

Roads without rails : European highway-network building and the desire for long-range motorized mobility

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Roads without Rails

European Highway-Network Building and the Desire for Long-Range Motorized Mobility

GIJS MOM

“Hannibal, before crossing the Alps, is reputed to have said ‘I will find a way or make one.’ We want more of that spirit.”¹

In the spring of 1958, a decade after the institution of the Marshall Plan and the year that Europe first experienced an exponential rise in motorized travel, Brussels hosted a world exhibition where some 10,000 visitors a day visited the General Motors exhibit at the Transport Pavilion. As envisioned by General Motors, the elevated “Road Network of the Future” would be constructed in three layers (two carrying unidirectional motorized traffic, the other a monorail) and run straight as an arrow, soaring above towns and terrain alike. According to an enthusiastic account in a Dutch journal for automotive technicians, this fantasy of “the year 2000, [when] automobiles and trains will move along one and the same electronic superautostrada . . . would be a revolutionary solution to the problem of traffic safety because all vehicles are under total electronic control.”²

A half-century earlier, the motor car had been viewed as the very symbol of anarchistic individuality. Now, an alarming rise in traffic fatalities was leading many to share the General Motors fantasy: a system of straight, unidirectional roadways in which motorized vehicles were centrally controlled by high-tech electronics and directed in much the same way as the linked cars of a train.

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1. *Road International* 1 (1950): 33.

2. “Het wegennet van de toekomst,” *Auto en Motortechniek* 18 (1958): 163.

This modernistic fantasy about efficient control of traffic flow was the culmination of a long tradition of road building and road-network construction that, especially in Europe and the United States, eventually evolved into transnational or continental projects. From the eighteenth century onward, it coincided with the development of modern “mobility machines” that included horse-drawn vehicles, bicycles, and, especially, motorized vehicles. During this process, the network became a multifunctional system of primary, secondary, tertiary, and even quaternary roads—serving international, national, regional, and local traffic—that was periodically adapted to new economic, political, military, and cultural uses.

Despite the localized nature of road building, these networks usually developed in four major phases. First, sand and dirt roads were paved, usually with bricks or macadam, to withstand greater horse and carriage traffic. Then, the coming of the bicycle and automobile brought a host of improvements: winding roads were straightened, allowing higher speeds; and tar, concrete, or asphalt was applied to reduce dust and vibration, providing a more comfortable ride. The increase in traffic (and traffic accidents) at the end of this phase brought proposals for limited-access highways, which were implemented (usually after extended debate) before World War II in Italy, Germany, and the Netherlands, and internationally after the war. Generally, major network expansion occurred only during this phase (the exception being in the United States, where road building often meant building new roads); but in the meantime, modern techniques of highway design and construction were extended to other types of thoroughfares. The last phase, still in its infancy, consists of efforts to develop “smart” roads (and “smart” vehicles to run on them) that recall the fantasy envisioned by General Motors in the 1950s.

In this essay, the emergence of the limited-access highway³ is presented as a turning point in the history of mobility. Focusing on the second and third phases of road building, it draws on the results of a four-year project that studied two hundred years of Dutch mobility history⁴ as part of a

3. Road nomenclature reflects the localized tradition of international road building. In this article, I use “limited-access highways” and “highways” to designate automobile-only, limited-access roads devoid of level crossings and designed to carry heavy and high-frequency traffic. The American equivalent is “freeways,” although that term is also associated with toll-free roads, which are less relevant in the context of this article. European equivalents are “motorways” (United Kingdom), “autostrade” (Italy), “Autobahnen” (Germany), “autoroutes” (France), and “autosnelwegen” (the Netherlands). I use “automobile” to denote all self-propelled, motorized road vehicles, including motorcycles, trucks, and buses.

4. “Mobility history” here indicates a paradigm differing from the traditional economic and political view of “transport[ation] history” in its greater emphasis on the user’s perspective and its preference for an intermodal, international approach; see Gijs Mom, “What Kind of Transport History Did We Get? Half a Century of *JTH* and the Future of the Field,” *Journal of Transport History* 24 (2003): 121–38. The research project was

larger, European story.⁵ During the course of this project, the question arose about why the debate within the Dutch road-engineering community during the early 1930s resulted in what seemed to be a “typically Dutch” compromise: combining completion of large road-improvement projects begun a decade or so earlier with construction of stretches of road to be reserved for automobiles—a totally new concept. This appeared significant in that the British, long an exemplar for Dutch engineers, continued to concentrate on road improvements, and this despite a more active highway lobby than that of the Netherlands. Like the United States and many other European countries, Great Britain did not begin to build a highway network until well after World War II. Only projects in Italy (in the 1920s) and Germany (1930s) preceded those of the Netherlands, and this raised questions about the role played in highway construction by the authoritarian regimes of these two countries, and how the Dutch case fit into the picture. In the 1920s, a decision to build limited-access highways would have been impossible in the Dutch context; and even ten years later traffic flow—whether in the Netherlands, Italy, or Germany—did not seem to require so costly an approach. If these projects were not driven by actual demand, then the importance of anticipated future use was clearly a factor to be investigated.

Against this background, the Brussels exposition nicely illustrates the core issues to be considered here: the emergence of an international highway network in Europe, and the possible contribution of fantasy to this process. These questions intersect with two bodies of scholarly literature, those of mobility history and the history of technology.⁶

Insofar as mobility history is concerned, international approaches are few, although it is generally recognized that these can help to overcome problems of generalization and parochialism; this is all the more true for the history of infrastructures, a relatively new subfield within mobility history.⁷ As

financed by the Dutch Ministry of Traffic and Water Management (Waterstaat) and executed by Ruud Filarski and Gijs Mom.

5. Recent monographs with a clearly international approach, although not greatly concerned with road building, include Christoph Maria Merki, *Der holprige Siegeszug des Automobils 1895–1930: Zur Motorisierung des Strassenverkehrs in Frankreich, Deutschland und der Schweiz* (Vienna, 2002); Kurt Möser, *Geschichte des Autos* (Frankfurt, 2002); and Gijs Mom, *The Electric Vehicle: Technology and Expectations in the Automobile Age* (Baltimore, 2004). For an older study with a supply-side perspective, see James M. Laux, *The European Automobile Industry* (New York, 1992).

6. The revival of historical research on road (network) building is seen in the special session of the 2003 SHOT conference (“The Atlanta Meeting, 16–19 October 2003,” *Technology and Culture* 45 [2004]: 142–53) and the dedicated conference in Neuchâtel, Switzerland, 13–15 February 2003 (“Mobility History and the European Road Network: Planning, Building, Use, and Spatial Organization,” proceedings forthcoming).

7. Most studies are national in scope, among them such seminal works as Mark H. Rose and Bruce E. Seely, “Getting the Interstate System Built: Road Engineers and the

for the history of technology, construction of road networks seems to lend itself to the Large Technical Systems (LTS) approach inspired by Thomas Hughes's seminal work on the electricity network. Even within this tradition, however, few studies address road building, and even those that do are largely limited to its fourth phase, the effort to automate traffic flow.⁸

It is argued here that this is no coincidence, nor is it a coincidence that Hughes's history of electricity production emphasizes the end result—the defeat of the proponents of decentralization by those advocating central control.⁹ In contrast, the present essay focuses not only on outcome but also on the process by which that outcome is reached, particularly in situations where definitive data may be lacking and decision makers must generate expectations—even fantasies—to guide their actions.¹⁰

These expectations, desires, and fantasies are a part of user culture, itself an outgrowth of the broader society; they neither come in easily readable packages nor form a blueprint for engineers. Desires, needs, and expectations challenge the economic theory of “utility maximization,” according to which a “rational, omniscient subject” selects from a spectrum of objects the particular artifact that best fits his needs.¹¹ But needs are often invented

Implementation of Public Policy, 1955–1985,” *Journal of Policy History* 2 (1990): 23–55; Mark H. Rose, *Interstate: Express Highway Politics, 1941–1956* (Lawrence, Kans., 1979); Bruce E. Seely, “The Scientific Mystique in Engineering: Highway Research at the Bureau of Public Roads, 1918–1940,” *Technology and Culture* 25 (1984): 798–831; and Bruce E. Seely, *Building the American Highway System: Engineers as Policy Makers* (Philadelphia, 1987). Whereas these works focus on road-building policy and the technocratic role of road engineers in the application of scientific principles to the modernization of existing roadways, more recent studies emphasize the effect of road networks on the national landscape or the importance of road building for regional development. Among the latter, see Thomas Zeller, *Strasse, Bahn, Panorama: Verkehrswege und Landschaftsveränderung in Deutschland von 1930 bis 1990* (Frankfurt, 2002); and A. G. Crosby, ed., *Leading the Way: A History of Lancashire's Roads* (Preston, Lancs., 1998).

8. Thomas P. Hughes, *Networks of Power: Electrification in Western Society, 1880–1930* (Baltimore, 1983); Oskar Juhlin, “Information Technology Hits the Automobile? Rethinking Road Traffic as Social Interaction,” in *Changing Large Technical Systems*, ed. Jane Summerton (Boulder, Colo., 1994), 291–308; Reiner Grundmann, “Car Traffic at the Crossroads: New Technologies for Cars, Traffic Systems, and Their Interlocking,” in *Changing Large Technical Systems*, ed. Jane Summerton (Boulder, Colo., 1994), 265–89.

9. Mark Granovetter and Patrick McGuire, “The Making of an Industry: Electricity in the United States,” in *The Laws of the Markets*, ed. Michel Callon (Oxford, 1998), 147–73. From a user's point of view, electricity production in the United States was largely non-centralized; as late as the end of the 1920s only 600,000 of the country's 6.5 million farms had electricity, half of them generated by an “isolated plant.” Until the mid-1910s, isolated plants were the most common electricity supplier (Mom, *The Electric Vehicle*, 233).

