should be an impartial body established that can review and assess the data collecting and to see that the proper information is provided and made available to all industry parties. At this stage, it would seem that this is a very important issue. There needs to be a better data base and it needs to be made available as soon as possible.

The discussion ended with a comment on the costs of transit as seen in a societal context. One of the purposes of transit may be to improve the economic base of the community. A project designed to enhance that economic base may look very bad in terms of transit costs. If a report goes to Washington, a transit facility could be penalized because of these high costs although the project may be the lifeblood of the community. DOT will have to broaden its scope in examining financial reports to include more indicators of the economic viability of the community.

Growth of Productivity and Labor Relations in Urban Mass Transit

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The urban mass transit industry is clearly in great difficulty. Transit patronage has steadily declined; in 1975 it was barely one-fourth the level of its peak in the 1940s. Many transit firms have gone out of business, especially in smaller urban areas and in the suburbs. Among those firms that remain in operation, service has usually been cut back, sometimes severely. The decline in patronage has continued, moreover, despite efforts by the remaining properties, especially in the past 15 years, to raise fares and cut back service only slowly. In the face of inflation and ridership losses, these fare and service policies led to enormous and rapidly growing deficits, usually publicly subsidized and accompanied by public ownership. By the mid-1970s, publicly owned properties probably carried 90 percent of all transit riders; passenger-fare receipts barely covered half of the industry's operating costs and a much smaller proportion of its total costs. Reliable estimates of the transit industry's nonoperating costs are not available, but estimates of ridership in publicly owned firms, passenger revenues, and operating expenses can be found in the Transit Fact Book (1).

Some observers suspect that the postwar decline of transit is partly attributable to the failure of growth in productivity in the industry to keep pace with growth in other industries. Slow growth in productivity undoubtedly contributed to transit's current difficulties, and an improved record of productivity would surely be helpful, although it might not be sufficient to reverse the industry's financial decline. To achieve improved productivity, labor-management cooperation will be important, in part because the most important opportunities for improvement in productivity commonly involve adjustments in long-standing work rules or other labor practices. If labor and management recognize that they have a common interest in the financial health of their industry and thus in increased productivity, a variety of possible strategies for improvement in productivity might be pursued.

IMPORTANCE OF IMPROVING PRODUCTIVITY

Productivity is the ratio of outputs produced to inputs consumed. Transit productivity must keep pace with that in other industries or the industry's services will become more expensive and less competitive than the services of other industries. Productivity can be improved either by increasing outputs while inputs are held constant or by decreasing inputs to achieve a specified output. In transit, this generally means providing services more highly valued by the industry's patrons without using extra labor or capital inputs (thus generating more revenue) or making the existing service provision more efficient by cutting costs without affecting output or revenue.

A slow rate of growth of productivity is not the only possible, and probably not even the leading, explanation for the transit industry's current difficulties. At least three trends beyond the industry's control have contributed to transit's decline over the past 30 years and are likely to continue to do so in the future.

The most important of these adverse trends is the rising level of personal incomes. Higher personal incomes increase the amounts people are willing to spend on travel, thereby making the automobile, with its privacy, relatively high comfort level, instant availability, and door-to-door service, a more attractive alternative. Transit cannot provide as comfortable, convenient, or even as fast service at comparable cost unless highway congestion, land prices, and the density of travel demand are all unusually high (2). Thus many of the amenities associated with the automobile might be provided by transit but not without increasing transit costs, probably by more than passengers are willing to pay. In addition, rising incomes affect transit adversely by increasing the wages transit companies must pay to attract qualified drivers and other personnel. This is especially important because transit costs are more sensitive to wage increases than the costs of automobile use; while transit drivers must be paid, most automobile users do not appear to find the task of driving all that onerous.

A second trend contributing to reduced transit rider-

ship and profitability is the postwar suburbanization of residences and employment. Changing manufacturing technologies, rising incomes, the postwar baby boom, the proliferation of highways, and a variety of other factors fostered these changes in location. But whatever the causes, suburbanization has reduced the relative demand for the types of trips for which transit is most competitive with the automobile: trips to and from the centers of large, dense, older metropolitan areas.

Finally, the transit industry has been hindered by a steady increase in the proportion of total transit trips that are made during the hours of peak transit use: the weekday morning and evening rush hours. The peaking of transit demand has become more pronounced partly because the suburbanization of residences is proceeding more rapidly than the suburbanization of jobs. As a result, the number of nonwork trips to downtown areas, which tend to be made in the off-peak, are declining in relation to the number of work trips to downtown, which tend to be made during the peak. Automobiles are also more attractive for off-peak trips because highways are less congested at that time and because these trips are often made in family groups, so that the automobile cost per passenger is lowered. The resulting concentration of transit trips in the peak period means that transit systems are increasingly underused for all but a few hours each weekday. The idle right-of-way, equipment, and employees during the off-peak period increase the costs of peak-period transit travel.

These trends, all adverse to the economics of transit, are unlikely to abate in the near future. Personal incomes, for example, probably will continue to increase. Moreover, two recent developments that have encouraged the transit industry—the regulation of automobile air pollution and rising energy costs—promise scant long-term relief. The potential effect on automobile costs of automobile pollution controls and rapid increases in energy prices can be offset in a variety of ways, such as using smaller and lighter cars or by adapting engine and gearbox designs. In short, the total automobile bill may remain much the same, albeit at some small degradation of what are perceived by many to be the automobile's amenities.

These continuing trends in income, suburbanization, and peaking will have a major effect on the growth of productivity in determining the industry's future. Nevertheless, even if improved productivity is not sufficient to singlehandedly reverse the industry's fortunes, it can significantly upgrade transit's performance. In fact these trends, which are beyond the industry's control, may make improvement in productivity more important in the industry's future. Without productivity gains to reduce costs and make services more attractive, the patronage, employment, and financial strength of the industry may decline even more rapidly in the future than they did in the past.

Although measuring the growth or decline of productivity in the industry is difficult, the most likely estimates of transit's postwar productivity record support the view that improvement in productivity is essential to the industry. The fundamental difficulties in measuring productivity for any industry are in developing acceptable measures of the rates of growth of outputs and of capital and labor inputs. In the transit industry, the problem of constructing a satisfactory index of outputs is especially difficult.

