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Motorsports and Motoring Public at Full Song[1] (1950 to 1965): Measuring Men, Creatively Destructive, or Stimulating Technology?

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Watching a motorsport race live is a visceral, sensory experience.[3] The smells are similar across racing categories and can be either accentuated at certain points on the track or mitigated depending on that day's weather. When the contest begins, the atmosphere nearest the track is permeated with both fuel and exhaust fumes as the cars are at that point closest to each other, fully loaded with fuel, and drivers accelerating feverishly in order to gain position(s) over their competitors. The fragrance of fuel and exhaust has changed over time in that prior to the late-1950s, teams were essentially practicing alchemy, or as former Lotus Formula One (F1) team engineer and current Technical Advisor to the Federation Internationale de l'Automobile (FIA) writes, "When fuel chemistry was free, combustion problems could be solved by various 'rocket fuel' recipes, brewed by the chemists."[4] Current gasoline specifications are now much closer to what is commonly purchased by the average car owner. Other distinctively redolent sources include burned gear grease when a car's differential has broken, or the sickly sweet smell of coolant when a car has overheated or coolant/water mix has entered the engine itself. Depending upon the circuit and its configuration, spectators located by curves can experience the added scent of melted rubber from tire degradation in conjunction with the potentiality of being pelted with small cast-off bits from the scuffing of tires. The tactile occasion continues when the vacuum of the cars' ground effect design packages and the volume of cars pushing through the air magnify the collection of surface grit, thrusting it toward those in attendance.[5]

Furthermore, each series has an aural uniqueness[6] in their engines as demonstrated by the top tier series currently known as Endurance (LeMans), Formula One (F1)[7], Indy Car[8], and NASCAR[9] Sprint Cup. Take for instance the recent movie *Rush!* in which the plot chronicles the 1976 F1 driver championship battle between Austrian Niki Lauda and Englishman James Hunt.[10] While visual depictions were retrospectively staged as best as possible or enhanced with computer generated imagery (CGI), the aural assault used to place the viewer *in situ* was primeval with help from the movie theater's modern sound replication and transmission technology. Continuing with the sound theme, to the ear of an enthusiast familiar with, or having grown up during, the 1970s/1980s, there was an unmistakable and oft-mimicked sound of a "Holley 4-barrel" carburetor exercised at full song, drawing in a massive quantity of air to mix with gasoline, but which is not replicable in writing.[11] More recently, Audi and Peugeot turbo-diesels have dominated endurance racing since their introduction at the dawn of this century while simultaneously emitting far fewer decibels than their standard engine counterparts. Where F1 engines once emitted a sound reminiscent of large angry mosquitoes, power-plant specification changes in 2014 diminished that sound to a docile growl. NASCAR has maintained its un-muffled thunder for decades and the pitch of Indy cars has modulated based on the year.

The seemingly ubiquitous human interest in competition and pushing the limits of speed, “faster”, “quicker”, existed well before ancient chariot races or Meso-American games from centuries ago. In current times, the Euro-American public has continued this desire with: “drive-thru” everything, supposedly speedier self-checkout lanes in stores, headline-only or sound-bite news, faster downloads and computer processing, *ad infinitum*. Emblematic of this characteristic, the American comedian Jeff Foxworthy (well-known for his observations on human behavior) had a recent stage routine where he emulated a frequently encountered male obsession for completing a recurring, long, road-trip in shorter time than during previous ventures. He concluded the parody with thumbs firmly locked in belt loops, a puffed out chest, and an exultative statement of how many minutes had been reduced from earlier iterations of the trek.

This article is a transnational look at technological momentum across society and the racing industry by way of the “interpenetration” of increased leisure time with technological advances,[12] along with the shifting threshold of society’s tolerance of mortality in motorsports.[13] To simplify this approach, the period will span 1950-1965 and cover F1, NASCAR’s top series (currently sponsored by Sprint), plus the annual events of *24 Heures du Mans* (LeMans), and the Indianapolis 500 (Indy 500). The century’s mid-point as the baseline is significant due to the formation of two motorsport organizations with regulatory and race sanctioning authority for competitive automobile racing. The first was the creation of NASCAR by Bill France, Sr. in 1948 for American stock-car racing and the second being establishment of the FIA in 1950 for the rest of the world.[14] Within the FIA's top series of F1, the chief protagonist in its growth has been (and still is) the British businessman Bernie Ecclestone although most of his control began to occur in the mid-1960s.[15] While both organizations have grown to include several series (the FIA has exponentially more), there are some distinct differences in these entities. The races which are sanctioned by the FIA are, with very rare exception, all "road" courses which means they follow the topographical surface with left and right turns to include some series on public roads/trails worldwide. However, the NASCAR series' are overwhelmingly American, always traveling counter-clockwise on purpose-built "ovals" which means they are generally oval in form with track surface banking from 5-degrees to greater than 30-degrees at the superspeedways of Daytona (Florida), Atlanta (Georgia), and Talladega (Alabama). This stimulates the question of how NASCAR in particular, may have evolved to its current racing format in a softly deterministic manner. By limiting the series to oval tracks, might it be possible that, as David Nye explains, "Once a society chooses…its preferred system…it is difficult to undo such a decision."?[16] The Sprint Cup, 36-race series has only two non-oval circuits and those are fully enclosed road courses where but a handful of teams have any success as the set-ups and driving techniques are exponentially different than running ovals at full song. Many fans of NASCAR have indicated they want more road courses.