10. On a reinterpretation of “technical choice” for the purpose of developing an evolutionary history of technology, see Gijs Mom, “Conceptualising Technical Change: Alternative Interaction in the Evolution of the Automobile,” in *Tackling Transport*, ed. Helmuth Trischler and Stefan Zeilinger (London, 2003), 9–46.

11. On the mobilization of “expectations” and “promises” of future technology for the purpose of coalition formation by social groups, see Johan Schot, “Innoveren in

as well, because desires and expectations tend to coevolve with technological change.¹²

Finally, this essay analyzes the concept of limited-access highways as it developed in Europe, taking the Netherlands as the starting point. It argues, first, that such highways could be effected only by the central state or (in the case of private companies) a state-sponsored entity; and second, that the concept broadened road-engineering practices to include the possibility of flow control, similar to that long used by railroad networks. The arguments, it is claimed, are linked.¹³

Unlike railroads, highways were not built “from scratch”; rather, they were superimposed on an existing hierarchical system whose individual roads had often benefited from prior technical improvements. Indeed, highways formed—and still form—only a minor part of such a system (two percent at most), although they now carry most of the traffic.¹⁴ Generally, the new system was “sold” to a sometimes resistant public and community of traditional road engineers through a mix of utilitarian and visionary arguments: speed and safety on the one hand, modernity and future use on the other. Fantasy was, in fact, an especially important element, since a network limited to automobiles was not a response to actual demand (in terms of the number of cars used for long-range mobility) but rather to expecta-

Nederland,” in *Geschiedenis van de techniek in Nederland: De wording van een moderne samenleving 1800–1890*, part 6: *Techniek en samenleving*, ed. H. W. Lintsen et al. (Zutphen, the Netherlands, 1995), 217–39, esp. 232–33. For a plea to integrate expectations as “an important determinant of entrepreneurial decisions” into economic history, see Nathan Rosenberg, “On Technological Expectations,” *Economic Journal* 86 (1976): 523–35; for objectifying “wants” and “needs” into the more easily measurable concept of “choice” in economic history, see Nicholas Georgescu-Roegen, “Choice, Expectations and Measurability,” *Quarterly Journal of Economics* 68 (1954): 503–34. An attempt to integrate expectations (here called “beliefs”) into formal economic theory based on the work of G. Katoana, K. J. Lancaster, and Lincoln Clark is offered by H. Baudet et al., “Consumenten en innovaties (I) Een nieuwe benadering van historisch consumentengedrag,” *Maandschrift economie* (1974): 562–93; see also Hornell Hart and Hilda Hertz, “Expectations of Life as an Index of Social Progress,” *American Sociological Review* 9 (1944): 609–21.

12. Kenneth Lipartito speaks of expectations as “projections of technology” in “Picturephone and the Information Age: The Social Meaning of Failure,” *Technology and Culture* 44 (2003): 50–81, esp. 57, 65, 73.

13. Other than country-specific literature, the main sources for the international aspect of this story are the conference proceedings of the Permanent International Association of Road Congresses (PIARC), held triennially since 1908, rarely used by historians of mobility; and the extensive archives in The Hague of the Dutch touring club Algemeene Nederlandsche Wielrijders-Bond (ANWB), a central player in the international tourism movement and instrumental in the dissemination of traffic-engineering principles to European road engineers after World War II.

14. In 1992, 2 percent (2,000 kilometers) of the Dutch paved-road system consisted of autosnelwegen, while the German Autobahnen system (13,445 kilometers) occupied 1.7 percent of the overall network, and in France and the United Kingdom, it was 0.9 percent (*Auto's in Nederland: Cijfers over gebruik, kosten en effecten* [Heerlen, the Netherlands, 1996], 23).

tions that these vehicles would be more widely used in the future, especially for tourism. Hence, highway building is an example of a self-fulfilling prophecy.

To present this case I will first discuss the costly, often overlooked projects that adapted existing roads to new user functions (such as bicycles, motorcycles, and automobiles).¹⁵ These projects were often completed well before World War II, their success resulting from (and, to a certain extent, influencing) a shift in the balance between the financial power of the central state and the decentralized executive power of states, provinces, counties, cantons, and *Länder*. In a second section I will describe the emergence of automobile-only roadways, for which expectations of future user functions were critical and that required not only different physical properties but also different user functions. A third section addresses the trans-European E-network and its relationship to both the Marshall aid program and American approaches to traffic engineering and road planning. I will conclude with a return to my initial questions.

Adapting Roads to the Automobile

In the 1830s, national railroad networks began to replace waterways and stagecoach systems as the means of connecting cities, harbors, and industrializing regions. At the same time, regional and local governments started to pave the roads used by horse-drawn vehicles in order to create a feeder system for the rail network and to accommodate increased traffic caused by local industrialization.¹⁶ European touring clubs (founded to promote bicycle tourism) established a transnational organization as early as 1897, mainly to resolve problems of frontier crossing for touring mem-

15. When analyzing competing technologies, it is crucial to distinguish between their technical properties and their relational user functions. A one-to-one relationship between these characteristics does not exist, and several properties enable the same functions without prescribing them, as is illustrated by various examples of “unintended use.” The classic example of unintended use is the telephone; see Claude S. Fischer, *America Calling: A Social History of the Telephone to 1940* (Berkeley, Calif., 1992). Conversely, a user function can be enabled by different properties, which is the very essence of technical choice. For other examples, as well as for an elaboration of the concepts of “properties” and “functions,” see Mom, “Conceptualising Technical Change.”

16. No recent monographs with a cross-modal and international approach to the history of European mobility exist. Among older but seminal works in English are Simon P. Ville, *Transport and the Development of the European Economy, 1750–1918* (n.p., n.d.); H. J. Dyos and D. H. Aldcroft, *British Transport: An Economic Survey from the Seventeenth Century to the Twentieth* (Leicester, UK, 1969); and, for the U.S., G. R. Taylor, *The Transportation Revolution, 1815–1960* (New York, 1951), all of which take a largely economic-historical perspective and thus tend to neglect the half-century or so in which vehicles had more of a societal than an economic function. A work covering the complete variety of mobility is long overdue.

bers. In 1904, automobile clubs also formed an international association, again for the purpose of accommodating international tourism.¹⁷

As automobiles became faster and more numerous, road engineers began to consider the problem of dust, a problem that France succeeded in putting on the international agenda by defining it as a matter of public health. In 1908, 1,600 representatives of national road-building institutions, local public-works organizations, and touring and automobile clubs gathered in Paris for a conference where twenty-two of 107 papers addressed the issue.¹⁸ Conference participants formed the Association Internationale Permanente des Congrès de la Route (AIPCR), better known in English-speaking countries as PIARC (Permanent International Association of Road Congresses). By 1913, it was supported by fifty nations (including the United States) and had grown to more than 4,000 members.¹⁹

PIARC conferences provided an effective means of transferring local knowledge and experience between not only national delegations but also national interest groups that included automobile and touring clubs, provincial and national road engineers, road-building and material-production companies, and civil servants in the transport ministries. Over time, and operating largely by persuasion, the PIARC community created a state-of-the-art systems approach to the European road network, then estimated at some 1.6 million kilometers.²⁰

Two examples will serve as illustrations. At the third PIARC conference (1913), member states adopted a British and American proposal (first raised at the preceding conference, held in 1910) that the continuing problem of dust be resolved with tarred macadam. They agreed that in addition to reducing dust, bituminous substances poured between the broken stones of macadam surfaces also reinforced the surface structure, allowing it to

17. In 1900, touring clubs founded the Ligue Internationale des Associations Touriste (LIAT), later the Association Internationale de Tourisme (AIT); the founding meeting was organized by ANWB in 1897 (box 292, folder “LIAT/AIT 1897 Amsterdam/Brussel,” ANWB archives, The Hague). In 1904, automobile clubs formed the Association Internationale des Automobile-Clubs Reconnus (AIACR), which became the Fédération Internationale de l’Automobile (FIA) after World War II. Despite their European character, most histories on this topic are national in scope (but see *100 Years of Mobility: AIT 1898–1998* [Geneva, 1998]).

18. Association Internationale Permanente des Congrès de la Route (PIARC), *Compte rendu des travaux du Ier Congrès International de la Route* (Paris, 1909). Early twentieth-century road-engineering handbooks presented road paving primarily as a dust-control measure: “It is a matter of common knowledge that our great infantile mortality is largely attributable to dust,” ran the first sentence of J. Walker Smith’s *Dustless Roads, Tar Macadam: A Practical Treatise for Engineers, Surveyors and Others* (London, 1909), 1.

19. PIARC, *Compte rendu des travaux du IIIe Congrès International de la Route* (Paris, 1913), 10.

20. “Systems approach” implies that the dust problem was seen as resulting from the interaction of vehicles and roads. Because there was no central system builder, roads were not conceived as part of a Hughesian system.

