

Orchestrating automobile technology : comfort, mobility culture, and the Construction of the 'Family Touring Car', 1917 – 1940

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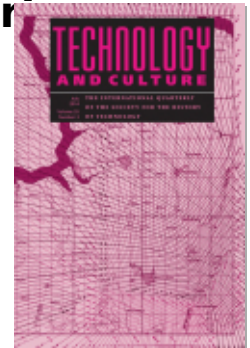
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**Orchestrating Automobile Technology: Comfort, Mobility
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Gijs Mom

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Orchestrating Automobile Technology

Comfort, Mobility Culture, and the Construction
of the “Family Touring Car,” 1917–1940

GIJS MOM

Introduction: The Car and the Senses

On the first pages of her 1918 war novel *The Marne*, U.S. writer Edith Wharton characterizes one of her protagonists by repeatedly, and ironically, calling his car “a large noiseless motor.”¹ Whereas before the war, engine noise was viewed (and heard!) as a token of power and modernity, postwar mainstream motoring had discovered silence as a new proof of modernity.² Low sound levels indicated the absence of waste and ineffi-

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1. Edith Wharton, *The Marne*, 3–7.

2. Motorcyclists during the interwar years did, however, continue to subversively cultivate the connection between noise and power by driving with an “open exhaust.”

ciency, while protests against motor traffic had sensitized urban populations to the noise nuisance.³ About a decade earlier, Wharton's friend Henry James had marveled at her open car, specially refitted as a closed car with interior electric lights, in which he had "three weeks of really *seeing*" his beloved France.⁴

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The final engineering design of the closed car (with an all-steel body, windows, and a windshield) was one of the most complex and costly operations in the history of car technology. It took U.S. engineers, and the users looking over their shoulders and sometimes guiding them outright, about fifteen years to reconcile the new way of traveling and build a consensus of what a car was all about. The technical shift itself, from an open tourer to a sedan or limousine, was, in many ways, the most straightforward part of the process, happening in only a few years. Culturally, this transformation of the automobile was part of a general process of "cocooning": a redefinition of travelers' relationship to the environment, a process in which the senses played a crucial role.⁵ Technically, it took place in one of the most innovative phases in car production and technology history, a period in which the relationship between the engineer and the user took on a new significance.⁶ Closing the vehicle was a process related to the many changes in other components: during the process, car development was crucially shaped by the parallel discourse about comfort, especially its "scientification."⁷

For several years, historians of technology and STS scholars, as well as students of mobility and its history, addressed the emotional and sensorial aspects of their subjects of study, emphasizing experiences and their bases, thus producing the corporeal, sensorial history of technology as a new inter-

3. Karin Bijsterveld, *Mechanical Sound*, chap. 4; Matthias Lentz, "Ruhe ist die erste Bürgerpflicht."

4. Hermione Lee, *Edith Wharton*, 230 (emphasis in original).

5. For the importance of the senses as a "bodily form of knowledge" and the shaping of the touristic world as "spectacle" (that is, dominated by the image), and the emergence of a "tourist perspective" or "tourist gaze," see David Howes, "Introduction"; and Kenneth Little, "On Safari." See also John Urry, *The Tourist Gaze*.

6. Paul Nieuwenhuis and Peter Wells, "The All-Steel Body as a Cornerstone to the Foundations of the Mass Production Car Industry." On the changing relationship between engineer and user, see Kathleen Franz, *Tinkering*. There is not much scholarship on the history of automotive technology proper, let alone on the details of the development of the closed-car body. For an innovation studies and business-history approach with the questionable claim, as this contribution testifies, that the 1930s was a decade of "punctuated equilibrium" in the United States, while the 1920s showed a frenzy of innovation, see William J. Abernathy, *The Productivity Dilemma*; and Abernathy and James M. Utterback, "Patterns of Industrial Innovation." A general overview from the viewpoint of the history of technology, implicitly denying the equilibrium thesis, is Peter J. Huggill's "Technology Diffusion in the World Automobile Industry"; for a contemporary overview, see U.S. Federal Trade Commission, *Report on Motor Vehicle Industry*, 907–19.

7. On the "scientification" of research on sound in general, see Bijsterveld, *Mechanical Sound*, and, specific to the car, "Acoustic Cocooning."

disciplinary synthesis.⁸ The form that multi-sensorial experience took in the case of the automobile was through the priority of comfort, which represented a new version of a specific U.S. car culture necessitating new user skills, such as conversing while driving and driving at higher speeds on the now rapidly expanding network of paved highways.⁹ On the production side, a new type of “riding and body engineer” emerged who was responsible for designing vehicles according to the evolving properties of mobility.

This rearrangement of technical properties and cultural and social functions could not have been accomplished without special attention to the production and consumption of sound. This article will show how the study of sound critically influenced the eventual design of the car as it developed into a multi-sensorial “room on wheels,” which although dominated by vision, was importantly supported by a “sound cocktail” deliberately “orchestrated” by manufacturers and users alike. After all, sound abatement and comfort enhancement have common physical roots: vibration. The article focuses on the United States, where the process was embedded in a well-documented engineering discourse about comfort, although the same process also occurred in Europe.¹⁰

The discourse on automotive comfort occurred against a background of a more general and controversially debated tendency toward “decadence” enabled by technological progress.¹¹ Car mobility was in the middle of this debate, as it was a leisure pastime that, according to many contemporaries, had to be “roughened up” by auto camping, with its “soft primitivism.”¹² Remarkably, the historiography of the car is as yet poorly developed when it comes to the sensory aspects of mobility, despite the call for a cultural turn by Colin Divall and George Revill some years ago.¹³

In the transition toward what was deemed a comfortable car, the role of

8. Nupur Gogia, “Unpacking Corporeal Mobilities”; Deborah Lupton, “Monsters in Metal Cocoons”; Paul Rodaway, *Sensuous Geographies*; Constance Classen, “Foundations for an Anthropology of the Senses”; Alexander Cowan and Jill Steward, eds., *The City and the Senses*; Sara Danius, *The Senses of Modernism*; Heike Weber, “Head Cocoons.” For the relationship between car driving and bodily sensations, see Mimi Sheller, “Bodies, Cybercars and the Mundane Incorporation of Automated Mobilities.”

