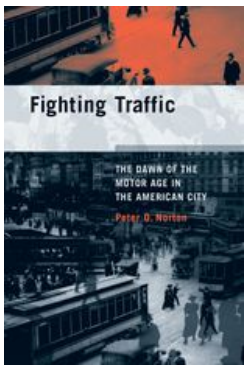

Fighting Traffic: The Dawn of the Motor Age in the American City

Peter D. Norton

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CHAPTER

Introduction What Are Streets For?

Peter D. Norton

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Abstract

This chapter notes that city streets underwent social reconstruction to become automotive-ready. The chapter examines how many cities had to be physically destroyed and reconstructed so that they could become more compatible for automobiles. The acceptance of automobiles on the streets, however, was not easy. The chapter takes a look at the different views that people had towards traffic. Eventually the point came when motorists started to fight for a new kind of street for automobiles, and many cities were rebuilt to allow for highway traffic.

Keywords: social reconstruction, automotive-ready, automobiles, technological frames, highway projects, automotive city

Subject: History of Science and Technology, United States History, Urban History

> Streets are public property—not to be abused but to be used with convenience for the good of the greatest number.
>
> —George H. Herrold, city planning engineer, St. Paul, Minnesota, 1927[1]
>
> The obvious solution ... lies only in a radical revision of our conception of what a city street is for.
>
> —*Engineering News-Record*, 1922[2]

The Social Reconstruction of the City Street

How did the American city become an automotive city? Why was much of the city physically destroyed and rebuilt to accommodate automobiles? The case presented in this book is that before the city could be physically reconstructed for the sake of motorists, its streets had to be socially reconstructed as places where motorists unquestionably belonged.

This social reconstruction was only one of several ways in which people tried to solve a new problem. New automobiles were incompatible with old street uses. Until the 1920s, under prevailing conceptions of the street, cars were at best uninvited guests. To many they were unruly intruders. They obstructed and endangered street uses of long-standing legitimacy. As a Providence newspaper editor expressed the problem in 1921, "it is impossible for all classes of modern traffic to occupy the same right of way at the same time in safety."[3]

The Social Construction of Technology

The social reconstruction of the street, as documented in this book, confirms others' findings about the social construction of other artifacts. First, it shows the importance of examining alternative constructions
p. 2 of an ↳ artifact "symmetrically"—that is, without presupposing the correctness (or falsehood) of any one construction. Today we tend to regard streets as motor thoroughfares, and we tend to project this construction back to pre-automotive streets. In retrospect, therefore, the use of streets for children's play (for example) can seem obviously wrong, and thus the departure of children from streets with the arrival of automobiles can seem an obvious and simple necessity. Only when we can see the prevailing social construction of the street from the perspective of its own time can we also see the car as the intruder. Until we do, not only will we fail to understand the violent revolution in street use circa 1915–1930, we will not even see it. This is why the full scale of the wave of blood, grief, and anger in American city streets in the 1920s has eluded notice.[4]

Success in such historical investigations requires not merely *looking* back from where we stand today at the actors of times past, but *getting* back to them, so we can stand next to them and adopt their perspective. The result can transform our view. Trevor Pinch and Wiebe Bijker, for example, discovered that the synthetic plastic Bakelite "was at first hardly recognized as the marvelous synthetic resin that it later proved to be."[5] Similarly, for years automobiles were not widely recognized as a good means of urban passenger transportation.

By adopting the perspectives of various social groups, we can recover more than one perspective. Borrowing their perspectives, constructivist historians of technology have discovered the "interpretive flexibility" of artifacts. One object can be different things to different people. To some young men of the 1880s, for example, a high-wheeled bicycle was a means of displaying physical prowess—a "macho bicycle"; to others the same device could be a dangerous machine—an "unsafe bicycle."[6] Constructivists have shown that this flexibility tends to be greatest when an artifact is new. But the present study confirms some researchers' findings that, under some conditions, flexibility can be reintroduced into a once-stable system. Prevailing social constructions of the street, for example, were stable in 1900. The automobile destabilized them. Social groups, such as pedestrians, parents, police, and downtown business associations, organized to preserve streets as they knew them. But their actions threatened to limit the automobile's urban horizons. In the 1920s, automotive interests (or *motordom*, as they were sometimes called) proposed that customary social constructions of the street were outdated and that only a revolutionary change in perceptions of the street could ease congestion and prevent accidents.

