Technologies in tension : horses, electric trucks, and the motorization of american cities, 1900-1925

Citation for published version (APA):

Mom, G. P. A., & Kirsch, D. A. (2001). Technologies in tension : horses, electric trucks, and the motorization of american cities, 1900-1925. *Technology and Culture*, 42(3), 489-518. <https://doi.org/10.1353/tech.2001.0128>

DOI:

[10.1353/tech.2001.0128](https://doi.org/10.1353/tech.2001.0128)

Document status and date:

Published: 01/01/2001

Document Version:

Publisher's PDF, also known as Version of Record (includes final page, issue and volume numbers)

Please check the document version of this publication:

- A submitted manuscript is the version of the article upon submission and before peer-review. There can be important differences between the submitted version and the official published version of record. People interested in the research are advised to contact the author for the final version of the publication, or visit the DOI to the publisher's website.
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Technologies in Tension

Horses, Electric Trucks, and the Motorization of American Cities, 1900–1925

GIJS P. A. MOM and DAVID A. KIRSCH

[I]n a short time the use of horse drawn truck wagons for Company work will be as rare as the dodo bird and the left-handed monkey wrench. You'll see a pair of horses drawing one of our rigs about as often as you see a gas jet illuminating the Edison Building. Every vehicle engaged in Company business including dump wagons and pole wagons will be operated by electricity by the first of the year.

—Edison Round Table, 31 October 1921

Twenty-six years later, in October 1947, the Commonwealth Edison Company of Chicago scrapped the last of its electric trucks. By 1950 the utility's transportation department owned and operated 824 vehicles, all of them gasoline-powered.¹ For the preceding half century, however, the company had maintained a fleet that included a mix of horse-drawn, electric, and gasoline-powered vehicles. Nor was Commonwealth Edison unusual in employing a range of vehicle technologies. Between the turn of the century

Dr. Mom is program coordinator for transport history in the Foundation for the History of Technology at the Technical University of Eindhoven. The author and translator of more than a dozen books on automotive technology and its history, his doctoral dissertation on the early history of the electric vehicle will be published by Johns Hopkins University Press in 2002. Dr. Kirsch is assistant professor of entrepreneurship in the R. H. Smith School of Business at the University of Maryland, College Park, and author of *The Electric Vehicle and the Burden of History*, published by Rutgers University Press (2000). They gratefully acknowledge the constructive comments of the *Technology and Culture* referees and the editor's encouragement to pursue this article as a joint presentation of their individual research projects.

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0040-165X/01/4203-0004\$8.00

1. J. Mulholland to J. F. Rice, memorandum, 6 June 1950, history folders, F3A/E3c, Commonwealth Edison Company, Chicago.

and the outbreak of the Second World War, many urban, transportation-dependent organizations used combinations of different technologies. Well into the 1920s, thousands of electric trucks provided valuable, reliable service in urban delivery and service vehicle fleets.

This article traces the history of the electric truck in U.S. cities during the first quarter of the twentieth century. Although internal combustion had emerged as the leading technology in the passenger car market by 1905, the market for commercial vehicles was much slower to adopt a single technological standard. Private firms in urban areas did gradually accept the passing of the horse, tentatively at first but with growing enthusiasm, and many chose electric trucks to replace their fleets of horse-drawn vehicles. The long Indian summer of the electric truck, in David Sicilia's phrase, thus presents a paradox for traditional interpretations of the history of the motor vehicle industry. If the electric vehicle was an inherently inferior technology, doomed to failure by the iron laws of lead and acid, why did so many successful, progressive, profitable companies—such as Commonwealth Edison, in many respects the flagship electric utility of the United States in the first third of the twentieth century—continue to purchase and use them through the 1920s? Did these organizations simply bet on the wrong horse, as automotive historian John Rae proposed in explaining the failure of an early electric taxicab company? Or does the success of the electric truck offer a window into the complex evolutionary process by which trucks gradually displaced horses?²

2. For most of this century, historians of the Automobile Age have focused on the passenger automobile, relegating the commercial vehicle to secondary status. The limited literature on the truck includes: Louis Rodriguez, "The Development of the Truck: A Constructivist History" (Ph.D. diss, Lehigh University, 1997); Robert Alan Raburn, "Motor Freight and Urban Morphogenesis with Reference to California and the West" (Ph.D. diss., University of California, Berkeley, 1988); John Montville, "Wheels for Commerce: A History of American Motor Trucks," in *The American Car Since 1775*, ed. L. Scott Bailey (New York, 1971); Robert F. Karolevitz, *This Was Trucking: A Pictorial History of the First Quarter Century of Commercial Motor Vehicles* (Seattle, Wash., 1966). On the presumed inferiority of the electric vehicle, James J. Flink typified a view held by many scholars when he described "the inherently superior technological feasibility of the internal-combustion engine for the motorcar at that time"; *America Adopts the Automobile, 1895–1910* (Cambridge, Mass., 1970), 307. Also see: James Rood Doolittle, *The Romance of the Automobile Industry* (New York, 1916); James J. Flink, *The Automobile Age* (Cambridge, Mass., 1993), 10; John B. Rae, *The American Automobile: A Brief History* (Chicago, 1965), 12–13; James M. Laux, *The European Automobile Industry* (New York, 1992), 13. Virginia Scharff has implicitly depicted the electric alternative as an inferior technology: see *Taking the Wheel: Women and the Coming of the Motor Age* (New York, 1991), 35–50; "Gender, Electricity, and Automobility," in *The Car and the City: The Automobile, the Built Environment and Daily Urban Life*, ed. Martin Wachs and Margaret Crawford (Ann Arbor, Mich., 1992); and "Putting Wheels on Women's Sphere," in *Technology and Women's Voices: Keeping in Touch*, ed. Cheris Kramarae (New York, 1988). Urban historian Clay McShane has taken a similar line; see *Down the Asphalt Path: The Automobile and the American City* (New York, 1994), 110. For a dissenting view, see Michael B. Schiffer, *Taking*

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In fact, at certain times, under specific conditions and for clearly identified groups of customers, the electric vehicle was both more reliable and cheaper to operate than comparable gasoline-engine or horse-drawn vehicles—the superior technology, that is to say, although its superiority could endure only as long as those specialized markets continued to exist. Technological superiority resided not simply in the physical properties of the individual technologies but in the contexts and systems in which motor vehicles were embedded. Thus it was crucially important who made the decision whether to use motor vehicles and for what purposes. For some organizations—those with established local transport service requirements already being met by horses—electric trucks continued to make sense well into the 1920s.

Today long-haul freight is the backbone of the American trucking industry, but during the five decades separating the Civil War from World War I the central transportation challenge was local collection and distribution. The expansion of the railroads allowed goods to move increasingly cheaply from railhead to railhead, but thousands of horses were needed to move those goods from the railhead to the local distributor. This horse-based, short-haul service created traffic congestion and pollution, and its costs equaled or exceeded those of long-haul freight.³ Short-haul trucking was the first arena in which the motor truck had to prove its worth, and the interaction of horse- and motor-based technologies was a crucial factor shaping the evolution of the urban commercial transport system.

The persistence of the market for electric trucks also sheds new light on the success of the internal combustion engine. Gasoline-engine trucks succeeded not because they were better at doing what electric trucks were already doing (that is, replacing horses in urban areas) but because they offered the possibility of universal service, thereby creating an entirely new

Charge: The Electric Automobile in America (Washington, 1994). The phrase “the long Indian summer of the electric truck” comes from David B. Sicilia, “Selling Power: Marketing and Monopoly at Boston Edison, 1886–1929,” (Ph.D. diss., Brandeis University, 1990), 342–61. In general, critics of the electric vehicle fail to explicitly identify the functional attributes upon which they base their judgment of technical inferiority. On the history of the electric passenger car and the technological competition that resulted in the triumph of internal combustion, see Gijs P. A. Mom, *Geschiedenis van de Auto van Morgen: Cultuur en Techniek van de Elektrische Auto* (Eindhoven, 1997); David A. Kirsch, “The Electric Vehicle and the Burden of History: Studies in Automotive Systems Rivalry in America, 1890–1996” (Ph.D. diss., Stanford University, 1996), and *The Electric Vehicle and The Burden of History* (New Brunswick, N.J., 2000). John Rae, “The Electric Vehicle Company: A Monopoly That Missed,” *Business History Review* 29, no. 4 (1955): 298–311. On the history of the early cab ventures, see David A. Kirsch and Gijs P. A. Mom, “Betting on the Wrong Horseless Carriage: The Urban Electric Vehicle Revisited” (paper presented at the annual meeting of the Society for the History of Technology, Detroit, October 1999).

3. F. M. L. Thompson, *Horses in European Economic History: A Preliminary Canter* (London, 1983), 102.

market.⁴ With one or two notable exceptions—such as Hartford and a handful of other cities that implemented a battery exchange system—the electric truck was limited to intraurban applications. Only gasoline-engine trucks could serve all the transport needs of small shopkeepers and other new vehicle users. Markets for the electric truck stagnated while the market for the gasoline-engine truck continued to expand, stimulated in large part by World War I. In the decade before the war, during the brief heyday of the electric truck, general trucking was basically unknown. But the Great War changed the ground rules for the commercial vehicle, and the gasoline-engine truck proved its versatility in the war. The universal truck had arrived to stay, even as some companies—such as Commonwealth Edison—continued to replace horses with electric trucks through the 1920s.