9. On acquiring new automotive skills in cars and airplanes, see Kurt Möser, *Fahren und Fliegen in Frieden und Krieg*; on the existence of a network of smooth main roads during the interwar years, see Gijs Mom, “Roads without Rails.”

10. Stefan Krebs, “The French Quest for the Silent Car Body.”

11. See, for instance, Joachim Radkau, “Auto-Lust” and “Die Nervosität des Zeitalters”; see also John E. Crowley, *The Invention of Comfort*.

12. Warren James Belasco, *Americans on the Road*, 83.

13. Colin Divall and George Revill, “Cultures of Transport.” For a call to “rethink mobility” along cultural lines more systematically, see Gijs Mom et al., “Hop on the Bus, Gus”; for a call to include communication and media in studies of mobility, see Heike Weber, “Mobile Electronic Media”; and for car histories that emphasize the visual dimension, see David Louter, *Windshield Wilderness*, and Christof Mauch and Thomas Zeller, eds., *The World Beyond the Windshield*.

sound synthesized with vision and other senses, such as touch (of the wind, for instance), or the nearness of strangers when touring through the countryside or in foreign countries. This becomes apparent through a close reading of the *Journal of the Society of Automotive Engineers* (*SAE Journal*), which often published accounts of engineering meetings at all levels—local, regional, national.¹⁴ In the analysis presented here special attention is given to the role of the end-user, even if the main sources allow only a glimpse of it, filtered as it is through the eyes of the engineers and producers.

The Changing “Automotive Adventure”: Early Car Tourism

The closing of the auto body started at the end of a first, pioneering phase in which car culture was shaped by what I have elsewhere called an “automotive adventure”—in time (driving speeds and racing), in space (wandering without a clear goal), and in function (tinkering and negotiating poor roads).¹⁵ When these early pioneers were joined by a wider, less technically educated middle-class user, the popular touring adventure began to be accompanied by calls for comfort. The desire for self-imposed hardship during motorized camping trips redefined the concept of comfort from earlier traditions of hotel-based holidays—a reformulation of an elite bourgeois practice into a middle-class mass practice. The automotive adventure was thus domesticated into a tamed version for the nuclear family. Sound engineering—the abatement of noise for both passengers and those on the road—formed a critical element in this domestication.¹⁶ In this context, *comfort* covered all of the senses, although the term was vague enough to function as an umbrella concept that helped define U.S. car culture—as opposed to the European model, which was considered sporty and Spartan.¹⁷

14. For the distinction among societies dominated by either vision or sound, see Classen, “Foundations for an Anthropology of the Senses”; and Constance Classen, *Worlds of Sense*. For two complementary approaches (cognitive science and ecological psychology) to analyzing the material world from the point of view of human perception, see Nicole Boivin, *Material Cultures, Material Minds*, and Tim Ingold, *The Perception of the Environment*; see also Sarah Pink, *Doing Sensory Ethnography*. For the concept of the “knowledge community” of engineers, see Ann Johnson, *Hitting the Brakes*.

15. Gijs Mom, “Civilized Adventure as a Remedy for Nervous Times.” For relevant histories of the U.S. car culture, see Clay McShane, *Down the Asphalt Path*; Rudi Volti, *Cars and Culture*; and Cotten Seiler, *Republic of Drivers*. From an ecological perspective, see Tom McCarthy, *Auto Mania*. On the closed car in particular, see also John A. Heitmann, *The Automobile and American Life*, 96–100. James J. Flink provides the basic and comprehensive narrative of automobiles in the United States in his *America Adopts the Automobile and The Car Culture*.

16. Orvar Löfgren, *On Holiday*, 55. See also Ronald Kline, *Consumers in the Country*; and Joseph Anthony Interrante, “A Movable Feast.” The best analysis of the U.S. car-tourism culture during the interwar period is still Belasco, *Americans on the Road*.

17. Gijs Mom, “Diffusion and Technological Change.”

Around 1914, cost calculations by tourists showed that it was cheaper for a family to travel by car than by train, especially when a tent and canned food were brought along.¹⁸ The automotive tourism movement occurred within a wider context of increased road-building, the emergence of paid vacations, and a general climate that fostered the “urge to travel” at the local, state, and federal levels.¹⁹ Nature parks and parkways with ersatz scenery were built for weekend tourism by city dwellers.²⁰

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The annual statistics of the National Park Service, founded in 1916 as a special bureau of the U.S. Department of the Interior, indicate that the automotive tourism movement was impressive. In 1928, 11 million cars (of 20 million registered) participated in summer tourism involving 44 million individuals, of whom 32 million lodged at hotels and motels and 12 million camped. Midway through the 1920s, cars overtook railroads as the main transportation to the parks, probably much earlier than they became the norm for commuting. In the nine most popular vacation regions that participated in “the business of selling scenery,” only 7 percent of visitors were “home-staters.”²¹ In 1934, 38 million motorists visited or passed through national forests, and 13 million stayed long enough to enjoy recreation. Many of them stayed in camps, explored in their cars, or hiked on trails built by the Civilian Conservation Corps. A good example of this federal support for building recreational infrastructure is the Going-to-the-Sun Road in Glacier National Park, Montana, completed in 1933, its sole purpose being to offer a purely scenic experience.²²