OCTOBER
2005
VOL. 46

better resist the deterioration caused by friction from the tires of speeding automobiles. Another controversy could not be resolved by consensus, however: Great Britain, which had more cars than all other European countries combined, proposed a decentralized approach to road management and construction, claiming that its own such system had given rise to 370,000 kilometers of “the best roads of the world.” When the French instead proposed that national road projects be centrally directed by agencies similar to their Corps Civil des Ponts et Chaussées, delegates agreed that every country should follow its own “style” according to its national character. Other European nations developed practices somewhere between these two extremes, northern countries leaning toward the decentralized British model and southern countries adopting the centralized approach of the French.²¹ Regardless, most countries initiated national road-reconstruction programs during the early 1920s, funding them with new automobile taxes that were often assessed on the basis of fuel consumption.²²

Between 1904 and 1930 the American paved-road network expanded by 50 percent, its “modern” concrete pavements serving as demonstration models for the international road-engineering community. In other industrializing nations, where new road construction was not a priority, asphalt—advocated by British engineers keen to preserve their extensive network of macadam roads—continued to reign, and tar from local gas factories was replaced with synthetic asphalt from oil refineries.²³

Whatever the paving material, huge reconstruction projects became possible only because planning power was gradually assumed by national institutions. This transfer, reluctantly accepted by smaller governmental units unable to bear the costs of complex, large-scale improvements, in fact allowed the state to diminish local and regional autonomy and to shift the balance between decentralization and centralization clearly toward the lat-

21. Controversy about methods of dust control had arisen at the second PIARC conference, with the French advocating cobblestones and granite pavers, the Anglo-American delegates tarred macadam (PIARC, *Compte rendu des travaux du IIe Congrès International de la Route* [Paris, 1911]); PIARC, *Compte rendu des travaux du IIIe Congrès International de la Route* (Paris, 1913), 276–78, 344; “Het derde Wegen-Congres te Londen, 23–28 Juni 1913,” 14–15, 26 (brochure, ANWB archives). The British system functioned well so long as the autonomous counties were adequately funded by the central government; it remained unchanged from 1872 to 1929, only strengthened by the foundation of a national road board in 1909.

22. Louis Delaney, *Strassenverwaltung und -finanzierung in fünfzehn Ländern* (Paris, 1937).

23. On the leading role of British road engineers in promoting the use of asphalt, see Gijs Mom, “Inter-Artifactual Technology Transfer: Road Building Technology in The Netherlands and the Competition between Bricks, Macadam, Asphalt and Concrete,” *History and Technology* 20 (2004): 3–23; Rees Jeffreys, *The King’s Highway: An Historical and Autobiographical Record of the Developments of the Past Sixty Years* (London, 1949), xiv, 136–39, 277; A. Stellwaag, *Was lehrt uns der englische Strassenbau?* (Halle, Germany, 1928), 57.

ter.²⁴ During the same period, road-building methods were standardized and upgraded by road-engineering communities supported by newly founded national road laboratories, the emergence of construction conglomerates with asphalt factories and concrete mills, and a developing preference for “modern” materials such as asphalt and concrete over traditional, local materials. In the Netherlands, for example, national road engineers actively opposed the traditional brick pavements generally praised by foreign motorists for their smoothness. That smooth surface was the result of a maintenance schedule that saw the entire network repaved every fifty years under the supervision of the Society of Waterstaat Supervisors (Vereeniging van Opzichters van den Rijkswaterstaat, or OTAR), founded in 1894. Taeke Huitema, one of the society’s more outspoken members (he characterized the campaign against brick as an “English disease”), spent most of his professional life protesting against “experts” who used “science” developed in their laboratories to pursue “novelties” simply because they were new.²⁵

Throughout Europe, as in the Netherlands, national guidelines and standards for road building were centrally formulated and imposed on local and regional authorities.²⁶ Nevertheless, although these lower governmental units saw their financial autonomy reduced, they remained instrumental in the location of new roads and the design of secondary and tertiary roads. The Dutch network of secondary and tertiary roads, for example, was some 20,000 to 30,000 kilometers long, while a primary road system of about 2,300 kilometers connected the country’s main harbors, industrial centers, and towns of more than 20,000 inhabitants. Between 1927 and 1940 several hundreds of millions of guilders were invested in road improvement (widening, straightening, repaving); only some thousand kilo-

24. For the United States, see Hal S. Barron, “And the Crooked Shall Be Made Straight: Public Road Administration and the Decline of Localism in the Rural North, 1870–1930,” *Journal of Social History* 26 (1992): 81–103. This is not to say that decentralized large-system building is impossible; see William H. TeBrake, “Taming the Waterwolf: Hydraulic Engineering and Water Management in the Netherlands during the Middle Ages,” *Technology and Culture* 43 (2002): 475–99, esp. 489–90, 498; and Arne Kaijser, “System Building from Below,” *Technology and Culture* 43 (2002): 521–48. Even in these examples, however, planning power was transferred to higher organizational levels as building projects grew in size and investment.

25. See T. Huitema, “Straatwegen,” *OTAR* (23 October 1923): 65; “Straatwegen (vervolg),” *OTAR* (22 December 1923): 82; and T. H. [T. Huitema], “Straatwegen en automobilisten,” *OTAR* (25 November 1926): 68.

26. For an example of standards definitions, see the responses of R. Loman and Bergmans to section 4–5, question 5 (“Examination and Standardization of Carriageway Surfacing from the Point of Their: a) Slipperiness or Rugosity and Resistance to Skidding; b) Light Value or the Degree to which They Absorb Light [under Artificial Illumination]”), in PIARC, *Compte rendu des travaux du VIIIe Congrès International de la Route* (Paris, 1938), 1–10.

meters of primary and secondary roads were new.²⁷ By the early 1930s, networks of paved primary (national) and secondary (provincial) roads existed in many countries, and by the end of the decade, pavement programs for tertiary (rural) roads had begun. Developments such as these, which shed light on the subsequent emergence of a highway network, have been largely overlooked by historians of road building.

OCTOBER

2005

VOL. 46

Mixed Roads or Automobile-Only Roads?

Another source of tension arose between local/regional and national/PIARC road experts due to the traffic-generating properties of the newly paved roads. Were they to be built for automobiles only, or should they also serve other users? The problem was, of course, especially acute in Europe, where nonmotorized traffic (horse-drawn vehicles, bicycles, pedestrians, pedestrian-powered carts) was slow to disappear.

The concept of building special roads for automobiles developed early and reflected a particular interpretation of the road censuses common throughout Europe from the mid-1920s on. Inspired by what they saw in the United States, proponents of automobile-only roads extrapolated from these data to promote road-building programs designed for future user loads. National engineering groups and PIARC, on the other hand, used them to demonstrate that the actual use of roads was peri-urban and regional at best and that the long-range use of automobiles was virtually nonexistent. In other words, the controversy revealed a clash of demand-driven engineering versus expectations, both positions based on the same quantitative material.

One supporter of automobile-only roads was Cornelis Lely, the Dutch minister of water management (“Waterstaat”) later known for a Zuider Zee landfill project, who even before 1900 had urged Parliament to build a road network where cars could travel between 60 and 80 kilometers per hour and bring civilization to the Dutch countryside. Lely’s ideas gained a wider

27. B. J. Kerkhof and W. N. van Vliet, *Wegenbouw: Handboek voor praktijk en studie betreffende het ontwerpen, aanleggen en onderhouden van de verschillende soorten van wegen* (Amsterdam, 1942–43), 36–39; J. F. L. van Gils, “Statistiek van de Rijkswegen, 1939,” *Wegen* 15 (1941): 181–84. Although it would be interesting to have similar calculations for other countries, this is no easy task, because it is often unclear whether “new roads” mentioned in the sources are “newly traced” or simply “newly paved.” Thus, using prewar road statistics are unreliable for international comparisons. During the first half of the twentieth century, for example, the Dutch road network was estimated at 30,000 kilometers, more than a third of it paved; after World War II, existing roads to farms and hamlets became important to planners and national road statistics more than doubled overnight. See J. Volmuller, “The Roadnetwork [*sic*] of The Netherlands,” *Bulletin de l’Association Internationale Permanente des Congrès de la Route* 40 (1951): 19–28; Centraal Bureau van de Statistiek, *Statistiek van de wegen, 1 Januari 1966* (The Hague, 1967), 7; and Centraal Bureau van de Statistiek, *Statistiek van de wegen, 1 Januari 1973* (The Hague, 1974), 9.

audience when Waterstaat engineer M. Caland proposed such a road in a session on “The Future Road” at the First International Road Conference in Paris in 1908. As with Honoré Saunier’s similar proposal to rebuild the French road system as a network open only to drivers with special “high speed” licenses, Caland’s ideas were rejected by the international road-engineering community, which cited road censuses in insisting on improvements to existing networks. Surprisingly, many automobile clubs agreed. A well-known Dutch automotive publicist characterized driving on such roads as “utterly boring,” appropriate only for big cities whose inhabitants wished to reach the countryside quickly. Most such motorists saw touring as a peri-urban or interurban pastime, and even in the case of international travel, they believed that the function of a road was to facilitate an enjoyable trip that included appreciation of “nature.”²⁸

Another faction within the automobile clubs was more interested in the high-speed aspect of the “automobile adventure,” and joined with the small group of engineers advocating automobile-only roads.²⁹ World War I was the most important factor in the development of limited-use roads, however. Military logistics, characterized by strict central command and harsh discipline, were evident on the 60-kilometer “Holy Road” (Voie Sacrée) between Bar-le-Duc and Verdun; 4 to 7.5 meters wide, it carried one truck per second (horse-drawn transport had to use parallel roads). Each kilometer was maintained by some twenty soldiers. During the Somme offensive, the British commanded 14,000 officers and 45,000 soldiers and prisoners of war who paved a road 8 meters wide with tar or asphalt to reduce “the extreme dust and mud plague.” A group of workers with a cylinder roller was stationed every two kilometers to repair defects in the road surface.³⁰

This structure of central command combined with high-level executive power recurred in the civilian context when, in 1922, Piero Puricelli, a building contractor from Milan, convinced Benito Mussolini that a system of dedicated automobile roads should be built between Milan and the lakes

28. See the responses by M. Caland and Honoré Saunier to question 4 (“La route future dans les Pays-Bas”) in PIARC, *Compte rendu des travaux du Ier Congrès International de la Route* (n. 18 above). Saunier mentioned *La Guerre infernal*, a novel by Pierre Giffard in which electrically propelled “mastodons with guns” rumble over “concrete lanes” to fight the war of the future. On Lely, see Willem van der Ham, *Heersen en beheersen: Rijkswaterstaat in de twintigste eeuw* (Zaltbommel, the Netherlands, 1999), 29.