Early Commercial Motor Vehicles

Electric utilities were quick to identify the local trucking market as an opportunity for electrification. As early as 1900, Elmer Sperry noted the unique character of the electric-vehicle charging load and challenged the utilities to help support the fledgling vehicle industry. Addressing the delegates at the National Electric Light Association (NELA) convention in Chicago in May 1900, Sperry cautioned that the electric vehicle market “belongs to the central station by right of discovery; but history repeats itself, and the opportunity will be lost if the territory is not occupied and its resources developed.” According to Sperry, central stations should use “duplicate [exchangeable] traction batteries” to allow charging to take place “at times and rates dictated by the station and practically under its control.”⁵ Sperry’s warning struck a chord. Industry leaders such as Samuel Insull had shifted the attention of central station managers from production to consumption. By offering differential rates, Insull and other forward-thinking electricity producers hoped to encourage electric vehicle owners to charge their vehicles with cheap electricity produced during the slack overnight period.⁶

4. Most observers of the commercial vehicle industry did not expect a single technology to provide motor vehicle service across all of the different transport markets that needed to be motorized. The capability of internal combustion to provide so-called universal service, and its consequent ascendancy, were largely unexpected.

5. Elmer A. Sperry, “Automobiles as Source of Revenue for Central Stations,” in *Proceedings of the National Electric Light Association, Twenty-Third Annual Convention, Chicago, May 22–24, 1900* (New York, 1900), 373.

6. Initial debates about electric trucks coincided with a massive central station campaign to introduce electric batteries as load-buffering devices. Before the turn of the century, American electricity providers lagged far behind their European counterparts in this area. Whereas the total installed energy content of stationary lead-acid batteries in 1895 was only 4,000 kilowatt-hours, nine years later total capacity of the nation’s storage batteries had increased a hundredfold. See L. B. Stillwell, “Electrical Power-Generating Stations and Transmission,” *Electrical Review*, 29 October 1904, 705–6.

The advantages for the utilities were many. First, by delivering energy during the nighttime and daytime “valleys” in the load curve, they could achieve a load-leveling effect that would ultimately reduce the cost of their peak power production. The electric vehicle provided a valuable “long hour load” of seven to eight hours per day without charging peaks. Also, the vehicle load was low demand. A typical utility needed eighty-six electric irons to generate the same annual income as would a two-ton electric truck, but the truck required only 6 kilowatts of installed power capacity, compared to 52 kilowatts for the irons. (This difference resulted from the fact that all eighty-six irons might, in principle, be used at the same time, while the truck battery would draw current over an extended period.⁷)

The utilities’ desire to sell off-peak current narrowed their view of the electric vehicle market. First, it led to their preference for public garages over home charging. Public garages not only promised more electricity sold for a given number of charging outlets, but also gave the central stations an effective ally in their struggle against “isolated plants,” privately owned and operated generating facilities that many plant and building owners first used to electrify their premises. As one utility manager remarked in 1909: “It is to the central station’s advantage to make provisions to furnish current where it can control it from the start and not allow this business to drift into the hands of a competitor in the form of isolated plants.”⁸ Despite the growth of the central stations, as late as 1916 isolated plants still generated twice as much electrical energy as the big, networked utilities.⁹ In this respect utility managers viewed the electric vehicle in the same light as the electric elevator, one of the first means identified by Insull to promote central station service and combat competition from isolated plants.¹⁰ The

7. A. E. Ridley, “The Electric Automobile as an Income Producer for Central Stations,” *Central Station* 3 (October 1903): 85; H. W. Hillman, “Relative Importance of the Electric Truck as Compared with Other Classes of Central Station Business,” *Central Station* 12 (February 1913): 248–52. Also, electricity sold to charge vehicle storage batteries did not have to be stored in and later retrieved from the utility’s own batteries, thereby shifting the charging and discharging losses (which amounted to 20 to 30 percent) plus a portion of battery maintenance costs to the vehicle owner; see Richard H. Schallenberg, *Bottled Energy: Electrical Energy and the Evolution of Chemical Energy Storage* (Philadelphia, 1982) 280.

8. “The November Meeting,” *Central Station* 9 (December 1909): 116–19.

9. Fred Darlington, “Central Station Electric Systems and Railroad Power,” in *Proceedings of the National Electric Light Association, Thirty-Ninth Annual Meeting, Chicago May 22–26, 1916* (New York, 1916), 552–63.

10. Electric elevators were bundled with other electric services, thereby increasing total demand for electricity and rendering customers less likely to purchase an isolated plant. As Harold Platt observed in his analysis of early marketing efforts at Chicago Edison, “a decision for electric elevators often had the added benefit of persuading building owners to cancel plans for a self-contained lighting system in favor of central station service”; *The Electric City: Energy and the Growth of the Chicago Area, 1880–1930* (Chicago, 1991), 104.

load-leveling impulse also led utilities to prefer trucks to cars. Trucks used more electricity per mile than cars, they traveled greater total distances, and in 1910 there were many more horses waiting to be replaced by motor vehicles than there were passenger vehicles in service.¹¹

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It should not come as a surprise, then, that central station managers were among the first to add electric trucks to their service fleets. Chicago's Commonwealth Edison Company was using an electric vehicle by the turn of the century. In 1902 New York Edison took delivery of an experimental 5-ton electric wagon made by the Electric Vehicle Company; a year later, it had purchased at least six more electric vehicles for the use of its regional superintendents, and by 1906 there were thirteen electric vehicles in the New York Edison vehicle fleet. Similarly, by 1904 the Edison Electric Illuminating Company of Boston was operating at least four electric vehicles, two trucks and two cars for its superintendents.¹²

If leading central stations were content to use electric trucks and service vehicles primarily for advertising and to meet internal transportation requirements, producers of the electric vehicles were eager to expand their markets. In 1906 the industry established its own trade organization, the Association of Electric Vehicle Manufacturers. The following year, Herbert H.

11. In his inaugural editorial for *Commercial Vehicle*, H. F. Donaldson noted some of the important differences between passenger and commercial vehicles. Whereas the car could "make a poor showing on the private ledger of its owner and still be considered an unqualified success," the commercial vehicle must "make good in dollars and cents. . . . It is a machine that makes money for its owner." Private vehicles were only operated during fair weather and were often garaged for months at a time, but commercial vehicles were expected to operate six days a week, year round. Commercial vehicles also had to contend with the "driver problem": while passenger vehicles were usually driven by the owner or under the owner's direct supervision, commercial vehicles were often entrusted to employees. See "The Commercial Vehicle," *Commercial Vehicle* 1 (March 1906): 28. According to the Bureau of the Census, total motor vehicle production in 1909 (including passenger cars) was 126,593 units, while the total horse population exceeded fifteen million; see Bureau of the Census, *Fourteenth Census of the United States, 1920* (Washington, D.C., 1921–23), vol. 10, *Manufactures*, 874.

12. During this period, profits from the sale of current and the underlying economics of motor vehicle operation were less important than boosting the public appeal of modern electric service. The use of electric vehicles—often illuminated with electric lights and decorated with signs proclaiming the benefits of central station service—to deliver bulbs, light street lamps, pull underground cables, and erect lamp posts kept electricity front and center in the public eye. And because a central station could use its existing technical infrastructure to charge and maintain its electric vehicles, the real costs of electric vehicles compared to those of the horse-drawn carts they replaced or to those of prospective gasoline service were unknown and, for the time being, immaterial. It was sufficient that the electric vehicles answered the calls and lit the lamps. For Commonwealth Edison, see "Licensed Automobile Operators in Chicago," *Western Electrician*, 15 September 1900, 169; for New York Edison, see "Edison Delivery Service," *Central Station* 8 (March 1909): 213; for Boston Edison, see "The Electric Automobile in Central Station Practice," *Central Station* 3 (April 1904): 244.

Rice, a manufacturer of Waverley electric vehicles, addressed the National Electric Light Association on the opportunity to sell current for vehicle charging. Not since Sperry's talk six years earlier had the national delegates been challenged to pursue the vehicle-charging load. Sperry had been content to draw attention to the future prospects for electric charging, but Rice was more outspoken: "Central-station men, who should have been foremost in advocating and pushing the sale of electric automobiles, have been most apathetic." Attributing this neglect in part to the "lamentable financial failure of early endeavors to utilize electric vehicles in cab service," Rice also cited the station operators' continued "ignorance" and their misguided belief that other sales opportunities were more lucrative. Even with their limited range and speed, electric vehicles could go "much faster than the city laws allow" and cover "sufficient mileage to satisfy all requirements of city use."¹³ For a vehicle producer such as Rice, the solutions were obvious: First, central stations should "quote favorable rates and encourage the sale of current." Second, a local representative should be appointed by every central station to "take a little time to find out what the carriage owner needs in order to take current from your mains." Third, central stations should purchase electric vehicles for their own transportation needs. "What will you think of an electric light company that burns gas for its own lighting? How about those whose officers and managers use horses instead of electric runabouts and employ horse-drawn wagons instead of electric trucks?"¹⁴ Electric vehicle makers saw an enormous potential market for their products (fig. 1), but realized that they needed the cooperation and support of the utilities.

Separate Spheres of Action

For most early-twentieth-century American businesses, transportation efficiency was defined by the capabilities of the horse-drawn wagon. Regional wholesale producers—bakers, brewers, ice houses, coal distributors—used large (5-ton) wagons to deliver their products to local merchants. Local merchants—and the growing department stores—used small (half-ton), one-horse wagons to deliver merchandise to individual customers. Efficient transport service was also based on prevailing modes of commerce. People bought and sold locally. Delivery was the norm rather than the exception. Prior to the introduction of parcel post in 1913, the merchant provided delivery service free of charge. Well into the twentieth century, delivery costs were not an issue; they were unknown. Some businesses subcontracted deliveries with local transport providers, but most

13. Herbert H. Rice, "Opportunities for the Sale of Current for Charging Electric Automobiles," in *Proceedings of the National Electric Light Association, Thirtieth Annual Meeting, Indianapolis, 4–7 June 1907* (New York, 1907), 498.

14. *Ibid.*, 507.

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FIG. 1 Advertisement promoting the use of electric trucks to replace horses. (*Electrical World* 58 [16 December 1911], 1495.)

frowned on the idea. As C. R. Langenbacher, delivery supervisor of Lord and Taylor department store in New York, phrased it: “How would it look for a delivery boy to enter an apartment or a house with a lady’s hat in one hand and a ham gracefully poised in the other?”¹⁵ Delivery offered an opportunity for the merchant to maintain direct contact with the customer, and few were willing to entrust it to contractors.

