Chapter 2
Early Highway Planning

Early highway planning grew out the need for information on the rising tide of automobile and truck usage during the first quarter of the twentieth century. From 1904, when the first automobiles ventured out of the cities, traffic grew at a steady and rapid rate. After the initial period of highway construction which connected many of the nation's cities, emphasis shifted to improving the highway system to carry these increased traffic loads. New concepts were pioneered to increase highway capacity including control of access, elimination of at grade intersections, new traffic control devices, and improved roadway design. Transit properties were privately held were the purview of cities.

Early highway planning was devoted to the collection and analysis of factual information and, on applying that information to the growing highway problems in the period prior to World War II. It was during this period that scientific and engineering principles were first used to measure highway traffic and capacity and to apply that knowledge to the planning and design of highways.

Federal Highway Act of 1921

In the early years of highway construction, the automobile had been regarded as a pleasure vehicle rather than an important means of transportation. Consequently, highways consisted of comparatively short sections that were built from the cities into the countryside. There were significant gaps in many important intercity routes. During this period, urban roads were considered to be adequate, particularly in comparison to rural roads which were generally not paved.

As the automobile was improved and ownership became more widespread, the idea of a highway network gained in strength. The concept of a national system of highways was recognized in the Federal Highway Act of 1921. The Act required that the State highway departments designate a system of principal interstate and inter county roads, limited to 7% of the total mileage of rural roads then existing.

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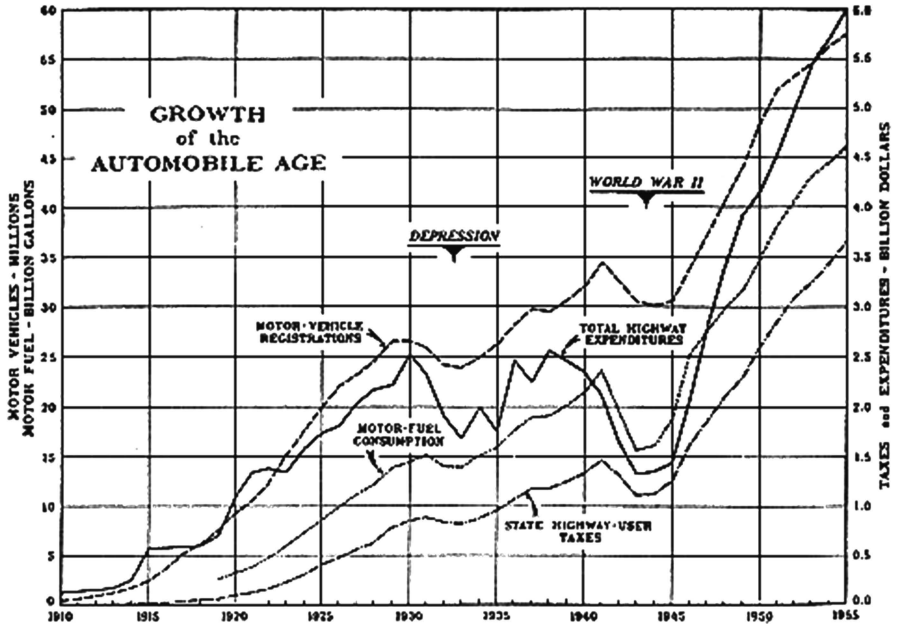

Fig. 2.1 Motor vehicle registrations, fuel consumption, user taxes, and highway expenditures, 1910–1955. Source: US Dept. of Commerce, 1954a, b

The use of Federal-aid funds was restricted to this system. The Federal government would pay 50% of the construction cost while the states would pay the other 50%. This concentration of attention on a carefully selected system of roads had a large influence on the rapid development of an integrated, nationwide network of improved highways.

The concept of a continuous national system of highways was reinforced in the Federal-Aid Highway Act of 1925 with the requirement for a US numbered highway system composed of important through routes extending entirely across the nation. Instead of using names and colored bands on telephone poles, this new system would use uniform numbers for inter-state highways and a standardized shield that would be universally recognizable. This was not a formal highway system but simply a basis for route marking as a guide for motorists. The US number highway system was adopted in 1926.