Previous analyses of transit productivity, by John Kendrick (3) and others, considered transit's basic output to be the transportation services provided to passengers and estimated that transit's productivity record was extremely poor (4, 5). Although no available metric adjusts satisfactorily for changes in the quality of passenger services rendered, the number of passengers or of passenger-kilometers is a fairly reasonable measure of the basic services provided to passengers by transit. If the number of passengers carried is used as the basic output index, total factor productivity (the ratio of outputs to an index of total factor inputs, both capital and labor) declined at an average annual rate of 1.2 percent from 1948 to 1970. Since the industry has been slowly substituting capital for labor, labor productivity (the ratio of outputs to labor inputs) declined at the slower average annual rate of 0.7 percent, while capital productivity (the ratio of outputs to capital inputs) declined at the faster annual rate of 1.3 percent.

Postwar trends in transit productivity probably have not been quite that adverse, however. The widespread public subsidization of transit services suggests that many people feel that transit produces socially important by-products in addition to the transportation services it provides passengers. These social outputs, which are admittedly extremely difficult to measure, might include reductions in automobile air pollution, energy consumption, and congestion, as well as aid to people who do not have ready access to an automobile because of poverty, age, or physical handicaps. Concern about these benefits often mandates that transit service be maintained despite declines in ridership; accordingly, the number of vehicle-kilometers operated might be a crude (though possibly optimistic) but measurable metric for these social outputs. Using this output index, transit productivity increased rather than declined during the postwar period. Total factor productivity rose at an average annual rate of approximately 0.6 percent, while capital and labor productivity increased at rates of 0.5 and 1.0 percent respectively.

Even using the most optimistic estimates of the industry's performance, however, transit's record of growth in productivity is substantially inferior to that experienced by other industries. For example, although total factor productivity in transit may have increased by as much as 0.6 percent/year during the postwar period, total factor productivity in the nonfarm domestic sector increased at a rate of about 2.5 percent/year during the same period (3). If transit output is measured in terms of services provided to passengers, the gap between productivity in transit and other sectors is, of course, even larger. Continued failure to keep pace in the growth of productivity will result, of course, in some combination of rapid increase in the industry's deficits (and its dependence on public subsidies) and the slow but certain pricing of transit services out of the market.

PRODUCTIVITY AND LABOR RELATIONS

Cooperation between labor and management is important if transit productivity is to improve. Some of the more consequential productivity improvements involve changes in working conditions, work rules, or compensation practices that are part of the labor contract and thus are clearly subject to labor-management negotiation. Even if the changes involve policies and practices that are not normally part of the labor agreement, labor's advice and cooperation are often the key to successful implementation.

Transit's undistinguished productivity record suggests that labor and management have not been as successful as they might have been in working toward increased productivity. An important factor complicating postwar labor relations has been the deteriorating financial position of the industry and the resulting fluc-

tuations in the size and composition of the transit work force. In the two decades after World War II, transit employment declined almost as quickly as ridership, from about 240 000 workers in the late 1940s to about 140 000 in the mid-1960s. Most of the labor force reduction was accomplished through natural attrition, but labor's concern about the declines in the unions' memberships and the possibility of layoffs or reduced pay often made negotiations difficult. With the advent of substantial public subsidies, transit employment stabilized in the late 1960s and increased by almost 20 000 between 1970 and 1975.

The reversal in transit employment trends did not remove the threat of layoffs or low pay, however, because of the uncertainty about the public's continued commitment to fund the required subsidies. Moreover, the new employment further complicated labor relations by creating a work force composed of two large groups with different interests and attitudes: older workers close to retirement and younger workers hired after the mid-1960s. Tensions within the transit unions sometimes developed because the younger employees tended to be more interested in improving wages than in pensions or other benefits and because the younger workers often included larger proportions of ethnic or racial groups that were different from the older, established leadership.

Extensive public involvement in the industry may also have increased the possibility of labor problems. Public officials, who often lack experience in labor relations or the transit industry, in many instances have had the power to intervene in negotiations in which transit firms are publicly owned or subsidized. While this power may be necessary, it has made the course of labor negotiations less predictable and therefore more difficult. Management's bargaining position can be weakened by the possibility of appeal to public officials outside management. Moreover, these outside public officials may be sympathetic to labor's perspective, if only because transit workers and their families and friends represent a large and well-organized block of voters. Labor leaders, by the same token, have become frustrated because they have no single authoritative counterpart with whom they can negotiate. Agreements reached with one responsible public official or manager are sometimes repudiated by another, especially as the fiscal problems of local governments worsen.

Chances for labor peace are further diminished by the vulnerability to strikes of labor and (to a greater extent) management. Labor may be vulnerable because the modest skills required for some transit jobs may make it possible to recruit and train new workers in the event of a strike. On the other hand, transit management can be strongly affected by strikes because transit service, like most other services, cannot be stockpiled against a work stoppage. Moreover, temporary interruption of transit service can cause substantial hardship to riders and others, especially in the larger, older metropolitan areas where transit carries a significant share of the peak-hour work trips. Finally, while transit strikes are illegal on many publicly owned properties, the antistrike laws are often not enforced and can be circumvented by, for example, running strictly by the rules or other such practices.

Unfortunately, many of the factors that have made postwar transit labor relations difficult have also shaped attitudes on the part of labor and (perhaps to a greater extent) management that discourage the search for opportunities to improve productivity.

Transit labor, while often cooperative in negotiating productivity improvements, has been slow to recognize that in the long run improved productivity is a prerequisite for increased employee compensation if the industry is to remain viable. The transit unions have taken great care to see that transit workers do not suffer from the declining fortunes of the industry. Accordingly, labor has argued that the increasing deficits and poor productivity record of the industry are the result of factors beyond the employees' control, especially public decisions to pursue certain social goals by maintaining extensive service in spite of declining patronage. In their view, transit workers should not be forced to pay the costs of such social policies through wage increases smaller than those received by workers with comparable skills and duties in other industries. Labor's argument, however, tends to overlook the fact that even when the social outputs of transit service are measured, albeit crudely as in the estimates reported previously, transit's productivity record still falls short of the record in other sectors.

