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Deepest Mediatization? Inventing the Autonomous Vehicle

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The fully autonomous vehicle (AV) promises to be both a prototypic example of deep mediatization in the built environment and the apotheosis of the mediatized automobile. Autonomy has been an elusive goal, however. Its achievement will depend on a persuasive sociotechnical imaginary (STI), along with breakthroughs in digital technology. The latter involve advanced artificial intelligence, of course, but also the transformation of the nature of media, a dynamic that goes well beyond the mere proliferation of in-car media. After exploring "media" and automotive deep mediatization, this article dwells on neglected examples of existing mobile autonomy. It then turns to STIs in general, which are visionary articulations of pioneering communities, and the American AV STI in particular. This is constructed through a close reading of recent semipopular publications that mostly promote the desirability of vehicular autonomy. The article concludes critically, with analysis of the unpersuasiveness of the current American AV STI, the vehicle in AV, and the transformation of media.

Keywords: deep mediatization, autonomous vehicles, sociotechnical imaginaries, American automobility, digital technology

"I don't understand how these machines can drive automatically . . . unless they can see?"
"They *can* see!" He pointed to an excrescence on each headlight of the machine, like a bud on a potato.
"That's the selenium eye . . . The electrical resistance of the metal selenium varies with the intensity of the light that strikes it; and that is a little camera chamber with a lens and a selenium network. By its means, the machine can *see*."
"The earlier machines had steering-wheels; their vision was a simple reflex for avoiding obstacles, while the driver had to choose the route himself. But . . . we developed the logging attachment to the speedometer, by means of which it is possible to lay out the route on a set of dials. The machine could then find its way without human aid . . ."
"Our machines are endowed with senses: sight, hearing, touch . . . We even gave them senses [that] human beings do not have, the ability to perceive various vibrations and forms of energy in the ether of space. They could do everything but reason . . ."
"[A]n insatiable thirst for progress drove us inexorably onward!"
(Breuer, 1930/2008, pp. 199–200)

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Prediction may be a fool's game, but 90 years on from Breuer's (1930/2008) fantasy, the connected car is becoming an autonomous vehicle (AV), in some cases eliminating the steering wheel, with the capacity to see collaboratively with other AVs and to program, by means of websites and applications, a real-time plan for travel, all knitted together with self-learning algorithms—a kind of reasoning mobile machine that was just beyond imagining in 1930.

Mediatization is a way of labeling the long historical process by which media have become increasingly important in everyday life. This has involved both the replacement of existing means of communication, as when the typewriter provided an alternative to handwriting, and the introduction of wholly new media, such as the smartphone. Couldry and Hepp (2017) claim mediatization has been going on for several hundred years in a series of three "waves": Mechanization (the printing press), electrification (telegraphy, broadcasting), and digitalization (datafication).[1] They say the cumulative effect of mediatization accelerated the pace of media change. Along with the crucial technological convergence and industry concentration fostered by digitalization, these conditions produced unprecedented media ubiquity across sociocultural, political, and economic life, what they call deep mediatization. Andersen (2018) points to search engines, algorithms, and databases as prime dynamics of deep mediatization that unavoidably infiltrate and reorient cognition, sociality, and epistemology, becoming new "means and modes of communication and sense-making we live by" (p. 1148). Hepp (2019), following Bolin (2017), shows how these significant and often fast-moving changes can even be experienced as generational markers, as in the case of "digital natives," who may see themselves and who are seen by others as being distinctively shaped by their intimate relations with new media.

Deep mediatization is a broad, abstract concept. It implies something more than just the state of mediatization: a greater degree, a heightened centrality, the increased power of media—of their technologies, occupations, organizations, and institutions. It suggests a kind of teleology in the mediatization process where media transcend simple, tool-like instrumentality and become, in McLuhan's famous phrase, "extensions of man," now in the posthuman sense of hybrid networks, actants, and cyborgs. Furthermore, deep mediatization not only labels the present moment; it implies a continuing process, a future of even more so. But as a recently articulated idea about a complex set of changing conditions, it is undertheorized. And as provocative hypothesis, it remains largely untested empirically.

One way of grounding the concept of deep mediatization is to explore specific emerging new media and related phenomena, their innovation, development, diffusion, and adoption. Examining the "constructed, put together, assembled" (Arthur, 2009, p. 2) side of new media technology would reveal such factors as their inventors' intentions, how they are designed to relate to and expand upon existing media, the range of interests that promote or inhibit them, and the extent to which they actually "deepen" mediatization. Each new medium and its related phenomena offer an empirically manageable exploratory

[1] The terms "digitalization" and "digitization" tend to be used interchangeably. Which to choose is unclear and often arbitrary. Here, "digitization" refers to moving from analog to digital form, as when the information in a news story is available on newsprint and on screen. "Digitalization" is a more comprehensive process that pertains to the transformations of social life resulting from digital media. This is an imperfect solution and a work in progress (Bloomberg, 2018).

case study of the dynamic, multidimensional mediatization process, one with the capacity to "observe the ocean in a drop of water," as the Chinese historian and poet Chen Yinke so inspiringly puts it (as cited in Johnson, 2021, p. 38). As a strategy, it "attempts to examine a contemporary phenomenon and the associated contexts that are not clearly evident" (Dooley, 2002, p. 338), which "can contribute in a holistic way to all phases of theory development" (p. 336).

