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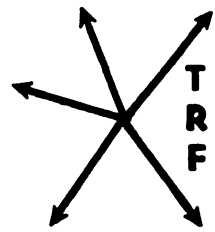

TRANSPORTATION RESEARCH FORUM

Rationalizing State Highway Systems: Key to Future Public Investments on Highways by State DOTs

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INTRODUCTION

STIMULATED by generous federal-aid programs, states have historically taken the lead role in undertaking capital investments on our highway systems. The establishment of the Highway Trust Fund and 90 percent federal financing of the Interstate System in 1956 were high-water marks of the highway expansion era. But a new era began in the late sixties and continues in this decade with public opposition to urban freeways, environmental concerns. the energy crisis (and the resultant effects on revenues), and with inflation in construction costs. Consistent with this new era, there is a need for major adjustment to our policies regarding public investments in our highways and, indeed, this is already occurring in many states [1, 2, 3, 4, 5].

If the future is to be marked by constraints on large capital projects and fiscal scarcity, how can state DOTs and highway departments adjust their highway investment strategy? Two major policy options appear. First is an emphasis on maintenance and preservation of the existing highway plant, towards which federal funds have recently been made available albeit in nominal amounts. Second is a rationalization of state highway systems, making them manageable in size and logical with respect to governmental responsibility. In the context of this paper, rationalization refers specifically to the identification of highway links and systems which serve the major activity corridors in a state and which deserve and must receive continued major capital investments. It also refers to the identification of lesser priority roads which should be returned through an orderly transfer process to the appropriate level of local governments.

While the first policy, emphasis on maintenance and preservation of the existing highway plant, is not controversial, this is not the case with the second policy, rationalization of state highway systems. For one thing, it may be difficult for highway planners and agencies accustomed to an expansionary outlook to accept the notion of continuing fiscal scarcity and to work within an austere fiscal framework. Nevertheless, the view that all capital improvements deemed necessary via traditional capacity and sufficiency ratings criteria (as in needs studies, for example) can be achieved, if only they are stretched out over the appropriate time frame, is no longer an acceptable basis for formulating capital policies. Tradeoffs between what can be afforded and what is really necessary need to be addressed in more explicit fashion. A second and related difficulty with the rationalization policy is that questions of interregional and intergovernmental equity (actual and perceived equity in interregional and intergovernmental control and distribution of resources) may arise more often and in a more visible manner. Resolution of such questions is difficult and seldom popular.

The objective of this paper is to describe recent contributions towards rationalizing the Pennsylvania state highway system. Two strategies are described; first, the identification of a high priority core system, and, second, the return of low-priority roads to local government. The focus is on the methodologies, the issues examined, and the resolution of these issues. It is hoped that this discussion will be of benefit to others engaged in similar work.

IDENTIFICATION OF A CORE SYSTEM

The central dilemma in formulating rational state highway investment policies for the future is that of reconciling the apparent large capital improvement needs of the systems on the one hand and the increasingly scarce bundle of resources likely to be available on the other. Reconciliation requires that either capital improvement expectations be lowered and/or resource availability be increased. A useful overall policy here is to develop alternative levels and composition of capital investments balanced

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with alternative scenarios of resource availability. Such an approach, if developed in a credible fashion, could be used to describe to legislators and the public in specific terms the tradeoffs between increased taxes (costs) and better highways (benefits).

In developing alternative capital investment programs, it is possible to employ different approaches. One approach would be to allocate the resources available from all sources, i.e., user taxes, federal aid, etc., among the different parts of the state, equally or in relation to some formula (such as percent of vehicle miles of travel, percent of lane miles, etc.). Given this first-cut allocation, particular projects to be undertaken could be determined on the basis of economics, local preferences, or other criteria. When resources are scarce, this approach is tantamount to spreading the misery around equally. Another approach differs in that the first-cut allocation is omitted. Thus, projects would be identified on a statewide basis using economics or other criteria. The danger here is that resources could be spread so thin that the capital program and the highway system might lose coherence and integrity.

An alternate approach investigated in Pennsylvania was that of limiting major capital improvements to a core network of highways [6]. Conceptually, this high quality core system serving significant activity corridors would support state economic and social activities better than would a longer but obsolete highway system.