With the adoption of a Federal-aid system, in the Federal-Aid Act of 1921, and the marking of through routes, the focus of highway construction was on "closing the gaps." By the early 1930s, the objective of constructing a system of two-lane roads connecting the centers of population had largely been completed. It was then possible to travel around the country on a smooth, all-weather highway system (US Federal Works Agency, 1949).

With the completion of this "pioneering period" of highway construction, attention shifted to the more complex issues resulting from the rapid growth in traffic and increasing vehicle weights. Figure 2.1 shows the growth in vehicle registrations,

motor fuel consumption, highway expenditures and tax receipts during the period (US Dept. of Commerce, 1954a). Early highways were inadequate in width, grade and alignment to serve major traffic loads, and highway pavements had not been designed to carry the numbers and weights of the newer trucks.

It became clear that these growing problems necessitated the collection and analysis of information on highways and their use on a more comprehensive scale than had ever before been attempted (Holmes and Lynch, 1957). A systematic approach to the planning of highways was needed to respond to these problems.

Early Parkways

The growing numbers of automobiles and the expansion of cities into nearby suburbs in the early part of the century created the need for specialized roadways. In New York, the city's growth was rapidly extending northward into Westchester County. Property along the Bronx River was coming into the market, and the subdivision of this land into smaller plots and the development upon it was polluting the river. The Bronx River Commission was established in 1907 to acquire the necessary lands, and build the Bronx River Parkway as a joint undertaking between New York City and Westchester County.

The Bronx River Parkway Reservation was the first public parkway designed explicitly for automobile use. The project began as an environmental restoration and park development initiative that aimed to transform the heavily polluted Bronx River into an attractive linear park. With the addition of a parkway drive the project became a pioneering example of modern motorway development. It combined beauty, safety, and efficiency by reducing the number of dangerous intersections, limiting access from surrounding streets and businesses, and surrounding motorists in a broad swath of landscaped greenery. The Bronx River Parkway Reservation, which parallels the parkway, was the first parkland in Westchester Count (Bronx River Parkway—Historic Overview).

The parkway drive accommodated four lanes of traffic on a 40″-wide pavement and included several important design features that would soon become hallmarks of parkway design. These included the avoidance of excessive grades and dangerous curves; the replacement of at-grade intersections with grade-separated crossings; and the division of traffic into two one-way drives separated by a landscaped median divider. Bridges were built for permanence with architectural treatment in harmony with their natural surroundings. Many of these features were duplicated by designers of other projects and became the hallmarks of parkways (Bronx River Parkway—Historic Overview).

The continued expansion of automobile ownership and the technological advances in automobiles soon required additional parkways. During the 1920s and 1930s a number of new parkways were built including the Hutchinson, Saw Mill, Grand Central and the Taconic, north of the New York City, the Henry Hudson Parkway in New York and the Palisades and the Palisades Parkway in New Jersey.

On Long Island, there were the Meadowbrook, Northern and Southern State, and Wantagh State Parkway. By 1934, there were some 134 miles of parkways in Queens, Nassau and Westchester Counties under the direction of Robert Moses (Walmsley, 2003). Also in the 1930s, the modern parkway movement expanded out of New York with construction of several Federal parkways including Skyline Drive in Virginia, Blue Ridge Parkway in North Carolina and Tennessee, and the Merritt Parkway in Connecticut (Loukaitou-Sideris and Gottlieb, 2003).

Radburn, New Jersey

The industrialization of the USA after World War I led to migration from the rural areas and a striking growth of the cities during the 1920's. This population shift led to a severe housing shortage. The automobile, which was becoming a mainstay in American life, added a new problem to urban living. Changes in urban design were necessary to provide more housing and to protect people from automobile traffic. To address these needs, Radburn, the "Town for the Motor Age," was created in 1929 in Fairlawn, New Jersey outside of New York City.

