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Stabilizing/Destabilizing the Driverless City: Speculative Futures and Autonomous Vehicles

LAURA FORLANO[1]
Illinois Institute of Technology, USA

This article extends theories about sociotechnical imaginaries by analyzing the case of autonomous vehicles (AVs), which suggest a future when humans may no longer need to drive. Drawing on Jasanoff's notion of sociotechnical imaginaries, this article analyzes the ways that this techno-determinist future is created through the claims and actions of corporate and government actors, stabilized in physical spaces at engineering test beds and on urban streets, embedded in popular culture through automotive manufacturers' advertisements, and extended globally as part of the push toward smart cities. However, rather than engaging in merely descriptive or normative discussions of AVs, this project focuses on speculative and generative interventions. Based on a one-year, multidisciplinary project on The Driverless City, this article argues that speculative design interventions offer ways of resisting, disrupting, and destabilizing the normative visions of linear technological progress toward an inevitable autonomous future. This article builds on the growing interest in the field of communications in experimental methodologies for studying the social aspects of emerging technologies.

Keywords: autonomous vehicles, design methods, futures, speculative design, cities

Driverless cars are already here! These breathless claims populate mainstream media coverage, city council meetings, and corporate boardrooms. Drawing on Jasanoff's concept of sociotechnical imaginaries, which includes the ways that society performs the importance of technological progress toward desirable futures, this article evaluates autonomous vehicles (AVs)[2] and draws on speculative design methodologies to destabilize the dominant visions that surround this technology. Specifically, the article

Laura Forlano: lforlano@id.iit.edu
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[2] This article uses the term *autonomous vehicles* (or *AVs*) to be consistent. The many names for AVs—including driverless cars, self-driving cars, and connected cars—in some cases, reflect different, competing technological systems.

describes the tensions between the imagined and material practices that are involved in this emerging technology, the ways in which the "already-here-ness" of AVs is performed through claims by corporate and government actors, AV tests at research sites and on urban streets, car advertisements, and visions for smart cities. In all these performances, scientific fact and imaginative fiction are blurred for the purpose of propelling society toward a future in which, for the sake of utilitarian values such as efficiency and safety, humans may no longer need to drive.

Based on a one-year, multidisciplinary project on The Driverless City, this article engages with the many ways AVs are, indeed, already here and, at the same time, elusive and beyond our everyday lived experience. Theories from the fields of communications, science and technology studies, and design are relevant for thinking through the role of new actors such as AVs in everyday life in cities. Drawing on ethnographic observation and qualitative interviews as well as speculative design, this article illustrates the ways in which AVs are stabilizing as well as destabilizing, arguing for the resistance of normative linear technological progress toward an inevitable autonomous future and, instead, embracing the many futures that are possible with or without the advent of this technology. This article uses ethnographic field notes from a visit to an AV test bed, a critical discourse analysis of an automotive company advertisement, a speculative fiction video, and a scenario-building tool as modes of understanding and engaging with the social imaginaries around AVs.

Autonomous Vehicles, Sociotechnical Imaginaries, and Speculative Design

This section describes The Driverless City project alongside discussions about sociotechnical imaginaries and speculative design.

The Driverless City Project

The Driverless City was a multidisciplinary project that integrated architecture, urban planning, design, social science, and engineering. The project employed a range of approaches and methodologies, including ethnographic observation and qualitative research, as well as design research methods such as visual mapping, sketching, prototyping, and video production. These methods used design as a mode of inquiry (Bardzell, Bardzell, & Hansen, 2015; Blythe, 2014; Zimmerman, Forlizzi, & Evenson, 2007) for exploring the relationship among and social implications of AVs for urban futures. Rather than using design to solve known problems, this approach emphasizes using design for problem making (Michael, 2012) by employing speculative design methods (Dunne & Raby, 2013), speculative civics (DiSalvo, Jenkins, & Lodato, 2016), inventive methods (Lury & Wakeford, 2012), and experiential futures (Candy & Dunagan, 2017).

The ethnographic observation included a visit and tour of the University of Michigan's Mcity test bed. In addition, interviews were conducted in Chicago with members of city government, commercial real estate experts, and university faculty and staff with expertise in robotics, operations, and related domains. The interviews provided a more in-depth understanding of the contexts, geographies, and issues that were identified through secondary research and site visits, which formed the basis for four speculative videos around the following themes: street space, parking space, delivery space, and commuter space. In the summer of 2017, the delivery space video was featured in an exhibition titled "How Will We Work?" curated

by Anab Jain and Gerald Bast as part of the Vienna Biennale (Jain & Bast, 2017). In November 2017, a visual mapping of the urban infrastructure issues related to AVs, was featured in *The New York Times Magazine* (Wiener, 2017).

In addition to the videos and the mind map, the project resulted in a 168-page report and a prototype for a "Scenario Builder" device that allows participants to build scenarios by using a set of 100 tokens developed by our team in collaboration with industrial designer Martin Kastner. The device engages two people in conversation to create stories about the future of mobility, urbanism, and social life. Over six months, the Scenario Builder was prototyped both within the project team as well as through a participatory design workshop with students enrolled in a summer doctoral program in the humanities. One of the original inspirations for the Scenario Builder was Stuart Candy and Jeff Watson's "Thing From the Future" card deck (Candy, 2010; Candy & Watson, 2013) along with a wide range of other card decks, games, and brainstorming tools.