Two key factors in the emergence of a new medium or the intensification of mediatization, whether ultimately successful or not, are its sociotechnical imaginary (STI) and the "pioneer community" (Hepp, 2020), which may or may not be geographically bounded, of scientists, entrepreneurs, and advocates who attempt to bring it about. In practice, they are closely related, since an STI is the ideational glue that holds the community together and articulates its collective aspirations. It may be that an STI is more visible sooner than the full range of actors who develop and promote it. A typical imaginary, which must extend into the realm of public opinion, will necessarily be accessible to a wide range of people. A pioneer community, on the other hand, is probably best understood retrospectively, from some future time when it has performed its function and ceased to be a tumultuous, highly charged zone of cooperation, competition, and conflict.[2]

With these observations in mind, this article examines the case of AVs. The study proceeds from the assertion that the fully autonomous automobile would be both a powerful instance of deep mediatization in the built environment, a material site where a constellation of new media is being applied toward revolutionary ends, and the acme of automotive mediatization. Analog in-car media, sources of generations of mobile infotainment and a hallmark of the experience of automobility, were transformed by digitization. Infotainment media became inseparable from the electronic operating systems of the car, at least as drivers and passengers encountered both in smartphone-like interfaces. Audiovisual and ambient digital media quickly made the automobile a striking example of the emerging connected, interactive, anticipatory, immersive qualities of deep mediatization. Replacing the role of human driver with artificial intelligence to achieve automated travel takes the next logical step.

To support this claim, the article discusses how deep mediatization challenges conventional ways of thinking about the nature of a medium and the mediatization of the automobile. It then presents examples of existing autonomous mobility, though of a kind with strict limits. Turning to the development of AVs, the article offers one measure of the current American STI for AVs through a close, critical reading of three recently published semipopular books and four chapters from similar publications, each of which makes a well-informed, opinionated case about the desirability and likelihood of vehicular autonomy in the United States. Finally, the article identifies conceptual and empirical issues that arise from the study and that bear on deep mediatization theory, the mediatization of the automobile, and the AV.

[2] Hepp (2020) offers Turner's (2006) account of Silicon Valley's unexpected roots in sixties California flower power as an example of pioneer community research. Turner's book was published decades after the events it so thoroughly and cleverly studies.

The Medium Under Conditions of Deep Mediatization

More than 40 years ago, the computer scientists Alan Kay and Adele Goldberg (1977), working at Xerox PARC, observed the emergence of what they termed a "metamedium." They explained that the digital nature of a computer allows it to be "*all other media*" and that its "messages," each of which is "*a simulation of some idea*," can also be engaged with interactively, previously something possible only in "a two-way conversation" (Kay & Goldberg, 1977, p. 31; emphasis in the original). "We think," they wrote presciently, that "the implications are vast and compelling" (Kay & Goldberg, 1977, p. 31).

What was then novel speculation derived from experiments with a prototype educational tablet, the Dynabook, has today become the globally scaled everyday reality of the so-called Fourth Industrial Revolution, "characterized by the fusion of the digital, biological and physical worlds, as well as the growing utilization of new technologies such as artificial intelligence, cloud computing, robotics, 3D printing, the Internet of Things, and advanced wireless technologies, among others" (Ndung'u & Signé, 2020, p. 61; see also Schwab, 2016, 2018). These are the technological features of deep mediatization, broadly understood.

Kay and Goldberg's (1977) mostly theoretical metamedium implies the convergence of previously discrete technologies of production, distribution, and consumption (see Balbi, 2017, for a review of the several meanings of media convergence). Now, like a Matryoshka nesting doll, a single digital device can be numerous media at once. This has many consequences. For instance, the distinctive materiality of a given medium is maintained only in a reassuringly skeuomorphed replica. Machine learning, data science, and artificial intelligence give media the power to adapt to and anticipate users' preferences. Media become embedded in nonmedia objects, as when smart doorbells' motion detectors trigger Internet-connected video recording. Location data both tracks users and allows way finding through real-time mapping. The Internet connectivity that underlies such developments as these is increasingly a fact of life. In 2021, 9 of 10 American adults used the Internet, and nearly 8 of 10 had a broadband connection at home. And ownership of devices is widespread. Eighty-five percent own a smartphone, nearly 8 of 10 own a desktop or laptop computer, and half own a tablet (Pew Research Center, 2021a, 2021b). At the core of deep mediatization, then, is present-day digital technology, ubiquitous, converged, embedded, intelligent, mobile, and inseparable from the conduct of everyday life.