29. Although national authorities had banned street racing as dangerous, automobile clubs experimented with speed even before World War I, building special racing circuits covered with “modern” pavements of tarmac at Avus, Germany (near Berlin) and Le Mans, France; see Kurt Gustav Kaftan, *Der Kampf um die Autobahnen: Geschichte der Autobahnen in Deutschland von 1907–1935 unter Berücksichtigung ähnlicher Pläne und Bestrebungen im übrigen Europa* (Berlin, 1955), 24–28.

30. “Wegenbouwtechniek in den oorlog” (reprinted from *Der Strassenbau*), *Wegen* 13 (1939): 460–65.

in northern Italy. Although from a national perspective this project can be considered highly decentralized, its success nonetheless depended upon entrepreneurial leadership.³¹ Meant to promote car tourism exclusively (motorcycles were not allowed), these concrete roads were built as perfectly straight lines through the landscape. In 1926, when the international road-engineering community could admire the first 133 kilometers of autostrade during the PIARC conference in Milan, British and American delegates successfully opposed the final conclusions of the meeting (namely, that all national engineering communities should follow the Italian example), because the project was a private enterprise financed by tolls.³²

In a report written for the Waterstaat on the desirability of automobile-only roads, the Italian project was seen as a “flight forward” because it disregarded the necessity of improving the existing system (a neglect Italy had to correct a decade or so later with a national reconstruction program).³³ The German Autobahnen project generated more admiration, because it included such improvements.³⁴

Initially, the Verein zur Vorbereitung der Autostrasse Hansestädte-Frankfurt-Basel (abbreviated to Hafraba), founded in 1925, failed to combat the existing road-building bureaucracy, but when Adolf Hitler seized power in 1933 his regime took over Hafraba’s plans (although eliminating its proposed tolls) as part of a national motorization fantasy. The Nazis effectively silenced those who considered the plans a direct threat to the railroads by giving the national railroad bureaucracy a voice in the planning and building process and by promising that it would have exclusive control of long-range trucking. Indeed, the first segments of the Autobahnen were “roadways of unwavering straightness” inspired by the tracing

31. Massimo Moraglio, “Politica e gestione del territorio nella storia della viabilità italiana: La città negli anni venti e il caso di Torino” (Ph.D. diss., Politecnico di Torino, Politecnico di Milano, Università degli Studi di Padova, 2002).

32. Lando Bortolotti, “Italia, Europa e oltre: Proposte e utopie autostradali al tramonto degli imperialismi e del colonialismo,” *Storia Urbana* 72 (1995): 133–61; Lando Bortolotti and Giuseppe De Luca, *Fascismo e autostrada: Un caso di sintesi, la Firenze-mare* (Milan, 1994), 17–33.

33. “Verslag inzake de autosnelwegen,” 13–14, (folder “Commissie van Overleg voor de Wegen,” ANWB archives).

34. Without a comprehensive history of German road building, it cannot be determined whether the Autobahnen project was as much a “flight forward” as its Italian counterpart; for example, the failure of the German road plan of 1930, which may be compared to the Dutch plan of 1927, may have been due to problems with financing (Thomas Kunze and Rainer Stommer, “Geschichte der Reichsautobahn,” in *Reichsautobahn: Pyramiden des Dritten Reichs, Analysen zur Ästhetik eines unbewältigten Mythos*, ed. Rainer Stommer [Marburg, 1982], 23). Non-highway road building existed at the state level, however; see Dietmar Klenke, “Autobahnbau in Westfalen von den Anfängen bis zum Höhepunkt der 1970er Jahre—eine Geschichte der politischen Planung,” in *Verkehr und Region im 19. und 20. Jahrhundert: Westfälische Beispiele*, ed. Wilfried Reininghaus and Karl Teppe (Paderborn, Germany, 1999), 249–70.

practices of the railways.³⁵ Three years after the project began, however, Fritz Todt, general inspector for German roads (Generalinspektor für das deutsche Strassenwesen), marginalized railway interests by imposing his own design principles, and, convinced that roads should not be limited to a feeder function, refused to continue the railway's monopoly on long-range land transport. (Although Todt may have had long-range freight transport in mind, the earliest stretches of the project were clearly designed for passenger cars "and could not withstand the weight of the heavy trucks that came into service after 1937."³⁶) When the project ended during 1941–42, 3,625 kilometers of the planned 7,000 kilometers of concrete highways had been completed; another 800 kilometers were abandoned.

In the years between the two world wars, road building in Great Britain continued to be decentralized; the same was true in Switzerland, where the cantons managed to retain most of the executive power.³⁷ All other countries fell somewhere between extreme centralization (Germany/Italy) and decentralization (Great Britain/Switzerland).³⁸ Among them was the United States, where plans for a superhighway system were developed before World War II, but where, as in most other countries, actual building focused on regional, state (where some motor roads were built), and (from 1936 on) secondary networks.³⁹ The French tradition of centralized road building appears to contradict the argument pursued here. Two factors that may be pertinent to the French approach are the rapid repair of an excellent road network after the devastation of World War I, and the heavy

35. Edward Dimendberg, "The Will to Motorization: Cinema, Highways, and Modernity," *October* 73 (1995): 90–137, in which he calls "perhaps not coincidental" the frequent use of trains in Autobahn films (98, n. 17).

36. Quoted in *ibid.*, 103; see also Kaftan (n. 29 above), 74–75; Erhard Schütz and Eckhard Gruber, *Mythos Reichsautobahn: Bau und Inszenierung des "Strassen des Führers" 1933–1941* (Berlin, 1996); Zeller (n. 7 above), 52–53, 61; PIARC, *Compte rendu des travaux du VIIe Congrès* (The Hague, 1937), 50–55. On Todt's struggle against the railway interests, see Franz W. Seidler, *Fritz Todt, Baumeister des Dritten Reiches* (Munich, 1986), 98, 102, 144–52; and Kunze and Stommer, 27.

37. Crosby, ed. (n. 7 above), 215; George Charlesworth, *A History of British Motorways* (London, 1984), 36–41; R. Gresham Cooke, "The Need for Motorways in Great Britain," in *Welt-Strassenwesen 1938*, ed. Kurt Gustav Kaftan (Berlin, 1938), 111–15; Hans-Ulrich Schiedt, "Der Ausbau der Hauptstrassen in der ersten Hälfte des 20. Jahrhunderts," *Wege und Geschichte* 3 (2004): 12–25.

38. Before Austria's integration (Anschluss) into the German Reich in 1938, the state governments (Landesregierungen) had developed a plan for improving 1,600 kilometers of roadways, and had completed 500 kilometers by 1931; see Bernd Kreuzer, "National Road Networks in the 1930s: The Case of Austria's Roads" (paper presented at the conference on "Mobility History and the European Road Network" [n. 6 above]).

39. Richard O. Davies, *The Age of Asphalt: The Automobile, the Freeway, and the Condition of Metropolitan America* (Philadelphia, 1975), 10–13; on cooperation between state road-building departments and the central Bureau of Public Roads in the United States, see Seely, *Building the American Highway System* (n. 7 above), 72–73.

involvement of the state in the national railway system.⁴⁰ The Netherlands fell on the midline of this spectrum, a position that makes the Dutch case especially relevant to any exploration of factors triggering the emergence of what we might call the “highway concept.”

With the publication of its first national road plan in 1927, the Waterstaat officially centralized road planning and financing. Because of the long tradition of local and regional (provincial) autonomy in the Netherlands, the Waterstaat had no say in the construction of urban roads, however; and provincial road plans (financed by a substantial portion of national tax revenues after Waterstaat approval) were executed more quickly than the national program. This was a necessary step. Although Dutch roads had been improved early in the century, those in the provinces were especially in need of upgrading after World War I, their surfaces continually threatened by trucks bought from army surplus and often equipped with iron or massive rubber tires. As a result, the Netherlands had one of the densest paved-road networks in the world by the beginning of the 1930s. There was one exception: the western part of the country, with its marshy soils, had a long tradition of canal and river transport. Road widening and straightening were impossible on its narrow, winding lanes, and any application of asphalt on the weak subsoil posed problems of wave formation. It was at this point that proponents of automobile-only roads saw a possibility of strengthening their case.⁴¹

As in Italy and Germany, these proponents centered around a building contractor, in this case S. ten Bokkel Huinink, who, inspired by the Italian example, had convinced certain businessmen and provincial Waterstaat engineers to consider an expensive viaduct-highway network, to be funded by a toll system and fares from an exclusive bus service.⁴² Ten Bokkel Huinink’s ideas were immediately rejected by the national Waterstaat, whose engineers had returned from the 1926 road conference in Milan disgusted by the “ugly” concrete scars in the landscape and the advertisement panels that lined the route. (They were also appalled by the inebriated bus drivers who had driven them over the autostrada at frightening speeds.) When those around ten Bokkel Huinink connected their scheme to the debate on road safety, however, their ideas gained more currency, and were

40. On the history of French road building, see Robert Salomon, *Les Routes à grand trafic* (Paris, 1927); and René Héron de Villefosse, *Histoire des grandes routes de France* (Paris, 1975).