Labor's success in gaining wage increases in recent years has, of course, made improved productivity an even more important goal for the transit industry than it would have been otherwise. The best yardstick of compensation for transit labor is the wage rate of transit operators or drivers. Operators are the largest single group of transit employees and the wages of most other employees, such as collectors, guards, starters, and maintenance workers, are traditionally keyed to the operators' rates. In a few firms in which maintenance employees are organized into craft unions, maintenance wages are usually tied to the prevailing craft rates for construction rather than to the operators' rates. However, in these firms maintenance wages have still increased at about the same rate as operators' wages, since wage rates in unionized building trades have generally gone up at the same pace as operators' rates.

In the postwar period as a whole, wage rates for operators have increased more rapidly than wage rates in many private-sector jobs: Operators' hourly wage rates increased at an average annual rate of 5.6 percent between 1950 and 1974, while wage rates in the private nonfarm economy as a whole rose by an average of 4.9 percent/year (6). If transit wage increases just matched the wage gains of other industries, productivity growth in transit would have to just keep pace with that in other industries in order for the relative costs of transit and other goods and services to remain similar. But since transit wage gains have been more rapid than those in other industries, transit productivity gains must outstrip productivity growth in other industries if the relative costs (expenses incurred, not necessarily the fares charged, since these can be stabilized if subsidies are forthcoming) of transit and other goods are to remain stable.

For its part, transit management has not always been overly aggressive in identifying and negotiating productivity improvements, particularly those that involve labor most directly. In some properties officials leave important aspects of labor negotiations to shop supervisors or to the junior management staff, giving little direction from the top. This is generally not a sign that top management feels labor issues are unimportant; most transit officials agree that labor productivity and compensation are key problems facing the industry. Rather, such managements apparently believe that they can do little to improve the current situation, partly because of the disruptive potential of transit strikes and the likelihood that their efforts will be thwarted by the intervention of local public officials.

Management efforts to negotiate improved productivity have also been discouraged, probably unnecessarily, by section 13c of the Urban Mass Transportation Act of 1964 (7, 8, 9). Section 13c was based on congressional

concern that federal transit grants might be used to purchase equipment that would replace employees. Congress stipulated that employee compensation and working conditions could not be made worse by the receipt of federal grants unless generous payments, specified in section 13c, were made to the affected workers. For example, a worker laid off because of a grant must receive full severance pay for 4 years or the length of his employment with the transit firm, whichever is shorter. The U.S. Department of Labor has been given the responsibility of determining, in the event of a dispute between labor and management, whether the law's requirements have been met.

Some transit officials argue that the provisions of section 13c significantly enhance labor's bargaining strength, particularly over productivity issues, by giving it the power to disrupt the flow of federal aid that has become so important to the industry. Their concern appears to be exaggerated, however, because few grants affect working conditions and compensation adversely and section 13c prohibits only changes that are unilaterally imposed by management and not those that are negotiated through the normal collective bargaining process. Most importantly, section 13c is only one of many factors, including the internal tensions of the unions or the local political climate, that determine the relative bargaining strength of labor and management.

A more active role for management in the negotiation of improvement in productivity, while it is not without its risks, is essential for future gains in productivity in the industry. Although labor leaders may recognize the importance of improved productivity to the future ability of the industry to pay wage increases, they normally are not in any position to initiate productivity proposals. To do so might jeopardize their position with certain elements among their membership. Quite understandably, labor looks upon the pursuit of gains in productivity as a management function and, unless industry managers seek it, prospects for greater productivity will be negligible.

If labor and management recognize the importance of productivity and management becomes more aggressive in identifying and proposing changes, the prospects for rapid growth in productivity would seem excellent. There appear to be many unexploited or underexploited opportunities for gains in productivity in the industry; they are described briefly in the remainder of this analysis and in more detail elsewhere (5). Admittedly, some of these opportunities for improved productivity are less readily adopted than others. A few of the suggestions made here would require significant changes in the current practices of the transit industry, and thus a careful examination of the practical problems involved would be required before they could be implemented. Some significant changes in industry practices may be necessary to alleviate long-standing productivity problems, however. Careful consideration of even these more difficult suggestions would seem worthwhile, therefore, if productivity growth is deemed important to the future of the industry.

ALLEVIATING THE PEAKING PROBLEM

Most of the opportunities to improve transit productivity can be sorted into three groups, each of which incorporates a distinct strategy for gains in productivity. The first and possibly most important of these strategies is to alleviate the productivity problems associated with the peaking of transit use during the morning and afternoon weekday rush hours. Peaking of transit demand causes the underutilization of transit right-of-way, equipment, and employees for all but a few hours per day. The share of transit trips taking place in the peak hours has increased during the postwar period and is likely to continue to do so in the future. As a result, the severe productivity problems associated with the pronounced peaking of transit demand are likely to become even more critical in the future.

Work rules that constrain the use of part-time drivers or the assignment of drivers to split shifts or runs (a daily work assignment that has a long unpaid break in the middle) are a significant cause of the peaking problem. Improving peak-hour labor productivity is extremely important because labor costs typically constitute 60 to 80 percent of transit operating expenses. Unless transit properties can use part-time labor or split shifts, they cannot meet peak labor needs without having extra employees during the off-peak hours. The use of part-time employees is prohibited by labor agreements in all but a handful of the smaller transit firms. In most firms, labor agreements also restrict the use of split shifts by limiting the proportion of such runs to 40 or 50 percent of the total, specifying a limit to the permissible total length of any split run (usually 12 to 13 h) and requiring premium pay for split runs of more than a certain length (usually 10 to 12 h).

One possible solution would be to negotiate relaxation of the work rules that limit the use of part-time labor or the proportion or length of split runs. In exchange, management could provide higher compensation, perhaps in the form of more premium pay for drivers assigned to swing runs. The importance of these work rules to labor strongly limits the possibilities for this solution, however. Employees strongly oppose suggestions to increase the use of split shifts because the workday would be so long and time off during the midday break would be difficult to use. Nevertheless, there is growing evidence that substantial changes in labor costs could be experienced if relatively small changes were made in the constraints governing split shifts. For example, one transit property used computerized scheduling techniques to estimate that a decrease in the maximum length of split shifts from 12.5 to 11 h would increase the total operating labor cost by 21.5 percent (these data were supplied under the condition that the transit property not be identified). If such substantial costs are involved, minor work-rule changes might be negotiated to the mutual benefit of both management and labor (e.g., increased compensation for split shifts).