If previously discrete media technologies have converged, so too have media industries consolidated. Until fairly recently, there were important technological, economic, and cultural distinctions that led to media being organized individually. There was, for instance, the idiosyncratic business of book publishing. There were the storytelling conventions of writing and layout at daily newspapers. Extreme close-ups were considered appropriate for TV but not for the much larger cinema screen. Such single-media distinctions became less justifiable with the rise, beginning during the 1960s, of corporate conglomerates that sought cross-media ownership. Today, five or six firms dominate in the United States, reaching across and within media cultures. Like a large shadow, each oligopolist's branding identity engulfs superficially separate "content" activities, often in the name of synergy.

The digital technological underpinning of concentrated media conglomerates is what Manovitch (2013) terms the "softwarization" revolution. It has fostered such a high degree of media hybridity that the

notion of discrete media may have lost its value. Instead, he proposes a species model in which data structures and algorithms combine and recombine (by means of "deep remixability"; Manovitch, 2013, p. 336) in ways parallel to biological evolution. Individual media come and go, their boundaries grow indistinct and permeable, and groups of media with related characteristics "overlap in their identities" (Manovitch, 2013, p. 237). Underlying these developments is the modular nature of software. Brian Arthur (2009) believes that modularity and recursiveness are inherent in technology generally, creating a global, persistent condition of the "combinatorial evolution" of material culture. This has led to modern technology becoming less about producing a given cultural output, like a motion picture, than being able to "be combined and configured endlessly for fresh purposes" (Arthur, 2009, p. 25). These technological features have implications for the deeply mediatized AV and the industry that produces them, as well as the social lives where people will use them.

The Automobile and Deep Mediatization

Historically, media have been a uniquely influential determinant of the experience of American automobility. Cars have been represented, and car culture enriched, from the beginnings of the horseless-carriage era by a range of media and forms, including news and advertising, short stories and novels, children's literature, Hollywood motion pictures, and enthusiast materials. A growing number of in-car media created the audio "cocoon" that enveloped drivers and passengers from the 1920s onward. Manufacturers' concept cars, auto shows, and races became multimedia spectacles. The mass media and the modern automobile were made for each other because, as Wolfe (1963) famously said about California's custom car scene, cars "are freedom, style, sex, power, motion, color—everything is right there" (p. 114).

The comprehensive digitalization that began in the decade or so before the millennium, what Couldry and Hepp (2017) call the "media manifold"—"almost infinite, and organized on very many dimensions" (pp. 55–56)—had profound implications for automobility. Digital technologies were steadily adapted to the automobile. Some served infotainment purposes. Some concerned the very operation of the vehicle, creating drive-by-wire conditions. And their shared interface replaced knobs and dials and analog instrumentation with the ubiquitous touch screen and voice commands. In addition, artificial intelligence inserted itself between driver and car and car and the road with new features like automatic braking, lane-keeping, adaptive cruise control, blind-spot detection, head-up displays, and even Level 2 autonomy, when the car can independently steer, accelerate, and brake, following a GPS map. Automobiles unlock at the approach of an owner and automatically personalize the vehicle's seating, mirrors, lighting, and infotainment. All of this has quickly become commonplace, with such offerings now essential to a car's market appeal (see Miller, 2017, for a history of the mediatization of the American automobile).

Perhaps the main reason for the desirability of the digitalized automobile is its familiarity. There can be a near-seamless media experience moving among smart devices and environments, mobile and immobile, with the car just one more connected media-consumption site along the way. And automotive representations have expanded into simulations. Video games like *Grand Turismo* and *Need for Speed* offer immersive virtual driving experiences. Sim racing like iRacing and Project Cars 2 involve professionally sanctioned series that often include professional drivers, who also regularly prepare for races by training on

simulations of racetracks. When the COVID-19 pandemic shut down actual racing, race organizations moved online, establishing, for example, the eNASCAR Coca-Cola iRacing Series.

To speak, then, of the deep mediatization of the automobile is to imply the vehicle in its several contexts, most of which are now combined by digital media into an augmented reality version of automobility, whether actually in the vehicle or engaged with a simulacrum, whose next—and maybe final—iteration is full autonomy.

Actual Existing Autonomy

Several examples of fully autonomous mobility exist today but are often given little thought. They include the elevator, mining trucks, trains, and aircraft. Together, they provide a temporal and technological frame around the quest for autonomy, beginning more than a century ago and ending at the edge of the most advanced, present-day, and emerging forms of transportation. Yet, they are rarely discussed with reference to AVs, which tend to be treated as a unique, solitary scientific quest.

