



Beverly Hills City Council Liaison / Planning Commission Committee will conduct a Special Meeting, at the following time and place, and will address the agenda listed below:

**CITY HALL
455 North Rexford Drive
4th Floor Conference Room A
Beverly Hills, CA 90210**

**Tuesday, June 25, 2019
4:00 PM**

AGENDA

- 1) Public Comment
 - a. Members of the public will be given the opportunity to directly address the City Council on any item listed on the agenda.
- 2) Autonomous Oriented Development
- 3) Adjournment

A handwritten signature in black ink, appearing to read "Lourdes Sy-Rodriguez", written over a horizontal line.

Lourdes Sy-Rodriguez, Assistant City Clerk

Posted: June 21, 2019

A DETAILED LIAISON AGENDA PACKET IS AVAILABLE FOR REVIEW IN THE LIBRARY AND CITY CLERK'S OFFICE.




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M E M O R A N D U M
CITY OF BEVERLY HILLS

TO: City Council and Planning Commission Liaison Committee

FROM: Ryan Gohlich, AICP, Assistant Director of Community Development / City Planner 

DATE: June 25, 2019

SUBJECT: **Autonomous Oriented Development**
City Council and Planning Commission Liaison Meeting

Mayor Mirisch has previously discussed pursuing further study of Autonomous-Oriented Development, and its potential applicability in Beverly Hills. Autonomous-Oriented Development was most recently discussed by the Autonomous Vehicles Committee on November 7, 2018, with a focus on a potential partnership with MIT to develop an Autonomous-Oriented Design Handbook. The purpose of the Liaison meeting is to further discuss Autonomous-Oriented Development and next steps that may be pursued. A number of attachments are provided with this memo as background information, which include a narrative on MIT's Autonomous Urban Mobility Initiative, as well as a number of recent articles pertaining to autonomous vehicles and the impact they are likely to have on planning and land use issues.

- Attachments:
1. MIT Autonomous Urban Mobility Initiative
 2. The New Autopia - A Chance to Transform Urban Planning (The Economist)
 3. Autonomous Cars are About to Transform the Suburbs (Forbes)
 4. As Self-Driving Cars Hit the Road, Real Estate Development May Take a New Direction (Curbed)
 5. The New York Times Takes a Trip to a Driverless Future
 6. Pave Over the Subway? Cities Face Tough Bets on Driverless Cars (The New York Times)
 7. As Cars Collect More Data, Companies Try to Move it All Faster (The New York Times)

ATTACHMENT 1

MIT AUTONOMOUS URBAN MOBILITY INITIATIVE

AUTONOMOUS URBAN MOBILITY INITIATIVE

Background

Autonomous driving (AD) and other automation technologies (AT) are rapidly emerging, with more than \$80 billion of investment to date. The first-order effects of AD include improved safety, reduced congestion, on-demand mobility, and cheaper and faster transport. The second and third order effects of AD and AT, however, will likely prove to be far more transformative to our ways of living: creating fundamental changes to society and the physical form of cities. These changes include radical new land-supply equilibriums, widespread flattening of the housing cost curve, and increased access to mobility by economically disadvantaged communities, the elderly, and those with reduced physical mobility. One of the most dramatic changes that will happen with AD is a rapid expansion of commuting sheds, which may shatter the longstanding rule of Marchetti's Wall—a maximum 60-minute commute pattern. AD predictions already show how a modest 25% increase in average driving speed could lead to a 56% increase in accessible land.

With these oncoming changes the relative importance of suburban development will only increase as metropolitan regions continue to spread outward. Meanwhile, denser urban cores are predicted to shrink as lower cost peripheral land is unlocked and developed into affordable and environmentally performative neighborhoods and high-tech business nodes — further decentralizing regional economies and driving.

For decades, metro regions around the world and especially in the U.S. have become more congested with private automobiles. Federal, state, and local governments no longer have the funds to massively subsidize or expand mass transit services, and a limited supply of real estate and connective right-of-ways make adding new trunk lines extremely difficult in dense areas. The image of mobility in urban areas increasingly is one of more density, congestion, parking shortfalls, and overburdened mass transit systems.

AD and AT have the potential to solve these big problems by fostering a new spatial economic landscape. Removing human drivers from the mobility equation allows for a radical rethinking of how we use highly inefficient paved surfaces of cities, including parking lots, streets, driveways, garages, refueling stations, and many more. Recent research has demonstrated that a parking lot for autonomously parked vehicles could accommodate the same number of vehicles in 62% less space. In addition, studies routinely document oversupply of parking in cities in the range of 25-60%. Parking lots at suburban big box retail malls are especially underutilized. With the advent of various forms of home delivery (such as autonomous drones), the 10 billion sq. ft. of retail space in the US, and the attached parking lots, can be dramatically redesigned.

Once paved surfaces are redistributed, adaptive reuse of highly accessible, centrally-located land resources could improve many critical environmental systems within metros, especially the ability to capture and treat stormwater and prevent urban flooding in the age of climate change. New live-work-play developments can be strategically inserted in places where paving is removed to catalyze economic growth throughout regions, increasing local revenue and jobs closer to home. An entirely new spatial economy will cluster around the newly created land resources and the reduced costs to access them.

Autonomous Urban Mobility Initiative (AUMI)

The MIT Norman B. Leventhal Center for Advanced Urbanism is a premier research center focused on the design and planning of large scale, complex, 21st century metropolitan environments. The center aims to create radically new solutions to the most pressing urban problems utilizing interdisciplinary collaborative practices and the world's most advanced analytical and representational tools.

The Autonomous Urban Mobility Initiative (AUMI) is an important component of the LCAU's strategy for engaging with cities and companies looking to partner and discover cutting edge solutions for future mobility. This initiative will provide a new forum to engage in conversations with MIT faculty and researchers over real-world urban challenges. The AUMI program invites 3-5 organizations who wish to join simultaneously on an initiative focused on the future of autonomous urban mobility. Participants will engage in joint conversations throughout the yearlong program, with the potential for funding future collaborative or proprietary sponsored research on Next Generation Autonomous Suburbs.

Initiative benefits

Annual membership to join the Autonomous Urban Mobility Initiative is \$30,000 per organization. Members will be engaged in a year-long benefits program that includes:

Months 1-3: A kickoff meeting between LCAU faculty and researchers begins a dialogue around future challenges and current research in the area of autonomous mobility. This meeting is an opportunity to begin exploring the mobility challenges that the members have identified, to begin identifying faculty whose research interests align with these problems, and for the MIT side to gain a deeper understanding of the context in which solutions will be applied.

Months 3-6: Once the problem has been well documented and clearly identified, the LCAU will hold a one-day workshop at MIT in Cambridge, MA to share the problem or sets of problems with a larger community of faculty, researchers, and students from across the MIT ecosystem. This workshop provides the opportunity to continue refining an area of interest for ongoing collaboration and research, and through meetings with members of affiliated faculty and researchers, it will expose AUMI members to new ideas and approaches that may be integrated into ongoing collaboration. The day's events and discussions will be documented and shared with the member.

Months 4-12: Following the workshop and initial kick-off meeting, the LCAU team led by the Membership Manager will engage in an iterative process with members and faculty to construct a research proposal that articulates: a problem statement, approach, timeline, and budget for future sponsored research within the discussed area(s) of interest. The member manager will liaise with the LCAU, affiliated faculty and member to ensure the proposal reflects an area of mutual interest.

AUMI partners will receive recognition on all LCAU publications, working papers, reports, and exhibitions. The LCAU regularly participates at international cultural events, such as biennales and leading exhibitions, showcasing its research and design work. Mobility members are also recognized in materials at these events. AUMI members will also receive invitations to LCAU events held periodically throughout the year.

AUMI members have the opportunity to assign an “in-residence visiting fellow” from their organization to be housed within the LCAU, to closely engage with us to craft a funded research proposal and work directly with researchers and staff during this process. Members may place an employee in-residence at the LCAU for a predefined period of time, subject to the discretion of the LCAU co-directors.

All AUMI members may use the LCAU as a neutral meeting ground to share ideas with other partners and center members, in the ethos of the LCAU’s mission to foster cross-discipline innovation and collaboration.

Directed research: Next Generation Autonomous Suburbs

Following the Autonomous Urban Mobility Initiative year, organizations can support our ongoing research into the next generation of autonomous suburbs. Research currently underway, is developing widely applicable parametric rule-sets for land-use conversion (from existing to AD) based on future programming projections and land-use conversion processes. These metric rules for AD futures will be applied using urban modelling, to predict and design outcomes for metropolitan land uses.

This research will develop a rigorous and comprehensive vision for AD metropolitan areas, one that considers all land-use types, and includes the integration and phasing strategies needed to unlock the wide-ranging benefits of a fully autonomous AD and AT future.

Other areas of interest include:

- What new daily patterns of family interaction and time budget management might evolve in an AD future, and how can these changes be managed to improve overall quality of life?
- What unanticipated or unintended consequences might emerge as we transition toward a fully AD future? How can solutions be designed to address these externalities?
- What development strategies are needed to best integrate Optimal Suburban AD Units within existing landscapes to preserve and ideally enhance ecological systems?
- What new indices and metrics are needed to measure and track the unique social, economic, and environmental impact of AD over time, especially to ensure equitable distribution of AD benefits to residents and cities?
- What new terminology and concepts do policy makers and developers need to define and explain these benefits?
- How can innovative urban transport and economic modeling be used to best simulate and communicate the impact of AD?