On the national roads, Americans en masse wished to “See America First,” as the patriotic slogan of the tourist movement exhorted.²³ As a result, the lengths and speeds of automobile touring increased: lengths increased from an average of 125 miles in 1916 to 400 in 1936; and accelerating speeds became a “pernicious disease,” as the tourist and recreation journal *Outing* explained. Around 1930, “making up miles” (as well as night driving, done by a third of the members of the American Automobile Association [AAA] surveyed in 1929) and trying to make up for lost time started to replace the bohemianism of earlier, slower-paced touring pleasure.²⁴ Shortly thereafter,

18. Mark Foster, “City Planners and Urban Transportation,” 385.

19. Michael Berkowitz, “A ‘New Deal’ for Leisure,” 190–91. For an international comparison, see Charles M. Mills, *Vacations for Industrial Workers*.

20. Clay McShane, “The Carriage and Urban Roads”; Timothy Davis, “The Rise and Decline of the American Parkway.”

21. Frank E. Brimmer, “Forty-four Million Awheel,” 33.

22. *Ibid.*; Jesse F. Steiner, *Research Memorandum on Recreation in the Depression*, 60, 64; Paul S. Sutter, *Driven Wild*, 49.

23. Marguerite S. Shaffer, *See America First*.

24. Ernest N. Smith, “A-Touring We Will Go,” 46; “What Price Delay?” 27; Myron H. Whitney, “Fording the Atlantic Coast,” 232; Robert Sterling Yard, “Glacier the Unspoiled,” 99; H.A. Brunn, “Body Comfort and Interior Appointments” (in *Journal of the Society of Automotive Engineers* [hereafter *SAE Journal*]), 22. On the value of speed as both bodily satisfying and an element of efficiency, see Jennifer Bonham, “Transport.”

U.S. motorists consumed as much gasoline during the winter as during the summer.²⁵

“We give the customer what he wants”:
Co-constructing the Car

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Although farmers, businessmen, shopkeepers, and salaried employees commuting to work are normally credited as the dominant actors in the breakthrough of automobiles, car technology evolved in a form that was specifically geared toward long-range tourism, not the day trip and the weekend excursion. Owners desired cars that served recreational, as well as utilitarian, needs, but the pleasure of the family trip seemed to dominate interwar car culture.²⁶ To enable travel for tourism, the technical properties of the car had to be geared toward what, in the 1930s, became known as “the affordable family car,” which was conceived as being not too fast and “sober, not to say sedate.”²⁷ Although Ford’s Model T has been celebrated as the quintessential “universal car,” during the 1920s new types of closed cars (including Ford’s own A and V8 models) superseded the “flivver,” and they became explicitly marketed toward the urban middle-class family just as other comfort-enhancing technologies were, such as the bathtub and the telephone.²⁸

Reviewing a quarter-century’s worth of *SAE Journal* reveals that engineers responded to seemingly isolated customer complaints communicated through automobile dealerships and, increasingly, via their ever-more-powerful sales departments, the engineers fixing a shortlist of general-function problems concerning the automobile’s comfort, economy, performance, and speed. Several items on this shortlist came from customer surveys, such as the questionnaire that the National Automotive Chamber of Commerce (NACC) sent in 1922 to 20,000 car owners, of whom about 10 percent responded, regarding endurance and economy of operation foremost, followed by comfort, price, and appearance. Remarkably, speed was nearly at the bottom of the list, just before service appointments.²⁹

25. H. J. Struth, “American Motorists Spend \$6,000 a Minute For Gas and Oil,” 46. On increased winter traffic during the Great Depression, see Owen D. Gutfreund, *Twentieth-Century Sprawl*, 69, 146.

26. It is difficult to find quantitative evidence of the precise use profile of the car during this phase. This author dedicates an entire chapter to this issue in his forthcoming *Atlantic Automobility*, resulting in the thesis that “pleasurable use” formed at least half of the average daily use of the automobile, probably more.

27. Alan R. Fenn, “The English Light-Car and Why” (no. 2), 212; “English Comment on the American Made Automobile.”

28. Leonard P. Ayres, “Saturation-Point for Motor Cars Pushed Ahead to 27,000,000,” 196.

29. J. E. Hale, “The Public’s and the Car-Builders’ Attitude Toward Balloon Tires,” 461. The 10 percent response information is from Norman G. Shidle, “Practical Data Gathered for Use in Selling Cars,” 351.

Manufacturers and engineers did not slavishly follow this wish list, however; on the contrary, they translated such items into their own view of the state of the art—for instance, when they decided “to give the public comfort and speedy transportation, even if this uses somewhat more gasoline than slower or less comfortable transportation.”³⁰ Thus the translation process from (perceived) user preferences into finished car design was complex and nonlinear, governed by a large amount of uncertainty on the engineering side about what the public wanted.³¹ As many Americans had witnessed firsthand during the war, European cars had higher standards of comfort: “Our cars come in for a great deal of criticism. They say we sit *on* our cars while they sit *in* theirs, and when you ride in their cars you agree with them. We spent 10 days in different makes of European cars. They ride remarkably ‘easy.’ . . . Their cars are most comfortable and they are very low.”³² But soon, U.S. automotive engineers began to distance themselves from their European counterparts (often reducing “Europe” to only the UK), just as European engineers did vis-à-vis U.S. car technology, hence setting in motion a process of mutual stereotyping that characterizes one side by defining the alterity of the other.³³ To give only one example among many: when a U.S. automotive engineer toured England, Belgium, Italy, and France in 1920, he observed that “[i]n Europe . . . the automobile is not transportation but adventure. [In America, the motorist] jumps into his four-door sedan as one boards a streetcar. . . . The European motorist demands less convenience than the American.” The American motorist, he continued, wished “to ride all day in an automobile without being cramped or lamed any more than they would be in the best railroad cars.” “Safety, comfort and elegance” was needed, another engineer opined. Especially on the Continent, the average motorist is “a courageous speed-hound”: they let their “noisy engines” roar at 4,000 rpm “without flinching for hours,” whereas the United States is “the paradise of the lazy driver.”³⁴