Autonomous Vehicles as Sociotechnical Imaginaries

AVs are powerful sociotechnical imaginaries, which Jasanoff and Kim (2015) define as "collectively held, institutionally stabilized, and publicly performed visions of desirable futures, animated by shared understandings of forms of social life and social order attainable through, and supportive of, advances in science and technology" (p. 4). According to Jasanoff and Kim, sociotechnical imaginaries are collective, durable, performative, temporally situated, and culturally particular. Although sociotechnical imaginaries share some qualities with other theoretical concepts—such as master narratives, discourses, ideologies, plans, and policies—Jasanoff and Kim argue that the language of sociotechnical imaginaries is better able to address difference and divergence, time and change (present and futures), materiality (beliefs, meanings, and practices), space and social order, individual identity, and collective formations. With respect to materiality, the notion of sociotechnical imaginaries captures the dynamic, changing nature of technoscience in the tradition of actor-network theory—the ways in which networks of human and nonhuman actors are stabilized and destabilized. With respect to the tension between stabilization and destabilization or change, Jasanoff (2015) identifies four key themes in research on sociotechnical imaginaries: origins, embedding, resistance, and extension. These four themes can be summarized as follows: (1) origins of new scientific ideas, technologies, and social arrangements; (2) embedding ideas into practices, including identities, institutions, and cultures; (3) moments of resistance; and (4) extension through persistence in time and space and across scales. According to Jasanoff, "Imaginaries reveal a dynamic interplay between binaries that are too often kept analytically distinct; they build on the world as it is, but they also project futures as they ought to be" (p. 326). These qualities of sociotechnical imaginaries—the ways they blur descriptive and normative distinctions as well as the ideal and material worlds—are of particular interest for our work on The Driverless City project.

Drawing on the narrative arc of origins, embedding, resistance, and extension, the next section first presents an overview of the ways that AVs as sociotechnical imaginaries are currently being framed and then moves on to analyze examples from The Driverless City project. This overview is not meant to be a comprehensive assessment of the social science literature about AVs as sociotechnical imaginaries but

rather an attempt to contextualize the topic within broader debates about smart cities as well as ethical and political concerns such as labor, safety, and sustainability.

A "Special Report on Artificial Intelligence" (2016) in *The Economist* states that the positive benefits of AVs could include decreased car ownership, less traffic congestion, fewer deadly accidents, less pollution, and more green space, residential space, and bike lanes. These claims about the value and importance of AVs for the future of cities function similarly to earlier technology imaginaries and technovisions, which often serve to perpetuate the magical (Irani, 2015), charismatic (Ames, 2015), and mythical (Mattern, 2017b) narratives around technology. Referring to Xerox PARC (Palo Alto Research Center), Paul Dourish and Genevieve Bell (2011) discuss the role of such claims:

> Like those earlier technovisions, PARC's technotales would also become myths: they would create a way to make sense of the future that appeared simultaneously magically but also manageably. That these myths emanated from the center of Silicon Valley gave them a sense of inevitability as well. After all, if smart engineers and computer scientists say this is our future, then surely it will be true. (location 65)

However, these claims and myths about AVs do not gain significance on their own; rather, they are embedded in institutions and cultures. AVs are already materially present in engineering labs and university test beds as well as on city streets. In The Driverless City project, we visited the University of Michigan's Mcity test bed. And on a recent visit to Tempe, Arizona, where Uber has been testing its autonomous fleet of gray Volvos, Ian Bogost (2017) watches from the "curb of the future," pondering the ways that urban environments might be transformed and arguing that cars, once signifying access, freedom, and self-expression, will fade into the realm of mundane urban infrastructure (p. 7).

While narratives about AVs and the ways they are embedded into institutions are important processes that allow for stabilization (Pinch & Bijker, 1984), these sociotechnical imaginaries are also resisted and destabilized in significant respects. With AVs, urban tests have been one site of resistance. For example, in August 2016, Uber announced that it would conduct urban tests in which its AVs could pick up passengers in Pittsburgh (Russell, 2016). Although urban tests seem to provide evidence that AVs are real (and thereby inevitably part of urban futures), at the same time they provide ample counterarguments. For example, the AVs that Uber used in Pittsburgh were modified Volvo XC90s with human engineers and drivers. According to TechCrunch:

> Each vehicle will be staffed by one engineer, who can take the wheel as/when needed, and a co-pilot to observe and take notes. There will also be a "liquid-cooled" computer sitting in the trunk recording trip and map data. (Russell, 2016, para. 6)

The presence of the engineer, copilot, self-driving equipment, and computer, which are necessary to demonstrate the safety of AVs, also illustrates that AVs are still not safe on their own. Furthermore, in May 2017, nine months after the project launched, Pittsburgh officials expressed disappointment with Uber when it began charging for rides, failed to support the city's bid for federal transportation funding, and failed to create jobs (Kang, 2017). Finally, in March 2018, an Uber self-driving car killed a pedestrian, which prompted

the company to suspend the program (Broussard, 2018). These news events about the inaccuracy of corporate and government claims about AVs as well as their technical complexities and failures complicate narratives of technological progress toward a safer urban future.

Recent scholarship about AVs provides additional possibilities for reflection on and resistance to these sociotechnical imaginaries about safe urban futures. In a recent article, Shannon Mattern (2017a) asks, "How do machine intelligences read and write the world?" (p. 1), inquiring about the ways that autonomous vehicles understand, measure, and map the world using cameras, radar, and sensors as well as global positioning systems and real-time maps. By highlighting how machines sense and operationalize the world, Mattern reveals "the protocols and politics of interaction among the various beings who share our cartographic terrain" and advocates for an active negotiation among these different modes, comprising an atlas that "invites comparison and appreciation of the ways in which our world is both known and unknown" (pp. 16–17). Taking a more philosophical perspective, Nassim JafariNaimi (2017) argues that society must move beyond techno-optimism and utilitarian framings around issues such as safety and efficiency and, rather, make space for ethical considerations based on principles of care as well as the possibility to rethink mobility and create inclusive and innovative designs that might benefit the most vulnerable groups. She argues that, instead of embracing "algorithmic morality," we must reframe questions around AVs as follows: (1) We must replace inevitability with uncertainty with respect to the adoption of self-driving cars; (2) we must substitute the utilitarian framing that is being shaped by corporations and government actors with a more situated and historical perspective; and (3) we must consider both broad and wide-ranging consequences. JafariNaimi writes, "Succumbing to algorithmic morality in the name of increased safety would be a grand failure of both our ethical and technical imagination" (p. 16). Exploring ethical interventions in debates involving AVs, Karen Levy (2015) has studied the trucking profession and the implications of digital surveillance technologies on autonomy and labor. This is significant because trucking is one of the professions that is often referred to in discussions of the labor implications of AVs, and it is likely that surveillance data will be used to further control and exert power over drivers.