If you are interested in joining the conversation around the next generation of autonomous suburbs, or have research interests that align, please contact Sasha M. Rollinger, Membership Manager (t: 617 324 6037, e: sashams@mit.edu).

Please note, any research project will be subject to a separate agreement (Sponsored Research Agreement) that will stipulate the scope of work to be conducted, timeline for research deliverables, and budget. The cost of the project will reflect the scope of work developed.

Overview

The goal of MIT's Norman B. Leventhal Center for Advanced Urbanism (LCAU) is to establish a new theoretical and applied research platform to transform the quality of urban life. The LCAU is committed to achieving this goal via collaborative interdisciplinary research projects, intellectual discourse, leadership forums and conferences, publications, education of a new generation of leaders in the field, and a distinctive, highly influential presence at international gatherings focused on urbanism.

Mission

The LCAU is a premier research center focused on the design and planning of large-scale, complex, 21st century metropolitan environments. The Center aims to redefine the field of urban design to meet contemporary challenges utilizing interdisciplinary collaborative practices and the most advanced analytical and representational tools.

Goals

To enable **real world collaboration** among interdisciplinary professionals to build new knowledge and deliver large-scale design and planning projects that address pressing global urban design, architectural, and environmental challenges.

To **disseminate the learning** from these projects in the form of new modes of analysis, frameworks for practice, and recommendations for the long-term functionality of metropolitan areas.

To **educate a new generation of leaders** who not only have a deep understanding of the issues facing our urban future, but also have the real-world project experience to catalyze change.

Rationale

The scale, complexity, density, and technological demands placed on the planning of 21st century cities are unprecedented. New challenges such as energy and waste conservation, planning for resilience and climate change, and finding solutions to informal settlements around cities only exacerbate this. Urban design, established as a field of inquiry about 40 years ago, remains architecture-centric and unable to solve these problems alone. An entirely new approach is needed in both theory and practice of city-making. Fields such as architecture, landscape architecture, urban planning, real estate development, engineering, materials science, and business management have become increasingly sophisticated with new analytical tools at their disposal. Barriers among these disciplines have largely dissolved at MIT: interdisciplinary theory and practice are welcomed and considered necessary for problem-solving around the complex, pressing challenges of the future of urbanity.

Research Areas

MIT's Norman B. Leventhal Center for Advanced Urbanism has four primary areas of inquiry addressing the most critical challenges to the future of urbanism. We seek collaboration with companies, government agencies, non-profit organizations, professional groups, and others to continue growing the research areas.

Climate + Urbanism revolves around understanding the increased risks and vulnerabilities of cities due to climate change, especially in highly populated, coastal areas. From this understanding comes the core mission of designing new templates for adaptation and for protective infrastructures as well as potential relocation strategies and environmental design.

Environment + Urbanism addresses urban environmental issues and their impacts on the future of the city, including: food, water, urban health, biodiversity, landscape performance, pollution and toxicity, building health, resource consumption, waste management, and more. The goal of this research is to design and develop more sustainable outcomes for cities to reduce dependence on limited natural resources and make cities healthier for all.

Technology + Urbanism tests the long-term consequences, benefits, and second-order effects of new technologies as they get implemented in neighborhoods and across metropolitan areas. Scenarios primarily test the impacts of technology on urban form and space but also considers the socio-economic and cultural consequences of introducing new technologies.

Global+ Urbanism specifically targeted at unique global contexts that require new models for urbanism. Global + Urbanism research is place-dependent and can vary widely based on geographic context, recognizing that urban form, protocols, and practices are radically different depending on institutional processes. With the global urban world expecting rapid growth to 2050, Global + Urbanism research asks what new urban models can be implemented to disrupt paradigms of city-making.

Research Themes

In addition to its four research areas, the Norman B. Leventhal Center for Advanced Urbanism establishes an overarching research theme that informs its research direction and programming for a two-year duration. These themes are timely topics within the urban discourse and provide consistency to the LCAU's lectures, workshops, courses, and conferences for their duration.

Equitable Resilience (2018-2021)

The Norman B. Leventhal Center for Advanced Urbanism's fourth research theme – Equitable Resilience – brings to the forefront questions of equity when designing for urban resilience: How can cities prepare now for a more equitable form of future resilience? It aims to use the momentum around global resilience thinking to address how planning and design can significantly reduce urban inequities as a result of climate change preparations.

Housing + (2016-2018)

By using various case studies, particularly in low to medium density settings, research and design will envision new approaches to housing that will focus on strategies for implementation. Solutions included new development models, conceptual master plans, housing prototypes, innovative building systems and materials, and new infrastructural strategies. Over the course of 2017, students and faculty traveled to Colombia, Rwanda, India, and other countries to explore this topic and consider forward-thinking solutions.

The Future of Suburbia (2014-2016)

With the success, growth, and increasing global social and economic dependence on suburbs the Norman B. Leventhal Center for Advanced Urbanism explored how they may be improved through better design and planning. We examined how new templates and technologies might be embedded into them for higher levels of sustainability and performance, and asked whether new suburban models can be created for developing world contexts, what this might mean for new land tenure models needed, and how new forms of the suburbs in the developing world may evolve over time.

Infrastructure (2012-2014)

The LCAU's first theme, Infrastructure, explored this integral component of urban existence through a series of conferences and symposiums. The Spring 2013 conference, *Infrastructural Monument*, asked whether infrastructure design and investment can go beyond providing services and connectivity to influence culture, public space, architecture, and landscape form. The Fall 2014 symposium took this a step further, looking at examples of integrated infrastructures that serve multiple functions simultaneously. And the Spring 2014 Conference, *Scaling Infrastructure*, exposed issues around sustainable infrastructure and infrastructural redundancy within the context of technical and political realities, design possibilities, and social and economic concerns.

Organization

MIT's Norman B. Leventhal Center for Advanced Urbanism is housed administratively in the office of the Dean of the School of Architecture + Planning at MIT. Two academic directors, one from the Department of Architecture and one from the Department of Urban Studies and Planning, are appointed by the Dean to lead the research and educational missions of the LCAU.

Faculty from these departments and the City Science Initiative from the Media Lab are the principal research investigators with support from other schools at MIT as needed. The LCAU organizes collaborations between the various affiliated faculty and labs to foster cross-disciplinary expertise.

Affiliated Faculty

Marie Law Adams, Lecturer, DUSP, **Azra Aksamija** Associate Professor, ARCH **Lorena Bello Gomez** Lecturer, ARCH **Eran Ben-Joseph** Professor and Department Chair, DUSP **Alan Berger** Professor, DUSP **Elizabeth Bruce** Executive Director, Big Data Initiative **Yung Ho Chang** Professor, ARCH **Alexander D'Hooghe** Associate Professor, ARCH **John Fernandez** Professor, ARCH **Dennis Frenchman** Professor, DUSP **Antón García-Abril** Professor, ARCH **Rania Ghosn** Assistant Professor, ARCH **Reinhard Goethert** Principal Research Associate, ARCH **David Hsu** Assistant Professor, DUSP **Sheila Kennedy** Professor, ARCH **Kent Larson** Principal Research Scientist, ML **John Lienhard** Professor, JWAFS **Sam Madden** Professor, EECS **Miho Mazereeuw** Associate Professor, ARCH **Heidi Nepf** Professor, CEE **William O'Brien** Associate Professor, ARCH **Mary Anne Ocampo** Lecturer, DUSP **Cristina Parreño Alonso** Lecturer, ARCH **Christoph Reinhart** Professor, ARCH **Brent Ryan** Associate Professor, DUSP **Adèle Naudé Santos** Professor, ARCH and DUSP **Lawrence Sass** Associate Professor, ARCH **Andrew Scott** Professor, ARCH **Rafi Segal** Associate Professor, ARCH **Karl Seidman** Senior Lecturer, DUSP **Anne Spirn** Professor, ARCH and DUSP **Phil Thompson** Associate Professor, DUSP **Justin Steil** Assistant Professor, DUSP **Gediminas Urbonas** Associate Professor, ARCH **Lawrence Vale** Professor, DUSP **James Wescoat Jr.** Professor, ARCH **Sarah Williams** Associate Professor, DUSP **Meejin Yoon** Professor and Department Chair, ARCH **Christopher Zegras** Associate Professor, DUSP, ESD **Jinhua Zhao** Associate Professor, DUSP

ARCH (Department of Architecture)

CEE (Department of Civil and Environmental Engineering)

CTL (Center for Transportation and Logistics)

EECS (Department of Electrical Engineering and Computer Science)

DUSP (Department of Urban Studies and Planning)

ESD (Engineering Systems Division)

ML (Media Lab)

Affiliated Labs

Big Data Initiative, Sam Madden, **City Science Initiative**, Kent Larson, **Civic Data Design Lab**, Sarah Williams, **Housing and Community Lab**, Adèle Naudé Santos, **Locus Lab**, Andrew Scott, **Mobility Systems**, Chris Zegras, **Nepf Environmental Fluid Mechanics Lab**, Heidi Nepf, **New Century Cities** Dennis Frenchman, **P-REX**, Alan M. Berger, **Resilient Cities Housing Initiative**, Lawrence Vale, **Sustainable Design Lab**, Christoph Reinhart, **Urban Risklab**, Miho Mazereeuw.

