THE ORIGINS AND GLOBALIZATION OF TRAFFIC CONTROL SIGNALS

CLAY McSHANE
Northeastern University

Traffic control systems are the most visible element of the urban infrastructure. They are not just physical systems like telephones or sewers or streets, although their technological elements, traffic lights, signs, and painted pavements, fit that description. Rather, they are systems that attempt to impose a strong social control over the most fundamental of human behaviors, whether to move or be still. Traffic engineers must control police, drivers, and pedestrians. For most other elements of the urban infrastructure, controlling the behavior of users did not constitute the primary goal of designers.[1] For traffic engineers, understanding and manipulating the behavioral patterns of drivers and pedestrians (a group that included not just walkers, but people using the street for play, social gatherings, and commerce) proved to be a more important problem than the control mechanisms themselves. Traffic engineers learned rapidly to pay careful attention to ergonomics, the interface between people and machines. There was also a political agenda of maximizing expert control.[2]

All over the globe, people stop and go as the traffic lights dictate. In a century marked by intense nationalism and insistence on multicultural variation, the same technology and internalized social control is the norm everywhere. Common belief insists that drivers are worse in

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Boston, or in Paris, or in Rome, or wherever. The perception of differences has a long history. In 1922, an American traffic engineer reported that European drivers paid more attention to traffic police because their culture made for conformity. What makes the report interesting is that five years earlier, an Italian visiting Boston had made exactly the opposite comment. One suspects that the behaviors were more similar than different. The emergence and dissemination of traffic control systems provide a striking example of the way in which urban policy is seldom just local, but emulates national, even global, patterns.[3]

The rise of traffic signals is tied to the rapid rise of automotive traffic. Urban traffic spurted enormously after Henry Ford introduced the Model T in 1908 and began to mass produce it in 1913. For the first time, cars were cheap and reliable enough for mass commuting. As early as 1913, New York experienced twice-daily jams. By 1915, at least some New Yorkers had given up driving to work and reverted to the subway. Chicago's trolley company complained that traffic had already slowed trolley speeds by 44 percent in that city's central business district, the Loop. Company officials claimed trolleys now traveled more slowly than their horse-drawn predecessors.[4] By 1918, approximately 49,000 motor vehicles entered the Loop every day.[5] In San Francisco, the number of motor vehicles surpassed the city's 10,000 horse-drawn vehicles in 1914. Two years later, San Franciscans still owned 10,000 horse-drawn vehicles, but they shared the streets with 26,000 motor vehicles. By 1924, the number of motor vehicles exceeded 100,000, with at least one-quarter of them entering the central business district daily.[6]

Growth could be nearly exponential in downtown areas. Between 1904 and 1917, traffic on Fifth Avenue in New York City grew at twice the rate of the city's population. Between roughly 1914 and 1920, downtown vehicle registration grew at three times the rate of population in Newark, six times in Brooklyn, seven times in Buffalo, and nearly nine times in St. Louis.[7] In 1920, the bridges entering Manhattan carried ninety-two million cars with 204 million passengers.[8] As early as 1923, one traffic expert noted that as business was deconcentrating to suburbs, so were traffic jams.[9] In 1925, U.S. Secretary of

Commerce Herbert Hoover estimated that urban congestion costs exceeded $2 billion a year.[10]

Traffic problems grew from more than just an increase in vehicles. One Detroit survey showed that traffic was rising more rapidly than the number of cars, suggesting that car owners took more trips than they had before.[11] Motorists also stored their cars on the streets, in effect making them a depot for abutters. By 1917, almost every photo in *American City Magazine* of downtown streets in large cities showed them lined with parked cars. Parking reduced downtown street area by 33 percent to 50 percent. In New York and, more surprising because of its wide streets and smaller central business district, Washington, D.C., pedestrians could travel faster than cars downtown during the rush hour.[12]

Such was likely the norm elsewhere. Stories about the traffic mess had already become a staple of the popular press. Some motorists evidently enjoyed jams; a Boston driving survey quoted one who "liked to view the passing show and be in the midst of congested traffic."[13] In New York City, always unique, transit ridership went up 15 percent between 1920 and 1923, a sign of hopeless auto stagnation.[14] In 1924, that city's leading traffic engineer claimed that jams had gotten so bad that although the number of automobiles was up, the number of trips per auto was down.[15] As early as 1925, one prominent engineer claimed that improving traffic speeds would only attract more traffic and more congestion.[16]

Automobility spread more slowly in Western Europe; incomes were lower, cars more expensive, and fuel heavily taxed because it was imported. France already had enough motor vehicles to move the garrison of Paris to the battle of the Marne in 1914 and to supply the fortress of Verdun in 1916, but daily traffic jams do not seem to have emerged in major European cities until the mid-1920s.[17]

The post–Model T wave of traffic control innovation occurred mostly in the United States because the United States had more traffic. Western U.S. cities had higher rates of car ownership than eastern cities after the car became more than a rich man's plaything. By 1910, Los Angeles had the highest per capita car registration in the world because it was a wealthy city with a good street system whose climate allowed year-round driving in the open cars that were the norm until

1923. Detroit and other midwestern cities did not lag far behind.[18] As long lines of motor vehicles backed up at intersections, some of them visibility-blocking trucks, control by police faltered, even when departments sent two or even four officers to busy corners. Coordinating police officers to allow a steady flow proved impossible.

Early attempts at less labor intensive, more visible traffic control involved the adoption of semaphore signals (first tried in Toledo, Ohio, in 1908) and midintersection towers with police in them (first tried in New York in 1915). Both grew out of railroad practice, both spread to cities throughout the Western world, and both failed. Semaphores were too difficult to see, especially at night, and towers obstructed traffic while still requiring officers. By 1930, all were gone.[19]

Many cities reported their first diurnal traffic jams in the spring of 1914. The center of traffic control innovation, which earlier had been New York, the largest American automobile market, had shifted to the booming auto-producing centers of the Midwest. That crisis spurred two effective and durable ameliorative devices. In 1914, Cleveland's police department installed a red and green traffic control light at the corner of 105th Street and Euclid Avenue, the first permanent installation in the world.[20] The colors derived from railroad signal systems (those, in turn, derived from maritime signals, and those from lighthouses).[21] The light faced in only two directions, with police officers controlling side street traffic. The light supplemented the officers stationed at the corner, who controlled traffic manually from a booth on the sidewalk. Nobody thought that drivers, motormen, or pedestrians would obey the signal without a police presence. The controlling officer was truly wired electronically, since the booth also contained a telephone, police telegraph, and fire telegraph. The expectation was that the officer also could turn the lights to clear the intersection for approaching emergency vehicles.[22]

In 1917, Detroit police officer William Potts made a major improvement in traffic lights, adding a yellow caution light to help pedestrians and allow traffic to clear the intersection between changes. Potts also built the first four-direction light in 1920. The original four-way lights could not assign any priority to colors in terms of height, since they had only three light bulbs. Thus, if the top light were red in one direction, it had to be green in the other direction. Twelve-bulb systems with red always on top became available in 1928. Placing hoods over the lamps and sandblasting the lens gave greater daytime visibility. By 1918, Chicago and New York adopted these manually controlled lights, and they spread rapidly through the American system of cities. Boston was a sluggard, getting its first light in 1925. Western Europe adopted them later, with Paris receiving its first light (red only and two-way only) in 1922, Berlin in 1924, and London in 1931. Although automatic signals were available by 1922, European cities, like American, always built their first lights with manual control by police, since they believed that drivers would ignore the lights unless they saw a police officer.[23]

Also in 1914, Detroit police sergeant Harry Jackson cut the corners off a square sign to create an easily recognized octagonal shape for the first red stop sign or "boulevard stop." Using the octagon was a brilliant stroke, since its unique shape facilitated recognition, especially by fast-moving motorists.[24] The Motor Club of Michigan, which financed the installation, placed the signs to halt cross-street traffic on a boulevard to the suburbs. This installation may have just reinforced existing right-of-way practice. Kansas City, Missouri, and Chicago had earlier required side-street traffic to yield the right of way to cars on suburban parkways.[25] Right-of-way ordinances had proven inadequate, in part because strangers crossing a boulevard or parkway might not know the right-of-way rule. Stop signs worked better and rapidly came into use at corners on major arteries where cross traffic seemed too light to justify a traffic cop.