With regard to automobility, the decade following the immediate postwar years revealed many new possibilities for discovery by societies on both sides of the Atlantic.

Among those avenues in Europe was the new option for individual travel at a time of that person's or family's choosing, to a destination they chose. This was enabled by the availability of modest cars affordable to most people, who suddenly had more leisure time and could draw upon more disposable income than in any earlier period.[17] In America, the new possibilities emerged in consumptive behavior and found expression in spending the considerable amounts cached in savings after years of rationing and doing without various goods and services.[18] One of the manifestations of this revived consumerism in America was through the acquisition of increasingly powerful and faster cars.

As car owners and enthusiasts became more interested in the automobile reflecting personal expression, national pride, or various other reasons, growing numbers were drawn to motorsports for its demonstration of men harnessing speed while pushing physical limitations with technological innovation.[19] What was not immediately recognized by the public was how automobile racing was actually an element of the entertainment business that was developing around other professional sports.[20] So, even though this connection was not readily apparent to all, the seeds were sown that racing, as a spectacle, needed to deliver something of value to the consumers of this sport. Thus, an interconnected causality developed whereby spectators and enthusiasts demanded close and exciting competition, race teams spent more (time, labor, and money) to innovate technologically in order to meet that demand, and drivers used those technologies to push speed and control boundaries even further. Pushing those limits sometimes resulted in catastrophic failures and fatal outcomes that in turn resulted in the expected reactive regulations and/or physical changes to tracks themselves. Those modifications eventually took place partly because of driver demands for safety and partly because, in the public's eyes, the spectacle of motorsports was neither seen, nor accepted, as gladiatorial mortal combat. So, across the latter half of the century, decade by decade, as technology exponentially enhanced the speed by which images were captured, reproduced, and transmitted to the consuming public, adaptations were implemented.[21] By capturing those images with cameras improved as a result of wartime military innovation, then distributing those images more rapidly to a growing number of homes containing the then-new novelty of television, people reacted to the full sequence of tragic incidents versus reading disassociated black and white text. Some of the implemented adaptations, such as energy dampening water/sand filled barriers at critical impact points, were eventually translated into the public sphere at highway exit ramps, work zones, etc. Once at a seemingly safe and acceptable juncture, continuously increased speed then triggered new cycles of innovation, incidents, and reaction. Nonetheless, this did not blunt the ever-increasing number of people, from broader demographics, having more choices to watch and greater options to attend a greater selection of circuits, as they consumed their increased leisure time.

GROWING THRILLS

The first 15 years of organized racing at the premier levels was truly an epoch of unbridled experimentation as individuals and teams sought to push the limits, in spite of the relatively few regulations. In NASCAR, one of the masters of ingenuity in circumventing the “grey areas” of regulations was the colorful crew chief Smokey Yunick. He was a mechanic by trade and an occasional car designer who could easily and quickly interpret various driver descriptions and feedback necessary to alter the car’s set-up for each particular circuit.[22] More importantly he owned twelve automotive and safety patents, was responsible for a whole host of innovations for the automobile and related technologies, and was inducted into the International Motorsport Hall of Fame in 1990. He was not always successful in skirting the relatively concise rulebook (compared to current rules), but hen he was, it contributed to his drivers earning almost sixty NASCAR victories and one Indy 500. Among the legendary tales of his escapades were numerous fuel tank modifications and one instance of a car he built whereby NASCAR inspectors had a long list of infractions he needed to fix before they would allow the car to race, then they removed the gas tank. After starting the car *sans* fuel tank, he drove toward the garage area informing the officials that they apparently needed to add one more violation.[23] There were many other notable crew chiefs in NASCAR such as Bud Moore, Leonard Wood and Dale Inman who were exceptional at coaxing speed out of their machines but Smokey Yunick was particularly adept at his craft.

At Indianapolis in the 1950s, experimentation for the annual 500 mile race was displayed when a car with a modified Cummins turbo-diesel truck engine earned the pole position with the best qualifying speed for the 1957 competition. Beyond merely the fuel/engine combination, the significance was that driver Fred Agabashian was very experienced and thus able to control the disproportionately heavy car during the aggressive measures needed to qualify – although his efforts resulted in shredded tires after just the minimum required four qualifying laps. Agabashian's earning the "pole" position shocked not only the fans and spectators, but the remainder of the 33-car field as well. That said, it is important to note here that a quarter century earlier a Cummins diesel entrant was the only car to ever complete the 500-mile race without stopping for fuel.[24] Lamentably, the 1957 effort was struck down by a simple design flaw which placed the air intake too close to the bottom of the car allowing tire discard marbles or "clagg" to build up and block air flow resulting in a DNF, for Did-Not-Finish.[25]