By 1906, users of commercial gasoline-engine and electric trucks could be divided into two categories: fixed-route, short-range delivery service and specialized hauling of bulk commodities. The express companies that transported small and medium-sized packages to and from railheads and dockyards owned some of the largest stables in American cities and experimented with many different types of motor vehicles. These companies purchased new vehicles in lieu of new horses; they “stabled” the trucks with the animals, and used them initially on the same service routes as the horses they replaced. Similar service requirements led local merchants—Macy’s, Gimbel’s, Tiffany’s, Abraham and Straus, and Gorham in New York, Houghton and Dutton in Boston—to purchase commercial vehicles.¹⁶

15. “Parcel Delivery Discussed by Truck Club,” *Commercial Vehicle* 9 (1 October 1913): 13.

16. The first vehicles purchased by Gorham in 1899 were made by Andrew Riker; see Howard Greene, “An Object Lesson in Electric Delivery,” *Commercial Vehicle* 1 (May 1906): 90, and “Gorham Electric Garage Is Truck Factory,” *Commercial Vehicle* 9 (15 October 1913): 38. For Abraham and Straus, see “Machines Effect Saving in Dry Goods Delivery,” *Commercial Vehicle* 6 (June 1911): 301–4; also see reports on length of service in “Electric Commercial Trucks are Increasing Throughout the Country,” *Commercial Vehicle* 9 (15 October 1913): 5–11.

Generally, these replaced one-horse or two-horse wagons. Merchants valued them because they were faster than horses, fostered a more modern and progressive public image, and could be parked on the street, freeing scarce and increasingly expensive stable space for other uses.¹⁷ However, both electric and gasoline vehicles cost more to purchase than horses and wagons, and fleet operators soon recognized that motor vehicles—whatever their motive power—would have to do more than simply replace horse wagons on a one-for-one basis.

Among commodity suppliers, coal, ice, and beer distributors were typical early users of motor vehicles.¹⁸ The distances covered were usually short, often less than five miles, and speed was less important than dependability. Under typical conditions, horse-drawn vehicles were perfectly adequate; in atypical conditions, they might become less so. When, for example, the weather was hot, ice melted faster and people drank more beer, but the heat also exhausted horses and made it more difficult for them to provide normal service, let alone pull heavier loads or cover routes a second or third time. Similarly, following a major winter storm demand for coal rose at the same time that city streets became impassable. A Chicago coal distributor advertised the fact that its 5-ton gasoline-engine truck had managed fourteen 5.3-mile trips on a single January day in 1912 when the temperature was -12 degrees Fahrenheit. Per mile costs were irrelevant, as no team of horses could have managed such a feat.¹⁹ These businesses valued the motor truck not for reasons of speed or economy but for its ability to operate in difficult conditions.

Combining traditional transport practices with expensive and unproven technology produced functional specialization, the assigning of separate spheres of action to different forms of motive power. The first commercial vehicle buyers did not simply replace their horses with trucks; rather, they bought trucks to augment their horse-drawn fleets. As late as 1914, few companies had dispensed with all of their horses.²⁰ Even in electric utilities' vehicle fleets, horses remained in service alongside electric and gasoline vehicles (table 1). Because wagons and trucks could not be used interchangeably, every owner of a mixed fleet was forced to apportion different duties to different types of vehicle. The question was simply which type of vehicle best suited a given task.

17. "Operating the Electric Vehicle; Cost Figures, Trips, Maintenance," *Commercial Vehicle* 7 (November 1912): 9.

18. So-called transfer service—moving goods between commercial warehouses—also employed large capacity vehicles. Chicago's Montgomery Ward Co., for instance, had been operating six 5-ton electric trucks in transfer service since 1903; "Gasoline and Electric Trucks in Chicago," *Commercial Vehicle* 1 (March 1906): 31.

19. "How Chicago's Coal Supply is Handled," *Commercial Vehicle* 7 (March 1912): 59.

20. "What Motor Trucks Are Actually Doing for American Users," *Commercial Vehicle* 10 (15 February 1914): 5–14.

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TABLE 1
REPRESENTATIVE CENTRAL STATION VEHICLE FLEETS, 1912

City	Horses	Proportion (%)	Electrics	Proportion (%)	Gasoline	Proportion (%)	TOTAL
Rochester	1	2.0	50	98.0	0	0.0	51
New York	4	3.7	103	95.4	1	0.9	108
Oakland	4	20.0	9	45.0	7	35.0	20
Chicago	113	56.8	70	35.2	16	8.0	199
Philadelphia	44	41.9	35	33.3	26	24.8	105
St. Louis	39	55.7	21	30.0	10	14.3	70
Boston	95	53.7	44	24.9	38	21.5	177
Kansas City	24	75.0	5	15.6	3	9.4	32
Baltimore	85	72.6	15	12.8	17	14.5	117
Newark	150	74.3	16	7.9	36	17.8	202
TOTAL (10 cities)	559	51.7	368	34.0	154	14.3	1,081

Source: Association of Edison Illuminating Companies, "Report of the Committee on Electric Vehicles," *Minutes of the Annual Meeting* (New York, 1912), 358-59.

The evolution of these separate spheres for horse-drawn and motorized commercial vehicles was rooted in the way turn-of-the-century companies organized their transport service. Businesses had developed a host of practices adapted to the capabilities of the horse. It would be impossible to catalog all of these practices, but some examples are instructive. Over the course of a day's work, a team might cover as much as 18–20 miles, at an average pace of 3–5 miles per hour. An experienced teamster would avoid pushing a team to exhaustion by providing frequent stops for water and rest. Either intentionally or accidentally, the typical rhythms of delivery service created such rest stops. Customers had the option of paying for goods at the time of delivery, for instance. They were allowed, even expected, to open and inspect the contents of all packages. Clothing and other personal items might be tried on while the team, as well as the driver, waited. Beer wagon drivers were responsible not only for unloading the new barrels and removing the empties, but also for tapping the fresh keg. Tradition dictated that the driver then sample the product with the tavern owner.²¹ All the while, the team of horses was resting.

Unlike horses, motor vehicles did not need time to recuperate between loads. Waiting time was lost time and, considering the high purchase price of a truck and the relatively high fixed costs associated with its maintenance, the loss was significant. Truck drivers did not stop observing time-honored practices like drinking a mug of beer with the tavern owner or waiting for a customer to try on a new item, but the opportunity cost associated with such behavior increased dramatically. Joseph Husson's study of beer delivery in New York City, for instance, reported that even after motorization 15 percent of total work time was spent "partaking of liquid refreshment."²² These examples underscore the extent to which the potential efficiency of motor truck service was compromised by continued adherence to horse-paced transport practices.²³

The pace of transport work, however, also helps explain the persistence of the operating sphere of the electric truck. In its various operating characteristics, the electric vehicle more closely resembled the horse than did the gasoline-engine truck. The electric truck traveled faster than the horse wagon, but not so fast as to encourage joyriding or speeding. A battery, like a horse, could do with a short rest now and then to allow the active electrolyte near the lead plates to become replenished by fresh electrolyte elsewhere in the battery cell. But the operating range of the electric truck was greater than that of the horse wagon, so a store or distributor could increase

21. Joseph Husson noted that this "custom" was "firmly rooted in all the truck drivers and was handed down from the horse-wagon days"; see "Brewery Trucks Reduce Delivery Cost and Increase Business Area," part 1, *Commercial Vehicle* 11 (1 November 1914): 6.

22. Ibid.

23. "Choosing the Type," *Electric Vehicles* 4 (March 1914): 96.

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overall delivery range while maintaining the approximate outline of its distribution system. In contrast, the efficient use of gasoline-engine trucks (which were less reliable until at least 1910) required that whole service and delivery organizations be reorganized to create longer delivery routes. Defending the need to completely rebuild transportation departments, one observer noted that "to adapt the [gasoline] truck to the shipping room is like making the man over to fit the coat." But for the risk-averse manager of the typical delivery department, it was easier to change only one variable at a time and let electric trucks do a little more than the horse wagon. The electric truck was a new coat that already fit.²⁴

Contemporary observers clearly articulated the early outlines of these specialized spheres of action for commercial vehicles. Among distributors of bulk commodities, steam and electric vehicles were the early favorites.²⁵ Commenting on the results of the first American commercial vehicle contest, held in New York City in May 1903, Albert Clough of *Horseless Age* concluded: "Experience will furnish the decisive evidence which shall assign each motive power to its appropriate sphere. Light delivery work in congested areas will perhaps become the province of the electric vehicle. In sparsely settled territory this duty may devolve upon the gasoline engine, while steam may do the bulk of the heavy trucking, pending the application of internal combustion engines to this service."²⁶ Another editorial noted that electric commercial trucks operated "in a field which is peculiarly their own," a view reiterated in a 1910 article, which observed that, despite the relative paucity of manufacturers and the lack of new models introduced, the electric vehicle was "holding its own in many applications in the larger cities for which it seems to possess peculiar suitability."²⁷

24. "Business Methods for Business Vehicles," *Commercial Vehicle* 8 (1 May 1913): 29. Another article referred to charging systems as "the hay and grain of the battery," further underscoring the practical similarities between the horse and the electric truck; see C. L. Morgan, "The Proper Garaging of Electric Vehicles," *Central Station* 10 (December 1910): 167–70.

25. At the Liverpool commercial vehicle trials in England in 1901, steam dominated the field, but vehicles based on similar designs found only limited success in the American market. As late as 1919, two-thirds of the forty-six trucks of the British road-hauling company Pickfords were steam powered; see Henri G. Chatain, "The Liverpool Trials," *Horseless Age*, 10 July 1901, 327, and Gerard L. Turnbull, *Traffic and Transport: An Economic History of Pickfords* (London, 1979), 153.

