Greater Philadelphia

FUTURE FORCES

Technical Report

CONNECTIONS 2045

DELAWARE VALLEY dvrpc REGIONAL PLANNING COMMISSION

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DELAWARE VALLEY dvrpc REGIONAL PLANNING COMMISSION

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GREATER PHILADELPHIA FUTURE FORCES SUMMARY

Regions around the world face an increasingly uncertain future. Scenario planning can help to better understand how emerging trends may create new challenges and opportunities. This effort builds scenarios from a set of Future Forces of change in Greater Philadelphia. Future Forces may accelerate or reverse current trends, or create new ones that significantly impact the demographics, development patterns, use of the regional transportation system, economy, and/or the natural environment in Greater Philadelphia. Part I shows how these Future Forces were collaboratively identified by the interdisciplinary Futures Group consisting of regional stakeholder experts:

Millennials and empty nesters moving back to walkable urban centers are the start of a long-term trend, as future generations show an even stronger desire for city living and walking, biking, and transit.

Individuals must create their own economic opportunities and contribute more to their healthcare and retirement, as labor efficiency and the rising cost of full-time employees cause large companies to continue to reduce their workforces.

Increasing atmospheric carbon levels, due to continued global use of fossil fuels, lead to significant disruptions from climate change. The region must prepare for hotter and wetter weather, more frequent and intense storms, and rising sea levels.

Smartphones, apps, and real-time information help people get around using a multimodal network of car sharing, taxis, ride sharing, transit, biking, bike sharing, walking, and new modes such as on-demand micro transit bus service and ride sourcing, where a vehicle is e-hailed for a point-to-point trip.

The region's economy grows with domestic natural gas extraction and distribution, and renewed manufacturing. An abundance of domestically produced energy keeps the cost of energy low and helps the region and the nation become more energy independent.

In Part II, the Future Forces are modeled and analyzed as "what-if" scenarios out to the year 2045. This highlights how the region may change over the next 30 years, looks at potential shifts in travel demand, and identifies specific opportunities and challenges that may arise. Part III then recommends actions and workforce skills needed to better position the region to respond to these Future Forces. Universal actions are beneficial regardless of which Future Forces come to fruition.

Universal Actions

- ☐ Update zoning codes to allow for mixed-use infill development.
- ☐ Build lifelong communities that facilitate aging in place.
- ☐ Encourage immigrant-friendly policies.
- ☐ Implement universal pre-kindergarten and other programs to improve k-12 educational outcomes.
- ☐ Use green infrastructure and stream buffer ordinances to improve water quality and livability.
- ☐ Promote megaregional collaboration and cooperation.
- ☐ Create regional or local big data team(s) to centralize and analyze datasets, guide decision making, and enhance government actions.
- ☐ Expand regional broadband infrastructure; and internet access and training for low-income individuals.
- ☐ Develop the impact economy, which uses a profit motive, public-private partnerships, and nonprofits to address economic, environmental, and social issues.
- ☐ Create a modern multimodal transportation system and a regional funding source to help pay for it.
- ☐ Enhance freight and goods movement.
- ☐ Carry out Vision Zero plans, which set a goal of no roadway fatalities.
- ☐ Improve infrastructure resiliency.

Contingent actions are specific to each Force, and leading indicators (see Appendix B) can help determine if a force is occurring in the region. As not all these actions can be implemented, the region must carefully weigh the costs and benefits of each, and prioritize the most critical for implementation.

Contingent Regional Actions

- ☐ (Re)develop without displacing existing households, allow for more multi-family housing.
- ☐ Thoroughly implement Complete Streets to accommodate all users, including goods movement, along with protected bike lanes, pedestrian-only areas, and shared space/living streets concepts that prioritize bike and pedestrian use, particularly in the region's centers.
- ☐ Expand and increase service frequency throughout the transit system.
- ☐ Retrofit office parks and commercial districts into dense mixed-use communities, update design guidelines with form-based zoning, and relax parking requirements.
- ☐ Protect industrial zones.

- ☐ Expand and support regional business incubators and accelerators, and small business and entrepreneurial training programs.
- ☐ Simplify business tax collection, licensing, and permitting, and ensure regulations do not unnecessarily restrict the pop-up economy.
- ☐ Increase transit service during off-peak hours and improve intra-suburban service and service to suburban office parks.
- ☐ Update zoning codes to allow for shared office space and mixed-use buildings.
- ☐ Build more middle-class housing units in urban areas, and foster regional cooperation for reducing poverty and homelessness.

- ☐ Increase interagency and intergovernmental coordination around climate change issues.
- ☐ Pursue climate change adaptation strategies, such as identifying and protecting vulnerable assets, updating building codes and floodplain ordinances for more extreme weather, building levees to protect key development areas, preserving and extending wetlands, increasing water storage, improving emergency preparedness, and developing a flood detour system for freight routes.
- ☐ Continue to reduce greenhouse gas emissions at the regional, local, firm, and household level.
- ☐ Preserve agricultural land and take other measures to increase regional food production.
- ☐ Continue to invest in, and make the region into an alternative energy and clean-technology hub, and accerate the move to lower-carbon electricity production.

- ☐ Promote coordination between public and private transportation operators to achieve a connected transportation system of complementary modes through singular fare payment instruments and multimodal travel information apps, developing multimodal transportation hubs, and information-sharing and open-data agreements.
- ☐ Incentivize public–private partnerships, private firms, or nonprofits to speed up project delivery and incorporate new technologies.
- ☐ Use traffic calming and protected bike lanes to diversify the transportation system, safeguard nonmotorized users, and discourage through-traveling vehicles on local roads.
- ☐ With declining vehicle ownership, prepare evacuation plans to move more carless households.
- ☐ Legalize ride-sourcing and micro-transit services, while requiring drivers to have commercial insurance, undergo background checks, and remit applicable local, state, and federal taxes, and identify ways to increase low-income individuals' access to jobs through these services.
- ☐ Ensure that new transportation technologies and services are accessible to individuals with disabilities and families with small children.

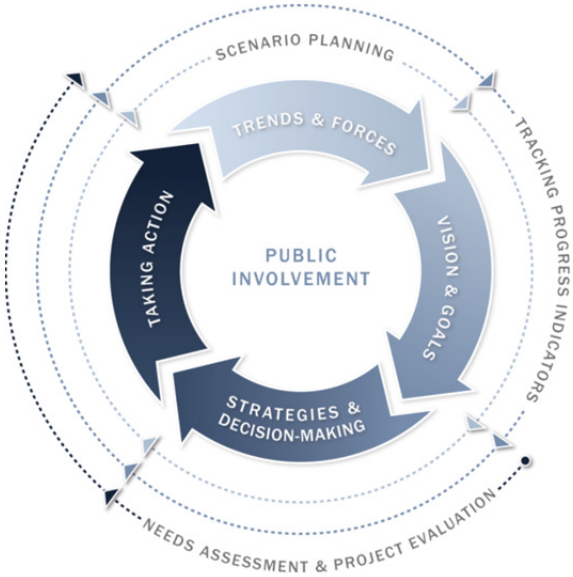
- ☐ Work with the refineries, port facilities, pipeline operators, and freight railroads to promote safety, clean air, and *freight as a good neighbor* initiatives within facility host communities, on National Highway System connector roads, and at key highway-railroad grade crossings and railroad bridges.
- ☐ Market the region internationally as an energy hub to encourage companies to relocate here for natural gas opportunities.
- ☐ Use natural gas as an intermediate energy source until clean energy technology matures, and continue to invest in regional alternative energy research and development, both to soften any potential energy boom crash and to diversify economic growth.
- ☐ Ensure personal safety, environmental risks, and public health impacts are considered in any benefit-cost analysis for investing in pipelines and other freight infrastructure.
- ☐ Add capacity on Airport Line to accommodate increasing passenger and freight demand.
- ☐ Convert municipal and goods movement vehicle fleets to run on natural gas.

PART I. FUTURE FORCES OF CHANGE

Regions around the world currently face major challenges, such as adapting transportation and other infrastructure systems to changes in climate, incorporating new technologies, and adjusting to shifting population and job locations. These are a few examples of broader social, technical, economic, environmental, and political (STEEP) trends that can create sudden and rapid change (see Figure 1). They are generally beyond the control of a government, business, or other organizations. Current events often create a bias toward specific STEEP impacts; however, these may impact only the short-term and may not be long-term game changers. To better understand how different forces will impact the future, Delaware Valley Regional Planning Commission (DVRPC) convened the Greater Philadelphia Futures Group, with representatives from academia, the private sector, nonprofit organizations, and government. Areas of expertise included economics, land use, the environment, public health, transportation, technology, and environmental justice (EJ), among others.

Figure 1. Future Forces Will Impact Core Long-Range Planning Areas

Figure 2. DVRPC Long-Range Planning Process



Source: DVRPC, 2016.

To prepare for an increasingly uncertain future, DVRPC uses scenario planning to better understand potential needs and challenges, and to guide the development and implementation of the region's Long-range Plan. Integrating scenarios into the planning process is part of a comprehensive management system, which also includes strategy development and performance monitoring to guide decision making (see Figure 2). This effort is intended to help further the Long-Range Plan's vision for a more equitable, sustainable, and innovative Greater Philadelphia.

The Futures Group met throughout the fall of 2014. The first two meetings brainstormed potential Future Forces that could affect the Greater Philadelphia region over the next 30 years. The initial meeting identified 31 forces. This list was revised and reduced to 17 during the second meeting. Futures Group members and DVRPC's Regional Technical Committee (RTC) then voted online for the impact and likelihood of each of these 17 forces of change.

Future Forces Voting List

1. Automation Nation

3-D printing, robotics, and other emerging labor-saving technologies flatten global manufacturing costs.

2. Confronting Climate Change

Pressure from urban areas, major corporations, and the Intergovernmental Panel on Climate Change (IPCC) grows the political will to significantly reduce carbon emissions through regulation and changing consumer preferences.

3. Enduring Urbanism

Urban locational preferences of millennials and empty nesters are just the start of a long-term trend, as future generations show an even stronger desire for city living and alternative transportation.

4. The Free Agent Economy

Individuals must increasingly create their own economic opportunities, as gains in labor efficiency and the escalating cost of full-time employees cause large companies to continue to reduce their workforces.

5. Intelligent Infrastructure

There are rapid advances in infrastructure technology, through 3-D printing, low-cost sensor technologies, road-embedded information technology (IT) and energy collection and distribution, nanotechnology, and stronger composite materials. The next generation of smart grids, micro grids, and distributed energy generation helps to make energy delivery more efficient.

6. Keeping up with the Joneses

The growing global middle class increases demand for finite supplies of energy and raw materials, leading to rapidly rising prices for them.

7. Megaregional Mobility

Improved service and speeds on Amtrak's Northeast Corridor improves access between major cities and airports in the megaregion.

8. Netvolution

Virtual reality, the Internet, and communications technologies disrupt current practices in education, medicine, and business as people become untethered from geographic location.

9. New Cures for All That Ails

Technology has advanced medicine into new frontiers: 3-D printers can make prosthetic or even replacement body parts; gene therapy, digital biology, and altering of genetic materials lead to improved treatments for many diseases.

10. Partisan Paralysis

Partisan politics and fiscal austerity hamper governmental effectiveness at all levels. Increasing personal, business, and government debt levels limit willingness to fund major new investments, public or private.

11. Putting the Ship Back in Shipping

As ever-larger ships (which Greater Philadelphia cannot currently serve) significantly reduce shipping costs relative to truck and rail, water-based transportation becomes the mode of choice for goods movement.

12. Sabergovernmetrics

Use of big data and better decision making help all levels of government become smarter and more efficient.

13. Robocars

Self-driving cars, trucks, and buses rule the region's roads. Thanks to their road safety and capacity enhancements, they constitute around half of the region's vehicle fleet by 2045.

14. Sharing a Lyft

Convenient ride-sourcing services, such as Uber, Lyft, and Sidecar, grow in popularity and capture a substantial portion of the trips taken in the region.

15. Severe Climate

Ever-increasing greenhouse gas emissions lead to the worst-case outcomes of climate change. The region must prepare for hotter and wetter weather, more frequent storms, and rising sea levels.

16. Transportation on Demand

Smartphones, apps, and real-time information help transportation system users seamlessly navigate a multimodal network of car sharing, taxis, ride sharing, transit, biking (including e-bikes and other small electric vehicles), bike sharing, and walking to get around.

17. The U.S. Energy Boom

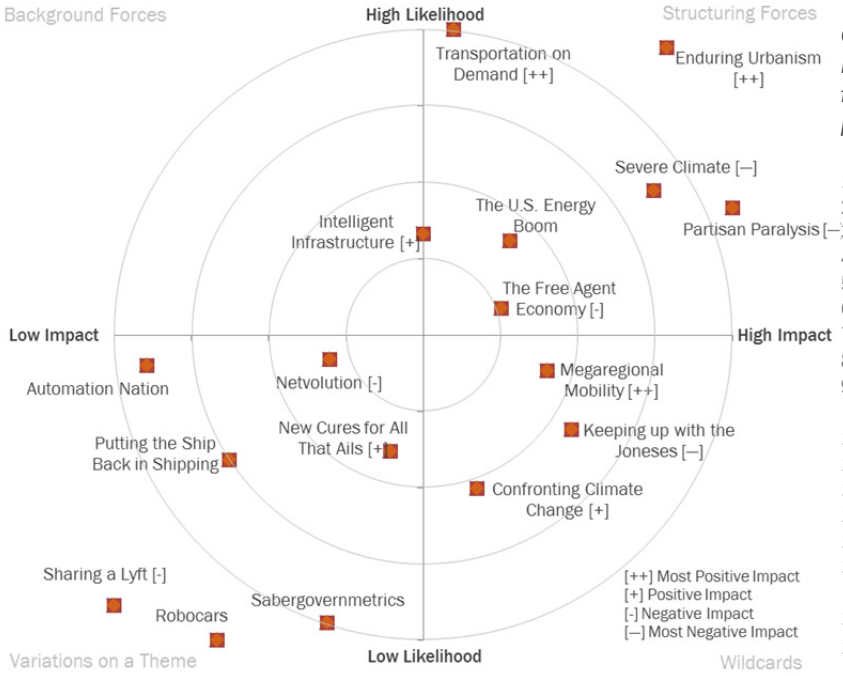
The region's economy grows with natural gas production and especially benefits from removing restrictions on petroleum exports. An abundance of domestically produced energy its cost low and helps the nation to become more energy independent.

Each Futures Group and RTC member had one vote, verified by e-mail address. The survey asked each respondent to identify which five forces were the most likely to happen, were the least likely to happen, would have the most positive impact on Greater Philadelphia, and would have the most negative impact.

A total of 62 votes were received. The force voted most likely to occur was given a score of 1, the second most likely 0.9, the third 0.8, the fourth 0.7, and the fifth 0.6. The forces voted most unlikely to happen were given the same scores negatively (i.e., the least likely to happen received a score of –1). Those forces that were neither in the top five nor bottom five were given a score of zero. The same scoring method was carried over to the impact votes. The absolute value was used to determine

the overall impact of the driving forces, regardless of whether it was rated positive or negative. The results, showing overall impact, are presented in Figure 3.

Figure 3. Futures Group Impact-Likelihood for Each Voting List Force



The results of the Futures Group survey ranked each Future Force from most positive for the region (#1) to least positive for the region (#17):

1. Enduring Urbanism
2. Megaregional Mobility
3. Transportation on Demand
4. Intelligent Infrastructure
5. New Cures for All That Ails
6. Confronting Climate Change
7. Sabergovernmetrics
8. The U.S. Energy Boom
9. Putting the Ship Back in Shipping
10. Robocars
11. Automation Nation
12. Sharing a Lyft
13. Netvolution
14. The Free Agent Economy
15. Keeping up with the Joneses
16. Severe Climate
17. Partisan Paralysis

Source: DVPRC 2014

The voting results are classified into one of four categories based on their likelihood and impact. Structuring forces are those potential futures that have a high probability of occurring and a high impact, either positive or negative. These are the focus of this analysis. Background forces may be incorporated as near certain changes into all the scenarios analyzed. Variations on a theme generally didn't receive additional consideration here due to their low likelihood and impact, but may reveal blind spots in our thinking. Wildcards have low likelihood, but high impact, and may also be of interest for further analysis. The most significant Future Forces identified are:

Millennials and empty nesters moving back to walkable urban centers are the start of a long-term trend, as future generations show an even stronger desire for city living and walking, biking, and transit.