Neighborhood groups often fought the installation of stop signs, since they sped up through traffic on boulevards in their vicinity. Since motorists knew that they had the right of way, they never hesitated for drivers (or, for that matter, pedestrians) who wished to cross their path. Not only did this make crossing broad radial streets more difficult, but the signs attracted more suburban vehicles. It seemed unfair to inner-city neighborhoods, as well as dangerous, to apply the stop signs to local, cross-town travelers, but not to drivers rushing to the suburbs. Surveys of stop sign effectiveness suggested neighborhood resistance. San Francisco's traffic engineer wanted only a very limited deployment of stop signs to accelerate boulevard traffic because his survey showed that 70 percent of cross traffic ignored the stop signs. Ann Arbor's traffic engineer reported that 98 percent of drivers obeyed red lights at lightly traveled intersections, but only 41 percent came to a full stop at stop signs. In other words, local drivers tended to defy the new signs. The signs probably increased collisions by giving arterial drivers an illusion of safety. New York's first traffic court judge confirmed neighborhood fears of outsiders' speeding on boulevards with stop signs, noting that drivers behaved more recklessly outside their neighborhoods. Still, police believed that stop signs reduced fatalities.[26]

As one might judge from the Motor Club financing in Detroit, the boulevard stop was clearly a pro-auto enactment. Chicago installed the new sign on its high-speed parkways in 1916, and most major U.S. cities were using boulevard stop signs by 1920, usually on heavily traveled roads leading to well-to-do suburbs. In the early 1920s, some city officials also deployed stop signs to relieve traffic jams by creating an uninterrupted bypass around the central business district through inner-city neighborhoods. Some traffic departments could not implement bypasses because Main Street business leaders objected to the posting of signs that encouraged traffic to avoid their streets.[27] When built, the bypasses also created what Bibbins called a "battle of the streets,"[28] with neighborhood groups opposing stop-sign-created bypasses on their streets. They perceived the signs as pedestrian unfriendly, since those crossing a street on foot never had the right of way. Courts were not always pleased with the new devices. Illinois courts briefly ruled stop signs illegal in 1922 as a violation of the rights of individuals to cross streets.[29]

Europe lagged in adopting the red octagonal signs, not acting until the 1930s. France evidently was the first to adopt the American-style octagon.[30] Paris adopted signs that emphasized symbols, especially shape, which became the norm for all of France in 1931. In 1931, a conference sponsored by the League of Nations adopted a uniform system of street signs, including the familiar octagon. The tourism industry led the advocacy for common signals. The motor car could encourage vacation travel, but only if drivers faced a somewhat similar experience everywhere. By 1960, all European countries had adopted them.[31]

Advances in electrical engineering technology made the next improvements in signaling possible. Engineers had developed automatic timers for military communications systems during World War I. In 1922, Crouse-Hinds, a railway signal firm, first applied automatic timers to traffic lights in Houston, its home city.[32] This idea also spread rapidly as a solution to growing congestion. New York and Los Angeles adopted them in 1924, and all major North American cities followed within a year. By 1926, New York had 98 automatic lights. Its engineers added 1,143 in 1927 and 2,243 in 1928.[33] London adopted automatic lights more rapidly than any other European city, installing them first in 1931.[34]

The automatically timed lights' major advantage was cost, since they replaced expensive traffic police. New York's police department found that it could reassign all but 500 of the 6,000 officers working for the traffic squad, saving $12,500,000 a year.[35] Automatic controls did require the addition of professional electricians to maintain them and careful engineering surveys of traffic to set the appropriate cycles, since both were beyond the skills of most police departments. Cities planned the controls to create a "platoon" system in which all the lights on a major artery changed simultaneously. Changing all lights at once presented a major safety drawback: drivers would race as fast as possible to make as many lights as possible before they all changed. The lights may have worsened safety initially by making drivers overconfident. A survey of 341 intersections with newly installed signals in Philadelphia showed that collisions increased at 40 percent of them.[36]

Engineers, after some initial skepticism, came to believe that lights controlled traffic more efficiently than police, but the big problem was convincing drivers of that. Goodrich dismissed automatic lights as a "fad."[37] McClintock was also skeptical of the new machines on their advent, not believing that they could replace police.[38] He believed that motorists and pedestrians would ignore signals without police backup. Although they sometimes attacked drivers for having what one called "delusions of grandeur such as afflicted the German Kaiser and his crowd"[39] and another described as "gasoline rabies,"[40] engineers preferred collaboration with drivers' organizations for both professional and political reasons. The motoring clubs could be valuable allies, even funding some traffic experiments. More important, they served an educational function, advising their members of the benefits of obeying the new systems. Threats backed up the educational programs, since police appeared to help enforce the first installations.

Pedestrians had a more difficult time adapting to the new automatic lights because they faced a new regulation of an old behavior, a more demanding adjustment than facing new rules for new behaviors (like driving). Pedestrians never organized themselves as well as motorists. American pedestrians lacked an equivalent of Britain's Pedestrian Association or Germany's Verkehrswachten.[41] They had enough influence in St. Louis to block an antijaywalking ordinance in 1936, but that seems an isolated exception to their political impotence.[42] Traffic engineers treated pedestrians as second-class citizens. In 1921, for example, one engineer described them as "a most serious hindrance."[43] On the most fundamental legal level, English common law had held that all street users were equal. At the urging of traffic engineers, however, city councils replaced this ancient rule with new ordinances that gave cars the right of way, except at intersections.[44] The first traffic engineering textbook noted that protection of life was more important than the speed of transport, but then added that safety and accident prevention seemed to be the last concern of officials. The same work complained that pedestrians were in a state of "revolt."[45] Certainly, they preferred signals to stop signs, since with signals they had the right of way at least part of the time. In New York City and likely elsewhere, new traffic lights in the 1920s became the occasion for neighborhood celebrations.