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Relevant Social Groups

Before motordom could champion such a daring cause, it had to give up hope in peaceful change. It had to find common interests strong enough to overcome many particular differences of interest between the groups that composed it (especially auto clubs, dealers, and manufacturers). In the 1920s the reactions of other social groups to the growing problems of accidents and congestion did just this.

Building their theory on historical case studies, Wiebe Bijker and Trevor Pinch have proposed that the social construction of artifacts evolves through interplay between "relevant social groups"—users and non-users with something at stake in the result.[7] In the case of city streets, these groups became distinct through their competing ways of fighting traffic accidents and congestion. Even before automobiles, diverse street users disagreed about what streets are for. Nevertheless, only with the arrival of automobiles in quantity were many street users forced under pressure to commit their loyalties. As the numbers of cars in city streets grew, the relevant social groups grew increasingly distinct. By the 1920s the groups were recognizable as pedestrians, safety reformers, police, street railways, downtown business associations, traffic engineers, and motordom. The categories were not tidy, however. In practice, streetcar patrons could be indistinct from pedestrians, since they normally had to enter streets on foot to reach streetcar stops. Street railways, however, sometimes sought stricter pedestrian control. Parents and educators concerned for the safety of children were often—but not always—in agreement with pedestrians about the dangers that automobiles posed. Small merchants often opposed the traffic platform of chambers of commerce dominated by bigger businesses.

But with time the relentless pressure of traffic tended to make social groups more cohesive. Groups more often acquired distinct names. More city people who wrote letters to the editor signed themselves "A Pedestrian." As improvised police traffic duties grew routine, some police became "traffic cops" or "cornermen." Chambers of commerce alarmed by congestion formed "traffic commissions." The municipal engineers they hired became "traffic engineers." And by the mid 1920s, organized automotive interest groups began calling themselves "motordom."

Traffic pressures also inspired rival groups to name each other. While older constructions of the streets prevailed, new motorists very easily became "joy riders," "road hogs," or "speed demons." Their machines were "juggernauts," "death cars," or "the modern Moloch." As motorists appropriated streets for new
p. 4 uses, respectable pedestrians became ↳ "jaywalkers" and streetcars became traffic obstructions. But not without a fight.

Technological Frames

Each group comprised diverse people with diverse views. Nevertheless, the groups grew recognizable to themselves and to each other for some shared interests, habits of mind, and perspectives. Members of a relevant social group thus shared an approach to traffic problems. Bijker called such a shared approach a "technological frame."[8] Angry pedestrians tended to retain inherited notions about what streets are and what they are for. Parents, worried for their children's safety, tended to look at traffic safety in moral terms. They looked for the guilty and the innocent, assuming the innocence of child pedestrians. In a word, their technological frame was *justice*. Police, with conservative habits conditioned by long experience with other problems, tended to protect old street customs and to perceive their fundamental enemy not as congestion or accidents, but as disorder. We can call their technological frame *order*. To street railways, chambers of commerce, and the engineers they hired, congestion was indeed a frightening enemy threatening financial ruin. Before the mid 1920s, automotive interests often joined these groups to fight accidents and congestion. Their rallying cry was *efficiency*. But thereafter, automotive interest groups (especially auto clubs, dealers, and manufacturers) developed their own technological frame, at first defining it in opposition to all the others. Soon, however, they developed a positive case for new ways to fight traffic accidents and congestion, coinciding with their new self-identification as "motordom." Often they presented their position clothed in a rhetoric of *freedom*.[9]

Motordom was ultimately the most successful combatant. Yet the details of its struggle for the street are messy and show the extent of the power all street users could wield. Motorists had the advantage of horsepower, and with it they drove many pedestrians unwillingly off the pavements—even at crossings. Pedestrians had advantages of their own, in numbers and agility. A bold (or foolish) pedestrian could even win a fight for street access by calling the bluff of an oncoming motorist. Motorists mindful of children's poor judgment were sometimes forced to drive slowly. And the grim stories of those who were hit became powerful newspaper stories with an anti-automobile moral. Where signal timings did not suit their needs, pedestrians defied them. Los Angeles learned from Chicago that if pedestrians were to be controlled then
p. 5 signals could not ignore pedestrians' ↳ needs. Recalcitrant pedestrians preserved informal access to streets wherever traffic allowed.

