The Grammar of Technology

German and French Diesel Engineering, 1920–1940

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At a meeting of the Verein Deutscher Ingenieure (VDI, German Engineering Society) in 1925 Imanuel Lauster, an honorary doctor of engineering, expressed his "deep satisfaction" with the latest successful developments in diesel engineering. As a board member of the Maschinenfabrik Augsburg-Nürnberg (M.A.N.), he was pleased to note that it was *German* engineers and companies that deserved the credit for this success. Lauster claimed that "the diesel engine in its present form is still a German engine" and hoped that "it will remain so."[1]

Lauster did not utter these words in connection with any kind of celebration or anniversary. His assertion of the German character of the diesel engine at that time was meant as an exhortation to retain Teutonic hegemony in the field of diesel engineering. Growing international interest in the engine was threatening to shift the initiative away from German firms to foreign companies. Lauster's address could be interpreted as a desperate attempt to build a German coalition that could withstand foreign competition and influence. A couple of years later, similar attempts would actually lead to the design of a German "uniform diesel" (*Einheitsdiesel*).

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0040-165X/99/4001-0002$8.00

1. Imanuel Lauster, "Entstehung und Entwicklung des Dieselmotors," in *Dieselmaschinen II* (Berlin, 1926), 31–33, at 33. German and French quotations throughout this article have been translated into English by the authors.

Lauster had his own ax to grind. Rudolf Diesel had grown up in France but had been forced to leave that country during the Franco-Prussian war. He had accepted the Frenchman Sadi Carnot's idea of the optimally efficient heat-engine process as his visionary goal, and he had lived for a decade in Paris as an adult.[2] The following comment attributed to Diesel makes Lauster's worries more understandable: "If I had not been chased out of France, then the engine that carries my name might have been French."[3] As things turned out, it was in Germany that Diesel would work out his first design plans and build a network of industrialists that could help him start to realize his ideas. Central to this network had been Maschinenfabrik Augsburg, one of the parent firms of M.A.N.[4] Lauster regarded it as a question of honor that the original design characteristics from this early period be acknowledged, at least by German companies.

In connecting artifacts and nationality, Lauster and Diesel reflected views that slowly began to emerge among historians and sociologists in their own time. In 1908 Conrad Matschoß, a pioneer of German history of technology, discerned what he saw as national differences between German and French steam-engine designs.[5] During World War I, Thorstein Veblen, the freethinking American sociologist and economist, delivered an analysis in which he contrasted the industrialization paths of these two European countries.[6] Their ideas had little effect at the time, and it would be more than half a century before similar ideas began to reemerge in a serious fashion in the writings of historians and sociologists interested in technological change. As in many other discourses, Lewis Mumford played a significant role.[7] His discussion about how authoritarian technologies developed in some parts of the world and democratic ones in other parts anticipated what during the last decade has become a surge of interest in the political, social, and cultural basis of technology.[8] In recent scholarship, national dif-

2. Concerning technological visions (in German, *Leitbilder*), see Meinolf Dierkes, Ute Hoffmann, and Lutz Marz, *Visions of Technology: Social and Institutional Factors Shaping the Development of New Technologies* (Frankfurt a.M. and New York, 1996).

3. According to *La praxis*, January 1936, 31, Rudolf Diesel supposedly said this to his friends.

4. Lynwood Bryant, "The Development of the Diesel Engine," *Technology and Culture* 7 (1976): 432–46; C. Lyle Cummins, *Diesel's Engine*, vol. 1, *From Conception to 1918* (Lake Oswego, Ore., 1993); Eugen Diesel, *Diesel: Der Mensch, das Werk, das Schicksal* (Hamburg, 1937); Andreas Knie, *Diesel: Karriere einer Technik. Genese und Formierungsprozesse im Motorenbau* (Berlin, 1991); Friedrich Sass, *Geschichte des deutschen Verbrennungsmotorenbaues von 1860 bis 1918* (Berlin, 1962); Donald E. Thomas, *Diesel: Technology and Society in Industrial Germany* (Tuscaloosa, Ala., 1987).

5. Conrad Matschoß, *Die Entstehung der Dampfmaschine* (Berlin, 1908), 107.

6. Thorstein Veblen, *Imperial Germany and the Industrial Revolution* (New York, 1915).

7. Lewis Mumford, "Authoritarian and Democratic Technics," *Technology and Culture* 5 (1964): 1–8.

8. See, for example, Donald MacKenzie and Judy Wajcman, eds., *The Social Shaping of Technology: How the Refrigerator Got Its Hum* (Milton Keynes, 1985); Meinolf

ferences in how technologies are developed and used have been extensively analyzed. The sociologist Werner Rammert has, for instance, drawn our attention to the various shapes and user patterns that characterize the telephone system in different countries.[9]

This article aims to contribute to the emerging scholarship on cultural differences in technology. In the history of technology, the concept of "style" has been commonly used as a tool for national and regional comparisons. Perhaps most well known is Thomas Hughes's analysis of differing technological styles operative in the electricity networks of Berlin, London, and Chicago.[10] Hans-Liudger Dienel has lately picked up this thread, suggesting that the style of German refrigeration technology was strongly influenced by the engineering sciences, whereas the American style was governed more by the structural demands posed by mass production.[11] Alain Dewerpe has talked about "national styles of production" in relation to shipbuilding technology in France, Germany, Great Britain, and Norway,[12] and John Staudenmaier has referred to the American inclination toward standardized parts and products to illustrate how style can be used to describe the patterns of technological action within a cultural sphere.[13]

Staudenmaier defines technological style as "a set of congruent technologies that become 'normal' (accepted as ordinary and at the same time

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Dierkes and Ute Hoffmann, eds., *New Technology at the Outset: Social Forces in the Shaping of Technological Innovations* (Frankfurt a.M. and Boulder, Colo., 1992); and Leo Marx and Merritt Roe Smith, eds., *Does Technology Drive History? The Dilemma of Technological Determinism* (Cambridge, Mass., 1994).

9. Werner Rammert, *Technik aus soziologischer Perspektive: Forschungsstand, Theorieansätze, Fallbeispiele* (Opladen, 1993).

10. Thomas P. Hughes, *Networks of Power: Electrification in Western Society, 1880–1930* (Baltimore, 1983). A growing interest in the study of "national styles" is also apparent in the history of science and may be exemplified by Herbert Mehrtens, "Der französische Stil und der deutsche Stil: Nationalismus, Nationalsozialismus und Mathematik, 1900–1940," in *Frankreich und Deutschland: Forschung, Technologie und industrielle Entwicklung im 19. und 20. Jahrhundert,* ed. Yves Cohen and Klaus Manfrass (Munich, 1990), 116–29; and Mary Joe Nye, "National Styles? French and English Chemistry in the Nineteenth and Early Twentieth Centuries," *Osiris,* 2nd ser., 8 (1993): 30–49.