MIT Faculty and Staff Bios



Eran Ben-Joseph
Professor of Landscape Architecture and Urban Planning
Department Head, Urban Studies and Planning

Eran Ben-Joseph is a Professor and Head of the Department of Urban Studies and Planning at the Massachusetts Institute of Technology. His research and teaching areas include urban and physical design, standards and regulations, sustainable site planning technologies and urban retrofitting. He authored and co-authored the books: *Streets and the Shaping of Towns and Cities*, *Regulating Place: Standards and the Shaping of Urban America*, *The Code of the City*, *RENEW Town* and *ReThinking a Lot*. Eran worked as a city planner, urban designer and landscape architect in Europe, Asia, the Middle East and the United States on projects including new towns and residential developments, streetscapes, stream restorations, and parks and recreation planning. He has led national and international multi-disciplinary projects in Singapore, Barcelona, Santiago, Tokyo and Washington DC among other places.

Eran holds degrees from the University of California at Berkeley and Chiba National University of Japan. Current Research: Urban Form and Health, Urban Form and the Aging Population, Urban Form and Ecological Models of Development, Urban Form and Manufacturing.



Alan Berger
Leventhal Professor of Advanced Urbanism
Co-Director, Leventhal Center for Advanced Urbanism
Director, P-REX Lab

Alan M. Berger is Professor of Landscape Architecture and Urban Design at Massachusetts Institute of Technology where he teaches courses open to the entire student body. He is founding director of P-REX lab, at MIT, a research lab focused on environmental problems caused by urbanization, including the design, remediation, and reuse of waste landscapes worldwide. He is also Co-Director of MIT Norman B. Leventhal Center for Advanced Urbanism (LCAU). All of his research and work emphasizes the link between our consumption of natural resources, and the waste and destruction of landscape, to help us better understand how to proceed with redesigning around our wasteful lifestyles for more intelligent design and development outcomes. Unlike conventional practice, there are no scalar limits in his outlook or pedagogy: projects are defined by the extent of the

urban and environmental problems being addressed. He coined the term “Systemic Design” to describe the reintegration of disvalued landscapes into our urbanized territories and regional ecologies.

In addition to his award winning books *Drosscape: Wasting Land in Urban America*, and *Reclaiming the American West*, his other books include *Designing the Reclaimed Landscape*, *The Infrastructural Monument and Scaling Infrastructure* (with Alexander D’Hooghe), *Nansha Coastal City: Landscape and Urbanism in the Pearl River Delta* (with Margaret Crawford), *Systemic Design Can Change the World*, and *Landscape + Urbanism Around the Bay of Mumbai* (with Rahul Mehrotra), and LCAU’s 2013 Report on the State of Health + Urbanism (with Andrew Scott). His forthcoming anthology, *Infinite Suburbia*, will be released in October 2017 (with Joel Kotkin, Celina Balderas Guzman).

Prior to MIT Berger was Associate Professor of Landscape Architecture at Harvard-GSD, 2002-2008. He is a Prince Charitable Trusts Fellow of The American Academy in Rome. He is a Visiting Honorary Professor at Oslo School of Architecture (AHO).



Kent Larson
Principal Research Scientist, City Science

Kent Larson directs the City Science (formerly Changing Places) group at the MIT Media Lab. His research focuses on developing urban interventions that enable more entrepreneurial, livable, high-performance districts in cities. To that end, his projects include advanced simulation and augmented reality for urban design, transformable micro-housing for millennials, mobility-on-demand systems that create alternatives to private automobiles, and Urban Living Lab deployments in Hamburg, Andorra, Taipei, and Boston.

Larson and researchers from his group received the “10-Year Impact Award” from UbiComp 2014. This is a “test of time” award for work that, with the benefit of hindsight, has had the greatest impact over the previous decade.

Larson practiced architecture for 15 years in New York City, with design work published in *Architectural Record*, *Progressive Architecture*, *Global Architecture*, *The New York Times*, *A+U*, and *Architectural Digest*. *The New York Times Review of Books* selected his book, *Louis I. Kahn: Unbuilt Masterworks* (2000) as one of that year’s ten best books in architecture.



John Leonard
Professor, CSAIL

John J. Leonard is Samuel C. Collins Professor of Mechanical and Ocean Engineering in the MIT Department of Mechanical Engineering. He is also a member of the MIT Computer Science and Artificial Intelligence Laboratory (CSAIL). His research addresses the problems of navigation and mapping for autonomous mobile robots. He holds the degrees of B.S.E.E. in Electrical Engineering and Science from the University of Pennsylvania (1987) and D.Phil. in Engineering Science from the University of Oxford (1994). He is an IEEE Fellow (2014). Professor Leonard is currently on sabbatical leave from MIT serving as Vice President for Autonomous Driving Research at Toyota Research Institute, where he is performing research to improve vehicle safety using autonomous driving technologies.



Daniela Rus
Director, CSAIL
Andrew (1956) and Erna Viterbi Professor of Electrical Engineering and Computer Science

Daniela Rus is the Andrew (1956) and Erna Viterbi Professor of Electrical Engineering and Computer Science and Director of the Computer Science and Artificial Intelligence Laboratory (CSAIL) at MIT. Rus's research interests are in robotics, mobile computing, and data science. Rus is a Class of 2002 MacArthur Fellow, a fellow of ACM, AAAI and IEEE, and a member of the National Academy of Engineering, and the American Academy for Arts and Science. She earned her PhD in Computer Science from Cornell University.



Jessica Trancik
Associate Professor, Energy Studies

Jessika Trancik is an Associate Professor of Energy Studies at the Massachusetts Institute of Technology. She is also an external professor at the Santa Fe Institute. She received her BS in materials science and engineering from Cornell University and her PhD in materials science from the University of Oxford as a Rhodes Scholar. Before MIT, she spent several years at the Santa Fe Institute as an Omidyar Fellow, and at Columbia University as an Earth Institute Fellow, where her research focused on energy systems modeling. Her research group studies the dynamic costs and environmental impacts of energy technologies to inform technology design and policy. Prof. Trancik's research centers on evaluating the environmental impacts and costs of energy technologies, and setting design targets to help accelerate the development of these technologies in the

laboratory. This work involves assembling and analyzing expansive datasets, and developing new quantitative models and theory. Projects focus on electricity and transportation, with an emphasis on solar energy conversion and storage technologies.



Jinhua Zhao
Edward H. and Joyce Linde Associate Professor of
Transportation and City Planning

Jinhua Zhao is the Edward and Joyce Linde Associate Professor of City and Transportation Planning at the Massachusetts Institute of Technology (MIT). Prof. Zhao brings behavioral science and transportation technology together to shape travel behavior, design mobility system and reform urban policies. He develops methods to sense, predict, nudge and regulate travel behavior and designs multimodal mobility system that integrates autonomous vehicles, shared mobility, and public transport. Prof. Zhao sees transportation as a language to describe a person, characterize a city, and understand an institution, and aims to establish the behavioral foundation for transportation policies.

Prof. Zhao leads long-term research collaborations with major transportation authorities and operators worldwide including London, Chicago, Hong Kong and Singapore. Prof. Zhao directs the Urban Mobility Lab (mobility.mit.edu) at MIT. He very much enjoys working with students.

ATTACHMENT 2

THE NEW AUTOPIA - A CHANCE TO TRANSFORM URBAN PLANNING (THE ECONOMIST)

SPECIAL REPORT: AUTONOMOUS VEHICLES

The new autopia

A chance to transform urban planning

How autonomous vehicles will reshape cities

Print edition | Special report
Mar 1st 2018



MODERN CITIES, PARTICULARLY in America, are habitats for cars as much as people, devoting huge amounts of space to roads and parking. “America is a great place to be—if you’re a car,” says Donald Shoup of the University of California at Los Angeles. The expectation that people should be able to drive anywhere, encountering little or no congestion on the way and parking at their destination, led to a splurge of construction in the 20th century. Urban freeways, commuter suburbs and mandatory parking requirements reshaped cities. Now AVs promise to transform them once again, undermining many car-centric assumptions made in the 20th century, opening up new possibilities and turning urban-planning debates upside down. “For the first time in a generation, we can really rethink what suburban development looks like,” says Alan Berger, a professor of urban studies at the Massachusetts Institute of Technology.

Simply put, building cities around cars increases congestion, discourages the use of public transport and encourages sprawl, all of which urban planners generally disapprove of. The odd thing is that AVs could either reverse or accelerate each of these trends. They could reduce or increase traffic; make affordable transport more or less accessible; and lead to denser cities or more sprawl. It all depends on the rules for their use, and in particular the pricing. AVs know exactly where they are at all times, which makes it much easier to introduce fine-grained road tolls and congestion charges based on time of day, traffic levels and so on. That makes them a powerful and flexible policy tool.

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Start with congestion. A switch to shared robotaxis could increase vehicle occupancy rates, reducing the number of vehicles needed to move people around and easing congestion. But low-cost robotaxis might also encourage more people to take more trips—the familiar problem of “induced demand” when road travel is cheap and easy. The roads could also fill up with autonomous delivery vehicles with nobody on board. The nightmare scenario, says William Riggs of the University of San Francisco, is that “we create another form of congestion—it just happens to be automated congestion.” But careful pricing of roads and rides should be able to prevent that. Some cities already have congestion-charging schemes of various kinds, or rules to encourage vehicle-sharing, such as dedicated car-sharing lanes. Some are starting to price access to kerb space, for example at airports. AVs would allow far more subtle forms of charging, taking account of time, place, vehicle type, number of riders, traffic levels and so forth, to maximise sharing and minimise congestion. “It will be that interplay that ensures we don’t end up with highly congested roads,” says Justin Erlich of Uber.