When it was introduced in the late 19th century, the elevator was an example of the highest new technology. Its very operation was so complex that the job was thought to be as demanding as a "railroad engineer controlling the movement of his locomotive" (Bernard, 2014, p. 153). Beginning in 1893, Berlin required that an elevator be operated by a "certified person" (Bernard, 2014, p. 160). But by 1907, fully automatic push-button controls had eliminated the need for an operator, at least for apartment buildings there. In a curious historical irony, American "self-operating" elevators first appeared in the new (neoclassical) headquarters of another high technology enterprise, the Postal Telegraph Corporation (Bernard, 2014, p. 157), just as the "telephone began to supplant the telegraph as the premier electrical communication medium" (Hochfelder, 2012, p. 4). The job of the elevator operator disappeared, perhaps the only occupation so far to be fully replaced by automation because of technological obsolescence (Bessen, 2016, p. 5).

What are called "autonomous haulage systems" (AHS), or automated trucks employed in mining, have been in operation for about 10 years, with more than 500 vehicles at work today in Australia, Chile, and Norway. These are massive trucks whose total haulage since their introduction runs into the billions of tons. Claims are made for their reduced operational costs, increased safety, and productivity. Rather like fixed-rail, AHS vehicles, repeatedly and unceasingly, run the same, precise routes (Morell, 2017).

The first fully automated subway line opened in 1967, in London. Fifty years later, more than 60 automated metro trains ran in 46 cities (Lokshin & Newson, 2020), reaching a combined 1,000 km distance. The Copenhagen underground system, which opened in 2002, was designed to be fully autonomous. Vancouver's SkyTrain spans 80km and 53 stations (Grey, 2018). Singapore's stations seal off trains from platforms to prevent train sensors being confused by human and other movement. This leads to the experience of "a giant elevator rather than a train" (Weedon, 2019), a metaphorical reversal of the earliest elevators being called "vertical trains." The common rationale for driverless trains, including airport shuttles, is safety, reliability, cost savings, and highly efficient on-time performance.

Probably the longest-established, most often used and least visible example of mobile autonomy occurs in commercial and military flight. As early as the 1930s, pilotless flight was being predicted by informed aviators. According to Timothy Schultz's (2018) comprehensive account of the steady redesign of flying away from human control, in 1947, an American "robot-piloted" military plane with a "mechanical brain" crossed the Atlantic without human intervention (p. 123). Today, he says, pilots act as "information managers" (Schultz, 2018, p. 139), rarely engaging in hands-on flying. In fact, more military pilots will be trained "to control unmanned aircraft from ground-based computer consoles" (Schultz, 2018, p. 122) than to fly conventional aircraft. Schultz's (2018) analysis of "the problem with pilots" rests on their physiological and cognitive frailties, like situational awareness, which can be fatally disrupted by poor visibility, and loss of consciousness induced by extreme G-forces. Pilots of the most advanced U.S. fighter jet, the F-35, wear $400,000 helmets that act almost as virtual reality headsets to help overcome these limitations. The pilot, Schultz (2018) judges, has now become "an organic cog in a complete cybernetic system" (p. 9).

These cases show that contemporary mobile autonomy works best in situations of fixed, regular routines of travel, sometimes literally constrained by rails and shafts. There, the need for a stand-by human presence at the controls has been eliminated. Autopilot and unmanned aerial vehicles (UAVs), or drones, however, complicate this understanding. Commercial pilots are said to fly their aircraft "through the autopilot," making adjustments to a predetermined flight plan as required. But under most conditions, these are minimal. Schultz (2018) boldly states that in flying, there is now a "human-machine complementarity where the machine may exert a dominant role that limits human inputs or overrides them altogether" (p. 180). And then there is autonomous weaponry, "where robotics alters not merely the lethality of war, but the very identity of who fights it" (Singer, 2009, p. 10; see also Klare, 2019a, 2019b).[3]

The STI of Autonomy

Sociotechnical imaginaries are, according to Jasanoff (2015), "collectively held, institutionally stabilized and publicly performed visions of desirable futures, animated by shared understandings of forms and of social life and social order attainable through, and supportive of, *imagined* advances in science and technology" (p. 4; emphasis added). Nordmann (2016) makes the friendly addition of the italicized word to her definition (p. 197). They are, Jasanoff (2016) says, "*futurescapes* that collectives actively wish to embrace" (p. 83; emphasis in the original). They are akin to master narratives that differ cross-culturally and historically (Jasanoff, 2015, p. 20). They differ also in their scale: some are expressed by and for elites; others circulate among mass publics. Temporally, they may precede the technology needed to realize the dream. And they may evolve along with technological development, in effect, giving voice to emerging machinic possibilities. Competing imaginaries can coexist. Some are undoubtedly the product of professional promotion. Others grow out of organized alternative societal visions. Science fiction, like the 90-year-old account of driverless cars that begins this article, imagines beyond "technology-as-we-know-it" and describes a fictionally realized "something else, unheard of, better," one of many "irreal conceptions of unprecedented machines" (Nordmann, 2016, pp. 196, 211). Geraci (2010) shows how "apocalyptic AI"

[3] Hildebrand (2021) considers drones a mobile medium, a change agent for mobility and media alike.

science fiction and popular science literature advance "technoscientific research agendas, creates the ideology for virtual life and presses for the acceptance of intelligent machines into human culture" (p. 6).