11. Hans-Liudger Dienel, *Ingenieure zwischen Hochschule und Industrie: Kältetechnik in Deutschland und Amerika, 1870–1930* (Göttingen, 1995).

12. Alain Dewerpe, "Le style et le drapeau: Les conventions du produit naval français au début du XXème siècle" (paper presented at the conference "Institutions et conventions du travail en France et en Allemagne, 1890–1990," arranged by the Institut de recherche sur les sociétés contemporaines [IRESCO] of the Centre national de la recherche scientifique [CNRS] and WZB in Paris, May 1995).

13. John M. Staudenmaier, *Technology's Storytellers: Reweaving the Human Fabric* (Cambridge, Mass., 1985), 200. In this paragraph we have chosen only to refer to historians of technology, but the concept of "technological style" is also discussed by archaeologists and historians of architecture; compare Steven Lubar and W. David Kingery, eds., *History from Things: Essays on Material Culture* (Washington, D.C., and London, 1993).

as normative) within a given culture."[14] In our comparison of German and French diesel engineering we start by using this concept, then try to go further and identify some of the mechanisms that led to the national differences observed. Lauster's remarks to the VDI imply that at least some German engineers went out of their way to try to coordinate the actions of their colleagues by promoting the idea of a normative standard—sometimes given the name the "true faith" (*reine Lehre*).[15] As this article will show, no such ambitions were discernible in France. Although French engineers and industrialists were always eager to point to French predecessors whose work could belittle foreign contributions, they never cultivated a strong sense of communality and normality. Where German firms dogmatically adhered to their own designs, their French counterparts were more open and flexible.

We will argue first that the concept of technological style is only partly applicable to German and French diesel engineering. Some records in Germany show quite distinct attempts to create congruence among various engineering groups in the interwar period. In France, however, no such attempts can be found. In contrast to the Germans, the French were, so to speak, without style. Second, these national differences can better be described and analyzed by means of concepts from the world of linguistics. Adopting the sociolinguistic approach of Pierre Bourdieu, we suggest that congruent technologies are created through processes similar to those that lead to the creation of official languages and grammars.[16] Terms such as "dialect," "language," and "grammar" could be particularly helpful in an analysis of how designs and engineering knowledge are worked out, formulated, and codified. These terms might allow the constructivist and semiotic approaches in the history and sociology of technology to expand in a more operational direction. More specifically, a sociolinguistic approach might better dissect the social processes whereby certain centrally placed and powerful "core-sets" of engineers define which practices should be accepted as correct and which should be discarded as incorrect.[17]

Market Patterns and Business Cycles

Diesel producers in Germany and France faced new but differing challenges in the wake of World War I. Whereas German firms were busy trying to regain old markets in the shipbuilding and electricity-producing

14. Staudenmaier, 200.

15. Theo Delfried Domina, "Antriebstechnik," in *Ein Jahrhundert Automobilgeschichte: Nutzfahrzeuge,* ed. Olaf von Fersen (Dusseldorf, 1987), 120–63, at 130.

16. Pierre Bourdieu, *Language and Symbolic Power* (Cambridge, Mass., 1991).

17. Harry Collins, "The Place of the Core-Set in Modern Science: Social Contingency with Methodological Propriety in Science," *History of Science* 19 (1981): 6–19.

industry, French machine producers worked hard to build a market from scratch. Statistics show that immediately before the war only 1 percent of the world's functioning diesel power was installed in France, compared with 45 percent in Germany.[18] (Statistically, it thus seems appropriate to call the diesel a German machine at that time.) Because of the shortage and consequently high price of gasoline in the postwar period, any engine that could be run on more accessible and cheaper heavy oils was welcome in both countries, not least by motor vehicle owners.

Nonetheless, designing an oil engine such as the diesel for road transportation was easier said than done. The classic diesel was a large, heavy, slow engine that worked well at a constant speed. Suited to stationary purposes and large ships, it could hardly be of any practical use for land transport before the design had been made much lighter and the piston speed increased. For trucks and buses, this step was taken in the 1920s; for automobiles, toward the end of the 1930s.

In the 1920s the potential market for diesel engines was particularly large in France. Total French industrial production had by 1924 reached its prewar level and continued to expand rapidly until 1931.[19] The number of registered automobiles in France increased more than tenfold in the 1920s, and the truck market boomed.[20] Weimar Germany's general industrial production did not follow this trajectory; by 1930, after a short boom, it had fallen back below its prewar level. In 1929, France manufactured more than twice as many engine-driven road vehicles as Germany; statistics from two years later indicate that there were ninety-four citizens to each such vehicle in Germany, but only twenty-seven in France.[21] The depression also hit Germany harder and earlier than it did France. Between 1929 and 1932 the motor vehicle market shrank dramatically in all Western European and North American countries, except Great Britain. In Germany vehicle production went down by over 60 percent, in France by only 30 percent. By then the diesel had begun to get a foothold in France while remaining marginal in the engine's home country. In 1933, only one thousand diesel trucks and buses traveled the roads in the whole of Germany, as compared to five thousand in France.[22]

18. For comparison: Switzerland, 13 percent; Russia and Belgium, each 9 percent; United States, 5 percent; and Great Britain, 4 percent (Eugen Diesel and Georg Strössner, *Kampf um eine Maschine* [Berlin, 1950], 142).

19. Dominique Renouard, *Les transports de marchandise par fer, route et eau depuis 1850* (Paris, 1960), 73; Alfred Sauvy, *Histoire économique de la France entre les deux guerres* (Paris, 1984), 3:323.

20. Louis Muron, *Marius Berliet (1866–1949)* (Lyons, 1995), 117.

21. The figures for 1929 (254,000 compared to 123,000) come from Walter Ostwald, "Um die Zukunft der deutschen Kraftfahrt," *Automobiltechnische Zeitschrift* 34 (1931): 225. The figures for 1932 are from Hans-Otto Neubauer, *Chronik des Automobils* (Gütersloh and Munich, 1994), 197.