Traffic engineers did not just rely on mechanical control, but also sought to have urban residents internalize the new rules. Most of the traffic victims were children. Because of this, city engineering departments resorted to educational campaigns backed by police warnings. Police departments, beginning in Newark in 1915, organized school safety patrols to apply peer pressure, ran educational campaigns in the schools, and even convinced non-English newspapers to advise parents in densely populated immigrant neighborhoods to keep a close eye on their children. When a Chicago area community moved some police from speed law enforcement on a high-speed, suburban radial to inner-city corners, it found that officers spent more time urging

"Polish and Lithuanian mothers" to keep their children out of the street than ticketing traffic law violators. One manifestation of this concern with education was the appearance of articles on school programs in the engineering press. For example, a description of the rules for the nursery school game "red light, green light" appeared in an otherwise sober technical journal.[46]

Most urban groups welcomed traffic lights. Trolley companies often paid voluntarily for their installation, including the pioneer lights in both Cleveland and Chicago. The companies distrusted the competence and fairness of individual cops, especially since they might share the populist distrust of transit monopolies. If they wired the first systems, they did so to increase trolley speeds. It is striking that an early experimenter with automatically controlled lights was the noted African American inventor Garrett A. Morgan, whose patents General Electric purchased when it went into the manufacture of traffic lights.[47] It is hardly surprising that American blacks would prefer control by a color-blind machine to control by a big-city police officer. For them and others, machines seemed fairer.[48] Engineering observations showed that the signals moved traffic at busy corners faster than individual police, since they were more regular and lights were less ambiguous than hand signals.[49] Tests in New York City, reported by the American Society of Civil Engineers, conclusively showed that automatic light systems always moved traffic faster than individual police, even if towers or a hillside location allowed coordination of police.[50]

Eventually, most drivers preferred the new controls. In Cleveland, the local motor club requested automatic signals in 1925. In Chicago, the Yellow Cab Company paid for the first system on Michigan Avenue, a major shopping street. The Southern California Automobile Club did the same in Los Angeles. Motorists had already accepted control by traffic lights backed up by police. They believed in the benefits of lights and obeyed them without a police presence, especially when it became clear that the platoon system increased travel speeds. On New York's Fifth Avenue, the lights were topped with small statues of Mercury, the Greek god of speed. By the mid-1920s, specialized systems that allowed control over turns at three-way intersections, reversal of lanes at rush hour, and traffic activation were available.[51]

The final step in the technology of traffic lights in this period was automatic timers that allowed the creation of staggered systems of signals to maximize traffic mobility. It was possible to automatically time all the traffic lights on a street, so that traffic moving in one direction and traveling at a fixed speed (usually 25 mph) would encounter only green lights. Like boulevard stops, this facilitated travel to the suburbs, but also made some provision for cross traffic and pedestrians. This system worked better on a one-way street, but even on two-way streets, lights could be set to help inbound commuters in the morning, outbound in the afternoon. The engineering was complex in many ways, since traffic engineers had to estimate not just average speeds, but also acceleration and braking times. Even the slightest congestion lowered speeds to the point that staggered lights worked against drivers. Exceeding the preset speed was counterproductive—one simply ran into a light not yet green. The pioneering works on the mathematics of lane capacity grew out of these systems.[52]

The methodology of staggered lighting took a long time to work out, so the first installations required constant adjustment and drew many complaints until a trial-and-error process could find the proper timing. The initial system on Euclid Avenue in Cleveland worked so poorly that motorists ran the lights unless there was a police officer around. Making traffic control a mathematical discipline obviously enhanced the power of the traffic engineers.[53]

General Electric installed the first of these staggered (or progressive) light systems on prestigious Sixteenth Street in Washington, D.C., in 1926. Once properly adjusted, they apparently doubled commuting speed on that street. Most major U.S. cities adopted the new system within two years on major radial streets leading to their suburbs. In 1931, Tokyo installed the first system outside the United States on the Ginza. Some cities also automatically controlled all the traffic lights in their central business district grid, beginning with Syracuse in 1925. Syracuse's engineers reported not only that the lights allowed faster travel in the central business district but that the city had recovered its cost in the first year from saved salaries of traffic police. Chicago adopted a similar system, built by the trolley company, that claimed that it improved central business district travel times by 50 percent.[54]

One striking characteristic of the new technology was its uniformity from place to place. It had not been self-evident that every city would wind up with almost identical traffic lights and stop signs. After all, American municipalities were largely autonomous from state control in traffic matters, especially since traffic emerged first in local, not intercity, travel. The U.S. Constitution constrained the national government from intervention in such local matters. There was and is no international agency with the power to bind different nations to the same pattern of traffic regulations. Here, it is necessary to look beyond the technologies and techniques that emerged in the first third of the twentieth century and examine the way in which the traffic regulators created a self-controlled national, then international, network. Once cities all over the world began to employ full-time, professionally trained engineers to direct traffic, they deployed only certain traffic solutions. Traffic engineers had linked themselves together into a large, self-reinforcing, international, professional community by the early 1930s.

Big-city political groups, especially downtown business interests, had a long history of turning to engineers for solutions to the diseconomies of urbanization. Engineers carried the enormous prestige of modern science and technology. Urban elites liked engineering models of problem solving. New technologies in the form of steamships and railroads had fueled the urban boom of the nineteenth century. Engineers had built the bridges and rapid transit systems that allowed so much urban deconcentration in the late nineteenth and early twentieth centuries. Urbanites believed that engineering techniques had solved the health problems of nineteenth-century cities by building water and wastewater systems. Increasingly, in the early twentieth century, city business leaders had convinced electorates in the United States to defer to engineers in matters of governance by hiring them as city managers or planners.[55] Of the interest groups concerned with traffic, transit companies most likely welcomed such control of cities by engineering experts, since they increasingly feared popular opinion.[56]

In 1928, the Erskine Bureau for Street Traffic Control published biographies of the twenty leading traffic planners in the United States. Nine were midwesterners, mostly with urban backgrounds. Six were from New England, and two were from New York City. All but two held engineering degrees. Before going into traffic, they had worked in a variety of jobs. Six were road engineers (usually for city governments or heavily urbanized counties), and another six had worked for the auto industry or motor clubs, suggesting clearly pro-automobile roots. Four had worked for transit companies. Typically, these four had moved from doing traffic surveys for their firms to municipal employment or general traffic consulting. Five had backgrounds in city planning, and thus were likely responsive to downtown business groups, which had bankrolled the early planning movement. Almost all had worked in municipal engineering positions. Three worked or had worked for traffic signal firms. Four had specialized in industrial safety, likely becoming interested in traffic safety through their affiliation with the National Safety Council or its local branches. No fewer than six of them, a surprisingly high proportion, served on university faculties, where they taught civil engineering, usually with an emphasis on roads and city planning.[57]

Thus, the social and economic roots of traffic engineering lay largely in municipal engineering. The municipal engineering professional organization, the American Society for Municipal Improvements, held discussions of traffic regulation as early as 1908 and began holding annual sessions in 1915.[58] As early as 1903, *Municipal Engineering* covered traffic, and it started a regular traffic column in 1915.

The conceptual roots of traffic engineering, as its practitioners realized, grew from the emerging discipline of industrial engineering ("scientific management" in progressive era terms). Traffic engineers borrowed freely from the popular ideas of Taylor and his followers.[59] Straetz claimed: "Traffic conditions on our streets and highways today greatly resemble the confusion and disorder, which prevailed in the industrial production field twenty years ago."[60] In the 1920s, when many business leaders believed that scientific management had solved the labor/capital problem, such an appeal was attractive to local business groups.

