The Electric Car and the Burden of History: Studies in Automotive Systems Rivalry in America, 1890-1996

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This dissertation explores the path dependent process by which internal combustion emerged at the turn of the century as the automotive technological standard. Could an alternative to internal combustion – i.e., the electric vehicle – have become the technological standard for the Automobile Age? Drawing upon methods and theoretical insights from history, economics, and environmental studies, the dissertation suggests that alternative technological pathways existed, but only for a brief period of time before 1902. During this window of opportunity, fledgling electric and, to a lesser extent, steam vehicles might have played an important enough role in the automotive system to have precluded the total dominance of the gasoline automobile. But this did not happen, and as the gasoline-based system expanded in scope and scale, alternatives to internal combustion were increasingly destined to fail.

First, a disclaimer: this work does not purport to be "The History of the Electric Vehicle." Postmodern theory aside, the existing literature on the history of the automobile and of electricity is too vast and the range of actors and events too great to hope for a comprehensive narrative. Rather, drawing upon methodological developments in the history of large-scale technological systems and the economics of technological change, I have identified a series of potential "turning points" in the evolution of the standard American car, points at which the very substance of the artifact was being contested. From complex cultural and institutional questions – i.e., Would the American car be privately owned, operated, and maintained, or would motor transport service be provided by hired drivers, livery owners, and fleet operators? – to seemingly straight-forward matters of standardization – i.e., Would Americans drive on the right or the left side of the road? – these issues were decisive in establishing the configuration of the early American automobile system. Due to the interactions of multiple, independent users and consumers – so-called network externalities – these turn-of-the-century decisions resulted in a path-dependent

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process and lent structure to the built environment that surrounds us even today. Accordingly, the narrative in the following pages, as in the longer dissertation from which these pages are taken, describes a series of vignettes, critical moments in the history of the automobile when alternative outcomes were possible and then foreclosed.

Second, the general reader may require a short overview of the relevant historical literature. The full dissertation contains a complete historiographic survey, and interested readers are invited to review it there. Several highlights are crucial to the purpose of the larger work. Specifically, an important impetus for this study was to "rescue" the alternatives to internal combustion from the shadow of orthodox interpretations of the history of the automobile. Accepting the "standard," gasoline automobile (i.e., the 1901 Mercedes or the 1908 Model T) as the logical endpoint of technological development, scholars have tended to view alternatives like steamers and electric cars as antiquarian footnotes to the mainstream story, technological curiosities that stood no real chance of shaping the course of American technological history. In this sense, automotive historians have long labored under the weight of their own intellectual path-dependence.

Viewed from afar, the orthodox interpretation is a near tautology. The best technology won because it was the best technology; moreover, because it had won – and was therefore the best technology – there was no need to question the fundamental criteria by which it was selected as the best technology. It was held to be self-evident: the putatively intrinsic characteristics of refined petroleum (high energy density) and the lead-acid battery (low energy density) destined the former to prevail over the latter.

To do what? For whom? In what social context? These questions have been seen as less important than what the winning internal combustion technology was uniquely capable of providing: speed, power, and range. Yes, the "standard" automobile came to possess these attributes, but was it preordained to be so, as the orthodox view would have us believe, or was the process of technological evolution potentially open to other outcomes? The "universal" car emerges from the literature as a given, but why was it necessary that only one fundamental technology would today power vehicles as different from each other as, say, a Mazda Miata is from a Chevy Suburban? Thus, in a host of subtle and not-so-subtle ways, the existing literature has shaped our collective thinking about the car and limited our ability to imagine the American automobile as anything other than what it is: privately owned, operated and maintained; driven on the right with a steering column on the left; using pneumatic or inflatable tires; and, most important for this study, powered by a stand-alone, 4-cycle, internal combustion engine.

This contribution to the literature about the automobile suggests that the automobile itself should not be considered a given. Society created the automobile; even the staunchest technological determinist must admit this fundamental truth. But what did we create it to do? And how did the stable technological configuration that emerged better satisfy social needs than the available alternatives? Why, for instance, was it important that automobiles be

capable of traveling long distances at high speed, instead of simply providing dependable, usable, clean local service? In answering these questions, this dissertation attempts to understand the automobile as the material embodiment of the dynamic interaction of consumers and producers, private and public institutions, existing and potential technological capabilities, and prevailing ideas about gender, health, and the environment. The automobile came to symbolize a specific constellation of social objectives – speed, technological prowess, the experience and conquest of road-accessible nature. We are locked in now, but as we look forward to the second century of the automobile, we can foresee the automobile in a new and different social context. The automobile system was always flexible – in theory – but in practice there were limits to this flexibility. These limits were set not by the workings of the internal combustion engine *per se*, but by the inertia of the technological system that grew up around it.

The Failure of the Electric Vehicle Company, 1897-1901

In the spring of 1897, the Electric Carriage & Wagon Company established the first motor vehicle service in the United States. Using approximately a dozen vehicles, the EC&WC's electric taxicabs were intended to compete with the horse-drawn cabs then in service on the streets of New York City. A central claim of the dissertation is that this venture – and its many progeny – represented a legitimate alternative technological system to that embodied by the choice of internal combustion.