Individuals must create their own economic opportunities and contribute more to their healthcare and retirement, as labor efficiency and the rising cost of full-time employees cause large companies to continue to reduce their workforces.

Increasing atmospheric carbon levels, due to continued global use of fossil fuels, lead to the significant disruptions from climate change. The region must prepare for hotter and wetter weather, more frequent and intense storms, and rising sea levels.

Smartphones, apps, and real-time information help people get around using a multimodal network of car sharing, taxis, ride sharing, transit, biking, bike sharing, walking, and new modes such as on-demand micro transit bus service and ride sourcing, where a vehicle is e-hailed for a point-to-point trip.

The region's economy grows with domestic natural gas extraction and distribution, and renewed manufacturing. An abundance of domestically produced energy keeps the cost of energy low and helps the region and the nation become more energy independent.

Partisan Paralysis was another structuring force, which did not have as clear of a direct impact as the other top vote-getters. As a result, it was put into the background forces along with Intelligent Infrastructure. Background forces are incorporated into all of the scenarios, unless contradicted by a specific element within a Future Force. This left five scenarios, the maximum number recommended in best practice guidance for scenario planning. The third and final in-person meeting of the Futures Group consisted of a brief overview of the Future Forces, followed by a discussion group for each force that considered the following questions:

- ☐ What are the likely outcomes of this Future Force?
- ☐ What action steps can the region take to accentuate the positive and to weaken the negative outcomes?
- ☐ What should be our regional transportation investment priorities based on this driving force?

This discussion produced a variety of opinions about each force, identifying a range of different outcomes. Frequently, there were dissenters who pointed out valid reasons as to why a Future Force may not happen. Similar meetings were conducted with DVRPC's RTC, Public Participation Task Force, Environmental Justice Working Group, Goods Movement Task Force, and Healthy Communities Task Force. As a result of these meetings, elements from some of the other voting list forces that wound up in the wildcard or variations on a theme categories were incorporated into the Future Forces. These discussions informed the Future Forces and what they could mean for Greater Philadelphia, and what the region should do to strategically prepare for them. Information identified in these meetings was used to help draft "what-if" scenarios that result from the Future Forces over the next 30 years.

Where's my Driverless Car?

Daily news articles about the imminence of autonomous vehicles (AVs) make them the 800-pound gorilla in the room. AVs drive themselves using computers, cameras, and sensors and may see wide adoption in the next 5 to 50 years. By taking the driver out of the equation, AVs could improve safety and traffic flow, increase vehicle trips, reduce per-mile emission rates, change how we design roads, revolutionize the trucking industry, and allow for more in-vehicle free time. If AVs are operated as shared vehicles, they may substantially reduce car ownership. However, AV deployment may be slowed by cost, liability, rate of integration into the overall fleet, or regulatory concerns. There are still issues with the technology, which may require significant advances in artificial intelligence and cyber security. The Futures Group was skeptical that AVs will comprise a significant portion of the total fleet within the next 30 years. However, the Transportation on Demand scenario does consider potential impacts of autonomous vehicles, which are assumed to comprise 30 percent of the vehicle fleet in this future.

The Futures Group also considered how other transportation technologies and new services are evolving. In Boston and Washington, DC, a private bus company, Bridj, is using big data to identify routes that fill gaps in market demand. Las Vegas 100 plans to offer an unlimited mobility on-demand service for a monthly fee, by combining a smartphone app with a variety of transportation options: ride-source vehicle, car share, bike share, and buses. Services such as these are seen as more likely to become widespread and impactful over the next 30 years, and are also explored in Transportation on Demand.

Background Forces

The Futures Group also identified some key Background Forces. They are based on ongoing trends that are likely to also impact the future, but to a lesser degree than the Future Forces. Unless a Future Force specifically counteracts these trends, they are assumed to continue to occur in the future. Identified Background Forces include:

- **Partisan paralysis** due to the inability to compromise and ongoing fiscal austerity hamper governmental effectiveness at all levels. Increasing personal, business, and government debt levels limit the willingness to fund major new investments, public or private. Gerrymandering has created many one-party districts. This has produced a situation where many elected officials have a greater fear of a primary challenge from a more extreme ideological candidate in their own party, than from the other party in a general election, and has reduced willingness to compromise. This suggests the region should look internally for solutions, and not wait for action from federal and state governments.
- **Intelligent infrastructure** is achieved through rapid advances in technology, such as 3-D printing, low-cost sensor technologies, road-embedded IT and energy collection and distribution, nanotechnology, and stronger composite materials. The Internet of Things (IoT) ties infrastructure together, creating new symbiotic relationships and more efficient maintenance and operations. The next generation of smart grids, micro grids, and distributed energy generation help to make energy delivery more efficient.
- **Connected vehicles** use wireless broadband and sensors to communicate with each other and roadway infrastructure to substantially increase road safety and improve the flow of people and goods.
- **Healthcare technologies** such as gene therapy, digital biology, nanotechnology, and 3D-printed body parts are helping people live longer. Telemedicine is expanding service, and wearable devices are expanding the data available to track health. For some lower income individuals, however, chronic health conditions will continue to reduce quality of life.
- The **aging population** will place additional burdens on all levels of government and nonprofits, which are all already stretched thin. Most boomers prefer to age in place where they have roots, but these areas are often poorly equipped to accommodate people with mobility impairments.
- **The sharing economy** will grow with more people finding it easier to rent things when needed than to own them, and needing to provide for storage and maintenance.
- Increasing **demand for same-day delivery**. This will require more overnight deliveries and strategically located consolidation centers (where multiple shippers bring goods into an area, and a single truck delivers them). AVs, ride-sourcing services, or delivery drones may also help meet the demand.
- **Improving freight logistics** will be done with more efficiency on the one hand, but also with more redundancy, which can increase costs. The mobility platform within the IoT will coordinate between smart infrastructure and connected vehicles to improve the real-time flow of people and goods.
- **School quality** will continue to drive family locational decisions for those who can afford better performing school districts.
- **Increasing immigration** will lead to a larger population, workforce, and economic growth.
- **Water quality** will continue to degrade due to inadequate stormwater management.
- **Panama Canal widening** increases goods movement in the region, with more small ships coming to port here as they are pushed out of nearby deep-water ports that are operating at capacity.
- Some degree of **climate change** is already baked in, with increasing economic impacts as temperatures begin to rise, storms increase in frequency, and there is more rainfall.
- **Flat or declining transportation funding levels**, as the Federal gas tax currently takes in about $35 billion dollars in revenues annually, with $55 billion in expenditures. The region is overly reliant on federal funding, which accounts for about 55 percent of total regional funding. Meanwhile, increasing vehicle fuel efficiency in the future is likely to further reduce revenue collections.
- **Declining infrastructure condition**, including transportation, water and sewer, electric, natural gas, and public buildings and facilities, will continue due to decades of disinvestment and deferred maintenance. At current funding levels, it is unlikely the region will attain many of the performance measure goals set in the Moving Ahead for Progress in the 21st Century (MAP-21) federal transportation legislation.

PART II. WHAT-IF SCENARIOS

"As public institutions, state DOTs must evolve and adapt to changing travel demand, emerging technologies, current policy priorities, and shifting external economic and development patterns."

—NCHRP Report 750 Strategic Issues Facing Transportation – Volume 5. Preparing State Transportation Agencies for an Uncertain Energy Future

This effort is forward looking, helping the region, in the words of hockey legend Wayne Gretzky, "skate to where the puck will be." To do this, each Future Force is carried out over the next 30 years as a what-if scenario to consider how it may reshape the region. Scenario planning is a tool for collaboration. By bringing together a diverse group of stakeholders to identify likely futures, it presents an opportunity for collective learning. It can be used to change perceptions, deal with uncertainty, and improve strategic decision making. The goal of scenario planning is not to get the future exactly right, but rather to identify intermediate actions that should be undertaken in order to make the most strategic decisions. This effort does not try to identify a "preferred" scenario for the future. DVRPC researched scenario planning best practices and published key findings in *The Future of Scenario Planning* (DVRPC publication #14038). *Connections 2045: Greater Philadelphia Future Forces* is the result of the process identified in the white paper.

The Future Forces what-if scenarios were developed based on Futures Group dialogue along with research documented in Appendix C. The scenarios consider likely potential outcomes of each force as they play out over time in the region given the best information we have available in the present. The Futures Group was surveyed for key assumptions in population, employment, income levels, vehicular fuel efficiency, and the cost of a gallon of gasoline (or equivalent energy source, if different in the future) in 2045. The results are shown in Table 1, and were used in scenario development and modeling. Table 1 summarizes what is expected to happen, if each scenario was to come to fruition. However, each force could go in many different directions over the next 30 years. The outcomes identified within these scenarios are often the less optimal ones. In Part III, the report identifies actions that would lead to better results. Some key caveats apply:

- The scenarios assume no major changes in federal legislation, unless otherwise stated. So something like the Affordable Care Act is neither repealed nor replaced with a single-payer system (this is consistent with 'partisan paralysis' as a background force).
- The analysis accounts for likely and widely predicted advances in technology. It does not account for the possibility that new, previously unthought-of, or seemingly unfeasible technology arises within the next 30 years, such as teleportation or energy generated by nuclear fusion.
- Existing technologies that have not proven to be commercially viable, such as personal rapid transit, are assumed to continue to remain so.
- Generally stable long-term relationships continue as they are, unless specifically changed by a Future Force. For example, working from home has been about four percent of workers despite predictions that telecommuting would substantially increase over the past several decades. No scenario assumes 50 percent of workers will telecommute, unless a Future Force suggests this is a possibility.

The Future Forces identified in this report identify key trends that could lead to drastically different futures than the status quo. Each force could move along a number of different trajectories. For instance, the U.S. Energy Boom is based on ending the ban on energy exports and the requirement that a U.S. flagged ship move products between U.S. ports. This leads to an end of Bakken crude shipments by oil train to the region. Without lifting these bans, the U.S. Energy Boom could turn out very differently, including the likely continuation of oil trains bringing Bakken crude to regional refineries.[1] Analyzing each force individually does not easily account for the inherent overlap between them. For example, decreased prices for energy—due to Marcellus Shale and the other factors that comprise the U.S. Energy Boom—would further reduce incentives for energy efficiency and could lead

[1] Though beyond the region's regulatory standing, oil train safety can be enhanced at the federal and state levels by: reducing oil-train speed limits in urban areas; removing volatiles from oils prior to transporting them; requiring oil-carrying train cars to be outfitted with thicker hulls and steel reinforced inner and outer shells; and advanced braking systems. Proposals to reroute trains around population centers seem unfeasible, because the necessary refinery, rail, and port infrastructure is located in developed areas.

to worsening effects from Severe Climate. The 'Interaction Between the Forces' section of this report begins to analyze how the forces relate to each other.

The Free Agent Economy and Transportation on Demand scenarios both rely on interconnected mobile communication devices, which are most prominently smartphones but increasingly vehicles, infrastructure, houses, appliances, and many other everyday items that are connected to the IoT. These are changing the nature of our businesses, travel patterns, and communities in ways that are just starting to be comprehended. How technological forces are changing the nature of travel, work, and other relationships is a key future uncertainty. In general, new technologies displace low- and some medium-skill jobs, while increasing demand for high-skill workers.[2] Automation and robotics may be the next disruptive technology, and could threaten even some highly skilled jobs. However, automation may not be cost competitive with the on-demand outsourcing model, and the interactions between them will be complex and may take years to fully resolve.[3]

The low cost and wide availability of fossil fuels is driving both the U.S. Energy Boom and Severe Climate. Renewable energy sources are fast becoming cost competitive with fossil fuels, providing further assurance of long-term cheap and abundant energy, while creating a risk for the U.S. Energy Boom, and a hope that the worst of Severe Climate can be avoided. Severe Climate suggests that small distributed energy networks which can be created with solar and wind facilities, rather than large centralized ones, are preferable for resiliency purposes. This is one of many examples where the region will need to carefully rethink how to reconstruct and modernize its infrastructure to also be more resilient, even in the face of significant funding constraint. The issue of fracking was the most divisive in all Futures Group discussions, with strong feeling for or against it and little middle ground. Many participants called for its outright ban.

Lack of funding to maintain our aging transportation system, much less expand it to meet the needs of a growing population and economy, is a major issue facing regions across the nation. Partisan paralysis, as a key background force, suggests that Greater Philadelphia should seek to find solutions using readily available tools that do not require substantial federal or state legislation. This also implies that a significant increase in transportation funding is unlikely. In order to hold the system together, the region will need to find ways to leverage transportation dollars with available tools such as county annual vehicle registration fees allowed in Pennsylvania under Act 89, public–private partnerships, tax-increment financing (i.e., TRID), and identify other new sources of revenue. Better use of data, software (i.e., Intelligent Transportation Systems), and other low-cost improvements, rather than expensive hardware (i.e., new facilities), will most likely be the route to making existing roads and transit systems more efficient, flexible, and resilient

Each Future Force what-if scenario was modeled in Impacts 2050 and the Rapid Policy Assessment Tool (RPAT) to further illustrate different impacts. Impacts 2050 is a socio-demographic systems dynamic model, and RPAT is a sketch level travel demand model. This was challenging as models are limited in accurately reflecting major systemic change, and tend to have a bias toward the status quo.[4]

The next section travels to the year 2045, and considers how each force has changed the region, and what challenges it is facing at that time.

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[2] William A. Galston, *New Challenges to Market Democracies* (Washington, DC: Brookings Institution, October 2014), http://www.brookings.edu/research/reports2/2014/10/new-challenge-market-democracies.
[3] "The Future of Work: There's an App for That," *The Economist*, January 3, 2015, http://www.economist.com/news/briefing/21637355-freelance-workers-available-moments-notice-will-reshape-nature-companies-and (accessed October 21, 2015).
[4] National Highway Cooperative Research Program, *NCHRP Report 750—Volume 6. The Effects of Socio-demographics on Future Travel Demand* (Washington, DC: Transportation Research Board of the National Academies, 2014), http://www.trb.org/Main/Blurbs/171200.aspx.