To Straetz, driver resentment of traffic rules was like worker resentment of work rules. Although ultimately exploitative, Taylorism did draw some input from employees, since it sought the most productive workers and then tried to teach others to emulate those workers' techniques. Figuring out how to convince workers to accept their recommendations was important to them. Taylorites preferred persuasion to coercion. So, the traffic engineers sought input from motoring groups (including cabbies and teamsters), as well as transit companies. To some extent, this approach was unavoidable, since those groups often had strong links to municipal politics. The engineers could often channel this political process, since these interest groups were groping for solutions. The first traffic engineering textbook warned that public hearings on new rules were vital for avoiding later resistance.[61] One engineer wrote: "In the scientific regulation of traffic the first and most important step is the education of those to be regulated."[62] McClintock, author of the first traffic engineering textbook, even defined traffic police as educators: "Think of him [the police officer] as teacher of civic and community obligations."[63] Traffic professionals avoided the traditional, confrontational style of police control based on rules drafted by city councils. Traffic engineers, like McClintock, contended that rules drafted by city councils were based "on opinion, not facts."[64]

The early traffic engineers also borrowed the term "survey" from civil engineers and employed it to describe their traffic counts. The survey was at the heart of their claim to be a distinct profession with a distinct methodology. They described these counts as "scientific," an obvious ploy to attract the authority that science confers in Western cultures.[65] The traffic columns in municipal journals therefore spent much time discussing survey methodology.[66] In its first five years, the *Institute of Traffic Engineers Proceedings* (1931-36) devoted one-sixth of its articles to surveys, more than any other topic. Properly done surveys also sanctioned the opinions of experts: "It [traffic control] is a waste of time if viewed as a purely political problem. . . . There is no Republican, nor Democratic method for handling traffic."[67] Ironically, having made this pitch for the nonpolitical nature of traffic engineering and having appealed for professional autonomy, he then suggested that traffic offices solicit funds for surveys from citizens with an "actual monetary interest in the traffic problem," since they were likely to finance the survey more liberally.[68] Despite their claims to be scientific, much of what the early engineers were doing was really guesswork—too many studies claimed improvements of "50 percent," suggesting that no precise measurements existed.

Traffic engineering was an application of engineering techniques (i.e., thinking about people and behavior in mechanistic terms) more than technologies. There is, as Ellul has pointed out, little distinction between the two.[69] This new group of engineers applied forms of analysis used by older types of engineers. They always began their work with surveys (at first of particular streets, later of entire cities) and searched the literature or traveled to find techniques adopted elsewhere. They sought to make the discipline as quantitative as possible to provide a firm measure of results, which they usually defined in terms of average speed through the central business district or average commuting time. They also worried about reducing the traffic mortality rate. To them, as all engineers, quantitative measurement implied certainty. Also, traffic was massive, knotty, and mysterious. To take one example, Detroit's 150,000 cars shared 10,000 intersections and 1,500 miles of streets.[70] Mathematical techniques best simplified such complexity. Engineers were also cost conscious. They worked out the exact cost variation between using a traffic officer, light, or stop sign at any particular intersection.

The first traffic "expert" was an amateur enthusiast. Beginning in 1903, William P. Eno ran an international, albeit unpaid, consulting practice. His contributions to spreading the gospel of education, one-way systems, and similar driving regulations were enormous. Eno, a New York philanthropist, wrote New York's first traffic code in 1903, borrowing many of his ideas from Paris. He opposed traffic lights, however, believing it possible for all vehicles at an intersection to weave while passing if they circled around a pole in the center. This worked at monumental rotaries like Columbus Circle in New York City, but not at ordinary intersections—eight lanes of traffic could not weave into four. Moreover, the system made no provision for pedestrians, only the flow of motorcars. Ultimately, this eccentric gadfly endowed a safety foundation and a traffic school at Yale, both pledged to his favorite rotary system. This kind of amateurism did not last long.[71]

The pattern of engineering professionalism was more enduring. F. Van Z. Lane, an engineer who had replanned traffic patterns on the Brooklyn Bridge, took out the first advertisement for a consulting traffic engineer in *American City Magazine* in 1915.[72] E. P. Goodrich and Harland Bartholomew also had consulting practices by that date.[73] Transit consulting firms branched into traffic work. When Pittsburgh hired Burton Marsh in 1925, the first full-time traffic engineer working for a city government in the United States, it started a trend. Seattle and New York also hired full-time engineers that year. By 1928, no fewer than twelve cities employed traffic engineers.[74] The engineering model of control had triumphed. The competence of traditional police control was often under attack. By the mid-1920s, traffic periodicals were ridiculing police or writing about the need to educate them.[75] The Kansas City police chief complained that his people were viewed as “slow-witted bouncers.”[76] Some law enforcement officials held out, one complaining: “Signals can never take policeman’s place, they have no power to arrest.”[77]

By 1931, U.S. traffic engineers were numerous enough to start a professional group, the Institute of Traffic Engineers, which published an annual set of conference proceedings. Once cities institutionalized traffic engineering into their municipal civil service, universities created specialized educational programs. Paul G. Hoffman, the president of Studebaker Motors, endowed the first university traffic engineering program, the Erskine Traffic Bureau, at the University of California in Los Angeles in 1925.[78] McClintock, director of the Erskine Bureau, wrote the first text on traffic engineering that year.[79] The University of Pittsburgh and the University of Michigan offered courses in traffic engineering in the mid-1920s. The University of Southern California offered a full-fledged program in 1928. A unified, national profession with common education, professional journals, conferences, and shared consultants would push American cities toward traffic uniformity, the local autonomy inherent in the federal system notwithstanding. A network of professionals controlled the network of traffic control.

Traffic engineers led the push for national uniformity in the 1920s.[80] If their discipline was truly scientific, the same solutions should apply everywhere—there was no such thing as New York, or Californian, or German, or Spanish science. After repeated suggestions in the journals for municipal planners and engineers, in 1920 the American Association of State Highway Officials asked the National Bureau of Standards to create a model uniform code for signs and traffic rules. To help formulate and propagate the system, it invited representatives of the American Automobile Association, the American Electric Railway Association, the International Association of Chiefs of Police, the National Auto Chamber of Commerce, and railroad and insurance groups.[81] Presumably, these representatives then asked their local affiliates to lobby for the conference's recommendations. Over 200 cities adopted the standards. U.S. signs had common shapes, but emphasized words, not symbols.[82] Obviously, lights and octagons, both symbols, were retained. This meant that some states sought to restrict licenses to those literate in English.[83] Secretary of Commerce Herbert Hoover convened the National Conference on Street and Highway Safety in December 1924, and its 550 delegates recommended similar standards.[84] Much of the public supported uniformity.[85] The municipal professional journals recommended that all cities follow those standards, as did the new traffic engineering journal, *Nation's Traffic*. To some extent, an engineer's professional reputation would derive from his adherence to best practice as determined by national organizations.

