urban areas with plans that do not adequately reflect:

1. Changes that have occurred in urban development since their adoption;
2. Changes in government regulations and public concern;
3. Changes in technology and management expertise in transportation systems; or
4. Current estimates of likely conditions and demands for the future.

The philosophical basis for nonevent planning rests on a belief that legislative action is most effective when it is related to policy and goals rather than to detailed project development.

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Implementing Transportation Policy: Lessons From the Interstate Highway Program

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Traditionally, state and local governments have responsibility for the implementation of federal highway programs and policies. The effectiveness and outcomes of these programs, therefore, largely depend on the complex relations between federal and state highway agencies and policies that are directly affected by individual differences in state political and socioeconomic conditions. To investigate differences in state highway policy implementation, data on political and economic conditions, highway revenue and expenditures, federal aid, and highway program development were compiled and analyzed. The relations among these variables are examined using factor and path analyses methods. The findings of this research suggest that the implementation of highway policy is weakened by inflexibility and internal contradictions between federal and state policies caused by differences in state and local transportation needs and categorical federal aid policy. In particular, the Interstate highway program depended on attractive federal aid matching incentives that were not necessarily responsive to or appropriate for state and local transportation requirements. A transportation trust fund that is subdivided into a hierarchy of separate interstate, regional, and urban transportation funds is recommended. The trust funds would promote the integration of the different transportation networks and would permit transportation agencies to draw on these funds as needed to match their individual problems to appropriate solutions, unhindered by categorical or model restrictions. Future policy decisions should include provisions for testing and evaluating results and performance.

In the past 20 years, about 54 700 km (34 000 miles) of rural and 14 500 km (9000 miles) of urban Interstate highways have been constructed. The total cost of the Interstate highway system (IHS) may exceed $80 billion. The project has preoccupied federal highway policy since the system was first authorized by the Federal-Aid Highway Act of 1956. This act also created the Highway Trust Fund, which provided the means for the construction of the Interstate highways. The trust fund has been a unique and efficient means for producing the fiscal resources and stability required to build the vast Interstate system. The implementation of federal highway policies and programs has traditionally been the responsibility of state and local governments; the founders of the program, therefore, included powerful incentives by providing 90 percent of the costs of construction. Such strong, single-purpose incentives inevitably created equally strong constraints to balanced transportation planning. Other transportation problems, impacts, and alternative modes were neglected (1). Indeed, the creation of the U.S. Department of Transportation (DOT) and the Urban Mass Transportation Administration (UMTA) was a response to the need for greater integration and balance in transportation programs (2).

The original purpose of the IHS, for example, was diverted for the purpose of building urban freeways simply because large amounts of federal aid were available. Although only about 20 percent of the IHS is within urban areas, urban areas absorbed nearly 50 percent of the total cost of the system. Transportation decisions were thus suboptimized by focusing too narrowly on federal aid for Interstate highways regardless of whether the solution was appropriate for specific local and regional transportation problems.

The thesis of this paper is that transportation development decisions must provide appropriate solutions to specific urban, regional, and national transportation network problems without unnecessary restrictions on category or mode. Federal aid programs must be flexible enough to allow decentralized decision making, planning, and implementation of transportation systems.

HISTORICAL PERSPECTIVES

The Federal Highway Act of 1921 set the pattern of cooperation between federal and state governments by requiring the development of state highway departments and creating the primary and secondary highway classification system as a basic framework for federal highway aid (3). The highway system grew rapidly as engineering practices and technology improved. The Federal-Aid Highway Act of 1944 created a national system of Interstate highways, not to exceed 64 000 km (40 000 miles) in length. No construction funding was authorized. The idea gained momentum and support during the early 1950s under Project Adequate Roads, which was broadly supported by highway user groups. In 1954, President Eisenhower appointed the Clay

committee to devise a means for financing the development of the IHS. After 2 years of congressional debate (mostly over financing) the Federal-Aid Highway Act of 1956 was passed, creating the Interstate highway program financially energized by the Highway Trust Fund. This was the benchmark legislation for what became a 25-year and $80 billion committment to the construction of the Interstate system.