The pages of *SAE Journal* provide ample evidence that U.S. engineers portrayed their design practices as simply responding to customer wishes, a characteristic that differentiated them in their own eyes from their European rivals. However, the engineers also had their own ideas when it came to design, consisting of at least two attributes that were not subject to discussion: production costs, and the decision to go with the gasoline

30. A. L. Putnam, “Chassis Design for Fuel Economy,” 441.

31. On the role of engineers as “translators” of users’ wishes, transforming (technical) properties into (relational) functions, see Gijs Mom, “Translating Properties into Functions (and Vice Versa)”; for an analysis of the state of the art on the basis of automotive-technology handbooks, see Mom, “Constructing the State of the Art.”

32. David Beecroft, “Conditions in the Automotive Industry Abroad,” 523 (emphasis added).

33. Stefan Krebs, “Standardizing Car Sound.” On the emergence of two different car cultures in the North Atlantic world, see Gijs Mom, “Transporting Mobility.”

34. Maurice Olley, “Comparison of European and American Automobile Practice,” 109–11; Andrew F. Johnson, “Passenger-Automobile Body-Designing Problems.”

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engine over others. The first attribute overruled any changes more radical than incremental improvements, and the second avoided any loss of city driving due to its special requirements, such as frequent stopping and starting, slow driving with large steering angles for turning and parking, and so forth, although no one ever explicitly voiced such concerns. It appeared, therefore, that for U.S. engineers, although they stressed the idea that “we give the customer what he wants,” this same customer had to be “educated” whenever he (and increasingly also she) threatened to oppose their own strongly held principles of good engineering.³⁵

One may wonder why more early motorists did not prefer the electric vehicle if comfort was such a desirable trait. After all, electrics were considered to be noiseless, and their comfortable, upholstered interiors made them attractive for those who did not wish to engage in the automotive adventure.³⁶ What happened instead was that critics increasingly derided electrics as “feminine,” while at the same time the electric’s comfort was used by the competition to soften the gas car’s so-called adventurousness. Taking over the threatening characteristics of its silent competitor (a technological version of “repressive tolerance”), producers and consumers alike co-constructed a masculine car culture in which the car was implicitly defined as adventurous to the senses, but in a civilized way.³⁷ From this perspective, the concept of *co-construction* has a double meaning. It refers to the dual construction work that professional engineers have to perform by first creating the product while at the same time defining its user-friendliness to prospective buyers. In other words, while the engineers are creating the product, they are also creating users and their opinions as well. Co-construction also refers, however, to the ways that both producers and users negotiate during and after the production process.³⁸ The examples below will illustrate how this process of co-construction worked. The cases of the engine, gearbox and gears, tires, and car body will make clear that comfort functioned as a guiding principle, which indeed set U.S. automotive technology apart from its European counterpart.

35. Austin M. Wolf, “Striking Engineering Progress Revealed in 1933 Cars,” 16.

36. For a detailed analysis, see Gijs Mom, *The Electric Vehicle*.

37. For this phenomenon, see *ibid.*, where it is called the “Pluto effect”; the characteristics of new technologies are often incorporated in the technologies to be replaced, making it more difficult for the users to opt in favor of the former.

38. Adri Albert de la Bruhèze and Ruth Oldenziel, eds., *Manufacturing Technology, Manufacturing Consumers*; Nelly Oudshoorn and Trevor Pinch, eds., *How Users Matter*; Steven Woolgar, “Configuring the User.”

Quieting Engines, Silencing Gears

The first example of the co-construction of a comfortable car was the development of highly oversized engines, so “elastic” (as automotive engineers today call it) that a driver hardly needed to shift gears and therefore could operate during most of a trip at a rather low load. Initiated by the consumers themselves because of their uneasiness with the complexities of gear-shifting, their desire to “go-anywhere-on-top” (in the highest gear) also drastically reduced the noise level.³⁹ The half-closed throttle in the inlet channel caused fuel consumption to rise, but this was a consequence that U.S. engineers were willing to accept for creating this sort of comfort, particularly because the country was the land of inexpensive gasoline. When engine speeds commenced rising in order to serve the growing long-range tourism trade and the need of frequent gear-shifting threatened the automobile’s use in cities, the U.S. automotive industry developed an elaborate and costly automatic transmission to relieve drivers of this “uncomfortable” task.⁴⁰

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Noise generated by the internal combustion engine was a delicate issue. One engineer estimated that duplicating the quiet drive of the electric vehicle in gasoline-powered cars consumed half of the engineers’ time, noting that “[o]ur goal, as engineers designing an automobile engine, is to create power plants that shall not be heard during operation and are free from vibrations.”⁴¹ Contrary to what was happening at the same time in Europe, where tax laws forced manufacturers to build high-revving “sporting” engines, U.S. automotive engineers viewed their own engines as “faithful servants which shall sink their identity and not be in evidence at any time.”⁴²

Soon, the struggle against noise expanded to the entire vehicle, especially the elusive howling of gear wheels—“the clutch and transmission jazz,” as one engineer called them.⁴³ Although advertisements in European trade journals reveal a similar discourse, as early as 1925, U.S. specialists from Bell Laboratories attended SAE meetings to explain the intricacies of noise production and measurement, while engineers and scientists commenced basic applied research to lay the groundwork for a new engineering approach toward vibrations and resonance. This occurred as part of a general trend toward a more scientific approach to automotive engineering, which became all the more necessary once engineers realized that, as

39. “Top Speed Gear Ratios,” 691.