Overseas in F1, Mercedes and Ferrari had been dominant during the initial postwar years until Englishmen John Cooper and Colin Chapman quite literally turned the sport around by focusing their sights on controlling the power and speed of the car as a whole rather than increasing the two for just the motor. Cooper's late 1950s mid-car rear-engine design innovation achieved greater balance, and thus efficiency, while Chapman's early 1960s monocoque chassis plus his aeronautic obsession with reduced weight enabled numerous upstart English teams (the eponymous company Chairman Enzo Ferrari referred to them dismissively as *garagistas*) to compete with the power-oriented Italian teams. Chapman drew heavily upon his aviation experience and colleagues at the British aircraft maker, de Havilland, for "optimum basic structure and developing his revolutionary chassis.[26] He

champion driver Graham Hill

Source: Nationaal Archief and Sparnestad Photo: http://www.gahetna.nl/collectie/afbeeldingen/fotocollectie/zoeken/weergave/detail/q/id/ab1b4b4a-d0b4-102d-bcf8-003048976d84 was also inspired by, "cross-pollination of ideas from other engineering fields and not just through having a blinkered approach to your own discipline."[27] This *in tempus* unconventional approach contributed to a major shift in the world of motorsports. Prior to the mid-1960s, the center of racing technology was a collection of small Italian specialty manufacturers clustered around the Modena and Turin areas in support of Maserati, Alfa-Romeo, among others, plus the Ferrari quest for undisputed superiority among the automotive elite in both motorsports and the motorcar.[28] However, while Enzo Ferrari was fixated on powerful engines in the front as the measure of successfully pushing limits of speed, Chapman and his fellow Brits were pushing those limits by combining innovative engineering design with greater control.[29]

Then the British pushed even further by working on the addition of a new Ford V8-engine known as the DFV (Dual Four Valve). The merging of a strong but inexpensive engine with a solid, stable chassis and rear-engine placement yielded a phenomenal parity in Grand Prix racing which began in the latter half of the 1960s. Of greater interest, however, was how the scenario which began developing in England during the late-50s to early-60s, was emblematic of a familiar theme originated by Henry Ford with his Model-T. By making highly competitive racecar components accessible, available, and customizable in their use, more teams were formed that not only solidly competed, but won races. The upshot of this tidal shift was that global motorsport technology research and development was de-centered from northern Italy and re-centered to a region in England between Birmingham and London which quickly became known as Motor Sport Valley (MSV).[30]

Mercedes-Benz (MB) racing teams in the early 1950s had rejoined the racing elite with a Janus-like aura both from Interbellum successes and resentment/embarrassment fostered by the two world wars. The MB Silver Arrows racing team had returned in the magnificently-engineered new W196 with skilled drivers managing both horse-power and traction to achieve championship success until a major tragedy occurred at the 1955 LeMans 24-hour endurance race.[31] The worst incident in motorsport history, it resulted in the deaths of 80 spectators and over 120 injured when Pierre Levegh's car, travelling approximately 150 mph, touched another car and caromed over the earthen embankments naively intended to deflect danger from the stands, disassembled itself in mid-air and spewed burning fuel onto magnesium car-body segments to which the unwitting fire crews applied water thus exacerbating the fire.