As sociotechnical imaginaries, narratives about AVs and their embeddedness in cities through test beds are also extended across time and space. Broadly considered, it makes sense to think of AVs as just one of many emerging technologies that underscore visions of smart cities, promising greater safety, increased efficiency, and improved sustainability. Currently, large technology companies such as Google, Facebook, General Electric, Microsoft, and Amazon are building entire neighborhoods and towns that will allow them to test a wide range of smart city technologies. For example, in Toronto, Sidewalk Labs, which is owned by Google's parent company Alphabet, is planning a test bed that it hopes will allow the company to "shape the real world as much as it has life on the Internet" with smart energy grids, sensors, noise and pollution monitors, adaptive traffic lights as well as a host of autonomous and self-driving transportation and delivery vehicles (Badger, 2017, para. 1).

Such ambitious projects are not particularly unique; well-known examples featuring China, South Korea, Malaysia, and several countries in the Middle East can be found in the growing literature on smart cities in the fields of urban planning, geography, design, communications, and science and technology studies over the past decade (Bratton, 2016; Foth, Forlano, Gibbs, & Satchell, 2011; Greenfield, 2013; Kitchin, 2014, 2015; Shepard, 2011; Townsend, 2013). For example, in their study of Songdo, South

Korea—one of three cities that make up the Incheon Free Economic Zone—Halpern, LeCavalier, Calvillo, and Pietsch (2013) refer to this phenomenon as "test-bed urbanism" in which cities are "governed not by a concentrated group of advanced leaders but by a diffuse network of machines" (p. 273). The authors define test-bed urbanism as:

> a new form of epistemology that is concerned not with documenting facts in the world, mapping spaces, or making representative models but rather with creating models that *are* territories. Performative, inductive, and statistical, the experiments enacted in this space transform territory, population, truth, and risk with implications for representative government, subjectivity, and urban form. (pp. 274–275, emphasis in original)

This statement urgently addresses what is at risk in the creation of sociotechnical imaginaries around AVs as they are embedded in larger smart city projects around the world that offer particular visions of safety, efficiency, and sustainability (and thereby exclude others). Fundamentally at stake are the very notions of what it means to be human and what it means to be urban.

Speculative Design Methods

What kind of people will we become in The Driverless City? Where will we live and work? How will we spend our time? What will become of cities themselves? These are some of the questions that prompted this research into long-term AV futures. While the concept of sociotechnical imaginaries is, according to Jasanoff, both descriptive and normative, our aim in The Driverless City project was to draw on speculative design to experiment with *what could be* rather than what is or what should be.

To engage in these more speculative questions, scholars have been experimenting with storytelling, fiction, invention, worlding, and speculation to pose questions about the present by creating alternative possible future worlds. Rather than problem solving, these speculative approaches are characterized as a more ambiguous and circuitous form of "inventive problem making" (Michael, 2012). These approaches—inventive methods (Lury & Wakeford, 2012), speculative design (Dunne & Raby, 2013), experiential futures (Candy & Dunagan, 2017), design fiction (Bleecker, 2009), material speculation (Wakkary, Odom, Hauser, Hertz, & Lin, 2015), speculative fabulation (Haraway, 2016), and speculative civics (DiSalvo et al., 2016)—are imaginative, visual, physical, and performative in nature to engage readers, communities, and publics in a more personal, visceral, affective, and embodied way. They reveal particular utopias, dystopias, and nuances to critique or complicate techno-centric notions of the future and "strive to create a rich, textured, often first person immersion in a credible alternate world through the use of multiple media and storytelling techniques" (Raford, 2012, p. 34). In the field of communications, a special issue of the *International Journal of Communication* engaged specifically with futures (Brooks, Sutko, Sinnreich, & Wallace, 2016; Lichfield, Adams, & Brooks, 2016; Sinnreich, Lingel, Lichfield, Rottinghaus, & Brooks, 2016; Wark, 2016).

Science fiction accounts are often used as evidence to justify techno-centric visions of linear progress toward the future as part of national innovation agendas and university research and development budgets. For example, the 2002 film *Minority Report* (based on a short story by Philip K. Dick) tells of a police unit that is able to arrest criminals before they commit crimes, predating our use of algorithms in what is known as

"predictive policing" software. According to Future Perfect, a recent conference at the Data and Society Research Institute (2017):

> The influence of 2002's *Minority Report* on gestural interfaces, surveillance technologies, and automation isn't an accident of history—the future envisioned in the film was created in close consultation with technologists and academics actively working on products that the film imagines in real-world settings. (para. 2)

Influenced by feminist science fiction writers, Donna Haraway has long been an advocate for such experimentation. She writes that "worlding" happens though storytelling. Knowledge making and world making come together through the "tight coupling of writing and research—where both terms require the factual, fictional, and fabulated" (Haraway, 2011, p. 2). Genres such as Afrofuturism and feminist science fiction reach beyond the typical expert audiences of speculative design, which have been criticized for confining their work to elite museum exhibitions and galleries rather than engaging people in a more participatory format (DiSalvo, 2012). They ask different questions with different political and ethical concerns about possible futures that are vital for sustaining different communities. For example, a recent collection called *Octavia's Brood*: *Science Fiction Stories From Social Justice Movements* edited by Walidah Imarisha and adrienne marie brown (2015) is dedicated to the African American science fiction author Octavia E. Butler.

