ENGINEERS AND HIGHWAY DEVELOPMENT: THE RISE AND FALL OF EXPERTISE DURING THE 20TH CENTURY

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ABSTRACT

The occasion of the almost-centennial of PIARC and the 23rd World Road Congress offers an appropriate time for considering the role of engineers in the process of highway construction, administration and policy. The Bureau of Public Roads (BPR) in the United States demonstrated that technical leadership in highways could be translated into authority in the policy arena. The paper first examines how this happened, highlighting an attitude of public trust in objective expertise as ideal decision makers and a cooperative administrative style. Underlying both was a deep rooted public enthusiasm and excitement for automobiles. The paper then compares the role of engineers in highway policy in several European countries, finding parallels that grew in part from the transfer of American approaches to highway and traffic engineering after World War II. Agents of diffusion included the BPR, Yale's Bureau of Street Traffic Research, and the International Road Federation. But this trust in highway engineers was undermined by changing conditions that forced roads to be seen as more than movers of vehicles. By the late 1960s highway engineers were losing authority, while as planners, transportation economists, and other social scientists entered or forced their way into the process of determining highway policy.

This paper reviews the shifting roles of highway engineers in the highway policy arena after 1900, emphasizing how expertise granted authority in the realm of policy and administration. The paper initially devotes attention to the American Bureau of Public Roads, but for purposes of comparison it also examines in less detail the place of engineers and experts in developing highway agencies and road policy in European countries. There is a surprising level of consistency among road building bureaucracies, both in terms of the emergence of public support for engineers as apolitical experts and then of the erosion and loss of that public trust in the 1960s and 1970s.

THE BUREAU OF PUBLIC ROADS: LINKING EXPERTISE AND HIGHWAY POLICY

In 1893, the United States lacked a national highway system, because roads had been a local responsibility since canals and railroads assumed transportation priority after 1830. But the craze for bicycles in the 1880s and complaints about the terrible condition of roads prompted Congress to create an Office of Road Inquiry in the Agriculture Department in 1893 [1]. The Office was charged with studying road improvement and disseminating information. Between 1893 and 1916, engineers in this office, eventually renamed the Bureau of Public Roads (BPR), established themselves as the leading source of information about road construction, materials, and highway administration and finance.

This approach fit the reforming mindset of the age. Citizens committed to the possibility of social and political improvement advocated assigning experts who created and interpreted

objective statistics and scientific data to that end. The reformers celebrated efficiency, a slippery word, but one that stood in contrast to the wasteful practices of political machines. They considered engineers and other experts, by definition, to be immune to the graft and corruption that characterized 19th-century politics. Examples of reform impulses included the Food & Drug Administration (1906), state-level public utility commissions, and the creation of educational administration systems, among other efforts [2].

The American highway program was a product of this reforming mindset. Indeed, in 1905 Congress explicitly required that an engineer head this agency. The first appointee, Logan Waller Page, earned an engineering degree from Harvard and came to Washington in 1900 to directed the office's testing lab after running a similar program in Massachusetts. He had visited France to observe testing facilities and returned with techniques and testing apparatus, which he modified and improved. Page elevated the technical reputation of the roads office though an extensive testing program covering most road materials, with many results translated into standards and specifications by cooperating with such groups as the American Society for Testing Materials. In 1906, the Office opened a new testing lab in Washington, DC, that *Scientific American* judged the "equal of any in the world." Then in 1912, an experimental center opened in Arlington, VA, that permitted full-scale tests [3].

These were not the Office's only technical efforts. In 1905, Page initiated a post-graduate training program that became the nation's first highway engineering course. The Office detailed some of its engineers to train and improve local road organizations, assignments that could last for two years. By 1916, 144 counties in 28 states had entertained federal engineers [4]. This effort led newspaperman E.W. Scripps to write to Logan Page to say, "In all this great nation, there are perhaps no other two men who have better opportunities to serve their country and who are making better use of them than you and Mr. Pinchot (famous conservationist and head of the Forest Service). Despite the fact that neither of you have any high sounding titles or official positions which in themselves give you great distinction -- perhaps just because of that fact, you are epoch-makers" [5].

It was this growing reputation that allowed , Page and his staff of engineers to translate expertise into political influence. Their actions reflected the deep public acceptance of the rhetoric of efficiency after 1900. As proven stewards of scarce road-building funds, federal engineers possessed credibility that allowed them to press for administrative reforms in the states. Page explained his platform in 1905: "My whole object …is to get the state highway department out of politics...and at the same time put in charge of engineers" [6]. Federal engineers had drafted a model road commission bill in 1904, and many state legislatures accepted the OPR's recommendations and installed engineers as managers.