“ Using AVs for the “last mile” to move people to and from railway stations could make public transport more viable in What about the impact on public transport? A study by UC Davis found that among Uber and Lyft riders in America, bus use fell by 6% and light-rail use by 3%. AVs would be cheaper, so they could draw even more people away from public transport and onto the roads. This might discourage further investment in public transport, which in turn could create more “transit deserts” where large numbers of people (typically the poor and the elderly) depend on public transport but get an inadequate service. The economics of robotaxis will work best in dense urban centres, says Mr Riggs, so “we could see social-equity implications around the fringes of cities.” But again, there is also a rosier scenario. Using AVs for the “last mile” to move people to and from railway stations could make public transport more viable in less densely populated areas. Some cities might also operate their own robotaxi fleets, or subsidise rides in poor neighbourhoods using toll revenues collected in rich ones.

The emergence of AVs helpfully coincides with a change in the structure of cities, says Shlomo Angel, an urban-studies expert at New York University. He argues that the monocentric model, with a centre surrounded by suburbs, is a thing of the past. In many large American and European cities, jobs are moving from downtown to the periphery, and workers increasingly commute from one suburb to another, rather than to and from the centre. His analysis shows that 75% of jobs in a typical American city are outside the urban centre. In European and Asian cities with dense public-transport networks this decentralisation is easier to cope with, but retrofitting the necessary infrastructure onto American cities would be too expensive. “American cities need door-to-door transport systems to get to work, and driverless cars will play this role beautifully,” says Mr Angel. Robotaxis hailed on demand promise to be a lot more efficient than privately owned vehicles, he says, and are well suited to the spatial structure of both present and future American cities. Mr Berger agrees. “It’s not affordable to build mass transit that goes from suburb to suburb,” he says. “The best solution I’ve seen in my career is the idea of shared autonomous vehicles.”

That raises the question of urban sprawl. On the one hand, a switch to shared AVs by urban dwellers could lead to denser cities as some of the space currently used for parking is reallocated to housing. New high-density housing is already being planned with pick-up and drop-off zones for ride-hailing vehicles, and fewer parking spaces. On the other hand, AVs could also encourage sprawl by making long commutes more acceptable, because riders will be able to work or even sleep on the move. “The biggest negative of suburban living is the driving and the amount of space that has to be devoted to cars,” says Joel Kotkin of Chapman University. By doing away with driving and making city centres easier to access, AVs will increase the appeal of suburban living. So it seems likely that AVs will make cities both denser and more spread out, depending on the road-pricing regime.

Turning back the clock

AVs could also make possible new kinds of suburbs, updating the 20th-century dream of garden cities. “Over the last 100 years our landscape has been drastically altered by the automobile,” says Mr Berger. With AVs, “all the land we’ve given to the automobile can be put back into landscape and ecological functions.” By doing away with parking and using one-way, single-lane roads that loop through neighbourhoods, the area of paved surface can be reduced by 50%, he calculates. That means more space for plants, more biodiversity and better water retention, reducing the risk of flooding in the urban core. Suburbs will have enough space to generate their own solar power or grow their own food.

City centres will end up looking different, too. In effect, cities have banked a large amount of valuable real estate in the form of parking lots and garages, notes Peter Norton of the University of Virginia, and must decide how to spend their windfall. Housing is one obvious use; parks are another. Some streets could be reconfigured to more imaginative uses than high-volume thoroughfares, he suggests. In particular, some quieter streets could become spaces where pedestrians and slow-moving AVs share the roadway as equals, with neither having priority. This would

mark a return to the way streets worked a century ago, before cars took over. "Streets should not just be roads for cars but places for people," says Mr Shoup.

In retrospect, many drawbacks associated with cars in the 20th century arose from a failure to price their use properly. With appropriate pricing, AVs should be able to avoid many of those problems, giving urban planners and policymakers a much wider range of choices about how cities and transport systems could be structured. The challenge will be to choose wisely.

This article appeared in the Special report section of the print edition under the headline "The new autopia"

Special report

Autonomous vehicles

Autonomous vehicles are just around the corner

A chance to transform urban planning

Self-driving cars will require new business models

Autonomous-vehicle technology is advancing ever faster

The success of AVs will depend on sensible regulation

Self-driving cars will profoundly change the way people live

Print edition | Special report

Mar 1st 2018



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ATTACHMENT 3

**AUTONOMOUS CARS ARE ABOUT TO TRANSFORM THE SUBURBS
(FORBES)**

EDITOR'S PICK | 21,595 views | Feb 21, 2018, 10:31am

Autonomous Cars Are About To Transform The Suburbs

**Joel Kotkin** Contributor 

Reinventing America

I cover demographic, social and economic trends around the world.

People look back at an autonomous self-driving vehicle, as it is tested in a pedestrian zone in Milton Keynes, north of London, on October 11, 2016. (JUSTIN TALLIS/AFP/Getty Images)

By Joel Kotkin and Alan M. Berger

Suburbs have largely been dismissed by environmentalists and urban planners as bad for the planet, a form that needed to be eliminated to make way for a bright urban future. Yet, after a few years of demographic stultification amid the Great Recession, Americans are again heading to the suburbs in large numbers, particularly millennials.

So rather than fight the tide and treat suburbanization as an evil to be squeezed out, perhaps a better approach would be to modify the suburban form in ways that address its most glaring environmental weakness: dependence on gas-powered automobiles. The rise of ride-sharing, electric cars and ultimately the self-driving automobile seem likely to alter this paradigm. In most other ways, suburbs are at the least no more damaging than dense cities, and they are superior in terms of air quality, maintaining biodiversity, carbon sequestration and stormwater management.

We may well be on the verge of evolving a new kind of highly sustainable, near-zero carbon form, one linked by technology, and economically (and increasingly culturally) self-sufficient. Autonomous cars will remotely park in solar-charged sheds off-site, to be called to the home through handheld devices, thus eliminating the need for garages and driveways. With safer vehicles that can see and react to situations better, roadways will be designed with much less paving to mitigate stormwater runoff and flooding. Homes will have drone delivery ports built in, greatly reducing the number of daily household trips and congestion. With much less redundant paving and more undisturbed land, autonomous suburbs will expand parks, bike trails and farms, and reduce forest fragmentation. Some of the next generation of suburbs will be anchored by main street districts, some of them restored, while others will be built from scratch, as we have seen in places like the Woodlands outside Houston and Valencia north of Los Angeles.

Taming the car

The traditional urbanist view of suburbs is that, if they must exist, they should be linked by mass transit to the city core. But in the U.S., outside of a handful of older cities, transit ridership is stagnant or in decline despite billions in investment from federal and local sources. In Europe, where bullet trains efficiently link suburbs to cities, strict local and national land use policies and high tax subsidies block development of peripheral land, making compact city forms possible. The U.S. has no national land use policy and we highly doubt voters will agree to much higher taxes to protect peripheral lands from development. Our vast geography allows us to spread out: The U.S. is more than 2.5 times the size of the E.U.

Simply put, the advantages of private transportation are, for the most part, too compelling in a country dominated by long distances and dispersed development. Elon Musk recently shared a brutally honest critique of mass transit. "It's a pain in the ass," he said. "That's why everyone doesn't like it. And there's like a bunch of random strangers, one of who might be a serial killer, OK, great. And so that's why people like individualized transport, that goes where you want, when you want."

In fact, no regional rail system has managed to make any sort of dent in car use. Since 2000, the increase in workers driving alone has been 15 times the increase in those using transit. Even the Progressive Policy Institute, a research organization affiliated with the Democratic Leadership Council, has noted, "The shortest distance between a poor person and a job is along a line driven in a car."

Los Angeles, hailed by the amen crew in the media as the "next great transit city" has experienced a considerable decrease in overall transit ridership over the last few years. Transit's share of work trips has stalled in such diverse markets as Houston, Dallas-Fort Worth, Atlanta and, remarkably, the transit mecca of Portland.

Meanwhile, instead of jumping on trains, thirty-something millennials are buying cars in huge numbers, heading toward the suburbs and starting families. Road travel this year hit a record, as it has the last five years. The increased popularity of ridesharing services like Uber and Lyft has been cited as a factor in the recent ridership declines in Los Angeles and even on the New York subway. It is also being cited as one reason why new extensions of Boston's transit system may no longer be needed.

With the assumption that private transportation will prevail, we need to come up with different solutions to reduce greenhouse gases within the context of suburbia. Renewable technologies in the home and much more tree planting can greatly offset carbon consumption, but workforce behavior also needs to change. One piece of the puzzle is the expansion of work at home. Demographer Wendell Cox has found that the share of the U.S. population that works from home has more than doubled since 1980 and now approximates the share that commute to work via mass transit, exceeding it easily outside of New York. The growth of

home-based work, which requires no commute, may be the quickest solution to reducing greenhouse gases.

And how about the transit dependent? Ride-sharing technology for transit dependent populations could prove both more cost effective and less time consuming. For example, in suburban San Francisco a transit operator has established a one-year pilot program to subsidize local ridesharing services and has canceled a lightly patronized bus route, reducing costs. Ride-sharing could also compliment public transit in the future, rather than replace it.

All these strategies could potentially reduce greenhouse gases far faster than the fanciful attempts of planners, notably in California, to reduce suburbanization and impose forced densification. A recent Berkeley study suggests that 1.9 million new housing units be built only in infill locations, about 4 percent of the state, saving about 1.8 million metric tons of California greenhouse gas emissions per year from reduced driving. This is less than 1 percent of the new 2030 reductions mandated by the state, and statistically meaningless compared with current annual worldwide emissions of 49,000 million metric tons.