More widespread replacement of the traditional manual vehicle and operator scheduling techniques with computerized scheduling methods would aid transit properties in evaluating changes in the work rules that govern split shifts. The aim of scheduling, whether manual or computerized, is to develop the least expensive set of employee and vehicle work assignments that meet the timetables established for each route and satisfy the relevant work rules. Rescheduling is often the only way to accurately estimate the cost or savings of a change in the work rules being considered in labor negotiations. The manual scheduling techniques traditionally used by the industry require such a high level of skill and enormous numbers of tedious, exacting, and repetitious calculations that rescheduling to estimate the cost of work-rule changes is often felt to be prohibitively expensive. With computerized scheduling, work-rule changes could be costed out to a reasonable degree of accuracy relatively cheaply.

An alternative solution to the peaking problems caused by work rules would be to find other useful, nondriving tasks for transit drivers during the off-peak hours. Although this solution represents a quite fundamental departure from current industry practice, it is probably

more appropriate in the long run because workers would be productively employed for their entire workday without the interruption and other disadvantages associated with split runs.

A variety of possible off-peak tasks for drivers can be suggested. One possibility would be to define two classes of drivers: a cadre of full-time employees, who provide both peak and off-peak services, and a group of part-time employees, who drive during the peak only but also have full- or part-time jobs in other firms. Such an arrangement has parallels in the provision of school bus and other public services.

A slightly different variant, possibly more acceptable to labor, would be to make the second group of drivers full-time employees of the transit agency and provide them with nondriving tasks in off-peak hours. Some workers who drove only in the peak might be employed during the off-peak at other tasks currently performed in transit firms, such as light maintenance or bookkeeping.

Another opportunity for off-peak employment could be in staffing special transportation services that transit firms are under increasing public pressure to provide for the elderly, handicapped, and poor. These services are labor extensive, often involve door-to-door transportation, and, unlike regular transit, are mainly used for nonwork trips and thus usually experience peak demand during the midday. Where this service is required of transit agencies, it should be made available largely during off-peak hours and staffed by employees who drive regular transit routes during the peak period.

Another closely related possibility would be to use transit drivers to provide jitney or taxilike transportation services during the off-peak period. In many cities the demands for taxis and transit service complement each other since taxi ridership does not peak during the hours of highest transit use. In Chicago and Washington, D.C., for example, taxi use peaks during the midday. In New York, on the other hand, taxi ridership is highest during the morning and evening rush hours (10, pp. 120-121). Transit-provided taxi services might experience two disadvantages in competing with regular taxis: (a) Transit firms would not be able to use their fleet of taxilike vehicles as intensively as a regular taxi operator since transit-provided service would only operate during the off-peak and (b) the hourly wage rates of transit employees would be much higher than those of taxi drivers—on the average, two-thirds higher (10, p. 89).

The fixed costs of owning a fleet of taxilike vehicles are such a small portion of the total costs of taxi service, however, that the penalty to transit agencies for lower rates of vehicle utilization would be relatively minor. For example, in New York City in 1967 the costs of vehicle depreciation, garaging, and maintenance were only 15 percent of the total costs of fleet taxi service. If these three costs represented the fixed costs of owning a taxi fleet and if taxis owned by transit firms can be used only half as many hours daily as regular cabs, then (all other things being equal) transit-provided service would cost only 7 percent more than regular taxi service. Of course, since depreciation and maintenance costs are not fixed but are partly a function of vehicle use, transit-provided service would not actually cost as much as 7 percent more than regular service (10, p. 86). In addition, the real hourly cost of using transit drivers during the off-peak hours may actually be below that of the wages of regular taxi drivers, if only marginal changes in transit's current split-shift rules are possible and alternative opportunities for off-peak employment of transit drivers are limited.

Obviously all of the possible means of employing drivers during the off-peak hours that have been suggested here would require significant restructuring of the current practices and organization of transit firms and unions and might be opposed by firms and unions outside the industry. For example, the taxi industry and the Teamsters Union, which represents taxi drivers in some cities, might oppose the provision of taxilike services by transit drivers. Further careful study of these problems would be necessary before any of the proposals could be implemented. Nevertheless, since alleviating the problem of peak-hour operator requirements is one of the key productivity problems in transit, labor and management should at least explore the possibilities of providing drivers with other employment during the off-peak hours.

While strategies to renegotiate work rules or employ drivers at nondriving tasks during the off-peak hours are probably central to alleviating the difficulties caused by peaking, an additional and complementary approach to the peaking problem would be to reduce the need for peak-hour drivers and vehicles. One promising method for reducing peak labor needs is to use some buses larger than the industry's standard 12-m (40-ft) 45-passenger model during the peak hours. Larger buses, such as double-decker or articulated vehicles, could provide the same number of seat-kilometers of service with fewer vehicle trips and drivers, if they were used to replace conventional buses on a seat-for-seat basis.

The savings in peak-hour labor needs could in many instances more than offset the additional capital costs of the larger vehicles, especially if double-decker buses are used as the larger vehicle. Articulated buses are much less attractive than double-decker buses because their capital cost per seat is much higher. Although prices of articulated buses may drop somewhat as more are produced, most articulated models currently cost as much per seat as conventional 12-m vehicles or even more. At current prices, replacement of conventional vehicles by articulated buses would not bring productivity gains (5). Seat-for-seat replacement of conventional buses would cause an increase in headways, but the longer headways would result in little or no reduction in service quality if the oversized vehicles were confined to routes on which passenger waiting time is less affected by headway changes. Prime candidates for the larger buses are radial routes during the peak hour, when headways are already very short, and those express or other routes on which headways are already long enough that passengers are accustomed to arriving at stops to meet a specific scheduled bus.