22. James M. Laux, "Les moteurs Diesel pour les transports," *Culture technique* 19 (1989): 20–28, at 24.

The general picture reversed after 1933. Partly as a result of the automobile-friendly policies of the National Socialist government, German production soon returned to 1929 levels, and by 1935 had climbed to a point more than 50 percent above 1929. The market for diesel-powered trucks and buses began to open up; in 1937, 12 percent of all German-produced trucks and 33 percent of all buses were equipped with diesel engines.[23] French production figures simultaneously declined, and France lost its position as the world's second largest producer of road vehicles.[24] The number of vehicle manufacturers decreased significantly, more so in France than in Germany. Historian Joseph Jones observes that the French transport policy of 1933 "consisted of increased taxes on road fuel and on heavy goods' vehicles explicitly aimed at compensating for the railway deficit by punishing the automobile."[25] In France a people's car (*Volkswagen*) was not on the agenda. With the creation of the state railway company, the Société nationale des chemins de fer français (SNCF), in 1937 the government became even more concerned with protecting the heavy public investments that the railroad represented. One measure that the government now proclaimed was to increase "the tax on diesel-oil, which had previously been far less heavily taxed than petrol."[26]

Whether due to these policies or to business factors, it is clear that the market developed more slowly in France: "By 1938, only one in four of French trucks was under five years old, compared to 60 per cent in Germany. . . ."[27] In the same year thirty thousand trucks were produced in France, as compared to as many as eighty-eight thousand in Germany—one-fourth of the latter being delivered to the military.[28] The total number of automobiles, however, still remained higher in France than in Germany: 1.8 million compared with 1.3 million.

Germany: Grammatical Codification

Against this background it becomes more understandable that, especially in the 1920s, people such as Lauster were concerned about losing con-

23. *VDA Tatsachen und Zahlen aus der Kraftverkehrswirtschaft, 1948* (Frankfurt a.M., 1949).

24. Jean-Pierre Bardou et al., *The Automobile Revolution: The Impact of an Industry* (Chapel Hill, N.C., 1982), 140; Patrick Fridenson, *Histoire des usines Renault*, vol. 1, *Naissance de la grande entreprise, 1898–1939* (Paris, 1972), 198.

25. Joseph Jones, *The Politics of Transport in Twentieth-Century France* (Kingston, Ont., and Montreal, 1984), 45.

26. Ibid., 89.

27. Ibid., 102.

28. Otto-Peter A. Bühler, "Nutzfahrzeugsgeschichte international," in von Fersen (n. 15 above), 10–119, at 24; Wolfgang H. Gebhardt, *Taschenbuch deutscher Lkw-Bau*, vol. 1 (Stuttgart, 1989), 7–20.

trol of the development of diesel technology. In 1923, Adolf Nägel, perhaps the leading combustion-engineering professor in the whole of Germany, had already given his colleagues in the VDI a worried report about the non-German contributions to the field.[29] Although Nägel was happy to conclude that foreign design solutions had not yet made inroads into Germany, he could not hide his concerns that the work of people such as Akroyd-Stuart of Great Britain, Brons of the Netherlands, and Hesselman of Sweden could develop into serious challenges in the near future. Nägel's immediate anxieties, however, concerned not market share but engineering congruence. These non-German engineers had launched solutions that departed so much "from the much tried and manifest" main principles of the original diesel engine that they threatened its "well-founded reputation."[30] There was a clear danger that these foreign dialects would corrupt, as it were, the German diesel language.

Nägel voiced a view apparently quite typical of the German engineering profession: Sound and accepted engineering solutions are of greater value than market success or adapting to the customer. Leading German engineers took it upon themselves to define what was to be considered legitimate knowledge and correct design solutions. They even coined a term to describe this sort of consensus-oriented effort: *technisch-wissenschaftliche Gemeinschaftsarbeit* (technical-scientific collective work).[31] Often organized in the form of official tasks, such activities aimed at the formulation of rules that were meant to guide practitioners, for instance those working in the oil-engine area. These engineers codified an engineering "grammar" meant to create conformity among those who spoke the oil-engine "language."

The leading forums for such codifying work were the *Fachsitzungen* (expert sessions) for internal-combustion engineering that were held in connection with the annual meetings of the VDI. At the 1927 meeting, for instance, director F. Schultz of the venerable Gasmotorenfabrik Deutz lamented the "confusion" that still ruled the area of diesel design and reported on the work that the VDI had begun two years earlier with the goal of "formulating new rules for internal-combustion engines."[32] Similarly, Nägel put much effort into getting the definition accepted that all heat engines where ignition starts as a result of high pressures be called "Diesel engines," thereby "honoring a well-deserving German engineer

29. Adolf Nägel, "Die Dieselmaschine der Gegenwart," in *Dieselmaschinen* (Berlin, 1923), 3–35.

30. Ibid., 26.

31. Gert Hortleder, *Das Gesellschaftsbild des Ingenieurs: Zum politischen Verhalten der Technischen Intelligenz in Deutschland* (Frankfurt a.M., 1970).

32. "Fachsitzung Verbrennungsmotoren gelegentlich der 66. Hauptversammlung des Vereines deutscher Ingenieure, Mannheim-Heidelberg 1927," in *Dieselmaschinen IV* (Berlin, 1929), 33–35, at 33.

who helped German engineering secure a much begrudged advantage through his vigor and his belief in the success of his engine."[33]

M.A.N.: DEFENDERS OF DIESEL ORTHODOXY

Two of Rudolf Diesel's most precious ideas were the direct injection of fuel into the cylinder and the simple shape of the combustion space.[34] Rejecting extra combustion chambers and complicated piston-head designs, he was the first vindicator of the direct-injection system. The controversy between proponents of direct injection and those of combustion chambers did not really take off until after Diesel's death, when it became possible to mix air and fuel without employing a heavy and bulky air pump. One could then choose between having the fuel pass directly from the fuel tank into the cylinder or mixing it with air in a specially designed space before it entered the cylinder. After Diesel's suicide in 1913, M.A.N. was the company that profited the most by being connected with his legacy. Not surprisingly, it chose the direct-injection system. For about a decade, its representatives turned out the most astute defenders of this orthodox faith.

One of the first firms in the world to build diesel-powered trucks, M.A.N. announced its first diesel truck in 1923. The vehicle was equipped with a direct-injection engine without an air pump. The distinct advantage of this machine was its low fuel consumption; the distinct disadvantage was its rough performance. Potential buyers were pleased with fuel costs much below those of a gasoline engine, but less than happy with a vehicle whose performance reminded them more of a tractor than a truck. Although sales turned out to be weak, the company continued to produce the diesel truck for eight years: by 1931, only 210 trucks of this design had found their way onto the road.

The same inattention to what today are called market signals can be found in large segments of the German engineering community during the interwar period. In the mid-1920s, the leading members of the VDI had already declared that direct injection belonged to the acceptable basic rules, the grammar, as it were, of diesel engineering. Such acceptance was, especially in the German setting, important for industrial practitioners. Wilhelm Riehm, one of M.A.N.'s board members, went out of his way at the VDI annual meeting in 1925 to get his company's new design solution accepted by his peers as legitimate knowledge, on a par with precombustion, the hot-head, and the Brons system.[35] His plea was heard. Direct injection soon received serious treatment by, among others, Fritz Modersohn, of

33. Nägel, 5. Interestingly, both Nägel and Lauster could make strategic use of Rudolf Diesel's name in the 1920s, although during Diesel's lifetime they had not always agreed with his design solutions (Eugen Diesel [n. 4 above], 360).