A sociotechnical imaginary must give hope for the realization of an attainable dream and probably reveal the practical means for doing so. In this way, an STI has much in common with political culture. There, multiple expressive forms, including language, music, visual imagery, and performance, afford a symbolic realm that attracts various kinds of participation, which in contemporary times van Zoonen (2004) has identified as being something like a pop culture fan. If that is an example of soft political culture—rather like the soft power of international public diplomacy (Melissen, 2011)—a harder version is classical propaganda, which Stanley (2015) defines as the "manipulation of the rational will to close off debate" (p. 48). If that seems too harsh, then any sociotechnical imaginary surely shares a great deal with the unavoidable advertising and marketing of life in a consumer economy.

A sociotechnical imaginary is woven of multiple strands. In the textual realm, one is fictional accounts that incorporate the emerging technology and encourage fantasies about its possibilities. A complement is the factual reporting of news based on timely but often fragmented information. Elite discourse is another, probably the best informed, and, by definition, not accessible to most people. A genre that draws from all of these is the semipopular narrative intended for the general reader. It combines compelling storytelling with a synthesis of a range of knowledge. Analytically, it might be considered an indirect measure of public opinion at the time of its publication: not too far ahead of what most readers already know about a subject but promising to reward their curiosity intellectually, helping them to form a rational opinion. Commercially, a semipopular article or book is pitched to educated readers who may, in their lives as consumers, act as early adopters or otherwise influence others.

This study uses three recently published books on vehicular autonomy as an expression of the current American AV sociotechnical imaginary. Each of them tells a different story about the development and promise of AVs. This, of course, results from the authors' perspectives, including their disciplinary and occupational backgrounds, their participation in analyzing, promoting or critiquing, and making AVs, along with the kind of empirical evidence they marshal in forming an argument—especially when they can draw on firsthand involvement with the subject. The orientation of the individual books, too, is directly related to their intended audiences and, in publishing terms, to the perceived timeliness of vehicular autonomy. Nevertheless, in the three books' thousands of words about vehicular autonomy, some version of this sentiment appears repeatedly:

> The shift away from human driving promised to be as influential as the car itself, if not more so . . . Just as the smartphone begat an app eco system, including a ride-hailing market . . . , robotic driving could create entirely new industries . . . The age of autonomous vehicles was coming, and—like sails, steam, combustion engines and the physics of flight—the technologies propelling it along would turn the word on its head. (Davies, 2021, pp. 5–6)

The Texts and Their Authors

Driverless: Intelligent Cars and the Road Ahead (Lipson & Kurman, 2016) offers an account of recent developments in autonomous mobility and makes a case for the desirability of autonomy, but it is mainly about the technology that AVs require, as suits a book published by MIT. Hod Lipson is a mechanical engineering professor at Columbia University whose research concerns robotics. Melba Kurman is described as a graduate of the School of Information Sciences at the University of Illinois and of Cornell University. She and Lipson coauthored another book, on 3D printing, *Fabricated* (Lipson & Kurman, 2013).

Autonomy: The Quest to Build the Driverless Car—And How It Will Reshape Our World (Burns, 2018). By a Detroit insider who, at the end of his career there, moved to Google's Chauffeur/Waymo program, the book very strongly advocates AVs and provides a detailed account of events since the 2004 DARPA Grand Challenge. Lawrence Burns worked for 40 years at General Motors, where he became vice president for research, development, and planning, and served on the CEO's strategy board. He has a PhD in engineering and has been affiliated with the University of Michigan and Columbia University. Burns is also a member of the National Academy of Engineering (his professional collaborator has cowritten wellness and fitness books).

Driven: The Race to Create the Autonomous Car (Davies, 2021) covers ground similar to *Autonomy.* But it throws its net somewhat wider, is less of an advocate, and is partly organized around the fate of Anthony Levandowski, a Google engineer convicted of taking trade secrets with him to Uber. Alex Davies is a journalist who has been a senior editor covering transportation at *Wired* magazine and *Business Insider*.

Three other recent books about cars spend a chapter or two dwelling on AVs, and the *New York Times Magazine* devoted a "tech and design issue" to autonomous cars. These additional sources offer more material to the STI.

Door to Door: The Magnificent, Maddening, Mysterious World of Transportation (Humes, 2016). This book is a sustained criticism of the car-centric world. In one chapter, it offers, in contrast, an extended, almost utopian scenario of ubiquitous, fully autonomous travel. Edward Humes won a Pulitzer Prize as a reporter for the *Wall Street Journal.* He is the author of 15 books whose subjects include trash, neonatal intensive care, forensic science, and juvenile court. He is a graduate of Hampshire College.