Congress periodically reviews and changes the Interstate highway program. It has authorized increased expenditures and highway distances, extended the construction period, broadened the tax base and rates of the Highway Trust Fund, and modified the goals of the Interstate program. The Federal-Aid Highway Act of 1962 increased the emphasis on comprehensive planning and urban freeways. Legislative and judicial decisions require officials to consider the social, economic, and environmental impacts of the highway systems. This includes comprehensive urban land use planning and increased citizen participation.

During the early 1960s, the environmental and social consequences of Interstate highways registered on the public mind, and greater attention was given to urban transportation problems (1, 4). The basic nature of urban transportation problems and the uneven role of the federal government in urban transportation (1, 5) were reassessed. Since then, highway policy has shifted more toward the integration of different transportation modes (2). The Federal-Aid Highway Act of 1973 opened the Highway Trust Fund to mass transit programs and renewed the emphasis on highway safety, planning, and relocation assistance, as well as on the completion of the Interstate system.

In total, the Interstate highway program brought new practices and standards for administration, comprehensive planning, safety, and environmental protection. However, the radical changes in the orientation of federal policy, matching formulas, and incentives for the development of the Interstate highways have created problems as well as progress. Perhaps the most significant of these problems relates to the ability of state and local governments to develop and implement flexible local solutions to regional rather than national transportation problems and needs. A number of constraints and disincentives to optimizing local transportation planning and problem solving are the natural outcome of strong and uneven incentives for achieving national interstate transportation goals.

The rapid increase of federal highway aid from $500 million/year to $4.5 billion/year between 1956 and 1972 is indicative of the impact of the IHS. Federal aid for primary highway programs (FAP) decreased from 48 to 10 percent of the total while the IHS required 75 percent of all federal highway aid by 1970. The availability of categorical federal aid in turn affected state highway policy expenditures. State expenditures showed a corresponding but more balanced rate of change; on the average, Interstate highway expenditures exceeded primary expenditures by 10 to 20 percent/year. As shown in the annual Highway Statistics reports published by the Federal Highway Administration (FHWA) for 1958 to 1972, capital outlays for urban primary and Interstate highways increased at a faster rate than rural highway expenditures during this period.

Interstate highway funds were especially attractive to metropolitan areas that had serious urban transportation problems (6). In response, the construction of urban freeways was emphasized. The outcome was a relative increase in the length and the cost of urban Interstate highways. More importantly, during the initial implementation of the program, urban sections of the IHS were started and completed at a more vigorous pace than were rural sections. Highway Statistics shows that this trend was reversed by 1968, as urban freeways became more controversial and impacts were politicized.

Many of the central problems of IHS implementation revolve around the stress between federal and state policy based on the differences between urban and rural transportation needs and local political and economic conditions. The categorical grant programs' different matching formulas for FAP, federal aid for secondary highway programs (FAS), and IHS aid were too inflexible and misleading for states to develop appropriate responses to local rural and urban transportation problems. This is widely recognized by highway policy makers, who have already recommended modifications to the present system of categorical grants. The singular commitment to the IHS prevented the development of a balanced and integrated transportation system by concentrating most of the available resources in one area. This situation limited the real options available for urban transportation to urban freeway construction because this was by far the largest source of federal aid.

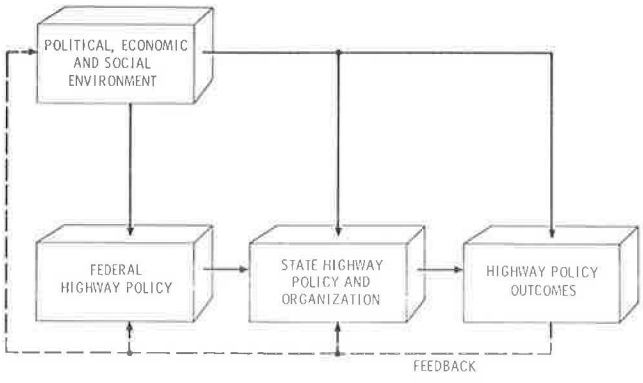
To test these observations, a quantitative analysis of the relations between federal and state highway policy was conducted. The concept of decentralized policy implementation suggests the testing of two initial propositions:

1. The outcomes of highway policy will depend on the political and socioeconomic variables in the individual states where the policy will be implemented.
2. Where federal policies and state needs are contradictory, policy implementation and the development of transportation systems will be suboptimized because the states act more independently or intervene between federal aid programs and respective environmental circumstances.