40. For the development of the automatic transmission, see Gijs Mom, “The future is a shifting panorama”; for a history conceived from the perspective of SAE’s engineers, see Philip G. Gott, *Changing Gears*.

41. “Powerplant Economics,” 305.

42. *Ibid.*

43. J. G. Vincent and W. R. Griswold, “A Cure for Shimmy and Wheel Kick,” 388.

“chassis engineers,” they had created an engine on wheels, whereas constructing a high-speed automobile required close attention to the complex dynamics of wheels, tires, steering, and braking.⁴⁴ This inspiration came from aeronautics, where scientific methods had been established much earlier.⁴⁵

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One consulting engineer analyzed the “[f]our general characteristic sounds” produced by gears—intermittent clicking, irregular growl, pulsating growl (or “run-out sound”), and high-pitched squeal—and pleaded for creating “harmonious sounds,” while another frankly opined, “[t]he time is here to design a car with a tuning fork.”⁴⁶ Indeed, the “snapping sounds,” “slapping impacts,” and “oil swishes” in the transmission and the squeaking brakes were now addressed in three ways: by more precise engineering that eliminated production variations; by sound absorption, if the first solution was not effective enough; and, preferably, by changing the sound. For this, the engineer not only had to develop a scientific approach, but also something of an artistic one as well. The transmission was now compared to a “violin body” and the engineering focused on “sound”—not noise, which engineers increasingly defined as “unwanted sound.”⁴⁷ Although the engineers knew that the demand for silence existed especially in the luxury automobile segment—some claiming that “[n]oise is and should be inversely proportional to price class”—by the middle of the 1930s, consumers had become so noise conscious that lower-priced cars had the same “noise characteristics of the heavier, expensive car.” Absorption materials filtered high-pitched noises out, thus giving these lighter cars a “heavier feel.”⁴⁸ By then, studies of noise had effectively abated disagreeable sounds to such a degree that some engineers feared it might jeopardize safety, since motorists “unconsciously run faster until the increased

44. This tendency can also be observed in automotive handbooks from the period under investigation; see Gijs Mom, “The Dual Nature of Technology.”

45. Johnson, *Hitting the Brakes*; Walter G. Vincenti, *What Engineers Know and How They Know It*.

46. H. Clyde Snook, “Automobile-Noise Measurement”; the remarks of the first consulting engineer are from Earle Buckingham, “Transmission Noises and Their Remedies,” 462; the second, from H. L. Horning, “Riding-Qualities That Are Physical and Mental Insults,” 93. For fundamental research applicable to automotive applications, see Floyd A. Firestone, “Technique of Sound Measurement”; on the European gear-noise discourse, see Stefan Krebs, “Sobbing, Whining, Rumbling.”

47. K. L. Herrmann, “Some Causes of Gear-Tooth Errors and Their Detection”; Buckingham, “Transmission Noises and Their Remedies,” 461; F. C. Stanley, “Causes and Prevention of Squeaking Brakes.” For “sound” and “unwanted sound,” see, respectively, Thomas L. Fawick, “Two Desirable Quiet Driving-Ranges for Automobiles,” 105, and Mary Douglas, qtd. in Karin Bijsterveld, “The Diabolical Symphony of the Mechanical Age,” 42.

48. Tore Franzen, “European Roads and American Cars,” 82; Alex Taub, “Power-plant Economics,” 723; Theodore M. Prudden, “Noise Treatment in the Automobile,” 267; Raymond W. Smilor, “Cacophony at 34th and 6th,” 26; “Noise-Engines-Springing at Car Sessions,” 37A.

speed of the car reaches the noise level to which [they] are accustomed. . . . Noise reduction,” the engineers concluded at a noise symposium, “tends to reduce the feeling of vibration, even though the vibration itself has not been reduced.”⁴⁹ It was the new type of smooth roads that allowed this increased speed: a new type of high-speed, long-range motoring was emerging.

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Co-constructing Tire Comfort

The next case of co-construction of car comfort involved powerful suppliers, tire manufacturers, who strengthened the position of drivers vis-à-vis the car manufacturers. Tire manufacturers had noticed during the early 1920s that customers deliberately underinflated tires so as to obtain a more comfortable ride as car speeds gradually increased, consciously accepting the rising costs of tire wear by doing so.⁵⁰ Suppliers like Goodyear developed balloon tires with a stronger carcass, enabling lower air pressure so that the tire could take up more of the springing work of the total wheel suspension. The automotive engineers fiercely opposed this innovation because they soon found that such tires would increase the danger of shimmy—a heavy vibration of the wheel around its steering pivot—which, apart from increasing the noise level of the vehicle, endangered steering and driving stability. It was dreaded as a “pernicious malady of mystery which is defying the cunning of near all car engineers.”⁵¹

Within two years almost all users had changed to the new tire type, thus forcing the car manufacturers to commence scientific research on the elusive phenomenon of “ride comfort.” The new properties of the tire necessitated changes in adjacent components, including the complete redesign of the suspension system, a process that took nearly two decades in an atmosphere of utmost uncertainty. One of the initial common solutions was a slight increase in tire pressure, but a decade later the “pernicious malady” recurred when “super balloon tires” appeared on the market, which consumers immediately embraced.⁵² In the end, the research resulted in the insight that only independent front-wheel suspension (by which the front wheels were not interconnected by a common axle or leaf spring) could remedy the shimmy phenomenon.⁵³

This case also illustrated that the engineering community was not a

49. Prudden, “Noise Treatment in the Automobile,” 267; “Noise Studies Now Important in Design,” 62.

50. J. E. Hale, “Shoeing a Car with Low-Pressure Air” and “The Public’s and the Car-Builders’ Attitude Toward Balloon Tires”; “Balloon Tires and Service”; B. J. Lemon, “Glimpses of Balloon-Tire Progress.”