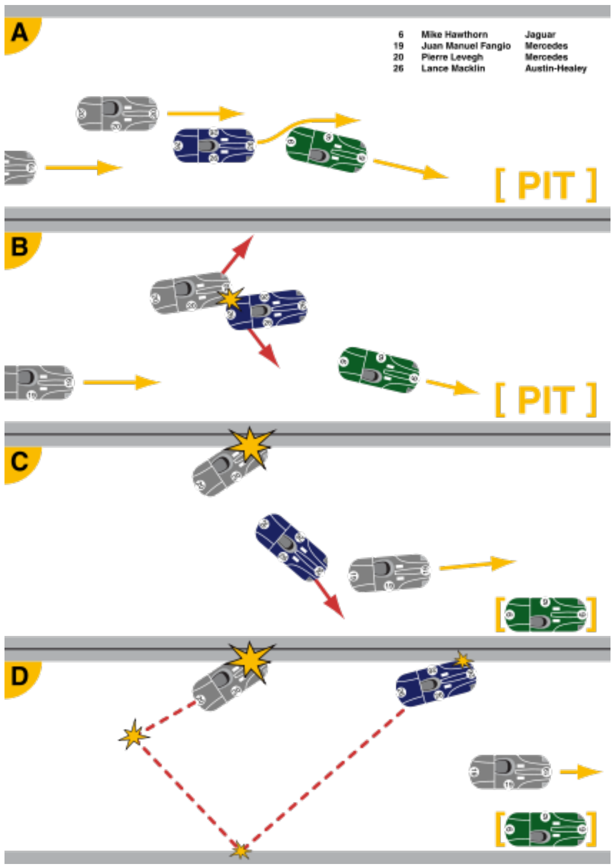

Figure 2: Simple diagram of how the tragic 1955 LeMans accident unfolded

Source: https://commons.wikimedia.org/wiki/File:Le_Mans_Unfall.svg

This incident illustrated above occurred on the front-stretch, across from the pit lane/garage area, which had the largest gathering of people anywhere along the circuit. In the formal reviews of the crash, it was determined to have been a racing accident related to technical disparity between teams' use of brake types[32] but individual blame/responsibility among drivers was never fully resolved. Consequently, the next four Grand Prix races were cancelled, Mercedes withdrew from racing entirely for decades not returning to Formula One until 55 years later, and Switzerland banned all motorsports, a ban that is still in effect today.[33] The shameful irony is that track owners and race organizers wanted throngs of people to attend these events yet they were unwilling to incur the expense of strong protective measures so they chose to have earthen embankments or bales of hay along the track peripheries. At the 1961 F1 race in Monza Italy, German driver Wolfgang von Trips' Ferrari replicated the LeMans disaster, but without the fire, killing 11 spectators as well as the driver. Even without a basic understanding of basic physics with respect to velocity and mass, it would seem that any one of the owners/organizers should have recognized the inadequacy of their tragic miscalculations. In similar fashion as with an American automobility and safety scenario outlined further below, the FIA did not over-rule on this matter as the authority for track safety was delegated to individual national motorsport governance, each of which was subject to a variety of disincentives toward improving safety despite increasing speeds. Among these were no punitive clauses in contracts for hosting a race, anemic safety enforcement, and basic disinterest in fiscal outlays to implement any safety measures.

On the public front, consumers in greater numbers were becoming exposed to automotive innovation. Most important was the relatively sudden accessibility and availability of mass-produced cars in several countries, on a scale not previously encountered, some of which have since become iconic marques. In England it was the Morris Mini (initially by BMC), in France it was the Citroën 2CV (*Deux Chevaux*), in Germany it was the Volkswagen (known by Anglophones as the "Beetle"), and in Italy it was the Fiat 500 (*Cinquecento*). In the same vein of accessibility and affordability as what transpired with English Grand Prix cars mentioned above, these passenger cars also shared a Fordist parallel with the Model-T of being new to their respective societies, reasonably priced, fairly reliable, and enabled individual freedom of participating in travel for a broader segment of the populace. The French car company

Citroën, for example, since its beginning, had demonstrated a consistent record of implementing unique innovations yet one of the most forward-leaning offerings of all was the 1955 DS, a larger automobile designed as a family sedan/saloon car. In the words of English historian L.J.K. Setright, “The Citroën DS was an engineers’ car, the thinking man’s car, far and away the most modern car in the world, not only in 1955 but for at least 15 years…”[34]

GROWING CHOICES

From the functional and technical perspective of innovation, speed, and controlling speed, the American triad known as Chrysler/Dodge/Plymouth (hereafter just as Chrysler) had begun elevating the performance of its engines with hemispherical piston heads (eventually becoming a brand upgrade marque and known simply as Hemi’s). This engineering design was not new to internal combustion engines as experimental efforts had taken place in the first decade of the 20th century, and had been dabbled with across subsequent years (successfully by the Italian company Alfa Romeo). However, during the period of this paper, Chrysler, Jaguar, and Porsche all began increasing the quality of their engines, thus raising the standard other manufacturers had to reach in order to retain current, and attract new, consumers.[35] The specifics of how Hemi’s achieved such an extra measure of power is less significant here than how it affected purchase and decision-making criteria by those who could afford the extra cost. As we know from the literature on postwar social and cultural history, the seemingly global desiderata of most of the consuming public was for anything American, especially cars[36], and beyond that, the allure of Detroit “Hemi’s”.[37]

This yearning for American cars would continue with much greater intensity until the global 1973 oil crisis. Conversely, efforts by non-U.S. car manufacturers to penetrate the American market on a large scale were rebuffed well into the 1960s. The reason was because at the time it was simply a market-driven issue, Americans were just not interested in the smaller and lighter European or Japanese models believing "heavier cars were said to be safer because they 'held the road' and protected their passengers in a collision.", plus misgivings about quality.[38] However, those forays by foreign car companies into the American domain would grow roots as the decade neared its end. Simultaneously, innovative American companies such as Kaiser, Nash, and Tucker died out in various ways, assisted by the car-masters of Detroit as documented elsewhere in scholarly literature.

As important as it was for consumers to have their cars quickly accelerate to full song, it was equally important to quickly slow or stop in a controlled manner and prevent the violent simultaneous demonstration of all three of Newton's laws of motion.[39] Braking systems as offered on the majority of production cars of that era had been, in retrospect, anemic in relation to their ever increasing speed and mass. It was during the 1950s that the diffusion of disc brakes slowly began with their initial implementation in Europe.[40] While Jaguar had been racing with disc brakes since the early 1950s, the first mass production car with this system was the aforementioned 1955 Citroën DS. In the United States however, Chrysler made overtures with disc brakes in the 1950s followed in the 1960s by a few other marques until the 1980s when a trickle effect took place as car companies started selectively including them. Due to their higher cost and requirement for greater hydraulic pressure, American companies of the 50s and 60s clearly were not interested in the increased expense of disc brakes. During those years, the management teams of American auto manufacturing firms adopted a self-fulfilling path of what later became anecdotally known as "safety doesn't sell" despite less than convincing empirical data to either support or deny this assertion.[41] The inaction on the part of the American government to over-rule those firms can be likened to having displayed a similar behavior as that of F1 track organizers' disinterest in the safety of its constituents as outlined above.[42] However, as callous as it might be, there may also be the consideration that, because of a virtually uniform exposure to danger or suffering through experiences during the Second World War, the initial acceptance of mortality was a zeitgeist of driving cars as well as attending a racing event.[43]