Radburn was designed by Henry Wright and Clarence Stein using Wright's "Six Planks for a Housing Platform":

- Plan simply, but comprehensively. Don't stop at the individual property line. Adjust paving, sidewalks, sewers and the like to the particular needs of the property dealt with—not to a conventional pattern. Arrange buildings and grounds so as to give sunlight, air and a tolerable outlook to even the smallest and cheapest house.
- Provide ample sites in the right places for community use, i.e., playgrounds, school gardens, schools, theaters, churches, public buildings, and stores.
- Put factories and other industrial buildings where they can be used without wasteful transportation of goods or people.
- Cars must be parked and stored, deliveries made, waste collected—plan for such services with a minimum of danger, noise, and confusion.
- Bring private and public land into relationship and plan buildings and groups of buildings with relation to each other. Develop collectively such services as will add to the comfort of the individual, at lower cost than is possible under individual operation.
- Arrange for the occupancy of houses on a fair basis of cost and service, including the cost of what needs to be done in organizing, building, and maintaining the community.

The primary innovation of Radburn was the Road System Hierarchy which separated pedestrian and vehicular traffic. This was accomplished by doing away with the traditional grid-iron street pattern and replacing it with an innovation called the superblock. The superblock was large block of land surrounded by main roads. The houses were grouped around small cul-de-sacs, each of which had an access road

coming from the main roads. The remaining land inside the superblock was park area, the backbone of the neighborhood. The living and sleeping sections of the houses faced toward the garden and park areas, while the service rooms faced the access road.

The idea of purely residential streets was a new idea at that time. The Radburn plan used the cul-de-sac as a rational way to escape the limitations of the checkerboard plan, in which all streets were through streets, with the possibility of collisions between cars and pedestrians every 100 m. The Radburn cul-de-sac lane was designed at a 100–130 m length, with only a 10 m wide right of way, as opposed to the prevailing 16–20 m width. The plan further reduced the paved driving lane to 6 m and allowed for the 2 m utility strip on each side to be landscaped and thus visually part of the garden. Building setbacks were 5 m and provisions were made for street parking.

The walks that surround the cul-de-sacs on the garden side of the houses divided the cu-de-sacs from each other and from the central park area. These paths crossed the park when necessary. Finally, to further maintain the separation of pedestrian and vehicular traffic, a pedestrian underpass and an overpass, linking the superblocks, was provided. The systems was so devised that a pedestrian could start at any given point and proceed on foot to school, stores, or church without crossing a street used by automobiles.

Another innovation of Radburn was that the parks were secured without additional cost to the residents. The savings in expenditures for roads and public utilities at Radburn, as contrasted with the normal subdivision, paid for the parks. The Radburn type of plan used small property lots and less area of street to secure the same amount of frontage. In addition, for direct access to most houses, it used narrower roads of less expensive construction, as well as smaller utility lines. The area in streets and length of utilities was 25% less than in the typical American street. The savings in cost not only paid for 12–14% of the total area that went into internal parks, but also covered the cost of grading and landscaping the play spaces and green links connecting the central block commons. The cost of living in such a community was therefore set at a minimum for the homeowner, and the cost to the builder was small enough to make the venture profitable.

Radburn was unique because it was envisioned as a town for better living, and it was the first example of city planning which recognized the importance of the automobile in modern life without permitting it to dominate the environment. None of the Radburn design features were completely new. Yet, their synthesis and integration into a comprehensive layout was a breakthrough in subdivision form. It was the first time in the USA that a housing development was attempted on such a large scale, proceeding from a definite architectural plan resulting in a complete town. Radburn was also important to builders because of the unique way that the parks and grading were funded.

The Radburn idea, however watered down, became the suburban model of choice. Planners enshrined it in cluster zoning ordinances. Developers, who had never heard of Radburn or its planning principles, grouped buildings around cul-de-sacs and marketed their product from “community centers”. Their projects routinely include

"common open space," a swimming pool, and sometimes tennis courts, indoor exercise facilities, and children's play equipment (Garvin, 1998).