Table 1. Assumptions Used to Build What-If Scenarios

Factor	Enduring Urbanism	The Free Agent Economy	Severe Climate	Transportation on Demand	The U.S. Energy Boom
2045 Population (millions)[a]	6.58 [+17%]	6.44 [+15%]	6.45 [+15%]	6.51 [+16%]	6.48 [+15%]
Demographic Trends	Young adults (20–34 years old) continue to flock to the region, and there are fewer persons per household	Population is more transitory, as people constantly move in search of economic opportunity	Region receives some in-migration from regions that are more severely impacted by climate change	Technologies allow workers to live anywhere and work remotely	Population and jobs increase due to the energy hub and economic growth
2045 Employment (millions)[a]	3.33 [+13%]	3.29 [+12%]	3.28 [+11%]	3.30 [+12%]	3.33 [+13%]
2045 Income per Capita[a,b]	$39,000 [+44%]	$36,100 [+33%]	$35,000 [+29%]	$37,400 [+38%]	$39,500 [+46]
Development Patterns	Population grows around dense regional centers but declines slightly in farther-out suburbs	New development centers emerge around universities, which become the creators and incubators of new businesses	More infill development and increased density in regional centers; Movement away from major rivers and floodplains	Mix of infill development that occurs near transit access and regional centers, and more traditional suburban development	Industrial growth reactivates the Delaware River waterfront, and spurs residential growth in areas with easy access to industrial jobs
Travel Demand Shifts	Increase in walking, biking, and transit trips	Fewer 9-to-5 work schedules, which harms transit agencies' ability to effectively deliver service	Slower growth rates in trade and goods movement	New transportation services, such as ride sourcing and micro transit, become major travel providers	Higher growth rates in global trade and goods movement
Transportation Infrastructure	Significant push to fully pedestrianize Main Streets, while adding protected bike and pedestrian infrastructure to all roads (except highways)	Strong desire for low-cost options, pushing a move toward Complete Streets	Extreme weather shortens transportation infrastructure lifespans and increases maintenance costs	New technologies, such as 3D printing, nanotechnology, and better asset management, extend the lifespan of transportation infrastructure and lower its costs	Low energy prices bring down the cost of building and maintaining transportation infrastructure
2045 Gasoline Cost/Gallon[a,b]	$3.60 [+26%]	$3.70 [+29%]	$4.60 [+61%]	$3.80 [+33%]	$3.10 [+8%]
2045 Average Vehicle Fuel Efficiency[a]	46 mpg [+109%]	44 mpg [+100%]	50 mpg [+127%]	60 mpg [+173%]	41 mpg [+86%]
Miscellaneous	Demand increases for new types of housing, such as micro apartments; urban schools slowly close the quality gap, reducing the push of families with kids to the suburbs	Demand grows for coworking space; 3-D printing, automation, and robotics brings more local manufacturing back to the region	The need to rebuild and make infrastructure more resilient limits other investments potentially slowing economic growth	A significant increase in zero-car households; innovations in alternative energy sources lead to lower energy costs	Fossil fuels remain the dominant energy source

[a] Numbers in parenthesis are comparisons to a 2010 baseline: regional population was 5.62 million; employment was 2.95 million; income per capita was $27,100; gasoline cost was $2.86 per gallon; and vehicles averaged 22 miles per gallon (mpg).
[b] In 2010 dollars.
Source: DVRPC, 2015.

WHAT-IF SCENARIO:

ENDURING URBANISM

"Today successful cities, old or young, attract smart entrepreneurial people, in part, by being urban theme parks."

—Edward Glaeser
Triumph of the City

Source:
BLT Architects, 2014.

In 2045, the City of Philadelphia is nearing a population of two million, while the region as a whole has grown thanks to interest in walkable lifestyles and having a variety of desirable areas—from large cities to small boroughs that offer a range of economic, cultural, and social opportunities. This force was strengthened by large coalitions of public, private, and nonprofit actors that pushed for tax reforms in urban areas, which followed the old adage of "tax what can't move or what you don't want." As the economics of cities, towns, and boroughs made them more competitive, large new agglomeration economies have formed, strengthening the entire region and making it a bigger player on the global stage. This has increased foreign immigration into Greater Philadelphia, which helps to enliven cities and towns with a wider blend of cultures and cuisines. Immigrants further strengthen the economy through connections with their homelands.[5] As cities and towns revitalized and regenerated themselves, they have attracted jobs and built new neighborhoods to further increase their tax bases. The most dramatic new community is the new regional center located over the nearly 100-acre neighborhood built over the 30th Street Station rail yards. By moderating development demand in Center City, it has allowed for more historic preservation than would have otherwise been possible.

[5] Edward Glaeser, *Triumph of the City: How Our Greatest Invention Makes Us Richer, Smarter, Green, Healthier, and Happier* (New York: The Penguin Press, 2011).

"Older residents and empty nesters increasingly do not want to have to maintain a large house on a large lot. They do, however, want to stay in their community, and will need newly constructed types of accessible housing to enable them to do so."

— Greater Philadelphia Futures Group Participant

While most people and families still live in single-family homes, there are many new types of housing that are becoming common: cohousing, shared housing, supportive housing, accessory dwelling units, and micro apartments. These new types of housing are designed to lower costs, particularly for students, younger workers, and the elderly. Keeping housing affordable is critical for both quality of life and regional economic competitiveness. Work on providing school choice has paid off over time. Now there are a variety of charter schools and home schooling options, along with improved public schools. The last one, especially, is due to considerable neighborhood efforts to improve them. Better public schools have helped to develop talented students, who bring much-needed skills, ideas, and entrepreneurship. They also help to attract high-skill workers, who are highly concerned about the education their children receive.[6]

Better stream and stormwater regulations, improved agricultural practices, and reduced demand for low-density development in environmentally sensitive areas, has improved water quality in the Delaware watershed. As a result, oysters and shad fisheries are flourishing, and the region's economy is benefiting from food resource development, and increased recreational activities and tourism.

TRANSPORTATION INFRASTRUCTURE AND GOODS MOVEMENT

Transit ridership is up by more than 75 percent since 2010, which is a big success that has brought new challenges. System capacity has only increased incrementally, primarily through larger vehicles. There is still a need to reprioritize or increase funding available to expand the system in order to meet the demand.

Since the millennials, each successive generation has had more extreme multimodal transportation preferences. Walking and biking trips have increased by 150 percent since 2010 (see Table 2). Cities and regions are now in fierce competition to provide the best walking, biking, and transit amenities in an attempt to attract and retain top talent. Vision Zero campaigns—intended to protect all transportation system users and eliminate fatalities—are credited with helping communities re-envision their streets to prioritize biking, walking, transit, and community livability. The first movers saw tremendous benefits—especially in attracting highly skilled, creative class individuals—from safe and inviting multimodal designs. Every community is aiming to create bustling living streets, with green infrastructure, attractive street furniture, and shops and restaurants that spill out into them. As more people walk and bike in urban areas, there is a virtuous cycle of demand for more and improved infrastructure, such as converting underutilized existing road space into pedestrian plazas, protected bike lanes, Complete Streets, and shared space. Growing movements are calling for fully capping over depressed interstates running through urban areas and closing all of Center City to automobile traffic.

More active transportation has brought a number of co-benefits, such as a reduction in obesity and chronic health conditions and more disposable income as transportation costs less—especially as increasing car sharing, ride sourcing, and bike sharing allow residents to own fewer personal vehicles. With less demand for on-street parking, street space has been cleared for additional goods movement, walking and biking, green infrastructure, and other uses. Lower automobile ownership rates also mean that residential buildings require less parking. Combining alternative transportation with denser, more compact development patterns has reduced demand for energy. This has made the region less vulnerable to volatile energy prices and moderated the need for road maintenance and new roadways. At the same time, though, it has lowered gas tax revenue, which has forced public agencies to be very strategic with their transportation investments and limited the ability to implement transformative projects, especially if they lack access to other local funding sources.

Continued growth in online shopping means more home deliveries, which are more efficiently delivered by freight companies. However, dense, active urban areas make shipping more difficult.

[6] Ibid.

Accommodating more small- and medium-sized trucks is a particular challenge, as they create a lot of congestion, and the region has narrower streets than many other parts of the county. Solutions have come from consolidation centers, smaller trucks, bicycle and e-bicycle drop-offs, overnight deliveries, and small delivery centers—which allow individuals to pick up their packages at a convenient time and are spaced every one to two miles or even on every other street corner in urban areas.

CHALLENGES FACED IN 2045

Challenges include gentrification, issues with population density, loss of industrial land, and fiscal distress in some suburban areas.

Inner City Gentrification

The cost of urban housing continues to rise, due in part to unmet demand as the market continues to focus on developing high-end housing and ignoring the need for mixed-income housing. Many middle- and lower-income households are being pushed out of their neighborhoods by wealthier individuals, particularly in the region's core areas.

Density

Higher population density has created problems with overcrowding and overuse. Many dense neighborhoods now oppose additional development, worsening the affordable housing problems. However, attempts to limit new dense urban buildings mean that development is either being pushed to farther-out areas in the region, or to other regions that are not as restrictive. In either case the region is less competitive as a result. Increased density has come with some risks: individuals are more likely to live in proximity to air pollution; viruses are able to spread more easily, particularly the flu; urban heat island effects are increased. There is a need for better access to nature and recreational opportunities.

Loss of Urban Industrial Land

Industrial land, particularly along waterfronts with access to existing transportation infrastructure, has too often succumbed to pressure for residential development. Failure to preserve it for manufacturing jobs, freight distribution, and other commercial uses necessary to compete in the global economy has led to missed opportunities. Some suburban areas have rezoned and worked to attract industry to vacant commercial office parks. However, these areas are much less likely to have freight rail access.

Suburban and Exurban Fiscal Distress

Some farther-out, low-density suburban and exurban areas have struggled as jobs followed people back into cities and boroughs, particularly townships that depended heavily on office parks for their tax base. With decreasing taxes from office parks, residential taxes had to be increased, creating a push factor out of the municipality. This has happened right when many aging suburban infrastructures needed significant rehabilitation or replacement. The combination of declining revenues and increasing investment needs has put many communities into fiscal distress. Attempts at suburban retrofits did have some success, but the continued acquisition of regional banks by large, multinational banks—which were reluctant to finance either greenfield projects or mixed-use suburban retrofits—has significantly hindered suburban (re)development.

WHY THIS SCENARIO MAY NOT HAPPEN

This trend may be the outcome of recent high oil prices, the recession, or millennials struggling with student loan debt and unemployment during their formative years. Once the economy recovers, or if oil prices remain low, young people may return to the more suburban lifestyle patterns of previous generations. Future generations also may not share the millennials' enthusiasm for urban areas, and could have more suburban lifestyle preferences.

WHAT-IF SCENARIO:

"Philadelphia will continue to be vital to the economy by creating and fostering the things that are driving residential preferences, and through agglomeration economies."

— Greater Philadelphia Futures Group Participant

Source: Benjamin's Desk

In 2045, many more individuals now work for themselves as continued outsourcing, the rise of robotics, and efficiency gains enable big companies to get by with fewer and fewer employees. These trends began with the decline of unions and worsening relationships between labor and management in the 1970s, and continued with increasing use of computers, and globalization. The smartphone accelerated the changing nature of the economy, businesses, and even individual careers, through its ability to connect people and get information in real time. This flattened transaction costs and reduced the need for firms, which were the traditional organization method for decreasing transactional expenses.[7] Recently, the primary economic struggle has been between on-demand outsourcing and the increasing use of robotics and automation. The relationship between them is highly complex and difficult to fully comprehend.

Traditional industry and jobs still exist, and large companies remain major economic players. They contract out most of their operations to freelancers, consultants, and temporary workers. Nearly any professional service—doctors, lawyers, accountants, engineers, web developers, and others—can now readily be found on demand. The most talented and entrepreneurial people embrace The Free Agent Economy. They seize opportunities and find success in many different ways. They have increased regional entrepreneurialism and are creating a new pipeline of companies that is helping to drive economic growth. Ironically, this has made it difficult to find personnel for conventional jobs, particularly in professional services. Companies often suffer from a loss of professional and

[7] "The Future of Work: There's an App for That."

"Urban reinvention is made possible by the traditional urban virtues … educated workers, small entrepreneurs, and creative interplay among different industries."

—Edward Glaeser, Triumph of the City

institutional knowledge, as workers are less tied to jobs than ever. Even individuals in the traditional workforce move between jobs regularly and have little commitment to any single employer.

The region's educational system is constantly trying to reconfigure itself to meet continually changing workforce needs. Universities had to reinvent themselves when they were disrupted by online classes and startups with more interactive and pedagogical teaching methods. Universities now focus more on research and new business formation, along with specialized and graduate education. For most students, colleges are now more of an educational "travel agent," helping to guide study programs, rather than a direct supplier of undergraduate classes.[8] Education has become a lifelong endeavor, as individuals look to continuously refine their skillsets to match economic demands. Secondary universities have repurposed themselves around job training. Major universities now draw recent graduates for entry-level job opportunities.

In the national context, Greater Philadelphia has become more appealing due to its dense urban agglomeration economy and proximity to many other large cities. The existence of higher-speed inter-regional rail linking Greater Philadelphia with nearby population centers is a competitive advantage, while the airport is a critical link between free agents and potential employers around the world. Individuals choose where they live based on access to employment options and flexibility. This access is easiest to find in or near a regional center or university served by transit, though ride sourcing does augment these locational decisions. Many people work at home or in neighborhood coworking and shared workspaces that are often located within walking distance of their homes.

High-skill and entrepreneurial immigrants are highly valued and sought after, and the region is working hard to attract them in order to grow the economy.[9] These individuals have the freedom to work from nearly anywhere in the world. While their preferred locations are often in places with warmer winter temperatures, Greater Philadelphia competes for elite talent through the provision of natural and recreational amenities, low cost housing and transportation options, and competitive tax rates.[10]

While there is less demand for commercial space overall, nearly every office features open floor plans and smaller, more flexible workspaces and is preferably located near alternative transportation, particularly transit. As there are fewer large companies taking up entire office buildings or parks, multi-tenant spaces proliferate. Many businesses get their start from successful trials in the pop-up economy, where a temporary shop or dining space is set up to test out new ideas.

By flattening transaction costs, the Internet, virtual reality, and other communications technologies continue to strengthen The Free Agent Economy. The use of the Internet for business purposes has meant more online communication and teleworking, and IT is still a major growth industry. The use of 3-D printing is commonplace and supports "maker" communities that personalize many of the items we purchase. Manufacturing occurs in smaller and more spread-out facilities, as 3-D printers changed the cost curve for local production. Conventional manufacturing has had to either improve quality or lower prices in order to compete. Many large, abandoned former industrial facilities remain empty and need to be remediated and rezoned, and possibly subdivided into smaller lots with an extended street grid, where they can more feasibly be redeveloped by one of the region's real estate entrepreneurs. The sharing economy continues to grow as individuals and companies earn income by renting assets such as houses or apartments, tools and equipment, or vehicles. As more major capital goods are shared, their durability has become a key selling point. This has benefited Greater Philadelphia and the United States, where manufacturing is still more about quality than quantity.

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[8] Butler, Stuart M. "Reimagine College." The Brookings Institution, December 22, 2014. http://www.brookings.edu/research/opinions/2014/12/22-reimagine-college-butler (accessed December 29, 2014).
[9] Glaeser, *Triumph of the City*.
[10] Michael Luis, *A Tale of Ten Cities: Attracting and Retaining Talent* (Seattle, WA: International Regions Benchmarking Consortium, 2009), http://www.psrc.org/assets/5585/IRBC2-Talent1109.pdf.

TRANSPORTATION INFRASTRUCTURE AND GOODS MOVEMENT

As the boundaries between personal and business life have receded, people seek to minimize all transportation expenses, targeting to keep costs under 10 percent of income. Desirable regions offer individuals, particularly those who commute, easy access to low-cost transportation options such as transit, walking, biking, and new private-market options, such as on-demand micro transit bus service. Commuting patterns continue to trend toward more off-peak travel and reverse commuting. Commercial corridors struggle with routine demand shifts, and transit operators rely on the flexibility of buses to quickly change routes. Transit agencies are still trying to figure out the best response to continually shifting commute patterns. Some are increasing mid-day and evening service and saving money by reducing their fleet sizes and peak-period frequencies. Others are adding more bus routes to serve a wider service area and new destinations with reduced frequencies on existing routes, while keeping the same number of vehicles. More people work from home, and those who do not are often in closer proximity to their workspaces, as the increase in renting allows people to readily move closer to work opportunities. This has shortened trip lengths, and many people are able to either walk or take transit to their worksite. More telecommuting has reduced peak-hour pressure on the road network.

The mid-day period sees more short trips to run errands, as opposed to being done on the way home from work. As people order more and more goods online, there has been an increase in residential deliveries. Goods movement volumes are increasing, although in a less centralized fashion, as the new economy requires a lot more small- to medium-sized trucks (i.e., FedEx, UPS) making smaller deliveries. Freight consolidation centers help to reduce the number of trips by making single deliveries to buildings housing multiple companies.