Why We Drive: Toward a Philosophy of the Open Road (Crawford, 2020). A polemic against various technological constraints on modern life and very much in favor of the pleasures of car culture, automotive mechanicals, and motorsports, the book has little good to say about automation. Matthew Crawford holds a PhD in political philosophy and studied physics as an undergraduate. He is the author of *Shopcraft as Soulcraft* (Crawford, 2009). Motorcycle riding, maintenance, and repair are regular themes and metaphors in his writing.

A Brief History of Motion: From the Wheel, to the Car, to What Comes Next (Standage, 2021). A single, succinct chapter adroitly sketches the AV situation, noting that new problems may arise should AVs come to pass and observing that, at the present moment, "fully autonomous vehicles seem to be stuck in

limbo" (Standage, 2021, p. 195). Tom Standage is deputy editor of the *Economist* and author of four history books, including *The Victorian Internet* (Standage, 1998), which is about the telegraph.

"Full Tilt: When 100% of Cars are Autonomous" ("Full Tilt," 2017) in the *New York Times Magazine* includes articles that address such themes as "the augmented reality windshield," "policing with no tickets," and "the end of roadkill."

All three of the primary books discuss the *problems* AVs are meant to resolve; present *origin stories* that set the books' narrative on course, identify *key actors*, and describe the *obstacles* or "challenges" to fully AVs.

Existing Problems

Human error—drink and drugs, distraction, fatigue, speeding—accounts for nearly all accidents, which kill about 40,000 Americans annually. With no human at the wheel, this source of danger on the road disappears. People spend many hours commuting. That time will become productive, free time with AVs. Accommodations for parking occupy substantial physical space, especially in cities. If autonomous cars are also continuously shared vehicles, the need for parking unused cars will be greatly reduced, creating new options for urban planning. That model also eliminates car ownership, making travel less costly. Mobility injustice will be reduced by increasing accessibility for the elderly, the poor, and others. Combustion engines produce a large proportion of air pollution. Because future AVs are assumed to be electric, they will be much less polluting.[4]

Origin Stories and Actors

The obvious starting event for the demonstration of state-of-the-art AVs in the United States, according to all the authors, is the 2004 Grand Challenge and its successors in 2005 and 2007, organized by the Defense Advanced Research Projects Agency (DARPA), which awarded a total of $5 million to competitors. DARPA's incentive was the 2001 military budget that required one-third of American ground-combat vehicles to be unmanned by 2015. (Although many accounts mention this very significant intervention by the American military-industrial-university complex, Davies [2021] offers more—especially the public relations value of the 2005 Challenge to DARPA in the face of the revelation of a DARPA-supported domestic surveillance program.[5]) Several researchers and their labs at Carnegie Mellon University are central figures in all these stories. Academics who are funded by, collaborate with, and often go to work for commercial programs like Google's Chauffeur and their spin-offs act as biographical engines for AV's chronological drama. Burns repeatedly presents himself in these terms: GM remains unpersuaded by his

[4] This assumption is made increasingly explicit, as in the keynote address to the 2021 CES (Consumer Technology Show) by GM chair and CEO, Mary Barra. She said, "At General Motors, our vision for the future is a world with zero crashes, zero emissions and zero congestion . . . The key to unlock that vision is electrification . . ." (General Motors, 2021, para. 3).

[5] The 2005 race was documented by the PBS television science series *Nova*, and broadcast in March 2006 (Seamans, 2006).

predictions and prototypes, and so he goes to Google, where his experience in actually building cars adds weight to the enterprise. This literary journalistic trope may engage the reader but reduces complex historical moments to the heroic actions of great men (and they are men) and a mostly uncritical celebration of scientific triumph.

Obstacles

Predictions about the introduction of fully AVs have been consistently wrong. Waymo announced 2018, GM 2019, and Ford 2021, for example. Public opinion about using or owning an AV is divided, with older people resistant and the youngest adults agnostic, more interested in mobility than in issues relating to driving. There have been at least six deaths associated with driverless vehicles in the United States, and the threat of fire from their lithium-ion batteries persists. AVs' minor accident rate may be higher than conventional cars. These events are dramatic, frightening, and garner press attention, disproportionate or not. The difficulty in writing software to address the 1% of anomalous situations, what roboticists term "corner cases," has yet to be resolved. There are severe culture clashes among the automobile industry, software designers, and start-ups that hope to design and build AVs that complicate working relations and inhibit success of the project. Legal regulation of AVs at the U.S. federal and state levels is, at best, patchwork and well behind the development of experimental driverless vehicles.