A national road program was not authorized until 1916, but when Congress acted, it followed the BPR's advice about the structure of highway programs. Urged by Page and ignoring recommendations from organizations that favored direct federal construction, Congress accepted the concept of expert control as the guiding principle of the federal-aid highway program. Congress placed administrative control over all aspects of highway construction in the hands of a renamed Bureau of Public Roads (BPR). Any state seeking federal matching funds first had to create a highway organization that met with BPR approval, and then allow inspection of all plans. BPR control was not absolute, for under this federalist program, the states and federal government shared the cost and the states actually built the new system of roads. By 1920, every state had accepted these rules.

Congressional acceptance of BPR advice was even more evident in the second major highway bill passed in 1921. This legislation created a national road network that linked

every major city in the country. Page's successor, Thomas H. MacDonald, was the force behind the bill, which was passed despite objections from opponents of the federal-aid approach. MacDonald's success in working with members of Congress marked the beginning of decades of cooperation that often saw the BPR's preferences transformed into national highway policy decisions.

A key to this situation was the way that Thomas MacDonald administered the federal-aid highway program. MacDonald had been chief highway engineer in Iowa before coming to Washington in 1918, and held his post as Chief of the BPR until 1953. Always, he envisioned the federal-aid highway program as a partnership, explaining, "The Bureau does not seek initiative. It does not seek to direct the states but to co-operate with them" [7]. But MacDonald always could rely upon the BPR's superior expertise to influence state actions, even if he operated carefully and with subtlety. G. Donald Kennedy, deputy highway commissioner of Michigan, explained how this worked process could work from personal experience. On Kennedy's first day on the job in 1933, BPR district engineer J.T. Voshell visited the Michigan highway department. Voshell "outlined the federal-aid program and what the states had to do and what the procedures were… [H]e made it very apparent that he wasn't going to let these new people get out of hand." Voshell directed BPR District 7 from 1917 into the early 1950s, yet was never heavy handed. As he wrote to another BPR engineer in 1924, "We must depend upon the integrity of the States, and our view is that our inspections are more for the purpose of seeing that the State had competent men in charge of the work than to actually control the construction" [8].

MacDonald's also worked steadily to increase the professional capability of state highway agencies. A central step here was the creation of testing laboratories, which over time grew into genuine research centers. The BPR remained the unquestioned technical leader, but MacDonald's strategy helped close the gap, thereby cementing close relations between state and federal engineers. To support them and coordinate all research activities, he helped found the Highway Research Board in the National Research Council in 1920 [9]. Further connecting state and federal engineers was the American Association of State Highway Officials (AASHO), which MacDonald used to insure two-way communication. He used AASHO committees as venues for discussing, and then publishing, the rules and all technical standards and specifications governing federal-aid highway construction, even though most data came from the BPR. In this way, for example, AASHO committees developed the highway numbering scheme for U.S. highways in the early 1920s. This process eliminated any appearance of federal engineers dictating policy to the states. And it worked. A survey of 41 highway departments in 1925 reported that 36 had few complaints. As Michigan's chief highway engineer added, "I wish to be emphatic in saying that there is no loss of initiative when the state and Federal engineers jointly strive for the best there is in highway practice" [10].

MacDonald also helped shape national highway policy during his long tenure, working closely with both congressional highway committees and presidents. His appearances before Congress were marked by expressions of respect for the "The Chief's" (as he was usually known) opinions. One long-time associate at the BPR later remembered that MacDonald "…was looked upon with deference everywhere he went. Even the Appropriations Committee looked upon Mr. MacDonald with deference." A committee staffer considered MacDonald "the best and toughest witness we ever had." Individual congressmen often asked him to take the thorny problems from off their hands. Yet he always shared the spotlight with AASHO officials [11]. And MacDonald built equally strong relationships with every president. Rexford Tugwell, the noted New Deal planner, reported that "Thomas MacDonald...was assiduous in educating me, and through me, Roosevelt.

We supported MacDonald...." Of all the bureau chiefs, Tugwell respected MacDonald most. "[He] was there both before and after we, shaping, through one Presidency after another, and one Congress after another, the nation's highway policy" [12].