34. Rudolf Diesel, *Die Entstehung des Dieselmotors* (Berlin, 1913), 9–10.

35. Wilhelm Riehm, "Schnellaufende Dieselmotoren für Fahrzeuge," in *Dieselmaschinen II* (n. 1 above), 63–68.

the Gasmotorenfabrik Deutz, and Julius Magg, author of an influential diesel textbook.[36]

Modersohn's contribution to the precombustion/direct-injection controversy is noteworthy because it included an attempt to bypass the "unnecessary" competition that displeased so many German commentators in the interwar period.[37] If manufacturers could agree on a compromise, then Modersohn was willing to accept both systems as legitimate solutions for the construction of high-speed truck and bus diesel engines. He suggested that they choose precombustion injection for small engines and direct injection for large ones.

In practice, another kind of consensus developed. After 1931 M.A.N. designed a diesel that included characteristics of both the direct-injection and the precombustion engine. Before the fuel entered the cylinder, it had to pass through a wide injection channel, where combustion got started. This compromise caught on so well with other companies that it developed into the previously mentioned "uniform diesel." Under the supervision of the Nazi government, five firms introduced this engine into their production program, but with limited commercial success.[38]

The preoccupation of leading German engineers with defining acceptable, legitimate solutions and of established German firms with orienting their design activities toward common norms is interesting. The German engineers' focus also stood in sharp contrast to the attitudes and practices of their French colleagues. Julius Magg was one of the most active German-speaking engineers in defining official solutions. His *Dieselmaschinen* had been commissioned by the VDI to avoid "divided opinions about the general basis of diesel engineering," thus protecting the craft from annoying customer demands. By codifying what they believed should be considered correct design solutions, Magg and his colleagues hoped to protect Diesel's original "ideal process" in a period of technical and market uncertainty. His and others' German textbooks were meant to serve the same function in engineering practice as grammars do for linguistic usage. By means of a diesel grammar, an "official diesel language" was to be developed to help withstand threats posed by a multitude of German and foreign "dialects."

36. Fritz Modersohn, "Druckeinspritzung oder Vorkammerverfahren? Zur Frage des Arbeitsverfahrens für kompressorlose Dieselmaschinen," in *Dieselmaschinen III* (Berlin, 1927), 3:64–72; Julius Magg, *Dieselmaschinen: Grundlagen, Bauarten, Probleme* (Berlin, 1928), 262.

37. See, for example, Mikael Hård and Andrew Jamison, eds., *The Intellectual Appropriation of Technology: Discourses on Modernity, 1900–1939* (Cambridge, Mass., 1998), chap. 3.

38. Gebhardt (n. 28 above), 16–17.

DAIMLER-BENZ: "WE UNDERSTAND MORE ABOUT AUTOMOBILE ENGINEERING THAN THE CUSTOMER DOES"

M.A.N. was by no means the only company to preserve the traditional diesel design ideals. When Daimler-Motoren AG, the largest German truck producer, decided shortly after World War I to develop a diesel engine for its trucks, it stayed true to the classical blueprint. The first diesel truck that the firm brought onto the market in 1923 even included the traditional air pump that had been the standard in ship and stationary diesels.

The decision proved to be commercially disastrous. Daimler did not sell a single vehicle equipped with this old-fashioned engine, which was an outgrowth of an almost extinct, albeit grammatically correct, idiom. Having invested considerable work and prestige in this design, Daimler's engineers struggled hard to retain it in the company's production line.[39] They did not succeed. After Daimler merged with Benz in 1926, their creditors went mercilessly through all activities in the new joint company. Daimler's air-pump diesel did not pass the test. Instead, Benz's precombustion chamber engine became the company's joint product. This design was certainly better adjusted to the market, even though Daimler-Benz's notorious arrogance toward its customers (exemplified by the quotation above) and preference for engineering delicacy made it difficult for the company to get out of the red.[40] The company managed to sell its first diesel truck in 1930, but it would take half a decade before its automotive diesels became important.[41]

Probably to Lauster's delight, Daimler-Benz's engines were thoroughly German.[42] Like most of their German colleagues, Daimler-Benz's engineers seem to have gone consciously out of their way not to pick up any foreign patents or other design solutions. German-speaking engineers such as Magg were busy building a consensus about what should be considered appropriate designs. Daimler-Benz was certainly not atypical in its preoccupation with design perfection and its lack of interest in mass-market demand and rational production.[43] As a result, German manufacturers lost domestic market share to American companies such as Ford.[44]

39. Karl-Heinz Roth and Martin Schmid, eds., *Die Daimler-Benz AG 1916–1948: Schlüsseldokumente zur Konzerngeschichte* (Nördlingen, 1987).

40. For a long time, "Wir verstehen mehr vom Automobilbau als der Kunde" (We understand more about automobile engineering than the customer does) was a catchphrase in the Daimler-Benz company. See Heinz C. Hoppe, *Ein Stern für die Welt* (Munich, 1991), 258, and Roth and Schmid, 333.

41. Gebhardt, 101.

42. Hans Christoph Graf von Seherr-Thoss, *Die deutsche Automobilindustrie* (Stuttgart, 1979), 271.

43. Fritz Blaich, "Die 'Fehlrationalisierung' in der deutschen Automobilindustrie," *Tradition* 18 (1973): 18–36.

44. Louis Betz, *Das Volksauto: Rettung oder Untergang der deutschen Automobilindustrie* (Stuttgart, 1931), 11.

KRUPP-JUNKERS: "RATHER ORIGINAL, BUT BY NO MEANS IDEAL"

The abhorrence that the German engineering core-set felt toward unconventional design solutions can be further illustrated by the case of Hugo Junkers's diesel. As a young engineer working with a gas-engine project in Dessau just after the turn of the century, Junkers had already decided in favor of the opposed-piston, two-stroke system.[45] Such a solution was indeed bold. Although it was theoretically possible to increase the degree of efficiency by having two pistons per cylinder instead of one, Junkers's engine challenged design traditions with roots going back to eighteenth-century steam-engine technology. Since Newcomen, combustion engines customarily came with one piston per cylinder.

When Junkers translated his ideas from the gas-engine to the diesel-engine language, he met little positive response. In 1912 he presented his new diesel at a meeting of the Society of Naval Architects (Schiffsbautechnische Gesellschaft), which, with VDI, was a leading German institution for the discussion and formulation of a correct diesel language. The reception was very cool.[46] Junkers's calculations could not shatter established conceptions of what constituted a well-designed machine. Since his "dialect" sounded too strange to square with the official language of diesel engineering it could easily be ignored, although in principle it remained within the limits set up by existing grammars.