51. O. M. Burkhardt, “Wheel Shimmying.”

52. B. J. Lemon, “Judging Super-Balloon Tires.”

53. Maurice Olley, “Road Manners of the Modern Car,” 163.

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monolithic entity (nor was the expanding group of consumers), but instead consisted of factions, schools (often associated with individual car manufacturers), and leading individuals who managed to convince their colleagues of the necessity of, and approach to, solving the problem. The role of SAE in this negotiation and translation process was often one of fostering compromise between opposing interests and initiating research in fields that were either too difficult to manage by one single firm or too far removed from the production process. The noise-abatement campaign was just such a field, which soon expanded into an entirely new sector of research aimed at improving comfort and covering the gamut of what a body experiences while driving. Some veteran engineering authorities protested that what customers really wanted was not the “very monotonous [and] extreme boredom [of] an absolutely smooth road,” even if such customers themselves would describe this situation as ideal: instead, they wanted a “heroic” vibration of the engine that “gave the impression of high speed.” But most of their colleagues agreed to engage in a project of which the outcome was uncertain, but that was clearly directed at redefining and further easing the automotive adventure, especially its acoustic and vibrational aspects.⁵⁴

Realizing that the U.S. car industry had “no satisfactory yardstick to measure riding-comfort,” but that “vibrations . . . are by far the greatest annoyance in a car,” SAE itself took the initiative in 1925 by approaching psychology professor Fred Moss of George Washington University in Washington, D.C., and setting up a Riding-Comfort Research Subcommittee. It developed a “wobble-meter” that could measure fatigue as an indicator of the much more elusive concept of comfort. Comfort, then, was defined as lack of fatigue and situated within a multi-sensorial view of the driving experience. By testing live human beings on a specially prepared “vibrating chair,” the body became a seismograph.

Later, Ammon Swope of Purdue University expanded this research by subjecting 135 men and women (mostly students) to tests in order to measure “sensory qualities,” such as motion, sound, sight, smell, and spatial relations and aesthetics, against the background of a number of characteristics, such as speed, noise from brakes, desirable amount of visibility, leg room, and the kind of floor covering. Swope distinguished between the responses by gender. For instance, women found skidding more objectionable, while engine noise appeared to be disagreeable to both. The feeling of acceleration also varied by gender. Not surprisingly, whether male

54. “Impressions That Are An Insult,” 392 (for Horning’s full text, see Horning, “Riding-Qualities That Are Physical and Mental Insults”); S. P. Hess, “Automobile Riding-Comfort” (no. 1), 82, and (no. 6), 543; H. L. Horning, “Bearing of Research Department Work on Car Developments,” 190; “Riding-Qualities Research”; “Riding-Comfort Investigations.”

or female, motorists preferred closed cars to open ones.⁵⁵ Comfort, one engineer now said, was a “state of mind” influenced by “mysterious rattles, squeaks and grunts.”⁵⁶ And yet, eight years after the problem was first identified, when Moss presented his final report, there was still widespread uncertainty among engineers about what defined “a good ride.”⁵⁷

At Purdue University, research continued on a new “shake table” that measured the physical responses of a hundred women, resulting in the conclusion that vertical vibrations were more easily endured than lateral ones.⁵⁸ When, by 1935, Chrysler stepped in to perform applied research for production, it developed simpler measuring instruments, such as the accelerometer invented by a Chrysler research engineer, C. A. Tea. In the process, new engineering concepts—for example, *roadability* and *harshness*—were coined, and a specialized “riding engineer” was added to SAE ranks to investigate the problems.⁵⁹

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Co-constructing the Closed Body

Just as with the adoption of the balloon tire, motorists themselves initiated the change to the closed body (which, according to some, was “the last major improvement of the automobile as a personal passenger vehicle”) during the 1910s by using soft “tops”—often makeshift winter tops with emergency curtains and celluloid windows—to place on their open cars, thus allowing year-round motoring.⁶⁰ The Hudson Car Company was the first to recognize this trend and developed, in 1919, together with the Fisher Body Company, the all-steel, closed-bodied Essex. By 1924, both Chrysler and Dodge (the latter’s bodies made by the Edward G. Budd

55. F. A. Moss, “Measurement of Comfort in Automobile Riding,” “Bodily Steadiness,” and “New Riding-Comfort Research Instruments and Wobblemeter Applications”; “Review of S.A.E. Research Activities,” 716; “Bodily Steadiness—a Riding-Comfort Index,” 111–14; G. C. Brandenburg and Ammon Swope, “Preliminary Study of Riding-Qualities”; Purdue: “Wind Resistance and Comfort.”

56. E. C. Gordon England, “The Body Problem and Its Solution,” 70–71.

57. C. H. Kindl, “New Features in Shock Absorbers with Inertia Control,” 176; “Can We Get and Measure Riding Comfort?”

58. H. M. Jacklin, “Human Reactions to Vibration,” 402.

59. C. A. Tea, “Riding-Comfort and Noise Problem Treatment Studied”; R. W. Brown and H. C. Dickinson, “Criteria Are Set for Riding Comfort Research,” 22; W. J. Muller, “Developing a Front-Drive Car,” 762; Hess, “Automobile Riding-Comfort” (all three sources); W. E. Lay and L. C. Fisher, “Riding Comfort and Cushions”; H. A. Hicks and G. H. Parker, “Harshness in the Automobile.”