Federal-Aid Highway Act of 1934

Beginning with the Federal-Aid Highway Act of 1934, the Congress authorized that 1–1/2% of the amount apportioned to any state annually for construction could be used for surveys, plans, engineering, and economic analyses for future highway construction projects. The act created the cooperative arrangement between the US Bureau of Public Roads (now the US Federal Highway Administration) and the state highway departments, known as the statewide highway planning surveys. By 1940, all states were participating in this program (Holmes and Lynch, 1957).

As an initial activity, these highway planning surveys included a complete inventory and mapping of the highway system and its physical characteristics. Traffic surveys were undertaken to determine the volume of traffic by vehicle type, weight, and dimensions. Financial studies were made to determine the relationship of highway finances to other financial operations within each state, to assess the ability of the states to finance the construction and operation of the highway system, and to indicate how to allocate highway taxes among the users. Many of the same types of activities are still being performed on a continuing basis by highway agencies (Holmes, 1962).

Electric Railway Presidents' Conference Committee

Electric railway systems were the backbone of urban mass transportation by World War I with over 1,000 street railway companies carrying some 11 billion passengers by 1917 (Mills, 1975). After 1923, ridership on the nation's electric railways began to decline as the motor bus, with its flexibility to change routes and lower capital costs, quickly began replacing the electric streetcar (N.D. Lea Transportation Research Corporation, 1975). With rising costs and the inability to raise fares to cover costs, the financial condition of street railway companies worsened.

In 1930, the heads of 25 electric railway companies formed the Electric Railway Presidents' Conference Committee (PCC). The goal of the PCC was to develop a modern streetcar to match the comfort, performance, and modern image of its competitors, and stem the decline of the street railway industry. The effort took 5 years and $750,000. It was one of the most thorough and efficiently organized ventures in urban mass transit. The product, known as the "PCC car," far surpassed its predecessors in acceleration, braking, passenger comfort, and noise (Mills, 1975).

The first commercial application of the PCC car was in 1935 in Brooklyn, New York. By 1940 more than 1,100 vehicles had been purchased. By 1952, when production was first halted, about 6,000 PCC cars had been produced. The PCC cars did improve the

competitive position of streetcars and slow the conversion to buses, but without other improvements, such as exclusive rights of way, it could not stop the long term decline in street railways. By 1960, streetcars remained in only about a dozen cities in the USA (Vuchic, 1981).

Manual on Uniform Traffic Control Devices

As the highway system was expanded and upgraded to meet the growth in automobile traffic, the need for high uniform standards for traffic control devices became obvious. These traffic control devices included signs, traffic signals, markings and other devices placed on, over or adjacent to a street or highway by a public body to guide, warn, or regulate traffic. In 1927, the American Association of State Highway Officials published the *Manual and Specifications for the Manufacture, Display and Erection of US Standard Road Markers and Signs*. The manual was developed for application of rural highways. Then, in 1929, the National Conference of Street and Highway Safety published a manual for use on urban streets.

But the necessity for unification of the standards applicable to different classes of road and street systems was obvious. To meet that need, a joint committee of the AASHO and the National Conference of Street and Highway Safety combined their efforts and developed the first *Manual on Uniform Traffic Control Devices* which was published by the BPR in 1935. The manual incorporated the shape of signs that have been used to date that were established by the Mississippi Valley Association of State Highway Departments. In 1923, the association developed a set of recommendations regarding street-sign shapes whose impact is still felt today. The recommendations were based on a simple idea: the more sides a sign has, the higher the danger level it invokes. The circle, which has an infinite number of sides, indicated danger and was recommended for railroad crossings. The octagon, with its eight sides, was used to denote the second-highest level. The diamond shape was for warning signs. And the rectangle and square shapes were used for informational signs.