Beginning in the 1920s, traffic control became international as non–U.S. cities drew on the American experience.[86] When they chose engineering models of control, they accepted a system of uniformity. The same professional predilections that drove uniformity in the United States drove it in Europe. American engineering periodicals and books were widely available. The four technical libraries that I have checked (the University of Birmingham, the University of Zurich, the University of Karlsruhe, and Imperial College, London) had subscribed to the *Engineering News-Record*, the most fundamental of American engineering periodicals by 1920.[87] Three had still older runs of the *Transactions of the American Society of Civil Engineers*. The University of Zurich even owned a copy of McClintock's

1925 *Street Traffic Control*. All four libraries had received the *Engineering Index*, which had a reprint and a translation service. By 1929, the *Index*, an American publication, abstracted over 1,000 periodicals, more than half of them non-American. Clearly, engineers outside the United States could find American sources. City engineers in both Stockholm and Tokyo notified *American City Magazine* in 1931 when they installed their first traffic lights. Tokyo's engineer, Taiji Hirayama, even thanked Americans for developing the technology. There was one published example of Europe-to-America dissemination of innovation. Stockholm's traffic engineer wrote a letter to *American City Magazine*. He was planning to add pedestrian signals, which eventually become widespread, to his city's new traffic lights and wondered if any U.S. engineers had tried them.[88]

Face-to-face communication was also important. When American engineers visited Europe, they consulted with their European peers and reported what they saw in U.S. periodicals. When traffic in Madrid and Barcelona became unbearable in 1928, the Spanish Ministry of Public Works sent J. P. Maroto on an American tour, focusing on New York and Chicago, to seek solutions. Spain was imitating a long tradition, since Paris, Berlin, and Tokyo had already sent traffic experts on similar missions. The International Town Planning Association (beginning in 1910) and the International Roads Conference (beginning in 1909) held regular sessions on traffic that included American experts. Beginning with Britain in 1921, European countries adopted national road sign standards, then evolved a European standard. Both the national and international standards grew in large part from American practice.[89]

The League of Nations held the first of a series of conferences on uniform traffic rules and signs in 1926. The United States, not a League of Nations member, did not participate. The new rules borrowed from American practice, including the pattern of red above green in traffic lights and red octagonal stop signs.[90] Of American signs, those were the most symbolic, relying on size and shape much more than words. In 1993, Professor Horacio Capel of the University of Barcelona showed me some tiles posted as traffic signs at alley corners in that city's medieval quarter, the oldest symbolic signs that I have seen. The tiles depict a rider leading a horse, indicating both a one-way street and a speed limit (horses must be led, not driven). The tiles date to around 1880.[91] It would seem that symbolic signing in the modern style likely emerged in Europe first, probably as a way to surmount linguistic differences. Thus, it is hardly surprising that Europeans would move rapidly in adopting the most symbolic of American controls. Although the Institute of Traffic Engineers did recommend adopting them as early as 1931, Americans did not have to worry as much about the linguistic variations that made symbols necessary in Europe and paid little attention to symbolic signs, other than the two most common, until 1971.[92]

The push to design standard signs, familiar to all street users, was powerful. Uniformity was more important than technical superiority. Perhaps the most startling indication of the engineering emphasis on behavior, more than machines, involved the rejection of a superior technology. In 1923, when there were probably fewer than 500 traffic lights in North America and only a few in Europe, engineers became aware of a major glitch with the new machines. Approximately 10 percent of adult males were color-blind, seeing both red and green as gray. An electrical engineer proposed substituting yellow and blue lights, technically superior because almost all color-blind people could distinguish them. Traffic engineers, believing that many drivers would not adjust easily to the new colors, rejected this improvement, although it would not have cost much to replace the existing lights. They feared losing the effect of their years of educating drivers about the meaning of colors, although it meant rejecting a superior system.[93] Waffling on as fundamental a matter as color could also undermine their credibility.

Other attempts to resist local, national, and international uniformity have been short lived. Examples abound. For several months in 1924, Fifth Avenue in New York City had a traffic light system in which orange meant vehicles on that avenue moved, green meant the cross streets should move, and red meant proceed with caution,[94] whereas Broadway had the standard red/green system.[95] At Madison Square, where the streets crossed, chaos would eventually ensue. Philadelphia's police tried to control all traffic on Broad Street with a white searchlight on City Hall at the end of the street.[96] On first adopting signal lights, Berlin lined them up horizontally[97] and Paris deployed red lights only.[98] Other engineers proposed an array of nine white lights in which a vertical line would mean go, a horizontal line would mean stop, and a diagonal line would mean caution.[99] An Irish American neighborhood in Syracuse, New York, insisted until the 1960s on having green displayed over red, although red on top had become the U.S. standard by 1930. None of these exceptions lasted. During China's Cultural Revolution, Red Guards proposed changing traffic light interpretation so that red would mean go. The proposal died after Zhou Enlai opposed it in August 1966.[100] Even what was arguably the most radical government of recent times could not change the fundamental standard laid out by traffic engineers early in the century.

Over time, sign standards have come closer together. When urban administrators hired engineers to direct traffic, they were hiring individuals with a cosmopolitan outlook, aware of developments in other cities and countries. The assumption was that a city's new traffic engineer would put in a state-of-the-art system that other places had tested. Obviously, this pattern could lead to something close to global uniformity with only marginal local differences. Uniformity also made sense in controlling a machine as ubiquitous as the automobile.

How effective was all this? Traffic lights triumphed for largely political reasons. They were acceptable to motorists, probably the most influential group concerned with traffic, but were cheaper than police control, and more pedestrian friendly than stop signs. The traffic engineers' task was Sisyphean: even if their techniques worked, they could not possibly keep up with increases in car registration and trips. At best, traffic engineers alleviated a steadily worsening condition. At times, they may have made things worse. The great paradox of early traffic engineering, according to McClintock, was that improving mobility only attracted more traffic, by either moving from another road or, if the improvements were more general, encouraging car owners to abandon transit riding.[101] Eventually, new traffic overwhelmed new controls. To their credit, American engineers knew that only city planning (including land use controls) and road building (including design components like limited access) solutions would work in the long term, however impossible they were financially and politically in the short term.

NOTES

1. Wastewater systems are the great exception to this. Urban residents had to learn a new set of psychologically fundamental excretion behaviors to use them.

2. On the increasing importance of supposedly apolitical experts, especially engineers in municipal administration, see Stanley K. Schultz and Clay McShane, "To Engineer the Metropolis: Sewers, Sanitation, and City Planning in Late Nineteenth Century America," *Journal of American History* 65 (September 1978).

3. Edward H. May, "What Europe Is Doing to Prevent Auto Accidents," *National Safety News* 5 (June 1922), 321; "An Italian's Advice to Italian Immigrants," *American Review of Reviews* 61 (July 1917), 100.

4. Paul Barrett, *The Automobile and Urban Transit: The Formation of Public Policy in Chicago, 1900-1930* (Philadelphia, 1983), 50.

5. "Traffic Census in Chicago," *Engineering News-Record* (February 7, 1918), 148.

6. Miller McClintock, *A Report on the Street Traffic Control Problem of San Francisco* (San Francisco, 1927), 29.

7. Robert Whitten, "Choking Our Congested Streets," *American City Magazine* 23 (October 1920), 353 (hereafter *ACM*). The exact dates varied slightly from city to city.

8. New York City Department of Plants and Structures annual report (1921).

9. J. Rowland Bibbins, "The Battle of the Streets," *ACM* 25 (October 1923), 365.

10. Cited in Mel Scott, *American City Planning* (Berkeley, 1971), 187.

11. G. A. Richardson, "Looking Ahead in Urban Transportation," *Electric Railway Journal* 75 (September 15, 1931), 504. Richardson, a transit company official, believed that autos were on the verge of choking themselves to death: "Movement is becoming slower, driving is more annoying and the air isn't so pleasant to breathe."