An obvious first question is how does one define this core system? How can an analyst decide whether a particular road is sufficiently important from a statewide perspective to be included—or more importantly that another can be left out? Obviously many criteria pertain here and only a few are amenable to rigorous engineering or economic analysis. In order to bring informed, representative judgment to bear the Delphi Method[1] was used in the Pennsylvania experience. Three rounds of questions were addressed to a group of experts on transportation matters and generally representtive of the state, both in terms of interests and geography. While the Delphi procedural details are of great interest, the following paragraphs focus on the substantive issues which arose during the exercise.

The principal variables examined were size of the core system, design or more specifically the lane status of the system,[2] time period for completion of the system, and the resources projected to be available over the time period. The analysis was conducted for two time periods. 12 years (corresponding to the length of the long range highway program in Pennsylvania) and 24 years.

The state highway system in Pennsylvania presently is one of the largest in the country and consists of about 45,000 miles of roads. The first iteration in the core system Delphi effort presented a network less than a tenth in size of the present system. The general criteria used to determine which routes or corridors should be included in the core network were eligibility of roads for federal aid, road use (ADT), the functional characteristics of the road, connectivity between major activity centers, and adequate access to all parts of the state.

Specifically, the core network was developed in this way. All Interstate and Appalachian Development Highway corridors in the state were included. Referring next to the functional classification of highways, all rural other principal arterials (OPA) and urban other freeways and expressways (OFE) as well as OPAs which connect to designated rural OPAs were reviewed and routes selected for inclusion. Those OPA and OFE routes which paralleled or otherwise duplicated service by other OPAs were deleted. Highway plans of all urbanized areas were reviewed to determine what proposed routes would be justified on the basis of usage for inclusion in the core network. Several routes were added as a result. Finally, in order to provide comparable service to the northern part of the state not adequately served by the above system of Interstate, Appalachian, and OPA and OFE routes, several minor arterials were added to the core network. The network thus developed consisted of about 1,200 miles of Interstate, 500 miles of Appalachian, and 1,900 miles of other state highways. The Pennsylvania Turnpike totaling about 470 miles, part of which is Interstate, was also added to the core network.[3]

The lane requirements for the core network highways were based on present traffic levels although in the cost estimates provision was also made for incremental capacity adjustments to handle future traffic growth. The following criteria were used to establish the need for four or more lane facilities:

rural—over 10,000 average daily traffic (ADT)

urban—over 15,000 ADT

In a few cases four lanes were recommended for slightly lower ADT in order to maintain system continuity. Also, two-lane relocations on four lane right-of-way were considered in those cases where improvements were deemed desirable in a corridor but four lanes were not justified at present traffic levels. Table 1

CORE SYSTEM SIZE AND COMPOSITION (MILES)

	Interstate	Appalachian	Other	Total
Existing 4 or more lanes	1,493	237	854	2,584
Proposed 4 or more lanes	75	238	546	859
Proposed 2 lanes on 4 lane right-of-way	0	25	104	129
Other[a]	0	0	500	500
Total	1,568	500	2,004	4,072

a All mileage under 4 lanes, adequate and deficient sections combined.

TABLE 1

shows the disposition regarding core system size and composition.

The next two steps were the estimation of capital costs and resource availability. Total costs of right-of-way, engineering, and construction were estimated for bringing the core network up to the selected standards as well as the costs of incremental capacity improvements for accommodating future traffic growth. The high rate of inflation, a doubling of costs in the past 10 years, is a major source of uncertainty in this calculation. Projecting resource availability also involved considerable uncertainty since estimates were required of future federal aid, the amount therein for which core network roads would be eligible, and the state contributions. The projections were discounted to account for one estimate of inflation.

The analysis showed that if current levels of state capital expenditures are sustained in the future, these coupled with projections of federal aid would provide over a period of 12 years sufficient resources to cover about 50 percent of the costs of the core network (see Table 2). Significant increases in resources were not considered since user tax revenues will be negatively impacted by federal energy policy and because of the widespread public resistance to substantial increases in taxes.