Further use of peak-hour express bus services, bus-priority techniques, and improved traffic management are other means of reducing peak-hour labor and vehicle requirements. Such changes reduce running times, thereby decreasing the number of drivers and vehicles required to make a given number of trips. Express operations increase average bus speeds by allowing some vehicles to skip less heavily used stops and, sometimes, to shift to faster parallel arterial streets or freeways for the nonstop portions of their routes. Adoption of express services may increase passenger waiting times by increasing headways at the skipped stops, but the effect of longer headways will be minimal if the stops are lightly used or if headways are currently either very short or long enough that passengers arrive at the stop to meet a specific bus.

Bus-priority and traffic-management techniques contribute to increased bus speed and reliability largely by reducing the effects of automobile congestion. One of the most successful of these techniques is priority entry for buses on freeways whose access ramps are otherwise metered to prevent high levels of congestion. Other

possibilities include preemption of traffic signals for buses, exclusive bus lanes on arterial routes or freeways, incremental changes in street design, or modification of street-management techniques, such as eliminating one-way streets.

A final method for reducing peak-period labor and vehicle needs is to discourage peak-hour travel by charging a higher fare during the peak than the off-peak hours. The reduction in peak demand would be small, since transit use is generally not particularly responsive to fare changes. Even a small decline in peak use, however, would be helpful in cutting expenses. Equally important, a higher fare can be justified on the grounds that a peak-hour passenger costs more to carry, since peak-hour use determines the number of vehicles needed and, under current labor practices, the property's labor expenses.

In recent years, several transit properties decreased off-peak fares in an attempt to reduce the difference between peak and off-peak use. Since transit use is not sensitive to fare changes, these off-peak discounts resulted in substantial passenger revenue losses and were usually quickly discontinued. Raising peak-period fares is a more practical means of encouraging more balanced peak and off-peak use, since it increases transit revenues.

In summary, the transit industry might use a combination of two approaches to alleviate the problems caused by the peaking of transit demand. One approach is to reduce the cost of employing a worker needed to drive only during the peak period. In the short run, this might involve negotiating marginal changes in the work rules that govern the use of split shifts or part-time labor in return for higher employee compensation, particularly for drivers assigned to swing shifts. In the long run, a more appropriate though more radical solution would be to find productive off-peak tasks for those drivers needed in the peak only, such as performing light maintenance or providing taxilike services. A second, complementary approach would be to reduce the number of employees and vehicles required during the peak. The number of drivers needed in the peak might be lowered somewhat by replacing conventional-sized buses with larger articulated or double-decker buses on a seat-for-seat basis. Express services and bus-priority and traffic-management techniques could also lessen peak-hour vehicle and operator requirements by increasing bus speeds. Finally, higher peak-period fares would reduce the demand for peak-period services and increase revenues as well.

DISCONTINUING LESS PRODUCTIVE SERVICES

An important determinant of the productivity of any industry or firm is the degree to which it successfully identifies and serves markets in which it has a comparative advantage. Therefore, another key strategy for the improvement of transit productivity is for the industry to discontinue its least productive services in favor of those in which it has a comparative advantage over competing modes.

In choosing between transit and alternative transportation modes, passengers consider fares and various aspects of the quality of service, including traveling time and a variety of other amenities. As personal incomes have risen during the postwar period, fares have become less important determinants of travelers' modal choices, while the quality of service, particularly traveling time, has become more important. The increasing preoccupation of travelers with service quality has put transit at a disadvantage in relation to its principal competitor, the automobile, which combines door-to-door service and instant availability to save travel time. Nevertheless, transit has a comparative advantage over the automobile in two important markets and perhaps several minor ones. In such markets transit services are most productive in providing passenger transportation.

One of these markets is radial commuting trips to the centers of large, dense metropolitan areas, especially those with smaller or older highway networks. For these types of trips the quality of automobile service is relatively low, because highways are congested, and the out-of-pocket costs of an automobile trip are often high (e.g., because parking is relatively expensive). Transit, on the other hand, provides relatively good service at low cost because the large number of commuters in the radial corridors of these metropolitan areas allows transit vehicles to operate on relatively short and convenient headways while still maintaining comparatively full passenger loads. Transit's advantages in this type of market can often be further enhanced if travel speeds are increased by providing express bus service or adopting some inexpensive traffic-management and bus-priority schemes.

The second major market in which transit has a comparative advantage is trips within neighborhoods that have extremely high population densities and many low-income residents, such as those found near the centers of large metropolitan areas. High population density often ensures sufficient travel demand that transit vehicles can operate on conveniently frequent schedules and still maintain full loads. High density is also associated with levels of street congestion and parking costs that make the automobile less attractive. In addition, low-income residents, by necessity, find cost relatively more important than service quality in determining their modal choices and thus are more readily attracted by the combination of moderate cost and service quality typically offered by transit.

Local public officials generally have not allowed the industry to concentrate on the radial commuting, inner-city, or other markets in which transit has an advantage in providing passenger transportation. Instead, they often require additional service, such as service during off-peak hours or in crosstown, suburban, or small-city markets. These added services are intended primarily to advance social objectives that are thought to be by-products of the transportation services provided to passengers. However, the result is that these services lower productivity in terms of the number of passengers carried and thereby increase the gap between passenger revenues and the industry's costs and, thus, the need for public subsidies.

Does more extensive transit service generate the social benefits claimed by supporters of transit subsidies? Most of the evidence indicates that extensive subsidized transit services are not an especially effective means of alleviating environmental and other problems of automobile use or of assisting the poor or other persons without automobiles (11). From a strictly parochial point of view, this entire debate would be irrelevant to the industry if the local officials who require more extensive service were willing to fund the deficits incurred. Instead, the public aid provided to the industry is often insufficient (indeed, for many years was almost nonexistent), and transit properties are and have been forced to cross-subsidize the publicly mandated services by using passenger revenues generated from services on which transit is more competitive. Given the common transit fare and service-quality policies described below, inner-city routes have been especially burdened by the demands of cross-subsidization, although the shorter radial commuting lines are often strongly affected as

well. The requirement for cross-subsidy further weakens the industry's ability to compete effectively with the automobile, even in the radial commuting and inner-city markets.