12. "Traffic Congestion and the Citizen's Pocketbook," *ACM* 17 (February 1917), 165; McClellan and Junkersfield, Inc., *District of Columbia Transportation Survey* (Washington, D.C., 1925), 181.

13. Quoted in Miller McClintock, *Street Traffic Control* (New York, 1925), 100. McClintock claimed that other drivers enjoyed "shooting traffic."

14. Arthur S. Tuttle, "Increasing the Capacity of Existing Streets," *American Society of Civil Engineers Transactions* 88 (1925), 248. Other engineers expressed fears in the commentary on this important paper that traffic had reached the saturation point (not surprisingly, the president of Gulf Oil dissented) and that arcading and double decking streets were too costly.

15. E. P. Goodrich, "Methods of Estimating Future Street Traffic and the Design of Street Systems Based Thereon," *American Society of Municipal Improvements Proceedings* 30 (1924), 128. This claim, if true, probably applied only to Manhattan.

16. Ibid.; Rowland J. Bibbins, "The Influence of Zoning on the Design of Transportation Services," *American Society of Civil Engineers Transactions* 88 (1925), 709.

17. F. M. Wehner, "Traffic Control Methods and Devices of German Cities," *ACM* 33 (October 1925), 377.

18. Clay McShane, *Down the Asphalt Path: American Cities and the Coming of the Automobile* (New York, 1994), ch. 9.

19. Gordon M. Sessions, *Traffic Devices: Historical Aspects Thereof* (Washington, D.C., 1971), 33-5; "Street Traffic Signals," *ACM* 26 (April 1922), 458; McClintock, *Street Traffic Control*, 128; "New York's Traffic Towers," *ACM* 26 (January 1922), 71; Eugene Casey, "An American Traffic Supervisor's Observations in Paris and London," *ACM* 37 (November 1927), 652; W. Frankel, "Neue Berliner Verkehrssignal Verehrstechnik," *Verkehrstechnik* (February 5,

1926), 90-2; Allen W. Keller, "Street Traffic Control and Regulation in Europe," *I.T.E. Proceedings* 2 (1931), 104. Traffic "expert" William Phelps Eno made the remarkable, unbelievable claim that the tower at Fifth Avenue and 42nd Street reduced waiting times in the rush hour from thirty minutes to thirty seconds. See *The Science of Highway Traffic Regulation, 1899-1920* (New York, 1920), 32.

20. There had been earlier temporary installations in Leipzig (Germany), Toledo (Ohio), and New York. Salt Lake City also had an earlier installation, whose permanence I cannot judge. It makes little sense to assign priority to any of these three, because they never made it into the contemporary engineering press. Although perhaps inventions, they were not innovations; that is, models for others.

21. Maxwell Lay, *A History of the World's Roads and the Vehicles That Used Them* (New Brunswick, 1992), 184-5. The earliest use of a red signal lamp was at Flamborough Head Lighthouse in England in 1806. Engineer Robert Stevenson needed a color to distinguish this lighthouse from a nearby one using white. Experiments with stained glass of various colors showed that red was the most transparent color available. The British Admiralty adopted red lamps as the standard signal for the port side of steamships in 1852 and sailboats in 1857. Its order required green lights for the starboard side. Ships were expected to pass starboard to starboard (i.e., on the side with green lights) in crowded anchorages. See D. Alan Stevenson, *The World's Lighthouses Before 1820* (London, 1959), 77-80; "Admiralty Notice Respecting Lights to Be Carried by Seagoing Vessels to Prevent a Collision," in *The Friend* (London, November 1852); and "Lights for Steam and Sailing Vessels," *The Mercantile Magazine and Nautical Record* 4 (September 1852), 266-9. Note here that the use of red derives not from some cultural value inherent in the color but from empirical tests of the transparency of the different types of stained glass available in 1806.

22. Alfred Bensch, "Regulating Street Traffic in Cleveland," *ACM* 13 (September 1915). One drawback of these systems was that officers often left their posts for emergencies.

23. Lay, *A History of the World's Roads*, 187; Sessions, *Traffic Devices*, 43, 58, 70-1; *ACM*, 33 (August 1925), 149; William Phelps Eno, "Traffic Regulation in European Cities," *ACM* 41 (October 1930), 161; Wolfgang Sachs, *For the Love of the Automobile: Looking Back Into the History of Our Desires*, trans. Don Reneau (Berkeley, 1984), 45; Wehner, "Traffic Control Methods and Devices of German Cities," 377; "More Traffic Signals in London," *ACM* 45 (August 1931), 120.

24. The National Conference on Street and Highway Safety in 1924 endorsed the shape and color as a national standard. The only other unique shape was the X-shaped railroad crossing sign.

25. Roy Weirick, "The Park and Boulevard System of Kansas City," *ACM* 3 (November 1910), 217; Barrett, *The Automobile and Urban Transit*, 147. In Chicago, the rule dated to 1863.

26. McClintock, *A Report on the Street Traffic Control Problem of San Francisco*, 107-8; Roger L. Morrison, "The Comparative Efficiency of Stop Signs and Stop-and-Go Signals at Light Traffic Intersections," *I.T.E. Proceedings* 2 (1931), 31; W. Bruce Cobb, "Auto Accidents, Their Cause and Prevention," *ACM* 21 (August 1919), 125; Charles Evan Fowler, "Detroit's Struggle With the Traffic Problem," *ACM* 30 (June 1924), 612-5. Women's groups often led neighborhood resistance to stop signs.

27. McClintock, *Street Traffic Control*, 34, 47. In other cases, central business district leaders favored bypasses, hoping that they would keep those passing through from streets that shoppers used.

28. Bibbins, "The Battle of the Streets," 364-5.

29. A.L.H. Street, "Limitations of Municipal Power to Control Vehicular Traffic," *ACM* (October 1922), 343. Specifically, the court ruled that the state-mandated speed limit created a right to uninterrupted travel that stop signs violated.

30. Marina Duhame, *Un Demi-siecle de Signalization Routiere: Naissance et Evolution du Panneau di Signalization Routiere en France* (Paris, 1994), 53. Initially, France used a differently shaped sign. France did have laws giving traffic on main routes the right of way before that date, but no sign specific to that purpose.

31. Duhame, *Un Demi-siecle de Signalization Routiere*, 71, 139. American traffic engineers would adopt only European-style symbolic signs—for example, a left-pointing arrow with a slash through it to ban left-hand turns—after another international conference in 1971. The shift may reflect a desire to facilitate European tourism in the United States.

32. For the first full-fledged technical description of a traffic light in an engineering periodical, see C.A.B. Halvorson, "Traffic Control Systems," *Transactions of the Illuminating Engineering Society* 20 (January 1925), 60-78.

33. Phillip D. Hoyt, "Traffic Control in New York," *American Society of Civil Engineers Proceedings* 53 (October 1927), 1999. Pedestrians, who were plentiful in New York, preferred lights to stop signs (which favored through motorists) and traffic cops (whom they did not trust).

34. "More Traffic Signals in London," *ACM* 45 (August 1931), 120.

35. "Automatic Traffic Signals Save New York City $12,500,000," *Nation's Traffic* 2 (May 1928), 26; Sessions, *Traffic Devices*, 72. Hoyt, "Traffic Control in New York," gives a slightly higher figure for the savings. There seems to have been little public policy debate over this—adding more police to control the increasing number of jammed intersections was a cost to be avoided.