CONCEPTUAL MODELS

A simplified conceptual model is needed to define the scope, select variables, and conceptualize research hypotheses (7). The policy system model used for this analysis of the highway system is illustrated in Figure 1. The highway policy model includes four general components: (a) federal highway policy; (b) state highway policy and organization; (c) political, economic, and social environment; and (d) highway policy outcomes. These components encompass variables that characterize the policies, programs, and operations of state highway departments and the FHWA as well as actual outcomes of highway system developments.

Figure 1. Analytical model of highway policy system.



Many of my initial research questions are based on previous studies of highway expenditure and revenue policy (8), state highway politics (9), transportation planning (2), and other historical accounts (3). The process of data selection and analysis was aided by Thomas Dye's research on the correlations between socioeconomic factors and state highway policy (10). The methodological model for this research and the use of factor analysis for the study of underlying relations among highway policy, politics, and economic factors were demonstrated by Sharkansky and Hofferbert (11). The analytical procedures are intended to develop simple multivariate measures of each component of the highway policy model by using factor analysis methods. This allows us to make generalizations about the basic properties of the highway policy system and to test the conceptual model itself via correlation and regression analysis of the factors (12).

First, available data were compiled, and a number of preliminary factor analyses were conducted to reduce the total number of variables to just the underlying correlations in the data set. A series of final factor analyses provided the multivariate indexes of each conceptual block of the highway policy model. Then, the generalized relations between these factors were examined by using correlation, partial correlation, and regression analyses. The actual study involved several hundred variables; only the highlights of the methods and findings are reported here (13).

Highway Policy Factors

Variables that represented the main underlying associations in the data were selected to construct the final set of multivariate indexes of federal and state highway policy, highway policy outcomes, and environmental factors. The selected variables were then subjected to a series of factor analyses, from which factor scores were computed. In most cases, the factors explain most of the orthogonal sources of variation in the data representing (a) measures of total level of highway expenditures or other measures of program activity and (b) distributive measures that include percentages or per capita variables. The analyses each yielded two factors of differing weighted importance that summarized the important sources of variation within each data set as follows.

1. The two political and economic factors represented (a) urban-industrial size based on personal income, general expenditures, and automotive business sales and (b) industrial and population density of the states based on an inverse relation between rural population and personal income from government versus suburban population, population density, and personal income from private industry (Table 1).

Table 1. Factor analysis of state politics and economy.

Variable	Factor 1: Urban-Industrial Size	Factor 2: Population Density
Personal income	0.95	0.26
Retail automobile sales	0.96	0.23
Vehicle kilometers of travel	0.94	0.24
Total state expenditures	0.97	0.12
Rural population, %	-0.46	-0.53
Suburban population, %	0.36	0.67
State expenditures per personal income	-0.25	-0.74
Personal income from government, %	0.00	-0.66
Personal income from industry, %	-0.24	0.70
Population density	0.09	0.70
Eigen value	5.35	1.69
Variance, %	76	24

2. Federal highway policy factors were related to (a) total federal aid expenditures, especially for IHS, and (b) the federal aid priority based on a positive loading of the percentages of federal aid for IHS and planning versus a negative loading of FAP and FAS aid (Table 2).

Table 2. Factor analysis of federal highway policy.

Variable	Factor 3: Federal-Aid	Factor 4: Federal Priority
FAS aid, %	-0.14	-0.89
FAP aid, %	-0.07	-0.91
IHS aid, %	-0.02	0.93
Planning aid	0.86	0.40
FAS aid	0.86	-0.24
IHS aid	0.85	0.47
FAP apportionment	0.99	-0.06
FAS apportionment	0.88	-0.21
Urban apportionment	0.82	0.32
IHS apportionment	0.84	0.46
Eigen value	5.83	2.83
Variance, %	67	33

3. State highway policy factors were structured like the federal factors by using total state highway expenditures data and the percentage distribution of state highway expenditure priority (Table 3).

Table 3. Factor analysis of state highway policy.