41. See the response by H. W. O. de Bruyn to section 2, question 4 (“Les moyens propres à assurer la sécurité de la circulation: a) en ville; b) en rase campagne; c) aux passages à niveau des chemins de fer; Législation, réglementation, signalisation”), in PIARC, *Compte rendu des travaux du VIII^e Congrès* (n. 36 above), 13; Internationaler Ständiger Verband der Strassen-Kongresse, *VIII. Kongress—Haag 1938* (Paris, 1938), 1, 6, 21.

42. During the interwar years, Mussolini also conceived a plan for a highway dedicated to electrically propelled trolley-trucks (“n Enorm Italiaansch trolleybussen-plan,” *Autokampioen* [1939]: 1517).

adopted by, among others, Anton Mussert, a Nazi sympathizer and provincial Waterstaat engineer who opposed the lenient manner of consensus formation among Dutch road engineers. He also argued against municipal autonomy, pleaded for a radical rupture with the past, and embraced highway building as the ultimate way of modernizing the country.⁴³

The problem was that improvements to existing roads had so increased motor traffic that the number of accidents, particularly those involving pedestrians and cyclists, had risen alarmingly since the mid-1920s, due in part to the continued use of horse-drawn vehicles and bicycles in and around cities. This had led national road engineers to explore the concept of “mixed roads” with separate lanes for fast and slow traffic, an idea borrowed from Great Britain and heavily discussed at international road conferences. The circle advocating the proposal put forward by ten Bokkel Huinink argued effectively that mixed roads would cost more than highways and would not solve the problem of dangerous road crossings. Gradually, some national road engineers became convinced by this line of reasoning, especially when they saw that the cost of building new roads in the western part of the country would be high anyway. They must also have become aware that the central control they favored could be strengthened by this change in paradigm.⁴⁴

This shift in discourse was reflected by a shift in metaphor, in the Netherlands as well as within PIARC. Whereas road networks had previously been compared to the human circulatory system (in which roads were “arteries” carrying an unrestricted “flow” of vehicles), partisans of the highway now adopted railways as the object of comparison. Ten Bokkel Huinink discovered “the same logic” behind the construction of rail and highway networks. Others held that Italian tolls were “comparable to the price of a railway ticket.” A French designer of highway systems called his roads “concrete rails.” Dutch protofascist Mussert argued that a highway network facilitated “control of the whole country, including its foreign connections.” And a British road engineer was quoted as saying, “The task of a road engineer would be much easier if he could design his road for the limited goals [that] the railroad engineer has when designing his roads.”⁴⁵

43. A. A. Mussert, *Vrije baan voor de toekomst: Bijdrage tot de kennis van het wegeenvraagstuk* (Utrecht, 1931).

44. Dirk Maarten Ligtermoet, *Beleid en planning in de wegebouw: De relatie tussen beleidsvorming en planning in de geschiedenis van de aanleg en verbetering van rijkswegen* (n.p. [The Hague], n.d. [1990]), 28.

45. *Wegen* 4 (1930): 181; *Wegen* 6 (1932): 237–38; *Wegen* 11 (1937): 504; “Tien jaar Italiaansche wegebouw,” *Wegen* 13 (1939): 111; [J. T.], “La question des autoroutes au Congrès Économique Européen (Bruxelles, 15–17 mai 1935),” *Revue Générale des Routes* 116 (1935): 199; Jacques Thomas, “Le Ie Congrès International des Autoroutes (Genève, 31 août, 1er et 2 septembre 1931),” *Revue Générale des Routes et de la Circulation Routière* 6 (1931): 312; “Vereeniging voor autosnelwegen: Ir. A. A. Mussert over speciale autowegen,” *Nieuwe Rotterdamsche Courant*, 18 September 1934 (*Wegen*, box 26, ANWB archives).

OCTOBER
2005
VOL. 46

Railway metaphors were not unique to this period, and neither was the relationship between the building of roads and railways. At the end of the nineteenth century, some road engineers had been recruited from the railway-building community within Waterstaat; this heritage was still evident in the first road censuses conducted in the Netherlands and elsewhere that evaluated vehicles in terms of their estimated average weight so as to ascertain their mechanical load on the road structure. What was new, however, was what might be called the “scientizing” of the flow concept, a process that occurred in all Western road-building countries.

Over time, and especially in the United States, several new models were introduced as part of the emerging discipline of traffic engineering. In the Netherlands, there was increased use of the “gravity model,” based on the assumption that traffic between two points was equivalent to the gravity attraction of two bodies in physics. This “scientific” approach to the design of roads and road networks replaced the static influence of individual vehicles on road-bearing capacity with the dynamic concept of a stream of automobiles. By focusing on safety (that is, by ensuring that the flow met no “resistance”), road-network design could be reduced to a functional split between classes of roads, the highest class exhibiting the unimodal, unidirectional flow characteristic of railroads. It should also be remarked that science was supplemented by the socioeconomic argument, based on the labor-intensive nature of road building during the years before World War II, that highways would provide unemployment relief; and in effect, road-network building emerged as one of the few large investment projects of prewar European governments that was not affected by the economic crisis.

By redefining road building as analogous to railroad building,⁴⁶ highway design triggered fantasies of increased influence among Waterstaat road engineers, who were previously marginalized when compared to those involved with rail- and waterways. If automobile flows were to be separated, a flow-control system could be designed comparable to other large-scale systems such as railroads. Such traditional “Hughesian” systems were fundamentally different from road networks, however, the control of roadways being rendered elusive by the nonsystemic character of automobile and motorcycle flows. Further, the flexibility and initially low infrastructural needs of motorized vehicles created anomalies in the mobility spectrum (such as the Dutch wildcat motorbuses and one-man truck companies using rebuilt Model Ts in the 1920s). Once nested in these niches, however, their expansion directly threatened such older forms of mobility as rural tramways and inland navigation. In short, privately owned vehicles presented an obstacle to central control by national authorities and were difficult to include in the “coordination policy” for rail and road systems.⁴⁷

46. G. Reverdy, “Parallèle des autoroutes et des chemins de fer,” *Revue Générale des Routes et des Aérodrômes* 43 (1974): 27–37.

47. For an elaboration of this argument, see Mom (n. 5 above), 288–96.

For reasons such as these, mechanisms for regulating road networks took some time to develop: traffic and tax laws had to be designed, consistent warning and directional signs had to be developed, and specialized traffic police had to be trained. All were tasks that regional governments could not be expected to perform. In other words, rendering automobile mobility measurable and calculable, a necessary condition for modern road building, could be done only on a national scale.⁴⁸

A good deal of time at PIARC conferences was devoted to fine-tuning such methods of measurement. In this discourse, grand (or grandiose) proposals began to circulate, such as the Lincoln and Dixie highways in the United States (the first spanning the continent from east to west, the second from north to south), proposals that, like the autostrada and the Dutch scheme by ten Bokkel Huinink, were developed by consortia outside normal road-building bureaucracies.⁴⁹ Most were based on projections of future tourism, although military or (in the case of Europe) colonial interests were never far behind. In 1930, for example, the British Automobile Association, supported by the Alliance Internationale de Tourisme (AIT), proposed a traffic “artery” from London to Istanbul, a route extended to Calcutta and the South African Cape at the 1932 AIT conference. Ten countries cooperated in this project, forming a Comité Permanent International de la Route Londres–Stamboul.⁵⁰ The British automobile club sent officers out by plane, train, and automobile to prospect this “Orient Express from Calais to Constantinople,” the metaphor emphasizing its similarity with large railway schemes. Such plans of “grand tourism” apparently struck a chord among touring and automobile club leaders. In the Netherlands, for example, the plan prompted the local club magazine to praise the “Tourism of the Future”: “Out of the way, minuscule earthworms, who in your insignificance think you can stop the automobile’s progress!”⁵¹

The French Pigelet and Lucien Lainé, the Italian Piero Puricelli, and the German Kurt Kaftan all designed international highway networks (as had

48. Axel Dossmann, *Begrenzte Mobilität: Eine Kulturgeschichte der Autobahnen in der DDR* (Essen, 2003), 13. For a similar characterization of traffic statistics as “a strategy of control,” see Dimendberg (n. 35 above), 92.

49. Frederic L. Paxson, “The Highway Movement,” *American Historical Review* 51 (1946): 239–42.

50. A. Dunscombe Allen, “Report,” *Conference on the Trans-Continental Route London–Istanbul, Budapest, 1935*; “Projet de Statuts,” *Comité Permanent International de la Route Londres–Stamboul* (both in box 301, ANWB archives).

51. “Tusschen Theems en Bosporus . . . ligt de nieuwste internationale autoroute,” *Autokampioen* (4 May 1935): 607; “Internationale autowegen,” *Autokampioen* (17 October 1936): 1649 (my translation). The idea of a “European road network” for bicycle tourism can be traced to 1901 when, at the third LIAT conference, the Union Vélocipédique de France proposed a project of a “complete European network” to be started by “the creation, on French territory, of highways from Paris to the borders of neighboring countries” (Union Vélocipédique de France, “Routes Internationales,” box 292, ANWB archives).