In June 1961 BPR published the 1961 MUTCD, which provided greater uniformity in signing by eliminating many of the alternatives permitted in the previous edition and by replacing them with a single standard. The emphasis on uniformity was indicated by a BPR requirement that all traffic control devices used on federal-aid highways must conform to the new manual. This was the first time that compliance with MUTCD standards had been linked to receiving federal highway funds (Hawkins 1992).

Over the years since that first manual was published, the problems and needs of traffic control changed. New solutions and devices were developed, as well as the standards to guide their application. The original joint committee continued its existence with occasional changes in organization and personnel. In 1972, the Committee formally became the National Advisory Committee on Uniform Traffic Control Devices to the FHWA. The Committee has been responsible for periodic revisions

to update and expand the manual in 1942, 1948, 1961, 1971, 1978, 1988 and 2000 (US Dept. of Transportation, 2000a, 1978b; Upchurch, 1989).

Hawkins, H Gene, Jr, 1992, "Evolution of the MUTCD: Early Standards for Traffic Control Devices," *ITE Journal*. July.

AASHO Policy on Geometric Design of Rural Highways

As new knowledge became available on the performance of vehicles and highway design features, there was a need to incorporate it into practice. The Committee on Planning and Design Policies of the American Association of State Highway Officials (AASHO) was formed in 1937 for this purpose. The committee's mode of operation was to outline a program of work which was performed by the BPR under the supervision of the Committee Secretary. The BPR gathered known information and developed draft guidance, known as policies, which were revised by the committee. The policies were finally approved by a two-thirds favorable vote of the States.

In the period from 1938 to 1944 the Committee under Secretary Joseph Barnett produced seven policies related to highway classification, highway types, sight distance, signing, and intersection design for at-grade, rotaries and grade separations. These policies were reprinted without change and bound as a single volume in 1950 (American Association of State Highway Officials, 1950).

The policies were updated, expanded and rewritten as a single cohesive document and issued as *A Policy on Geometric Design of Rural Highways* in 1954 (American Association of State Highway Officials, 1954). The policy contained design guidance on the criteria determining highway design, vertical and horizontal alignment, cross section elements, at-grade and grade intersections, and interchanges. The volume, which became known as the "Blue Book," went through seven printings by 1965. It received wide acceptance as the standard guide for highway design. The policy was again reissued in 1966 in revised and updated form to reflect more current information (American Association of State Highway Officials, 1966).

Much of the material in the 1954 Rural Policy applied both to urban and rural highways. As new data and research results became available on urban highways, the AASHO Committee decided to issue a separate policy for the geometric design of urban highways (American Association of State Highway Officials, 1957).

The development of these policies typified the approach to highways standards. Research engineers collected data on the performance of vehicles and highways. These data were brought together in the form of design standards, generally by staff of the BPR under the guidance of the AASHO. Eventually, they became part of highway design practice through agreement of the States. As a result of their factual basis and adoption through common agreement, the policies had immense influence on the design of highways in the USA and abroad.

Toll Road Study

By the mid 1930s, there was considerable sentiment for a few long-distance, controlled-access highways connecting major cities. Advocates of such a highway system assumed that the public would be willing to finance much of its cost by tolls. The US Bureau of Public Roads was requested by President Franklin D. Roosevelt in 1937 to study the idea, and 2 years later it published the report, *Toll Roads and Free Roads* (US Congress, 1939).

The study recommended the construction of a highway system to be comprised of direct, interregional highways with all necessary connections through and around cities. It concluded that this nationwide highway system could not be financed solely through tolls, even though certain sections could. It also recommended the creation of a Federal Land Authority empowered to acquire, hold, sell, and lease land. The report emphasized the problem of transportation within major cities and used the city of Baltimore as an example (Holmes, 1973).

Highway Capacity Manual

During the 1920s and early 1930s, a number of studies were conducted to determine the capacity of highways to carry traffic. Early efforts were theoretical but, gradually, field studies using observers, cameras and aerial surveys created a body of empirical data on which to base capacity estimates. By 1934, it was clear that a coordinated effort was needed to integrate the results of the various studies and to collect and analyze additional data. The BPR launched such an effort from 1934 to 1937 to collect a large quantity of data on a wide variety of roads under different conditions (Cron, 1975a).