This analysis suggested that core system improvements would need to be staged over a considerable time period and, therefore, that a prioritization scheme be set up to determine the order in which the improvements would be made. Such a prioritization procedure was developed and demonstrated on two core system road projects. While this procedure was specific to projects in Pennsylvania, the central elements were a conventional cost benefit analysis supplemented by considerations of secondary effects such as employment, system continuity, and potential resource development and so have more general applicability.

The core identification strategy is defensible given that quality maintenance and rehabilitation are to be the cornerstones of future public concern for highways, with capital investments focusing on improvements of a limited high-class system of vital activity corridors under this policy. The issue of whether some state roads should be transferred to local governmental units also merits close attention. In Pennsylvania, for example, reducing the 45,000 mile state highway system by reordering the division of road responsibilities between state and local governments offers several advantages: (1) it allows the state agency to concentrate its efforts on a limited system with attendant benefits in increased efficiency and better public credibility; (2) it offers reduction in maintenance cost since local governments can often perform this function with fewer resources because of lower labor cost and tailoring maintenance action to suit the needs of the roads; (3) better service to road users is made possible through greater decentralization of decision-making. Where the local tax base can be expanded or efficient state revenue pass through developed and where diseconomies of scale do not arise, rationalization of the state highway system through such transfer of responsibilities is an attractive proposition [7]. The next section examines typical issues which arise when this strategy is pursued.

HIGHWAY TRANSFERS TO LOCAL GOVERNMENT

Principal issues which arise in reducing the state highway system via a

TABLE 2

ESTIMATED FEDERAL AND MATCHING STATE SHARE FUNDS AVAILABLE FOR IMPROVEMENTS TO CORE SYSTEM IN PENNSYLVANIA

	Projected Funding for 1976-77	Projected Funding Over 12 Years 1976-1988	Projected Funding Over 24 Years 1976-2000
Interstate	$157 million	$1,665 million	$3,049 million
Appalachian	83	884	1,623
Other Funds			
Urban	8	64	106
Primary	20	192	332
Total	$268 million	$2,805 million	$5,110 million

transfer of responsibilities from state-to-local governments are the following:

- To whom should the roads be transferred?
- What criteria should be used to identify roads which more properly are the responsibility of local governments?
- What will be the impacts of such a road transfer on state and local government and what measures are needed to ensure that the distribution of impacts is not grossly inequitable?
- What are the net benefits and costs of a road transfer program?

A first issue is one of jurisdiction—to whom should the roads be transferred? In most states, county governments would probably be the logical choice. However, in Pennsylvania, county governments play a very minor role in local highway responsibilities and, hence, given political reality, townships appeared to be the appropriate units for taking control of the transferred roads.

Three criteria which are important in considering roads for transfer are the functional use of a road (character of road use), volume of travel, and the extent to which a road contributes to (or its transfer detracts from) system continuity. Where a road is heavily used for interregional travel or interregional movement of freight,[4] the road should remain the responsibility of the state. Only under state control can effects which would be considered as external if decisions on maintenance and improvement of the road are made from a wholly local perspective tend to be internalized. Volume of travel also is an important consideration since it affects the frequency and quality of maintenance and improvement functions. Where the volume is great and the required services are large scale, there may be economies of scale if the state agency performs the necessary functions. Finally, system continuity should be a factor considered to ensure that transfer of a road would not leave voids in the state network which lead to unnecessary increases in service costs.

The federally mandated functional classification of roads[5] can often serve as the basis (at least on a first cut) for identifying the appropriate division of responsibilities between state and local governments. These functional classifications consider the factors mentioned above and the categories range from roads (such as Interstate) which primarily serve a regional mobility function to roads which largely serve a land access function. In Pennsylvania, about a fourth of all roads in the state highway system were judged as belonging in this last category and thus are candidates for transfer.

Several types of impacts must be assessed in considering a road transfer program. These include the savings in maintenance and capital expenditures to the state agency through the reduction in the state highway system, the increase in highway expenditures by local governments, and one-time costs for improvements necessary to ensure that local governments are not faced with an inequitable cost burden.