Taken together, these arrangements with the states, with Congress, and with the presidents, translated into enormous influence and made federal highway engineers the arbiters of American highway policy from 1916 through 1960. To be sure, theirs was not the only voice heard in the technical and political debates, for many other actors existed at every level of government and in the private sector. And the BPR's influence most definitely waxed and waned with certain issues. The BPR was not always right in its approaches or future projections. It supported an approach to highway planning, for example, that placed such heavy emphasis on the movement of vehicles that land-use and development factors were rarely visible. The BPR also predicted incorrectly that the Pennsylvania Turnpike, built in 1939-40 as a work relief measure, would fail to generate enough traffic to pay off its bonds. Yet the BPR's stature generally remained untarnished into the 1950s, providing federal engineers with greater influence than almost any other participant in highway policy debates. Describing an attitude that prevailed for forty years, an official at the American Automobile Association commented in 1922: "The Association will avoid taking any stand at variance from that of the highway officials and the Bureau in important matters" [13].

Numerous examples demonstrate this point. While others were deeply involved, BPR engineers especially influenced the shape of urban express highways from the late 1930s. Joseph Barnett, for example, developed high-speed transition curves and designs for interchanges that were first used on the George Washington Parkway outside Washington, DC. AASHO's design and standards committee, which Barnett chaired for more than 20 years, disseminated this idea. Barnett also advised more than 100 cities as they began to develop express highway plans in the 1940s. Similarly, BPR attorney L.E. Boykin crafted the legal structure that permitted limited-access highways. Boykin draft legislation helped states pass constitutional amendments in the late 1930s and 1940s, common law held that any property owner had access to an adjoining highway [14].

Another influential BPR engineer was H.S. Fairbank, who developed widely adopted methods for measuring and counting traffic. Again, he was not alone in this effort, as two consultants, William Phelps Eno (founder of the Eno Foundation for Highway Traffic Control) and Miller McClintock (creator of the Harvard Bureau of Street Traffic Research, which move to Yale in 1941), developed techniques that came to be called traffic engineering [15]. But it was Fairbank who created statewide highway planning surveys. these emerged from efforts in the 1920s to justify highway construction by demonstrating in economic terms the benefits of roads. As Thomas MacDonald repeatedly argued, "We pay for good roads whether we have them or not." The BPR initially explored ways to measure the costs and benefits of roads by launching traffic counts in Chicago and Cleveland during the 1920s. By 1930, however, a new rationale for planning emerged as the BPR attempted to match scarce construction dollars to the routes most in need of construction. In collaboration with the Michigan highway department, Fairbank developed a methodology for statewide highway planning. MacDonald then persuaded Congress to require every state to conduct such surveys [16]. By 1938, the BPR had consistent national data that allowed Fairbank to analyze congressional proposals for cross-country toll roads modeled on the German autobahn. The BPR branded these wasteful and unnecessary in a landmark report– *Toll Roads and Free Roads.* The BPR also offered an alternative system of roads, and reported that the most pressing traffic problems were in and near cities, not on transcontinental highways [17].

Toll Roads and Free Roads eventually became the basis of the Interstate Highway network of the 1950s, but only after extensive efforts by BPR engineers to shape key policy elements. From 1946-1956, BPR engineers, along with many other groups and agencies, worked with Congress and the Eisenhower administration to find ways to fund this system of 44,000 miles of high-standard highways [18]. Perhaps most importantly, the BPR supplied the data used by everyone – statistical analyses of traffic growth, highway usage, and funding needs, maps of alternative plans, and studies on numerous topics. They provided the technical staff for the famous Clay Committee, whose report helped break a legislative logjam in 1955, even though many of its ideas were rejected in Congress. BPR engineers also quietly influenced the final legislation, working to preserve the federal-aid concept when officials in the Eisenhower administration sought to create a national road program, repeal the federal gasoline tax, and use bonds and tolls to pay for road construction. As always, respect for the BPR's expertise proved crucial in winning support for the engineers' core ideals. Engineer Francis C. Turner was the BPR's key figure, as he directed the staff assigned to the Clay Committee and drafted the committee's report. Turner then spent 1955 and half of 1956 as congressional liaison, helping congressional committees prepare highway legislation. White House staffer General John Bragdon clearly had Turner in mind when he bitterly blamed the BPR's "horse and buggy" thinking for blocking the changes he and White House staffers favored. He believed the BPR feared losing control over highways, but Eisenhower's political advisers labeled the changes backed by Bragdon politically impractical [19]. The June 1956 legislation that launched the Interstate program reflected the BPR's long-standing views about highway development, thanks to the efforts of Frank Turner. Many others contributed to the final policy, but the BPR's technical credentials provided special legitimacy for its views.