36. Burton Marsh, "Traffic Signals, When and Where?" *National Safety Council Transactions* 3 (1930), 157. Marsh warned against "oversignalling," which he believed bred contempt for the lights and increased accidents.

37. E. P. Goodrich, "Comments," *American Society of Civil Engineers Proceedings* 53 (December 1927), 2802.

38. Miller McClintock, "Police Functions and Street Hazards," *National Safety News* 7 (September 1923), 17-9.

39. Sidney J. Williams, "For a Working Partnership of Police and Public on Traffic Regulation," *ACM* 33 (September 1925), 228. Sometimes hard data supported these attacks. One 1928 survey showed that 20 percent of those killed in grade-crossing accidents hit the train after the locomotive had already passed. In other words, they drove into the train. These drivers could only have been blind drunk. See "Motorists Need Protection From Themselves," *ACM* 39 (December 1928), 89.

40. Stephen Tuthill, "Attitude of the Motorist Toward Traffic Regulations," *National Safety Council Proceedings* 12 (1923), 810. Tuthill blamed the soaring accident rate on the fact that automobility had percolated downward to young men of the working classes. He called for speed governors on engines and rigid enforcement of the traffic laws.

41. William Plowden, *The Motor Car and Politics, 1896-1970* (London, 1971), 278; A. G. Straetz, "The International Aspect of Motor Traffic," *I.T.E. Proceedings* 2 (1931), 101.

42. "Kill Bill to Control Pedestrians," *National Safety News* 34 (August 1936), 34.

43. Robert H. Whiten, "Painted Traffic Markings on Streets," *ACM* 24 (June 1921), 617.

44. Ralph W. Robinson, "What Can We Do for the Pedestrian," *National Safety Council Transactions* 3 (1930), 119.

45. McClintock, *Street Traffic Control*, 9. Of all the early traffic engineers, McClintock consistently expressed the most concern with safety.

46. Jessica McCall, "School Safety Patrols," *ACM* 12 (March 1915), 305; Harriet E. Beard; "Teaching Accident Prevention," *ACM* 24 (February 1924), 256-7 (Beard made the very likely exaggerated claim that her program in the Detroit public schools had reduced the number of fatalities by 400 in one year); Franklin Kreml, "Accident Investigation for Conviction of

Violators," *National Safety Council Transactions* 3 (1930), 67; "A Traffic Game for Children," *ACM* 33 (November 1925), 500.

47. "Garrett A. Morgan," in *Dictionary of American Negro Biography*, ed. Rayford W. Logan and Michael R. Winston (New York, 1982), 453.

48. To give a parallel example, I have found that students who resist my attempts to improve their prose style accept the same comments much more willingly from the grammar/style checkers that come with word-processing software. They do not attribute personal motives to a machine.

49. C.A.B. Halvorson and J. G. Regan, "Traffic Control and the Traffic Problem," *Illuminating Engineering Society Transactions* 10 (November 1925), 998; Hoyt, "Traffic Control in New York."

50. Hoyt, "Traffic Control in New York." Hoyt noted some resistance to lights in New York because they tended to turn streets into racetracks, to the pedestrian's disadvantage.

51. "Traffic and Parking Regulation in the Downtown District of Cleveland," *ACM* 33 (July 1925), 73; William G. Beard, "One Year of Traffic Lights on 'Boul Mich,' " *National Safety News* 10 (October 1924), 49 (Beard's reference to "Boul Mich" was a play on words, using the nickname of Boulevard St. Michel, the main artery on Paris' Left Bank to give Michigan Avenue a touch of class); Edward Mueller, "Aspects of the History of Traffic Signals" (unpublished paper, Library of the National Museum of American History, 1967), 24; "Evolution of Traffic Control on Fifth Ave., New York," *ACM* 40 (August 1929), 164 (New York had just removed the last of the traffic towers); Halvorson and Regan, "Traffic Control and the Traffic Problem," 994; McClintock, *Street Traffic Control*, 103; "Safety Protection for Holland Tunnel," *Society of Automobile Engineers Journal* 60 (January 1927), 156; "Full Use of Street Width During Rush Hours," *ACM* 36 (June 1927), 802-3. Sessions, *Traffic Devices*, 73, describes horn-activated lights. Pushbutton lights for pedestrians show up in the record but were rarely deployed.

52. Lay, *A History of the World's Roads*, 196, elaborates on the evolution of the mathematics.

53. John F. Robb, "Letter to the Editor," *ACM* 34 (February 1926), 203; J. S. Baker, "How Traffic Engineers Can Assist in Dealing With the Human Element in the Traffic Problem," *I.T.E. Proceedings* 5 (1934), 16, writes about the mathematics of setting cycle times to incorporate the reflex, as well as braking/acceleration times, for drivers.

54. M. O. Eldridge, "Making the Nation's Capital Safe for Motorists and Pedestrians," *ACM* 33 (August 1925), 129. The system had been suggested as early as 1916, when Goodrich suggested it to the National Conference on City Planning, but technology lagged behind. See "Progressive Traffic System Originally Suggested Eleven Years Ago," *ACM* 36 (May 1927), 615; I. C. Miller, "Platoon Traffic System Cuts Running Time in Two," *ACM* 34 (June 1926), 553-4; Taiji Hirayama, "Traffic Control in Tokyo," *ACM* 47 (November 1932), 87; John Walrath, "Effective System of Traffic Control in Syracuse," *ACM* (June 1925), 641; Daniel E. Lillis and H. M. Starline, "How Signal Lights Have Aided Syracuse Traffic," *National Safety News* 11 (May 1925), 29; Sessions, *Traffic Devices*, 66.

55. Schultz and McShane, "To Engineer the Metropolis," 408-10.

56. They sponsored many early traffic reports. See McClellan and Junkersfield, Inc., *District of Columbia Transportation Survey*. This company's surveys usually produced the most pro-transit results; not surprising, given its background in contracting with trolley companies.

57. Erskine Bureau for Street Traffic Research, *Street Traffic Bibliography* (Cambridge, 1928), 218-22.

58. "Report of the Committee on Traffic in the Streets," *American Society for Municipal Improvements Proceedings* 21 (1915), 285-7.

59. A. G. Straetz, "Scientific Management as a Guide to Traffic Planning," *ACM* 32 (April 1925), 579.

60. Ibid.

61. McClintock, *Street Traffic Control*, 177.

62. William Phelps Eno, *The Science of Highway Traffic Regulation, 1899-1920* (New York, 1920), 2.

63. Miller McClintock, "Police Functions and Street Hazards," *National Safety News* 8 (September 1927), 17.

64. McClintock, *Street Traffic Control*, 17.

65. Clarence R. Snethen, "Los Angeles Making Scientific Study to Relieve Traffic Congestion," *ACM* 15 (January 1924), 158-9. This city employed those well-known scientists, the Boy Scouts, to perform its survey.

66. For the first example, see "A Proposed Standard Form for Making Traffic Counts," *ACM* 19 (January 1917), 73. For the first example of an accident survey, see C. L. Edholm, "An Accident Map and Its Use," *ACM* 18 (May 1918), 471.

67. Miller McClintock, "How to Make a Community Traffic Survey," *National Safety Council Proceedings* 15 (1926), 140.

68. Ibid., 141.

69. Jacques Ellul, *The Technological Society*, trans. John Wilkinson (New York, 1969), 4-7.

70. G. A. Walters, "Preventing Accidents by Regulation and Education," *National Safety Council Proceedings* 11 (1972), 741.