60. George J. Mercer, “Style in Automobile Bodies,” 124; L. C. Hill, “The Convertible Body,” 172; Robert Paul Thomas, “Style Change and the Automobile Industry during the Roaring Twenties,” 121, 128–31; the cost of the annual model change increased threefold during the 1920s, 122. The costs of the body were one-third of the total costs of the car (Mercer, “Style in Automobile Bodies,” 123).

Manufacturing Company) followed Hudson's example, and when, after 1925, a wave of closed models hit the market, they were mostly priced the same as the open versions, with astonishing results. After 60 percent of respondents in the eastern states and 40 percent in the southern states to the previously mentioned NACC survey indicated that their next purchase would be a closed car (citing weather, general comfort, year-round use, and better appearance as their motives), sales of closed cars exploded—first in the more expensive price class, then, and most spectacularly, in the medium and lower segments. By the end of the decade, nearly all passenger-car production was of the closed variety, a body style known as the “sedan” (and, in the UK, “saloon”).⁶¹ This change also decreased the interior size: while previously most cars traditionally came with seven passenger seats, now the norm became five or even four, aimed at the average U.S. family size.⁶²

The introduction of the closed body had an enormous impact on automotive technology, as well as its production and user culture; a British journal spoke of “almost a new motoring.”⁶³ At first, the immediate (“depressing,” one engineer opined later) effect on the driver was a decrease in visibility because the metal roof and small windows, which in cold weather were misted by the poor interior ventilation, blocked the motorist's vision. Although throughout the decade the engineers successfully wrangled with their sales departments to gradually increase the vehicle's glass surfaces and added ventilation and heating systems as well, soon a more expensive convertible version was introduced that, by the beginning of the 1930s, was in particular demand in the more variable climate in New England and the Midwest rather than in the South and the Pacific Coast region.⁶⁴ Around the same time, the engineers complained that the new, mass-produced seats were often less comfortable than the former ones in open-body vehicles.⁶⁵ The nearly 40 percent weight increase in smaller cars also necessitated a further increase in engine power to propel the heavier load.⁶⁶

Although the purpose of closing the vehicle was to isolate the human body from the environment, thus enabling a year-round user culture, the

61. “Closed-Car Demand Increasing”; Edward G. Budd and J. Ledwinka, “Building of All-Steel Vehicle Bodies”; Thomas, “Style Change and the Automobile Industry during the Roaring Twenties,” 129.

62. George J. Mercer, “Cheaper Closed-Body Construction,” 213. This may also have reflected declining family sizes.

63. “Where Cars Are Better,” 735.

64. “The Passenger Car of the Future,” 237; E. W. Goodwin, “Automobile Body Design and Construction,” 277; George J. Mercer, “The Trend of Automobile Body Design,” 269; Hermann A. Brunn, “Trends in Body Design,” 680; J. W. Frazer, “Bodies Considered from the Car Buyer's Viewpoint,” 299; Henry M. Crane, “How Versatile Engineering Meets Public Demand,” 31.

65. Richard M. Bach, “Design and Style as Selling Factors,” 474.

66. In 1921, the closed-body car weighed, on average, 362 pounds more than the open car; see “Weights of 1921 Cars on Which Kansas Bases License Fee.”

effect on the senses was unintended and needed to be remedied. One problem was that the body panels caused new noise: as “sounding boards,” they amplified the vibrations from the propulsion system and other chassis sub-systems, as well as from the road, while windows rattled in doors and panels squeaked when moving relative to one another, emitting the notorious “drumming”—a resonance phenomenon.⁶⁷

Such problems rendered acoustic engineering into one of the essential elements of the riding-comfort process, a decade-long effort to translate motorists’ experiences into a viable vehicle design. Visibility was part of comfort as well; the engineers also focused their attention on designing a side-post that not only allowed unobstructed vision, but “yet will not look very light.”⁶⁸ Even the sound of shutting the door was an object of study, as potential buyers preferred a soft rather than tinny sound.⁶⁹ After a decade of research and practical experience, body panels were coated with materials (often asphalt) to deaden noise as a matter of routine, while components were increasingly rubber-mounted, including the engine and transmission and the car body itself on its chassis.⁷⁰

A gradual shift from technology to appearance and aesthetics in both the industry’s marketing and buyers’ preferences accompanied the closing of the body. By the end of the decade, when the body had slowly been rendered rattle- and leak-proof, *appearance* had advanced before *comfort* in perceived consumer desires, followed then by performance, reliability, value, and durability. The closing of the car body was not solely responsible for this trend; one slogan for open-bodied cars proclaimed: “The Body Sells the Car.” But aesthetics did have consequences for engineering: the box-like, rather static appearance of the closed body in an increasingly high-speed traffic flow posed extra challenges to body designers.⁷¹

While the classic *chassis* engineers (especially the engineers who designed the engine and transmission) remained skeptical, new *body* engineers tried to reconcile the wish for comfort (which, tellingly, was initially compared to that of a quiet streetcar or train) with the increasing complexity of the car.⁷² In other words, the closed body definitively made the

67. “New Problems in Body Design,” 630; Hermann A. Brunn, “Body Comfort and Interior Appointments”; “Noise Studies Now Important in Design.” For a picture of a resonance pattern in a car roof, see “Spring-Movement and Vibration Study of a Car,” 448.

68. R. H. Dietrich, “Tomorrow’s Trend in Automobile Body Designing,” 767.

69. The door-sound preference was described by a British engineer as typical for British buyers. See Alan R. Fenn, “The English Light-Car and Why” (no. 4), 487.

