Designing a High-Low Tech System using Enthusiast Automobiles

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On my honor as a university student, I have neither given nor received unauthorized aid on this assignment as defined by the Honor Guidelines for the Thesis-Related Assignments.

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Introduction

On March 22nd, 2025, I sat in the cockpit of VM23 "Arnold Palmer," Virginia Motorsport's FSAE car, for the third time. The car — small, nimble, and powered by a 600cc motorcycle engine — felt alive beneath me. At the signal, I eased off the hand clutch and launched onto the autocross course, darting through cones in the chicane, sliding through turns two and three, and accelerating down the short straight before diving back into the corners.

Even with some experience behind the wheel, driving this machine felt unlike any other driving I had done before. I could feel the roar of the tiny engine climbing toward twelve thousand RPM behind my head, the tremendous heat bleeding through my fireproof race suit, and the sharp pull of lateral G-forces threatening to throw the car off course. Each lap demanded my full attention — my senses strained to detect the slip of the rear tires as I edged closer to their grip limit. Determined not to embarrass myself in front of the club's more seasoned drivers, I pushed harder with every lap, chasing the elusive balance between control and chaos.

After what felt like half an hour, but was in fact only ten minutes, I was flagged back to the paddock to reattach a loose body panel and give the next driver a turn. My arms trembled from the physical strain of wrestling the car through the course, and I was soaked in sweat from the intense heat. A teammate joked that I looked like I had aged five years in those few minutes — and I certainly felt like it. I will not forget the visceral thrill and total exhaustion of piloting a purpose-built race car. Experiences like this reveal something increasingly rare in modern driving: a deep, physical, and emotional connection between driver and machine. In an era where technological innovations make cars safer, more accessible, and easier to operate, the embodied intensity of "pure" driving is fading into a niche pursuit.

In this paper, I examine this tension through the lens of Science, Technology, and Society (STS), tracing the historical evolution of automotive deskilling, exploring the cultural and sensory appeal of classic and performance cars, and analyzing the "driver-car" social entity. Drawing from these insights, I propose a "high-low tech" sociotechnical design framework that seeks to balance advanced technology with meaningful human interaction using the enthusiast automobile as a case study.

High Tech of Yesterday becomes Low Tech of Today

Few complaints about technology in America are more universally recognized than frustrations with automobiles. Even the least mechanically inclined drivers can offer detailed accounts of their car's misbehavior—stories of engines refusing to start before work, strange noises when turning right but not left, or mysterious dashboard lights. Although such complaints often target aging, high-mileage vehicles, even today's rusted twenty-five-year-old sedans are safer, more reliable, and easier to operate than the automobiles that preceded them.

As Dutch engineer and historian Gijs Mom chronicles, the automobile developed through a quasi-evolutionary process shaped by technological innovation and shifting consumer preferences (Mom 2). The most consistent threads in this evolution have been the trend of automation—the gradual transfer of control tasks from driver to machine (Mom 37) and the homogenization of technology used by car brands. Importantly, these trends did not begin with electronics as many modern enthusiasts complain but were introduced mechanically with the beginning of automotive technology. Driving enthusiasts have consistently pushed against skill automating changes in automotive technology since the advent of driving, with subsequent generations adopting and accepting once contested technological changes.

In the earliest automobiles, manual engine timing and fuel mixture adjustment were essential tasks performed continuously during driving, since the early combustion engines used were designed for running at constant speeds with consistent load, not the dynamic acceleration and deceleration of driving over varied terrain and traffic. The driver would adjust the air fuel mixture ratio with a foot pedal and advance the engine timing with a hand lever to control the speed of the car, along with shifting gears and controlling the clutch (Mom 34). The complexity of driving restricted it only to a technical elite of wealthy motoring enthusiasts and paid chauffeurs, the invention of the automatic carburetor and automatic spark advance replaced these tasks, with the accelerator foot pedal simply controlling the proportional fuel/air mixture to increase acceleration, decreasing the driver's mechanical role when driving. The elite motoring enthusiasts protested this change, but driving became accessible to a much wider consumer base.

The driving interface that has seen the most improvement in accessibility is the transmission. Early transmissions used a sliding gear system instead of the modern constant mesh gear system. This means that to change gears, the driver would physically move the drive gear to the driven gear in a noisy, violent process that required great mechanical sympathy to execute smoothly. Naturally this was enjoyed by the macho driving enthusiasts who mourned its loss when replaced by the comparatively smooth constant mesh gear system (Mom 94). The constant mesh gear transmission is still used in manual transmissions and has several sets of gears at different ratios that are fixed together, with the driver engaging the desired pair with the gear selector instead of unmeshing and remeshing gears in the sliding gear transmission. The addition of the synchromesh to the transmission further reduced the skill requirement, since the synchromesh bushing performed the task of matching the engine speed to the wheel speed during gear change for the driver, eliminating the skillful requirement of double clutching for smooth downshifting (Mom 100). Ultimately, the driver needing to change gears was eliminated in most