Specifically, the industry should attempt to withdraw from the markets in which it is less competitive unless local public officials are willing to provide sufficient assistance to cover the required deficits. This strategy represents a sharp break with past practices and probably will be strongly resisted by the local public officials who regulate transit properties. These officials are likely to be especially concerned that the withdrawal of transit service from markets in which it is not competitive will leave many people who are too poor, old, or handicapped to own or drive an automobile without adequate public transportation.

Transit might alleviate public concern for these individuals by encouraging the taxi industry to take responsibility for these markets. In markets in which the density of travel demand is extremely low, taxis are sometimes able to provide transportation services at a cost comparable to that of transit or nearly so. More importantly, taxis provide a higher quality of service than transit, since taxis provide door-to-door transportation. Door-to-door service may be extremely valuable to some of the groups that have limited access to automobiles, especially elderly and handicapped people who have difficulty walking.

The public's major objection to taxis as the sole provider of public transportation is, of course, that taxi fares have traditionally been higher than transit fares; high fares are thought to be particularly burdensome for some people who lack automobiles. A solution to this problem might be to transfer the public aid received to operate poorly used bus routes to taxi operators, in exchange for releasing transit from the responsibility for maintaining those services. Although that public aid would not be sufficient to make taxi fares comparable to the former transit fares, many people without automobiles would probably find the taxi's superior door-to-door service worth the difference. Transit properties might offer taxilike service in these markets as well, but only during the off-peak hours and as part of the strategy for alleviating the difficulties caused by the peaking of transit demand.

In short, transit's ability to serve its two most advantageous markets is threatened by a combination of public requirements that it serve other markets as well and public reluctance to fund the needed subsidies. Both the transit industry and the intended beneficiaries of these publicly mandated services would probably be better off if the subsidies and the responsibility for these services were transferred to the taxi industry. For transit, however, the most important objective should be to withdraw as rapidly as possible from the markets in which it is not competitive.

SPECIALIZATION AND PRODUCTIVITY

In addition to alleviating peaking problems and discontinuing less productive services, a third strategy that transit might employ to improve productivity is specialization. Firms in the transit industry often use similar marketing and pricing policies, equipment, maintenance procedures, and other practices in a variety of circumstances. Sometimes it is possible to improve productivity by varying these practices or equipment according to the peculiar needs of different situations.

The prime example of an area that has potential for specialization is that of marketing policies, particularly those regarding fares and the quality of service. In many transit properties a trend has evolved toward charging relatively uniform fares and offering a similar quality of service throughout the service areas. The trend toward uniformity is most evident in fares. Transit's cost in providing service varies according to the length of the trip, the time of day, the quality of service offered, and the volume of passengers carried. At one time fares reflected these differences: Most transit properties charged different fares for different types of trips. Now, however, some properties charge a single fare, regardless of trip length or service quality (two exceptions in this trend toward uniform fares have been the recent widespread adoption of discounts for elderly and handicapped persons and the implementation of a stage-fare system using automatic ticket-vending and ticket-collecting equipment in San Francisco's new Bay Area Rapid Transit). Uniformity is also evident in the quality of service, though to a lesser degree. For example, often all routes operate with a similar ratio of passengers to seats, and express services, which represent an improvement in service quality, are generally rare.

The uniformity in fares and service conflicts with the varied characteristics of the travelers in the radial commuting and inner-city markets. Although transit use is generally less sensitive to changes in fares than to changes in the quality of service provided, the relative importance of fares and service quality differs significantly between transit's two major markets. Passengers on radial commuting services between the suburbs and downtown are usually more sensitive to service quality than to fares, both because their transit trips are longer and because they generally have relatively higher incomes. On the other hand, inner-city passengers are less willing to pay for higher quality service since they usually travel in the transit vehicle for shorter distances, have lower average incomes, and have a variety of feasible transportation alternatives, such as walking or taxis.

Uniform fares also ignore differences in the cost of providing transit service (at a given level of service quality). Radial commuting trips between downtown and the suburbs are usually more expensive to operate because they are longer and more heavily concentrated in peak hours, when the real cost of additional operating labor and vehicles is highest. Conversely, inner-city service is often less costly since trips are shorter and include a sizeable proportion of off-peak shopping or recreational journeys.

Similar fares and service quality in radial commuting and inner-city markets reduce patronage unnecessarily. In the longer distance radial commuting markets, for example, uniform fares may discourage transit properties from offering the premium service that is often desired by travelers. Since downtown-to-suburb radial commuting trips are longer and more peak-hour oriented, they incur a relatively high deficit if similar fares are collected on all types of service. Deficits would increase inordinately if the quality of radial service were improved without raising radial fares at the same time. Yet on some radial routes passengers probably find the current low fare a small attraction and would be more than willing to pay for better service. Since reduced travel time is especially valued by these travelers, the various methods of increasing vehicle speeds—such as express service and bus-priority techniques—may permit substantial revenue gains on radial routes as well as some relief from the cost disadvantages caused by peak loads. Radial travelers are more likely to be able to pay for other amenities too, such as assurance of a seat, more comfortable seating, or air conditioning.

Perhaps the best evidence in support of increasing service and fares on radial commuting routes is that the

few remaining private transit firms in large cities usually survived because they adopted this policy. For example, in Boston and New York numerous small private operators provide express service from outer suburban communities to the central business district using more comfortable intracity buses and assured seating. These companies are able to charge fares high enough to cover costs, often more than $1/passenger each way.

Uniform fares and service quality discourage transit use in the inner-city market as well. Because they are less expensive to serve, inner-city trips are usually the most profitable type of service if a flat fare is charged for all trips. The relatively high markup on short trips encourages the use of alternatives, however, such as walking, taxis, or fewer trips, especially since inner-city riders tend to have lower incomes. Moreover, because of the patrons' lower incomes and shorter trips, some of the service amenities commonly provided on such service, especially air conditioning, may not be worth their cost to the users.