Concurrent with the diffusion of disc-brake technology onto the market was the formation of a "knowledge community" by research and company-employed engineers who were dedicated to the development of the vehicular Anti-lock Braking System (ABS).[44] However, what seemed to stymie efforts to implement ABS technology during the 1950s and 1960s was partly due to the common business dilemma of passing a company's cost/benefit analysis as well as the familiar "Leonardo Problem" of technology. As Joel Mokyr eloquently explains: "…gadgets and devices can be conceived that are known to be possible, but cannot be built efficiently because supporting technologies are lacking".[45] A problem inextricably linked with innovation that would cause implementation delay well into the final years of the century before it was effectively included with passenger cars. Furthermore, as a foreshadowing of brake innovation yet to develop, exploration of regenerative braking for automotive applications began in the 1920s,[46] and the French engineer-inventor F. E. Myard was investigating the notion of regenerative braking using rubber rings in 1950.[47] The methods for recovering kinetic energy lost through the braking function later became a topic of intense exploration as the broad roll-out of ABS features were coming on the market for passenger cars in the late-1990s and in racing during the 2010s known by the name KERS.[48]

GROWING PAINS

The period 1950 to 1965 provides important examples of a broader sixty year process of knowledge flow, innovation, and use across motorsports, automobility, and manufacturing. In particular it affords an interesting view of how societies and cultures were stimulated by, and interacted with, technology as each affected how the other proceeded on the postwar trajectory of advancing the automobile's capabilities. Put another way, technological threads connecting people, the car, leisure time, and interest in motorsports increasingly made up part of the social fabric. It should be evident this timeframe was the equivalent of a "crawl" stage in the relationship between the car, society, and technology.[49] In motorsports the atmosphere was more like a Wild West environment with minimal regulations and limited enforcement of the few that did exist. Innovators designed, built, and assembled exciting technology by calculated engineering formulas for some and others did so by simply relying on their senses.[50] Prior to the FIA finally establishing fuel guidelines in the late 1950s, teams were involved in pseudoscience as mentioned at the beginning of this article. As for physical safety in European motorsports, there was no movement toward correcting the problems until the late 1960s, and this mirrored the way public safety regulations developed in America. For NASCAR and Indy Car, however, the matter was not as outrageously bleak as those events took place on closed oval tracks which became ringed by guardrails, known in the industry as Armco barriers for the company that initially provided them for race-tracks. However, it soon became apparent that one level was not sufficient as stock-cars continued to periodically hurtle over the barriers, fortunately not always with catastrophic results. Over time, levels were added until three high was determined to be an appropriate barrier, thereafter by concrete walls. The struggle over installing them at European tracks was partly based on those lighter cars not being able to safely dissipate energy in a crash.

Despite the safety issues outlined above, a large enough group of enthusiasts within society demonstrated their continued support for what the innovators built and how drivers worked to harness speed. As more people began to experience car ownership some of them expanded into DIY (Do-It-Yourself) maintenance, repair, and customization, drawing upon high-performance knowledge found in new magazines and journals on the subject.[51] This explosion of self-help literature built upon the profusion of short technical articles or bulletins in the 1920s by Murray Fahnestock to help Ford Model-T owners understand and work on their cars.[52] Sharing their newly discovered knowledge with follow-on generations eventually led to individual professionalization and employment in automotive and motorsport related fields.[53] With a growing segment of society accepting or embracing cars in general and racing cars in particular, demand for enjoyment value increased pressure on participants (in all fields) to supply both increased speed and control capabilities. As a result qualification and racing lap records were broken annually while people taking trips by car completed their treks faster (usually) in 1965 than they did in 1950.

Technological knowledge during this period was not always shared openly since motorsport is a secretive industry, but was acquired through observation of innovation once in use.[54] It was only when a race-car was on the track that opponents could learn what their opposites were developing. More recent knowledge flow took place through personnel changes, the shuttering or starting of race teams, discontinuation of sponsorship or of a production vehicle, etc. Granted, secrets and intellectual property were protected but techniques and experiential knowledge remained with the individual. While an initial thought might be to focus on just the race teams that would be a mistake as it would overlook the highly significant specialty manufacturing companies which supplied race teams with intricate parts[55]. The likes of Smokey Yunick, Colin Chapman, and even Enzo Ferrari relied on the knowledge and experience of specialty producers to quickly fabricate precision components, operational tools, and assembly machines, as did the large car-making corporations. Those components contributed to both incremental and radical changes in technology stimulating drivers, helping cars go faster.[56]

It is purely by coincidence that this paper ends with 1965 which was the year Ford introduced its now-iconic Mustang sports car while attorney Ralph Nader began embarrassing the American car companies and their attitudes/behaviors which were briefly mentioned above.[57] As a quick overture for those who may not be aware of Mr. Nader, while the Detroit car companies promulgated their seemingly hegemonic agenda over all things automotive, his congressional testimony and research showed a pattern of misinformation and disregard for safety measures by those corporations. For a closing analogy, I again draw upon the large body of literature covering social and cultural history on the latter half of the twentieth century. If the years 1950-1965 and the decade immediately after were likened to musical pieces, they could be portrayed by the slow starting yet ever increasing, almost manic ending tempo of a tarantella dance,[58] or "In the Hall of the Mountain King" from Edvard Grieg's Peer Gynt with its crescendo finale, or even the American hard-rock group Blackfoot's "Highway Song" where the final chords are repeated faster and faster as they fade away into silence. I referred above to a "crawl" for this 15-year segment but the speed by which the trajectory climbed over the subsequent ten years escalated exponentially. The momentum pushed past the "run" stage until the relationship between society and cars (in both automobility and motorsports) came to a crashing halt which required regulatory first aid.