Similarly, in Haraway's (2016) book *Staying With the Trouble*, she crafts a speculative fabulation called "The Camille Stories" about a possible future in which the population of the Earth declines to 3 billion by 2400 as humans learn to live with and as part of nature. Similarly, in a recent presentation on a panel titled "Life Finds a Way: Bodies, Futures, Embodied Futures," sociologist of science, medicine, and technology Ruha Benjamin (2017) reads a series of factual and fabulated field notes from 2016, 1816, and 2216, which link the social dimensions of genetic engineering, histories of slave trade, and a future foodie colony. According to a statement from the presentation that I have transcribed from video, Benjamin's work

> explores the relationality of innovation and containment, asking who and what is fixed in place, corralled and coerced so that others are free to innovate the future . . . in the process of designing ideal genomes, what versions of humanity are potentially discarded?

By telling alternate histories of science and technology that have gone undocumented or underdocumented, scholars can challenge commonly held assumptions about the linear flow of time toward the future propelled by science and technological invention at the hands of individual (often male) genius.

According to design scholar Ramia Mazé (2016):

> The future is not empty—it is already occupied by stuff, images and skills that design takes part in (re)producing. Design activities, such as those amended as "concept," "critical," and "persuasive" outlined here, orient explicitly toward the future or, rather, possible and preferred futures. (location 1349)

In contrast to these explicitly future-oriented approaches, Johan Redström (2017) proposes the creation of "alternative nows, as a matter of populating a wider base with examples of how things could be different—not in the future but now" (location 2751). In recent years, the emergent field of design anthropology has oriented toward futures (Gunn, Otto, & Smith, 2013; Smith et al., 2016). Furthermore, approaches such as anticipatory governance (Barben, Fisher, Selin, & Guston, 2008; Fisher, Selin, & Wetmore, 2008; Selin, 2008) and anticipatory design oriented toward utopian futures (Lindtner, Bardzell, & Bardzell, 2016) allow for engagements with and intervention into techno-determinist futures.

In fact, these speculative, generative, inventive, and interventionist methods, which bridge traditional social science and design approaches, are already being used to study AVs. For example, Melissa Cefkin and Eric Stayton (2017) describe "speculative ethnography"—a method they have used to study AVs—as "ethnographic encounter staged through speculative futures" that questions the "distinction between the real and the speculative" (para. 5). They use Nissan's high-tech Silicon Valley lab as a simulated space for ethnographic observation where they can study human experiences of emerging technologies that are not yet out in the world. Through this research, they are able to challenge binary conceptions of what it means for a vehicle to be autonomous and, instead, engage with the more nuanced ways that people experience autonomy. They ask "how and where and when and why they [vehicles] exhibit autonomous properties" (para. 13). Pink, Fors, and Glöss (2017) have used design anthropology and sensory ethnography to study automation, mobility, and future imaginaries using in-car video ethnography. Sensory ethnography allows for the study of unspoken and invisible "mundane ways of feeling when in a car" (p. 104. They use the concept of cocooning to rethink spatial and temporal categories around driving. Rather than understanding driving as a relationship between a human and a car, they argue for a "driver-car-environment configuration" (p. 100). Furthermore, they argue that "driving is a way of feeling in the body that refers to past, present and imagined future ways of sensing the world" (p. 104). Interaction designer and engineer Wendy Ju and her colleagues have used embodied design to conduct "ghost driver" experiments that explore pedestrian behavior with respect to autonomous vehicles using a human driver in a costume that blends with the car seat (Rothenbücher, Li, Sirkin, Mok, & Ju, 2016; Sirkin et al., 2016; Wang, Sibi, Mok, & Ju, 2017). In these experiments, the researchers conclude that pedestrians are likely to behave normally when interacting with AVs.

Four Approaches to Speculative Futures

This section offers four examples of speculative futures from The Driverless City project: an ethnographic field note from a visit to an autonomous vehicle test bed, a critical discourse analysis of an automotive company advertisement, a speculative fiction video, and a scenario-building tool. The first two approaches illustrate the ways ideas about AVs are stabilized throughout society; the second two approaches are intended as modes of destabilization, which disrupt existing sociotechnical imaginaries.

A Field Note From the Future

One way the future sociotechnical imaginaries of AVs are made visible in the present is through simulated, experimental test beds. In April 2015, The Driverless City team visited and drove through the University of Michigan's Mobility Transformation Center's Mcity—a simulated "real world" city (see Figures 1

and 2). Mcity is real, but not real; a lab, but at the same time in the wild; simulated, but not entirely a simulation.

Figure 1. A map of the University of Michigan's Mcity test facility, from https://mcity.umich.edu.

Figure 2. A photo of the entrance of the Mcity test facility.

Here is an excerpt from our field notes documenting the trip:

> Head North on Route 75 toward Flint, said the scratched green sign. We stopped carefully at the flashing red light in our rented, black Chevy Tahoe SUV and then proceed on the ramp toward Gd River Ave. on Route 5 and through a tunnel. We turned slowly to the left (taking note of the 25 mile an hour speed limit), passed a canopy of trees and went over a short narrow bridge. Now, just past the traffic signals at the railroad crossing in the intersection, we could see the colorful facades of familiar stores from a small town in the Midwest emerging in the distance. The adjacent sidewalk was dotted with garbage cans, mailboxes, benches, streetlights, fire hydrants and parking meters. A painted bike lane curved along the right side of the street along the curb. We turned right onto Wolverine Ave., down State St. and headed toward Pontiac Tr. Somehow, we were right back where we started. We could have driven around and around all day on an infinite loop but never arrived anywhere at all. And, certainly, not any closer to the future of the city. (Ann Arbor, MI, April 1, 2016)