Concluding Observations and Implications

The 1930s dreams of driverless cars stopped short of reasoning machines. The AV may realize what was then considered unachievable. That development will occur in the far larger context of fully converged digital media, a smart built environment and the general technological and social condition of deep mediatization. The automobile will be a significant site of these changes to the extent that its very nature may change, becoming a mobile unit of the Internet of Things. Getting from here to there will require a convincing sociotechnical imaginary, one that, so far, does not exist in the United States, and artificial intelligence that, as yet, remains in progress—along with a profoundly reordered system of automobility.

A Problematic STI

Like any persuasive discursive form, sociotechnical imaginaries must share common features that make them successful, apart from the qualities of the technology they champion. One of them is probably an internal coherence in the dream they imagine and promote, the imagery that promotes it, and the capacity to achieve it. A cardinal principle in political communications, and advertising and marketing, as well, is credibility. This is not the same as truth; it has more to do with an internally consistent, persuasive message. This is how commercial branding works. But credibility risks becoming mere fantasy without a convincing link to the experience of everyday life in relation to the dream. If the message is incoherent, the intended recipients of the futurescape may miss the point, be confused, and otherwise lose interest.

The books on driverlessness are informed about the science, economics, and industrial politics of creating AVs in the United States. They are mostly optimistic accounts that also appreciate the genuine obstacles that autonomy confronts. They reveal inspiring innovation efforts by otherwise anonymous academics and entrepreneurs. But they are also nearly utopian in claiming that AVs will resolve numerous persistent, structural social issues, from environmental damage to soulless urban design to the often-inhumane experience of daily commuting. They acknowledge the poor record of prediction and offer no good alternative. And they show, perhaps inadvertently, the strikingly in-grown, self-rewarding, and even unethical culture where American AV development is taking place. This narrative disjunction, between realism, near fantasy, and repellant behavior, surely dilutes the strength of the AV sociotechnical imaginary. These books and similar journalism may be read mainly by worldly elites who wish to freshen their existing knowledge of autonomy. A larger, less knowledgeable audience seems unlikely to find inspiration for the quest for a driverless future. Those readers are more apt to discover complexity, ambiguity, and uncertainty, leading to skepticism and even disbelief in the AV future, especially since autonomy has virtually no presence in their everyday lives.

The books' authors and the colleagues they write about operate as an informal community of innovation pioneers who act collectively as "laboratories for the making of deep mediatization" (Hepp, 2020, p. 39), in this case, driverless vehicles. Their visions of the future inform the STI's central features. Their actions constitute a shared, self-defined forerunner role that embodies cutting-edge expertise within and beyond the community. Their novel practices serve to train others directly as consultants and indirectly as models of new ways of thinking and doing (Hepp, 2020, pp. 32–33). The AV pioneer community comprises mainly engineers and computer scientists who may work initially in various geographies and organizations, seeded with federal government funding, but frequently alight in Silicon Valley seeking the commercialization of AV. This homogeneity is probably a key source of the STI's limitations.

The common connection to Northern California invites labeling the AV sociotechnical imaginary what Richard Barbrook and Andy Cameron (1995) term the "California ideology." That would be unhelpful. Although they were early secondhand observers of the sometimes-incongruous combination of New Left, libertarianism, the "virtual class" of knowledge workers, "free market dogmas," "elitism," and "retro-futurism," it was, for them, an entirely toxic development. Their intense polemic, originally published in an online British arts magazine, links "techno-boosters" with "the bitter legacy of slavery." Barbrook and Cameron (1995, para. 3) identify "a nearly universal belief in technological determinism" informed by "macho sci-fi novelists" and describe *Wired* magazine as a kind of hand puppet of extreme right-wing American politics. For Barbrook and Cameron (1995), "the long-predicted convergence of the media, computing, and telecommunications" (para. 1) was happening, and there was little good to say about it. Rather, the American—or northern Californian—case served for them as reason enough to call for alternative E.U. new media policy. Their California ideology, then, is itself very much a period piece, a near caricature of a specific historical moment with little relevance to present-day deep mediatization.[6]

[6] Cameron became an interactive artist and designer who worked for Fabrica, Benetton's communications research center. Barbrook was a senior lecturer at the University of Westminster, where his former website said he was studying "the politics of ludic subversion" ("Richard Barbrook," 2022).

The Vehicle in AV

It is evident that the automobile has gone through a long process of intensifying mediatization, beginning in its earliest days. This included both the cultural construction of automobility by mass media and the addition, over time, of more numerous and more sophisticated analog in-car audio media. The turn-of-the-century digitalization of the car involved the use of electronics for its operation and the introduction of network connectivity for infotainment and other purposes. The next stage, an AV, would be a deeply mediatized mobile site, perhaps the best, and maybe the first complete example in the built environment.