The enormous influence of highway engineers, especially those from the BPR, demands explanation, for few other groups of technical experts have exercised such influence over policy for such a long time. One factor in the influence of state and federal highway engineers was the cooperative style that permeated the federal-aid program. But probably more crucial was the high level of popular support for road construction programs. That support began with bicycle groups that launched the Good Roads Movement in the 1880s and rural residents eager for RFD mail in the 1890s; it grew stronger with the ever-growing numbers of automobile drivers after 1910. Yet until 1910, railroads were the largest corporate supporters of road improvement. The rapid growth of road expenditures at the federal, state, and local level are good markers of public support, with perhaps the single best indicator being acceptance of gasoline taxes. Oregon pioneered this financial innovation in 1919, which historian John J. Burnham labeled the only popular tax in American history [20]. Propelled partially by this revenue source, road building became one of the largest government programs of the 20th century. During the New Deal, more money was spent on roads than on any other work-relief program. Then came the Interstate program, authorized at $25 billion in 1956 with a final price tag approaching $140 billion. And the states and local governments spent much more money on their roads.

Throughout, engineers were the preferred stewards for this enormous investment in what was the world's largest public works project. This trust in experts proved quite long lasting. During the 1950s, for example, this trust showed in the adoption of another BPR idea -- sufficiency rating systems. Several legislatures accepted this approach as a solution to tremendous political fights for highway dollars. These systems determined priorities for highway projects by assigning points based on traffic counts and pavement condition. By

1952, 21 states had adopted this “scientific, statistical” approach“ in order to “take road building programs out of the pork barrel” [21]. The logic was perfectly captured by the comment of a highway engineer in 1939: “When every state has a planned highway procedure free from politics or the influence of politicians of very caliber, one will be able to say then, in truth, that highway planning is beginning.” Clearly, the ability to invoke the image of apolitical expertise gave highway engineers a ticket to the highway policy arena.

TECHNICAL EXPERTS AND HIGHWAY POLICY IN EUROPE

The ability of highway engineers to influence highway policy has not been limited to the United States. In part, it seems that similar challenges prompted similar solutions, arrived at independently. But it is also true that U.S. approaches to highway administration and construction were borrowed and copied in Europe, especially after World War II. This section surveys the experience of European countries and the role of expert authority in their highway programs before the war, and then examines the transfer of U.S. ideas abroad during the postwar period.

Even five years ago, historical resources devoted to highway developments in European countries was limited. But a growing body of literature recently has emerged, thanks to projects such as the Tensions of Europe program, which is studying the history of technology in 20th century. One subject of this study is transportation and mobility. At the same time, the International Association for the History of Transport, Traffic and Mobility (T2M) has appeared to connect scholars of transport in history, while the *Journal of Transport History* has been revived as an outlet for scholarly studies in the field [22]. Efforts to find patterns in highway administration owe much to these developments.

Comparative study of European highway programs indicates that highway engineers played roles that extended well beyond actual design and construction, but the specific role varies from country to country. Britain’s privately financed 18th-century turnpikes, for example, showcased the engineering talents of Thomas Telford and John Macadam, but British highway development remained a local issue well into the 20th century. This situation limited not only road construction but also expert control. On the other hand, the centralized French road network was developed by engineers at the Corps of Bridges and Roads. Logan Page, remember, traveled to France in 1900 to study and acquire French testing machines, text books, and laboratory techniques. In 1900, the French road systems and highway administration agencies were the best in the world [23].

As in the U.S., the growth of the automobile stimulated larger road programs in Europe. But the same mixed pattern evident in England and France concerning the role of engineers is visible in European road programs before 1940. Often political actors dominated the scene. In Italy, businessman and engineer Piero Puricelli created the first high-speed *autostrada* as a private concern between Milan and Lake Maggiore between 1923 and 1925. At that time Italians owned 60,000 automobiles and road construction was a local matter. A state road agency was not created until 1928 and it was not very effective, even as private toll road concessions were bought by the state between 1933 and 1940. By that time, political concerns rather than engineering control were the important factor in the road program. The military significance of roads in the north and their propaganda value (Mussolini boasted that the autostrada tied the Fascists to ancient Rome and its roads) were central factors. Even so, one observer noted that “Every Italian is keen about motor cars. Every item of automobile mechanism or design rivets his

attention; details of construction are matters of wide popular interest." But beyond Puricelli, engineers were not highly visible in the Italian road program [24].