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Endnotes

[1] The term “at full song” is a descriptive term relating to a machine or system working at full pace or top speed.

[2] Having served as an Army officer, followed by 20+ years working in large and small companies, the author is currently a Lecturer in the Department of Engineering and Society in the School of Engineering and Applied Sciences at the University of Virginia. He is also a Ph.D. Candidate (ABD) in the History and Sociology of Technology and Science at the Georgia Institute of Technology. He wishes to thank Marionne Cronin for her insightful comments on this article and Alison Kreitzer for her helpful remarks.

[3] The author respectfully draws upon the wise advice of Tony Judt and Bob Post that historians must recognize the obligation of being careful, as “a contemporary to most of the events”, to not cloud ones professional judgement. Having stood at the trackside fence at NASCAR’s Atlanta Motor Speedway (1995) and the venerable “Eau Rouge” section of Belgium’s Spa-Francorchamps (1973) however, I can testify that it is a truly sensory experience. On being a “contemporary” see p. xiii in, Tony Judt, *Postwar: A History of Europe since 1945*(New York: Penguin Books, 2005). See also both Prefaces to: Robert C. Post, *High Performance : The Culture and Technology of Drag Racing, 1950-2000*(Baltimore: Johns Hopkins University Press, 2001). On racing’s sensory experience see also a speech by Dr. Carlos Martinez-Vela: Carlos Martinez-Vela, "Speed Matters: Innovation in the Nascar Motorsports Industry," in *Annual Luncheon of the North Carolina Motorsports Association*(Speedway Club at Lowe's Motor Speedway, Charlotte, NC2007).

[4] See p. 66 in, Peter Wright, *Formula 1 Technology*(Warrendale: Society of Automotive Engineers, 2001).

[5] The same is true for any car parts (usually very small) that detach from a vehicle. As race-cars became more powerful in recent decades, some seating was moved further away from the track’s edge but, where unfeasible to move, either heftier safety protocols were implemented or sections were closed entirely.

[6] For varied perspectives on cars and sound see the special April 2014 edition of *Technology and Culture* dedicated to the automobile especially Kevin Borg’s introduction and Gijs Mom’s insightful contribution. Kevin Borg, "Introduction: Constructing Sociotechnical Environments - Aurality, Air Quality, and Automobiles," *Technology and Culture* 55, no. 2 (2014)., Gijs Mom, "Orchestrating Automobile Technology: Comfort, Mobility Culture, and the Construction of the "Family Touring Car", 1917-1940," ibid., David Morris, "Cars with the Boom: Identity and Territory in American Postwar Automobile Sound," ibid.

[7] Formula One is the top series of FIA with an annual television audience greater than one billion. Only the quadrennial Olympics and football’s World Cup have a larger viewership than Formula One. The chief protagonist in running F1 was (and still is) the English businessman, Bernie Ecclestone.

[8] The current series, Indy Racing League (IRL), has endured multiple large-scale changes in its comparatively brief 30-year existence as a multi-race series.

[9] National Association for Stock Car Automobile Racing. Sprint Cup is the current name of NASCAR’s top level.

[10] Ron Howard, "Rush,"(Universal, 2013).

[11] Holley was one of the more sought after brands at the time and is still in business today.

[12] For discussion of technological momentum see: Thomas P. Hughes, "Technological Momentum," in *Does Technology Drive History?*, ed. Merritt Roe Smith(Cambridge: MIT Press, 1994; reprint, Fifth, 2001). On “interpenetration” of leisure time see: Stefan Poser, "Leisure Time and Technology," *European History Online*(2011), http://www.ieg-ego.eu/posers-2010-en. For exploration of technology and increased leisure time see: Arnulf Grübler, *Technology and Global Change*(Cambridge: Cambridge University Press, 2003).

[13] This included all high-impact, full-contact sports like boxing, professional wrestling, etc.

[14] In addition to racing, the FIA also has sister organizations FIA Foundation promoting road safety, and FIA Institute for automotive research and development.

[15] For a distinctly non-hagiographic insight to FIA and F1 machinations see, Tom Bower, *No Angel: The Secret Life of Bernie Ecclestone*(London: Faber & Faber, 2011).

[16] See discussion p.55 in, David Nye, *Technology Matters: Questions to Live With*(Cambridge: The MIT Press, 2007).

[17] For thoughtful insight to Postwar European society see: Richard Pells, *Not Like Us: How Europeans Have Loved, Hated, and Transformed American Culture since World War Ii*(New York: Basic Books (a division of HarperCollins

Publishers, Inc.), 1997). See also: Judt, *Postwar: A History of Europe since 1945*., as well as: Eric Hobsbawm, *The Age of Extremes: A History of the World, 1914-1991*(New York: Vintage Books, 1994). and Victoria De Grazia, "Changing Consumption Regimes in Europe, 1930-1970: Comparative Perspectives on the Distribution Problem," in *Getting and Spending: European and American Consumer Societies in the Twentieth Century*, ed. S. Strasser, Judt, M.(Cambridge: Cambridge Univerity Press, 1998).

