BART. Because of labor problems BART was carrying only about eighty-five percent of its usual passenger load, and it was during summer vacation.

39. AC realigned some ninety-nine bus lines or over ninety percent of its lines in district one, which made the transfers viable.

40. Note that the figure given refers to purchases rather than transfers actually used. Currently Muni keeps track only of purchases and does not actually count transfers received on its buses.

41. Interview No. 18.

42. Interview No. 50.

43. Interview No. 17.

44. Interview Nos. 5 and 11.

45. Interview Nos. 16 and 19.

46. Interview No. 36.

47. Interview No. (old #38).

48. See Martin Landau. "Redundancy, Rationality and the Problem of Duplication and Overlap." Public Administration Review, v. 29, July 1969.

49. Landau and Stout. op.cit.

50. Bendor. op.cit.

51. See David W. Jones, Robert Taggart, and Edith Dorosin. The Metropolitan Transportation Commission: An Innovation Experiment in Incremental Planning; A Cautious Experiment in Regionalism. The Stanford Transportation Research Program and the Center for Interdisciplinary Research, Stanford University, 1974.

52. Interview Nos. A2 and A3.

53. Interviews Nos. A7, A9, A11, A14, and A16.

54. Frank C. Herringer. "U.S. Urban Mass Transportation and BART." Address delivered to the Commonwealth Club of California, July 28, 1978, pp. 5-6, emphasis added.

55. <u>Ibid</u>, p. 7.

56. See W. H. Pierce. "Redundancy in Computers." <u>Scientific American</u>, V. 210, 1964. C. E. Shannon and W. Weaver. <u>The Mathematics of Communication</u>. (Urbana: University of Illinois Press, 1949). John Von Neuman. "Probabilistic Logics and the Synthesis of Reliable Organizations from Unstable Components," in C. D. Shannon and J. McCarthy, editors, <u>Automata Studies</u>, (Princeton: Princeton University Press, 1956).