70. “Recent Progress in Automobile Design,” 249; C. L. Humphrey, “Noise and Heat Control in the Automobile Body.”

71. “Big Detroit Body-Division Meeting”; Brunn, “Trends in Body Design,” 682.

72. Goodwin, “Automobile Body Design and Construction,” 277. On the controversy over body engineering, see Kingston Forbes, “The Body Engineer and His Relation to the Automotive Industry,” 437. “[M]any engineers haughtily turned a cold shoulder to the idea [of extending engineering into the body]. Only upon the insistence of man-

car into a consumer product influenced by fashion, and, in general, a curious mix of engineering rationality and the creativity of the artist-designer.⁷³ The growing significance of the body engineer as a distinct specialist is apparent in the proceedings of the annual SAE meetings. While SAE organized its first session on the body in 1914, a separate division, as part of the Detroit Section, was only founded in 1928.⁷⁴ One of the new engineering tasks was to accede to the constant pressure from the sales department to further lower the body and still make it appear to be speedy even if it sat at curb level.⁷⁵

By the beginning of the 1930s, body engineers had started to conceptualize unit constructions, making a separate chassis superfluous (again, with the streetcar as an example) and consequently using 15 percent less steel, allowing the body to be lowered even more and be given a streamlined shape (for example, rounded corners and slanted windshield) for the automobile's new use in long-range touring. Moreover, specially designed coloring of the body enhanced the appearance of speed.⁷⁶

However, wind resistance resulting from the higher speeds introduced a new source of noise, while the sound of the tires also became noticeable as if to compensate for the decreasing engine sounds. Each technical refinement created a new noise issue: the engineers seemed to be heading toward an insurmountable noise barrier. This became all the more acute when, at the end of the 1920s, car radio made a rapid appearance. This much was clear: Americans were equipping themselves to go on long family tours in car interiors that, in 1937, still showed a sound and noise level of 82 decibels (dB) at 60 mph (which was 2 dB more than a large orchestra).⁷⁷

By the end of the 1930s, the leaders of SAE noticed that appearance was so important to car owners that they "will accept a certain degree of discomfort."⁷⁸ Noise abatement and sound engineering, meanwhile, had developed so far that engineers openly started to conceptualize an "ideal car [that] should rapidly traverse an ordinary road in such a manner that the only indication of motion would be the sight of the passing landscape." Thinking from the point of view of the driver, engineers had been trying to eliminate sound to enable vision: shakes and harshness had been smoothed out enough to engender the idea of driving as "flight"—a fantasy of the driving experience during the previous forty years. With all bumpy motor-

agement did they give it any consideration"; see R. E. Chamberlain, "This Body Business," 107.

73. Paul Thomas, "The Secret of Fashion and Art Appeal in the Automobile."

74. "10 S.A.E. Activities," 25–26.

75. Mercer, "The Trend of Automobile Body Design," 267.

76. H. Ledyard Towle, "Projecting the Automobile into the Future," 38; "Design Trends Clarified at First National Passenger Car Meeting," 18.

77. "New Problems in Body Design," 629; Crane, "How Versatile Engineering Meets Public Demand."

78. Henry M. Crane, "The Car of the Future," 141.

ing engineered away and acceleration issues resolved, the automotive capsule could now be displayed as a rolling advertisement for itself.⁷⁹

Conclusion

This analysis of nearly a quarter-century of the co-construction of technical properties and user-culture argues that the tourism wave did not alter the main impulse behind general automotive engineering—namely, to preserve at all costs the ideal of the automobile as both city car and touring car. Automotive engineers were not interested in developing a car exclusively for touring; instead, by carefully designing its properties, they introduced the touring function without jeopardizing the automobile's more general function. The dual-purposed family touring car resolved these contradictory preferences.

A critical element of this touring car was its sensorial characteristics, which emerged as a result of a complex engineering effort constrained, in part, by sales managers and car owners. This engineering effort took into account perceived though abstract customer wishes, such as the desire for comfort and performance. At the same time, engineers maintained and defended their own general principles, such as resisting alternative types of engines and limiting increasing costs, which could drive them out of business. In this restricted sense, the engineers indeed “gave the public what it wanted”; the constant focus on comfort led to an increasingly softer ride, hence liberating the senses for the visual. This means that in the design of technical properties, although customers' influence was often indirect, it was nevertheless real. Users were increasingly enclosed in a capsule in which the sounds were consciously changed, such that the acoustic feel of the exterior was softened, even decoupled from the interior. Comfort was defined as smoothness, perfect flight, and, ultimately, a dampening of the automotive adventure—without, however, giving it up entirely, as many thought had happened in the case of the electric car. Riders experienced comfort in a closed automobile, hence leisure; fatigue was identified with work in an American culture that maintained a strict separation between work and leisure. To the American way of thinking, the alternative approach of the European sporting-car culture was viewed as backward.⁸⁰

U.S. automotive engineering ended up featuring vision instead of sound as the dominant sense for touring. Although initially the visual field of closed cars was secondary because the windows were small, gradually the problems of noise and vibration (testifying to the principal synesthetic character of vision, hearing, and touch), as well as the later addition of the car radio, fostered noise-abatement and riding-comfort engineering that pro-

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79. On the experience of flight by early motorists, see Mom, *The Electric Vehicle*, 38.

80. Michael Bull, “Soundscapes of the Car.”

moted visual perception as central to the motoring experience. Increased motoring comfort rendered *noise* into *sound*, thus allowing vision to become a “tourist gaze.” When, by the end of the century, the multi-sensorial revolution occurred, highlighting comfort to all of the motorist’s senses for the purposes of marketing, the visual was paramount.⁸¹ The silenced closed car again allowed, in the words of Henry James, “really *seeing*.”

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