CHALLENGES FACED IN 2045

Regional challenges include risks to the university and medical business models, employment and income stability, retirement and health benefits, and inequality and suburban poverty.

The Shifting Role of Meds and Eds

Greater Philadelphia's economy was once built around an impressive concentration of higher educational and medical institutions. As more classes and doctor visits have moved online, there is a growing disconnect between where we live and where we work, go to school, or even undergo medical examinations. Virtual classrooms and telemedicine have undermined the place-based nature of the region's two biggest employment sectors.

Employment and Income Instability

With fewer people working for large companies, incomes are less stable. Renting is much more common than it was 30-years ago. Buying a home requires a confidence in one's ability to keep landing jobs—a luxury that few have. Lack of regular income has convinced many individuals to delay or not have children, which impacts quality of life and, eventually, end-of-life support. As companies look to cut expenses during economic downturns free agents are particularly exposed, since they do not receive income from unemployment compensation. Under- and unemployment has left many individuals reliant on the "gig" economy as their main source of income. This work involves temporary one-off and irregular tasks and opportunities in driving, editing, cleaning, cooking, gardening, tutoring, and other areas. These sometimes lead to more secure work but more often fail to pay even the minimum wage, despite requiring a significant amount of time looking for work and commuting. Many individuals make ends meet by filling multiple tasks over the course of a day. While smartphone apps aim to minimize transportation needs for individual workers, this part of the economy still creates unpredictable and irregular demands for use of the region's transportation system at the macro level.

Retirement and Health Benefits

Employers were the traditional source of retirement and healthcare benefits. Now individuals are increasingly responsible for securing their own health insurance and retirement income, which consumes more personal time amid busy schedules trying to make ends meet. Lack of paid time off has lowered quality of life and slowed the tourism industry. Public pensions continue to weigh heavily on government budgets, leaving less to invest in basic needs such as transportation and education. Homes in low-density areas are not worth as much as homeowners thought they were, hurting individuals and families who planned on downsizing their home to help pay for retirement. In order to keep expenses down, many freelancers are choosing lower-cost, higher-deductible health insurance plans, which means they are less likely to visit the doctor when ill and may put off needed treatments. Both increase the chance that they wind up in the emergency room for conditions that could have been treated at a lower cost and with less negative individual health outcomes.

Inequality and Suburban Poverty

Inequality has worsened for those who do not have access to capital resources or entrepreneurial capabilities. The owners of capital and assets have income diversity advantages over those who rely solely on their labor. Low-skill workers have a particularly hard time finding regular work. The risks associated with the global economy have created social tensions and demands for more government intervention to protect workers.

Many formerly middle-class neighborhoods are seeing increasing poverty rates. This has created new challenges for transportation, job access, and provision of much-needed services, particularly in the suburbs. There are still places in urban areas that have had deeply entrenched poverty for generations. While these areas tend to have good transit service and other assets, improving quality of life for their residents remains difficult. The City of Philadelphia continues to lose middle-class households, particularly in neighborhoods well beyond Center City. The city has become a wealthy core surrounded by low-income areas with higher concentrations of poverty.

WHY THIS SCENARIO MAY NOT HAPPEN

This force is ongoing. A 2015 Kelly Services survey found about 31 percent of U.S. workers think of themselves as free agents. The key question is how much stronger it will become in the future. Intuit has forecast that this number will grow to about 40 percent of all workers by 2020.

WHAT-IF SCENARIO:

"To avoid two degrees of warming, the global economy now needs to decarbonize at 6.2% a year, more than five times faster than the current rate, every year from now till 2100. On our current burn rate we blow our carbon budget by 2034, sixty-six years ahead of schedule. This trajectory, based on IPCC data, takes us to four degrees of warming by the end of the century."

— Price Waterhouse Cooper.
Low Carbon Economy Index 2014

Even in the face of a rapidly changing climate, there still has not been successful coordinated global action to lower emissions by 2045. Due to continued global use of low-priced fossil fuels, the region has seen increased precipitation, more frequent and intense storms with subsequent flooding, rising temperatures with more variability, a greater number of days with temperatures over 90, or even 100 degrees in the summer, more freeze–thaw cycles in the winter, and sea level rise. As more land area becomes vulnerable to flooding, some areas are no longer habitable, and some transportation infrastructure has become unusable, or usable only at very high cost.

Many areas of the world experience more serious consequences. Rampant climate change has led to heat waves, droughts, crop failures, and premature deaths around the globe. Water scarcity has increased pressure on limited clean water resources, and a significant portion of farmland is devastated each year, while droughts lead to unpredictable yields. Growing global food insecurity underscores the importance of global and local food systems and the ability of regions to feed themselves. Economic and environmental declines have led to civil strife and unrest in some parts of the world. Inflation is rising fast, even as economic activity has been slowing down, and there is more informal trade and bartering.

Relative to other areas, Greater Philadelphia has become a more desirable place to live due to less risk of sea level rise and the continued water availability. Population has increased from climate change-driven immigration. There have been a number of local actions taken to reduce emissions,

"Food is poised to become the oil of the 21st century."

—Nathan Halverson. "How China Purchased a Prime Cut of America's Pork Industry"

and per capita residential energy and on-road transportation emissions are down by 30 percent since 2010. This has been achieved through denser, more centralized development patterns, although the region is attempting to direct growth away from flood-prone major rivers and low-lying floodplains. Further emissions reductions have come from more fuel-efficient vehicles, appliances, air conditioning, heating, and lighting. Excess water capacity has drawn industries, such as agriculture (which now has a longer growing season) and water-intensive manufacturing (such as circuit boards), and is a competitive advantage. There is an increasing push to use long-abandoned and build new multi-level industrial buildings for hydroponic and raised-bed agriculture. Their efficiency has helped to lower the amount of greenhouse gas generated by food production.

Not all the news is good, however. Parts of Philadelphia and other municipalities along the Delaware and Schuylkill rivers are increasingly threatened by frequent flooding, resulting from both sea level rise and more intense rainfall. Port facilities, the Navy Yard and Philadelphia International Airport are increasingly at risk of flooding. Some major roads and transit routes are flooding more frequently, presenting additional delay for commuters. Portions of Amtrak's Northeast Corridor are increasingly facing inundation, threatening rail connectivity up and down the east coast. These low-lying areas need to be protected by constructing flood levees. The cost of this, as well as for relocating residents and businesses that face repeated flooding, is stretching state, municipal, and corporate budgets. Some smaller scale efforts to improve the resiliency of the region's infrastructure have provided ancillary benefits. In areas where power lines have been buried, there have been fewer electricity outages during high wind and other storm events. This investment has also provided good-paying jobs for workers and improved the aesthetics—and desirability—of communities across the region.

TRANSPORTATION INFRASTRUCTURE AND GOODS MOVEMENT

There has been little growth in trade and goods movement, in part due to routine extreme weather events that cause the temporary closure of infrastructure, and the fact that everything has become more expensive—particularly energy and raw materials. More severe weather events cause road buckling, rail bed movement, and other impacts to infrastructure condition due to heat and freeze–thaw cycles. This increases crash rates, non-recurring delay, and traffic interruptions on the region's roads. Power disruptions cause delays on transit and regional rail service. More hot days and precipitation, along with warmer winters, has led to a seasonal shift of walking and biking trips. This also affects infrastructure maintenance, as workers cannot spend as much time outside in the scorching summer heat.

With system reliability decreasing, goods movement customers and service providers are seeking multiple delivery options. Where freight facilities need to be moved to areas less susceptible to significant weather events, resiting has been made difficult by public opposition to locating undesirable uses in or near residential areas. Increased output by regional agriculture and manufacturing sectors requires new investments in freight infrastructure. Extreme weather has led to increased costs for things such as more frequent inspections and maintenance costs, due to more climate-related damage to transportation infrastructure. Finding the funding to pay for any of this has been difficult. The end result is that transportation has become much more expensive for both people and goods, and this is directly borne through increased vehicle operating and repair costs incurred by the user or business, which then pass it along to consumers.

CHALLENGES FACED IN 2045

The worst impacts of climate change are yet to come, and the near-term future will see far worse outcomes than have been experienced to date. The long-term prognosis of climate change suggests that long-range planning should be conducted with a 50- to 100-year time period in mind. Key regional challenges include climate change disruptions to trade and infrastructure, lack of national economic competitiveness, climate equity, crisis management, and public health concerns.

Trade and Infrastructure Disruptions

Climate change is disrupting global supply chains as well as the flow of people and goods. Sea level rise is affecting operations of ports and adjacent facilities. Bridge clearance heights have been reduced by higher water levels, limiting the size of ships that can navigate the Delaware River. As a transportation facility closes due to damages or needed repairs, delay increases significantly on parallel routes. Food prices are rising well above the inflation rate, and more people around the world are going hungry. As more wealth is spent trying to maintain what we have already built, there is less available for growing the economy. Incomes and economic activity are stagnant, both globally and within the region. Transportation is growing more and more unaffordable. The average household is estimated to spend 20 percent of their income on transportation, well above the general rule-of-thumb of 15 percent (see Table 2).

Lack of National Economic Competitiveness

Governmental failure to regulate greenhouse gas emissions continues to benefit less efficient modes (trucks and sports utility vehicles), fuels (gasoline and diesel), and infrastructure investments (roadway widening). Failure to properly price carbon has put the region and nation at a competitive disadvantage to international locales that have pushed more efficient, climate-friendly technologies, investments, and development patterns. Not taking action on climate change was expected to bolster the economy, but instead it has substantially increased the cost of doing business, while letting other countries take the lead on clean tech innovation.

Public Health and Climate Equity Concerns

Severe Climate has been accompanied by a number of health concerns. Ticks carrying Lyme disease are more likely to survive the winter, creating a year-round risk. Tropical diseases, such as West Nile virus, have become more common with warmer weather. Seniors, low-income individuals, and other vulnerable population groups have higher morbidity risks during extreme heat waves, due to lack of air conditioning or fear of opening windows. Many of the areas that have been most negatively impacted by climate change are low-income communities that were poorly equipped to handle the effects. This has illustrated the difficulty of the region's reliance on decentralized local governments. While wealthier communities were able to prepare for climate change, poorer ones were less ready for these threats. Even worse, they were often left in a position where they had to trade off the environment for economic opportunity. Lack of open space in EJ communities increases their isolation and exacerbates many of the negative health and environmental outcomes from climate change.

Crisis Management

Climate change has created a variety of challenges in electricity and drinking water distribution, and stormwater removal. Hotter summers put more strain on the region's electrical grid, leading to more blackouts. Lack of funding and dealing with crises as they arise means that infrastructure systems still have not been brought up to modern standards. Infrastructure, such as emergency generators, vehicles, and vehicle fueling infrastructure, is routinely damaged by major weather events, which cause temporary closures and costly repairs. Low-lying rails, roadways and bridges, and Philadelphia International Airport are particularly vulnerable. Long-term maintenance costs have dramatically increased, and hard choices are continually being made about what infrastructure to "harden" to withstand more frequent storm events. More infrastructure maintenance also means more energy and raw material use—increasing greenhouse gas emissions.

WHY IT MAY NOT HAPPEN

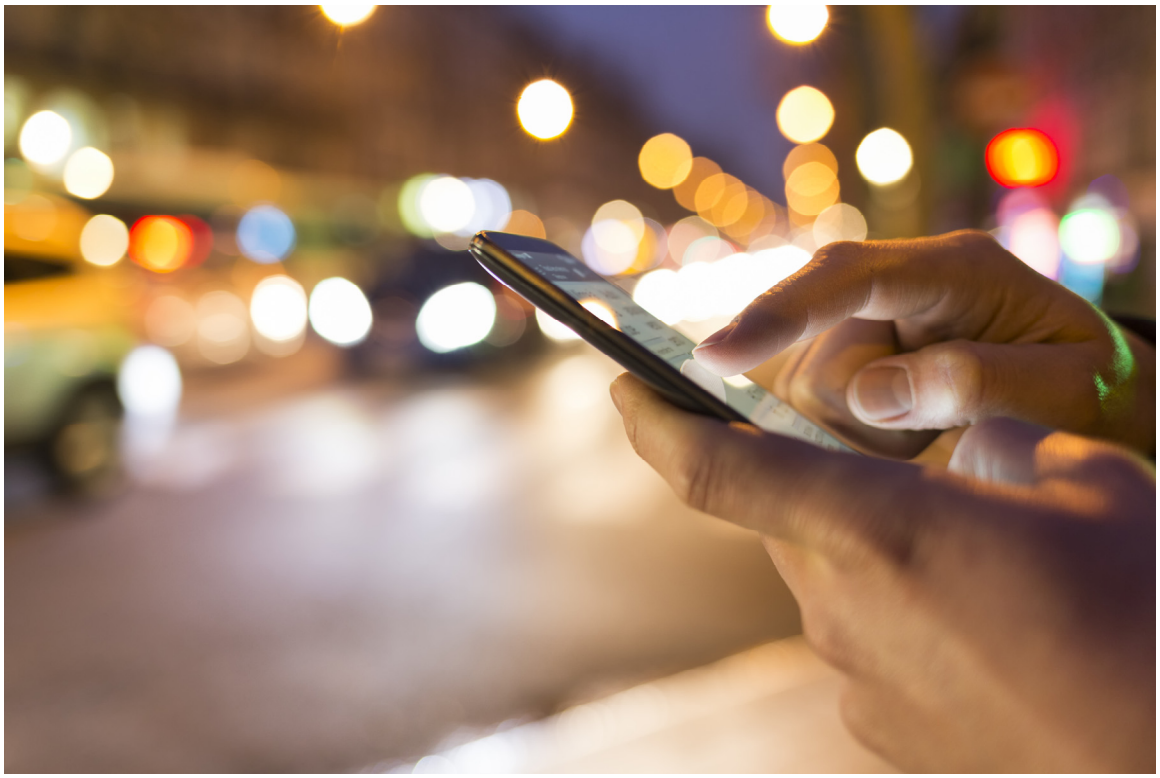
Multilateral agreements to reduce emissions in a binding manner, such as through cap and trade or carbon taxes, could lower the risk of the "business as usual" outcomes outlined here. New technologies may create cleaner vehicles and electricity generation.

WHAT-IF SCENARIO:

TRANSPORTATION ON DEMAND

"Driving used to be seen as personal time. Now it is seen as wasted time."

— Greater Philadelphia Futures Group Participant



In 2045, people increasingly purchase mobility as a service, rather than owning a personal vehicle. New technologies have dramatically reshaped transportation, with more and more people—particularly those who are young, highly skilled, and well educated—finding there is little need to own a car. Mobile communication devices allow individuals to obtain real-time information on transit or book taxi, bike share, car share, ride source, or micro transit services. Mapping programs enable more efficient use of the system through driving directions and encourage the use of alternative modes, thanks to the ability to better orient in new or less familiar areas. The "mobility platform" within the IoT, combined with low cost sensors embedded into transportation infrastructure, helps to efficiently move people and goods spatially in real time. This access to real-time information allows for smarter travel choices and has made the shared multimodal transportation network nearly as convenient as a personal vehicle was in the past. With less need to drive, people have more time to work, read, or socialize while moving about.

New transportation network companies continue to shake up the market with unlimited mobility options through a monthly subscription, or micro-transit bus service or ride sourcing on demand. Even carpooling has undergone a makeover, with drivers and passengers able to connect on the fly for trips between similar origins and destinations. Internet-based social networks are enablers that help to build trust between individual transportation service providers and consumers. These technologies

"More and more, the transportation sector is relying on data to drive decisions, and on technology to reimagine how we move people and goods."