German highway engineers played a similar role, in that they were visible but they also operated under significant political constraints. The most obvious example of this was the autobahn project that the Nazis launched based upon private plans developed during the 1920s. The key party here was HAFRABA, formed in 1926 to develop plans a high-standard motor highway from Hamburg through Frankfurt and south to Basel. This private group included engineers and automobile enthusiasts; Piero Puricelli in particular encouraged HAFRABA. But plans were not realized until the Nazis came to power. Hitler then appointed Fritz Todt, a railway engineer, oversaw construction of the autobahn on a tight schedule of about 1000 km per year [25].

The autobahnen attracted much attention from engineers around the world, and Todt clearly ran the construction effort [26]. But It was apparent that the Nazis were unwilling to grant engineers autonomy beyond narrowly a restricted range. Richard Vahrenkamp has suggested that the autobahnen actually lacked a consistent technical vision because Nazi political and social expectations kept changing. Even military goals were not formulated consistently A somewhat more consistent element of the autobahn project was the desire to fit the roads into nature, and attention to the landscape has been carefully studied by historian Thomas Zeller [27]. But even here, expert authority in the realm of highways was restricted by the political and ideological considerations of the Nazi regime.

The case of Austria also shows the limits of engineering authority in Europe before the war. Historian Bernd Kreuzer has shown that as the Austrian state began to construct roads in the 1920s and 1930s, the country faced several obstacles. These included post-World War I economic difficulties, the Depression, and finally a small motoring public. The state charged the Federal Ministry of Commerce and Transport with guiding the development of road policy, and that agency developed a reputation for expertise. They plotted plans for developing tourist roads especially in the Alps, but also found that some problems could not be solved by expertise alone. The question about which side of the road motorists should drive on, for example, was unresolved in the mid-1930s. Both right- and left-handed driving existed in different sections of the country, reflecting strong regional preferences. Only after the Nazi *Anschluß* in March 1938 was a solution imposed, not by engineers but by politicians [28].

The Austrian Ministry of Commerce and Transport was not alone in attempt to develop a base of expertise from which to guide highway policy. In the Netherlands, as historian Gijs Mom shows, experts became the central figures in road programs after 1880. Two agencies that played key roles in Dutch highway development, the touring club ANWB and the Waterstaat (the state water department), did so because both utilized public respect for their expertise to help shape the nation's highway policy. On a whole range of issues, including the road bed, road management, finances (who should pay), regulation, and planning, Mom suggests that the key policy questions often came down to whether to adopt a technical fix or find solutions via regulations and rules. By the 1930s spending on roads approached the huge scale of the Zuider Zee land reclamation program. The preferred choice, as cryptically stated by a Waterstaat engineer, resembled the position supported by American highway engineer Logan Page: "Keep politics away from road management!'" And this mindset generally prevailed, allowing two Waterstaat engineers to dominate highway discussions, one before and one immediately after World War II. Both pursued policy goals couched in such technical terms as efficiency and flow [29].

The Netherlands was not alone in witnessing engineers move into positions of greater policy influence after 1945. This was especially the case in Scandinavia, where technical expertise was widely embraced when public support for automobiles increased and brought demands for expanded highway systems. In Norway, for example, Për Ostby has traced the role of a group of engineers within the government's Council of Transport Economics as they developed Norway's highway policy during the 1950s. Significantly, the country's ruling labor government largely opposed automobiles through much of the 1950s. But the engineers continued their efforts, and stressed placing control of the country's road development in the hands of technical experts. By the 1960s, Norway's highway policy rested on exactly such an assumption [30]. Ostby's findings are matched by other scholars exploring the development of highways in Scandinavia after World War II. In case studies examining the formation of a "car culture" in Sweden, the adoption of street traffic planning for Stockholm, and the formation of a national highway program in Finland, a common thread is the important role of technical experts as shapers of highway policies. As Pår Blomkvist of the Royal Institute of Technology in Stockholm observed, the placement of engineering control at the center of highway developments reflected a desire to "technify the question" and remove messy politics from the administration of road highway programs [31].