OCTOBER
2005
VOL. 46

ten Bokkel Huinink and his circle for the Netherlands). Such plans received additional stimulus when Albert Thomas, founder of the Office International des Autoroutes (OIA) in Geneva and first director of the League of Nations' International Labor Organization, developed a continental highway-building program intended as a European New Deal and to have been financed by the Bank of International Settlements. At 14,000 kilometers in length, the scheme would have required 126 million labor-days.⁵²

Thomas's death in 1932 left his proposal without a champion. But even if his initiative had been pursued, such a plan could not have been implemented in a prewar Europe where continental highways were drawn on a map as straight lines between capitals and local and regional needs were ignored. Only when an authoritarian central power developed to overrule autonomous bureaucracies could such plans meet with success; and no central power existed at the transnational European level.⁵³

The case of the Netherlands shows that there were exceptions to this pattern. Since, as was said above, new roads had to be built in the western part of the country, the central Waterstaat bureau, impressed by the German example, integrated them into their road planning. In 1936, the Waterstaat minister published a 1,200-kilometer "highway plan" integrating new roadways into the existing network and, in some cases, proposing two-lane roads that could be widened if and when the need arose. Two years later, PIARC convened in The Hague and proud Waterstaat engineers treated their international colleagues to a tour of the first hundred kilometers of the Dutch highway. Even the reluctant British came to embrace the concept of automobile-only roads at this conference, although one British participant, while admiring the "modern" look of the concrete roads and functionalist concrete bridges, could not help asking where the traffic was.⁵⁴ In

52. J. T., "Le IIe Congrès International des Autoroutes (Milan, 18–21 April 1932)," *Revue Générale des Routes et de la Circulation Routière* 7 (1932): 167–77; E. Grey Cameron, "Un projet grandiose de routes internationales," *Bulletin de l'Association Internationale Permanente des Congrès de la Route* (1933): 112–19; on Albert Thomas, see *Encyclopaedia Britannica, Micropaedia*, 15th ed. (Chicago, 1985), 11:713.

53. Kurt Gustav Kaftan, *Europa braucht Autobahnen! Vorschläge und Entwürfe zur Erbauung nationaler Autobahnnetze als Ausgangspunkt zur Errichtung eines europäischen Autobahnnetzes* (Berlin, 1936); Leopold Örley, *Das Fernstrassenproblem Europas und seine Lösung für Länder geringerer Bevölkerungsdichte* (Vienna, 1936). The first "European highway" was built between Germany and Austria by Fritz Todt; a month after Austria was integrated into the Reich, construction started on the first Autobahn segment to Vienna (Dimendberg, 100). Although not conceived as a highway, the London–Istanbul scheme seems to have been developed beyond mere planning, with several European governments executing improvement works on their national segments of this road, monitored by the Secrétariat de la Conférence Internationale Route Londres–Stamboul headquartered in the Magyar Touring Club, Budapest ("Rapport sur les problèmes, ayant trait à la route Londres–Istanbul," box 301, ANWB archives). The history of this road has yet to be written.

54. Tom van der Meer and Steven van Schuppen, *Op weg: 4000 jaar Nederlandse wegen* (The Hague, n.d. [1987]), 40.

fact, photographs and censuses from the Netherlands and other European countries support the conclusion that these early highway projects were built ahead of demand and with other purposes in mind. This is especially true of Germany, where car densities were among the lowest in Western Europe and prewar mass-motorization schemes failed.⁵⁵

After the War: Building the E-Network

In July 1948, representatives of Belgium, Denmark, France, Great Britain, Italy, the Netherlands, Poland, Czechoslovakia, the United States, Sweden, and Switzerland conceptualized an international highway network within the framework of the United Nations Economic Commission for Europe. By the autumn of 1950, eighteen countries (now including occupied Germany) were involved in planning a network with Berlin as its central point, three east-west and four north-south routes, and a projected length of 42,000 kilometers, 20 percent of which was in the four German occupation zones.⁵⁶

When the cold war gained momentum, a “little Europe” that excluded Eastern European countries and the Soviet Union came into being, and economic recovery became intertwined with military unification against the communist bloc. One of the instruments for achieving this was the Marshall Aid Plan (1947–51),⁵⁷ used to finance housing and road building, particularly in countries with a strong communist movement. Agriculture (including mechanization) received most of the Marshall Plan’s money, however. While such projects are readily seen as supporting the plan’s commitment to industrial and agricultural productivity, Marshall Plan scholarship fails to appreciate the importance of the service sector, especially tourism, to European recovery, even though some Marshall funds went to hotel building, and “[t]ravel by citizens of the United States to and within participating countries” was explicitly mentioned in the Foreign Assistance Act of 1948 that enabled the launch of the plan. In other words, international tourism was considered not only essential to transnational unification, but also an excellent opportunity to “market” Europe to the United States and strengthen the monetary self-sufficiency of the Continent. According to a brochure for the British Travel Association written on behalf of sixteen European countries united in the International Union of Official Travel Organisations, American tourism “affords a means of expanding invisible income relatively without limits, at the same time assisting rather

55. Dimendberg analyzes the imagery of “endless stretches of (empty!) open highway in many Autobahn films,” 108.

56. Pierre Michelet, *Les Transports au sol et l’organisation de l’Europe* (Lausanne, 1961), 29; Václav Kostelecký, *The United Nations Economic Commission for Europe: The Beginning of a History* (Goteborg, 1989).

57. Michel J. Hogan, *The Marshall Plan: America, Britain, and the Reconstruction of Western Europe, 1947–1952* (Cambridge, 1989).

than disrupting the internal economy of North America"; and the Dutch–American agreement under the Marshall scheme obliged the Netherlands to cooperate fully in visits by American tourists to the country.⁵⁸

This sheds new light on the skepticism, recently surfaced in the literature, about the unifying effects of the Marshall Plan. Although European countries often failed to coordinate requests for Marshall funds, the flow of tourists, supported by the ideology behind (and resources from) the plan, presaged a "Europeanization from the bottom up" well before the establishment of an interconnective highway. Clearly, expectations about long-range tourism, which helped fuel the building of that highway, are a neglected aspect of mass consumption.⁵⁹ From a cultural perspective, the Marshall Plan can be seen as part of the "Americanization of Europe," a complex and controversial process that also involved the countervailing European influence on American technology and culture. While it is not yet understood how, or if, the postwar European urge to travel is related to the American desire to visit Europe, it is plain that insofar as road building is concerned, knowledge transfer was unidirectional. Even if the prewar road network in the United States was influenced by the design of the Autobahnen, the postwar network in Europe was inspired by the American approach—an approach that had long-lasting consequences for the European landscape.⁶⁰

Few European countries profited as much from Marshall aid as did the Netherlands. During 1948–49, 11 percent of Dutch national income came from American taxpayers, second only to Austria. Four percent of the 3,148 billion dollars of Dutch "counterpart funds" was spent on roads, bridges, canals, tunnels, and harbors. A recent study argues that "mental Marshall aid" was as—or more—important, however. In the Netherlands alone, for example, 1,956 farmers, civil servants, students, union members, and engineers received permission to take courses or participate in "productivity groups" in the United States, the only requirement being that they report on their experiences on their return. More than 100 such reports were published.⁶¹

58. "European Recovery 1948–1951 and the Tourist Industry: A Report Prepared for the Oslo Conference of the International Union of Official Travel Organisations" (London, n.d. [1948]), 4; Pierre van der Eng, *De Marshall-hulp: Een perspectief voor Nederland 1947–1953* (Houten, the Netherlands, 1987), 138.

59. Frank Inklaar, *Van Amerika geleerd: Marshall-hulp en kennisimport in Nederland* (n.p. [The Hague], 1997), 32–33; D. W. Ellwood, "The Impact of the Marshall Plan on Italy: The Impact of Italy on the Marshall Plan," in *The Netherlands and the Integration of Europe 1945–1957*, ed. R. T. Griffiths (Amsterdam, 1990), 122.

60. Seely, *Building the American Highway System* (n. 7 above), 148. The concept of "Americanization" is discussed by Inklaar, 140–42; and in Rob Kroes, Robert W. Rydell, and Doeko F. J. Bosscher, eds., *Cultural Transmissions and Receptions: American Mass Culture in Europe* (Amsterdam, 1993); and Doeko Bosscher, Marja Roholl, and Mel van Elteren, eds., *American Culture in The Netherlands* (Amsterdam, 1996).

61. Alan S. Milward, *The Reconstruction of Western Europe 1945–51* (London, 1984),

Because of the cold war, the second European highway plan (1950) was reduced to 23,000 kilometers. Presented as the E-network in 1953 by a Conference of European Ministers of Traffic, the revised system avoided Eastern Europe and focused on the rich industrial zone running from London, over the Rotterdam and Antwerp harbors, and through the Ruhr valley to northern Italy. The E-network was not a road plan in the prewar sense. The E numbers—which could be given to existing secondary roads and reassigned when the highway was completed—referred to “routes” rather than “roads” and were intended to guide the flow of international tourism. Single-day traffic censuses conducted throughout Europe during the summers of 1955 and 1960 indicated that international tourist traffic was only a minor part of overall E-road travel, however.⁶²

When European countries failed to reach consensus on a centralized financing scheme, both the network and international tourism began to grow from the bottom up. In 1963, although construction was barely under way in most European countries, the system was already 6,700 kilometers long, most of it in nations that had started highway networks before the war: Germany (3,000 kilometers), Italy (1,400 kilometers), and the Netherlands (500 kilometers). Soon thereafter, Great Britain and France undertook, or planned, major domestic highway projects, and by 1972 each had added nearly 6,000 kilometers to the network. In 1968, the European Investment Bank began to underwrite construction of cross-border connections. By the end of the 1980s, the European highway network had increased to 40,000 kilometers. Still, several areas—Greece, southern France, the Eastern bloc—remained outside the system until well into the 1990s.⁶³

96–97, 112; Inklaar, 30–31; van der Eng, 20, 78, 119, who notes (183) that in 1948, some American congressmen protested that the Netherlands had imported 767 luxury automobiles with Marshall money.