26. Albert Clough, "General Deductions from the Test," *Horseless Age*, 27 May 1903, 619–621. Raburn (n. 2 above, p. 85) argues that support for the idea that different types of motive power should operate in different spheres of action resulted from the marketing and promotional efforts of electric vehicle industry groups such as NELA and the EVAA. In particular, he discounts the findings of the group of MIT-based transport engineers because Boston Edison funded their research. However, belief in functional specialization predated the organized activities of NELA in support of electric vehicles by several years, and the group that eventually became the Electric Vehicle Association of America was not organized until 1909.

27. "Internal vs. External Combustion," *Commercial Vehicle* 1 (October 1906): 266; "A

Electric Truck Partisans

By 1910, the idea of appropriate spheres was firmly established within the commercial motor vehicle industry. Under the headline “Do Not Make Civil War,” a 1912 editorial in *Commercial Vehicle* started with the assumption that “the electric and the gasoline truck each have a separate and different field.” These fields occasionally overlapped, according to the editorial, but only when personal “prejudice” rather than efficiency determined the choice. Ultimately, it was “ridiculous” to compare the two: “All comparisons are odious.” From the journal’s perspective, it was simply a question of educating consumers about the suitable uses of these different forms of motive power.²⁸ A 1913 survey was similarly matter-of-fact: “The fields of the electric and gasoline truck are becoming more definitely and universally recognized as separate and thus competition between the two is becoming more and more a thing of the past. . . . [Mixed] systems are becoming fashionable.”²⁹ No less an authority than the manager of the General Motors Truck Company observed in 1914 that “today more than ever before the transportation problem is not to be settled by an off-hand declaration, either in favor of gasoline or electric trucks.”³⁰ Indeed, General Motors had invested in the electric truck market, purchasing the Lansden company in 1912.³¹ The company continued to offer a line of electric trucks through the 1916 model year.³² Thus, in the years before World War I the

Substantial Industry,” *Commercial Vehicle* 5 (April 1910): 150. Early attempts to specify the respective tasks for electric, steam, and gasoline vehicles were not limited to the American market. Expectations about which mode would dominate which sphere differed by country. For instance, Sir David Salomons, president of the Self-Propelled Traffic Association in Great Britain, predicted in 1897 that the gasoline engine would only be suitable for motorcycles, whereas steam traction would be used “when real work is called for, and where a return upon capital expenditure is required. . . . Electric energy, if the necessary adjuncts exist, has a great field open in towns, as a luxury, where the question of upkeep is not a vital item”; “Motor Traffic,” *Automotor and Horseless Vehicle Journal*, 15 May 1897, 295–305, at 305.

28. “Do Not Make Civil War,” *Commercial Vehicle* 7 (November 1912): 36.

29. “The Motor Truck Industry As It Is: Makers, Models, Users and Sales,” *Commercial Vehicle* 8 (January 1913): 5.

30. W. L. Day, quoted in “National Automobile Show,” *Electric Vehicles* 4 (January 1914): 4.

31. General Motors’ purchase of Lansden prompted an editorial envisioning an “ideal” market in which “all of the best firms would build both kinds in all sizes so as to have a complete line and thus compete for any order”; “The Two Kinds of Truck Power,” *Commercial Vehicle* 7 (March 1912): 49.

32. “Features of GMC Electric Trucks,” *Commercial Vehicle* 7 (May 1912): 42–43. General Motors ceased selling electric trucks with the 1917 model year; “A Directory of Motor Truck Makers,” *Commercial Vehicle* 15 (1 November 1916): 17–43. Inexplicably, a recent article by GM engineer Kaushik Rajashekara claims that GMC Truck began producing electric trucks in 1916; see “History of Electric Vehicles in General Motors,” *IEEE Transactions on Industry Applications* 30 (July/August 1994): 897.

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commercial vehicle industry accepted the principle of separate spheres for gasoline-engine and electric trucks, at least in theory.

Putting the theory of functional specialization into practice posed considerable challenges for vehicle operators. Which type of vehicle should be used for which purposes? To assist fleet owners, a number of different heuristics were proposed to help set the boundaries between the separate spheres. Where one stood depended, of course, upon where one sat. Frank Smith, president of the independent Electric Vehicle Association of America (EVAA), claimed that 98 percent of all transportation needs could be met by electric vehicles.³³ Noted electrical engineer Charles P. Steinmetz suggested that 90 percent of all transportation requirements could be satisfied by a vehicle capable of traveling 30 miles on a single charge.³⁴ Warehouse owner Walter C. Reid was more modest still, proposing a 20-mile service envelope encompassing 80 percent of all city work.³⁵ The National Bureau of Standards concluded that electrics were most economical within a 10-mile service radius.³⁶ Day Baker, of the General Vehicle Company, offered two guidelines: "Never try to make deliveries with gasoline trucks if they *can* be made with an electric" and "[A]fter leaving the delivery room, don't stop the gasoline truck until beyond the 15-mile limit."³⁷ Perhaps William Blood, an ex-president of the EVAA, summed up the situation best when he opined that the "car for the middle field of moderate distances with frequent stops is the electric."³⁸

33. "The Fifth Annual Convention of the Electric Vehicle Association of America," *Central Station* 14 (November 1914): 154. The Electric Vehicle and Central Station Association had been established under the motto "To encourage the adoption and use of electric commercial and pleasure vehicles by electric light and power stations and their customers"; its successor, the EVAA, was founded in 1909 and expanded its scope in 1910 when Thomas Edison gave his personal blessing to the creation of an independent national electric vehicle association modeled on NELA. The EVAA's membership included central stations, battery manufacturers, and vehicle producers. Devoted mainly to consciousness raising, the organization hosted meetings at which papers were read purporting to show the "perfection" of the electric vehicle, recent sales were reported, and glasses were raised in toasts to the electric future. Over the course of its five-year existence, the organization spawned fourteen local chapters, helped numerous central stations evaluate regional opportunities for supporting the electric vehicle, underwrote two national advertising campaigns to increase awareness of electric vehicles, and sponsored a handful of significant studies on operating costs, charging facilities, and other aspects of electric vehicle operations. It was reabsorbed into NELA in 1915. See Kirsch, "The Electric Vehicle and The Burden of History" (n. 2 above), 151–205, and Mom, *Geschiedenis van de Auto van Morgen* (n. 2 above), 411–96.

34. "The Central Station Opportunity in Electric Vehicles," *NELA Bulletin*, July 1914, 441.

35. Walter C. Reid, "Electricity as a Substitute for Horses in Local Removals," *Central Station* 12 (August 1912): 52.

36. "Federal Government Buys Electric Trucks," *Central Station* 12 (August 1912): 58.

37. Day Baker, "Electric Vehicle Fleets in the United States," *Commercial Vehicle* 6 (May 1911): 252. Emphasis in original.

38. Discussion of "Report of the Committee on Electric Vehicles," *Proceedings of the*

The difficulty of coming up with acceptable definitions of service compounded the problem. Should trucks and horses be compared according to purchase price? Trucks cost more than horses, but they did more work. But the way service was defined and measured influenced assessments of efficiency and value. The ton-mile emerged as the favored rubric, if only after a struggle. Initially, delivery companies were more concerned with the number of packages delivered than with their weight. Using average costs per package, electrics often outperformed slower horse-drawn wagons and more cumbersome gasoline-engine trucks.³⁹ Other operators favored a system that accounted for time as well as weight and distance; the ton-mile per hour, however, did not find broad acceptance.⁴⁰ Even operators who did measure service by ton-miles disagreed over how to categorize trips that involved multiple loading and unloading points. The commercial ton-mile was proposed to distinguish value-added service from absolute ton-miles hauled.⁴¹ Another study tried to incorporate standing time, speed, and ton-miles into a single score, but the complexity of the scheme limited its appeal.⁴² Because different spheres required different services, the absence of agreed-upon definitions of service meant that operators were unable to establish boundaries among them *ex ante*; instead, measurement systems were ultimately used only to monitor relative efficiency after a given type of vehicle had been adopted.

Supporters of the electric truck tried to come to grips with this problem by enlisting the help of university researchers. Boston Edison invited Harry F. Thomson of the Massachusetts Institute of Technology to perform a comparative study of electric, gasoline, and horse traction. Comparing five different types of vehicle service (suburban, city, furniture, beer, and coal), Thomson and his colleague Harold Pender concluded that electric vehicles were more economical than either gasoline-engine trucks or horse wagons, thereby supporting the dictum that electrics should be used wherever they were technically capable of doing the job. By the time Thomson and Pender completed their research, in 1915, they had identified three economic zones of operation (short, medium, and long haul) roughly corresponding to the domain of each of the different commercial vehicles:

National Electric Light Association, Thirty-Fifth Annual Convention, Seattle, 10–13 June 1912 (New York, 1912), 255.

39. Harold Pender and H. F. Thomson, "Observations on Horse and Motor Trucking," *Central Station* 12 (April 1913): 325–31.

40. "Efficient Work of Commercial Vehicles," *Commercial Vehicle* 8 (15 May 1913): 22.

41. "What the Ton-mile Is and How to Figure It," *Commercial Vehicle* 12 (15 April 1915): 21.