Nevertheless, the prevailing social construction of the street changed. By 1930 most street users agreed that most streets were chiefly motor thoroughfares. Social constructivists call such declines in interpretive flexibility *closure*, which is followed by *stabilization*, when one interpretation prevails. Objections persist, but they typically do so within the frame imposed by the prevailing interpretation. For example, even most jaywalkers after 1930 would agree that they were jaywalking (that is, using the street in an unconventional way), though in 1920 most would have objected to the term. After closure, problems (such as casualties and congestion) can remain (or even worsen), but solutions are sought within the prevailing framework. Closure can "obscure alternatives," Thomas Misa explains, "and hence appear to render the particular artifact, system, or network as necessary or logical."[10] Thus, in the motor age, the solutions to casualties were pedestrian control, school safety instruction, penalties against reckless drivers, and "foolproof highways," and the solution to congestion was ample motor highways. Since we still live in the motor age, the apparent inevitability of motor age ways conceals the alternatives that prevailed before it.

Closure Mechanisms

Constructivists have proposed various mechanisms by which closure is accomplished, particularly *rhetorical closure* and *closure by redefinition of the problem*.[11] Both "closure mechanisms" were at work in city streets. In rhetorical closure, problems (such as congestion or accidents) persist, but promotional language is used to assert the success of the new way, much as advertising promotes a product. Such promotional rhetoric for motor age methods grew common in the 1920s. "Motor age" was itself a promotional term, for it carried a built-in justification for overturning established custom. It combined rhetorical closure and problem redefinition, just as similar phrases have been used in more recent years to justify workplace smoking bans, cleaner fuels, and tightened security at airports.

Street railways and safety reformers attempted alternative rhetorical efforts, but these were dimmed by the shadows of a mammoth campaign to sell the motor age city. By 1930 the American Automobile Association had overtaken safety councils for leadership in school safety. In 1939 motordom's work culminated in one of
p. 6 the most monumental works of promotional showmanship in the history of technology: the Futurama ↳ model depicting the motorized city of 1960, displayed in General Motors' "Highways and Horizons" pavilion at the New York World's Fair. It was a motor age dream city, entirely dependent on automobiles but entirely free of accidents and congestion.

The closure of circa 1930 also followed a redefinition of the problem. When they were new, automobiles almost automatically strained the limits of street customs. The minor nuisances they caused were treated as violations of fairness. (Why should a motorist use his horn to drive a pedestrian out of his way?) More serious problems were injustices (perhaps legal, but certainly moral). Thus the prevailing problem definition was "What is just?" Justice, in turn, stemmed in part from custom, to which many appealed. Many safety reformers promoted their answers to the question through a rhetoric of innocence versus guilt, appeals to pity, and expressions of outrage. Police more often used a rhetoric of order.

Traffic engineers, influenced by experience in municipal engineering and by the needs of their clients (downtown business associations) for accessibility, defined the problem differently. They asked "What is efficient?" Some safety reformers joined engineers in this problem definition, decrying accidents as wasteful. A rhetoric of efficiency was ready to hand in the 1920s. Applied to traffic problems, the loss of street capacity to curb-parked cars became "the parking evil."

By the mid 1920s motordom had found that it could no longer work within existing problem definitions. It found an alternative stance in the problem "What is free?" By casting the problem in terms of political freedom and market freedom, motordom found that it could sidestep difficult questions of justice, order, and efficiency. Through this problem definition, it could characterize low speed limits as oppressive—an impediment to freedom. Overzealous do-gooders were "hog-tying the automobile," as an Ohio auto club put it.[12] Engineers who discriminated between modes of transportation on the basis of their spatial efficiency were violating free-market principles. Why should experts favor one mode over another? Let the market decide! As an ally to this rhetoric of freedom, motordom turned to a rhetoric of modernity. It was used to thwart appeals to custom, which could become "outmoded." Macabre safety publicity could look old-fashioned next to "modern" advertising, with its relentless good cheer. A new era demanded new ways. Motordom declared that a new era was dawning and named it "the motor age."

In the streets, rhetorical closure and closure by redefinition of the problem were accompanied by a third,
p. 7 closely related mechanism. We can call it "closure by control of use and misuse." The constant struggles to ↳ define use and misuse are seldom noticed as such. When a park bench acquires a central arm rail, those who define sleeping on a bench as a misuse have seized the high ground. Similar struggles to define the use and misuse of streets were at their hottest in the 1910s and the 1920s. When automobiles were new, many city people regarded them as a misuse of streets. By obstructing and endangering other street users of

unquestioned legitimacy, cars violated prevailing notions of what a street is for. As long as defenders of automobiles fought their cause without questioning these notions, they were fighting on their adversaries' terms. By the mid 1920s, however, motordom knew its enemy. From then on it expressly challenged old ideas about what streets are for. It proposed that street uses that impeded automobiles were misuses of the street. Even as accidents and congestion continued, restriction of cars was no longer the only way to fight them. After all, cars *belonged* in streets. At first this claim was a difficult one to make, but by 1930 motordom was on the road to success.