In 1944, the Highway Research Board organized the Committee on Highway Capacity to coordinate the work in this field. Its chairman, O.K. Norman, was the foremost researcher on highway capacity at that time. By 1949, the Committee had succeeded in reducing the enormous volume of factual information on highway capacity to a form that would be usable to highway designers and traffic engineers. The results were first published in *Public Roads* magazine, and then as a separate volume entitled, the *Highway Capacity Manual* (US Dept. of Commerce, 1950). The manual defined capacity, and presented methods for calculating it for various types of highways and elements under different conditions. This manual quickly became the standard for highway design and planning. More than 26,000 copies of the manual were sold, and it was translated into nine other languages.

The Committee on Highway Capacity was reactivated in 1953, again with O.K. Norman as chairman, to continue the study of highway capacity and prepare a new edition of the manual. Much of the work was done by the staff of the BPR. The new manual, which was issued in 1965, placed new emphasis on freeways, ramps, and weaving sections because they had come into widespread use. A chapter on bus transit was also added. Other types of highways and streets continued to

receive complete coverage. This manual, like its predecessor, was primarily a practical guide. It described methods to estimate capacity, service volume, or level of service for a specific highway design under specific conditions. Alternately, the design to carry a given traffic demand could be determined (Highway Research Board, 1965).

The third edition the *Highway Capacity Manual* was published by the Transportation Research Board in 1985. It reflected over two decades of empirical research by a number of research agencies primarily under the sponsorship of the National Cooperative Highway Research Program and the FHWA. The procedures and methodologies were divided into three sections on freeways, rural highways, and urban streets with detailed procedures and work sheets. The material in the third edition offered significantly revised procedures in many of the areas, and included entirely new sections on pedestrians and bicycles (Transportation Research Board, 1985c and 1994).

The most recent revised edition of the *Highway Capacity Manual 2000* was published in metric units, as well as in the US customary system units used in the traditional manual. In addition to improvements in current analysis methodologies, HCM 2000 included a chapter on interchange ramp terminals, several chapters with material for planning uses of the manual, and a discussion of when simulation models should be used instead of the manual. The HCM 2000 was also published as a CD-ROM. In addition to the text and exhibits of both versions of the book, the CD-ROM included tutorials, narrated example problems, explanatory videos, navigation tools, hyperlinks between sections of the manual, and easy access to application software (Transportation Research Board, 2000).

Interregional Highway Report

In April 1941, President Franklin D. Roosevelt appointed the National Interregional Highway Committee to investigate the need for a limited system of national highways to improve the facilities available for interregional transportation. The staff work was done by the US Public Roads Administration, which was the name of the Bureau of Public Roads at that time, and in 1944 the findings were published in the report, *Interregional Highways* (US Congress, 1944). A system of highways, designated as the "National System of Interstate and Defense Highways," was recommended and authorized in the Federal-Aid Highway Act of 1944. However, it was not until the Federal-Aid Highway Act of 1956 that any significant work on the system began.

This study was unique in the annals of transportation planning and the implementation of its findings has had profound effects on American lifestyles and industry. The study brought planners, engineers, and economists together with the highway officials responsible for implementing highway programs. The final route choices were influenced as much by strategic necessity and such factors as population density, concentrations of

manufacturing activity, and agricultural production as by existing and future traffic (Holmes, 1973).

The importance of the system within cities was recognized, but it was not intended that these highways serve urban commuter travel demands in the major cities. As stated in the report, "…it is important, both locally and nationally, to recognize the recommended system…as that system and those routes which best and most directly join region to region and major city to major city" (US Congress, 1944).

The report recognized the need to coordinate with other modes of transportation and for cooperation at all levels of government. It reiterated the need for a Federal Land Authority with the power of excess condemnation and similar authorities at the state level.

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