Unable to pass inspection by the German engineering world, where he would remain an outsider, Junkers sought acceptance in other camps. His truck engine would later be accepted in France. His greatest German success came in the aeronautics industry, which was apparently less concerned with preserving age-old traditions than were the shipbuilding and motor vehicle industries.[47] In particular, aircraft manufacturers were open to any solution that promised to decrease engine weight per horsepower. When Junkers's diesel reached a weight-to-power ratio of less that 0.5 kilograms per horsepower, it began to attract considerable attention.[48] In 1936 Deutsche Luft-Hansa put its first Junkers-equipped airplane in regular service across the Atlantic, initiating the short but memorable heyday of the so-called Jumo (Junkers-Motoren) planes.[49]

However, within the German motor vehicle industry Junkers's design remained marginal. None of the large companies picked up this strange dialect. Only KRAWA (Kraftwagenabteilung), the relatively small vehicle

45. Günter Schmitt, *Hugo Junkers: Ein Leben für die Technik* (Planegg, 1991), 45.

46. Hugo Junkers, "Studien und experimentelle Arbeiten zur Konstruktion meines Großölmotors," *Jahrbuch der Schiffbautechnischen Gesellschaft* 13 (1912): 264–339.

47. Compare Edward Constant II, *The Origins of the Turbojet Revolution* (Baltimore, 1980).

48. Hermann Golle, "Zur Entwicklung des Junkers-Gegenkolbenmotors," in *Kolloquium zum 125. Geburtstag von Hugo Junkers* (Dessau, 1984), 71–80.

49. Paul W. Wilkinson, *Aircraft Diesels* (New York and Chicago, 1940), 234.

division of the Krupp AG, became a German licensee for Junkers's trucks and buses.[50] Of course, Krupp was no marginal company, but its involvement with road vehicles was not wholehearted, nor were its plans consistently carried out. Although Krupp had taken part in the early work with diesel engines at the turn of the century, it never put any effort into developing its own automotive engine in the twenties. When M.A.N., Daimler-Benz, and other German truck manufacturers began to design their own road-vehicle diesels, Krupp took the easy way out and in 1928 bought the rights to Junkers's patents. Production continued on and off for the ensuing three decades, but without any noteworthy innovative activity.[51] There are also no signs that the company tried to coordinate its work with the French who spoke this dialect. By positioning itself outside mainstream engineering, the company lost the possibility of drawing on others' experience. Strange and singular dialects tend to disappear, which is exactly what happened to Junkers's.

France: Multilingual Competence

Because the demand for trucks grew so rapidly in France in the twenties, the potential market for an automotive diesel was considerable. As we have noted already, German commentators were concerned that this expansion might threaten their efforts to maintain hegemony in diesel engineering. In France, commentators expressed more economic concerns, namely that their home market would be flooded by German diesel engines and diesel trucks. Reviewing an automobile exhibition in 1928, the technical journalist G. Delanghe wrote that four or five German firms had plans to make inroads into the French market with their high-speed diesels, and that "it is, unfortunately, not yet possible to meet them with an equivalent French engine."[52] The situation, however, soon changed. In 1931, Delanghe could happily note that "[a]lmost all truck manufacturers offer their customers chassis mounted with diesel engines."[53] The French diesel was now ready to meet the soaring market.

50. B. Reinders, *Die Motoren- und Kraftwagenfabriken der Fa Fried. Krupp Essen 1920–1955/56* (Essen, [1957?]).

51. The "rather original" quote is from A. E. Thiemann, *Fahrzeug-Dieselmotoren* (Berlin, 1929), 283. See also J. Pietsch, "Bemerkenswertes über den 6,5-t Lastkraftwagen," *Technische Mitteilungen Krupp,* no. 1 (1938), 11–13; H. Haase, "Aus der Entwicklung der Krupp-Fahrzeugmotoren von 1924 bis 1957," *Technische Mitteilungen Krupp,* no. 15 (1957), 106–12.

52. G. Delanghe, "Les salons européens de l'automobile en 1928," *Le génie civil* 94 (1929): 34–37, 62–64, at 62.

53. G. Delanghe, "Le XXVe salon de l'automobile, véhicules industriels," *Le génie civil* 99 (1931): 617–23, 647–54, at 618.

PEUGEOT-C.L.M.: "ECONOMY, SAFETY, SIMPLICITY!"

In 1908, an associate of the Peugeot automobile company, the mathematically trained engineer E. H. Tartrais, had begun to analyze and experiment with heavy-oil engines, but not until 1921 did his investigations begin to show such promise that the company decided to spread the word about them. Technical descriptions and popular articles were placed in various journals. In line with the tradition of those days, well-staged journeys were made to attract public attention.[54] At the request of Peugeot's managing director, the journalist Henri Petit wrote favorably about his return trip from Paris to Bordeaux shortly before the annual motor vehicle exhibit in 1922.[55] Petit made the 1,100-kilometer trip in two days, allegedly without incident: "[the engine] met all the expectations that the Peugeot company had created."[56] The only nuisances Petit recorded were that the oil engine ran rougher than a gasoline engine, emitted "light smoke," and was more difficult to get started. In his technologically optimistic way, Baudry de Saunier wrote in *Omnia*: "By giving its confidence and full assistance to the Tartrais engine, the house of Peugeot deserves the praise of our country. It has indeed oriented itself toward the engine of the future. Well done, engineers!"[57] *La science et la vie* stated with no less enthusiasm that the Tartrais engine would be particularly useful in the French colonies, since it might be possible to run on vegetable oils.

Tartrais's engine was heterodox vis-à-vis the official language of diesel engineering on several scores.[58] It ran on heavy oil, but it was not defined by its contemporaries as a diesel engine. Tartrais departed from the diesel grammar in that he employed an electrically heated filament to support ignition. He had also designed two chambers that looked very similar to those of precombustion diesels, but whose function was not the same. This heterodoxy made it difficult to find outside solutions to problems that plagued the engine. There was, simply put, no one to talk to. Very little help could be found in France, and the German patents that Tartrais received in 1920 and 1921 were never picked up by firms in that country. Peugeot's

54. Such trips were quite common in the early years of the automobile. They served the double purpose of creating public interest and of submitting the engines and cars to an endurance and reliability test (Mikael Hård and Andreas Knie, "The Ruler of the Game: The Defining Power of the Standard Automobile," in *The Car and Its Environments: The Past, Present and Future of the Motorcar in Europe,* ed. Knut H. Sørensen [Brussels and Luxembourg, 1994], 137–58).

55. A lengthy, verbatim section of his account is reprinted in Pierre Dumont, *Peugeot sous le signe du lion* (Paris, 1976), 385–88.