Transit marketing efforts in both radial commuting and inner-city markets might also be aided by marginal changes in the location of routes and in timetables. The major determinants of route location and scheduled headways have gradually shifted over time. In virtually every metropolitan area, new residential, shopping, and employment areas have developed, while others have declined. Occasionally new freeways or arterial routes are opened whose higher traffic speeds make them an attractive locus for transit routes. Where such changes occur, passenger satisfaction can often be greatly increased at little cost by coordinating schedules so that transfers require less waiting, combining routes to eliminate transfers altogether, extending routes slightly or shifting them over a street or two to minimize walking, or making other simple improvements that require only a careful analysis of demand.

Most transit firms have responded to changes in the location of residences and businesses or to the opening of streets by altering their routes and schedules somewhat. A recent analysis of routes and schedules in Washington, D.C., however, suggests that some important opportunities for marginal changes may remain underexploited (12). That analysis found that a slightly altered route structure and schedule could reduce travel time for 26 percent of the passengers (though increasing the time for 9 percent), reduce transfers by 18 percent, and, at the same time, lower vehicle and operator requirements by 1.7 percent.

The replacement of manual by computerized scheduling techniques could assist in the refinement of fare and service-quality policies and in the analysis of route location and schedule changes. It is often necessary to reschedule a substantial portion of a transit system in order to accurately estimate the cost of a contemplated service change. Extensive rescheduling is often required because a change in service on one route often affects the costs of service on other routes, since vehicles and drivers are commonly interlined among routes to improve their productivity. In addition, a change in service at one hour of the day can affect the costs of service at other hours because of the complex work rules governing the use of split shifts. As noted previously, the expense of traditional manual scheduling techniques has discouraged firms from doing the extensive rescheduling needed for accurate costing of service changes. Computerized scheduling should make it easier to assess service changes in the future.

In short, transit should do more to tailor the quality of service, fares, routes, and schedules to the different markets it serves. In the longer distance radial commuting markets, transit firms should consider upgrading somewhat the quality of the service provided through, for example, high-speed express bus services, more comfortable seats, lower load factors, and air conditioning. In addition, fares might be raised, in some cases substantially, to reflect the costs of these greater amenities, longer distances, and more peak-hour travel. In the inner-city market, on the other hand, quality improvements are less important to passengers and the desirability of a few of the commonly provided amenities, such as air conditioning, might be reassessed. Fares are more important in this market and should be raised much less, if at all, to reflect fewer amenities, shorter distances, and more off-peak use. Finally, route locations and schedules should be carefully adjusted to changing circumstances.

Equipment, especially vehicles, is another area in which specialization may bring productivity gains for the industry. Most other transportation industries use vehicles of a variety of sizes for different circumstances, but the transit industry uses a standard 12-m bus on almost all types of routes. Industry resistance to the introduction of vehicles of different sizes stems in part from the effect they would have on maintenance training and parts-inventory expenses. Nevertheless, the benefits from selective use of both larger and smaller buses might more than outweigh the costs.

The gains from acquiring at least some larger buses were described earlier: Larger buses might decrease peak-hour labor needs without significantly affecting capital costs or service quality, if deployed properly. Some smaller buses may be advisable as well, since they cost substantially less to purchase, fuel, and (perhaps) maintain than standard vehicles. Replacement of standard by smaller vehicles could cut costs without affecting service quality if they were confined to those routes on which headways are determined by the need to maintain a conveniently frequent schedule rather than by the passenger capacity of the standard vehicle (5). And, of course, a fleet of small vehicles would also be advisable where a transit property provides jitney or taxilike service to increase the off-peak productivity of regular transit drivers.

Carried too far, a strategy of specialization can lead to productivity difficulties rather than to improvement. The classification of maintenance jobs is an area in which specialization, loosely understood, may be both a problem and a potential solution. Most transit maintenance departments employ two systems of job classification: Some of the jobs are classified by specialized crafts, such as machinist, electrician, or welder, while other jobs are classified as general-purpose repair persons, with several gradations in skill. Craft employee unions usually insist on restrictive rules governing the specific tasks that craftsmen can perform, partly to protect the integrity of their crafts. In a few transit properties, productivity difficulties occur because too many of the maintenance employees are classified as craftsmen and restricted to specific tasks.

Labor costs have a tendency to increase because these specialized workers become involved in routine maintenance jobs that require a combination of skills but only a low degree of proficiency in any one. On the other hand, in a larger number of properties equally severe productivity problems occur because the general repair persons are not specialized enough. In these properties some general repair persons may be poorly qualified to do even simple maintenance tasks because training courses are not well organized and recruitment to and promotion within the general repair grades are based on seniority rather than on tests of skills or on-the-job performance.

Contracting for services with outside firms is a final

example of the potential benefit of specialization. Contracting out may be particularly appropriate for vehicle maintenance, since there appears to be a great deal of variation among transit properties in the cost of performing standard maintenance tasks. The cost of rebuilding a bus engine, for example, varied between $1500 and $6000 in a sample of four large transit properties in 1976. Although part of this cost variation is undoubtedly due to unavoidable differences in local operating conditions (such as harsh weather or hilly terrain), most is probably attributable to differences in the productivity of maintenance departments.

If productivity problems at the higher cost properties cannot be resolved satisfactorily, it may be advisable for those properties to contract with other more efficient transit (or perhaps even nontransit) firms for the performance of certain maintenance tasks. The rebuilding of bus engines is a task that could easily be contracted out. Even routine maintenance of vehicles, which absorbs the largest part of the vehicle-maintenance budget, might be contracted out as well. One possible means of contracting out routine maintenance would take advantage of the fact that maintenance requirements increase as a vehicle ages. The Urban Mass Transportation Administration (UMTA), which pays 80 percent of the cost of virtually every new transit bus already, might set up a system of financial incentives that would cause buses to be used by properties with less efficient maintenance departments in their early years and then be transferred to the more efficient properties for their later years.

Contracting out for transportation services might be even more beneficial than contracting out for maintenance, since transportation expenses make up the largest part of transit costs. The contract might specify minimum standards of service to be provided, including route location, headways, and the maximum fares that could be charged. Negative bids or requests for subsidies could be allowed if desired. Contracts could be awarded by competitive bids. Potential bidders would include operators of school buses, sight-seeing or taxi services, or small privately owned transit companies. To make it easier for a number of firms to compete on a continuing basis, service on different routes might be put out for bids separately. The firms would have strong incentives to improve their productivity if the contracting were competitive. Higher productivity would result because the firms that marketed the services and controlled costs most effectively (within the limits set by the contractual service standards) would win the most contracts and earn the greatest profits (13).