42. Joseph Husson, "Excessive Loading Time Decreases Efficiency of New York Brewery Trucks," part 4, *Commercial Vehicle* 11 (15 December 1914): 20–22. Electrics performed especially poorly on this combined score, but it is difficult to gauge the biases of the weighting system employed. In a sense, the eventual ascendancy of the ton-mile as the basis for comparison simply reflected the victory of the gasoline truck.

horse-drawn vehicles within a two-mile radius; electric trucks within a 6- to 10-mile radius; and gasoline-engine trucks for areas beyond a 10-mile radius (all depending upon local service conditions, of course).⁴³ For the supporters of the electric vehicle, this was welcome confirmation of the desirability of specialization.⁴⁴

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If the MIT survey and other reports comparing the relative costs of different modes of transport provided intellectual support for the idea of functional specialization, another major survey conducted by William P. Kennedy reflected a second ideological current within the community of electric truck supporters. A veteran of the very first electric vehicle ventures, Kennedy had occupied several important positions within the electric vehicle industry, including sales manager of Studebaker Brothers and chief of the Bureau of Service Efficiency at the Baker Motor Vehicle Company in Cleveland.⁴⁵ Kennedy criticized the university researchers because he distrusted their method of questioning utility managers, who, in Kennedy's words, were "necessarily amateurs" in these matters. As a result of their faulty methods, he argued, the detailed cost data revealed such a quantitative spread "as to destroy rather than to create any confidence in them."⁴⁶ Committed to building support for fleet management as a specialized profession, Kennedy emphasized that reliable data were available, but that most

43. "Boston Tech. Fixes Fields of Motor Trucks," *Commercial Vehicle* 13 (1 November 1915): 26–27. Based on a sample of 1,181 trucks and 5,787 horses in 107 companies, Thomson and Pender established that the electric truck, depending on the type of load, was 7 percent to 24 percent cheaper than the horse, whereas the cost of operation of gasoline trucks ranged between 86 percent and 111 percent of the cost of horse traction in like service. For package delivery, compared using total cost per package delivered, the electric was cheaper overall than the internal combustion truck. Equally noteworthy was their conclusion that the horse was cheaper than the gasoline truck in parcel delivery service within a range of seven miles. This study was only one of dozens if not hundreds of analyses attempting to demonstrate the relative advantages of one or another mode of commercial transport service; we discuss it in some detail here because it was among the most comprehensive and rigorous.

44. Pender and Thomson, "Observations on Horse and Motor Trucking," 331. For the MIT reports, see Harold Pender and H. F. Thomson, *The Economical Transportation of Merchandise in Metropolitan Districts* ([Boston], 1912), *Notes on the Costs of Motor Trucking* ([Boston], n.d.), and *Observations on Horse and Motor Trucking* ([Boston], 1913); H. F. Thomson, *Relative Fields of Horse, Electric, and Gasoline Trucks* ([Boston], 1914); H. F. Thomson, H. L. Manley and A. L. Pashek, *The Delivery System of R. H. Macy and Co. of New York* ([Boston], 1914). These were reprinted in *Commercial Vehicle* 13 (15 December 1915).

45. "The March Meeting," *Central Station* 9 (April 1910): 217–18; "Studebaker Activity," *Central Station* 10 (December 1910): 1786; *Central Station* 9 (February 1910): 242; *Central Station* 13 (February 1914): 340.

46. William P. Kennedy, "Operating Costs for Commercial Electric Vehicles," *Electrical World* 64 (3 October 1914): 664–65, and "A Practical Project to Secure Authentic Cost of Operating Commercial Electric Vehicles" (paper presented at Fifth Annual Convention of the Electric Vehicle Association of America, Philadelphia, 19–21 October 1914), Automobile Reference Collection, Free Library of Philadelphia.

of these data were confidential. In 1914 he started a campaign in the pages of *Electrical World* to collect these data using standard forms. The end result was an idealized national overview of the operating costs of three thousand electric trucks in which all reference to range and average distance covered was suppressed.⁴⁷ Beyond supporting the direct sale of electric vehicles, Kennedy had a longer-range goal: by inculcating cost-consciousness within the “horse economy,” he hoped to convince owners of horse-drawn commercial vehicles that they should opt for electric traction on purely rational grounds. Recognizing the threat that internal combustion posed to the electric truck, Kennedy omitted all mention of distance in his comparisons of the two. For Kennedy, public apprehension about the suitability of electric vehicles needed to be addressed by the “superior mentality” of the electric sales organization. This superior mentality gave the salesman “the function of the school teacher, rather than the essay of the scientist or the *spectacular delusiveness* of the so-called modern advertiser. . . . Therefore, *the real germ* to be cultivated in the salesman is an appreciation of the difficulties of mental conflict . . . together with a masterly domination by that force of superior will power which will practically compel a decision in his favor.”⁴⁸ Kennedy therefore expressed the costs of trucking not in dollars per mile or per ton-mile, but in dollars per day or per parcel.⁴⁹

Toward the Universal Commercial Vehicle

Electric trucks were purchased mostly—though not exclusively—for urban commercial vehicle fleets. According to an optimistic estimate produced by the German battery manufacturer Accumulatorenfabriek (AFA), at the end of 1913 there were 34,075 electric passenger cars and 17,687 electric trucks in the United States. Significantly, while electrics represented

47. William P. Kennedy, “Operating Cost of Commercial Electric Vehicles,” *Electrical World* 66 (21 October 1915): 1316–22, and “Operating Cost of Commercial Electric Vehicles” (paper presented at Sixth Annual Convention of the Electric Vehicle Association of America, Cleveland, 18–19 October 1915), Automobile Reference Collection, Free Library of Philadelphia.

48. William P. Kennedy, “Administrative Engineering and Salesmanship in the Commercial Car Field,” *Central Station* 11 (July 1911): 17, 24, and “Problems Involved in Advancing the Use of Electric Vehicles,” *Central Station* 10 (November 1910): 138–40 (emphasis in original).

49. Several nonutility fleet owners followed Kennedy’s advice. “[O]ne of the largest department stores in New York City,” for instance, reported that the reliability of its gasoline trucks varied between 70 percent and 90 percent, compared to 98 percent for its electric trucks. Similarly, a Chicago brewer reported that he employed only two men to maintain his fifty-eight electric trucks (some of which traveled as much as 50 miles per day), whereas his fifteen gasoline trucks “of the finest European make” were being repaired 30 percent of the time. See W. J. McDowell, “The Electric Truck in Brewery Service,” *NELA Bulletin*, March 1917, 213–15, at 215; “Electric Vehicle Efficiency in Department Store Work,” *NELA Bulletin*, December 1916, 922.

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only 3 percent of the total U.S. passenger car market, they accounted for almost 23 percent of the national commercial vehicle fleet.⁵⁰ Even though such comparisons are misleading (because they compare apples with oranges, electric city trucks with gasoline-engine trucks intended to provide universal service), the data do suggest, at a minimum, that even as late as 1914 the electric truck failed only in relation to the extraordinary success of internal combustion, not in absolute terms. At the regional or metropolitan level the data are even more striking. In metropolitan New York in 1914, 39 percent of all trucks were electrically driven. By 1916, the New York electric truck fleet had expanded to three thousand vehicles, nearly a quarter of the electric trucks in the nation. In Chicago, the largest electric passenger car market in the country, 910 electric trucks were in operation in 1915. According to a survey by *Commercial Vehicle*, by 1912 most large trucking fleets consisted of electric vehicles.⁵¹

But this pattern of expanding use of electric trucks could not hide the fact that smaller businesses were not buying them. In 1912 a mere forty companies owned 40 percent of all American electric trucks, and those represented only 10 percent of all American trucks; the other 90 percent were spread among seven thousand smaller companies. Contemporaries estimated that in fleets of fewer than five vehicles the electric truck conferred no cost advantage unless the owner could use a neighborhood public garage to help defray maintenance costs.⁵² Accordingly, proponents sought to expand the appeal of the electric truck for small-scale operators by reducing the purchase price, increasing the operating range, or both.

For the small merchant, purchase price posed a major barrier to the acquisition of a motor vehicle. Applying sales techniques developed in the passenger car market, gasoline-engine truck manufacturers and their representatives therefore stressed the relatively low price of their vehicles and de-emphasized operating and maintenance costs, which were higher. In response, several EVAA members proposed to build a light, cheap, delivery van, and Thomas Edison even tried his hand at becoming the "electric Ford." The most publicized response, however, was the Ward Special, which

50. H. Beckmann, "Das Elektromobil als Nutzwagen," *Allgemeine Automobil-Zeitung* (Berlin edition) no. 22 (1914), 23–26, 25–26.

51. F. F. Samson, "The Proper Application of the Commercial Vehicle," *Proceedings of the National Electric Light Association, Forty-Second Annual Meeting, May 19–22, 1919* (New York, 1919), 98–127. "Report of the Garage and Rates Committee" (paper presented at Sixth Annual Convention of the Electric Vehicle Association of America, Cleveland, 18–19 October 1915), Automobile Reference Collection, Free Library of Philadelphia. "The Trend of the Times in Truck Work, Part II: A Consideration of the Electric Vehicle," *Commercial Vehicle* 7 (March 1912): 27.

52. Stephen G. Thompson, "Is Central Station Activity in the Electric Vehicle Field Justified?" *Central Station* 11 (January 1912): 198; "The Electric Commercial Vehicle," *Central Station* 12 (July 1912): 30; C. L. Morgan, "The Proper Garaging of Electric Vehicles," *Central Station* 10 (December 1910): 167–70, at 167.

made its debut at the Electrical Show in New York in October 1914. The Ward Special sold for \$875, one-third to one-half the price of the cheapest and lightest electric trucks then available on the market.⁵³ But it was a specialized vehicle, stripped of all “unnecessary” extras (including sufficient batteries to make it usable as a general city vehicle), and suited only to fleet use. It had limited capabilities, even for an electric vehicle, and was therefore not a realistic option for the individual grocer or butcher who wanted a truck that could at least outperform a horse. Given a choice between an electric city vehicle and a more versatile, if less reliable, gasoline-engine truck, the individual merchant generally selected the latter.