Whose Street?

Motorists arrived in American city streets as intruders, and had to fight to win a rightful place there. They and their allies fought their battles in legislatures, courtrooms, newspapers' editorial pages, engineering offices, school classrooms, and the streets themselves. Motorists who ventured into city streets in the first quarter of the twentieth century were expected to conform to the street as it was: a place chiefly for pedestrians, horse-drawn vehicles, and streetcars. But in the 1920s, motorists threw off such constraints and fought for a new kind of city street—a place chiefly for motor vehicles. With their success came a new kind of city—a city that conforms to the needs of motorists. Though most city families still did not own a car, manufacturers were confident they could make room for motor traffic in cities. The car had already cleaned up its once bloody reputation in cities, less by killing fewer people than by enlisting others to share the responsibility for the carnage. Engineers said they could rebuild cities to accommodate cars, and they were already breaking ground. In the following four decades, urban transportation problems were treated as tasks for highway engineers, and until the 1960s, among all urban transportation needs, state and federal policy recognized urban highway projects almost alone as a public responsibility.

The result was the automotive city—a city that made room for private automobiles. It was a city lacking good transportation choices. Those who argued for accommodating motorists often claimed that urban
p. 8 highways ↳ would let city people themselves choose the mode they preferred, since many would prefer automobiles. Yet transportation is a system of interdependent parts, and efforts to accommodate motorists degraded other modes. Since the middle of the twentieth century, people traveling in American cities have had few options. "The basic characteristic of the automobile-dominated city," observes a transportation economist, "is that, when one looks for an alternative to the private car, there is little or nothing there."[13]

In the 1960s and the 1970s, engineers and government began to encourage alternatives. Public funding began to benefit other urban transportation modes. In belated recognition of the interdependence of transportation modes, highway engineers renamed their profession *transportation engineering*. Since the 1970s, transportation engineers have striven to devise ways to lure motorists out of their cars and into other modes. They rejected the highway engineering orthodoxy of the middle four decades of the twentieth century.

Transportation engineers' recent aversion to automobiles in cities is not new. In the 1920s, traffic engineers also sought to limit the urban sphere of the car. Together, downtown business leaders and a popular safety movement strengthened the engineers' hand. The future of the automobile in city streets was the prize in a protracted and sometimes bitter contest. It was a clash not merely of methods but of first principles, as the conflicting views expressed in the epigraphs on page 1 attest.

These differences made the participants see the same problems in entirely different ways. All agreed that traffic jams were bad and that traffic accidents were intolerable. But was a traffic jam a symptom of wasted street space? Or was excessive urban concentration to blame? Or inadequate streets? If a motorist struck a child in the street, was the child responsible? Or was the newcomer to the street—the motorist—more to blame? The answers depended on who was asked, and the prevailing answers changed with time.