Expenditure Variable	Factor 5: State Expenditure	Factor 6: State Priority
Planning and research	0.98	-0.02
Total highway	0.98	-0.21
IHS	0.93	0.05
FAP	0.88	-0.33
FAS	0.64	-0.14
Research, %	0.12	0.45
Planning and research, %	-0.20	0.64
Highway payroll	-0.15	0.27
FAP, %	0.17	-0.65
IHS, %	-0.03	0.59
Eigen value	4.33	1.14
Variance, %	75	25

4. The highway policy outcome factors distinguish between variables related to (a) Interstate highway development based on the length of Interstate highways open to traffic, length of urban freeway, and high-density traffic volume on the urban IHS and (b) primary highway system development based on the length of the FAP system, motor vehicle distances traveled, and motor fuel use per motor vehicle kilometer (Table 4). The relations between these factors were then analyzed and several general causal inferences were made about

Table 4. Factor analysis of highway policy outcomes.

Variable	Factor 7: FAP Development	Factor 8: IHS Development
Urban IHS open	-0.18	0.97
Rural IHS open	0.44	0.80
High-density urban IHS	-0.35	0.75
IHS improved	0.30	0.91
Rural FAP, %	0.88	0.12
Urban FAP, %	-0.88	-0.12
Highway deaths	0.76	-0.16
Motor fuel use	0.49	0.00
Urban IHS use	-0.73	0.37
Rural IHS unstarted, %	-0.33	-0.13
Eigen value	3.47	3.17
Variance, %	52	48

highway policy implementation structures from the partial correlation and path analysis.

The eight factors serve as indexes of the key parameters of the highway policy system in the United States. As predicted, the correlations in Table 5 show a high degree of association among political and economic conditions, federal and state highway expenditures, and highway policy outcomes. When the urban-industrial size (factor 1) is greater, for example, the federal highway expenditures (factor 3) and the state highway expenditures (factor 5) are also greater. Federal and state highway expenditures are directly associated with Interstate highway development (factor 8). The second set of correlations in Table 5 shows an inverse relationship between the federal aid system priority (factor 4) and primary highway system development (factor 7). That is, the greater the percentage of federal aid for the IHS, the less the development of the primary system. State highway system priority (factor 6) is directly related to primary system development (factor 7) and inversely related to population density (factor 2).

Table 5. Bivariate correlations of highway policy factors.

Highway Policy Factor	F1	F2	F3	F4	F5	F6	F7	F8
Factor 1	1.0							
Factor 2	0.00[a]	1.0						
Factor 3	0.92	0.05[a]	1.0					
Factor 4	0.08[a]	0.39	-0.04[a]	1.0				
Factor 5	0.92	0.22[a]	0.87	0.25	1.0			
Factor 6	-0.02[a]	-0.43	0.10[a]	0.02[a]	-0.21[a]	1.0		
Factor 7	-0.10[a]	-0.71	0.01[a]	-0.52	-0.21[a]	0.40	1.0	
Factor 8	0.78	0.04[a]	0.88	-0.07	0.75	0.14[a]	0.00	1.0

[a]Not significant at 0.05 level of probability.

When we control for the effects of political and economic factors (factors 1 and 2), several interesting patterns in the data persist and new relations emerge. The relation between federal expenditure policy (factor 3) and the development of the IHS (factor 8) remains strong even though we controlled for the effects of political and economic differences in the states (Table 6). The previously high bivariate correlations between state highway policy factors and outcomes were all substantially reduced, including the relation between (a) state and federal expenditure factors and (b) state expenditures and urban Interstate development factors. This indicates that state policy factors are related to highway outcomes as intervening variables.

When the effects of state highway expenditures (factor 5) are examined more closely, state highway policies behave as intervening variables do, much as depicted by the policy system model. Rather than acting as independent causal determinates, state highway policies are influenced to varying degrees by both federal highway policies and state political and economic conditions.

Table 6. Partial correlation of highway policy factors controlling for political and economic factors.

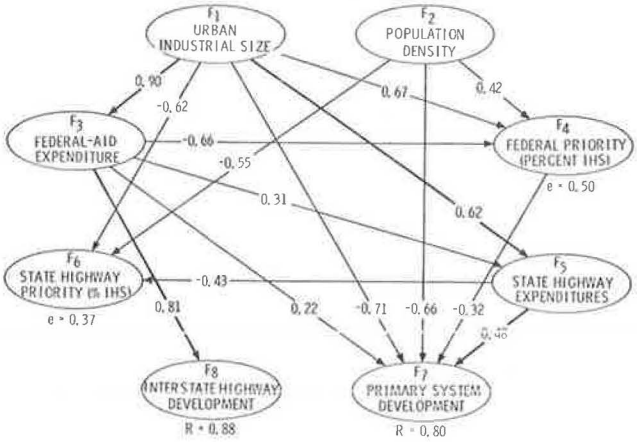
Highway Policy Factor	F3	F4	F5	F6	F7	F8
Factor 3	1.0					
Factor 4	-0.32	1.0				
Factor 5	0.28	0.29	1.0			
Factor 6	0.33	0.23	0.31	1.0		
Factor 7	0.39	-0.36	0.16[a]	0.14[a]	1.0	
Factor 8	0.64	-0.25	0.13[a]	0.31	0.24	1.0

[a]Not significant at 0.05 level of probability.