Clearly, nations on both sides of the Atlantic exhibited a similar willingness to trust experts to resolve difficult challenges with technical roots, even if the specific reasons for this choice varied. The moralistic assumptions about experts that motivated American reformers seem not have been replicated in European nations. The Dutch, for example, had long turned to engineers for matters of national survival, such as land reclamation and ocean protection. The French also had a long tradition of centralized engineering bureaucracies working in the service of the state. And in industrial societies of the 19th and 20th centuries, confidence in the ability of engineers forms part of the outlook of the modern world. Even so, there is evidence that parallels between European and American model of highway administration reflect deliberate attempts by European nations to copy and emulate what they saw in the United States. This process of technology transfer was most evident after 1945, as American approaches to traffic engineering spread to European nations whose citizens embraced the automobile. Primary actors in this process of diffusion included the Bureau of Public Roads, which sponsored technical assistance and training programs; the Yale Bureau of Street Traffic Research, a primary center for the development of traffic engineering; and the International Road Federation (IRF), an industry-based advocacy organization [32].

The Bureau of Public Roads developed international programs to disseminate American approaches to road building in ways that extended the cooperative administrative style it employed in the United States. Logan Page of the BPR had been the American contact from the founding of PIARC, but because of congressional limitations on participation in international organizations, the BPR never became a leader within the organization. A few engineers traveled to Washington to observe American practice, but contacts were strictly informal. The BPR's first international outreach program was the Inter-American highway project – later the Pan-American Highway – launched in 1930, but progress was slow. Even so, this type of technical assistance expanded after 1945, when BPR engineers were assigned to as technical advisers in other countries. The first groups went to the Philippines (1945) and Turkey (1947), but the list of nations that hosted BPR training programs expanded during the Cold War. In Latin American countries, Iran, Jordan, Yemen, and Pakistan, American engineers provided training in heavy construction equipment, highway engineering principles, and in highway administration [33].

At the same time, the BPR developed educational programs that brought engineers from around the world to the U.S. In 1946, the BPR hosted 22 engineers in Washington, DC; by 1948 116 engineers from 23 countries participated. Between 1949 and 1953, 200 engineers enrolled in a 16-week highway engineering course. The BPR then expanded that program to permit visitors to spend time in state highway departments and observe highway programs in conditions similar to those in their home countries. About 75 engineers enrolled in this program each year. Similar efforts were created for European engineers as part of the postwar rebuilding effort, as when the Mutual Security Agency sponsored a five-week program on American traffic engineering and highway planning that brought 32 European highway administrators from 11 different countries to Washington in 1954. A BPR Commissioner later commented, "I am confident that the work of the Bureau in foreign nations, along with our program of intensive training of foreign engineers in this country, will result in greatly enlarged highway systems directed by well-trained staffs of local officials who will be thoroughly familiar with U.S. design methods and U.S. materials" [34].

The Yale University Bureau of Street Traffic Research also played a crucial role in diffusing American engineering styles to Europe. This organization grew out of the work of William Phelps Eno and Miller McClintock. Eno, an internationally known expert on traffic congestion, founded the Eno Foundation for Highway Traffic Control in 1921 and supported an extensive program of publications on this subject. McClintock was a consultant who advised numerous American cities about traffic solutions from a position at the Bureau of Street Traffic Research at Harvard, which he established in the mid 1920s. McClintock developed techniques for traffic surveys and tools for measuring and then controlling traffic. He once boasted that "if it were possible to apply everything that we know about traffic control, we could eliminate 98 percent of all accidents and practically all congestion." In 1938, McClintock moved his center to Yale, where Eno's Foundation had been located since 1933, and he remained as director until 1941 [35]. By that time, the Bureau of Street Traffic Research was widely recognized as the center for the emerging field of traffic engineering. Renamed the Bureau of Highway Traffic in the 1950s, the Eno Foundation retained a Yale connection through most of that decade and launched the primary journal for the field, *Traffic Quarterly,* in January 1947. Yale researchers, who included Wilbur S. Smith, a leading urban highway consultant during the Interstate construction boom, and the Bureau's director in the early 1950s, Theodore Matson, published pivotal documents that advanced traffic regulation. Throughout, the Yale Bureau welcomed international visitors to participate in courses, and a significant number of European engineers took home what they learned at Yale [36].

The International Road Federation (IRF) was the third agent involved in the diffusion of American highway and traffic engineering practice. Organized in 1948 by corporate officials from Shell Union Oil, Standard Oil of New Jersey, Socony-Vacuum Oil, the Automobile Manufacturer's Association, and five leading American tire makers, the IRF was much more then a disguise for American corporate interests. The IRF presented itself as non-political and committed to education about the need for roads and ways to build better highways; it encouraged the formation of national good roads organizations to press these goals. The IRF also emphasized the development of expert-control in national highway building programs, adopting the slogan "Better Living Through Better Roads,". The eight national roads groups in existence in 1948 grew to more than 70 by 1963 [37].