1. “The Parking Problem in St. Paul,” *Nation’s Traffic*, July 1927, 28–30, 47–48 (29).
2. “Motor Killings and the Engineer” (editorial), *Engineering News-Record* 89 (Nov. 9, 1922), 775.
3. “Jay Walker Problem,” *Providence Sunday Journal*, June 26, 1921.
4. Clay McShane was the first historian to begin to appreciate the scale and significance of urban traffic casualties at the dawn of the motor age, though he nevertheless assigned it a much less important role than it is given here. See Clay McShane, *Down the Asphalt Path: The Automobile and the American City* (Columbia University Press, 1994), esp. 173–179.
5. T. Pinch and W. Bijker, “The Social Construction of Facts and Artifacts, or How the Sociology of Science and the Sociology of Technology Might Benefit Each Other,” in *The Social Construction of Technological Systems*, ed. W. Bijker et al. (MIT Press, 1987), 24.
6. T. Pinch and W. Bijker, “The Social Construction of Facts and Artefacts, or How the Sociology of Science and the Sociology of Technology Might Benefit Each Other,” *Social Studies of Science* 14 (Aug 1984), 399–441 10.1177/030631284014003004 ; Pinch and Bijker, “Facts and Artifacts”; Bijker, *Of Bicycles, Bakelites, and Bulbs: Toward a Theory of Sociotechnical Change* (MIT Press, 1995).
7. Ibid 10.1177/030631284014003004 .
8. Bijker, *Of Bicycles, Bakelites, and Bulbs*, 122–127.
9. This example corroborates Anique Hommels’s observation that groups excluded from prevailing frames “typically propose radical alternative technological designs.” See Hommels, “Obduracy and Urban Sociotechnical Change: Changing Plan Hoog Catherijne,” *Urban Affairs Review* 35 (2000), 669.
10. Misa, “Controversy and Closure in Technological Change: Constructing ‘Steel,’” in *Shaping Technology/Building Society*, ed. W. Bijker and J. Law (MIT Press, 1992), 111.
11. Pinch and Bijker, “Facts and Artifacts,” 44–46.
12. “Hog-Tying the Automobile,” *Ohio Motorist*, Oct. 1924, 8.
13. Charles L. Wright, *Fast Wheels, Slow Traffic: Urban Transport Choices* (Temple University Press, 1992), 167. See also the comments of Satoshi Fujita, a Japanese visitor in the United States, in “Observations on Literacy and Morality,” in *Compulsory Schooling and Human Learning*, ed. D. Bethel (Caddo Gap Press, 1994). Fujita was surprised to find that in American cities it is “necessary for everyone to drive a car in order to survive” (28).
14. The dean of historians of the automobile in America, John Rae, assigns an important role to Americans’ “love affair with the motor vehicle,” which was “welcomed in American life” (Rae, *The American Automobile Industry*, Twayne, 1984, 59, 69).
15. Scott L. Bottles, *Los Angeles and the Automobile: The Making of the Modern City* (University of California Press, 1987), 254.
16. Ibid., 253–254.
17. Bradford Snell, “American Ground Transport,” in Senate, Committee on the Judiciary, The Industrial Reorganization Act: Hearings Before a Subcommittee on S. 1167, 93rd Cong., 2d sess. (1974), 26–49. For a convenient abridgement, see Snell, “American Ground Transport,” in *Crisis in American Institutions*, sixth edition, ed. J. Skolnick and E. Currie (Little, Brown, 1985), esp. 322–328.
18. Mark Foster, *From Streetcar to Superhighway: American City Planners and Urban Transportation, 1900–1940* (Temple University Press, 1981), 177.
19. The most important work crediting city planners with major influence is John D. Fairfield, *The Mysteries of the Great City: The Politics of Urban Design, 1877–1937* (Ohio State University Press, 1993). Fairfield’s book closely follows the model of elite subversion of the interests of city people.
20. McShane, *Down the Asphalt Path*.
21. Ibid., 212, 203.
22. Almost alone, McShane has noted the distinctly urban hostility to motorists on grounds of safety. See *Down the Asphalt Path*, 176–177.
23. Harland Bartholomew, an engineer for the St. Louis City Plan Commission, expressed a typical expert view in 1924: “It would be financially impossible to provide for unlimited accommodations of all kinds of traffic. The first step toward a solution of this problem is the reduction or elimination of unnecessary traffic movements.” See *Proceedings of the American Society of Civil Engineers*, May 1924, and *Electric Railway Journal* 63 (May 31, 1924), 857–858.
24. The change of terms occurred gradually in the 1920s, with some prodding by auto interests. In 1922 a Washington auto dealer recognized that the “pleasure car” idea “has somewhat impeded the progress of the automotive industry.” His reply was to claim that “the automobile itself has become an essential rather than a luxury.” R. H. Harper, quoted in “Auto Overcomes Expensive Toy Idea,” *Washington Post*, Dec. 3, 1922.
25. Bottles, *Los Angeles and the Automobile*, 249. Early in the century the greater Los Angeles area was exceptionally well suited to automotive transportation and poorly suited to mass transportation. The dense, congested downtown, where mass transit made most sense, was small by comparison to the diffuse surrounding region. The climate was the best in America for early motorists, and an unusually large proportion of Southern Californians could afford automobiles. Los Angeles therefore led the nation in automobile ownership rates and began to accommodate automobiles early. No city as

large or larger was nearly so conducive to the automobile. In urban transportation history, Los Angeles is the least representative city in America. Nevertheless, Bottles uses transportation in Los Angeles to represent urban transportation in America, as his book's subtitle and the boldly stated conclusions in his epilogue show.