56. Ibid., 386.

57. Quoted in Pierre Dumont, *Peugeot d'hier et d'avant-hier* (Fontainebleau, 1983), 379.

58. Ludwig Hausfelder, *Die kompressorlose Dieselmaschine: Ihre Entwicklung auf Grund der in- und ausländischen Patent-Literatur* (Berlin, 1928), 188–90.

engineers did not overcome the drawbacks that Petit had noted, and in 1926 the company decided to turn in other directions.[59]

The ensuing changes were made in two ways that illustrate not only the ease with which French firms switched designs, but also their dependence on foreign archetypes.[60] First, Peugeot turned the Tartrais engine into a pure diesel engine. The outcome was a two-stroke engine with a precombustion chamber in which ignition was caused by high pressure in the cylinder.[61] This engine, however, seems to have created more interest in engineering circles than among potential customers.

Second, in 1927 Peugeot bought a license for a German patent: the Junkers design. Peugeot decided that production should begin at its old plant in Lille and, with thirty-five million francs as capital, set up a separate company, la Compagnie Lilloise des Moteurs (C.L.M.).[62] C.L.M.'s strategy was straightforward: building engines that could easily fit into existing boats, rail cars, trucks, bulldozers, tractors, and even airplanes.[63] The goal was to create a multipurpose diesel that could be used where high speeds were required. Although this strategy sounds simple enough, it was not an easy task to accomplish at a time when the diesel was generally defined as a slow and heavy engine, unsuitable for motive applications, and in an environment of little experience with opposed-piston engines. Junkers's fifteen-year track record in this business did not relieve his French licensee from problems. Despite C.L.M.'s access to a well-established motor vehicle factory with roots extending back to the nineteenth century, it took two years before the firm had adjusted well enough to this foreign dialect that it could undertake production of all the engine's central components on its own: "From 1928 to 1930 the very intricate manufacturing of fuel pumps and injectors was brought to perfection—thanks to the quality of the workers and technicians."[64]

But C.L.M. did not wait until 1930 to market its engine.[65] The first truck fitted with one of its diesels was shown at the Paris exhibit in the

59. Christophe Dollet and Alain Dusart, *Les sorciers du lion: Un siècle dans le secret du Bureau d'Études Peugeot* (Paris, 1990), 55.

60. Concerning the concept of archetype, see Mikael Hård, *Machines Are Frozen Spirit: The Scientification of Refrigeration and Brewing in the Nineteenth Century—A Weberian Interpretation* (Frankfurt a.M. and Boulder, Colo., 1994), 50.

61. Hausfelder, 190–92; Thiemann (n. 51 above), 219–21.

62. In 1937 C.L.M. became a part of la Compagnie Générale des Moteurs, which Peugeot owned with Crédit du Nord. In 1949 C.L.M. left the Peugeot sphere altogether and was drawn into Industrielle de l'Est et du Nord (INDÉNOR), only to return to its origins in 1965, when INDÉNOR was sold to Peugeot.

63. Stephan Ittner, *Dieselmotoren für die Luftfahrt: Innovationen und Traditionen im Junkers-Flugmotorenbau bis 1933* (Berlin, 1995), 143.

64. File "Peugeot (F) - 120G/1201G (1921–1928)" at Archive de la Fondation automobile Marius Berliet, Lyons (hereafter cited as AFAMB).

65. "Économie, sécurité, simplicité" were norms that C.L.M. put forth in advertisements presenting their engines; see file "C.L.M. (F) Catalogues publicitaires," AFAMB.

spring of 1928, and soon C.L.M. diesels could be found not only in Peugeot but also in Laffly and SOMUA (Société d'Outillage Mécanique et d'Usinage d'Artillerie) trucks.[66] The company sold more than a thousand engines in a year and a half.[67] Demand grew rapidly, and by 1940 C.L.M. had produced a total of twenty-five thousand diesel engines consisting of seventeen different models.[68] The multipurpose strategy worked.

The Peugeot-C.L.M. case illustrates several points. It shows how difficult it may be even for large and established firms to maintain unique technical dialects, and it indicates that some advantages exist in adopting modes of speech common to a larger group. By choosing the Tartrais engine, Peugeot's engineers isolated themselves from the national and international engineering community. Since they spoke a strange dialect that did not square with the diesel grammar, they got into a situation in which they could not adequately communicate with other engineering milieus. Their choice to accommodate Tartrais's engine to the diesel grammar in 1926 could be seen as a way of escaping this isolation. Although the decision to go for the Junkers engine did not place the French in the mainstream of diesel engineering, it can be interpreted as a means of finding a common ground between German and French technology: "The Junkers engine . . . reproduces the mechanical outline that is well known from the Gobron-Brillié engines."[69]

BERLIET: "COPY AND IMPROVE!"

Marius Berliet was a self-taught technician whose name belongs with the other pioneers of French motor vehicle engineering.[70] A restless tinkerer by nature, he quickly picked up new trends and was seldom afraid of taking on large challenges.[71] Considering his strong background in truck production, Berliet's dawning interest in the diesel engine toward the end of the twenties came as no surprise. His company had just gone through a difficult period, but had now managed to pay off its bank debts and was reasonably free to start new projects.[72] Because little was known of the high-speed diesel in France, Berliet went to Germany in 1929 to learn about the latest developments. The outcome of this trip was a license agreement,

66. *Le génie civil* 95 (1929): 607.

67. *La vie automobile,* 25 June 1928, 241; *Automobilia,* November 1929, 27.

68. Laux (n. 22 above), 24.

69. *Automobilia,* February 1929, 19.

70. *Moteurs diesel* (Bologne-Billancourt, 1988), 77–78.

71. "Copier et améliorer" (Copy and improve) was part of a slogan that Marius Berliet, founder of the Société des Automobiles Berliet, used to characterize his business strategy; see Sanchez Annick, *Études et recherches chez Berliet-R.V.I.* (Lyons, 1988), 76.

72. Paul Berliet, "La fabrication du moteur diesel chez Berliet," November 1994, manuscript located at the Fondation de l'Automobile Marius Berliet, Lyons. Paul Berliet is Marius's son and started to work in the company in 1935. He now directs the Fondation de l'Automobile Marius Berliet in Lyons.

concluded in March 1930, between the Société des Automobiles Berliet and Robert Bosch AG for the production of diesel engines equipped with the so-called Acro (American Crude Oil Company) injection system.