American and Japanese cars with the automatic transmission and the continuously variable transmission (CVT), European consumers preferred the manual synchronized transmission, and today most European manufacturers offer it in more cars. Automotive enthusiasts continually protested the deskilling of driving, especially in respect to transmission style, but subsequent generations adopted the new technologies, few enthusiasts today bemoan the loss of sliding gear transmissions, though some older enthusiasts remiss on the "masculine" unsynchronized transmission. Transmissions also transitioned from being developed in house to being sourced by third party manufacturers, like Aisin and ZF, standardizing the feel of many vehicles across manufacturers. Earlier manufacturers feared that this standardization would reduce the distinct character of each brand and make cars feel more like commodities (Mom 91).

The electronics revolution beginning after WWII marked the most dramatic shift in automotive design with even more standardization between brands. The solid-state transistor and large-scale integrated circuit allowed nearly all mechanical engine control tasks to be electronically controlled. At first, during the late '50s to mid '70s electronics replaced existing automated features that were mechanically controlled, like spark advance and fuel mixture. Going into the '80s, the engine itself became electronically controlled with the ECU, replacing analog sensors with digital and enabling the engine to dynamically tune itself to varying conditions and display diagnostics results to technicians. In the '90s and into 2010, navigation and communication began to be handled by the car, informing drivers of vehicle status and making navigation much simpler through GPS (Mom 177). Electronics integrating into cars contributed to the loss of brand identity of cars, since brands would source electronics from the same central supplier, like how transmission suppliers reduced uniqueness among vehicles.

As automotive technology evolved, manufacturers had to meet stricter efficiency and safety laws and compete with narrower profit margins for each vehicle. Cars became safer, larger, more efficient and easier to drive than their predecessors, but also increasingly similar to each other. Common transmission manufacturers led cars to drive similarly, and common electronics manufacturers led cars to have similar buttons, dashes, and infotainment systems. Enthusiasts continuously complained about the mechanical and electronic deskilling of driving but evolved with the vehicles as the baseline for what skilled driving entailed shifted with the technology. "Low-tech" vehicles are a constantly shifting definition. My 1992 Toyota Pickup, with its mechanical ignition timing, analog dash and simple electronic radio seems ancient compared with my 2017 Subaru Outback's modern interior and electronically controlled engine. Yet the CVT on the Outback and the synchronized manual transmission on the Pickup are vastly easier to drive and more technologically advanced than an unsynchronized, carbureted truck from the '50s, or worse, a 1920's Model T with sliding-gear transmission, no electric start or automatic spark advance. Enthusiast pushback to driver deskilling is a constantly shifting cultural value that changes with technology, the "high-low tech" system instead needs to account for the essential characteristics of an automobile that are embodied in how the enthusiast and vehicle interact.

If High Tech Becomes Low Tech, What was Lost in Translation?

By common consumer metrics, the modern car is superior to the "classic" automobiles. Modern cars are objectively safer, more reliable, comfortable, faster, and more efficient than any vehicle considered antique, which now includes model year 2000 according to the DMV. Classic car enthusiasts are therefore aptly described as the "lunatic fringe" by Derek Tam-Scott in his essay describing the qualities enthusiasts enjoy in a classic car (Tam-Scott, 2009). I will further define how a driver and car interact using Dant’s Driver-Car theory (2004), where a driver and car combine to form a larger social entity, with the driver gaining mobility and enhanced perception through the interface points of the car.

The main experiential pleasures of a classic car come from the visceral, behavioral, and reflective aspects of driving it (Tam-Scott, 2009). The visceral experience of a classic car is easily defined, the engine sounds are deeper and unfiltered without smog and noise laws restricting them, the engines and interiors smell distinct of oil, exhaust, wool and leather, and the tactile feel of the car is stronger, with wooden steering wheels and metal on metal contact for doors and switches. These materials have “honesty” (Tam-Scott, 2009) compared with new cars, with synthetic interiors faking the appearance of natural materials and hidden fasteners disguising how the car is assembled. Classic cars require different behaviors when driving them, with less automation technology present, a driver must operate the vehicle with extra attention, engaging the choke before the oil warms up in a carbureted car, double clutch downshifting an unsynchronized manual car, and modulating brakes in a car without ABS. The extra mental engagement of driving combines with the extra visceral senses of the car creating a more memorable and authentic driving experience.