State highway policy, in turn, partly influences some aspects of the development of the state highway system.

Previous findings are summarized in the path diagram in Figure 2. The beta weight or partial standardized regression coefficient (β) shown on the paths between each pair of factors is equivalent to a partial correlation

Figure 2. Path analysis of highway policy factors.



between the two variables at either end of a given path, when we simultaneously control for all preceding variables. We can see that the hypothesized relations among federal policy, state policy, environment, and outcome factors correspond to the path network. However, we now find an additional strong path from federal aid expenditures (factor 3) directly to Interstate highway development (factor 8). Each factor provides an estimate of the variation in each of the different blocks of the policy system model, and the interrelations among factors are examined via multiple regression analysis reported in the path diagram (Figure 2). Two distinct patterns are observed in the path analysis.

1. A direct relation among urban-industrial size, federal expenditure policy, and Interstate development forms a separate causal path that bypasses state expenditure policy factors.
2. Urban-industrial size is more closely related to state expenditure policy and primary system developments.

Thus, federal policy is most directly associated with Interstate highway development outcomes, and state highway policy exercises some independent influence, especially with respect to the development of the FAP.

These findings are not surprising, considering that the federal government pays for 90 percent of the IHS program but only for 50 percent of the FAP. The other patterns, however, suggest a schism between federal policies and state implementation. Inferences from the path analysis (Figure 2) suggest that federal policy is completely determined by urban-industrial interests that, at the national level, lead directly to urban Interstate highway development. In other words, individual state highway policies do not affect urban Interstate development outcomes even though these policies are implemented by state highway departments. Urban states would, of course, embrace urban Interstate priorities underlying recent highway policy, but large rural states would naturally resist, as shown by the finding that the greater the total state expenditures, the less the relative priority given to the IHS.

States that can afford to follow their own priorities give greater emphasis to other highway needs.

Some states follow their own priorities in spite of the federal government's enticement of $0.90/$1.00 spent for building the IHS versus $0.50/$1.00 spent for building primary highways. In fact, state highway expenditures are determined mostly by state urban-industrial size (β = 0.62) and are only partly influenced by federal aid (β = 0.31). The effects of federal policy cancel each other out as far as explaining primary system development. State expenditure policy is directly related to the development of the FAP system when we control for the effects of all other variables (β = 0.48). Note also that the relation is much stronger than it appears in rural states, because if the urban-industrial size is less, the primary system development is greater.

CONCLUSIONS

The findings of the preceding analysis are numerous and complex and will require further research and evaluation.

The political and economic environment is highly associated with highway transportation variables. For instance, total retail automotive sales and vehicle kilometers traveled are highly intercorrelated with total personal income and general expenditure of state governments. Rural and urban political and economic conditions vary in several important respects so that as the population density and personal income from industry are greater, the state government expenditures per capita and the personal income derived from government employment are less (Table 1).

Federal highway policy is dominated by the Interstate highway program, although the use of these funds varies tremendously from state to state. Federal aid for planning and research is directly associated with the percentage of IHS aid and inversely related to FAS and FAP aid. The percentage of total federal aid for secondary and primary systems is inversely related to Interstate highway aid, i.e., the more federal aid received by the states for the IHS, the less federal aid received for FAP and FAS highways (Table 2).

State highway policy factors show that the percentage of capital outlays for FAP is inversely related to both IHS and total expenditures (Table 3). However, changes in state policy have not been as radical as those in federal policy; the states have retained their responsibility for building and maintaining the primary and other highway systems.