You ain't seen nothing yet

America's next suburban wave will be driven by technology, smart devices and Internet-of-things connectivity between cars, roads and homes, offer significant potential breakthroughs, particularly if shaped by the public need, not those of large tech firms. Roy Amara, the late president of the Institute for the Future has said, "We tend to overestimate the effect of a technology in the short run and underestimate the effect in the long run. Self-driving cars are as much of a paradigm shift as the invention of the telephone, and we all need to get prepared for the ride of our lives."

Americans continue to move, for the most part, to less congested, less dense areas with lower levels of transit service and away from the more tightly packed areas with better transit service, and autonomous vehicles will likely exacerbate this trend. By one estimate, as much as a trillion dollars of real estate value could swing to locations far from job centers that will become more attractive due to

autonomous vehicles while reducing the “premium” now awarded to closer in neighborhoods and inner-ring suburbs.

A recent report by the global consulting firm Bain & Co. predicts that technological advances such as the autonomous car will help to create a “post-urban economy” that will be more localized and home-based. By 2025, its analysts write, fewer people could live in urban cores than in exurbs, which it defines as “beyond the traditional commuting belt.”

Bill Gates’ proposed new city in Arizona, which will feature these new technologies, is located on the far fringes of the Phoenix area-- to the predictable horror of ‘smart growth’ advocates.

Over time, the autonomous car could make even more revolutionary impacts on both the urban form and transit. Automated car proponents claim that the cost of operations will be considerably below that of today’s cars. If that should be achieved, the autonomous car could be used to provide door-to-door mobility not only for the elderly and disabled, but also for people who currently cannot afford their own cars. Under any circumstances, this innovation seems certain to further weaken conventional transit outside the cities with legacy cores. In the future, mass transit will be able to geographically refocus its resources on the most dense cores to provide better service, rather than spreading less dollars per square mile, and poorer service, everywhere.

There is considerable disagreement about how soon autonomous vehicles will become commonplace, but development activity is proceeding at a fast pace. There are currently 50 companies testing 387 autonomous vehicles in California alone, according to the state Department of Motor Vehicles.

The sunniest optimists suggest that by 2030 the conversion to autonomous vehicles will be nearly complete. Other researchers predict the roll out of autonomous cars is going to proceed at a modest pace, with total sales in 2035 equaling only one-quarter of present world production.

Despite these disagreements about the pace of change, our way of life, both in cities and suburbs, is being radically transformed. What we need to do now is envision how to design the fully autonomous, low-carbon suburb so that water, air

and natural landscapes can be preserved in ways better than we have been capable of in the past.

Alan M. Berger is Professor of Landscape Architecture and Urban Design at the Massachusetts Institute of Technology and founding director of its P-REX lab, a research lab focused on environmental problems caused by urbanization. Kotkin and Berger are co-editors of the anthology 'Infinite Suburbia.'



Joel Kotkin Contributor

I cover demographic, social and economic trends around the world. I am the R.C. Hobbs Professor of Urban Studies at Chapman University in California, executive director... **Read More**

ATTACHMENT 4

**AS SELF-DRIVING CARS HIT THE ROAD, REAL ESTATE
DEVELOPMENT MAY TAKE A NEW DIRECTION (CURBED)**



PROPERTY LINES

As self-driving cars hit the road, real estate development may take new direction

2

Planners are anxious about automated vehicles and their potential to reshape development patterns and the urban landscape

By **Patrick Sisson** | Updated May 16, 2017, 2:43pm EDT



An Uber driverless Ford Fusion drives down Smallman Street on September, 22, 2016 in Pittsburgh, Pennsylvania. | Jeff Swensen / Getty Images

PROPERTY LINES

Property Lines is a column by Curbed senior reporter Patrick Sisson that spotlights real estate trends and hot housing markets across the country.

Comments, tips, and suggestions on where Property Lines should head next are welcome at patrick@curbed.com.

The futuristic vision offered by automated vehicles—the freedom to be active during your commute instead of wasting away behind the wheel while stuck in traffic— isn't quite as utopian a scenario when you run it past cautious and concerned city planners.

Ask Don Elliott, a zoning consultant and director at Clarion Associates in Denver, and he'll tell you the idea of empty cars congesting city streets and mobile offices zipping around main roads can become downright dystopian.

"I've seen the blood run out of people's faces," he says when talking about the impact of automated vehicles on transportation, land use, and real estate. "For years, planners have been fighting for a 1 or 2 percent change in transportation mode [getting more people to use transit or bike instead of drive]. With this technology, everything goes out the window. It's a nightmare."

The much-hyped transition to autonomous cars, while still years, or even decades, away, according to experts, is an opportunity and challenge that has wide potential to reshape our transportation systems.

But many believe that as city planners, transportation officials, and, eventually, developers start grappling with the changes to come, autonomous vehicles' potential to reshape real estate, development, and city planning will rival that of the introduction of the automobile. At the American Planning Association's annual conference earlier this month in New York City, the issue of autonomous vehicles and driverless cars, one admittedly far in the future, was the subject of numerous present-day panels, discussions, and debates.

“This will completely change us as a society. I think it’ll have the same transformational change as the introduction of the automobile.”

A recent policy brief by the Institute of Transportation Studies at University of California, Davis, was even more clear. The convergence of three new technologies—automation, electrification, and shared mobility—has the potential to create a whole new wave of automation-induced sprawl without proper planning and regulation.

“This will completely change us as a society,” says Shannon McDonald, an architect, assistant professor at Southern Illinois University-Carbondale, and an expert in future mobility planning. “I think it’ll have the same transformational change as the introduction of the automobile.”

With no real timeline for how or when this technology will roll out, there has been little in the way of planned regulatory response. The federal government released suggested guidance on autonomous vehicles (AVs) last fall, a series of national test sites have begun to look at safety and urban-design issues (as local government officials jockey for the spotlight), and the National Association of City Transportation Officials (NACTO) released a set of policy suggestions in response to the potential impacts of AV.

And, as Elliot noted, there are currently 263 million non-autonomous cars on the road, and roughly 2 billion parking spaces in the United States. While tests, such as the recently announced Waymo trials with families in Phoenix, may have already started, it will take a long time for AV tech to dominate our roadways.





Waymo's new AV trials on Phoenix, featuring minivans, are testing the technology in a more suburban environment. | Waymo

But that hasn't stopped many planning and development experts from thinking about the ways this technology will reshape planning, cities, and, eventually, real estate. As local governments deal with important transportation and land-use issues, the results of these decisions will potentially inflate or depress real estate values and change the way developers operate. Even expected shifts in roadway and traffic design that will be made in the next few decades suggest big shifts will come to future development.

“Streets are 25 to 35 percent of a city's land area... [the] most valuable asset in many ways,” says Zabe Bent, a principal at transportation consulting firm Nelson\Nygaard and a speaker at the APA conference. “We need to really think about how we manage those spaces for the public good and for reducing congestion.”



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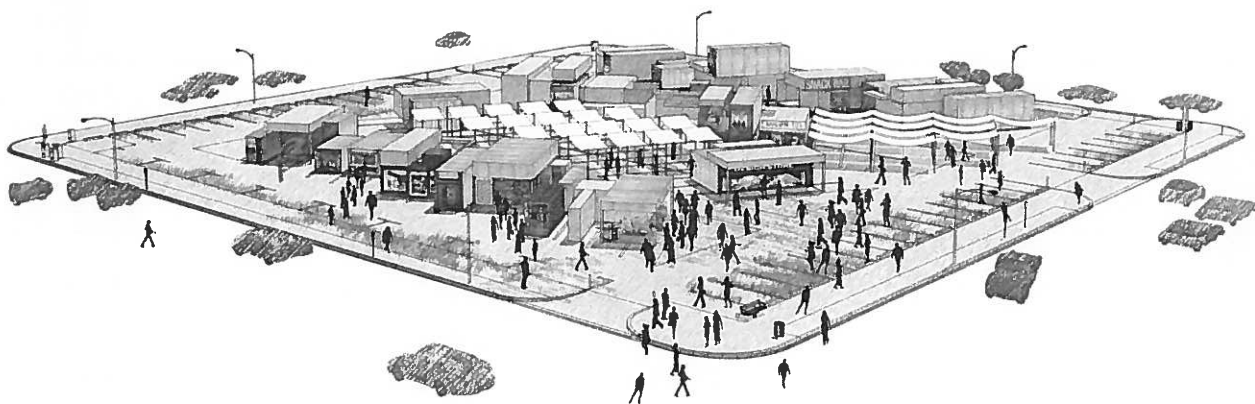
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The huge potential in parking space

Elliott, the zoning consultant, sees the steady rollout of autonomous-vehicle technology as a catalyst speeding up existing trends. While many technologists may predict a new wave of specialized infrastructure, he believes the future is in the smart repurposing of existing spaces and structures, and policies and zoning codes that support those types of projects.

There's a tendency to think of new solutions, Elliot says, when the reality is that smart reuse will be key for urban development. Planners will face this shift by using traditional tools—zoning, street design, and traffic regulation—in new ways, which will, in turn, impact how developers operate.