To advance this agenda, the IRF sought to spread American highway design practices to the rest of the world. Initially, IRF's leadership focused on Europe, but its activities reached worldwide by the 1960s. A central part of this mission was publication of the

journal *Road International* in August 1950 [38]. But as is usually the case in with technology transfer programs, the most effective vehicle of diffusion were direct connections between American engineers and road builders from other countries. The IRF encouraged the participation of engineers from around the world in the educational programs at the BPR and at Yale through its fellowship program launched in 1949. The first fellowships for study at American universities went to two engineers from Mexico and Peru. The fellowship program grew steadily, enabling 216 engineers from 60 different countries to visit the United States. By 1975, 658 graduate engineers had studied in the US, and by 1990, 919 Fellows from 101 countries had received IRF fellowships [39].

The impact was lasting. Nearly every engineering leader who shaped road or traffic policy and construction programs in Sweden, Norway, and Finland, for example, had participated in American study trips. Most had been fascinated by the American "car culture" before their visits, and all left determined to find ways to advance that ideal upon their return. A central feature that most learned was the principle of expert control of road construction and traffic management programs. Many realized the missionary nature of their tasks, and tried to stay in touch with Americans after their return to Europe. Thus in June 1955 a dozen European traffic engineers who had studied at Yale Bureau of Highway Traffic under IRF Fellowships convened for discussions at Weisbaden. The IRF commented at the time that they "were the only engineers in Europe with university diplomas in the science of traffic engineering..." [40].

The presence of this American influence does not mean that only American ideas, techniques, and outlooks guided the planning, construction, and administration of highways in Europe. The story is vastly more complicated than that. Certainly Americans usually indicated their preference for automobile transport over rail, but postwar highway programs in Europe reflected numerous other factors beyond the Marshall Plan and Cold War concerns. Highways were connected to the development of a range of political and institutional developments designed to connect Europe. For example, Blomkvist discusses Gunnar Myrdal's hope that technology – especially transport and technical expertise – advanced through international cooperation and planning could bring Europe together. One example of this line of thinking was the concept of the E-road network linking Europe that appeared in the early 1950s [41]. Clearly, more than American styles of engineering expertise shaped European thinking. But it is apparent that during the immediate postwar period European engineers played important roles shaping systems and policy in ways that resembled the authority exercised by their American counterparts.

THE DEMISE OF EXPERTISE IN HIGHWAY POLICY

The extensive influence of highway engineers in the policy realm was not permanent, however. This changing situation proved to be the case in the United States as well as in European nations. For American engineers, the loss of public trust in expertise is directly traceable to the construction of Interstate highways into and through American cities. In most cases, construction did not begin in earnest until 1960. Shortly thereafter, strident complaints about road construction began to be heard. There is too little space here to examine fully the cause of complaints about the Interstate program. But we can note the program was designed to speed construction. This meant that urban planners, elected officials, and residents alike encountered a process with few points for input. Public hearings were pro forma events intended to tell people what the engineers were going to do, not to solicit input on routes or exit locations. To save costs, roads were routed through parks and the poorest neighborhoods, often in conjunction with urban renewal

projects. Those in the path of the highways were almost powerless to stop construction. Hundreds of thousands of families were displaced, many in a rather cavalier fashion. Robert Moses' bulldozer approach in metropolitan New York was an extreme case, but it was very clear that federal highway engineers controlled many of the choices about Interstate highways with little public involvement. Anger spread and prompted court cases that stopped road construction in San Francisco, New Orleans, Boston, Philadelphia, Washington, DC, and other cities. Many highway engineers did not completely grasp that support for both roads and for engineering control over road programs and highway policy was eroding. This "Freeway Revolt" soon prompted national and state political leaders to replace the old system of engineering control with new mechanisms that allowed public input and control. Congress passed the National Environmental Policy Act of 1969, requiring a public hearings on all projects using federal dollars, and mandating detailed environmental impact statements. Sensing that many engineers were not prepared to respond to changing public expectations, state legislatures and governors brought politics back into the process of road building and administration. They appointed lawyers, accountants, and even journalists, to oversee departments of transportation. In Mississippi, for example, the public relations director was put in charge; in Massachusetts the man who led the fight against Boston's inner freeway took over [42]. The era when engineers such as Thomas MacDonald and Francis Turner exercised largely unchallenged engineering control was over.