—U.S. Department of Transportation. Beyond Traffic 2045

have helped to reduce one of the most inefficient parts of the nation's transportation system, cars traveling with mostly empty seats. Whereas the average vehicle traveled with 1.3 passengers in it 30 years ago, today it is closer to two passengers per vehicle. In addition, the on-demand nature of the transportation system allows vehicles to be sized properly for many trips, adding a new element of efficiency. Reduced auto ownership rates have decreased parking space needs, and many parking lots have been put to better uses. With about two out of every five households now carless, residential garages are regularly being repurposed into new rec rooms, apartments, workshops, offices, or small stores. These new transportation options have improved service throughout the region—they have a higher cost and longer wait times in lower density areas, due to spread-out development patterns and disconnected street networks.

Over the last several decades, an ongoing evolution in automation has freed drivers from more and more responsibility in operating a vehicle. Fully autonomous vehicles (AVs) are operating on the region's roads and currently make up about 30 percent of the vehicle fleet. Prior to this, autonomous buses and trucks with specific travel routes were able to hit the streets even earlier but required very detailed mapping programs that had to be kept up to date.[11] The new AVs were made possible by growth in robotics and advances in artificial intelligence, which are driving economic growth.[12] Although AVs have delivered the safer, more controlled, and better-routed benefits they were long touted to have, giving up driving personal vehicles is a tough sell for some individuals. For non-drivers, such as the elderly, disabled, and the young, AVs have meant a considerable increase in mobility.

Curbside pick-up and drop off points are the new parking lots.

The majority of AVs are being used as taxi-like services, picking up and dropping off passengers through e-hailing apps. However, a number of them are privately owned and operated, often by well-to-do individuals. These cars are allowing wealthy enclaves to locate even farther from population centers, and are often used to run errands without a passenger. AVs are simultaneously providing new shared use options to support and enhance existing densely developed regional centers, while privately owned AVs enable very low density patterns to spread into largely rural areas at the periphery of the region, and just outside it. Improvements in vehicular technologies, connected vehicles, and now AVs have further reduced fatality rates, helping get the region that much closer to the Vision Zero goal of no road deaths. Somewhat surprising is that non-fatal crash rates are on the rise, as extra-cautious AVs and human drivers are having a hard time reacting to and predicting each other's behavior.[13] This is increasing calls to either ban human drivers—which is highly controversial given that many individuals value their freedom to drive or refuse to ride in computer driven vehicles—or create separate AV-only and human-driven-vehicle-only lanes and facilities, which is expensive.

Extreme hybridization means that many new vehicles can run off any readily available fuel—gasoline, electric battery, natural gas, hydrogen fuel cell, and others—ensuring there are alternatives, and the owner can choose the least expensive option available.

TRANSPORTATION INFRASTRUCTURE AND GOODS MOVEMENT

With better travel demand data, there is better informed decision making and improved allocation of limited resources. People travel more, thanks to the number of options for how to get around and lower transportation costs, but the uncoordinated nature of different modes and competition between them has led to worsening congestion.

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[11] Gomes, Lee. "Driving in Circles: The Autonomous Google Car May Never Actually Happen." Slate.com, October 21, 2014. http://www.slate.com/articles/technology/technology/2014/10/google_self_driving_car_it_may_never_actually_happen.2.html (accessed October 22, 2014).

[12] Ibid.

[13] Naughton, Keith. "Humans are Slamming Into Driverless Cars and Exposing a Key Flaw." Bloomberg.com, December 17, 2015. http://www.bloomberg.com/news/articles/2015-12-18/humans-are-slamming-into-driverless-cars-and-exposing-a-key-flaw (accessed December 21, 2015).

Freight shippers increasingly offer same-day delivery. The need to deliver quickly has led to things being produced or sourced closer to where the purchase is made. Items often come from either regional warehouses or manufacturing locations, which are stocked with customizable goods and raw materials. The region's freight network must handle higher volumes, using smaller vehicles to serve more businesses and residences rather than large stores with loading docks. Efficiently moving locally produced goods to international markets is critical to the region's global competitiveness. Thanks to the foresight of placing FedEx and UPS centers at the airport, Greater Philadelphia remains well positioned for same-day delivery and highly connected to the global economy.

More efficient urban freight routing, through consolidation centers, on-demand trucking, and the IoT, has lowered truck VMT. Ride-sourcing drivers, and now autonomous taxis, supplement their travel by making local deliveries (groceries, small packages, etc.) rather than logging empty road miles. Autonomous "shipping containers" make delivery more efficient by turning roadways into warehouses. This skips the warehousing middleman, while saving the labor costs of the driver. In suburban and rural areas, deliveries are often made by drones.

CHALLENGES FACED IN 2045

Key regional challenges include a disjointed transportation network, transportation equity, congestion, short-term rental demand for residential units pricing out residents from urban centers, and growing system complexity.

Disjointed Transportation Network

An increasing number of modes operate in the region's constrained right-of-way. It is not easy to find space for all of them. While the transportation system has been reimagined to be as flexible and to accommodate as many modes as possible, achieving this vision has proven difficult. The system is highly fragmented, and a number of service providers and modes tend to compete with each other, rather than cooperate and work together toward the same goal. Users often find there to be a disorienting number of choices.

Transportation Equity

Although costs of mobile technologies have been low enough that many low-income individuals are able to own them, they still struggle to afford ride-sourcing and micro-transit services. These new mobility options often offer less adequate transportation service in low-income communities, and they don't have geographic service provisions similar to public transit and taxis. Ideally, these new services would be highly integrated with transit, but unfortunately competition has ruled the day. Integrated transit, ride sourcing, and micro transit services could have helped low-income individuals to have dramatically improved access to job opportunities and the broader regional economy.

As retail is increasingly accessed online, there are far fewer brick-and-mortar stores than there were 30 years ago. This has made it harder to purchase basic needs without the technology needed to access e-shops, and made everyone more vulnerable during power or internet service disruptions. The wider on-demand economy is raising property values in and around regional centers, as using properties for short-term rental (less than 30 days) has proven to be more profitable than renting longer-term. While it is good for tourism, it is also pushing residents out of many desirable central locations. As walkable centers have fewer residents and suburban roads have more and more vehicles on them, walking and biking have been made less attractive.

Increasing Traffic Volumes and Speeds

The region's roads are overrun with competing versions of ride-sourcing and micro-transit companies, while better real-time road information means that more cars and trucks use local roads to try to avoid congestion. AV owners have found they can send their cars out to run errands passengerless, and businesses willingly provide service to them. These zero-occupant vehicles have created a lot of controversy, especially as they have added to the region's traffic problems. While AVs have brought crash rates down, there are ongoing safety concerns, particularly for females, when sharing or riding alone in a largely unregulated service. Also, it remains unclear if the region is prepared to evacuate large numbers of carless households in an emergency.

Privacy, Security, and Growing Complexity

Growth in the interconnected IoT means that most individuals, vehicles, appliances, and infrastructure have a presence online. This is generating a vast variety of data that is continuously being put to new uses. However, this data is creating privacy concerns for individuals, and hacking and other cyber risks to Internet-connected devices, creating new security threats. Due to lack of standardization, interoperability between digital devices and the IoT can be challenging. As new disruptive technologies have dramatically changed the region's economy and transportation system, there have been some poor investments in technology that did not take off. Despite this, it would have been worse to not invest at all, due to fear of failure, and falling behind other early-adopter regions. As technology increases system complexity, it is becoming very difficult to recognize defects or vulnerabilities before detrimental events transpire.[14] The convergence of real-time mobility technologies with AVs has shifted the demand associated with travel and land development patterns, leading to wide day-to-day variation in vehicle volumes on the region's roads.

WHY THIS SCENARIO MAY NOT HAPPEN

This trend is already underway. The big question is how quickly the technology evolves and the pace at which people and regulatory agencies embrace and adapt to these changes. Overcoming regulatory hurdles and getting to price points well below the cost of owning a vehicle are necessary to engender widespread use of ride sourcing and micro-transit services. The economic, regulatory, and/or security limitations for some of these technologies, particularly drones or autonomous vehicles, may make them less viable. Several lawsuits are in progress addressing the question of whether ride-sourcing drivers are independent contractors or direct employees. A finding of direct employees could undermine the economics of transportation networking companies.

[14] U.S. Department of Transportation, *The Smart/Connected City and its Implications for Connected Transportation* (Washington, DC: U.S. Department of Transportation, 2014), http://www.its.dot.gov/itspac/Dec2014/Smart_Connected_City_FINAL_111314.pdf.

WHAT-IF SCENARIO:

"[In 2013] the U.S. became the largest oil-producing country, bypassing Saudi Arabia."

—U.S. Department of Transportation. *Beyond Traffic 2045*

In 2045, the energy boom in Greater Philadelphia has coalesced around natural gas shipping and manufacturing, which has become a catalyst for economic expansion. Growth initially occurred around a regional energy hub along the Delaware River, and was followed by increased petrochemical production. There has been some increase in manufacturing in other sectors as well, particularly for industries looking for ready access to low-cost energy. However, technologies such as 3-D printing and robotics have limited the need for manufacturing workers. Most production facilities today are designed and built with no more than a five-year lifespan in mind. This is because manufacturing continues to be highly mobile, and it remains particularly responsive to ongoing shifts in globalization and technology.

The repeal of federal restrictions on natural gas and oil exports, which dated back to the Arab Oil Embargo of the 1970s, has restructured the global energy trade. The region benefitted greatly from becoming a major export hub of natural gas extracted from Marcellus Shale. The nation was able to allow energy exporting as it became more energy independent and was made necessary because of the mismatch between the light crude being produced, and the heavy crude U.S. refineries were set up for. Heavy crude was still being imported for refining, while there was a growing backlog of light crude that did not have a large enough domestic market.[15] Repealing the export ban opened markets up to

[15] Baker, George. "Repeal the Decades-old Oil Export Ban To Help Energy Renaissance." The Hill, March 11, 2015. http://thehill.com/blogs/congress-blog/energy-environment/235220-repeal-the-decades-old-oil-export-ban-to-help-energy (accessed August 24, 2015).

"A key issue to watch for is the point at which it is cheaper to ship Bakken crude (North Dakota) and Marcellus Shale gas to the region than importing Brent crude (North Sea) oil. The recent drop in oil prices reduces the economic competitiveness of both of these domestic fuel sources."

— Greater Philadelphia Futures Group Participant

more global trade, generated more opportunities to sell abroad, and increased demand for port facilities. This has also reduced reliance on rogue nations for energy, decreased the risk of supply disruption, and led to more energy price stability.[16] These actions have saved consumers money at the gas pump, and contributed to growth in employment, wages, and gross domestic product. Areas of energy extraction have been the greatest benefactors of these federal policy changes.

The agreement to remove energy export restrictions was tied to revoking the Jones Act, which required that a cargo ship had to be flagged in the United States in order to move products from one American port directly to another. This essentially traded off the nation's shipbuilding and, to a lesser extent, refining industries for the greater benefits that accrued to drillers and producers. Without repealing the Jones Act, it would have been cheaper to ship crude oil overseas, refine it, and then ship it back to the United States for sale, than to ship it within the United States for refining. U.S. shipbuilders have had a hard time competing without protection from foreign competition and Philly Shipyard (formerly Aker Shipyard), along with domestic oil refiners are all struggling in the global market. Rescinding energy export restrictions did, however, bring about an immediate end to shipping Bakken crude oil by train to the region. It now travels by pipeline to the Gulf Coast, and is then shipped to a local port at a fraction of what it cost to move by train.

The average resident has benefited from savings on home heating and increasing disposable income. Low energy costs and increasing wealth has generally led to lower-density development patterns. The region's economic growth has been correlated with decreasing inequality, as opportunities have expanded for lower- and medium-skilled individuals. Energy companies, in particular, can employ people of all skill levels.

Transportation Infrastructure and Goods Movement

As a result of the oil and gas boom, the region has been able to improve and more fully utilize its freight and manufacturing infrastructure. New pipelines have been built to connect the region to areas of natural gas production. A larger portion of goods are moved by water, rail, and pipeline as economic activity focuses on gas production and related manufacturing. Low energy costs have led to more driving and calls for expanding the region's limited road space. The average person now drives about 13 percent more miles per year than in 2010, which has contributed to a 36 percent increase in annual delay per capita (see Table 2).

CHALLENGES FACED IN 2045

Key regional challenges include keeping residents safe from the risks of gas and petrochemical shipments, worsening environmental and health conditions, reliance on fossil fuels, and economic instability due to increasing reliance on a single industry.

Petrochemical Train and Pipeline Safety

Residents' concerns about the safety of petrochemical trains and pipelines impede necessary infrastructure improvements. Although there have been continued technological improvements to ensure safety—such as the use of drones in front of trains to monitor the track and sensors to monitor braking and structural systems—no system is perfect. While the rail and pipeline safety records continue to improve, accidents still do occasionally occur around the nation.

Environmental and Health Conditions

This force has worsened Greater Philadelphia's air, land, and water quality, while harming human health in a variety of ways. Increasing stationary emissions has hampered the ability of the region to meet national air quality standards. As health insurance costs have become a major factor in where

[16] Charles K. Ebinger and Heather Greenley, *8 Facts about U.S. Crude Oil Exports* (Washington, DC: Brookings Institution, September 9, 2014), http://www.brookings.edu/research/reports/2014/09/09-8-facts-about-us-crude-oil-production (accessed January 2, 2015).

businesses choose to locate, the region's poor public health, particularly due to air quality, has made Greater Philadelphia less appealing to businesses looking to relocate around skilled workforces. There has been damage to the region's brand, which is being viewed as unsympathetic to environmental concerns. While many residents continue to loudly protest the energy boom, well-educated young people are too often leaving the region, and individuals who may have moved to the region in the past, now often choose to live in other large cities—unless they have a connection to the energy industry. Externalities, climate change impacts, and loss of biodiversity are intensifying due to continued reliance on fossil fuels.

Continuing Reliance on Fossil Fuels

A focus on natural gas as an energy source has hindered the development and adoption of clean, sustainable energy technologies and has weakened the region's ability to be a leader in green technology. The U.S. Energy Boom support for natural gas and other fossil fuels has increased greenhouse gas emissions, accelerating the worst impacts of the Severe Climate scenario. As regulations on natural gas fracking were put into place, the cost of these fuels has increased, and there are some doubts about long-term viability of this industry.

More Exposure to Boom-Bust Cycles

The energy boom has crowded out other importing and exporting industries for the use of the region's limited freight rail and port facilities. Poor air quality has made obtaining the necessary permits more difficult for manufacturers and those without ties to or need for natural gas have shied away as a result. This has led to an increasing reliance on an interrelated set of energy-based industries which has left the region more vulnerable to the dire bust cycles of economic downturns, and brought an end to our reputation as being a slow and steady growth region. Meanwhile, the knowledge economy continues to be the primary driver of global growth, and economies tied too heavily to traditional manufacturing and resources are falling behind.[17]

WHY THIS SCENARIO MAY NOT HAPPEN

Energy prices are highly volatile, due to international forces well beyond regional control. Continued low energy costs could slow domestic energy production. Federal and state regulations will help to shape the future of energy, and it is hard to predict what those will be. Local government collaboration and coordinated decision making is critical to developing the energy hub and the infrastructure needed for it. Greater Philadelphia is in competition with Texas and other regions. While our locational advantage is a key opportunity, particularly in terms of shipping costs, we are already behind in the race. Pipelines are currently being reversed to allow commodities to flow to Texas and other areas. Local opposition to expanding pipeline capacity could also suppress the boom. Nationwide, wastewater disposal wells are being correlated with greater earthquake frequency and intensity; a more definitive link between them could increase calls to ban fracking outright.

The cost of renewable energy is quickly becoming competitive with natural gas and coal, while increasing energy efficiency may reduce total demand for energy. Natural gas wells are not lasting as long as predicted and could prove to be not economically viable. Global international agreements on carbon taxes and other measures to fight climate change could alter the equation as well.

[17] Luis, *A Tale of Ten Cities: Attracting and Retaining Talent*.