The perception of the road through the car is the essential core to how the driver-car social entity functions. The driver-car cyborg is the idea that when a driver gets in a vehicle, they form a combined social entity called the driver-car (Dant, 2004). This social entity can be used to explain how driver-cars navigate roads with other driver-cars, perceiving great quantities of information at high speeds to maneuver around cars, avoid obstacles and navigate to the driver-car's destination. The human is embodied within the car and perceives the world differently in it, enjoying the automobility of the car and the freedom associated with it. The driver experiences the world through the car, perceiving with vision through the windshield, feeling the road through the suspension and steering, and interfacing with the car through the steering, pedals, and shifter. The driver forms the driver-car through the interface points of the car, which have stronger feedback in a classic car, with less sensory feedback lost in the simple suspensions, hydraulic power steering and manual transmissions than the padded, sound-deadened interiors of modern cars.

"Warbirders", people who maintain and fly WWII aircraft, frequently mentioned the mutuality of themselves and their planes (Wayland 217). They choose to fly antique aircraft for the relationship of understanding and interdependence with the machine which they find missing in modern technology. The sense of mutuality comes from the sense of oneness with the machine, where pilots feel at home, as if they were part of the machine, and it were a part of themselves (Wayland 218). Like classic cars, these planes have a personality, which emerges from the imperfections of technology of the past. Old engines, in planes and in cars, cough and smoke on starting and require a special, individual staring sequence to get going. Modern aircraft, like modern cars, sound identical and start on command, both reducing their individual personalities and replacing the feeling of mutuality with one of dominance.

The reflective aspect of owning and operating a classic car is the reflective behavior required to keep it on the road. Maintenance is required more frequently than modern cars and is simultaneously easier for the enthusiast to do at home with simple tools but also requires a deeper knowledge of the mechanical systems of the car, since they lack the onboard diagnostics of modern vehicles. Owners of classic vehicles need to reflect on the performance of the vehicle and the sensory feedback of the exhaust smell, spark plug colors, vacuum leak sounds, among others to keep the vehicles running smoothly. This reflection strengthens the driver-car relationship beyond the interface points of the car to the entire mechanical operation of the vehicle, tasks which are now automated by the ECU and OBD2 diagnostics. It is worth noting that many “classic” vehicles now have ECUs and OBD2 diagnostics, since the low-tech system is constantly shifting, but most vehicles from 2000 and earlier still feel more connected to the road and engaging to the driver, suggesting that there is a larger design ethos in these vehicles that has shifted in the past decade.

The Virginia Motorsports FSAE car, for example, uses the engine from a 2016 Yamaha R6, has an ECU and diagnostics, and has a modern double-wishbone suspension setup, yet feels more alive than any vehicle I had previously driven. This is due to the utterly unmuffled interface points of the vehicle: there is no power steering, no windshield, no sound deadening, and only three hundredths of an inch of sheet metal separating me from the engine. The car is tiny, weighing less than five hundred pounds and a wheelbase shorter than half of my Outback. This makes the car feel like a true extension of my body and perfectly embodies the idea of forming a combined driver car entity. This car was exhausting to drive and required immense concentration, but purpose-built racecars were never meant to be daily driven.

While the appeal of a classic car or racing car is great for many people, it would be foolhardy to return to manufacturing them. Not only would this feel disingenuous to classic car enthusiasts, but their poor safety and efficiency would be disastrous on roads and for the environment. Instead of remaking classic cars, the ethos of the car-driver system should be understood for these vehicles and recreated in a new way. Fundamentally, the classic car driver relationship boiled down to a deep relationship with a personally meaningful object, one that was built with intention and honesty (Tam-Scott, 2009). The enthusiast vehicle does not hide the road and world outside from the driver but immerses the driver into a larger combined entity where the driver experiences heightened perception and sensory feedback from the car. Modern vehicles lauded as “driver’s cars”, including the Mazda MX-5, are applauded as emphasizing the connection between driver and car. Mazda uses the Jinba Ittai (人馬一体) design philosophy in its vehicles (Notarfrancesco, 2022), which translates to the oneness of the horse and rider. High-tech cars prioritize comfort, ease, and safety — but at the cost of dulling the driver's connection with the machine. The oneness of the driver and car is the key to the high-low tech framework.

Designing a High-Low Tech Sociotechnical Framework

Classic car enthusiasts value a rich sensory experience with technology that rewards intimate knowledge and mental engagement, but the technology that classifies a vehicle as classic is constantly changing. Therefore, the high-low tech framework cannot specify specific technologies to be used in an enthusiast vehicle, but the design practices that encourage designing an experience with humans and technology in a mutual relationship with visceral feedback. The principles of the high-low tech system will be designed from the qualities experienced by drivers of classic and enthusiast cars and supported by the sociotechnical design principles defined by Albert Cherns (1987). The fundamental requirement of sociotechnical design is that the system must define the minimum of constraints needed to meet its goals to allow people the flexibility to adapt the system to varying conditions and applications (Cherns, 1978). To meet this requirement, the high-low tech system will include just three principles to be used to guide engineers to balance advanced technology with meaningful human interaction.