After the agreement was signed, feverish activity followed at Berliet's factory in Vénissieux, just outside Lyons.[73] Here he had everything that a truck manufacturer could want: an engineering department, a foundry, shops, and assembly rooms. Under the supervision of André Cattin, the "perfectionist" head of the Bureau d'Études, drawings and models were made in the spring and early summer.[74] Since the Bosch license only concerned the injection system, several parts of the engine had to be designed from scratch, although the engineers could, of course, make extensive use of their experience from gasoline engine design. In August 1930 Berliet's factory cast the various engine parts and in September assembled the first prototype.[75]

Between 1931 and 1936 the company put 7,400 Acro diesels onto the market.[76] The design, however, had some fundamental drawbacks. The piston was relatively heavy, which meant that it was practically impossible to exceed 1,500 revolutions per minute (rpm). Since consumers all over the world demanded ever higher engine speeds, this limit became a serious competitive disadvantage.[77]

Marius Berliet's search for another solution had already begun in 1933 during a trip to the annual truck and bus exhibit in London.[78] His attention had been especially drawn to AEC buses, manufactured by the Associated Equipment Company and used by London Transport with good results. They were fitted with Harry Ricardo's diesel engines, which had a much lighter piston than the Acro engine and could be run up to 2,000 rpm. Otherwise, the most well-known feature of Ricardo's engine was its so-called turbulence chamber, a space at the top of the cylinder designed to simplify the process of mixing the fuel with air, thus maximizing fuel efficiency. The Frenchman immediately decided to approach Ricardo, but a license agreement could not be signed until May 1935. Marius Berliet and his engineers now faced the challenge of turning from the Acro to the Ricardo system.

Although this move took place within the diesel grammar, it was not easy or straightforward. It took one year before the first Berliet vehicle equipped with a Ricardo diesel was considered ready for market, a year

73. Jacques Borgé and Nicolas Viassnoff, *Berliet de Lyon* (Paris, 1981), 178.

74. Muron (n. 20 above), 123.

75. Annick, 73.

76. Ibid.; Annick wrongly states the number as 74,000.

77. H. E. Degler, *Diesel and Other Internal-Combustion Engines* (Chicago, 1943).

78. The following account is largely based on a contemporary description written by an unknown collaborator of Ricardo: "Historique 'Ricardo,' 12.12.39," manuscript at AFAMB. Part of the process can also be followed in the archives of Ricardo Consulting Engineers, Shoreham-by-Sea, England.

filled with frequent trips and much traffic of letters, telegrams, and even engine parts between Great Britain and France. Even so, all problems had not been solved in 1936, when the first trucks with Ricardo engines were presented to the French market: "In the beginning of the year 1937, we registered some complaints about broken cylinder heads and cracked injectors. . . ."[79] Similar problems reemerged one year later. But it seems that truck drivers were used to such nuisances in those days, and in 1938 Berliet managed to sell 1,720 engines of the Ricardo type.

Berliet discontinued the production of Ricardo engines one year later, after producing almost eight thousand of them. The company's experiment with diesel engines remained on hold until after World War II, when Berliet again picked up the Ricardo system, only to replace that design after another decade with—once more—a German type. This time the choice fell on the "M" model, designed by M.A.N.

This flexibility and lack of interest in protecting the company's technical fingerprint is striking. At Vénissieux apparently no technical design had such an aura of prestige as to preclude fundamental changes. Compared with several German firms, Berliet's attitude toward technical solutions was more open, and its willingness to learn new languages and dialects more pronounced. Why was this the case?

Some of the reasons directly concern Berliet's self-understanding and practice. Marius Berliet's conscious business strategy was to "copy and improve" rather than "inventing at the expense of the customer."[80] One historian summarizes the company strategy this way: "Serious investigations should, in particular, be directed at the perfection of existing models, and newly designed models should only be taken into production after extensive and conclusive experiments had been made."[81] As we have seen, the second half of this ideal was not always followed in practice. Customers were indeed drawn into the development process, as it were. Clearly, however, imitation, as well as diversification, was an important vision that guided the company's practice. The strategy of diversification manifested itself in a large model array. In the thirties, not only could the company offer its customers diesel and gasoline engine trucks, it could also give them a choice of half a dozen diesels and an astounding two dozen gasoline vehicles of all sizes. The diversification strategy likely caused Berliet to enter the diesel arena, and the copy-and-improve strategy probably led the company to pick different technological archetypes pragmatically. Berliet's strategy resembled C.L.M.'s and was as successful. Automobile historian James M. Laux points out Berliet's place in vehicle

79. "Historique 'Ricardo,' 12.12.39," 10.

80. The complete slogan read: "N'inventez-pas aux dépens du client, commencez par copier et améliorer"; Annick (n. 71 above), 76.

81. Gérard Declas, *Recherches sur les Usines Berliet (1914–1949)* (Paris, 1977), 37.

production: "At the outset of the Second World War his engines dominated French truck production."[82]

Conclusion

Does it make sense to talk about "styles" in technology, especially national styles? German and French engineers indeed differed in how they conceived of and chose to design diesel engines in the 1930s. Why did these differences exist, and how should they be analyzed?

As shown earlier, certain German engineers were preoccupied with defining the diesel engine as a German machine. Lauster, Nägel, and other leading engineers, including college professors and chief engineers in industry, argued forcefully that the engine that Rudolf Diesel and M.A.N. had created was thoroughly German. Their concern was, it could be said, to create a "national style" in diesel engineering. By introducing a national rhetoric, they gave the engine a *meaning* that went far beyond instrumental performance and commercial success. Instead of primarily discussing market acceptance, the German engineers went out of their way to create a discourse based on a preference for theoretical correctness.[83]

The Germans were not alone in regarding the diesel as a German machine, as the writings of the French technical journalist Delanghe attest. In France, however, this signification called forth quite a different strategy. Instead of utilizing the allegedly German character of the engine to defend an orthodox and pure design, Delanghe took it as an excuse for demanding that French engineers get their act together and design a diesel that could meet the market challenge posed by the Germans.

In the interwar years, diesel-producing firms were much more flexible and open in France than in Germany. French companies did not develop corporate design characteristics as strong as those of their German counterparts and remained strikingly dependent on foreign—not least German—patterns. Developments in Germany were more controlled than in France. German engineers struggled to retain stability in the face of dynamic markets, but were finally forced to accept certain shifts—for example, from air-injection to precombustion chamber technology. These events can be treated in linguistic terms. By applying concepts such as "grammar" and "dialect," we can better understand the processes that lead to the formation of stylistic differences.

When Rudolf Diesel presented his ideas to the engineering community in 1893, his peers praised his theoretical contributions but raised serious doubts about their practical usefulness. His analysis and suggestions fit the

82. Laux (n. 22 above), 24.

83. Compare Herbert Mehrtens's (n. 10 above), discussion of the German formalist style in mathematics.

research and development program of technical thermodynamics, a program that had been developed by academically trained engineers such as Gustav Zeuner and Carl von Linde (Diesel's teacher) in the second half of the nineteenth century.[84] Like "grammarians, who hold the monopoly of the consecration and canonization of legitimate writers and writing,"[85] Zeuner, Linde, and their followers had defined what they considered legitimate knowledge in this field. The primary vehicles for the codification and diffusion of this knowledge were textbooks and educational programs in technical thermodynamics and related fields, just as grammars and schools serve the purpose of teaching children how to read and write.