The value of contracting out may depend partly on the extent to which peak-hour labor needs remain a problem for transit properties. Contracting out for transportation services may be especially valuable for properties in which labor and management are unable to arrange productive off-peak nondriving jobs for some drivers. Some firms bidding for service contracts will undoubtedly find it easy to employ transit drivers during the off-peak hours, especially taxi, charter bus, school bus, or sight-seeing companies.

If solving the peaking problem is the primary rationale for contracting out, the transit firm might employ directly all the drivers used during both peak and off-peak hours and contract out just for drivers needed only during peak hours (14). The value of contracting out for transportation services is probably less, however, for properties in which the problem of peak labor needs is solved by other means. In such properties it may not even be desirable to contract out maintenance or clerical tasks, since these are potential sources of off-peak employment for the drivers.

SUMMARY

Numerous potential opportunities to improve the productivity of urban mass transit can be identified. Many of these possibilities involve relatively small departures from standard industry practices and thus might be relatively quickly implemented. These more readily adopted changes include the use of more express services and bus-priority techniques, deployment of some buses larger and smaller than the standard model, negotiation of changes in split-shift work rules, adoption of computerized scheduling, and tailoring of fares, service quality, and schedules to conform better to transit's distinct markets.

Other opportunities for productivity growth are clearly possibilities for implementation only in the more distant future, if at all, since they alter more fundamental and traditional procedures used in the industry. Although these opportunities will take much more time and effort to implement, they may ultimately prove more worthwhile because they address some of the more basic causes of transit's productivity problems. Probably the most important among these long-term possibilities is to find some productive off-peak tasks for employees who are needed as drivers in the peak hours only. A second important long-term change is to discontinue transit service in markets in which it is least competitive with the automobile.

The industry's record of decline or relatively slow growth in productivity cannot be sustained for long, since the cost of transit would increase in relation to the cost of other goods and services. Failure to implement innovations that improve productivity, like the ones suggested here, will result in some combination of rapid growth in the industry's deficits (and its dependence on public subsidies) and the slow but sure pricing of transit services out of the market.

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Discussion

No area of labor-management relations in transit is currently more volatile than productivity; it permeates every aspect of transit. After the authors' paper was presented, a management representative stated that, in order to increase productivity, his organization had requested the opportunity to have part-time employees do peak work as well as to have their own employees pick extra pieces of work; both of these requests were denied.

A labor spokesman responded that since 1945 the transit property in Washington, D.C., has always had a provision that regular employees of the company who are not included in the bargaining unit can work as part-time employees driving buses, provided they are paid time and a half of operators' wages if that exceeds their own time-and-a-half rate. None of the managements of this property has ever availed itself of this opportunity. Instead, they have constantly pleaded for part-time employees, even though they have this right to part-time employees, which has led this labor spokesman to believe that they are really only seeking cheaper staffing.

A second labor spokesman raised the issue of split shifts and transit time to a work site. His comments illustrate the emotional nature of the issue:

> This is still the only major industry in this country that allows time to be unpaid to accommodate the industry. . . .Now you want, for the sake of productivity, to revert to the 1930s, when one got paid only for the actual time worked, under one guise or another. We are not going to take take such a step back. . . .Furthermore, transit time to a work site is taking longer today than it did many years ago.

The authors' point that transit driving jobs could be paired with other off-duty jobs that are performed by the transit firm itself or other firms was countered by a labor person:

> This question recently came up during collective bargaining. The union proposed that there be a transition so that a bus driver could be used for other purposes. But as soon as the union said that the wage rate would be that of the bus driver and not that of the cleaner or shifter, management lost interest. It became clear that the reason for suggesting the interchange of jobs was the desire to reduce the wage rate not the need for better use of operators.

At this point the discussion took on larger dimensions. A labor spokesman stated that, because of urban sprawl, the distance from the pickup point to the drop-off point has been extended and that traffic congestion has complicated the situation. Both of these factors, he felt, prevent comparisons over time. There was then some debate on whether it is possible to compare the relative productivity of various modes. In this regard it was observed that it is useful to try to make a distinction between issues of productivity that are under the control of management and labor and are subject to the collective bargaining process and those issues that are a matter of transportation policy.

As the discussion progressed, the participants began to focus on whether it was possible to measure productivity within the transit industry, taking into account the effect of social by-products.

> If you believe the social by-products of transit are worth anything, then vehicle-kilometers served is a metric for transit output. It is an optimistic metric, since even empty buses and nearly empty buses would contribute to it, but transit will still fall short of a lot of other industries.

> Many of the points we are discussing involve decisions that are not made by people in this room. They are not made by people who are managing the transit authority. They are made for political, social, or economic reasons. One of our most expensive services is run for high-cost stores whose customers have high disposable incomes. We lose money, and it affects our productivity, but the merchants and the taxpayers do not lose. I think we have to be very careful when we talk about productivity concerning the employee. Everyone knows both management and the supervisor and employee can do better and we are working at that. I think most industries are.

> I think it is terribly unfair to use passenger-kilometers, even adjusted for quality changes, as the output metric in any productivity study of the industry. You must account for all the socially mandated services. But I think that using vehicle-kilometers as the metric for the industry's output probably accounts more than adequately for those things, because it essentially indicates that a vehicle-kilometer is fine even if it is an empty vehicle-kilometer. And using that metric, the industry's productivity has not kept pace; that is the important point. It is very difficult to measure social by-products, and there is no question that the public mandates to provide certain kinds of services ruin productivity figures in terms of numbers of passengers carried. But even when you account for that, there is still a gap.

A speaker then observed that federal government regulation of both school bus operations and charter services has severely impaired transit productivity. These regulations also affect labor since the enlarging of these operations has brought about industry demands for nonconsecutive days off and part-time operators, all because of the vacuum that has been created by the inability to do the work that used to be done.

The discussion ended with a return to a dialogue on the larger nature of the transit problem, including the role of the automobile, the need to break away from the preoccupation with profit and loss, and the evaluation of the social purposes of transit.