How did the vision of motorized road transportation put forward by engineers Henry Morris and Pedro Salom differ from that shared by the other automobile manufacturers of the day? Among the several distinguishing features of Morris and Salom's effort, the most important was their decision to retain ownership of the experimental motor vehicles. Morris and Salom were convinced that the motor car – regardless of its motive power – was as yet too complicated and unreliable to be entrusted into the hands of lay operators. Recognizing the latent demand for motor service, Morris and Salom opted to create a transportation service company rather than a simple automobile sales company. In this respect, the two pioneers differed not only from the typical internal combustion vehicle producers, but also from other electric vehicle manufacturers as well.

Morris and Salom's strategy was based upon the model of livery stables that leased horses and carriages by the trip, by the day, or even by the month. They chose not to sell artifacts into the hands of unsuspecting and untrained owners, but instead to design an integrated transportation system. Their initial operating results, self-reported in the automotive press after six months of service, suggested that their vehicle service was not yet competitive with the horse-drawn cabs. Daily mileage averaged approximately 11 miles per cab, and using cost estimates from studies conducted at MIT in the early 1910s, the electric vehicle service was almost certainly a money loser during its first half-year. Yet, regardless of its initial profitability, the venture established an

alternative to horse-drawn passenger transportation service and demonstrated sufficient potential to encourage the owners to expand the fleet from a dozen to over 100 electric vehicles.

Over the course of the following four years, the electric vehicle service started by Morris and Salom blossomed into the largest automobile enterprise of the day. At its height the Electric Vehicle Company was both the largest vehicle manufacturer and the largest owner and operator of motor vehicles in the United States. With multiple assembly plants, operating companies in the half-dozen largest cities in the country, and sales agents from San Francisco to Mexico City to Paris, the EVC was also one of the first American motor vehicle makers to move away – however tentatively – from the small-scale production of custom-made vehicles that dominated the emerging industry in the 1890s. Rather, the expansive, multi-divisional corporate structure of the EVC anticipated some of the innovations in corporate governance – Alfred Chandler's managerial revolution – which would spread through the rest of the automobile industry in the decade following the collapse of the EVC. Unfortunately, following its takeover by the Whitney-Philadelphia syndicate, the Electric Vehicle Company also became synonymous with trust building, stock jobbing, financial chicanery, and the infamous Selden patent.

Had the EVC succeeded in establishing profitable operating companies in major urban areas, and had those companies attracted customers, suppliers, and infrastructure providers to the electric vehicle bandwagon, it is possible to envision a radically different transportation system today. As it was, the enterprise was beset by problems, from production delays and warehouse fires to shareholder suits and blistering public attacks. Although several regional operating companies were established and perhaps 2,000 vehicles distributed to them, by 1902 all had declared bankruptcy, and the parent company was reduced to little more than a holding company for the contested Selden patent. The assets of the New York branch were transferred to a local operator, and the vehicles were used intermittently for service in and around Central Park for several more years. An unfavorable legal decision and an economic downturn would ultimately force even the EVC itself into default in December, 1907, ending once and for all the founders' dreams of electric cabs on every corner in every major American city. Between its humble beginnings and its ignominious collapse, the EVC demonstrated that electric vehicles could provide valuable transport service.

The Electric Vehicle Association of America and the Electric Commercial Vehicle

If the failure of the EVC at the turn of the century suggests a "path not taken" on the road to mass motorization, the failure of subsequent efforts to reintroduce electric vehicles underscores both the speed with which American society embraced the internal combustion standard and the magnitude of the barriers to further change which the gasoline standard erected. For a brief period before 1902, several doors were open, each leading to different auto-

motive futures. Two subsequent chapters of the dissertation explore attempts to hold the door open and thereby prevent the complete dominance of internal combustion; space constraints only permit an overview of the first of these chapters.

The Electric Vehicle Association of America was officially created in 1909 through the efforts of Boston Edison. During the course of its seven-year existence, the EVAA served as a focal point for supporters of electric vehicles. Following a period of intense competition and structural consolidation in the 1890s, the electricity supply industry (consisting of local "central stations") underwrote various marketing schemes aimed at increasing consumption of their product. Diversification – spreading the electrical load across a wide range of individual, commercial, and industrial applications – was a crucial part of this general strategy. And, compared to other electrical appliances like fans, irons, hot plates, and domestic lights, the electric vehicle represented close to the ideal load. Electric vehicles consumed large quantities of electricity; they could be charged at off-peak times when stations had excess power that they were otherwise unable to sell; and the "character" of the load was "absolutely ideal" – vehicle batteries drew power evenly over relatively long periods of time (i.e., overnight). Yet, prior to the establishment of the EVAA, only a handful of central stations had bothered to support the spread of electric vehicles.