The quotation in the paragraph above comes from a paper by Pierre Bourdieu, in which he tries to show how grammarians use their social position to "fix and codify legitimate usage."[86] Like the centrally placed engineers in this article, Bourdieu's men of letters exercise considerable power: they have reached a position from which they may define normal behavior. Applied to the history of technology, a sociolinguistically inspired approach can help explain the social processes by which "normal" and "congruent" technologies—that is, "technological styles"—are shaped. This approach also allows a socially founded power perspective in constructivist studies of technology.

Although they are very influential, grammarians at Oxford, Duden, and Larousse do not attempt to create disembodied, *formal* grammars. What they devise are *descriptive* grammars that to a certain degree reflect changing language practices. Correct language usage is neither invented in an empty space nor forever frozen and fixed. Rather, grammatical rules "are derived *ex post facto* from expressed discourse and set up as imperative norms for discourse yet to be expressed."[87] The same can be said of codified engineering norms. They are disseminated through lectures and journal articles and further discussed in engineering circles. VDI was the most important forum for the "normalization and codification" of engineering practices in Germany.[88] Engineers from different corners of the Reich met at VDI's annual conferences to exchange information and discuss common problems. To these meetings the participants brought along ideas and solutions that had been developed in their home environments and formulated in their local technological dialects. Since they

84. Compare Hård, *Machines Are Frozen Spirit* (n. 60 above), chap. 7.

85. Pierre Bourdieu, "The Production and Reproduction of Legitimate Language," in *Language and Symbolic Power* (n. 16 above), 43–65, at 58.

86. Ibid., 60.

87. Ibid., 61.

88. Peter Hindrichs and Ingo Kolboom, "Industrielle Rationalisierung in Deutschland und Frankreich bis zum zweiten Weltkrieg," in *Frankreich und Deutschland: Forschung, Technologie und industrielle Entwicklung im 19. und 20. Jahrhundert,* ed. Yves Cohen and Klaus Manfrass (Munich, 1990), 383–410.

Language Communicative practice based on social and intellectual competence	→	English	→	Oil Engineering
Grammar Codified norms and rules formulated to control and regulate practice	→	*The Advanced Learner's Dictionary of Current English*	→	Magg, Nägel
Official language Legitimate practice that follows the codified rules set down in grammar	→	Queen's English	→	M.A.N.
Dialect Communicative practice common to a distinct group in which no core-set has decisive power	→	Lake District dialect, pigeon English	→	Junkers-Krupp, Daimler-Benz, Peugeot, Berliet

FIG. 1 Linguistic definitions exemplified by reference to the English language and oil engineering.

shared a common language, the language of diesel engineering, the engineers could communicate, despite this multitude of dialects (see fig. 1). Through the creation of discourse coalitions and the adherence to engineering grammars, an official language developed, allegedly free from local peculiarities. This language was not static. In the face of changing dialects, both the official language and the established grammar could be modified.

This approach enables social analyses of how certain groups define what should be recognized as correct design solutions, much as sociolinguistics studies how "correct speech" is being established.[89] Simultaneously, it helps explain the social processes underlying what Wiebe Bijker has analyzed as different degrees of inclusion into specific "technological frames."[90] Like Weberian and Bourdieuan sociology, a nonfunctionalist sociolinguistic methodology makes possible the analysis of technological closure processes in terms of (defining) power and (linguistic) profit.[91]

89. Edna Andrews, "Cultural Sensitivity and Political Correctness: The Linguistic Problem of Naming," *American Speech* 71 (1996): 389–404.

90. Wiebe E. Bijker, *Of Bicycles, Bakelites, and Bulbs: Toward a Theory of Sociotechnical Change* (Cambridge, Mass., 1995), 279–88.

91. On defining power, see Hård and Knie, "The Ruler of the Game" (n. 54 above). On linguistic profit, see William Labov, "Is There a Creole Speech Community?" in *Theoretical Orientations in Creole Studies,* ed. Albert Valdam and Arnold Highfield (New York, 1980), 369–88.

The challenge posed by the fast-moving diesel is an example. In the early 1920s the emergence of direct-injection and precombustion technologies in response to the increasing interest in vehicle applications threatened some of the design prescriptions around which closure had been formed twenty-five years earlier. Lauster took it upon himself to defend both the accepted ("Oxford") grammar and the official ("Queen's") language of diesel engineering, but emerging local practices at numerous firms worked against him. Since these new dialects soon became strong enough to modify the official language of diesel engineering, the defenders of purity had to give in. The grammar had to change.

By contrast, the French engineering community apparently lacked a forum of the same impact and centrality as that found in Germany.[92] It is well known that relatively few former *grandes-écoles* students in state service dominated French engineering in terms of theory, but recent historical research indicates that their influence on French industry was weaker than the standard account has had it.[93] In Marius Berliet's sources, one finds no evidence of his visiting or paying attention to the discourse at the French Society of Civil Engineers (la Société des ingénieurs civils de France). Of course, French engineers also wrote textbooks that defined legitimate spaces of thought and action and arranged meetings at which common problems were debated. Nonetheless, these forums evidently did not have the same including effect as did their German counterparts.[94] French books and journals in automobile engineering also had a more practical and descriptive character than the corresponding German ones. Both René Bardin's survey of diesels and semidiesels and *Le génie civil* can be read as catalogs of dialects rather than prescriptive grammars.[95]

This liberal and open character of French engineering practice largely explains the flexibility among French diesel manufacturers. Since all French diesel firms, except Renault and Panhard-Levassor, had license agreements with different foreign companies, a strong need to cultivate an official French oil-engine language likely never developed. Unlike Lauster and his colleagues, Berliet and his collaborators had no vested interest in a specific or grammatically correct design. Each local French group was busy enough trying to understand the German or British dialect that it had decided to "copy and improve." A French "uniform diesel" was never on the agenda.

92. Hindrichs and Kolboom.

93. Albert Broder, "Enseignement technique et croissance économique en Allemagne et en France, 1870–1914: Quelques éléments en vue d'une analyse approfondie," in *Frankreich und Deutschland: Forschung, Technologie und industrielle Entwicklung im 19. und 20. Jahrhundert,* ed. Yves Cohen and Klaus Manfrass (Munich, 1990), 66–95.

94. Ibid., 81.

95. René Bardin, *Les moteur à combustion Diesel et semi-Diesel,* 3rd ed. (Paris, 1933).