Highway policy outcome factors are clearly differentiated according to FAP and IHS highway development. States that have a higher percentage of the rural FAP system are characterized by a higher number of traffic deaths and higher fuel consumption per motor vehicle distance traveled. The total length of urban IHS open to traffic is correlated with high-density traffic volume, kilometers of IHS completed to standard, and the percentage of vehicle kilometers of travel on the urban IHS (Table 4).

Federal highway expenditures are most directly determined by urban-industrial factors. Consequently, federal aid expenditures are the main determinant of Interstate highway development, but federal highway expenditures are only slightly related to primary highway development. State highway expenditures are partly determined by state urban-industrial factors but are also influenced by federal policy. Acting as an intervening factor, state highway expenditure policy has its greatest impact on primary highway development and a smaller inverse effect on the percentage of Interstate highways within the state.

The relative effect of each highway policy and environmental factor on outcomes also shows a clear separation both according to whether conditions are urban or rural and according to whether it is federal or state highway policy. Interstate highway development is almost entirely explained by federal aid expenditures. In contrast, primary system development is influenced by a number of factors, but state highway expenditures have the largest direct effect; therefore, the greater the total expenditures, the greater the development of the FAP system. Primary system development is also greater in rural states, i.e., the greater the urban-industrial size and population density, the less the FAP development. The complex patterns set up between federal and state highway policy and political and economic conditions in the states indicate some basic differences and frictions between federal highway policy, which is oriented toward urban Interstate highway needs, and state policy implementation, which is sometimes oriented toward the primary highway needs of larger and rural states.

IMPLICATIONS AND RECOMMENDATIONS

The early commitment of the U.S. Bureau of Public Roads to high standards of engineering and organization are reflected in the overall quality of today's federal aid highway system and the technical and administrative capabilities of state highway departments. However, my analysis suggests several fundamental weaknesses in these implementation structures, which tend to limit the flexibility and responsiveness of federal and state policy to changing transportation needs, and wide-ranging political, economic, and environmental problems in the states. As the Interstate highway program nears completion, new highway policies must be developed for a postsuperhighway era of transportation needs. Decisions should reflect the lessons of the Interstate highway experience. Three observations about the implementation structure of the highway policy system are especially important.

1. The political and economic characteristics of the different states affect every stage in the policy process. The dominant political coalition that decides federal highway policy favored development of the urban Interstate system.
2. The differentiation between federal and state policy based on these political and economic variations in the states has two implications for policy making: (a) federal policies that tend to contradict political, economic, and social conditions of various states are less likely to be implemented uniformly and as originally intended and (b) implementation capabilities will vary with the technical and economic resources available to the respective states.
3. The original purposes of the Interstate highway program were partly diverted in the 1960s for urban freeways, thus increasing the cost of the program and helping to create the crisis in mobility that we face today. Part of this diversion and the consequent effects on urban transportation could have been avoided if there had been balanced transportation planning and institutionalized provisions for monitoring and reviewing the impacts of the program as it was being implemented.

The criteria for effective transportation problem solving and successful program implementation should include:

1. Implicit recognition of different hierarchical levels of transportation functions, including urban,

rural, regional, and Interstate;
2. Flexible use of funds to optimize transportation systems according to specific needs and political and economic conditions;
3. Encouragement of the development of technical and administrative capability at all levels of implementation; and
4. Ensuring the integration between and within different transportation networks and modes.

Federal policy makers have already taken steps toward changing the way federal aid is apportioned by recommending the creation of a single urban fund to be used for both mass transit and highway programs within metropolitan areas and the creation of a rural federal-aid system for highway projects and a rural general transportation fund for other surface transportation projects (14). Forty percent of the urban funds would be allocated to individual metropolitan area governments, 40 percent would be allocated directly to the states for use in metropolitan areas, and DOT would keep 20 percent as discretionary funds for urban mass transit projects. The plan would allow greater choice and flexibility for transportation programs but fail to provide for integration of the national, state, rural, and urban transportation networks. It may be even more serious that it places a federal wedge between urban and state authorities by dividing urban funds between different state, metropolitan, and federal agencies, although the opposite effect was probably intended.