EVAA members, who included electric generating companies, vehicle manufacturers, and storage battery makers, adopted a simple motto – "To encourage the adoption and use of electric commercial and pleasure vehicles by electric light and power stations and their customers." This encouragement took many forms. Managers of central stations were prodded to use electric vehicles for their own transportation needs, to offer reduced rates for electricity for charging vehicles during periods of slack demand, and to develop and operate public garage and charging facilities. Massive publicity campaigns were mounted to counter the negative image of the electric vehicle, to highlight the general advantages of the electric vehicle as an urban alternative to the horse, and to encourage motorization for commercial services. An EVAA committee sponsored research to develop a standard charging plug to allow vehicles of different makes to be charged at remote locations. Eventually, in 1916 the association was enfolded into the National Electric Light Association (NELA) – the umbrella association for the electrical industry. There, it survived for several more years as the Electric Vehicle Section of NELA before finally being phased out in the mid-1920s.

Although the dissertation describes the history of this institution in considerable detail and explores a range of questions concerning its relative success or failure, for the central argument about path dependence and the process of technological standardization of the American automobile, we can narrow the scope of the analysis considerably. Specifically, if the electric vehicle was a valuable addition to the central station's load curve, as all concerned agreed and as 1990s energy policy analysts continue to claim, why was enthusiasm for electric vehicles within the electrical industry so slow to emerge? Several possible explanations can be advanced. Richard Schallenberg

attributed the delay to the decline of interest in passenger electric vehicles. Only with the commercial revival at the end of the first decade of the century did the central stations rediscover the benefits of the electric vehicle load. This interpretation misses the point. The electric vehicle revival occurred because a few central stations in leading cities like Boston and New York never stopped using electric vehicles. A better causal account is needed. Perhaps the successful introduction of the Edison iron-nickel battery explains part of the change of heart among the central station executives who had been trained with Edison's distrust of the lead-acid battery ringing in their ears. Looking at the development of various industrial sectors, it is also possible that at the turn of the century, the electrical industry was still in the midst of major structural consolidations and technological changes that blinded management to the electric vehicle market. In 1900 central station managers were focused on scaling up, on expanding production, and on building larger and more efficient electrical systems. The introduction of the first turbogenerators led managers to look towards larger turbogenerators, not to the small, distributed systems used in automobiles. And to many in the industry, the car was still just a toy – a weekend distraction – not a serious business proposition. It was only as the central station business environment stabilized and managers began to see the automobile as more than another fad that the industry began to look seriously at the electric vehicle market.

Might the competition among steam, gasoline, and electric vehicles have turned out differently if the central station industry had thought to create the EVAA in 1898 instead of 1908? Possibly. David Sicilia concluded of the EVAA that "marketing could not guarantee the economic success of a weak technology; at best it could only induce an Indian summer." But had the association existed in the late 1890s, when all three technologies were, in certain respects, equally "weak," concerted intervention by a powerful industry might have been able to tip the scales towards a more robust separate sphere for the electric vehicle. Instead, a decade-long head start for internal combustion was too much for the central station industry to overcome.

Conclusion: What "Really" Might Have Happened?

Had the EVC succeeded in establishing dependable, for-hire transport service at the turn of the century, central stations might have recognized the potential of electric vehicles sooner than they did. Battery service might have been introduced ten years earlier, and with an expanding market for electric vehicle service, progressive central stations might even have established remote battery exchange depots to extend the overall service area. It would certainly have been no more unreasonable to imagine urban and suburban battery exchange stations sprinkled throughout our neighborhoods than to envision gasoline stations equipped with underground tanks containing thousands of gallons of highly flammable refined petroleum delivered weekly by tanker truck. Although by 1900 electric vehicles were already at a disadvantage for touring and an all-electric system might have been out of the question, a hybrid system

in which gasoline and electric vehicles served separate markets might have persisted for years, if not decades. Both the timing and the scope of the failure of the EVC were crucial; only a massive venture that provided transportation service as a system stood a chance of fending off the dominance of internal combustion. Yet it was the very scope of the EVC's failure that soured public opinion against electric vehicles and undermined other efforts to introduce the technology.

The inter-system rivalry that first emerged in the late nineteenth century continues today, but under very different circumstances. Not only has the unprecedented spread of internal combustion resulted in dramatic changes in the built environment, but the intervening decades have also witnessed the extraordinary success of electricity. By 1980 nearly 40% of primary fuels were being used to generate electricity. Electricity has become the energy carrier of choice for almost every imaginable stationary application of power. Despite the relative decline of fixed-route public transit and the singular failure of American railroads to electrify long-haul service, electricity still plays an important role in transportation. Moreover, electrification is now sufficiently universal and standardized that the availability of electricity would no longer restrain the spread of electric vehicles. The long-run prospects for increasing electrification of transportation are good. The question is "when," not "if." Although today we are further from an all-electric, motorized road transportation system than ever, the medium-term outlook for a new hybrid electric trajectory is very good.

References

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