Key 2045 What-if Scenario Projections

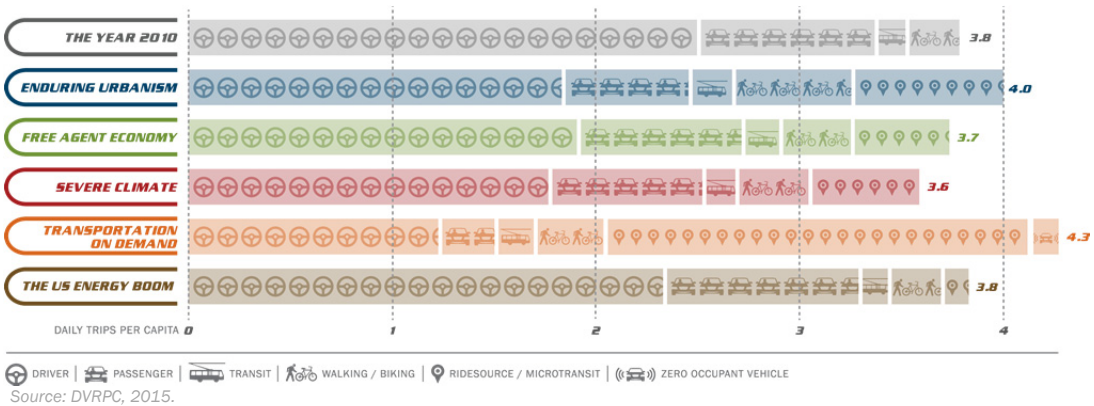
These projections are included in order to further illustrate the different futures, and stimulate discussion about the scenarios. Base year (2010) values are provided for comparison. In some futures, the systemic change makes some measures difficult to estimate. For instance, the blurring of public transit and private vehicles in Transportation on Demand makes it difficult to distinguish between transit ridership and VMT. Safety improvements are anticipated from connected vehicles in all scenarios, and further improvements from AVs in Transportation on Demand.

Table 2. Greater Philadelphia Future Forces What-If Scenario Projections for 2045

Factor	2010	Enduring Urbanism	The Free Agent Economy	Severe Climate	Transportation on Demand	The U.S. Energy Boom
Percentage of Population <16	19%	18%	18%	19%	19%	20%
Percentage of Population >65	13%	20%	20%	19%	20%	18%
Total Households (millions)	2.13	2.62	2.38	2.32	2.46	2.50
Population per Household	2.64	2.51	2.71	2.78	2.64	2.59
New Footprint Residential Acres Developed, 2010–2045	-	20,300	64,300	70,100	145,700	226,400
New Footprint Commercial Acres Developed, 2010–2045	-	25,900	52,700	59,000	62,700	95,500
Population in *Connections 2040* Centers	23%	25%	24%	23%	23%	20%
Employment in *Connections 2040* Centers	22%	23%	23%	23%	22%	21%
Annual Residential Energy Greenhouse Gas Emissions per Household ($MTCO_2E$)	7.6	6.4	6.7	6.5	6.2	7.2
Average Annual Household Residential Energy Costs[a]	$2,210	$1,380	$1,500	$1,810	$1,410	$1,340
Vehicles per 1,000 Capita	573	518	576	565	395	627
Percent Zero-Car Households	15%	26%	15%	15%	38%	13%
Daily VMT (millions)	107.0	116.1	114.1	109.5	146.4	139.2
Annual VMT per Capita	6,940	6,440	6,470	6,190	8,220	7,840
% VMT through Ride Sourcing/AVs	0%	16%	11%	14%	58%	3%
Average Vehicle Occupancy	1.3	1.6	1.6	1.6	1.8	1.4
Daily VHT (millions)	3.57	3.74	3.66	3.48	4.98	4.68
Average Daily Speed (mph)	30	31	31	32	29	30
Annual Recurring Vehicle Hours of Delay per Capita	22	22	20	21	31	30
Annual Fatal Crashes	326	186	194	176	196	225
Annual Injury Crashes	31,784	16,730	17,410	15,785	17,750	20,240
Daily Gallons of Gasoline (millions)	5.0	2.5	2.6	2.2	2.4	3.4
On-Road Greenhouse Gas Emissions, Tailpipe Only (Annual $MTCO_2E$ per Capita)	3.9	1.3	1.3	1.1	1.3	1.8
Daily Linked Transit Trips (millions)	0.8	1.4	1.2	1.2	1.3	0.9
Daily Walking and Biking Trips (millions)	1.5	3.8	2.3	2.3	2.3	1.7
Annual Household Transportation Costs[a]	$10,870	$14,260	$8,860	$17,530	$15,120	$10,490
Transportation Costs as a % of Income	15%	15%	10%	20%	16%	11%

[a]In 2010 dollars.

Figure 4. Daily Trips per Capita and Mode Share



Source: DVRPC, 2015.

Future Fairness

DVRPC's Long-Range Plan aims to build a more sustainable, innovative, and equitable future for Greater Philadelphia. A central component in achieving equitable outcomes is to practice environmental justice (EJ): the fair treatment and meaningful involvement of all people, regardless of religion, race, ethnicity, income, or education level in planning and decision making. Equity means ensuring all people have fair and meaningful opportunity to lead healthy lives, with particular emphasis on avoiding or mitigating adverse human health or environmental effects on minority and low-income populations by governmental decision-making and programs. Equity between generations also needs to be a key consideration in decision making, this includes considering how those who have not yet been born will be impacted, called intergenerational equity, as well as the impact to EJ protected groups under Title VI of the Civil Rights Act. These groups are discussed in the Future Forces in the following ways:

- Enduring Urbanism – higher housing costs in regional centers, and risks of gentrification puts undue burden on low-income populations.
- The Free Agent Economy – people are more and more frequently being left to fend for themselves in the economy, risking a loss of consistent employment along with healthcare and retirement benefits. This force could help drive an increase in entrepreneurship in low-income and disadvantaged communities.
- Severe Climate – Negative health impacts, increased flooding, and other weather-related damages to homes and neighborhoods in low-income areas.
- Transportation on Demand – private sector ride-sourcing and micro-transit services may present job opportunities, but also lead to diminished taxi and transit service in EJ communities, as private companies are not required to serve these areas.
- The U.S. Energy Boom – More lower-skill job opportunities will be created, but also negative air quality impacts in neighborhoods located near the energy hub.

The potential opportunities and problems that could arise from the Future Forces make equity an important part of the conversation about how change is likely to occur in the region. As more and more economic activity is coordinated through apps, and social trust comes from peer reviews, what role do bias and discrimination play in economic development? As ride sourcing becomes more and more common, how will it serve the physically disabled? Or even families with small children? As access to the internet and skills to use it highlight ongoing concerns about the digital divide, how will lower skill individuals find opportunities in a world of continued outsourcing and automation, where most jobs will require high-skill levels?

Across all what-if scenarios, the region projects to be older, have more immigrants, and potentially greater income disparities. One of the ultimate challenges for Greater Philadelphia moving forward is trying to find ways to create more equitable outcomes in housing, health, education, economic opportunity, and access to technology. Thus, it will be essential to identify and pursue actions that protect and improve the health and welfare of all residents, particularly low-income and EJ communities. The Philadelphia Association of Neighborhood Groups has proposed a set of goals for achieving a more equitable future. These goals are that low-income and EJ communities be able to: influence the decision making that shapes their community, benefit from improvements to their neighborhood, access resources and services that fulfill basic needs and enhance quality of life close to home, have choices in where they live and work, and not be involuntarily displaced from their preferred neighborhood.[1]

[1] Philadelphia Association of Community Development Corporations, *Beyond Gentrification: Toward Equitable Neighborhoods* (Philadelphia, PA: Philadelphia Association of Community Development Corporations, 2015), www.phillylandbank.org/sites/phillylandbank.org/files/u3/PACDC_EcDevPlat_Full%20Platform.pdf.

Interactions between the Future Forces

Although the scenarios were developed independently from each other, it is important to consider the interactions between the different Future Forces should they arise simultaneously. While, highly speculative, this section begins to consider how the five forces may relate to each other; potentially leading to very different outcomes than would be expected from each force individually. There are different ways in which the forces may react: strengthening both, weakening both, or having mixed impacts—where one is strengthened (or weakened) and the other is weakened (or strengthened).

- Both are strengthened—in these cases there is a symbiotic relationship of sorts, where the impacts of one magnify the impacts of another (note the impacts can be positive or negative outcomes).
  - Enduring Urbanism and The Free Agent Economy—both are anticipated to push denser, more center-based development patterns to help build agglomeration economies.
  - Transportation on Demand and The U.S. Energy Boom—low energy costs, low-density development patterns, and increased travel options all promote more motorized transportation.
- Both are weakened—in this case the overall outcomes of both are made less severe or impactful, or in a sense they cancel each other out. As a result, it is doubtful that these forces can co-exist.
  - Enduring Urbanism and The U.S. Energy Boom—negative environmental and health outcomes may make the region less desirable to those who would choose to locate here for urban lifestyles. However, these individuals may have enough influence to limit The U.S. Energy Boom's regional extent.
- Mixed Impacts—in other instances the impacts of one force are improved while the outcomes of the other are worsened, or little changed. Essentially the results move in different directions.
  - Enduring Urbanism and Severe Climate—the dense development patterns in Enduring Urbanism are reinforced by Severe Climate; however, they are not enough to significantly mitigate climate change.
  - Enduring Urbanism and Transportation on Demand—both support a more car-free lifestyle and multimodal transportation. This combination of forces may further increase walking, bicycling and transit use, with perhaps lower ride sourcing and micro transit trip rates than in Transportation on Demand on its own.
  - The Free Agent Economy and Severe Climate—the center-based development patterns needed to build agglomeration economies in The Free Agent Economy are reinforced by Severe Climate; however, they are not enough to significantly mitigate climate change.
  - The Free Agent Economy and Transportation on Demand—The Free Agent Economy is made worse off as more spread out development patterns weaken agglomeration economies.
  - The Free Agent Economy and the U.S. Energy Boom—increased need for low- and moderate-skilled workers in The U.S. Energy Boom reduces how many workers are left fending for themselves in The Free Agent Economy.
  - Severe Climate and Transportation on Demand—Severe Climate may limit the lower density, motorized trip rates that arise in Transportation on Demand. However, Severe Climate will not be heavily influenced by Transportation on Demand.
  - Severe Climate and The U.S. Energy Boom—The U.S. Energy Boom may worsen the outcomes in Severe Climate, while growing concerns about Severe Climate could limit the magnitude of The U.S. Energy Boom.

Table 3. Potential Interactions Between the Future Forces

Force 1	Force 2	Relationship	Interactions Between Them
Enduring Urbanism (+)	The Free Agent Economy (+)	Strengthens Both	■ The Free Agent Economy may be a cause of Enduring Urbanism. Together, they may strengthen the region's agglomeration economy.
Enduring Urbanism (+)	Severe Climate (0)	Mixed Impacts	■ Severe Climate may reinforce Enduring Urbanism, though it could restrict development of desirable riverfront areas, and add risk to growing development centers. ■ Enduring Urbanism could reduce the risk of Severe Climate.
Enduring Urbanism (+)	Transportation on Demand (0)	Mixed Impacts	■ Transportation on Demand provides more travel options that do not require car ownership, which is being sought by some individuals interested in Enduring Urbanism lifestyles. ■ The ability to be car-free or car-lite in more suburban settings could weaken the desire for Enduring Urbanism. ■ Conversely, Enduring Urbanism preferences for walking and biking could reduce growth in Transportation on Demand.
Enduring Urbanism (-)	The U.S. Energy Boom (-)	Weakens Both	■ The U.S. Energy Boom could worsen air quality and environmental conditions, and low-cost energy generally encourages lower-density development. In sum, this potentially detracts individuals interested in Enduring Urbanism lifestyles, making it less likely to happen. ■ Ongoing weakness in the energy market combined with ongoing interest in living in walkable centers could strengthen regional movements against increasing regional energy distribution.
The Free Agent Economy (+)	Severe Climate (0)	Mixed Impacts	■ Severe climate may encourage denser development patterns that help to build critical agglomeration economies. ■ Warmer winter temperatures may attract more free agents.
The Free Agent Economy (-)	Transportation on Demand (0)	Mixed Impacts	■ Mobile technologies are largely driving both. The Free Agent Economy considers the business and economic effects of these technologies, while Transportation on Demand considers their travel impacts. Ride sourcing and micro transit drivers in Transportation on Demand are working in The Free Agent Economy. ■ This combination suggests lower-density development patterns than needed to build agglomeration economies in The Free Agent Economy. ■ Transportation on Demand will need to offer lower cost transportation than car ownership to grow in The Free Agent Economy.
The Free Agent Economy (-)	The U.S. Energy Boom (0)	Mixed Impacts	■ Increased demand for low- and medium-skill workers in U.S. Energy Boom lessens the need for workers to fend for themselves.
Severe Climate (0)	Transportation on Demand (-)	Mixed Impacts	■ Transportation on Demand is likely to increase motorized vehicle and energy use, but could do so in a more efficient manner thereby reducing emissions. ■ Not certain how Severe Climate would change individuals' transportation choices.
Severe Climate (+)	The U.S. Energy Boom (-)	Mixed Impacts	■ Both are driven by low-cost fossil fuels. In the medium term, emissions can be reduced by replacing coal with natural gas. ■ Effects to limit climate change would reduce the extent of The U.S. Energy Boom. ■ More fossil fuel production would make Severe Climate more likely to occur.
Transportation on Demand (+)	The U.S. Energy Boom (+)	Strengthens Both	■ Low-energy costs suggest more reliance on motorized transportation and lower-density development patterns.

Legend
(+) Force is made stronger, or more powerful, as a result of the other force
(-) Force is made weaker, or less potent, as a result of the other force
(0) Force will not be significantly changed as a result of Interaction with other force

Source: DVRPC 2016.

PART III. TAKING ACTION

"The only relevant discussions about the future are those where we succeed in shifting the question from whether something will happen to what we would do if it happened."

—Arie de Geus, former coordinator, Group Planning, Shell International Petroleum Company

The region will need to use the best information available to take advantage of the opportunities and mitigate for the challenges that each of these forces will bring. Taking knowledge and turning it into action is a key goal. The Futures Group and other DVRPC task forces have identified this initial draft list of strategic short- and medium-term actions, which was supplemented by research documented in Appendix C. These actions are not limited to DVRPC's transportation, land use, economic development, and environmental planning areas. Nor are they DVRPC's responsibilities alone. There are many actors throughout the region that will need to work together in a coordinated fashion to bring them about. Decisions collectively made in the present will have large effects on the region's future economy and demographics. For example, significantly increasing bicycle and pedestrian infrastructure funding, to take advantage of the growing cycling culture, could change regional patterns of in- and out-migration.[18] In addition to attracting more well-educated young individuals seeking walkable center-based lifestyles, an array of additional benefits could be realized, including better public health, improved air quality, and lower transportation costs. This is an example of the complex system dynamics at play within the provision of transportation infrastructure and other investment decisions made in the region.

Recommended actions include policy directives, workforce skills necessary to effectively compete in the global economy, and transportation investments to ensure the efficient movement of people and goods. Workforce skills are central to competitiveness, growth, and building agglomeration economies. A skilled workforce is the top consideration that industries consider when relocating or opening new subsidiaries, as well as for developing the economy from within. A growing economy can then be used to improve quality of life, increase educational attainment, and enhance regional amenities that can attract further investment in a virtuous cycle. Some actions are universal, meaning they are beneficial regardless of whatever the future brings. Others are contingent, or specific to each particular Future Force coming to fruition. Whether or not this is happening can be determined by tracking the leading indicators identified in this section (see also Appendix B). Even in the best-case scenario, only a handful of these recommended actions can be implemented. This puts increasing pressure on the region's decision makers to very carefully weigh the options and pursue the actions that offer the highest benefits to Greater Philadelphia.