26. The street, in other words, is an instance of a "commons." See Garrett Hardin, "The Tragedy of the Commons," *Science* 162 (Dec. 13, 1968), 1243–1248. In medieval England a commons was a place of exceptional economic laws, unlike those that obtain in private property. Like a commons, roads and streets are a shared good; individual users cannot be charged for each use. This sense of the metaphor is clearer in its original formulation; see William Forster Lloyd, "Two Lectures on the Checks to Population," in *Lectures on Population Value, Poor-Laws and Rent* (1837; reprint: Augustus M. Kelley, 1968), 30–31. See also Mancur Olson, *The Logic of Collective Action: Public Goods and the Theory of Groups* (Harvard University Press, 1965, 1971), 2: "Unless the number of individuals in a group is quite small, or unless there is coercion or some other special device to make individuals act in their common interest, rational, self-interested individuals will not act to achieve their common or group interests." Motorists have paid for much of their consumption of road and street capacity through gasoline taxes. In the 1920s, however, the tax was a very minor source of funds for streets. The gasoline tax is also not equivalent to a charge for a commodity of trade in a free market, since street capacity varies widely in value. A government cannot use gasoline taxes to charge a motorist for road use with any more success than a department store can charge customers for purchases by the pound.
27. William D. Hudson, "Grade Separations at Intersections," *City Planning* 2 (Jan. 1926), 36–41 (37).
28. Daniel Rodgers documents Haussmann's extensive intellectual influence on American urban design but finds that "few of the Haussman-inspired designs came to fruition." Rodgers also notes that the show boulevards that were built in the United States were "destined to be overwhelmed by automobile traffic" because of "their excessive centralizing tendencies, their etoiles and converging diagonals." See Rodgers, *Atlantic Crossings: Social Politics in a Progressive Age* (Belknap, 1998), 164–174, 181 (173).
29. Paul Barrett, *The Automobile and Urban Transit: The Formation of Public Policy in Chicago, 1900–1930* (Temple University Press, 1983).
30. Ibid., 3, 6. According to Barrett, the reasons for this difference were both cultural and practical. Most importantly, street railways, into the 1920s, often could and did pay their own way; this reinforced the idea that they should and must do so (see esp. 4). A similar disjuncture of definition is apparent today, when passenger rail service is again expected to pay its own way, while roads and highways (though largely funded by gasoline tax revenues) are treated as a public responsibility. The problem of charging users is perhaps the chief reason why the street was traditionally a public responsibility. Street railway entrepreneurs, however, could easily charge users, and therefore willingly built lines. Until early in the twentieth century, city streets were financed primarily by assessments on the owners of abutting property, since they were among the chief beneficiaries of improvements. Clearly, however, many others who were not charged benefited. Note also that a store owner (for example) paid for the benefit accruing from a street improvement, but did not pay for equivalent benefits from street railway extensions, except indirectly (through increased property assessments or rents). Increasingly, bond issues against cities' general revenues paid for improvements; this method corrected the deficiencies of assessments, but clearly benefitted motorists disproportionately. State gasoline taxes grew important in city thoroughfares as state roads more often entered cities in the second quarter of the century. This method had the salutary effect of charging motorists for their use of the roads but also became the basis for claims that roads and streets belong exclusively to motorists.
31. Barrett, *The Automobile and Urban Transit*, 215, 210.
32. Baldwin, *Domesticating the Street: The Reform of Public Space in Hartford, 1850–1930* (Ohio State University Press, 1999).
33. On problem definition, see selections in *The Politics of Problem Definition*, ed. D. Rochefort and R. Cobb (University Press of Kansas, 1994), esp. Rochefort and Cobb, "Problem Definition: An Emerging Perspective," 1–31. For a brief, incisive case study in problem definition and how it can change, see Jameson M. Wetmore, "Redefining Risks and Redistributing Responsibilities: Building Networks to Increase Automobile Safety," *Science, Technology and Human Values* 28 (summer 2004), 377–405. On social and cultural factors in technological problems, see the growing work of historians studying the social construction of technology, the standard introduction to which is the essays collected in *The Social Construction of Technological Systems*, ed. W. Bijker et al. (MIT Press, 1987).
34. See the growing body of scholarship from the "social construction of technology" school, exemplified by Bijker, *Of Bicycles, Bakelites, and Bulbs*.