While the first impact, savings to the state agency, could be estimated from data readily available, extensive cost studies were needed to estimate the lat-

ter two impacts. Assuming that the state's program for capital improvements remains valid, the avoidable cost to PennDOT would be approximately 12 percent. The maintenance cost saving to PennDOT was estimated by assigning maintenance cost within the projected maintenance standards to the turnback roads. The avoided cost here was approximately 10 percent of the total.

Attitudes of local government and impacts on them were estimated by site interviews with a representative sample and a questionnaire to the entire group. Also PennDOT engineers prepared estimations of upgrading costs based on a sample of approximately 800 miles of roadway distributed throughout the state. The attitude of local governments was generally positive with 73 percent willing to consider a transfer (see Table 3) providing adequate financial terms were arranged. Upgrading costs varied by area and with the standards but, in all cases, were formidable (see Table 4). Finally, based on past maintenance and improvement costs incurred by local governments, the additional maintenance cost was calculated (see Table 5).

A key question concerned the disposition of bridges. This is a serious problem not only in the state but throughout the nation. The severely deteriorated condition of many bridges required that their replacement or reconstruction remain a responsibility of the state. Whether a state agency can claim sovereign immunity from damage suits, as is the case in Pennsylvania, would have an important bearing on this question. The recommendation was for acceptable bridges to be transferred while others remain in the state system pending upgrading.

Most states provide grants-in-aid to local governments for maintenance of locally-owned roads. Such aid is generally supplemental to revenues derived from local income and property taxes, federal revenue sharing funds, and other general funds used for local highway purposes. An increase in these grants-in-aid to accompany a transfer of road responsibilities as well as the extent of one time major road improvements referred to earlier are policy questions which will need to be resolved in arriving at a road transfer program. In Pennsylvania, as noted earlier, standards selected for upgrading involved a cost that could only be covered in a time-staged fashion. Hence, the transfer would be accomplished over a recommended time period of ten years. This time-staged approach also has the advantage of diffusing the maintenance and improvement cost burden on local governments.

Finally, there is the question of how a road transfer program, especially one which is time-staged, would be managed. Notions of equity and simplicity in administration lead to several general observations. First, a single, well-understood set of standards should be adopted for any upgrading of roads performed prior to a transfer and for any state subvention for continuing maintenance costs. The standards for upgrading

TABLE 3

SUMMARY OF LETTER RESPONSES

Type of Response	Number of Responses	Percent of Total Response (approximate)
1. Opposed to road transfer[1]	90	27%
2. Willing to consider transfer	247	73
(a) Willing to accept under present circumstances	4	1
(b) Oppose unless additional maintenance funds given and/or upgrading	179	53
(c) Need more information to give specific response	64	19%
Total	337	

1 Although many of these responses cited lack of equipment, labor, and adequate tax base as reasons for their view, their response was couched in sufficiently strong words that it was felt they would likely oppose a transfer except under the most generous terms.

TABLE 4

COSTS OF UPGRADING OPTIONS

Option[1]	Average Cost/Mile	MILLION DOLLARS One-Time Costs	Annual Costs Over[2] 5 Years	10 Years
D.1	$ 0	$ 0	$ 0	$ 0
D.2	7,700	97.5	23.2	13.3
D.3	31,000	395.0	93.8	53.7
D.4	40,300	512.2	121.6	69.6
D.5	42,100	535.9	127.2	72.8
D.6	49,000	624.0	148.1	84.8

1 D.1 is no upgrading. D.2 involves general maintenance only. D.3 also includes resurfacing and related betterment work as needed. D.4 additionally includes road widening if necessary. D.5 further includes complete replacement of guardrail where needed, and D.6 also involves bridge replacements or reconstruction where required.
2 Assumes an inflation rate of 6 percent.

should be expressed in engineering performance terms which would mean that costs of achieving the standards would vary depending on the initial condition of the roads and regional differences in costs of improvement. Also, a mechanism for arbitration of disputes which might arise between the state and local governments might need to be established. Formation of a temporary board with adequate representation of state agency and local government interests might be one way of managing the road transfer program.