Electric truck supporters also sought to mimic the versatility of the gasoline-engine truck by increasing the electric’s operating range. Several schemes to sell electricity by the mile were proposed. For instance, in June 1912 the Hartford Electric Light Company, with the technical support of the General Vehicle Company and the Edison Storage Battery Company, instituted what it called a Battery Service System (BSS). An individual would purchase a new truck without batteries, thereby reducing initial costs by several hundred dollars, and garage the vehicle in a BSS garage, where it would be maintained for a fixed sum. Whenever the battery ran low the driver could have it replaced with a fresh one. All costs of battery maintenance and repair would be handled by the garage, and at the end of each month the owner of the vehicle would receive an invoice based on the size of the truck and the number of miles traveled. By the fall of 1916 similar initiatives were reported in Spokane, Baltimore, Harrisburg, San Francisco, Los Angeles, Worcester, Fall River, and Wichita, serving a total of two hundred commercial vehicles.⁵⁴ Although none of these schemes succeeded in penetrating the large urban markets along the Eastern seaboard, other technological developments extended the operating range of the electric truck and reduced the competitive gap between the electric and the gasoline-engine truck for intraurban use.⁵⁵ The robust Edison alkaline battery,

53. “A Notable Electric Vehicle Campaign,” *NELA Bulletin*, November 1915, 706–7; Charles A. Ward, “The Small Electric Vehicle and Its Application,” *Proceedings of the Sixth Annual Convention of the Electric Vehicle Association of America, Cleveland, October 18–19, 1915* (New York, 1915), 9–11; “The Ward Special at the New York Electrical Show,” *Central Station* 14 (October 1914): 111–12; “The Ward ‘Special,’” *Central Station* 14 (February 1915): 251–52.

54. Willis M. Thayer, “The Hartford Electric Light Company’s Experience with the Battery Exchange System for Commercial Vehicles,” *Central Station* 15 (December 1915): 141–44; P. D. Wagoner, “Battery Service,” *Central Station* 16 (August 1916): 40–42.

55. This is an example of what may be called “the Pluto effect”: Think of Disney’s cartoon dog pulling the cart of technological change because a man on the cart is holding a sausage in front of his nose. Pluto—the alternative technology—never reaches his goal, whereas the man on the cart—the leading technology—will. See Gijs P. A. Mom, “Gasturbine als alternatieve voertuigaandrijving,” *Polytechnisch tijdschrift, editie Werk-tuigbouw* (November 1991): 44–47. For an example from the competition between electric power and gas lighting, see Hans-Joachim Braun, “Gas oder Elektrizität? Zur

introduced in 1909, and its lead-acid competitor, the Ironclad Exide, were both designed to withstand the “boost during lunch,” which doubled the range of the electric truck and rendered the difference in range between it and gasoline-engine trucks immaterial within city limits.⁵⁶

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Why, then, did the electric truck fail to make greater inroads into major urban markets once these improvements were in place? Several general observations provide crucial context. First, the electrical network was unevenly distributed across the vast American continent. Of twenty-two million American homes in 1917, only seven million were connected to an electrical grid, mostly in large cities, and fewer than one percent of these were “wired for *complete* electric service”—that is, wired to use electricity for lighting, power, and heat. In other words, electricity itself was not yet universal enough to support the universal electric truck.⁵⁷

Second, battery exchange was never as popular in the United States as it was in Europe, where such systems were financed, built, and operated by fleet owners and battery makers rather than central stations. In Amsterdam, the Amsterdamsche Taxameter Automobielen Maatschappij (ATAX), a successful electric cab company, used a disciplined and centralized maintenance schedule to produce increased range and profitability. In Berlin, the battery manufacturer AFA financed and built the public taxicab charging station.⁵⁸ But in the United States, both battery and vehicle manufacturers

Konkurrenz zweier Beleuchtungssysteme, 1880–1914,” *Technikgeschichte* 47, no. 1 (1980): 1–19.

56. A partially discharged battery could be 30 percent recharged in the space of one hour. An EVAA commission calculated that two boosts per day, one of an hour and another half an hour long, could double the original radius, making range unproblematic. Bruce Ford, “Recent Developments in the Lead Battery for Electric Vehicles,” in *Proceedings of the Fourth Annual Meeting of the Electric Vehicle Association of America, Chicago, October 27–28, 1913*, reprinted in *Central Station* 13 (November 1913): 69–71, at 70. Several ESB customers reported that the Ironclad Exide with tubular positive plates performed satisfactorily for as long as three years, with some battery sets covering more than 20,000 miles; see “Veterans,” *Central Station* 14 (September 1914): 75; “Ironclad-Exide’ Storage Batteries,” *Central Station* 14 (April 1915): 322.

57. “Looking Backward and Abroad,” *Central Station* 17 (December 1917): 196–98, at 197 (emphasis in original); George J. Kirchgasser, “The Electric-Vehicle Situation in Milwaukee,” *Electrical Review*, 27 May 1911, 1033–35. Of the six public garages in Milwaukee, half obtained power from an isolated plant.

58. An offshoot of Amsterdamsche Rijtuigmaatschappij (ARM), the major Amsterdam horse taxicab company, ATAX operated a fleet of approximately eighty electric taxicabs in the Dutch capital from 1909 to 1926. Using identical French Krieger cabs built under license in the German city of Bremen, the venture was so successful that it helped ARM weather the crisis of the Great War and the early twenties. Thanks to the managerial talents of technical director J. F. Friderichs and efficient maintenance contracts with

looked to the central stations as the natural focus for battery service. Moreover, American battery exchange plans were aimed at the general commercial truck market rather than at specific niche markets, as in Europe. All told, these plans did not produce high returns for the energy providers. In Boston, for instance, only the vehicle and battery manufacturers made a profit; the utility had to invest so much money in infrastructure and working capital that the battery service operation remained in debt as late as 1919.⁵⁹

Third, because both the battery and electric vehicle markets were highly competitive, no standardized battery service system ever emerged. Few companies were willing to surrender existing markets and proprietary technologies for the uncertain prospects of a thoroughly standardized electric truck. Other factors slowed developments aimed at increasing the range of the electric truck. During the war years, fears of municipalization—a takeover of services from private providers by cities—inclined many central stations against massive expansion into new, potentially monopolistic markets such as car and truck rental. And within the EVAA, opinion was biased toward large fleets. Despite sporadic appeals to remember the passenger car market, the individual commercial customer, and the smaller cities, the EVAA proved unable to integrate its efforts to support these disparate markets with its focus on large, urban fleets.

Taken individually, none of these factors need necessarily have resulted in the demise of the increased-range electric truck. But the domestic truck industry was transformed by the outbreak of war in Europe in 1914. The belligerents had recognized the military relevance of the motor truck several years earlier, and the main combatants, at least, had established programs to subsidize buyers of commercial vehicles. In France, Britain, Germany, and, later, Russia, prospective truck purchasers received up to \$1,200

the German battery producer AFA and some tire manufacturers, the cab fleet was a model of reliability and profitability. Founded in 1887, AFA used a decentralized network of regional engineering departments to enforce proper battery maintenance procedures and soon emerged as the leading German manufacturer of stationary batteries. After initially delaying entry into the automobile battery market, by 1908 AFA had introduced a highly reliable vehicle battery and established a leading position in that market as well. The new battery, in which thin sheets of wood were inserted between the lead battery plates, borrowed from techniques originally developed by AFA's American cartel partner, the Electric Storage Battery Company. It took AFA more than two years to fully develop this battery, drawing upon its close connections with major taxicab companies in Berlin, Hamburg and Bremen. See Gijs P. A. Mom, "Das Holzbrettchen in der schwarzen Kiste: Die Entwicklung des Elektromobilakkumulators bei und aus der Sicht der Accumulatoren-Fabrik AG (AFA) von 1902–1910," *Technikgeschichte* 63, no. 2 (1996): 119–51, and *Geschiedenis van de Auto van Morgen* (n. 2 above), 251–341.

59. J. B. N. Cardoza, "The Electric Vehicle from the Salesman's Standpoint," in *Proceedings of the National Electric Light Association, Forty-Second Annual Meeting, New York, May 19–22, 1919* (New York, 1919), 69–74, at 73.

from the government if they bought an approved truck, maintained it to military specifications, and agreed to surrender it to the state in case of war.⁶⁰ Although electricity was important at the front, electric trucks were not well suited for military applications. Not only did these subsidy programs tilt European markets away from electric and other nonstandard vehicle designs, but military subsidies also made the peacetime truck a de facto military technology. Standards for speed, range, and other performance measures were consequently set higher than commercial service alone would have required. When war needs rapidly exceeded the supply of subsidy trucks, the Allies turned to the American truck industry, and truck exports from the United States expanded dramatically in 1914 and 1915 as manufacturers rushed vehicles to Europe.⁶¹

The essential role played by motor trucks in the Great War has been examined elsewhere, but it has been overlooked by most historians of the automobile.⁶² As a director of Daimler Motorenengesellschaft observed, "the war might have shown many horrible things, but for automobilism it was the best conceivable propaganda."⁶³ For present purposes, it is important to note the multiple, reinforcing effects of war production upon the standardization of the commercial, peacetime truck. Electric vehicle manufacturers did make some minor initial gains. Britain purchased a number of electric delivery trucks to replace horses and gasoline-engine trucks that had been requisitioned for war duty.⁶⁴ When the United States government announced a series of carless Sundays in the fall of 1918, electric vehicles were excluded from the regulation. And electric trucks saw use in munitions depots and on navy docks.⁶⁵ In Europe, acute gasoline shortages cre-

60. "Conclusions from French Trials," *Commercial Vehicle* 5 (January 1910): 34-35; "Russian Army Buying More Trucks," *Commercial Vehicle* 9 (1 January 1914): 47.

61. In addition to European demand for trucks, the Allies also purchased thousands of American horses for export. Some 289,340 horses and 65,788 mules were exported from the United States in fiscal year 1915; "\$76,671,667," *Commercial Vehicle* 13 (15 August 1915): 17. Horses were still essential to the war effort; as one war correspondent reported, "The wastage of vehicles in the war is great; the wastage of horses is enormous;" "War Trucks Prove Value, Presage Progress," *Commercial Vehicle* 11 (15 November 1914): 17.