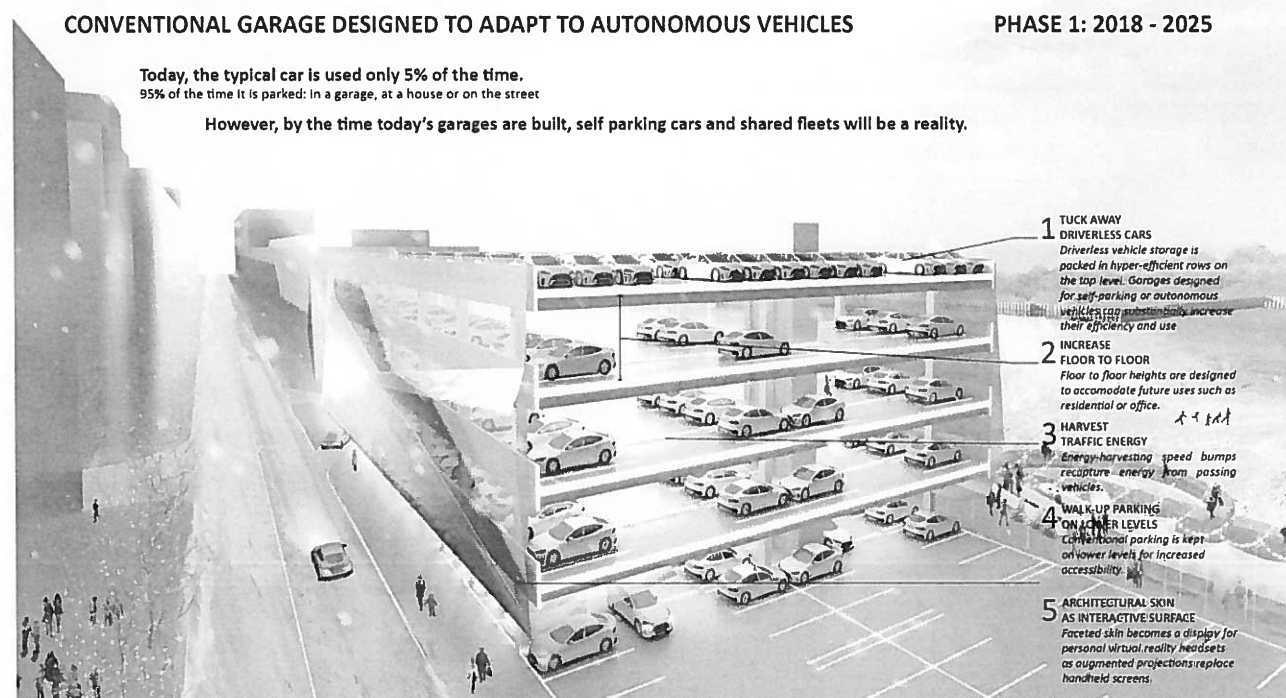


According to Kinder Baumgardner, a landscape architect at SWA, the advent of driverless cars will radically reshape how cities and towns use space, especially roads. With less need to own cars, suburban developments will have extra open space. | CITE Magazine/SWA Group

He sees two small but significant changes affecting urban real estate development in the age of driverless cars. A reduced need for parking may be the most significant. High-value property in urban areas needs to account for mandatory parking allowances, forcing developers to factor the cost of parking spaces into construction costs and rent.

Elliot gave the example of a 300-square-foot micro-unit studio in a dense downtown area that, due to code requirements, needs two parking spots, meaning the vehicles may end up with more space (324 square feet) than the tenant.

But with the potential for driverless tech to reduce private car ownership, developers won't need to worry about parking spaces, and can make more money by avoiding wasting space on cars. Elliot sees debates around parking allowances becoming much more important, since it's a potential tool to create more mixed-use, transit-oriented development and accelerate trends favoring downtown living (and new suburb development that mimics a similar density and walkability).





Boston-based architectural firm Arrowstreet has developed plans for parking garages that will be adaptable and respond to changes in car ownership and vehicle technology. | Arrowstreet Inc.

Some in the real estate world are already planning for this future. In Los Angeles, the mega-developer AvalonBay Communities Inc. has begun work on an apartment development in the city's arts district with parking garages specifically designed to be convertible, to take advantage of a time in the near future when extra spaces won't be needed.

Brentwood, a mixed-use development in Nashville, will also be built with a smaller parking-related footprint, and the city of Somerville, Massachusetts is collaborating with Audi's Urban Future Initiative and the Federal Realty Investment Trust on a garage design that could cut needed parking space by 62 percent. Audi estimates the design could save \$100 million once it's finished.

"Developers will start using the promise of AV and driverless cars to realize net savings," says Elliott. "It's not necessarily cheaper, but more space can be used for commercial or residential purposes."

Real estate firms will negotiate for fewer parking spaces, perhaps even setting up their own agreements with autonomous bus or transportation-network companies, such as Uber or Lyft, to provide tenants with transportation access in exchange for gaining more usable, high-value urban space. Though banks and financial institutions will need to get on board with the concept, this would offer a new way to add density, and could help spur more mixed-use, walkable cities.

The question marks around AVs cut both ways; some, including Elliott, believe AVs could also be tools for sprawl, since commutes will suddenly be more enjoyable and "not everyone can live in funky lofts."

Street-level shifts

Just as driverless car technology will speed up a change in the way cities think about parking allowances, it'll also accelerate a shift in how we design roadways, specifically pick-up and drop-off zones for vehicles. The growth in services such as Lyft and Uber are beginning to make this issue clear, but as autonomous vehicles eventually hit the streets, the way buildings and developments welcome and adapt to traffic flow will become increasingly important.

“Our streets aren’t designed for door-to-door service,” says McDonald.

New land-use rules and traffic codes will need to be designed to properly funnel AV traffic and prevent what could be a series of bottlenecks on the road, especially during rush hours, as people get to and from work and school.

Redesigning parking lots and entrances to be less about static parking and more about increasing the flow of dropoffs and pickups, as well as serving as staging areas for driverless cars not in use, will both free up space and ideally protect roadways from potential congestion.

UC Davis researchers believe more research is needed in this field. Instead of focusing on highway situations, automakers and tech companies need to run more simulations with street-level and pedestrian interactions (such as those undertaken at the MCity testing grounds in Michigan) to develop better loading and unloading zones.





The MCity testing ground in Michigan helps automakers and engineers develop autonomous vehicle technology within a simulated city environment. | MCity

Developments that don't begin to factor this in may become the sites of frequent traffic jams during peak hours. Allowing Uber and Lyft to take up these spaces for drop-off without creating new regulations is just asking for congestion.

"Curbside loading will become more and more critical," says Bent. "We need to understand how to manage that curb, since it'll be important for loading, unloading, cyclists, and transit. It's an increasingly important place for cities, and we need to learn how to use it better."

"Our streets aren't designed for door-to-door service."

Traffic regulations, even slight shifts to speed limits due to driverless cars, may prove to be important battles over regulation and control. Elliott believes that automakers and tech companies will push hard for state and even federal guidelines for AV to make it easier to program and sell vehicles for a national market.

Local government will need to act decisively to regulate drop-off lanes, speeds, and new parking rules before market forces, and other governments, begin making decisions for them. Technology firms shouldn't reap the rewards after cities make the investments necessary to adapt to a new transportation reality.

Parking, of course, won't totally disappear; even the most optimistic, far-reaching prediction for AV adoption suggests we'll need parking for older, standard vehicles, and staging areas for cars not in use. But the decreasing need for, and importance of, parking will come at a come for cities and municipalities.

Decreasing parking revenues (as well as fines, since AV would be programmed to avoid overstaying a meter or parking during street sweeping) could hit city coffers hard without additional revenue streams. Bent believes that cities will begin to adopt new forms of raising money from transportation, such as user pricing (charging for empty vehicles) or congestion pricing, driving up the cost of moving during peak hours.



Rush hour may become longer and more productive, encouraging sprawl, unless planners are proactive. | AP Photo/Eric Risberg, File

This kind of pricing becomes even more important as a long-term tool to fight sprawl. According to the UC Davis report, as the perceived price of transportation decreases due to automation, it'll be cheaper for developers to fund projects far from dense urban areas unless municipalities take the lead to incentivize infill development and perhaps even charge for vehicle-miles traveled as a way to make AV commutes less amenable.

Planning for the future

So far, most cities and planning departments haven't extensively studied the issue and begun to factor it into long-range planning, though that is starting to change. Scott Peterson is the director of technical services for the Metropolitan Planning Organization, a Boston-area regional planning group that released a white paper about autonomous vehicles and city planning.

"These issue came up before, but we couldn't do them justice during our last plan," he says. "But now that there's been more research on safety issues and rollout, we can start factoring it in."

This recently released white paper places Boston at the forefront of preparing for this big transportation shift. The MPO will begin to run local workshops in October to gauge how area municipalities see this impacting their operations, and will factor autonomous vehicles into long-range planning for their next long-term plan, which comes out in two years.

Peterson sees any impact of autonomous vehicles at least a decade away, and believes that a change won't happen overnight. But in 20 years, it'll be a significant topic of conversation, and a majority of vehicles might be using this technology. So it's definitely time to start looking at the many land-use issues this technology will leave in its wake.

“We really need to update our analytical tools and process to be reflective of this shift,” he says. “Nobody has the definitive answers about this, and how people are going to use this technology, and even their time in their cars.”

ATTACHMENT 5

THE NEW YORK TIMES TAKES A TRIP TO A DRIVERLESS FUTURE

The New York Times

The New York Times Takes a Trip to a Driverless Future

By **Bill Wasik**

Nov. 12, 2017

Ever since I started as an editor at The New York Times Magazine a little more than three years ago, one of my main guiding principles has been: Don't go too far out on a limb. That precept feels particularly important to me because many of the stories I oversee are about science and technology, two subjects where it can be easy for journalists to get too far ahead of the facts. A new study might suggest some scientific breakthrough is on the horizon, but The Times should never cover it in a way that seems to imply it's already here. In my previous job, at Wired magazine, my colleagues and I had one example of hyperactive prognostication that we used as a running joke: "commuting in dirigibles." That absurd mental image was a stand-in for all the other ridiculous sci-fi fantasies that, cool as they may look on a magazine cover, have basically no chance of arriving.