As an alternative, federal transportation policy could be organized to promote the integration and optimization of all transportation modes within and between a hierarchy of interstate, regional, and urban transportation networks. This can be accomplished by establishing integrated federal aid programs for each regional network that have additional provisions to ensure proper comprehensive planning, implementation, effective use, and balance of different transport modes. An integrated transportation trust fund could be set up as follows:

1. Urban Transportation Fund—to be used for all transportation programs within metropolitan areas and smaller urban places apportioned according to urban population, population density, and standard metropolitan statistical area (SMSA) land area. Projects would be planned and implemented by metropolitan and urban governments and coordinated within respective regional and interstate networks.
2. Regional Transportation Fund—to be used for intercity transportation links, including extensions through metropolitan areas, and for rural transportation networks. These funds would be apportioned on the basis of total population, rural population, and total land area and would be planned and implemented by state and rural government agencies.
3. Interstate Transportation Fund—to be used to develop an interstate transportation network, including the completion of the IHS, and to develop workable alternatives for surface and air transportation. Future national programs should be planned and implemented by DOT, which must also provide research and development, technical assistance, and coordination for regional and urban transportation authorities.

The responsibility for transportation integration must rest at all levels, but upward integration—from local networks that connect and interface at higher levels—is theoretically easier. Given the authority and responsibility for their own transportation, states and cities would be encouraged to develop their planning, implementation, and technological capacities instead of depending on the federal government. This would mean more state responsibility and shift federal responsibility to truly national transportation systems. If the IHS had been built by the Bureau of Public Roads and the U.S. Army Corps of Engineers, for example, perhaps the system could have been completed in less time and at less cost. More importantly, the program may not have been diverted into excessive building of urban freeways and consequent underemphasis of mass transportation technology.

Public policies must include not only the means for implementation but also the means to regulate, monitor, and assess the impacts and overall performance of the policy and to provide for its regular review. The long delays between the decision, implementation, feedback on effects, and finally, some governmental response is a major problem, especially with respect to large-scale technological developments. When the impacts are known, regulatory procedures should be set up and negative impacts corrected in the process of implementation. When effects are uncertain and risks are great, experimental or prototype programs should be conducted so that impacts can be adequately evaluated before full-scale development and implementation proceed. All future transportation programs and policies should include explicit provisions and authority for testing and evaluation of performance, periodic reviews of the policy, and appropriate channels for performance feedback from affected population groups. Preferably, this evaluation authority should be independent of the implementation agency for the program.

The integrated and hierarchical organization of transportation authority and programs will, it is hoped, permit better policy analysis and decision making by allowing the vertical and horizontal integration of transportation networks and modes between different geopolitical areas. This would be accomplished without violating the political integrity of existing governments but would depend on formal cooperation and coordination. New federal policies should take a leading role in the development of a modern and integrated transportation system by improving intergovernmental implementation and administrative structures.

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REFERENCES

1. L. Mumford. The Highway and the City. Harcourt, Brace and World, New York, 1963.
2. H. Mertins, Jr. National Transportation Policy in Transition. Lexington Books, Lexington, MA, 1972.
3. C. Dearing. American Highway Policy. Brookings Institution, Washington, DC, 1941.
4. J. Meyer. The Urban Transportation Problem. Harvard Univ. Press, Cambridge, 1965.
5. G. M. Smerk. Urban Transportation: The Federal Role. Indiana Univ. Press, Bloomington, IN, 1965.
6. W. Owen. The Metropolitan Transportation Problem. Brookings Institution, Washington, DC, 1966.

7. H. Blalock, Jr. Causal Inferences in Non-Experimental Research. W. W. Norton, New York, 1964.
8. P. H. Burch, Jr. Highway Expenditure and Revenue Policy in the U.S. Rutgers Univ. Press, New Brunswick, NJ, 1962.
9. R. S. Friedman. State Politics and Highways. In Politics in the American States (H. Jacob and K. N. Vines, eds.), Little, Brown and Co., Boston, 1965.
10. T. Dye. Politics, Economics and the Public. Rand McNally, Chicago, 1966.
11. I. Sharkansky and R. Hofferbert. Dimensions of State Politics, Economics and Public Policy. American Political Science Review, Vol. 63, Sept. 1969.
12. W. Cooley and P. Lohnes. Multivariate Data Analysis. Wiley, New York, 1971.
13. T. J. Kuehn. The Social Performance of Technological Systems: A Multivariate Analysis of Highway Transportation Policy in the United States. Program in Social Management of Technology, Univ. of Washington, Seattle, dissertation, June 1976.
14. The 1972 National Highway Needs Report, Pt. 1. Federal Highway Administration, March 15, 1972, pp. vi-xii.

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