62. “Het Europese net van internationale wegen,” *Wegen* 27 (1953): 112–13, 117; Van Gils, “Verkeerstellingen op internationale hoofdwegen in 1955,” *Wegen* 28 (1954): 75–79; *Roads and Road Transport in Europe: A Look Ahead; an Examination of the Relationship of the Increasing Motor Vehicle Population and Current and Projected Road Programs in 17 European Countries* (Washington, D.C., n.d. [1964]); “De ontwikkeling van het E-wegenet sedert de instelling van de CEMT,” *Wegen* 38 (1964): 347, 355; Jean-Antoine Winghart, “L’Autoroute, charpente d’une Europe réunifiée,” *Revue Générale des Routes et des Aéroports* (1990): 37–51; Heinrich Hasskamp and Richard Vreden, “Europastrassen—Hauptstrassen des internationalen Verkehrs,” *Strasse und Autobahn* 27 (1976): 419–30.

63. W. H. Spencer, “Development of the Inter-Urban Motorway Network in England and Wales,” *International Road Safety and Traffic Review* 12 (1964): 3, 5–15; W. H. Spencer, “The French Road Programme 1960–1975,” *International Road Safety and Traffic Review* 8 (1960): 40–42; J. Jakob, “Die Entwicklung des Strassenverkehrs und der Ausbau des Strassennetzes bis zum Jahre 1985 in der Schweiz,” *Strasse und Autobahn* 24 (1973): 223–31; J. W. Tops, “Die Entwicklung des Strassenverkehrs und der Ausbau des Strassennetzes bis zum Jahre 1985 in den Niederlanden,” *Strasse und Autobahn* 24 (1973): 196–207; E. Santucci, “Die Entwicklung des Strassenverkehrs und der Ausbau des Strassen-

OCTOBER
2005
VOL. 46

The design of these national networks differed markedly from the pre-war experience. The old PIARC, run by engineers employed as civil servants in their respective countries, was disconcerted by the refusal of the American road-engineering community to rejoin after the war on the grounds that the organization should first become a part of the United Nations. At the same time, British and American businessmen in road building and automobile manufacturing founded the International Road Federation (IRF), which quickly gained official United Nations advisory status.

From bureaus in Washington, London, Paris, and Geneva, the IRF—supported by a worldwide network of engineers and managers of its member companies—lobbied for diffusion of American road-building techniques and equipment. To this end, it bypassed the PIARC structure, encouraged alliances of road-building and automobile-manufacturing companies across Western Europe, used them as pressure groups to obstruct national road-building plans proposed by the old coalitions, and generally ignored the consensus-building methods that had traditionally governed unified national levels of road management. Instead, the IRF focused on young, carefully selected, and “reeducated” engineers, drawing them from existing national communities. Among the methods it used was the successful Fellowship Training Program, instituted in 1949 and initially funded by Marshall money, that sent a stream of road engineers to British and American universities—most especially to Yale, an institution that had rapidly developed into a center of traffic engineering. By the late 1950s, the nearly five hundred engineers from eighty-three countries who had completed these courses formed, as an IRF commemorative publication called it, an “elite corps of highly-trained road administrators, ministers, and directors throughout the world.”⁶⁴

The consequences of this new approach are still to be studied. The PIARC, which enjoyed an active Dutch contingent made up of national and provincial Waterstaat engineers, urban planners, and a few road-building companies, was a dominant force in the Netherlands from 1920 on, its influence little challenged by the Algemeene Nederlandsche Verkeersfederatie (ANVF) (General Dutch Traffic Federation), a nascent pressure group founded by touring clubs, automobile clubs, and oil and construction companies. It was a different case in Great Britain, where the national car-manufacturing organization joined with a few road-transport companies in

netzes bis zum Jahre 1985 in Italien,” *Strasse und Autobahn* 24 (1973): 208–13; André Thiébaud, “Die Entwicklung des Strassenverkehrs und der Ausbau des Strassennetzes bis zum Jahre 1985 in Frankreich,” *Strasse und Autobahn* 24 (1973): 186–95; European Investment Bank, “Bestaande en geplande wegen in de EEG,” *Beroepsvervoer* (21 March 1968): 448–49.

64. *International Road Federation, Fifty Years of Service, 1948–1997* (Geneva, 1997), 32; J. J. Jonker, “De Commission Internationale Permanente des Congrès de la Route: Verslag van de vergadering op 31 Aug. 1949 te Parijs,” *Wegen* 23 (1949): 241–42.

1932 to establish a lobbying group that later became the postwar British Road Federation and the nucleus of the IRF.⁶⁵

After World War II, the Netherlands saw the previous members of the ANVF coalition joining in Stichting Weg (Road Foundation), another pressure group that became an early member of the IRF. Stichting Weg nevertheless failed to become the dominant roads lobby. This role was instead assumed by the Dutch contingent of PIARC that, shifting toward IRF ideology (without, however, fully absorbing it), became the group that sent local engineers to Yale for reeducation as traffic engineers. Such engineers, it was reported, were “specialists, as a separate group more or less standing between road building and politics” and “masters of adaptation [who] see to it that the space for traffic and parking will be exploited to the maximum, with a limited amount of expensive tools.”⁶⁶ Gradually, PIARC and the IRF began to organize common activities; in 1962, André Rumpler of France was both president of PIARC and director-general of the IRF. Many Dutch engineers believed the IRF “image [to be] somewhat commercial,” however. Until the early 1980s, they played no official role in IRF conferences, but they did complain that PIARC conferences had become a one-way communication between Western engineers and those from Third World countries.⁶⁷

A system builder in the Hughesian sense emerged during this phase. Bert Beukers, who like many of his peers began his career at a provincial branch of Waterstaat, was sent to Yale by his superiors. Upon his return he was promoted to the central Waterstaat headquarters, where he initiated a new planning department and staffed it with engineering graduates from the newly established road-design program at Delft Technical University. To a certain extent, Beukers was aided by the war, which had caused a good deal of previously acquired common knowledge of road building to fade away.⁶⁸ Because Dutch law required that a new road plan be formulated every ten years, one of Beukers’s first tasks was to develop the plan for 1968, which he did by incorporating American principles of planning and construction rather than by taking the traditional approach of seeking proposals from provincial Waterstaat branches. He and his colleagues met with some resistance from spatial planners in the Ministry of Spatial Planning and the Environment, which was influenced by urban traffic experts antagonistic to the American approach,⁶⁹ but they countered this opposition by

65. Mick Hamer, *Wheels within Wheels: A Study of the Road Lobby* (London, 1952), 8–9.

66. “De XIIde Wegverkeersdag van de K.N.A.C. op 12 November 1954,” *Wegen* 29 (1955): 48.

67. “PIARC—Wereldcongres 1979: Wenen,” *Wegen* 51 (1977): 64–66.

68. Ligtermoet (n. 44 above), 39.

69. Interview with B. Beukers, 20 April and 14 July 2004; on Dutch spatial planning, see Hans van der Cammen and Len de Klerk, *Ruimtelijke ordening: Van grachtengordel tot Vinex-wijk* (Utrecht, 2003).

establishing a Waterstaat spatial-planning subdepartment—a strategy used in the United States and elsewhere.⁷⁰ This new approach to road building had profound consequences for the Dutch highway system. Since 1960, planning had focused on a 1,200-kilometer network with Utrecht at its center, but Beukers's plan contained more than 3,600 kilometers of highways with elaborate interchanges and multiple lanes, reflecting principles set out in O. K. Norman's American *Highway Capacity Manual*.⁷¹ Beukers proposed a rectilinear system (unofficially called "Beukers's checkerboard") modeled on an embryonic grid developed around Rotterdam that provided entry to the city center.⁷²

This building frenzy lasted only some fifteen years. Road expenditures in the Netherlands reached an all-time high during the 1970s, while in the 1980s more money was spent on maintenance than new construction. During the energy crisis of the 1970s spatial planners regained some control of the design process and used popular discontent with road building and the automobile to reduce the size and scope of projects. Thus, Beukers's original plan was never fully executed. Also, at the local level, comparable tensions arose. For instance, at the invitation of Stichting Weg, the American urban planner David Jokinen offered a proposal for the city of Amsterdam that would have radically altered the Dutch capital by introducing urban highways deep into the city. The plan was never executed, and in fact the only highway that flows directly into a city center is in The Hague (it ends abruptly within a kilometer of the government district and has created bottlenecks ever since its construction).⁷³

The end result was that the Dutch road network mixed American planning methods with a traditionally economical use of space. Further, because Beukers could not alter the underlying road system, the Netherlands continues to lack a secondary system (such as the Routes Nationales in France) that could decrease congestion by carrying local and regional traffic.⁷⁴

70. Daniel M. Albert, "Order Out of Chaos: Automobile Safety, Technology and Society 1925 to 1965" (Ph.D. diss., University of Michigan, 1997).

71. J. G. Wardrop, "Praktische toepassingen van de verkeerstheorie," *Tijdschrift voor verkeerstechniek* 15 (1964): 262.

72. Michelle Provoost, *Asfalt: Automobilititeit in de Rotterdamse stedenbouw* (Rotterdam, 1996), 63–65, 81. The "Americanization" of the Dutch highway network was to have extended down to the font used on directional signs. Beukers said during his interview (n. 69 above): "I proposed the American letter type, but the typographers said 'that's barbaric,' so they gave it an extra curl; but basically we now have American-type lettering on our panels" (my translation).

73. David A. Jokinen, *Geef de stad een kans* (n.p., n.d.); "Give the Town a Chance," *Road International* (June 1968): 27–33; Provoost, 95.