Universal Actions

Universal actions are beneficial to the region regardless of which forces come into play in the future. Universal workforce skill sets include science, technology, engineering, and math, which can help to drive ideas and innovation, the foundation for economic growth. Data science and the ability to work with big data are likely to be particular growth areas. Entrepreneurial skills, which can turn ideas and innovations into viable commercial products and services, may be more important. A certain amount of skilled manual labor is likely to remain in demand, and there should be more training for it. Another valuable ability is to be able to perform complex problem solving while working with one's hands.

Universal Regional Actions

- ☐ Encourage **mixed-use infill development** where transportation and utility capacity already exist. Update zoning and building codes to allow for a variety of smaller housing options, including more attached homes, multi-family development, and micro apartment units.
- ☐ Build **lifelong communities** that allow for aging in place. Retrofit older homes, and ensure new ones have visitability (one no-step entrance, a minimum 32″ opening for all doorways, and a bathroom on the first floor).

[18] National Highway Cooperative Research Program, NCHRP Report 750—Volume 6. The Effects of Socio-demographics on Future Travel Demand.

- ☐ Implement **universal pre-kindergarten** and other programs that help to improve educational outcomes for the region's future workforce, particularly for low-income and EJ communities that are falling behind. This will help to attract talented workers, who are concerned about the quality of their children's education, to the region.
- ☐ Develop and grow the region's **impact economy**, which addresses economic and social challenges our communities and organizations face. This includes companies that have an environmental or social impact and generate a profit, creating shared value through public–private partnerships, and using private and endowment capital to do public good while seeking a return on their investments. This can particularly support the desire of many young adults who are seeking work opportunities with a higher purpose.
- ☐ Encourage **immigrant-friendly policies** in preparation for population growth and integration, including outreach to these communities and education about how to connect the immigrant population with existing language, social service, and business resources.
- ☐ Strengthen **Northeast megaregion collaboration and cooperation**, build partnerships, and recognize that Greater Philadelphia benefits from a broader economic unit. Support efforts to improve mobility within the megaregion through higher-speed interregional rail.
- ☐ Create **regional or local big data team(s)** to centralize and analyze datasets in a single, shared platform to guide decision-making, and enhance government programs. Use design thinking to tame big, ill-structured problems.
- ☐ Expand **telecommunications bandwidth** infrastructure to better connect with the global economy, and enhance internet access and training for low-income individuals.
- ☐ Build **green infrastructure** and use biophilic design concepts to mitigate the urban heat island effect and flooding, lower costs, improve air and water quality, and bring nature back into densely developed areas. Encourage adoption of new suburban **stream buffer ordinances** and strengthen and enforce existing ones in order to preserve water quality and reduce flooding.
- ☐ Create and implement **Vision Zero** plans, which set a goal of zero roadway fatalities, to ensure new technologies enhance safety and protect all transportation system users through reduced speed limits, intersection improvements, road diets, and other appropriate safety measures.
- ☐ Develop a structured **freight enhancement plan** to identify and prioritize freight infrastructure investments, raise awareness of freight issues, manage delivery times, designate truck routes, and encourage the development of freight consolidation centers. Utilize alternative funding mechanisms to pay for freight improvements through market pricing, such as congestion fees or loading zone fees.
- ☐ Create and implement regional **infrastructure resiliency** plans. Increase funding for projects that reduce vulnerability, and enhance flexibility and resiliency of infrastructure to the effects of climate change. Accommodate relocation of critical assets where possible and harden them where it is not. Develop alternative energy sources and micro grids.
- ☐ Preserve, maintain, and **modernize transportation infrastructure**, while creating a multimodal network. Explore dedicated regional funding to improve the transportation system.

Contingent Actions

The Futures Group identified leading indicators (see Appendix B) to determine if a force is occurring in the region, the workforce skills needed to compete in the future economy, and action steps the region should take to prepare for each force. Contingent actions, skills, and leading indicators specific to each force follow.

ENDURING URBANISM

Enduring Urbanism assumes that tax reforms can be successfully implemented to improve business climates and grow economies, particularly in regional centers. Centers need to maintain their commercial functions and business and industry should not be priced out by demands for residential and entertainment space. Schools, particularly in urban areas, need significant improvements in order to attract and retain families. Social and analytic skills will be highly valuable in this future. With increasing globalization and continued evolution of the knowledge economy, translators and language skills will be a growth area. Maintaining equitable outcomes will be a major challenge. There will be strong demand for major new pedestrian facilities, such as pedestrian plazas and pedestrian zones

within central business districts (which will need to consider freight accommodations in their design) and complete rethinking of road design (shared space, protected bike lanes, Complete Streets).

Redesigning streets to provide more bike and pedestrian features, green infrastructure, and natural amenities can make dense urban areas more vibrant and appealing to people of all ages.

Top Regional Actions

- ☐ (Re)develop without displacing existing households through policies and programs that:[19]
  - ☐ Enable individuals, community groups, businesses, and developers to form inclusive neighborhoods.
  - ☐ Develop and maintain affordable housing throughout the region.
  - ☐ Expand economic opportunity in neighborhood and regional centers and work with major employers to increase local hiring and sourcing.
  - ☐ Research and better understand the impacts of displacement and extend assistance programs.
- ☐ Thoroughly implement Complete Streets policies to accommodate all users, including goods movement, along with protected bike lanes, pedestrian-only areas, shared space/living streets, and/or open/play streets that prioritize bike and pedestrian use, particularly in the region's centers.
- ☐ Update zoning codes to allow for more construction of multifamily units, including accessory dwelling units, cohousing, micro apartments, shared housing, and supportive housing.
- ☐ Take advantage of growing demand for transit service by increasing frequency, and focus expansions around emerging walkable suburban centers and low-income communities.
- ☐ Decrease urban and suburban parking requirements, price parking to more efficiently use land.
- ☐ Redevelop suburban office parks and commercial districts, and update suburban design guidelines to allow for more mixed-use development and form-based zoning.
- ☐ Improve community aesthetics through better street cleaning, urban design, and other strategies.
- ☐ Identify and protect critical regional industrial zones, particularly those with multimodal access.
- ☐ Emphasize all "universal actions," particularly mixed-use infill development; immigration-friendly policies; building lifelong communities; expanding telecommunications bandwidth; Vision Zero; green infrastructure; freight improvements, especially consolidation centers; universal pre-kindergarten; infrastructure resiliency; and modern multimodal transportation.

Leading Indicators

- ☐ Percentage of total population, employment, and residential building permits in core cities and developed communities, or regional centers.
- ☐ Annual VMT and transit ridership per capita.
- ☐ U.S. Census mode share using transit, biking, or walking.

FREE AGENT ECONOMY

Transportation, telecommunications, and social networks are all critical to helping individuals make connections in The Free Agent Economy. A better understanding of how goods, people, and ideas flow in and between megaregions is needed.[20] Municipal regulations must be rewritten to reflect changes being wrought by the Internet and the sharing economy. Reforms should equalize tax treatment of homeowners and renters. Suburban residents will need a relaxation of municipal restrictions that ban working from home. As companies transfer more and more risk to the workforce, workers will need better protection against wage theft and labor violations, while receiving a living wage, health, retirement, paid time off, and other benefits.[21] A new classification for dependent workers, who largely work as contractors for a single company, could help expand worker protection. Third party platforms

[19] See also Philadelphia Association of Community Development Corporations, *Beyond Gentrification: Toward Equitable Neighborhoods* (Philadelphia, PA: Philadelphia Association of Community Development Corporations, 2015), http://www.phillylandbank.org/sites/phillylandbank.org/files/u3/PACDC_EcDevPlat_Full%20Platform.pdf.

[20] Volpe Transportation Center, *Transportation Drives Economic Competitiveness in Megaregions* (Cambridge, MA: Volpe Transportation Center, November 13, 2014), http://www.volpe.dot.gov/news/transportation-drives-economic-competitiveness-megaregions (accessed January 5, 2015).

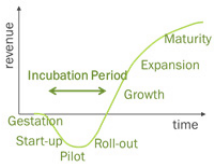
[21] Sarah Treuhaft, "Can We Bend the Sharing Economy toward Equity?" Rooflines Blog published by the National Housing Institute, February 19, 2015, http://www.rooflines.org/4049/can_we_bend_the_sharing_economy_toward_equity/ (accessed February 27, 2015).

could allow freelancers to retain their digital identifications and reputations if they move between online work platforms, ensuring they don't have to rebuild their accreditations from scratch.[22]

Education is critical, especially for EJ and low-income communities, where it is the key for escaping poverty. The next round of automation may displace many medium-skill and even some high-skill jobs. The region will need a flexible workforce, able to quickly adapt to changing economic needs. Specific skills needed include critical thinking, problem solving, sales, the ability to self-promote, customer service, strong communications, and the ability to work with their hands. As each project may be done working with an entirely different set of people, independent contractors need to be diplomatic, self-assured, and persuasive. Creativity and social skills are particularly hard to outsource or automate.

Top Regional Actions

- ☐ Consider ways to improve social safety nets for paid time off, retirement, and healthcare for all workers, with particular attention paid to the needs of freelancers.
- ☐ Expand and support regional business incubators, accelerators, and innovation hubs that help businesses beyond the start-up phase.
- ☐ Increase transit service during off-peak hours, along with intra-suburban service, and improve service to suburban office parks.
- ☐ Update zoning codes to allow for shared office space and mixed-use buildings.
- ☐ Build more middle-class housing units with a wider mix of types: duplexes, triplexes, fourplexes, courtyard apartments, bungalow courts, townhomes, live/work space, mid-rises, and high-rises.
- ☐ Ensure that zoning and permitting regulations do not restrict the pop-up economy, which allows entrepreneurs and businesses to test new concepts and ideas in the short term at low costs.
- ☐ Simplify tax collection, licensing, permitting, and other regulations to better fit a world where most people employ themselves, and expand small business and entrepreneurial training programs.
- ☐ Increase connections to the global economy through more international flights to and from Philadelphia International, and/or increasing passenger flights from smaller regional airports.
- ☐ Seek regional cooperation to identify policies that can alleviate poverty and homelessness.
- ☐ Emphasize all "universal actions," particularly mixed-use infill development; immigrant-friendly policies; growing the impact economy; expanding telecommunications bandwidth; megaregional cooperation; freight enhancements; universal pre-kindergarten; regional/local big data teams; infrastructure resiliency; and modern multimodal transportation.



Business incubators, accelerators, and innovation hubs can help start-ups grow and expand by lowering the steep cost for office space during the pilot and roll-out phases of a typical business lifespan.

Leading Indicators

- ☐ Square feet of shared/coworking office space.
- ☐ Percentage of all firms with four or fewer employees.
- ☐ Self-employed workers as a percentage of all working-age population.
- ☐ Percent of households who rent.

SEVERE CLIMATE

Action related to climate change must both minimize the severity of climate change by aggressively reducing greenhouse gas emissions, and adapt to more intense weather patterns. Reducing greenhouse gases will require developing carefully crafted policies to regulate emissions which minimize impacts on economic growth and well-being. It will also require recognizing that a transition to a low carbon economy can stimulate growth in sectors such as energy efficiency and renewable energy production, and positioning the region to take advantage of these opportunities through workforce training programs and policies that ease the adoption of new technologies.

To adapt to climate change, policy makers must accept that the past is no longer a sufficient guide for designing infrastructure facilities, which will need to tolerate a larger temperature range, be prepared to handle greater rainfall, and withstand higher wind speeds. Regional dialogue is needed to determine which of our most critical assets are vulnerable to the impacts of climate change, and

[22] Wladawsky-Berger, Irving. "The Continuing Evolution of the On-Demand Economy." CIO Journal of the Wall Street Journal, July 24, 2015. http://blogs.wsj.com/cio/2015/07/24/the-continuing-evolution-of-the-on-demand-economy/ (accessed December 7, 2015).

action needs to be taken to either protect them or relocate them to areas out of harm's way. Greater Philadelphia must maintain and develop additional redundancies to assure transportation and other infrastructure systems remain resilient as the climate changes. Skills to help successfully navigate this transition include a strong understanding of natural systems, renewable energy systems, energy efficiency, and other sustainable approaches to the design and the built environment.

Top Regional Actions

- ☐ Expand interagency and intergovernmental coordination as climate change affects numerous systems simultaneously across multiple jurisdictions.
- ☐ Focus on climate change adaptation:
  - ☐ Evaluate the critical transportation and community assets that are vulnerable to climate change, and take steps to minimize risk, including protecting and relocating assets as required.
  - ☐ Improve emergency preparedness: model and prepare evacuation plans, conduct pre-event planning, system management during events, and post-event recovery to quickly get systems back online.[23]
  - ☐ Preserve and extend wetlands, and build levees to protect key development areas and infrastructure from flooding. Reconfigure major freight routes to avoid flood prone areas.
  - ☐ Update building codes and practices to make structures less prone to more unpredictable and extreme weather events, such as increased wind speed, rainfall, and snowpack.
  - ☐ Update floodplain ordinances to incorporate expected impacts of climate change. Initiate a system to reevalate these ordinances as climate change proceeds.
  - ☐ Increase water storage capabilities, for stormwater management and drinking water preservation.
- ☐ Continue to pursue actions to reduce greenhouse gas emissions at the regional, local, firm, and household level:
  - ☐ Upgrade indoor and outdoor lighting to efficient LED or fluorescent lighting.
  - ☐ Improve building energy efficiency through smart thermostats to prevent unneccesary use of heating and cooling equipment, air sealing and insulating building envelopes, and high-efficiency HVAC systems.
  - ☐ Lower regulatory and permitting barriers to solar panel installation.
  - ☐ Encourage production of solar passive, net-zero, and energy positive buildings.
  - ☐ Promote cogeneration plants to use waste heat from electricity production to heat and cool (through the use of chillers) homes, and capture carbon emissions for use in other manufacturing processes, such as beverage carbonization.
  - ☐ Ease procedures for installing electric vehicle supply equipment and charging stations in residential, workplace, and commercial settings to accelerate the shift to electric vehicles.
  - ☐ Encourage automobile insurance companies to offer pay-as-you-drive policies for light-duty vehicles.
  - ☐ Implement travel demand management and parking strategies that improve land use and transportation efficiency. Examples include parking cash out, (increased) parking fees, parking maximum regulations, and municipal payment in lieu of parking programs.
- ☐ Preserve agricultural land and take other measures to increase regional food production.
- ☐ Continue to invest in and make the region into an alternative energy and clean technology hub. Accelerate the movement toward low-carbon electricity production.
- ☐ Emphasize all "universal actions," particularly mixed-use infill development; megaregional cooperation; growing the impact economy; freight enhancements; green infrastructure; infrastructure resiliency (including microgrids); and a modern multimodal transportation system.

A passive building design in Philadelphia. Passive buildings use insulation, ventilation, design, and technology to maintain a comfortable temperature. They require very little energy for heating or cooling as a result.

Source: Wallace, Roberts, and Todd and The Maze Group, Philadelphia, PA

Leading Indicators

- ☐ Global atmospheric CO_2 parts per million.
- ☐ Average regional temperature and precipitation.
- ☐ Delaware River sea level rise.

[23] See also National Highway Cooperative Research Program, *NCHRP 750—Volume 2. Climate Change, Extreme Weather Events, and the Highway System* (Washington, DC: Transportation Research Board of the National Academies, 2014), http://onlinepubs.trb.org/onlinepubs/nchrp/nchrp_rpt_750v2.pdf.

TRANSPORTATION ON DEMAND

New technologies offer a unique opportunity to thoroughly reimagine the entire transportation system. Research and effort should be put into a national vision for the transportation system, and how investments and regulations can help support that vision. Fast changing technologies present many challenges in keeping transportation regulations current, and potentially transformative transportation and safety advances could be held back.[24] Thus, regulations should be seen as a way to spur innovation and an opportunity for governmental and private market collaboration. This can help technology be better tested and put into production more quickly.[25] New shared mobility platforms and other technologies need to be better incorporated into long-range planning. Integrating transit with new ride-sourcing and micro transit services offers the opportunity to better connect low-income individuals to jobs and make last-mile transit connections.