Principle I: Mutuality

All vehicles, even future autonomous vehicles, form a combined social entity called the driver-car (Dant 2004). Driver-cars form a deeper relationship when there is a mutual relationship of human and technology, and the Warbirders fear the loss of mutuality due to automation. Mazda engineers designed one of the best modern driver's cars through the design principle Jinba Ittai, or oneness of driver and car. The modern car fails to create a mutual relationship with the driver by removing human agency with varied tasks from driving and lacking personality from flaws accumulated with time. Modern manufacturing, with standardized components reduces character and identity between car makes and models, so each vehicle on the road feels the same.

Suggesting that modern vehicles abandon reliability and safety features is ridiculous, but designing with the mutuality principle in mind changes the design intent of automating driver features with technology to working in tandem with the driver, neither fully automating the car nor making it fully manual. The design implications of mutuality in technical design are simply put, where the user and technology have a "relationship of understanding and interdependence – intimacy – with a place for human agency." (Wayland 217). The word "user" itself violates the mutuality principle, the human in a human-technology relationship should be seen as a partner, not an operator.

Principle II: Comprehensibility

The best way to foster a mutual relationship between humans and technology for it to be understandable to the user. F1 cars embody this principle well, with data collection technology gathering information on the car and driver's performance during a race, which the driver uses to learn where the car can be pushed harder (Mitchell, 2022). The Warbirders working on their vintage planes valued how they could understand the system compared to the complicated physics of jet planes (Wayland 255). Classic car enthusiasts form personal relationships with their vehicles through the reflective process of diagnosing and tuning old analog engines, which requires deep understanding of the workings of carburetors and valves. The "honesty" (Tam-Scott, 2009) of the fasteners and materials in the interior of the cars also gives an innate understanding of how the car was assembled and where the materials came from compared with hidden fasteners and synthetic interiors of modern cars.

Designing with the comprehensibility principle in mind should account for the information flow principle of sociotechnical design. Information in a system needs to flow to the place it is relevant first, rather than overwhelming the top of the information hierarchy (Cherns, 1987). Physical feedback from the car's suspension and steering is the best way to communicate the condition of the road and the grip of the car to the driver subconsciously, designing comprehensible technology should utilize subconscious feedback to develop intuitive understanding of the device. High-low tech comprehensible technology should not mask its functionality from the user but be transparent in its operation. The process of learning and understanding a system should be rewarding to the user but there is a fine balance between frustration and patronization.

Principle III: Experience

The final principle of high-low tech design is that the process of using technology should be an enjoyable, mentally stimulating experience. Modern cars insulate the driver from the outside world compared with classic cars, cutting off the sensory experience of driving. Users of high-low tech style technology should be allowed to experience the sensations of using the technology. Memorable experiences with technology give back technology the personality lost from standardization and improved manufacturing without creating unreliable machines. The experience of using technology should involve active engagement of the user and meet principle eight of sociotechnical design by allowing the user to develop skills and have active decision making (Cherns, 1987).

Conclusion

High-low tech design may not suit all users or systems—it currently fits best within fringe communities like automotive enthusiasts who value experience over efficiency. However, the framework still raises questions about how technology should be incorporated to best elevate people and machines together. What would a high-low tech slideshow editor, cell phone, or washing machine feel like to use? At what point does technology transcend its role as an appliance and become something more like an extension of the self, like an automobile? Even if the approach only appeals to a niche audience, providing meaningful, engaging technological experiences is a worthwhile design goal. At its core, the high-low tech design philosophy simply asks if modern technology has become "cheaper" and "soulless" in ways that go beyond simple nostalgia.

References

Cherns, A. (1987). Principles of sociotechnical design revisited. *Human Relations, 40*(3), 153–161. https://journals.sagepub.com/doi/10.1177/001872678704000303

Dant, T. (2004). The driver-car. *Theory, Culture & Society, 21*(4–5), 61–79. https://doi.org/10.1177/0263276404046061

Mitchell, S. (2022, November 18). *How data works in Formula 1*. Racecar Engineering. https://www.racecar-engineering.com/articles/how-data-works-in-formula-1/

Mom, G. (2014). *The evolution of automotive technology: A handbook*. SAE International.

Notarfrancesco, E. (2022, October). Jinba Ittai: The meaning behind Mazda's driving philosophy. *Drive*. https://www.drive.com.au/caradvice/jinba-ittai-mazda-meaning/

Tam-Scott, D. (2009). Rationalizing the lunatic fringe: Bases of classic car enthusiasm. *Intersect: The Stanford Journal of Science, Technology, and Society, 2*(1), 104–125.

Wayland, K. A. (2006). *A better past through technology: World War II warplanes as cultural heritage* (Doctoral dissertation, University of Virginia). https://doi.org/10.18130/V31G4Z