The overriding question is one of political feasibility. There appears to be

TABLE 5

HIGHWAY EXPENDITURES FOR CONSTRUCTION AND MAINTENANCE BY TOWNSHIPS OF THE SECOND CLASS IN 1975

			Total	Per Mile
Mileage			46,305.85	
Direct Highway Expenditures			$121,707,147	$2,628
Capital[1]		$27,474,206		593
Maintenance		59,416,301		1,283
General Maintenance	$51,477,363			1,112
Snow Removal	6,036,586			NM
Traffic Services	1,902,352			NM
Equipment		5,592,372		121
Gen. Adm. & Engineering		9,851,655		213
Highway and Traffic Police		19,372,613		418
LFT Allocation[2]			43,133,858	931
Outstanding Debt[3,4]			5,028,333	NM
Issues[3,5]			1,973,381	NM
Debt Service (Interest + Redemptions)[3,5]			1,141,254	NM

SOURCE: Bureau of Transportation Planning Statistics, PennDOT. Information as listed in FHWA Form PR-535, revised Nov. 1974.

1 Includes right-of-way, engineering, and construction
2 Includes interest and refunds
3 Includes both bonds and notes
4 As of the end of 1975 calendar year
5 During 1975 calendar year
NM = Not Meaningful

the potential for a coalition of state and local governments for the purpose of increasing resources available for highways. Generous funding of highways in the past has not made such a coalition necessary, but present trends in state financing argue strongly for its development. A transfer program between mutually supportive parties is obviously more feasible than under the adversarial climate of the past.

SUMMARY

This paper has discussed two aspects of rationalizing state highway systems, one dealing with channeling major capital investments to a limited network of vital activity corridors in the state, and the other with reducing the highway system by transferring ownership of the lower priority state roads to local governments. The purpose of these two actions is to insure the continuing viability of our highway systems under fiscally austere climates now prevailing and expected to prevail in the future. Failure to make innovative adaptations in future highway policies may cause our roadway plant to go down the same track traveled by the northeastern railroads.

FOOTNOTES

1 This method involves a group of experts responding sequentially to questionnaires interspersed with feedback from earlier responses. Main features of the method include (a) group judgment, (b) anonymity, and (c) controlled feedback.

2 In theory, many design characteristics can be varied but practically the body of practice, both state and federal, essentially precludes such changes. During this effort, based on the input given, it was decided that the highways in the core system should be built and maintained to Interstate or Class 1 standards. This decision fixed the final cross section and other geometric features.

3 The Pennsylvania Turnpike is not part of the state highway system and is maintained and improved under separate authority using toll revenues.

4 The word interregional refers to crossing of local governmental unit boundaries. If the unit in receipt of the transferred road responsibilities are counties, for example, interregional movements refers to intercounty movements.

5 Originally directed by Section 17 of the 1968 Federal Aid Highway Act (P.L. 90-495), the national functional classification study offers a good starting point for rationalization of state highway systems. Functional classification is a process by which highways are grouped into classes according to the character of service they are intended to provide.

REFERENCES

[1] Rao, S. et al., *New Directions for PennDOT—A Fiscal Review*, Report PTI 7616, The Pennsylvania Transportation Institute, University Park, PA, Oct. 1976.

[2] California Highway User Tax Study Commission, *Transportation Financing for California*, Sacramento, CA, Jan. 1976.

[3] Iowa Department of Transportation, *Transplan '77*, Des Moines, IA, May 1977.

[4] American Safety Foundation, et al., *Summary: Better Highways for Washington — Needs, Financing, Law*, Washington, D.C., 1969, pp. 6-9.

[5] Leatham, H. B., "Utah's Collector Road Program, From Studies to Legislation," presented to the 1970 Northwest Roads and Streets Conference, Corvallis, OR, Feb. 4, 1970.

[6] Rao, S., *Rationalizing the State Highway System: The Core System Approach*, Report PTI 7719, The Pennsylvania Transportation Institute, University Park, PA, Sept. 1977.

[7] Rao, S., *Rationalizing the State Highway System: A Study of Transferring Some Roads to Local Governments*, Report PTI 7718, The Pennsylvania Transportation Institute, University Park, PA, Sept. 1977.