The test facility, which opened in July 2015, is a 32-acre site with five miles of track that is oriented north-to-south to test global positioning systems. The site is used by university and industry researchers to test the wireless communication systems that are necessary for AVs to communicate with the transportation infrastructure in complex, real-world scenarios. On the one hand, Mcity—the only facility of its type in the world—is a safe, secure, controlled, and repeatable environment; on the other hand, it is in the real world. The traffic signs have been donated and deliberately scratched to test the accuracy of image-processing systems. The tree canopy is a metal frame structure covered with black fabric to simulate the interference

that trees can cause in the transmission of wireless signals. It is even possible to simulate humidity in the natural environment and its impact on the communication systems. The building facades and other aspects of the test facility are all made with materials such as glass, brick, wood, aluminum, and vinyl. A digitally printed, stylized image of Zingerman's Deli in Ann Arbor is integrated into the facade, which depicts a densely populated business district with multiple local shops side by side. The building facades (only the facades have been simulated) give the strip the feeling of a Western frontier town. While the road itself is designed to scale, many of the components—such as the bridges, tunnels, and intersections—are smaller and shorter.

According to Jim Sayer, deployment director at the University of Michigan's Mobility Transformation Center, this combination of real and simulated that we observed on our site visit is necessary. "We are not going to rebuild all of our infrastructure to accommodate automated or autonomous vehicles. Vehicles are going to need to learn to operate in the legacy system that we have," he says in a video featured on the Mcity website (Mcity Test Facility, 2016).And this real-world testing presents a significant economic opportunity for cities and states. For example, following the early success of the Mcity test bed, the state of Michigan is planning a new site that is 335 acres, or 10 times the size of Mcity (Learn about the Facility, 2016). The new site is at a former factory built by Henry Ford that was used to make B-24 bombers during World War II, providing an example of how the infrastructures of the industrial economy are being repurposed to support the postindustrial economy.

As a sociotechnical imaginary, the experimental test bed serves as a physical manifestation that embeds AVs in institutions such as, for example, the University of Michigan and the state of Michigan. The materiality of the test bed (as well as the digital representations) is evidence that the sociotechnical imaginary of AVs exists in the world. The focus on testing suggests that safety is an important concern, as voiced by government and corporate stakeholders advocating for AVs. Of course, if the goal were only to make driving safer, a wide range of possibilities exists that might allow society to achieve that goal: more rigorous driver's tests, a greater investment in public transportation, and increased enforcement and regulations. As we learned from our visit to Mcity, safety goes hand in hand with economic development for the region and for bolstering the automobile industry.

In fact, the focus on test beds is a shift from earlier paradigms around safety testing in the auto industry, which progressed from "crude trials done on the road, to controlled laboratory experiments, and to today's complex math-based simulation models" (Leonardi, 2010, p. 243). Leonardi explains how this seemingly linear and technologically deterministic narrative that supported the investment in simulation technology was actually the result of technological, organizational, and regulatory changes, including legal issues related to liability in car crashes. In the case of AVs, a different narrative of technological determinism around safety is emerging that, in contrast, argues that the technologies—software, algorithms, artificial intelligence, robots, and wireless communications systems—must be tested in the real world to prove their ability to function safely.

In addition, like speculative ethnography and sensory ethnography described earlier, our experience driving through the test bed allowed us to gain an embodied experience of what it might be like to be in an autonomous vehicle (or even what it might be like *to be* an autonomous vehicle) navigating a simulated test

bed. Our "field note from the future" complicates popular mass media and science fiction accounts of transportation in high-tech cities and, instead, destabilizes these narratives by revealing the more mundane, makeshift, and messy realities of striving toward sociotechnical imaginaries, thereby offering openings and possibilities for alternative, pluralistic futures.

The Future Sells the Present

Along with urban test beds and simulated, experimental test beds, future sociotechnical imaginaries come to life through mainstream media representations and, in particular, advertisements and promotional materials for future products. Here, the promise of imagined futures is demonstrated, prototyped (Stark & Paravel, 2008; Turner, 2016), and marshaled to sell the products and services of the present. With these visions of the future, consumers are invited to participate in the aspirations of corporations and their technologies without a consideration of the complicated political implications, social relations, and environmental trade-offs that are embedded in decisions to adopt these technologies.

For example, in April 2016, Ford Motor Company posted an approximately two-minute video of a demonstration of an autonomous vehicle driving at night (see Figure 3). Throughout the video, a small pop-up add suggests that viewers learn more about the Ford Fusion. The Fusion vehicle for sale cannot drive autonomously at night. But the company attempts to entice consumers to buy the current model to participate in the promise of its future capabilities, regardless of whether they are ever realized.

Figure 3. A screenshot of Ford's Project Nightonomy video.

The demo, which took place at sunset on March 1, 2016, as part of the company's "Project Nightonomy: Autonomous Vehicle Testing in the Dark," is described as follows:

> Driving in pitch black at Ford Arizona Proving Ground marks the next step on the company's journey to delivering fully autonomous vehicles to customers around the globe. It's an important development in that it shows that even without cameras, which rely on light, Ford's LiDAR—working with the car's virtual driver software—is robust enough to steer flawlessly around winding roads. (Ford Motor Company, 2016, para. 1)

According to Jim McBride, the Ford technical leader for autonomous vehicles that is featured in the video, "To do something as ambitious as making a car drive itself, you need lots of testing in lots of places so that you can cover all of the scenarios that you would expect them to see." The video then cues a darkened image of a man putting on a helmet with night-vision goggles along with a dramatic sound track reminiscent of a Hollywood action thriller or war film such as *The Bourne Identity* or *The Hurt Locker*. What follows are selected excerpts of the voice-over in the video, which I have transcribed, along with descriptions of some of the key visual elements:

> MVG is good to go.
>
> Fusion 9012, prepare to go dark.
>
> [A staff member prepares the car for the demo, placing a piece of black fabric on the dashboard.]
>
> Fusion 9012, are all personnel in position.
>
> [There is a brief shot of a coyote or fox turning away from the camera.]
>
> Fusion 9012, could we get a systems check please?
>
> Lidar is go. GPS is go. IMU [inertial measurement unit] is go.
>
> [The image filter turns a familiar green, instantly recognizable from cinematography in this genre.]
>
> Radar is go. Camera is go.
>
> [The camera zooms in on a computer screen with an open program that looks like a spreadsheet.]
>
> All systems are functioning. We are ready to go autonomous.