74. *Van Netwerk naar Werkend Net: Netwerkvisie Wegen van Rijkswaterstaat* (n.p. [The Hague], 2003), 9. Although a lack of coordination with local planners in the building of national highway networks contributes to the sometimes negative impact of mass motorization, the present essay focuses on the national perspective. On this decentralizing trend in the United States, see Raymond A. Mohl, "Stop the Road: Freeway Revolts in American Cities," *Journal of Urban History* 30 (2004): 674–706; and Zachary M. Schrag,

By the end of the twentieth century, the Netherlands had superimposed a 2,100-kilometer highway grid on some 115,000 kilometers of existing roads (whose width, pavement technology, and directional signage had gradually been brought into conformity with the primary grid). Planners also managed to preserve green space in even the highly urbanized western provinces and to introduce or retain other characteristics since accepted as normal, including passenger railroads, waterways to carry freight, and 9,000 kilometers of bicycle paths. Further, in order to reduce traffic speeds, they deliberately combined types of road use so that motorized vehicles share city streets with cyclists, pedestrians, and children at play.⁷⁵ Clearly, this was a departure from state-of-the-art traffic engineering, which still advocated the separation of flows.

Doubtless, other European countries have responded differently to “Americanization,” but all have had to cope with forced modernization in one way or another. It should be noted that the Dutch touring club *Algemene Nederlandsche Wielrijders-Bond* (ANWB) played a pivotal role in the dissemination of American-inspired road-building techniques throughout Europe. When the United Nations asked the *Organisation Mondiale du Tourisme et de l’Automobile* (OTA), an association of European touring and automobile clubs, to design a “European course for traffic engineers,” ANWB was invited to internationalize the course subsidized by Waterstaat and the Dutch Ministry of Traffic that it had already developed for Dutch road engineers as part of a plan to build a “military headquarters for traffic” (*Generale Staf voor het Verkeer*). In 1953, the first “International Course in Modern Traffic Engineering” was held in The Hague and drew 110 foreign participants. Each year since, OTA, PIARC, and, eventually, the IRF organized similar courses in other countries that were taught by senior European traffic engineers. Through the early 1970s (when OTA disbanded, fractured by a lack of consensus on differences on energy and environmental policy between its automobile and touring clubs), hundreds of regional and national road engineers, planners, and police officers enrolled in these courses. In 1960, for example, the course held in Nice, France, was attended by 400 participants from thirty countries.⁷⁶

“The Freeway Fight in Washington, D.C.: The Three Sisters Bridge in Three Administrations,” *Journal of Urban History* 30 (2004): 648–73. Because highways were generally constructed around cities in the Netherlands, Dutch resistance to road building differs substantially from the American experience. Much of the protest against “asphalt” in the Netherlands focused on the deterioration of the landscape, the lack of space forcing Waterstaat engineers to locate roads in such areas as the western “green zone” (Hans Buijter and Kees Volkers, *Oudennrijn: Geschiedenis van een verkeersknooppunt* [Utrecht, 1996]; Cees Grimbergen, Rob Huibers, and Dick van der Peijl, eds., *Amelisweerd: De weg van de meeste weerstand* [Rotterdam, 1983]).

75. Interview with J. Volmuller, 7 October 2003; *Van Netwerk naar Werkend Net*, 10.

76. *Jaaroverzicht ANWB 1951*, 11; *Jaaroverzicht ANWB 1952*, 15; *Jaaroverzicht ANWB*

A centralized European agency able to enforce standardized highway building took a long time to develop and gain acceptance, but this process was complete by 1989, the year when the fall of the Berlin Wall led to both expansion and a new west-east orientation.⁷⁷ More difficult to explain (because no statistics are available) is how this network caused travel by automobile to be identified with long-range tourism. Answers to this question may be found in the archives of national touring and automobile clubs. Those held by ANWB in The Hague, for example, show that it “marketed” its support of the E-network by stressing that it was “especially of interest to those motorists who wish to reach their holiday resorts [in southern Europe] as fast as possible.” The network may also be compared to a rail network, in that it increased the efficiency of freight transport. (Evidence indicates that the average trip made by Dutch international trucking firms increased from 175 kilometers in 1950 to 559 kilometers in 1990.⁷⁸)

Desires, Centralized Planning Power, and the Road Network

Over the course of the twentieth century, road building in Europe developed in three stages. It is argued here that the resulting network cannot be fruitfully analyzed if two aspects are neglected: the first is its multi-layered, hierarchical, and multifunctional character (in other words, “the road” is a useless category and roads should instead be analyzed according to their specific functions and corresponding technical properties); and second, in designing and using roads, expectations and fantasy play a more important role than has hitherto been recognized.

From this perspective, the history of American road building does not differ fundamentally from the European pattern, although the United States has had to build more new roads to accommodate increasingly dense automotive “populations.” From an American perspective, European highway building anticipated demand. While this is true, it has been argued here that only in countries with strong (even authoritarian) national governments were highways built ahead of demand, and that this occurred because only a centralized administration could silence those sectors of the road-engineering community that viewed their task as serving traffic demand rather than traffic control. Before World War II the road-building community in the United States developed a model inspired by the appar-

1953, 27–28; *Jaaroverzicht ANWB 1960*, 78; “Aanzet tot One World Organisation, 1969–1971” (box 319, ANWB archives). For OTA, see “Historical Record of the Matter of the AIT/FIA Fusion,” AIT (5 May 1970) (box 319, ANWB archives).

77. Axel Dossmann, *Begrenzte Mobilität: Eine Kulturgeschichte der Autobahnen in der DDR* (Essen, 2003), 96.

78. *Jaaroverzicht ANWB 1968*, 20; Aart Camijn, *Wegvervoer, een grensverleggende activiteit: 50 jaar Stichting NIWO, Nationale en Internationale Wegvervoer Organisatie* (n.p., 1996), 68.

ent simplicity of unimodal railroad design; stripped of the railroad metaphor, the model was exported to Europe after the war through the principles of American traffic engineering.⁷⁹

Arguing that fast road transport could not be accomplished at acceptable safety levels without separating the automobile from other mobility modes, the European highway movement became entangled in the gradual transfer of power from regional to national governments. Highway-network building was a catalyst, not a result, of this process. The end product was a network that emphasized international road tourism, a phenomenon that initially formed only a tiny fraction of actual traffic flow. It is maintained here that it was fantasy (expectations) rather than actual demand that formed this network, and that this fantasy originated in the railway system.

To fulfill the fantasy, roads had to be reinvented and redefined as “roads without rails.” Only in this sense, and only during this third stage of road building, did a Hughesian system emerge, one that included, in the Dutch case, a clearly identifiable system builder with enough executive power to implement his plans. This system was superimposed on a previously existing system that had been designed on different principles, just as the national electricity grid in the United States was superimposed on a decentralized system of local electricity production. Once built, these highways not only attracted traffic from lower-order roads, they also created new traffic. When an American geographer in 1960 analyzed the “connectivity” of the interstate highway system with modern graph theory, he concluded that “it is more comparable to networks of airline and railroad routes than present highway [i.e., nonfreeway] networks.”⁸⁰

Eventually, road traffic came to resemble railroad traffic, in that roads caused traffic to become long-range rather than peri-urban or regional.⁸¹ Similarly, twentieth-century automobile travel began to resemble nineteenth-century railway travel. It thus came to differ markedly from the nostalgic experience of driving on meandering secondary roads—an experience reminiscent of the horse-drawn carriage, which by its nature emphasized the

79. Note the title of a postwar traffic-engineering handbook by Donald R. Drew: *Traffic Flow, Theory and Control* (New York, 1968).

80. William L. Garrison, “Connectivity of the Interstate Highway System,” *Papers and Proceedings of the Regional Science Association* 6 (1960): 122.

81. It is important to note systemic differences between rail and road mobility that stem from their differing relationships of infrastructure and use. Although railroads in the Netherlands during the interwar era experienced an increase in average passenger-trip length (dominated by regional trips of 30 to 40 kilometers), trains were perceived as long-range transport because their trip lengths were longer than passenger-trip lengths. The international “coordination debate” of the 1920s and 1930s in fact centered on the protection of railways as long-range mobility modes, and in countries such as Germany and Great Britain licensing regulations for buses and trucks were introduced to keep them from becoming long-range; see Paul Wohl and A. Albitreccia, *Road and Rail in Forty Countries: Report Prepared for the International Chamber of Commerce* (London, 1935).

OCTOBER
2005
VOL. 46

“foreground.”⁸² Two scenarios were thus merged: the transnational tourism scenario of automobile and touring clubs, and the flow-control scenario of road engineers. In a later stage, resemblance to the railroad evolved even further, as guardrails were installed to channel moving vehicles and programmable signals warned of speed limits, road conditions, and lane changes.⁸³ Beukers, who devised such a “dynamic traffic management system” for the Netherlands during the 1970s, did not hide the motives behind such projects: “[After my trip to America] I started to tell everybody that we could not keep on leaving these little cars to follow their own routes; they needed some sort of guidance system which we could provide.”⁸⁴ Recent “smart road” projects are aimed at further reducing the autonomy of individual vehicles and making them behave like wagons in an endless train.

The taming of the automobile, an icon of anarchistic individuality in the early 1920s, evolved through a process of enforced systemization. Perceived as a frontal attack on the older railway transport system, road building assumed several characteristics (functions, not properties) of that system. If contemporary road engineers are correct in predicting that automation will eventually allow the complete control of traffic on national and international routes, then the evolution of the mobility system will have come full circle, and “road-trains” of electronically coupled automobiles will run on “roads without rails.”

82. On the emergence of the “industrialized” view from fast-moving automobiles on American freeways, see Gabrielle Barnett, “Drive-By Viewing: Visual Consciousness and Forest Preservation in the Automobile Age,” *Technology and Culture* 45 (2004): 30–54; on the recovery of the “foreground” by early motorists, see Mom (n. 5 above), 42–43.

83. Guardrails between lanes of opposing traffic were introduced in the Netherlands in the 1950s and 1960s in response to public outcry about an increased number of road accidents (*Bedrijfsvervoer* 17 [1963]: 1083).

84. Beukers interview.