62. For exceptions, see Raburn (n. 2 above, pp. 164-78), who describes two turning points in the evolution of the American military truck, the military expedition into Mexico in pursuit of Pancho Villa and the siege of Verdun; James M. Laux, "Trucks in the West during the First World War," *Journal of Transport History* 6 (September 1985): 64-70; and Rodriguez (n. 2 above), 95-132. Also see Norman Miller Cary Jr., "The Use of the Motor Vehicle in the United States Army, 1899-1939" (Ph.D. diss., University of Georgia, 1980).

63. K. Helfferich, *Der Weltkrieg*, vol. 2 (Berlin, 1919), quoted in Joachim Radkau, *Technik in Deutschland: Vom 18. Jahrhundert bis zur Gegenwart* (Frankfurt am Main, 1989), 240.

64. "Baker Electrics Invade England," *Commercial Vehicle* 11 (1 December 1914): 11.

65. This intrafacility transport spurred the development of electric industrial trucks,

ated a cost umbrella that sheltered European electric vehicle fleets. In England, as in the Netherlands, the war was a bonanza for electric vehicle fleets. In Amsterdam, the ATAX taxi company prospered, and some British trucks remained in service for many years, forming the basis of the English milk and laundry “floats,” light-duty delivery vehicles that survived for decades.⁶⁶ But the war pushed electric trucks into an increasingly marginal market position. On the other side of the Atlantic the dominant effect was to increase the scale of commercial vehicle production and lower prices of American gasoline-engine trucks. Local and regional authorities may have favored electric traction (more so in Europe than in America), but national policies began to view transportation from an interurban perspective and to focus on the long-distance capability of the gasoline-engine truck.

Second, wartime pressure on the national railroad infrastructure and the devastating coal shortages of the winter of 1918 highlighted the need for an alternative to the railroads for long-haul transport. As more and more companies began to experiment with motor trucks for overland freight, road building assumed strategic and military importance. Mobilizing for war revealed the importance not just of good roads but of a road network that would facilitate efficient haulage.⁶⁷ As one *Commercial Vehicle* editorial observed, “the war has shown the businessman how to use trucks in ways heretofore undreamed of.”⁶⁸ The strong export demand also allowed makers of gasoline-engine trucks to reorganize their manufacturing processes to take advantage of important economies of scale. As William Kennedy noted in a speech to the EVAA in 1916, the “abnormal” growth in demand for gasoline-engine trucks for military purposes had allowed those manufacturers to unload “old or obsolete materials” and “organize their equipments [*sic*] for quantity production.”⁶⁹ And following the war, thousands of surplus trucks were distributed to state highway departments to further the construction of good, truck-ready roads.⁷⁰

a market that would later become the mainstay of electric traction during the interwar years. “Electric Vehicles Not Barred on Sundays,” *NELA Bulletin*, September 1918, 499; “Electric Transportation for Explosives,” *NELA Bulletin*, April 1917, 308; “Government Use of Electric Trucks,” *NELA Bulletin*, June 1918, 390.

66. Stanley M. Hills, *Battery-Electric Vehicles* (London, 1940), 9–14.

67. Describing the situation in early 1916, another editorial noted, “We are not lacking in mileage of good roads. The difficulty is that such as we have are not correlated into any sort of logical or strategic system”; “Motor Preparedness,” *Commercial Vehicle* 14 (1 February 1916): 13. Raburn, 183. Rodriguez argues convincingly that the gasoline truck was more important than the passenger car in shaping early highway construction efforts. Also see Bruce Seely, “The Scientific Mystique: Highway Research at the Bureau of Public Roads, 1918–1940,” *Technology and Culture* 25 (1984): 798–831.

68. “Back to Business,” *Commercial Vehicle* 19 (15 November 1918): 26.

69. William P. Kennedy, “Central Station Promotion of Electric Vehicle Use,” *Central Station* 15 (June 1916): 322.

70. By midsummer 1919, 27,983 trucks had been transferred to state ownership;

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Third, war needs guided the technological development of the military standard Class B truck (the so-called Liberty truck) and its many technological descendants away from strictly commercial performance criteria.⁷¹ For instance, pneumatic tires, which enabled operation at higher speeds, soon became standard equipment on all commercial vehicles, as did large fuel tanks, running lights, and heavy-duty bumpers. After the war these standardized trucks were the preferred means for farm-to-market transport, the backbone of the truck industry in the 1920s.⁷²

Production figures suggest the scale of the changes brought about by the war. In 1911 U.S. annual truck production amounted to about 11,000 units; by 1919 that number had increased to 335,000, and the national truck fleet totaled 900,000 vehicles.⁷³ As late as the 1920s, the United States Bureau of Public Roads found that 71 percent of the trucks in California, 72 percent in Ohio, and 81 percent in Pennsylvania and Connecticut were driving daily routes shorter than 29 miles. Most of this service, in other words, could have been provided by electric trucks. However, the bureau also found that of the 420,503 "motor truck fleets" in the United States, 65 percent consisted of one or two vehicles.⁷⁴ The universal gasoline-engine truck held a commanding market position.

With the spectacular expansion of the gasoline-engine truck market, support for the electric truck in general, and for the EVAA in particular, degenerated into a highly ideological, if not quasi-religious, movement: "spreading the gospel," "converting the public," and "preaching . . . the ser-

George Romney, "The Motor Vehicle and the Highway: Some Historical Implications," in *Highways in Our National Life*, ed. Jean Labatut and Wheaton J. Lane (Princeton, N.J., 1950), 224. Raburn (n. 2 above, 178) has argued that the surplus trucks were less important than the enormously expanded production capacity.

71. In contrast to the Europeans, the American military establishment had failed to incorporate trucks into war planning. The federal government owned several hundred trucks for use by various departments and for transportation at naval shipyards, but on the whole the American public sector was a distant observer of the motor vehicle market. As of 1916, the industry, by virtue of a year and a half of war exports, knew more about military trucks than the Quartermaster Corps. Discussions aimed at creating a standard war truck were initiated through the Society of Automobile Engineers, and by the time the United States entered the war, in 1917, several standard designs were already on the drawing board. "Opportunities for Demonstration," *Commercial Vehicle* 1 (July 1906): 176; "No Trucks for Army Work," *Commercial Vehicle* 1 (August 1906): 213; "Motor Preparedness," *Commercial Vehicle* 14 (1 February 1916): 13; "101 Makers Out of a Possible 200-Odd Bid on Five Classes of Army Trucks," *Commercial Vehicle* 16 (15 June 1917): 14–15.

72. Raburn, 188; also see S. V. Norton, *The Motor Truck as an Aid to Business Profits* (Chicago, 1918), 473.

73. F. Van Z. Lane, *Motor Truck Transportation: The Principles Governing Its Success* (New York, 1921), iii.

74. John Lieb, "Electric Vehicles," report prepared for Union Internationale des Producteurs et Distributeurs d'Energie Electrique, Paris, July 5–10, 1928, ConEd (formerly New York Edison) library, New York; H. C. Cushing Jr., *The Electric Vehicle Handbook* (New York, 1923), 182.

mon of the electric truck” became common metaphors in an association that grew increasingly frustrated as the market for electric vehicles failed to expand. William Blood, the first EVAA president, called himself “a firm believer” in the electric truck and noted that the EVAA was founded “to sing the praise of the electric vehicle as such.” Celebrities such as Charles Steinmetz and Thomas Edison functioned as priests who prophesied a golden future for the electric vehicle. At a 1914 appearance, Steinmetz predicted that the market for electric vehicles would reach two million vehicles within ten years, and at every EVAA conference the audience was reminded of Edison’s 1910 forecast that within fifteen years more electricity would be sold for electric vehicles than for industrial purposes.⁷⁵

Utility managers clung doggedly to their view of the future of motor vehicle technology. For NELA president Walter Johnson, for instance, “electricity [was] destined to supersede all other forms of energy for light, heat and power, and . . . such a condition can be more readily and easily secured through the scientific co-ordination of all related efforts.”⁷⁶ Within the more narrowly focused vehicle culture of the EVAA the ultimate ascendance of the electric truck was a similar article of faith. The more the market for internal combustion trucks expanded, the more a kind of ecstatic belief in an imaginary future was strengthened, and the more the outside world was seen as hostile to a just and rational cause. As the electric vehicle campaigns wore on, setbacks in the spread of the electric vehicle were experienced as proof of insufficient belief in the good cause. This remarkable process of sect formation culminated in mid-1915 in the publication of “A Creed,” signed by a number of utility managers. The first lines of this “doctrine of the electric” read as follows:

WE BELIEVE

In the electric vehicle.

That the electric vehicle is destined to
supersede other forms of transportation methods
at least for city and suburban work.⁷⁷

The true believers knew that the electric vehicle was destined to succeed.⁷⁸

75. A. Jackson Marshall, “Report of the Electric Vehicle Section,” *NELA Proceedings of the War Convention, May 9–10, 1917, New York* (New York, 1917), 7–14, at 9; E. S. Mansfield, “Address of Chairman Mansfield,” *Proceedings of the National Electric Light Association, Forty-Second Annual Meeting* (n. 59 above), 2–8, at 6; William Blood, presidential address to the first annual meeting of the EVAA, New York, 18 October 1910, reprinted in *Central Station* 10 (November 1910): 3; “June Meeting of the Electric Vehicle Association of America,” *Central Station* 14 (July 1914): 13–21, at 17; “Steinmetz Predicts Electric as Eventual Vehicle,” *Commercial Vehicle* 10 (15 June 1914): 15–17.

76. Walter H. Johnson, “Electric Vehicle Section, N.E.L.A.,” *NELA Bulletin*, 1916, 199–200, at 199.

77. “Electric Vehicle Association of America,” *Central Station* 14 (June 1915) 381–96, at 395.