In the Tech and Design issue, out this week, my colleagues and I have made an exception to my rule.

Indeed, we've gone so far out on a limb — veering into pure speculation — that the branch has surely broken. That's because the subject of our issue, self-driving cars, is a science-fictional technology that has taken tremendous strides over the past few years, with billions of dollars being invested every year by some of the world's biggest companies, toward becoming a reality. This looming transformation of the car, itself the most transformative invention in American history, is still quite a few years off, and it still very well might stall or reverse entirely. But if it does arrive, and human drivers go the way of the carriage horse, the implications of that shift would be profound. With that in mind, we thought a little speculation might be called for.

This week's edition is one of 15 special issues that the magazine will put out this year. Some of these issues let us give broad attention to important subjects — education, say, or business — that we otherwise might not cover enough. But in many cases, we've found it especially fun (for us and also, we hope, for readers) to use them to go deep on one story or theme, turning it around and seeing it from every angle.

For the Tech and Design issue, we zeroed in on the autonomous car — and the future it might usher in. Two of our favorite business writers, Kevin Roose and Jon Gertner, visited Ford and Tesla to take the measure of their self-driving projects — and ride around in the autonomous cars they're making. Kim Tingley visited a start-up that's teaching large trucks to coordinate on highways in order to save on fuel.

But the real limb-breaking happens in the two essay packages that consume much of the magazine. In twenty short provocations, we've asked writers to imagine transformations the world could undergo if humans are no longer driving themselves around. The Times business reporter Nathaniel Popper thinks through the question of how car insurance would change. Gretchen Reynolds, our Well columnist, sketched out an autonomous-car workout. Other writers forecast the effects of autonomous cars on everything from drug dealing to sex to roadkill. Definitely don't miss the back page, where the illustrator Tomi Um has envisioned what a "Museum of Driving" would be like, in a future where the idea of driving your own car seems as remote as piloting a horse and buggy would today.

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Will any of us see a driverless future? It's hard to say. Right now, the technology works only under very controlled conditions, and something as simple as snow can change the environment around cars in ways that researchers are only beginning to figure out how to account for. But the strides have been so great, and the investment in the technology so vast. Certainly you're more likely to commute some day in a self-driving car than you are in a dirigible.

A version of this article appears in print on Nov. 10, 2017, on Page A2 of the New York edition with the headline: Daydreams of a Driverless Future

ATTACHMENT 6

**PAVE OVER THE SUBWAY? CITIES FACE TOUGH BETS ON
DRIVERLESS CARS (THE NEW YORK TIMES)**

The New York Times

Pave Over the Subway? Cities Face Tough Bets on Driverless Cars

Transit advocates fear that unrealistic hopes for new technology — and how soon it'll get here — could lead cities down the wrong path.



By Emily Badger

July 20, 2018



A quiet moment on the New York subway. Because it's so hard to predict the future of transit, some technologists feel a key is to keep options open by laying concrete and letting innovators design what rides on top of it. By definition, rail precludes all possibilities other than a train. Edu Bayer for The New York Times

Autonomous vehicles that will outperform buses, cost less than Uber and travel faster than cars stuck in traffic today are two years away. Or 10. Or 30.

But visions of the future they'll bring have already crept into City Council meetings, political campaigns, state legislation and decisions about what cities should build today. That unnerves some transportation planners and transit advocates, who fear unrealistic hopes for driverless cars — and how soon they'll get here — could lead cities to mortgage the present for something better they haven't seen.

“They have imbued autonomous vehicles with the possibility to solve every problem that was ever created in transportation since the beginning of time,” said Beth Osborne, a senior policy adviser with the advocacy group Transportation for America. “That might be a tad bit unrealistic.”

In Indianapolis, Detroit and Nashville, opponents of major transit investments have argued that buses and trains will soon seem antiquated. In Silicon Valley, politicians have suggested something better and cheaper is on the way. As New York's subway demands repairs, futurists have proposed paving over all that rail instead for underground highways.

Autonomous cars have entered policy debates — if not car lots — with remarkable speed. And everyone agrees that making the wrong bets now would be costly. Cities that abandon transit will come to regret it, advocates warn. Driverless car boosters counter that officials wedded to “19th-century technology” will block innovation and waste billions.

“We are definitely going to have pushback,” said Brad Templeton, a longtime Silicon Valley software architect who preaches the potential of “robocars.” (He believes the subway paved over in concrete for autonomous vehicles could transport more passengers than rail can.) “I regularly run into people who even when they see the efficiency numbers just believe there is something pure and good about riding together, that it must be the right answer.”

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His advice to cities: “Infrastructure plans for 2030 are sure to be obsolete.”

In some ways, this is a choice we've faced before. The marketing simulations at autonomous car conferences remind Jeffrey Tumlin, a transportation consultant, of Futurama, the 1939 World's Fair exhibit sponsored by General Motors that introduced the public to a future of "magic motorways."



"Nothing has changed at all," said Mr. Tumlin, a principal with the firm Nelson\Nygaard. "It is the 1939 World's Fair, and it is so exciting. There's the model, and traffic is flowing smoothly. And there's this promise of limitless free mobility."

'Please, Please, Please, Please Don't'

If you believe that autonomous cars will compete with transit rather than complement it — or that autonomous ride-hailing will give cities that never built transit something like it — there is appeal in holding out now.

"Don't build a light rail system now. Please, please, please, please don't," said Frank Chen, a partner with the venture capital firm Andreessen Horowitz. "We don't understand the economics of self-driving cars because we haven't experienced them yet. Let's see how it plays out."

Theoretically, when companies like Uber and Lyft no longer have to pay drivers, rides could be as cheap as bus fare. And when autonomous vehicles platoon, they could squeeze more capacity and speed out of roadways, eroding some of the timesaving advantages of railways.



A light rail car in Minneapolis. Rail remains the most efficient way to move large numbers of people, despite the promise of driverless cars. Tim Gruber for The New York Times

Technologists also draw an analogy to the internet, infrastructure that was conceived to be simple and uniform, compatible with any application. The intelligence lay in what was built *on* the internet, not the internet itself. For cities, Mr. Templeton suggests this means “smart cars and stupid roads.” Just lay concrete and let innovators design what rides on top of it. By definition, he said, rail precludes all possibilities other than the train.

Inherent in this idea is the fear that cities will lock in the *wrong* future, or that they’ll prevent better ideas from arriving. They’ll bet, for example, on docked bike-sharing systems, and then be caught off-guard when dockless scooters arrive.

“I get very nervous when city planners or municipal bus operators are making technology bets,” Mr. Chen said. “That’s hard enough for us, and we live and die by the quality of the technology bets we make.”

Public transportation agencies can certainly be inflexible. Frank Martz, the city manager of Altamonte Springs, Fla., envisioned a service in the late 1990s that was basically Uber before smartphones. He wanted to allow riders to use computers or kiosks to order smaller vehicles with optimized routes. The local transit agency struggled to bring his idea to life.

“They just could not think about anything other than buses and bus lanes, and drivers and unions,” Mr. Martz said. “They could not think about the user.”

This month, Altamonte Springs finished a two-year pilot offering discounts on Uber rides instead, a model that appeals to the belief that private companies can provide these services better anyway.

“I expect by 2030, most transit agencies are going to be zombie agencies that exist mainly to collect taxes from people to pay down their debt,” said Randal O’Toole, a senior fellow with the libertarian Cato Institute who blogs, provocatively, as “The Antiplanner.” In the meantime, he argues that cities should put no new money into infrastructure.

He acknowledged that he believed transit was wasteful for taxpayers long before everyone got excited about driverless cars. But now he and others who say no to transit also have something positive to say. *Something better is coming.*

Las Vegas Isn’t in a Gambling Mood

Las Vegas has been preparing to build precisely the thing these critics say they shouldn’t: the region’s first light rail line. The city is running several autonomous pilots, too, but officials aren’t sold on the imminent driverless future.

“It’s very easy to get caught up in these sensationalized visions,” said Tina Quigley, general manager of the Regional Transportation Commission of Southern Nevada. “Some of these visions may eventually come to fruition. But we are not talking about them happening in the next five years even, some of them in the next 10 years.”

Many potential benefits of driverless cars won't kick in until there is mass adoption. Even in that distant future, Ms. Quigley said, there simply won't be enough space in the busiest corridors for everyone to ride in an autonomous vehicle.



A driverless shuttle making a stop at the University of Michigan in Ann Arbor, where two of the vehicles were put into service this summer. Paul Sancya/Associated Press

Highways today can carry about 2,000 cars per lane per hour. Autonomous vehicles might quadruple that. The best rail systems can carry more than 50,000 passengers per lane per hour. They move the most people, using the least space. No technology can overcome that geometry, said Jarrett Walker, a Portland-based transportation consultant.

“Let’s talk about what we can predict,” he said. “The problem of the city is a problem of sharing space. In 2100, the problem of the city will still be a problem of sharing space.”

By that logic, cities should invest even more in high-capacity rail and dedicated bus lanes in key corridors. Autonomous vehicles might handle other kinds of trips — rides from the train station home, or through suburban neighborhoods, or across the parts of Las Vegas without rail.