The video then shows the lidar sensor beams on the top of the car surveying the ground. Next, the video simultaneously shows a computer-generated image of the car moving on a track akin to a video game as well as a video image of the actual car driving on the road. The camera then focuses on the steering wheel of the car with a test driver, his hands just inches away from the wheel, ready to take over the driving if necessary.

Complete the mission. Then we will restart the mission and do another lap.

Car is driving by itself in the middle of the night.

The video declares Project Nightonomy complete and transitions into a 10-second advertisement for the current Ford Fusion vehicle (see Figure 4).

Figure 4. A screenshot of Ford's Project Nightonomy video.

The video illustrates the complex sociotechnical arrangement of humans and nonhumans that participate in the demonstration of AVs' night-driving ability. Key technologies such as lidar sensors, global positioning systems, radars, cameras, IMU, and computer programs are verbally mentioned as well as, in some cases, featured visually. We also see and hear people who are standing by to observe the test, people readying the car to be tested, and a test driver in the car itself. One can surmise that a film crew with videographers shooting from various angles as well as people managing the various equipment and props were also required. We even see a coyote in the background, perhaps signifying that it is dusk, when evening predators go out to seek their dinner.

One objective of the video seems to be to convince potential consumers of Ford's research and development in the area of emerging technologies such as AVs, suggesting that AVs are just another logical step on a linear path of upgraded product features. Put simply, the future is used to sell the present. The promises of technological progress in the future entice potential consumers and distract them from the drawbacks of the present model. Yet it is not only in advertising that this strategy is used; in research with transportation justice activists, our team learned that some cities avoid addressing issues involving access to transportation due to the potential of AVs as a solution. Despite these claims, many experts have expressed serious doubts that AVs will be realized in our lifetimes, if ever. This suggests the need for a broader critical technological literacy with a focus on narratives around innovation, technology, and futures. From structural inequality to climate change, by shifting the focus of attention toward an elusive future made possible by technology, we fail to take responsibility for the problems in the world today.

But there are darker issues at play in the Ford demonstration described above. The sociotechnical imaginary that is summoned is one of technological progress and military prowess. While not explicit, the advertisement's desert setting exudes a politics of nationalism and patriotism with patrolled borders and boundaries. From the fonts that are chosen to annotate the images, to the walkie-talkie communication protocol voice-overs, to the green night-vision filter, to the language of the "mission" being complete (with the word *complete* literally stamped in red over the Project Nightonomy title in one of the final screens; see Figure 4), it resembles something akin to a U.S. Marines recruitment advertisement. Here, the future of AVs is linked to what it means to be an American; it is to be a car owner and a car buyer and to buy an American-made car with the promise that you are buying into a future of limitless innovation, a car that will always have the latest features.

These first two examples—the experimental test bed and the advertising demonstration—illustrate how narratives around AVs are stabilizing around issues of safety as part of linear narratives of technological progress. The second two examples, based on The Driverless City project, illustrate the ways in which speculating and fabulating alternative possible futures can interrupt these narratives, offering opportunities for resistance.

Fabulating Other Futures

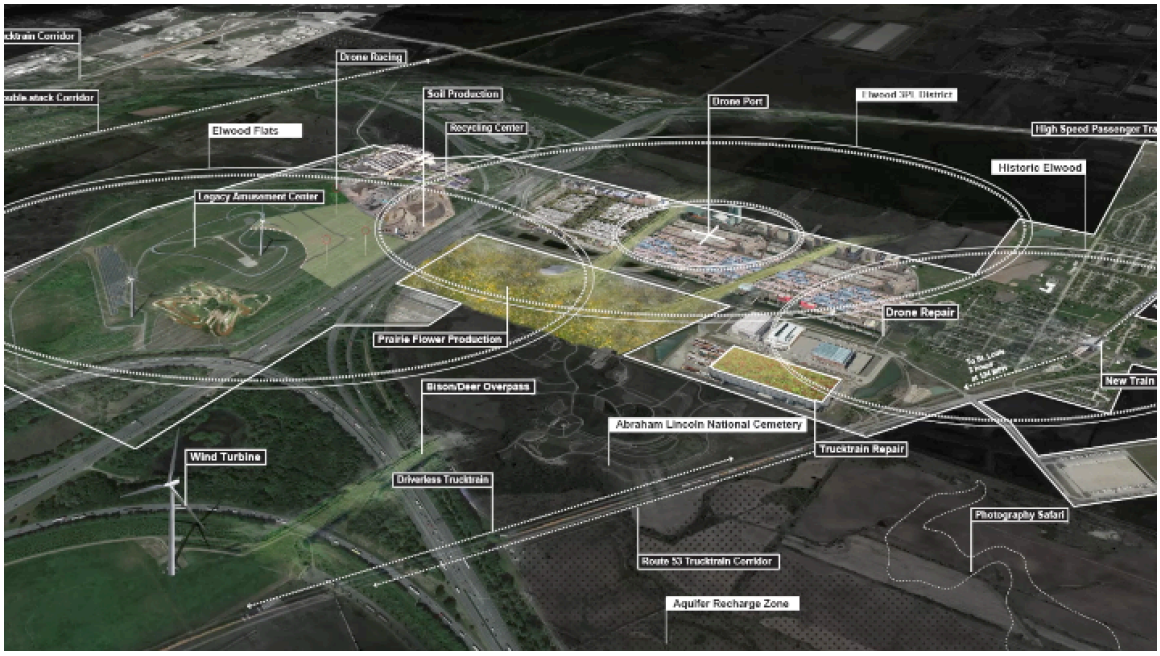
Speculating and fabulating refer to the use of conceptual scenarios or stories that can be used to illustrate critical—dystopian, utopian, or more nuanced—futures. In The Driverless City project, four short videos use a speculative approach to engage with alternative possible futures. Qualitative interviews with government officials and business leaders provided some of the factual material to confirm some of the ideas and create an engaging narrative. According to Jessie, a real estate expert interviewed for the project:

> It's likely that the driverless trucks almost become essentially moving warehouses. There's this constant cycle of trucks that are out delivering goods, and, of course, capitalism seeks efficiency and supply chain efficiencies are something that are always sought. Therefore, the private market seeks out the most efficient system, and if you had this technology, it would stand to reason that if in fact it's possible, more and more companies would look to

> use these, basically this inventory system . . . what's the point of sending it to a warehouse if you can just send it directly to where it needs to go. (Personal interview, July 25, 2016)

In the delivery space video (see Figure 5, which was featured in the Vienna Biennale art exhibition, we speculate about truckhousing in the script:

> By 2036, pockets of Chicago and new centers Naperville and Joliet had become so congested with last-mile delivery vehicles that aerial drones began replacing autonomous vehicle delivery, thus reducing the need for the sprawling warehousing and distribution centers that populated the Chicago Metropolitan Area throughout the 20th century.


Drone Racing
Soil Production
Drone Port
Elwood Flats
Recycling Center
Historic Elwood
Legacy Amusement Center
Drone Repair
Prairie Flower Production
Bison/Deer Overpass
Abraham Lincoln National Cemetery
Wind Turbine
Trucktrain Repair
Driverless Trucktrain
Photography Safari
Route 53 Trucktrain Corridor
Aquifer Recharge Zone

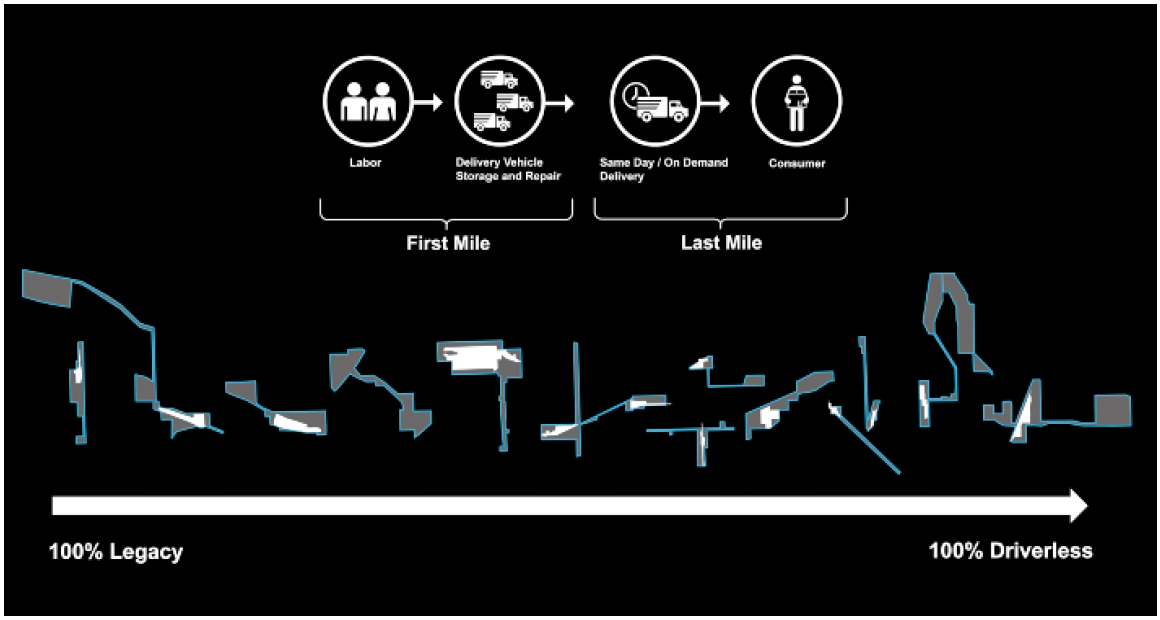


Figure 5. Screenshots from The Driverless City project's delivery space video.

The video goes on to speculate about the demand for "hyper-specialized goods," "in-place retailing," and "networked markets for recycling." And, due to claims that autonomous vehicles may make driving safer, we create a scenario around the disappearance of roadkill, the overpopulation of certain species, and the emergence of a new economy around seasonal hunting and trapping to replace lost jobs in trucking and warehouses. However, rather than playing a prescriptive role, these videos are intended to provoke thinking and raise questions about "new forms of production, and civic life."

Thinking through the future possibilities of AVs is an exercise in considering our priorities, values, and choices today. Unlike the earlier two examples, which analyze existing instances of AVs being tested and demonstrated, the speculative videos use fiction, fabulation, and storytelling to call attention to the worlds that *could be*. While social science critique serves to question the politics driving particular narratives about technological progress, speculative engagements allow for more flexibility in affect, format, and purpose. For example, speculative approaches might ask what kinds of cities we might inhabit if AVs are adopted, which requires the (temporary) suspension of one's critical stance. At the same time, speculative approaches allow for the generation of multiple alternatives that coexist with the adoption of AVs, such as networked markets for recycling. Although speculative approaches do not necessarily place faith in technological progress, they might temporarily take the claims around emerging technology as possibilities for the purpose of generating narratives that can support critique, dialogue, and reflection about the choices that we make as a society to design and adopt technology. But speculative approaches might also resist or object to existing claims about emerging technology, illustrating the ways that society might mobilize effective counterarguments or imagine more radical

worlds that, for example, eliminate not only drivers and driving but also our dependence on the auto industry in favor of more sustainable forms of living and working.