78. Joseph J. Corn has identified similar religious tendencies among prewar American

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But as the market for electric vehicles stagnated, the number of true believers dwindled. In 1916, the EVAA ceased to exist as an independent entity and was reorganized as the Electric Vehicle Section of NELA. Although the electric truck went through a third modest wave of interest during the early twenties, the utilities that had pinned their hopes on the electric truck began to look elsewhere—to refrigeration, for example—for load building and leveling. When NELA president George B. Foster liquidated the Electric Vehicle Section in 1920, he justified his actions by noting that “less than 2 per cent of . . . [the electric truck manufacturers’] products [were sold] to or through central stations.”⁷⁹ Like small-scale truck owners earlier, by 1920 even the smaller electric utilities were lost to the cause of the electric vehicle.

Despite the collapse of the idea of separate spheres and the ultimate failure of the universal electric vehicle, the electric truck continued to play an important role in fleet service. By far the most impressive example was the fleet of the American Railway Express Company (AREC). The result of a merger of four large express companies (Adams, American, Southern, and Wells Fargo), in 1919 AREC operated a fleet of 1,058 electric trucks in twenty-three cities. In 1924, Edward E. La Schum, superintendent of AREC, conceded that gasoline-engine trucks were always cheaper to operate than electrics on a ton-mile basis. However, La Schum argued that it was the cost per route, not the cost per mile or per truck, that justified the choice of one technology over another.⁸⁰ La Schum collected data from ten unspecified cities in which American Railway Express operated both electric and gasoline-engine truck fleets. La Schum’s data (table 2) show that, based on over 9 million gasoline-truck miles and 6 million electric-truck miles, electric trucks were considerably cheaper to run and keep than gasoline ones.⁸¹ “The electric truck,” La Schum concluded, “is essentially a city delivery unit, and especially economical in house-to-house delivery. It is not the best unit for most of the work the gas truck has taken from the railroads or created for itself. It is the most economical transportation unit sold for practically

aviation enthusiasts; see *The Winged Gospel: America’s Romance with Aviation, 1900–1950* (New York, 1983). More recently, David F. Noble has explored these themes at a more general level in *The Religion of Technology: The Divinity of Man and the Spirit of Invention* (New York, 1997).

79. “Electric Vehicle Section Session,” in *Proceedings of the National Electric Light Association, Forty-Third Annual Meeting, Pasadena, May 18–22, 1920* (New York, 1920), 451–56, at 455.

80. Edward E. La Schum, *The Electric Motor Truck: Selection of Motor Vehicle Equipment, Its Operation and Maintenance* (New York, 1924), 12, 285.

81. La Schum recognized that gasoline and electric trucks were not strictly comparable. Because gasoline trucks could travel farther and faster, La Schum presented data from the Westcott Express Company of New York City on its fleet of fifty-one electric and twenty-nine gasoline trucks. In 1922, Westcott paid 14.9¢ per package delivered by gasoline and 12.7¢ per package delivered by electricity. La Schum, 218–21, 286.

TABLE 2
RELATIVE COSTS OF DELIVERY BY ELECTRIC VEHICLE, AMERICAN RAILWAY EXPRESS COMPANY, 1922

	City Number										AVERAGE
	1	2	3	4	5	6	7	8	9	10	
Miles Traveled											
Gasoline	3,467,458	1,189,254	253,972	808,039	2,284,526	716,780	678,043	318,059	288,062	250,776	
Electric	2,661,241	777,954	328,084	1,239,121	634,573	503,642	331,539	201,035	365,915	216,420	
Fuel											
Gas/Oil	1.81	1.92	2.02	1.73	1.31	1.48	1.56	1.05	1.27	1.96	1.61
Charging	0.65	0.42	0.42	0.60	0.45	0.48	0.48	0.41	0.66	0.56	0.51
Batt. Main.	0.94	0.61	0.19	0.19	0.83	0.55	0.12	0.68	0.65	1.41	0.62
Electric Total	1.59	1.03	0.61	0.79	1.28	1.03	0.60	1.09	1.31	1.97	1.13
Garage Expenses											
Gasoline	1.69	0.94	1.81	2.13	1.49	1.10	0.99	0.85	1.34	1.78	1.41
Electric	1.01	0.67	1.37	1.18	1.10	0.96	1.32	1.40	0.84	1.70	1.16
Chassis Repair											
Gasoline	2.81	3.00	2.76	3.14	1.87	2.01	2.04	1.14	0.23	1.50	2.05
Electric	1.52	1.35	0.71	0.86	1.19	1.27	0.36	0.22	0.43	0.75	0.87
Total Costs											
Gasoline	6.31	5.86	6.59	7.00	4.67	4.59	4.59	3.04	2.84	5.24	5.07
Electric	4.12	3.05	2.69	2.83	3.57	3.26	2.28	2.71	2.58	4.42	3.16
Electric as Percent of Gasoline	65.3	52.0	40.8	40.4	76.4	71.0	49.7	89.1	90.8	84.4	62.1

Source: Edward E. La Schum, *The Electric Motor Truck: Selection of Motor Vehicle Equipment, Its Operation and Maintenance* [New York, 1924], 219–22.)
Note: Costs are per truck per day. Figures are U.S. dollars except as noted.

all the work still done by horses in cities and large towns. It is the most economical transportation unit for much of the work the gasoline truck has taken from the horse.”⁸²

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Nor was AREC alone in its enthusiasm for the electric commercial vehicle. Commonwealth Edison of Chicago continued to add electric vehicles to its service fleet through the 1920s. With the retirement of the last of its horse-drawn wagons, in March 1922, the evolution of the Commonwealth Edison service fleet reached its midpoint. Over the remainder of the decade the company touted the benefits of electric trucks and expanded its stable of electric vehicles. It helped organize an “Electric Vehicle Course,” twice-weekly lectures offered through the Automobile Continuation School of the Chicago Board of Education, intended for “drivers, mechanics, garage employes [*sic*], battery mfg. employes [*sic*], and owners of cars.” Other promotional activities included an electric vehicle show at which prospective customers were invited to see the latest in electric vehicle technology.⁸³ In mid-February 1925, John Gilchrist reported that the company was operating between 350 and 375 electric vehicles: “Naturally we would use electric automobiles [commercial vehicles] if they were at all economical, but we are glad to say that they are very much more economical than gasoline trucks.”⁸⁴ Although the market for new electric trucks remained quite small, Commonwealth Edison continued to operate electric trucks throughout the 1920s, and to build them, through its subsidiary the Walker Vehicle Company.

But in 1933 Commonwealth Edison sold the Walker Vehicle Company to the manufacturing concern Yale and Towne. Thereafter, the utility bought no new electric trucks, and the number of electrics in the vehicle fleet began to shrink through attrition. In 1947 the last one was taken out of service, forty-eight years after the company had registered its first electric commercial vehicle.⁸⁵ This general pattern of substitution was replicated many times in various firms and organizations; the electric truck paved the way for motorization, but in the end proved incapable of satisfying the demand for universal, mass motorization.

82. *Ibid.*, 299.

83. The show was originally organized to coincide with the NELA annual meeting in Chicago in 1921, but it was so successful that the exhibit continued for several years as an annual promotional event. See *Automobile Continuation School*, folder F3a/E4, Commonwealth Edison Company, Chicago; also see *Edison Round Table*, 15 October 1922, 3.

84. John Gilchrist, speech before the Women’s Club of Chicago, 26 February 1925, history folders, Commonwealth Edison Company, Chicago.

85. *Edison Round Table*, October 1947, 11.

The Limits of Rational Choice

The demise of the electric commercial vehicle suggests several points about the history of the motor vehicle industry and the history of competing technologies more generally. At the most general level, it underscores the extent to which the universal vehicle emerged in fits and starts. In retrospect, the process of convergence upon internal combustion appears continuous and self-evident. But key events, such as the initial failure of the electric automobile at the turn of the century and the surge in demand for gasoline-engine trucks created by World War I, shaped the evolution of the universal vehicle. For many, especially in the Electric Vehicle Association of America, there could be no such thing as a universal vehicle unless it was electric. The truck was not a “toy” like the internal combustion passenger car; it was a business proposition, and since (in specific places, at certain times, for discrete functions) electric trucks were demonstrably cheaper and more reliable than gasoline-engine vehicles, a shared market should necessarily persist. Among the electric utility elites, who had seen their product conquer market after market, there was even the hope that with the help of battery exchange systems, and by developing the practice of partially recharging the battery during the work day, the electric vehicle would become the universal standard. The norms defined by the pace of horse-drawn transport and the belief in the benefits of recognizing separate spheres of action for both new and traditional forms of motive power also shaped the process of universalization, and they are as important to the history of motorized road transport as are pneumatic tires, pasted battery plates, and the assembly line.

Neither the outbreak of war nor its technical liabilities determined the fate of the electric truck. Rather, its peculiar success resulted from the functional congruence of horse wagon and electric truck. The electric vehicle allowed merchants to expand service without destabilizing existing business organizations. The continued use of horses for short-haul freight dictated the necessity of recognizing separate spheres of action for horse-drawn and motorized vehicles, and in those circumstances electric trucks seemed different, better, and, therefore, worthy of their own sphere. But with the demise of horse-based transport, acceptance of more fundamental changes in delivery systems, eventual agreement on a standard definition for the ton-mile, acknowledgment of speed and range as important design criteria for commercial trucks, and the inability of the proponents of specialization to effectively define the economic boundaries between the supposedly distinct fields of action of the horse, the electric, and the gasoline-engine truck, the electric truck’s sphere grew smaller and smaller.

The needs and constraints of small businesses—the butcher, the grocer, the merchant who owned one or two commercial vehicles—proved crucial in the end. As long as the market for electric trucks in urban commercial

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vehicle fleets was expanding, manufacturers, fleet owners, and central stations could combine to form an effective advocacy organization, the EVAA. In these settings, electric traction was a superior technology, not an inferior one. But as demand from that quarter lagged, the electric truck market essentially stopped growing. The small-scale owner did not have the luxury of assigning different vehicle types to specialized tasks. For small-scale commerce, the versatility of the gasoline-engine truck conferred an unanswerable advantage. It seems that the process of rational choice, often presumed by economic theory to occur when technologies compete, may be powerfully constrained by time, place, and especially intended application.