[18] See p. 233 in, Susan Strasser, *Waste and Want: A Social History of Trash*(New York: Metropolitan Books, 1999).

[19] The lack of empirical data on the increasing interest during this period prevents a more detailed analysis.

[20] Except by Bernie Ecclestone and Bill France, Sr.

[21] In their Introduction on p. 3, the co-editors write: "Changes in transportation and communication revised ideas of distance, space, and time…" in, S. Strasser, Judt, M., ed. *Getting and Spending: European and American Consumer Societies in the Twentieth Century*(Cambridge: Cambridge University Press, 1998).

[22] This is an affirmation of James Scott's discussion of mētis, "When rapid judgments of high (not perfect) accuracy are called for…there is no substitute for mētis." p. 330 in James C. Scott, *Seeing Like a State: How Certain Schemes to Improve the Human Condition Have Failed*(New Haven: Yale University Press, 1998). For an F1 driver's "feel" from the cockpit see: Nigel Mansell, *In the Driving Seat: A Guide to the Grand Prix Circuits*(London: Stanley Paul, 1989).

[23] Beyond the broad conversational basis for this attribution by drivers and crew chiefs, this author not uncovered primary source validation of this scenario. However, it is representative of the mindset that existed in 1950s racing.

[24] It finished on the lead lap in 13th place. Peter Westin, "Sparky, the Patriot, and Turbo-Diesels: The Relevance of "Failed" Motorsport Innovations to the History of Technology," in *GTRIC Ivan Allen College Paper Competition*(Georgia Institute of Technology2013).

[25] The term "clagg" comes from David Hobbs, a former driver and current F1 analyst on NBCSN. See also, Peter Westin, "How Green Was the Flag?: The Maturation of Motorsports' Relationship with Automobility and the Environment," in *Society for the History Of Technology*(Copenhagen, Denmark2012).

[26] Chapman served in the Royal Air Force as a pilot and continued his personal interest in aviation throughout civilian life. Karl Ludvigsen, *Colin Chapman: Inside the Innovator*(Newbury Park: Haynes Publishing, 2010).

[27] Ibid, p. 24

[28] M. Jenkins, Floyd, S., "Trajectories in the Evolution of Technology: A Multi-Level Study of Competition in Formula 1 Racing," *Organization Studies* 22, no. 6 (2001). See also, Karl Ludvigsen, *Ferrari, the Factory: Maranello's Secrets 1950 - 1975*(Hudson: Iconografix, 2002).

[29] G. Foxall, Johnston, B., "Innovation in Grand Prix Motor Racing: The Evolution of Technology, Organization, and Strategy," *Technovation* 11, no. 7 (1991). See also, John Barnes, *Ferrari: 25 Years of Formula 1*(Scarsdale: John W. Barnes, Jr. Publishing, 1974).

[30] N. Henry, Pinch, S. , "Spatialising Knowledge: Placing the Knowledge Community of Motor Sport Valley," *Geoforum* 31(2000). On the concept of de-centering see pp. 85-89 in, Fernand Braudel, *Afterthoughts on Material Civilization and Capitalism*(Baltimore: Johns Hopkins Press, 1977).

[31] This nickname came from their 1930s shape and appearance known in German as *Silberpfeil*.

[32] The Jaguar involved had better-performing disc brakes, while the Mercedes had lesser quality drum brakes.

[33] There have been numerous works on this sports disaster with many detailed interviews and forensic investigations. As significant as this incident was, it is not the focal point of this article, yet it is one of several lenses through which to examine automotive speed and its repercussion(s).

[34] L. J. K. Setright, *Drive On! A Social History of the Motorcar*(London: Granta Books, 2004). Among the many technical advances he lists in his text on p. 100 were: self-levelling suspension, progressive nitrogen springing, front disc brakes, automatic load-sensitive lock-inhibition [rear brakes], Michelin X radial-ply tires [very newly developed], front-wheel drive stability [carried forward from their World War II era *Traction Avant* car], and a Porsche-like drag coefficient.

[35] For the many enthusiasts who preferred Detroit muscle-cars it was mostly about quicker Elapsed Time (ET) in straight line quarter-mile drag racing, whereas the Jaguar and Porsche enthusiasts were more interested in "conquering" the topography on roads.

[36] See Chapter 9 of: John Rae, *The American Automobile Industry*(New York: Twayne Publishers, 1984). See also Chapters 15 & 16 in James Flink, *The Automobile Age*(Cambridge: The MIT Press, 1992)., and Chapter 5 of Rudi Volti, *Cars and Culture: The Life Story of a Technology*(Baltimore, MD: Johns Hopkins University Press, 2006).