Speculative design has been critiqued as elitist for circulating primarily among audiences of designers; however, like science fiction, it holds great potential for connecting with the public around complex sociotechnical issues. In this project, to date, while we have exhibited and shown the videos online as well as in galleries and conferences, we do not yet have data about their impact on broader audiences. We argue that speculative approaches are one mode of engaging with and intervening in the tensions around stabilizing and destabilizing narratives about AVs.

Citizen-Driven Scenarios About Urban Futures

The previous example of speculative videos illustrates one generative mode of engaging with narratives around AVs. The next example explores a physical prototype called the Scenario Builder (see Figure 6) that we developed to facilitate exploration, imagination, and critical reflection about AVs through the creation of scenarios about the future of mobility, urbanism, and social life. As noted earlier, some scholars argue that designers can play an important role in the curation and organization of public discussion around scientific and technological issues (DiSalvo, 2009; DiSalvo et al., 2016). In the field of design, it is common to use digital and physical artifacts—card decks, maps, games, models, and prototypes—to bring multiple stakeholders together in co-design sessions (Forlano & Halpern, 2016). Beginning in February 2016, we experimented with existing design tools such as Stuart Candy and Jeff Watson's "The Thing From the Future" with graduate students in a landscape architecture studio. We found that existing tools allowed our team to quickly and collaboratively generate and explore various scenarios around AVs and urban futures. As a result, we decided to begin prototyping the Scenario Builder to engage stakeholders in the discussion of key issues related to reimagining urban infrastructure.

Figure 6. Images of The Driverless City project's Scenario Builder prototype. Image by Lara Kastner, May 2017.

Building on our primary and secondary research, we created cards that represented actors, practices, relationships, and infrastructures. For example, building on a mind mapping exercise, we created sociospatial categories related to mobility practices, including tourism, commuting, parking, and delivering as well as street life. The following categories were also included in the prototype: locations and environments, human and nonhuman actors, emotions and moods, technological capabilities, and business models.

One of the early prototyping sessions—held on an Amtrak train to Ann Arbor to visit the Mcity test facility—allowed us to reframe and clarify our themes by adding and eliminating categories. Furthermore, we were able to continue to iterate the development of the prototype through interviews with experts on urban planning, facilities management, transportation, and industrial real estate. Our interviews enabled us to build relationships with key stakeholders by sharing information about recent developments related to autonomous vehicles while learning about the opportunities and challenges.

Working with industrial designer Martin Kastner from Crucial Detail, we made prototypes using a range of materials, such as aluminum spheres, acrylic plastic chips, and brass cards. We also experimented with various ways of spreading out the cards, spinning and flipping chips, and rotating balls in the hand (inspired by Chinese meditation balls). The final version of the Scenario Builder is a set of keywords etched into curved chips (similar to poker chips). To use the prototype, a person randomly selects five chips and spreads them out to create a story in response to a question about the future of mobility, urbanism, and social life. The stories enable stakeholders to imagine and prototype the alternative possible urban futures that could co-evolve with advances in transportation such as AVs.

Unlike the speculative videos, the Scenario Builder is a generative approach that actively engages participants in collaborative storytelling about urban futures. According to DiSalvo, Jenkins, and Lodato (2016), we might consider this approach one of "speculative civics: a way to explore potential, alternative, and future conditions by articulating their existence in generative forms, with a particular focus on the complications of governance and politics disposed by computational technologies" (p. 2). Again, like the videos, the Scenario Builder is an intervention into the ways narratives about AVs are stabilized and destabilized, expanding the modes of engagement in sociotechnical imaginaries from descriptive and normative to speculative.

Conclusion

This article extends theories about sociotechnical imaginaries by exploring the case of autonomous vehicles and urban futures. Specifically, while sociotechnical imaginaries are typically engaged through descriptive and normative research, this article argues for the value of speculative and generative interventions to contemplate not what is or what should be but rather what could be. Drawing on a one-year project on The Driverless City, this article explains how sociotechnical imaginaries around AVs are stabilizing through experimental test beds and automotive industry advertising as well as how they might be destabilized and resisted using speculative design methods. The project uses fabulated videos and

scenarios to reorient conversations about AVs and urban futures. As such, possible futures can be understood not as far-off, distant realities but rather as "alternative nows."

Many have recently argued that the pace of technological development has inhibited our ability to successfully describe, analyze, and theorize about emerging technologies (Markham, 2018). With its focus on speculative futures, this article argues for and demonstrates the value of new approaches to social science research—at the intersection of art, design, and the humanities—that can both anticipate the emerging technologies under development as well as intervene in reimagining and destabilizing the sociotechnical imaginaries about these technologies that circulate widely about the future. In short, the field of communications research must not only engage in describing what is but also participate in "inventing the social" (Marres, Guggenheim, & Wilkie, 2018) if we are to create meaningful, ethical, equitable, and just posthuman futures (Forlano, 2016, 2017, 2018) at the intersection of humanity and emerging technology.

However, integrating speculative and inventive approaches into the field of communications research (along with broader humanities and social science fields) will not be an intellectually comfortable process. It will require that we rethink our research from a wide variety of perspectives, including: What counts as data, and how should we go about collecting and analyzing it? In what order should we plan our research projects if we aim to integrate both descriptive and speculative approaches? What is the role of theory, and what new theories are necessary to make sense of the world? How will we balance intellectual contributions to knowledge in traditional forms along with the making of things that are intended to help us think? How might we understand the impact of our interventions? Despite the difficulty of answering these questions, rethink we must. Multiple possible futures—both with and without AVs—depend on us.

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