This possibility is not radically different from today. Uber and Lyft offer the closest approximation to how people will behave in an autonomous future, when consumers use cars they don't own. Both companies are frequently cited by opponents of transit. But they also now back big transit investments, without which their riders in congested cities would be stuck in even worse traffic.

No system of autonomous cars could be more efficient than the New York subway, said Andrew Salzberg, Uber's head of transportation policy and research. Uber needs that transit, just as it will need electric scooters and bikes and the congestion pricing it also supports in New York to ensure that cheaper transportation doesn't simply lead to more traffic.

The efficiency that autonomous vehicles promise is more likely if people share them — and don't use them for every trip.

Cities fixated on that future, however, could be making another risky bet. New forms of transportation like Uber and Lyft are heavily subsidized by venture capital today, and so cities that expect private services to replace public transit are counting on those subsidies, too. They're betting that driverless cars will get here, changing the economics of transportation, before the venture capitalists lose patience.

Emily Badger writes about cities and urban policy for The Upshot from the San Francisco bureau. She's particularly interested in housing, transportation and inequality — and how they're all connected. She joined The Times in 2016 from The Washington Post.
@emilymbadger

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ATTACHMENT 7

**AS CARS COLLECT MORE DATA, COMPANIES TRY TO MOVE IT
ALL FASTER (THE NEW YORK TIMES)**

WHEELS

As Cars Collect More Data, Companies Try to Move It All Faster

By John R. Quain

Aug. 16, 2018

Cars need to get faster — not on the road, but on the inside.

Speed has always been part of the mystique of the automotive business. But cars have been notoriously slow when it comes to handling information. It is a problem that has only become more pressing as the era of autonomous vehicles looms, with competing interests racing to be the first with a solution.

Cars have long relied on a relatively simple network standard called the CAN or Controller Area Network bus. The CAN bus coordinates all the microprocessors and electronic control units, or E.C.U.s, that need to trade engine, powertrain, and diagnostic information, transmitting details like transmission status and fluid levels. As more electronics like window and seat controls were added to cars, the CAN bus was tweaked over the years with additional local interconnection networks, or LINs, to handle the swelling communications load.

But the CAN bus, which was originally developed by Bosch more than 33 years ago, is showing its age.

New advanced driver assistance systems like automatic emergency braking, electronic stability control and lane-keeping assistance demand instant communications. So automakers have been supplementing their networks, adding 100 megabit per second (Mbps) Ethernet cabling, for example, to the rat's nest of wiring inside vehicles.

"But when every new feature gets added, you add a new E.C.U. and a new layer of wiring," said Jack Weast, the chief systems architect for autonomous driving solutions at Intel. That approach is inefficient, expensive, heavy — and still slow. "So from a connectivity point of view there's a need to re-architect the vehicle from the inside out," Mr. Weast said.

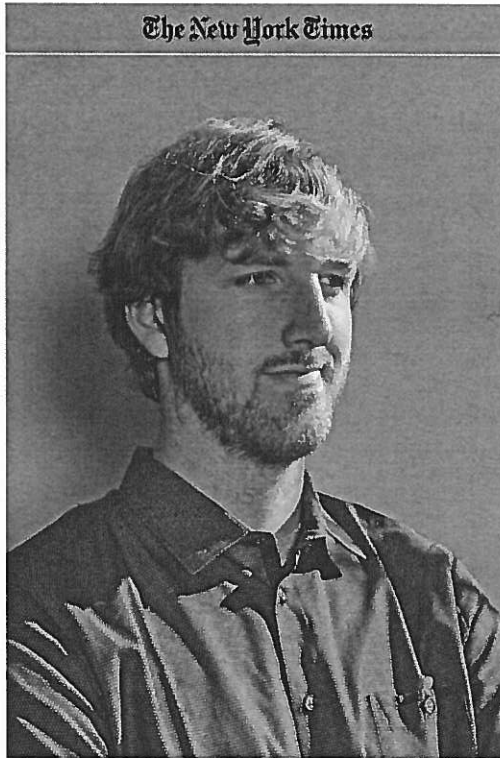
Underscoring the urgency for a new high-speed network in cars is the coming wave of autonomous driving systems.

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A test drive through congested Manhattan streets with Austin Russell, chief executive of the lidar company Luminar, demonstrated just how much more data is going to be generated inside self-driving vehicles. Prowling the Upper West Side, a car fitted with Luminar's lidar system, which uses near-infrared light to detect objects around it, created high-resolution scans of thousands of data points 10 times a second, painting a 3-D picture of cyclists, pedestrians, street vendors and even dogs up to 800 feet ahead.

BUSINESS

The New York Times



"You have to have ridiculous, super-human sensors to make up for the fact that computers aren't nearly as smart as humans — and won't be for a very, very long time," said Austin Russell, chief executive of Luminar.

Cayce Clifford for The New York Times

"You have to have ridiculous, superhuman sensors to make up for the fact that computers aren't nearly as smart as humans — and won't be for a very, very long time," said Mr. Russell, as the car's sensor swept the crowded blocks ahead on Central Park West.

That means more sensors — and more data. Experimental designs for autonomous cars incorporate as many as 16 video cameras, 12 radar sensors, half a dozen ultrasonic sensors, and four or five lidar sensors. And still more sensors and scanners might be necessary to make self-driving cars impervious to exigencies like blinding blizzards and soaking downpours.

"We have seen an explosion in data bandwidth," said Lee Bauer, a vice president at Aptiv, a supplier of autonomous and driver-assistance systems. Mr. Bauer cited what has become a mantra among autonomous vehicle engineers: Self-driving cars will generate 4 terabytes of data per hour. That includes live information about road conditions, weather, objects around them, traffic and street signs — all of which has to be shared among components in the car and used to make split-second driving decisions.

Automakers are aware of the coming data tsunami.

"They think we need 300 teraflops of computing power," said Willard Tu, a senior director at chip supplier Xilinx. A teraflop is a trillion operations per second, which means that every vehicle would be a rolling supercomputer. "So the type of pipe and the diameter of that pipe" that is going to connect all these components, Mr. Tu said, "has to be very flexible." Estimates for how big that pipe needs to be range from 25 to 40 or more gigabytes per second.

The catch? "No one's solved the problem of how do I stream all that data to the central processor?" said Mr. Tu.

While engineers and automakers agree that today's cars need to be completely rewired, the question for many is, with what?

Eliminating the cables entirely by using a short-distance wireless system would be the easiest way to bridge the gap.

However, wireless systems are susceptible to radio frequency interference, which could affect reliability and endanger lives. And wireless systems are more vulnerable to security threats, said Mr. Weast of Intel.

Optical fiber offers some of the highest speeds and lightest cabling. But fiber is expensive and fragile; humidity, vibration, and dust in its connectors can all lead to signal loss, said Amir Bar-Niv, a spokesman for semiconductor firm Aquantia. Some luxury brands have tried optical fiber with mixed results. "So automakers have said they are not going to have fiber in the car," he said.

Experimental designs for self-driving cars use four or five lidar sensors, like this one from Luminar, in addition to a raft of other technologies. Cayce Clifford for The New York Times

By far the most popular candidate for a car's internal network wiring is still copper. Although copper faces some challenges transmitting high-speed data over long distances, the lengths required in most cars are relatively short, and automakers have decades of experience working with it.

Perhaps more important than the physical cabling is the type of network protocol cars should use to speed up the flow of information. The most common local area network protocol is Ethernet, the same format that has been a business and home networking standard for decades. But most current Ethernet networks typically have a top speed of 1 gigabit per second (Gbps) — not fast enough to handle the torrent of data that an autonomous vehicle would produce.

To help speed things up — and encourage the use of Ethernet — several companies recently formed the Networking for Autonomous Vehicles Alliance. The NAV Alliance includes leading parts and systems suppliers like Bosch and Continental, as well as the chip makers Nvidia and Aquantia — and the world's largest automaker, Volkswagen. The goal is to get the industry to coalesce around a faster Multi-Gig Automotive Ethernet network standard with initial proposed speeds of 2.5 Gbps and eventually 10 Gbps.

There are other contenders to rewire the automotive industry, however, such as HDBaseT. Initially developed to handle high-resolution video and audio, HDBaseT can also transmit power and Ethernet-based communications — up to 6 Gbps — over unshielded copper cables. Developed by Valens, HDBaseT has garnered support from major consumer electronics companies, including LG Electronics, Sony, and Samsung Electronics, which has also been investing heavily in autonomous car technology. HDBaseT's supporters also believe updated versions will quickly reach speeds of 20 Gbps and 40 Gbps.

There's a potential windfall for whoever wins the race to bring high-speed networks to cars, which will create a market for millions of new connecting chips, gateways, and controllers to support the new standard. It's what companies like Aquantia, Valens, and Xilinx are hoping for.

Flexibility may ultimately be the deciding factor. The old CAN and LIN networks aren't likely to be abandoned soon, said Bobby Hambrick, chief executive of AutonomouStuff.

"The CAN bus will be used for really basic stuff and LIN will control the horn or blinkers because the chips for those are really cheap," said Mr. Hambrick, whose company builds autonomous car platforms, including the open-source Apollo platform from the Chinese firm Baidu. Any new high-speed Ethernet or HDBaseT network, he said, will have to be backward compatible with those systems.

Furthermore, the components and sensors needed for self-driving cars and trucks — and how all that information should be managed and interpreted — is far from set in stone. Most companies haven't committed to particular types of cameras or lidar sensors for their future autonomous cars, so any new network will have to accommodate a variety of components.

"I go to two carmakers, and I get three different opinions" about what kind of system they want, Mr. Bar-Niv said. "But they all want a high-speed network."

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