Although cars today, having become "computers on wheels," offer various driver assistance technologies, none is fully autonomous. Demonstrators with high levels of autonomy are today either experimentally adapted conventional cars, specially designed test vehicles like Google's 2014 Firefly, or concept cars like Audi's 2021 Grandsphere ("Audi," 2021). Level 5 automation may well eventually eliminate "the car" and contribute to a comprehensively new system of mobility that collapses familiar modal distinctions among planes, trains, cars, trucks, buses, and so forth. This can already be seen in such developments as autonomous electric air taxis (Reichmann, 2021) and delivery robots that carry packages over the "last mile" from a truck to the consumer (Marshall, 2020). Cars may become ever more intense sites of mobile media consumption, while the same digital dynamics help evolve the automobile into a radically different transportation mode. Yet as the car becomes more like a traveling unit of the Internet of Things, its current sociotechnical imaginary seems instead to emphasize the ways autonomy will perfect the familiar automobile. It may be that robotic trucks, some traveling in convoys, will achieve autonomy sooner than personal cars and shared vehicles (Korosec, 2021). Such a development would be more akin to the elevator, mining truck, and train examples discussed above than a truly driverless car.

There is a long history of American auto manufacturers creating concept cars that are not produced, are not for sale, and may not even run (Zuehlke, 2007). Their ostensible function is to predict future automobility and encourage a demand for it. Some of their features may eventually find a way into mass-produced cars. But they usually embody a future that is deeply rooted in their present; they age badly and, apart from nostalgic appreciation, quickly become historical footnotes. In fact, what constitutes a desirable, normal car can change abruptly, as when foreign and compact cars upended Detroit's penchant for longer-lower-wider-more powerful automobiles in the 1960s, or even today's growing market for electric vehicles (Desilver, 2021). This suggests that present-day examples of relatively autonomous cars, sometimes futuristically alluring, are not at all reliable predictors of what fully autonomous "cars" may become. Their ultimate emergence and adoption may require a wholesale transformation of the "system of automobility" (Urry, 2004) that, in turn, may force a fundamental redesign of personal transportation generally.

Media

The fully autonomous automobile will be a media-saturated means of transportation. Even during the last several years, many new cars have become sites of greater media activity than most households' so-called media rooms. They are certainly digitally smarter than nearly all homes. So, although the automobile remains an undeniably material, still mechanical object, its immaterial properties only grow in importance. Digital systems operate as a kind of nervous system, with implications for control and ambience, among other things.

Digital control is illustrated by a Formula 1 racer. When it is running, data streams wirelessly off the car from as many as 300 sensors and cameras to computers at the track and at the home factory, which can be a continent away. For example, tire temperature, air pressure, and wear are reported hundreds of times per second. Other monitored areas of the car include the drive train (combustion engine, electric motors, and transmission), battery energy storage, driver's use of acceleration and braking, hydraulic systems, and aerodynamic loads. This continuous information is analyzed in real time by engineers who watch for problems and advise on race strategy. By means of an audio link, the advice is passed on to drivers, who can reset electronic controls in the car and drive differently. Data is also used in television coverage of the race. Corner analysis (Smedley, n.d.) graphically displays the line a car takes through a corner and its lateral and longitudinal speeds at different points through the turn. This display can provide comparisons between cars and drivers and analyze track performance. More prosaically, in many major cities, cameras and road sensors, accident data, and weather conditions provide real-time traffic monitoring and control. They are further augmented by data from built-in vehicle navigation devices, smartphones, and other tracking devices.

Digital technology strongly influences the overall experience of travel in an automobile interior. Volvo even offers Ambience Interior, which includes selected musical themes, light patterns projected onto the interior roof with accompanying sounds, and scents that match light and sound effects. Ambient LED lighting has become a common feature, illuminating numerous areas of the automotive interior in many colors (Kia offers 64). New cars allow the digital selection of drive modes that save fuel, offer a comfortable ride, or provide sporty handling, all of which affect the driving and riding experience. And, of course, the dashboard has become an interface, which controls infotainment, communication, and GPS in addition to basic car functions like interior temperature, most of which can be customized to the user's liking. Teslas now come with external speakers that turn the vehicle into a rolling boombox. Cars are routinely auctioned and bought and sold online, where manufacturers host virtual car culture, marque-centered events, and information, and where social media automotive forums flourish, including those operated by automobile museums and archives.

Presumably, these conditions foreshadow further automotive mediatization, and they raise questions: When in this process does the car cross from mere mediatization into deep mediatization, and how? If the automobile becomes a realized version of Kay and Goldberg's (1977) metamedium, and especially if it gains in autonomy, does it cease to be "a car"? Is this an unexpected, material instance of powerful "media logic" at work? Does the autonomy of vehicles presage important aspects of the smart built environment? And how will the realities of AV development and adoption become harmonious with a persuasive dream of driverless automobiles? Questions like these must be addressed in future media studies through collaboration with other fields, mobility studies in particular (Miller, 2018).

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