In another fascinating set of parallels, similar changes were underway in Europe during the same years. As in the United States, the popular reaction against experts and "technocrats" was related to wider dissatisfactions, such as the war in Vietnam and the emerging environmental movement, that created the turbulent politics that brought students into the street in 1968. But whatever the local contexts, road builders who saw traffic and roads primarily as technical problems encountered challenges to their methods and to their authority. It was not that citizens were turning against the automobile; indeed the opposite was true. But by the 1970s, the question was how the automobile was going to be accommodated. Street planners in Stockholm and national highway planners in Norway both found that narrow technical approaches resting on vehicle counts were no longer adequate in the eyes of the public. Considerations such as land use, patterns of economic development, and the viability of neighborhoods had to be factored into plans if engineers were to receive public approval. Everywhere, grand – or grandiose -- plans for super highway systems were scaled back. In the Netherlands, for example, a scheme for a 5300-km network of super highways (a "frenzy" of construction) was trimmed back to a more realistic 3900 km after oil price increases began in 1973 [43].

An especially clear example of the tensions that marked this new era of highway development and its consequences for engineering control emerges in a recent study of the different outcomes of street and highway development in Switzerland and Germany in the 1950s and 1960s. In seeking to explain why Swiss cities face 15 percent less automobile traffic than comparable German cities, Ueli Haefeli argues that a crucial difference was the nature of technical experts involved in street planning and construction in the two countries. Especially in Switzerland, traffic engineers did not "own" the issue of planning, but rather had to work with urban planners who thought about more than moving vehicles. Swiss consultants were much more ambiguous about American decision to push Interstate roads into and through city cores. German experts, he reported found the American approach seductive and appealing, especially since the longer American experience with the automobile suggested that they knew what they were doing. Haefeli reports that like their American counterparts, German engineers often seemed frustrated when forced to consider different viewpoints. In Switzerland, however, urban planners

never embraced the idea of serving cars. “It soon became obvious to the experts that the traffic situation in American towns serves as more of a deterrent for European planners than as a model.” Swiss planners, less driven by engineering imperatives, envisioned more opportunities for transit [44].

A similar outcome emerged in Paris. Despite a strong tradition of engineering control in France, Mathieu Flonneau demonstrates that engineers encountered substantial opposition in the late 1960s to plans to move traffic into and through Paris on express highways. Challenges began when their road plans threatened the city’s heritage – especially the neighborhood of the Cathedral of Notre-Dame. Flonneau reports that residents feared the rising “car tide” and eventually the impact of the new roads on the tourist appeal of Notre-Dame. These concerns prompted greater attention to the overall environmental consequences of the planned highways. The result was a decision to limit the intrusion of modern highways into the center of Paris. Nor was this the only indication of the limits of engineering authority in France. Political scientist James A. Dunn reports that engineers remained key figures in France, but did not dominate. He finds, for example, that in the postwar period, truckers and other private group persuaded the government to earmark fuel taxes for roads, especially for a superhighway system, despite the opposition of road engineers and the Finance Ministry. Ministry officials preferred to evaluate road construction plans against other national priorities. In other words, national priorities and local concerns alike meant that technical expertise enjoyed circumscribed authority in France, a country that had once had one of the strongest traditions of centralized authority based on engineering expertise [45].

CONCLUSION

This rapid comparative review of highway development and the role of engineers suggests that highway experts in Europe and the U.S. have operated within similar political environments. A common element in the effort to explain the high level of trust in engineering leadership of highway programs is the popular enthusiasm for the automobile. This in turn translated into an eagerness for roads, and in the formative stages of highway programs, few were worried that little emphasis was placed on land use, economic development, or other social and economic considerations. But popular support for the motor vehicle was not a universal solvent, and once express highway began to enter cities and disrupt neighborhoods, local economies, and traditional environments, the unquestioned love affair with highway generally ended. Another way to look at this change is to return to the comment of Swedish historian Pår Blomkvist, who noted that engineers possessed a strong voice in policy debates when all the principals agreed to “technify the question.” Or as James Dunn reported about French highways, as long as the questions remained narrowly technical, decisions remained within the control of engineers. But if the issue was redefined to include wider questions, it “lead to the explosion of the policy community and bring in much wider participation” [46]. These descriptions describe the fate of expert control of highway programs in the late 1960s and 1970s, whether it be the United States, Sweden, Norway, the Netherlands, or France. Given the political controversies that have surrounded all transportation debates since the 1960s, it seems almost quaint to think that anyone ever argued that transportation could be considered “merely” a technical issue and left to the experts to decide. How times have changed!

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