71. McShane, *Down the Asphalt Path*, 185-7.

72. *ACM* 12 (January 1915), 79.

73. Erskine Bureau for Street Traffic Research, *Street Traffic Bibliography*, 218.

74. Burton Marsh, "Municipal Traffic Engineers—Recent Developments in Their Appointment and Activities," *ACM* 40 (May 1929), 154.

75. Maxwell Halsey, "New Trends in Enforcement," *I.T.E. Proceedings* 6 (1935), 94-5.

76. Ray Ashworth, "Traffic Fatalities," *I.T.E. Proceedings* 7 (1936), 42. At the state level, there was a revival of interest in police enforcement because traffic fatalities in the mid-1920s soared in numbers, grew in rate, and spread into rural areas, where state police were the likely enforcement agency. In 1925, New York's new Motor Vehicle Bureau suspended or revoked 10,800 licenses. See C. T. Fish, "The Empire State's War on Reckless Drivers," *National Safety News* 10 (November 1926), 13.

77. Robbins B. Stoeckel, "Motor Vehicle Discipline," *National Safety News* 13 (July 1926), 10.

78. "Bureau for Street Traffic Research Created," *ACM* 33 (December 1925), 690. The bureau moved to Harvard two years later.

79. McClintock, *Street Traffic Control*.

80. Moreover, commercial groups did not want regulation to be so localized as to drive away freight traffic or touring motorists, especially after long-distance travel by road became more commonplace in the 1920s. In 1909, Europe worked out a system of comity on licenses at the International Law Conference, and New York, Connecticut, and New Jersey were the first American states to work out a similar agreement. The American states feared a federal licensing law, which might deprive them of the lucrative license revenues. See Lay, *History of the World's Roads*, 186; and Straetz, "The International Aspect of Motor Traffic," 99.

81. Jacques Hazelton, "Color Standardization for Motor Traffic Control," *ACM* 25 (August 1921), 112. For adoption, see *ACM* 25 (December 1921), 21.

82. New York City was always the exception to traffic standardization, only partially adopting national standards (e.g., stop signs and red/green for lights). To cite one example, it resisted yellow lights until the 1950s because its police commissioners believed that they were confusing. Some of New York's different practices were due to the higher volume of pedestrian traffic. See Philip D. Hoyt, "New Traffic Regulations Effective January 1, 1927 in New York City," *ACM* 36 (January 1927), 101. The avoidance of the national pattern resembles the way that the United Kingdom resisted adopting the European standards and likely has something to do with the way residents of both places perceived themselves as imperial rulers, not to be bound by laws created by tributary states.

83. Carman T. Fish, "Detroit Applies the Facts," *National Safety News* 19 (March 1929), 17.

84. National Conference on Street and Highway Safety, *Report* (Washington, D.C., 1925); "Constructive and Remedial Measures for Traffic Relief and Highway Safety," *ACM* (January 1925), 25.

85. "Uniform State Motor Vehicle Laws," *Society of Automobile Engineers Journal* 20 (February 1927), 220.

86. "Metropolitan Traffic," *Engineering* 97 (January 16, 1914), 87. This article reported that London traffic had become so bad that in 1912 the trams had lost ridership. However, these riders seemed to be going to buses, not private cars. This judgment is based on U.S. sources and needs to be confirmed from more accurate, local sources.

87. All have catalogs accessible by Internet. The Zurich library is remarkable. In many ways its collection of American engineering periodicals from the 1920s is larger than any in the Boston area.

88. Hirayama, "Traffic Control in Tokyo," 87; "First European Traffic Engineering Magazine," *ACM* 48 (May 1933), 521; "Safety on the World's Streets," *ACM* 44 (February 1931), 142. When W. R. Manning wrote the first article in a British engineering periodical on traffic lights, he never once mentioned that they had already been deployed in the United States. See "Street Traffic Regulation by Means of Coloured Signals," *Surveyor* 16 (July 4, 1924). Obviously, this is a contrary example. The first European traffic-engineering periodical, *Il Traffico Urbano*, appeared in Milan in 1933.

89. Eugene Casey, "An American Traffic Supervisor's Observations in Paris and London," *ACM* 37 (November 1927), 652; W. H. Tiedeman, "Study of European and American Thoroughfares," *ACM* 38 (March 1928), 145-6; Eno, "Traffic Regulation in European Cities," 161; Keller, "Street Traffic Control and Regulation in Europe," 102-7; J. P. Maroto, "Las Problemas de la Circulacion en las Grandes Ciudads y su Resolucion," *Revista de Obras Publica* 76 (August 1 and August 15, 1928), 277-9 and 292-4; Maurice Giradot, "The Organization of City Street Traffic," *Engineering and Contracting* 59 (June 6, 1923), 1275-80 (translated from the French journal *Genie Civil*); "Berlin Studies American Traffic and Transportation Methods," *ACM* 35 (November 1926), 745; S. L. Reuter, "Die Verkehrspoleme der Nord Amerikanischen Grosstaedte—Americanischen Reiseedruecke," *Verkehrstechnik* 39 (September 27, 1929), 663-9; Hirayama, "Traffic Control in Tokyo," 87; N. P. Lewis, "Report on the Recent First International Road Congress," *Engineering News* 61 (January 21, 1909), 58-65 (Lewis was New York City's chief engineer, later city planner, and one of the first advocates of traffic engineering); "Standardized Road Signs in England," *ACM* 25 (October 1921), 303.

90. Lay, *A History of the World's Roads*, 190.

91. Ibid., 190, suggests that a 1906 Austrian sign was first. The Barcelona sign is clearly older, to judge from its iconographic style and typeface. They were not entirely symbolic. Each included the Catalan word *entrada* (entry) or *salida* (exit), just as octagonal stop signs include the word *stop*.

92. Straetz, "The International Aspect of Motor Traffic," 99. Britain held out against much of the international system until the 1950s. And driving on the left, a much older tradition, still persists in British-influenced countries. For the best available, but not thoroughly convincing, explanation of the origins of driving on the left or right, see Lay, *A History of the World's Roads*, 197-201.

93. They recommended banning color-blind drivers instead. See Eldridge, "Making the Nation's Capital Safe for Motorists and Pedestrians," 129.

94. W. T. Perry, "A New Way to Control Traffic," *ACM* 22 (May 1920), 476. Obviously, this system predated the development of four-way lights. See also McClintock, *Street Traffic Control*, 215.

95. "Street Traffic Control System on Broadway," *ACM* 31 (October 1924), 331.

96. Sessions, *Traffic Devices*, 50. The problem with this system was that the searchlight was hard to see in daylight and invisible at all times to side-street traffic.

97. Wehner, "Traffic Control Methods and Devices of German Cities," 377.

98. Keller, "Street Traffic Control and Regulation in Europe," 104.

99. See "Mechanical Devices for Highway Traffic Regulations," *ACM* 29 (December 1923), 635-6; Halvorson and Regan, "Traffic Control and the Traffic Problem," 998; and McClintock, *Street Traffic Control*, 215.

100. Interview with Ye Weili, University of Massachusetts at Boston, July 25, 1993, courtesy of Christina Gilmartin.

101. McClintock, *Street Traffic Control*, 4.