[37] Since the millennial turn 15 years ago, the proliferation of televised automotive auctions where high-quality "classic" cars and muscle cars from the 1950s and 1960s change ownership has become a media phenomenon showcasing auction companies such Barrett-Jackson and Mecum in addition to Bonham's, RM Auctions, and Gooding among others. See also discussions of car modifications and Hot Rods in: David N. Lucsko, *The Business of Speed: The Hot Rod Industry in America, 1915-1990*(Baltimore: Johns Hopkins University Press, 2008). On the tensions between enthusiasts and government see, "Of Clunkers and Camaros: Accelerated Vehicle Retirement Programs and the Automobile Enthusiast, 1990-2009," *Technology and Culture* 55, no. 2 (2014).

[38] Quote on p. 155 in, David Gartman, *Auto Opium : A Social History of American Automobile Design*(London ; New York: Routledge, 1994).

[39] "A [car] is always accelerating, either positively under the influence of the engine or negatively under the influence of braking", G. Savage, "Formula 1 Composites Engineering," *Engineering Failure Analysis* 17(2010). p.94. Those laws are crudely synthesized here for brevity as: 1) inertia, 2) negative acceleration, and 3) for every action there is an equal and opposite reaction.

[40] In the United States, Chrysler made overtures of disc brakes in the 1950s followed in the 1960s by a just a few exclusive marques until the 1980s when a "reverse titration" occurred as one company after included them.

[41] The true source of this mantra remains elusive and, as yet, has not been directly attributed to any one person. Peter Westin, "From Beauty to Beastly: The Lost Years of the American Automotive Industry, 1973 - 1985,"(Georgia Institute of Technology, 2010). Unpublished.

[42] The car industry lobby was strong in the 1950s but began losing ground to popular sentiment beginning in the early 1960s when elected officials were forced by their constituents to investigate claims.

[43] The author is grateful to Marionne Cronin for informing on a similar theme in Wade Davis' monograph *Into the Silence* about World War I and mountaineering in the person of George Mallory.

[44] Despite the veil of corporate secrecy, knowledge and its production vis-à-vis ABS technology was shared in several ways by participants. For detailed exploration see, Ann Johnson, *Hitting the Brakes: Engineering Design and the Production of Knowledge*(Durham: Duke University Press, 2009).

[45] See p. 146 in, Mokyr, *The Lever of Riches,*

[46] F.A. Stepney Acres, "Some Notes on Four-Wheel Braking Systems" (paper presented at the Proceedings of the Institute of Automobile Engineers, England, 1924). On the history behind regenerative braking technology see: Peter Westin, "A Fly in the Patriot's Wheel: The Intersection of Applied Research, Regenerative Braking, Motorsports, and Industry" (Master's, Georgia Institute of Technology, 2012). On innovation and prior art see also, George Basalla, *The Evolution of Technology*(Cambridge: Cambridge University Press, 1988)., and David Edgerton, *The Shock of the Old: Technology and Global History since 1900*(Oxford: Oxford University Press, 2007).

[47] F.E. Myard, "Frein a Inertie a Récupération," *Le Génie Civil* 127, no. 5 (1950).

[48] KERS is the acronym for Kinetic Energy Recovery System.

[49] Drawn from the common analogy crawl, walk, run as used for evolution of processes and relationships.

[50] For an interesting treatise on the sub-categorization of tacit knowledge see: Harry Collins, *Tacit and Explicit Knowledge*(Chicago: University of Chicago Press, 2010).

[51] Among these were *Speed Age, Rod and Custom, Hot Rod, Car Craft, Motor Trend, Road& Track*

[52] A re-printed compendium of those "how-to" periodicals can be found in, Murray Fahnestock, *The Model T Ford Owner*(Lockport: Lincoln Publishing, 1999).

[53] Not all who enjoyed and/or learned mechanical, design, or engineering skills would grow to actually "turn wrenches" professionally. For a more detailed explanation of what Collins refers to as "interactional expertise", see p.137 in, Collins, *Tacit and Explicit Knowledge*. For historical insight on the profession of automotive repair see, Kevin Borg, *Auto Mechanics: Technology and Expertise in Twentieth-Century America*(Baltimore: Johns Hopkins University Press, 2007).

[54] On the complexities of use and users see: David Edgerton, "From Innovation to Use: Ten Eclectic These on the Historiography of Technology," *History and Technology* 16(1999)., R Kline, Pinch, T, "Users as Agents of

Technological Change: The Social Construction of the Automobile in the Rural United States," *Technology and Culture* 37, no. 4 (1996)., W. Newman, Vincenti, W., "On an Engineering Use of Engineering History," ibid.48, no. 1 (2007)., N. Oudshoorn, Pinch, T., ed. *How Users Matter: The Co-Construction of Users and Technology.*(Cambridge: The MIT Press, 2005).

[55] On specialty manufacturing, see: Philip Scranton, *Endless Novelty: Specialty Production and American Industrialization, 1865-1925*(Princeton: Princeton University Press, 1997).

[56] On the American industry of Speed Equipment Manufacturers Association (SEMA) see Chapter 7 in, Lucsko, *The Business of Speed: The Hot Rod Industry in America, 1915-1990*.

[57] Ralph Nader, *Unsafe at Any Speed: The Designed-in Dangers of the American Automobile*(New York: Grossman Publishers, 1965).

[58] A tarantella is a lively Italian dance that lore links to ridding a person of a tarantula spider's venom.