If autonomous vehicles do emerge, they probably won't be a silver bullet that solves all of our transportation problems. Instead they will likely improve the system in some ways, for instance through improved safety and reduced congestion. They will also create new challenges, such as promoting more spread-out, low-density development and potentially increasing traffic speeds and volumes, both of which could harm community livability. Consistent federal AV regulations are preferable to a patchwork of state ones. Individuals who have the skills to work with technology, big data, and robotics will be well suited for this future.

Top Regional Actions

- ☐ Promote coordination between public and private transportation operators to achieve a connected, multimodal system where the whole is greater than the sum of the parts:
  - ☐ Develop a singular regional fare payment and real-time information app that allows individuals to use and pay for transit, bike share, ride sharing, micro transit, ride sourcing, and taxi services. It should give real-time travel information for all modes and include cost, wait time, time to complete, and the trip's greenhouse gas emissions. The payment instrument would have no need for exact change or to make cash transactions. It can overcome equity questions by serving as a banking mechanism for those who do not have access to a credit card or bank account.
  - ☐ Create multimodal transportation hubs that work as a one-stop alternative transportation shop, by blending a transit station or stop with car sharing, bike sharing, micro transit, ride sourcing, ride sharing, and taxi pick-up and drop-off points. Replace some on-street parking spaces with curbside pick-up and drop off points.
  - ☐ Use new shared modes as last-mile to transit connectors, particularly in suburban areas.
  - ☐ Continue to maintain and expand publicly accessible schedule and real-time open data for transit operations, and encourage open data and data sharing with ride sourcing, micro transit, and other private transportation companies.
  - ☐ Bring outdated, incomplete, and missing highway interchanges up to modern standards.
- ☐ Invest in a diversified transportation network, traffic calming on local roads, and protected bike lanes to safeguard nonmotorized users and deter neighborhood street use by through-traveling vehicles.
- ☐ Expand electrical outlets, Wi-Fi, and cellular networks in and around transit vehicles and stations.
- ☐ Prepare evacuation plans to move larger numbers of carless households.
- ☐ Legalize ride-sourcing services to pick up passengers who have prearranged travel and cost through a smartphone app, while requiring ride-source drivers to have commercial insurance, undergo background checks and vehicle inspections, and make automatic remittances of applicable local, state, and federal taxes at the time of the transaction. Taxi regulations could also be loosened, in order to level the playing field, though these services should be seen as serving different markets. More research is needed on the cost effectiveness and efficiency of different background check and vehicle inspection systems.[26]

Mobil.Punkt stations in Bremen, Germany, combine a transit stop with car sharing and bike sharing.

Source: www.carsharing.de

[24] U.S. Department of Transportation, *Beyond Traffic 2045: Trends and Choices* (Washington, DC: U.S. Department of Transportation, 2014), https://www.transportation.gov/sites/dot.gov/files/docs/Draft_Beyond_Traffic_Framework.pdf.
[25] Ibid.
[26] See also Transportation Research Board. *Special Report 319: Between Public and Private Mobility: Examining the Rise of Technology-Enabled Transportation Services*. Washington, DC: Transportation Research Board of the National Academies, 2015. http://www.trb.org/main/blurbs/173511.aspx.

- ☐ Incentivize the private sector, nonprofits, and public–private partnerships to participate in infrastructure development to speed up project delivery and better respond to new technologies.
- ☐ Reduce or eliminate minimum parking requirements for developments that incorporate or allocate existing parking spaces to car sharing services, and lower parking fees or taxes for car sharing spaces.
- ☐ Consider strategies to increase access for low-income individuals to jobs through ride sharing, ride-sourcing, and micro transit.
- ☐ Ensure that new transportation technologies and services are accessible to individuals with disabilities and are friendly to families with small children.
- ☐ Emphasize all "universal actions," particularly building lifelong communities; Vision Zero; freight enhancements; expanding telecommunications bandwidth; regional/local big data teams; infrastructure resiliency; and a modern multimodal transportation system.

Leading Indicators

- ☐ Non-single-occupant vehicle commute mode share.
- ☐ Car ownership per capita.
- ☐ Percentage of zero-car households.

U.S. ENERGY BOOM

Safety is paramount, both for protecting citizens and maintaining their support. Aging and inadequate infrastructure is a major challenge, along with bringing pipelines into port facilities and increasing port capacity. The long-term framework of needed investments must be weighed against the short-term volatility of fuel prices and the instability of major oil-producing countries. The next focus area is to enhance other infrastructure that serves the ports. Improvements are needed in rail and truck corridors, particularly last-mile connectors. The region will need to consider the flexibility of the transportation infrastructure and ensure it will be able to respond to future changes in the economy. Achieving production increases will require more capacity for chemical manufacturing and refining. And more manufacturing may increase the need for regional freight distribution facilities. Lastly, seek ways to enhance U.S. ship building and refinery competitiveness in the global market.

Top Regional Actions

- ☐ Personal safety risks, public health, and environmental impacts should be included in the decision-making process for investing in new pipelines and other freight infrastructure.
- ☐ Market the region internationally as an energy hub to encourage companies to relocate here and take advantage of natural gas opportunities.
- ☐ Work with the refineries, port facilities, pipeline operators, and freight railroads to promote safety, clean air, and *freight-as-a-good-neighbor* initiatives within facility host communities, on National Highway System connector roads, and at key highway-railroad grade crossings and railroad bridges.
- ☐ Encourage private investment and seek grants for alternative energy research and development, and energy efficiency, both to soften any potential energy boom crash and to diversify economic growth.
- ☐ Separate freight and passenger service on the Airport Line to accommodate increasing demand for goods movement; and improve National Highway System connector access to port facilities.
- ☐ Consider different ownership structures for publicly owned utilities: privatization, public–private partnerships, or allowing them to more creatively use resources; This last option may require changes to management structures to allow for more flexibility, quicker decision making, and granting ability to finance and invest in opportunities as they arise. Any restructuring must ensure protections for low-income and EJ communities.
- ☐ Accelerate the Clean Power Plan's shift away from coal- and petroleum-fired power plants and use natural gas as an intermediate source until clean energy technology matures.
- ☐ Convert municipal (particularly waste haulers) and goods movement vehicles to run on natural gas.
- ☐ Emphasize all "universal actions," particularly Vision Zero; growing the impact economy; green infrastructure and stream buffers; megaregional cooperation; freight enhancements; infrastructure resiliency; and a modern multimodal transportation system.

Leading Indicators

- ☐ Annual natural gas exports from the region.
- ☐ Petrochemical jobs in the region.

CONCLUSION

"The future has arrived; it's just not evenly distributed."

—William Gibson

Greater Philadelphia Future Forces describes the process by which the Futures Group identified the five most likely and highest impact Future Forces of change. It then develops these forces as what-if scenarios through the year 2045. The what-if scenarios in this report often result in less optimal outcomes, and the resulting recommendations are aimed at improving the region's end results. There is a range of universal actions that can be applied across all futures, and contingent actions that can respond to each individual force's likely outcomes. These are recapped in the Summary at the beginning of this report. The action step recommendations in this report have not been prioritized, nor does this report offer a step-by-step action plan.

In the analysis of the forces and their what-if scenarios, a series of emerging issues arise, which need to be better understood:

- As seen in The Free Agent Economy and Transportation on Demand: mobile communication devices, particularly smartphones, are a key part of the digital revolution that is connecting people and things, providing information, and flattening transaction costs in real time.
  - This is propelling on-demand outsourcing by changing the equation for when it makes sense for companies to increase their staffing levels or farm out needed tasks, how people travel around the region, and where businesses and individuals prefer to locate.
  - New technology often displaces low-, and even medium-skill jobs, while increasing the demand for highly skilled workers. This is why workforce skills and flexibility are so critical to regional economic competitiveness.
  - Automation and robotics may be the next disruptive technology. This could even threaten some high-skill jobs, but it will need to be cost competitive with on-demand outsourcing.
  - Digitization of devices, also known as the IoT, is capturing and analyzing infinite amounts of new data. This will change how we see and act in the world and allow for more customization in everything we produce. It promises improved decision-making, reduced loss and waste, and increased productivity with lower costs. This also poses serious risks such as data breaches, economic upheavals, a worsening of the digital divide, and a loss of personal privacy.[27]
- As seen in the U.S. Energy Boom: the low cost and wide availability of fossil fuels, increasing energy efficiency, and cost competiveness of renewable energy sources points toward an abundant and low-cost energy future.
  - This has significant implications for the region's future climate and environment, economy, development patterns, and gas tax transportation revenues.
  - This should not be seen as an absolute certainty, as any number of factors such as increasing efficiency leading to even more use (Jevons Paradox or the rebound effect), growing unrest in energy producing nations disrupting supply, and/or an inability to scale up renewable energy sources could lead to a more scarce energy future, which would increase prices.
- As seen in Enduring Urbanism and Severe Climate: climate change, funding constraints, and changing locational preferences suggest the region needs to rethink how to reconstruct and modernize infrastructure for resiliency and economic competitiveness.
  - Software and data (i.e., Intelligent Transportation Systems), rather than hardware (i.e., new facilities), used to provide better information will likely be the more cost-effective way to make road and transit systems more efficient.
- How interactions between two or more forces, arising concurrently, could affect their outcomes.
- The recent past is increasingly a poor guide for what the future will bring.
  - Forecasting the future can be done with some reasonable, albeit low, degree of confidence out for about 15 years, but climate change and other issues suggest that long-range planning needs to be conducted with longer 50- to 100-year horizons.
  - Decisions made today will significantly change future trajectories of the region's population, economic activity, and travel demand.

[27] Dubravac, Shawn, Ph.D. Digital Destiny: How the New Age of Data Will Transform the Way We Work, Live, and Communicate. Washington, DC: Regnery Publishing, 2015.

- Travel demand models and other decision-support tools need to more fully consider changing system dynamics and take into account a wider range of possible futures. Scenario planning is one way to better account for both of these needs.
- More consideration is needed to identify the best leading indicators available to guide decision making. This can be seen as applying "Moneyball" principles to transportation investments.

Increasing uncertainty provides new challenges for decision-makers. Funding should be directed toward where it is most needed and used to support the public's shared vision and goals for the region. For transportation, this may mean reconsidering the need for new or expanded facilities. More effort needs to be made to identify flexible or adaptive options, particularly those that make infrastructure more resilient. Pilot projects and other low-cost trials that can test out new concepts and ideas before implementing expensive projects should be used wherever possible to promote low- or no-regret investments; this is an area in which to take risks and accept that not all efforts will be successful. The region will need to seek out new and innovative ways to move people and goods, and find ways to fund the projects that do so.

Taking advantage of the opportunities and overcoming the challenges these forces present will require stakeholders to collaboratively work together. This report is an initial effort to advance the dialogue about how change is likely to occur in the region, and what we should do to strategically prepare for it. Solving today's challenges, and those that arise tomorrow, are generally beyond the capacity of any single entity. Taking action requires ongoing discussion, and building consensus and partnerships. The support of a large number of groups and individuals is needed to see the process through, even when there is no immediate success.

The discussion will be ongoing as the *Connections 2045* Long-Range Plan is developed. What other challenges do you think the region will face as a result of these forces? What other actions should we take, skills should we focus on developing, or investments should we make as a region? How can we build consensus on paying for the suggested actions? What are the priority actions? While none of the actions contained within this report are easy, if the long-term benefits significantly outweigh the short-term costs, then it is incumbent on us all to find ways to bring them about and move forward the vision of a more sustainable, equitable, and innovative Greater Philadelphia.

Learn more about the Future Forces and the *Connections 2045* Long-Range Plan update at www.dvrpc.org/connections2045/.

GLOSSARY

Accessory Dwelling Units are secondary residences on single-family lots, developed as apartments within existing units ("granny flats") or as small separate units on the same lot ("elder cottages").

Agglomeration Economy benefits arise when groups of similar businesses and industries locate near each other: higher productivity due to access to labor, assets, and suppliers; knowledge spillover and innovation; ease of new company formation due to profusion of partners, suppliers, and capital; and connections to other opportunities if the initial concept fails.

Biophilic Design improves connections between nature and people into the built environment, responding to the innate human need to interact with nature and other forms of life.

Brent Oil is a light sweet crude extracted from the North Sea, and is used as a benchmark for world oil prices.

Cohousing allows residents to collaboratively and actively shape and manage their community around common shared spaces for meals, childcare, recreation, and other activities.

Complete Streets are designed for safe access for all users (including walkers, bicyclists, motorists, and transit riders), of all ages and abilities.

Consolidation Centers unify freight distribution where multiple shippers bring goods into the facility and a single truck delivers them to their final destination, reducing the number of trucks on the road in urban areas.

Coworking Space is a shared, flexible office environment designed for new and atypical independent work schedules, and is usually not for the sole use of employees from a single company. Coworkers are generally telecommuters, self-employed, or freelancers.

Design Thinking is a collaborative process that starts with a goal statement aimed at creating better future conditions, rather than simply addressing a particular issue. Brainstorming and consensus building are used to generate creative, iterative solutions to big, ill-structured problems. A particular aim may be to come up with a pilot or prototype to quickly test ideas. Sensors connected to the IoT can allow for continuous tracking of data and goals, and can gauge the effects of actions and decision making in real-time.

Digital Biology uses computer simulation of biological systems, from pathways to cells to entire ecosystems, to study life.

Environmental Justice (EJ) is the fair treatment and meaningful involvement of all people, regardless of religion, race, ethnicity, income, or education level, in the planning and decision-making process.

Gene Therapy replaces missing or defective genes with normal ones to treat or prevent disease.

Gig Economy work is flexible labor that involves temporary one-off and irregular tasks with no long-term connection to an employer. Companies that operate in the gig economy include: Fiverr, Postmates, Flavor, Instacart, and TaskRabbit.

Green Infrastructure uses natural landscaping to capture stormwater, reduce flooding, and improve air and water quality. This design technique can help reduce the need for expensive grey infrastructure, such as underground pipes. Green infrastructure examples include green streets, porous pavement, green roofs, rain gardens, bioswales, tree plantings, tree trenches, and naturalized retention basins.

Impact Economy is the ecosystem that supports the work of entrepreneurial enterprises to address social needs in the community, either through the products they make or the process or strategies by which they do business, while they build profitable, and often scalable, enterprises. The components of the impact economy include: companies, investors, intermediaries, and customers.

Internet of Things (IoT) is a network of people, animals, and objects that exchange production, operational, or locational data using embedded electronics, sensors, and other forms of connectivity.

Living Streets are safe for all users and are created through participatory design to reclaim excess road space, make inviting places for people, incorporate green infrastructure, and emphasize social and environmental justice.

Micro Apartments are single-room living units under 400 square feet containing space with a bathroom and a kitchenette. Often they have access to a communal kitchen, garden, or rooftop balcony.

Micro Grids are local electricity generators that are connected to the traditional grid, but can also disconnect from it and operate independently. They are often powered by renewable resources, such as wind or solar, and can increase the resiliency of power systems. By generating electricity nearer to the end user they can reduce energy loss during transmission and distribution.

Micro Transit blends the convenience of personal vehicles with the efficiency of fixed-route transit, through shared rides on demand. These services use a variety of vehicle types, from cars to mini-buses to regular-size buses. Passengers can be picked up and dropped off from different trip origins and destinations, or at designated stops. Companies and services include Via, UberPOOL, Lyft Line, Bridj, Loup, Chariot, and Shuddle.

Pedestrian Plazas reassign underutilized paved areas for bicyclists and pedestrians, public space, or green infrastructure. A low-cost trial approach can be used to gauge community reaction to a different use of the space.

Precautionary Principle is a risk management perspective that puts the burden of proof that an action or policy does not risk harm to the public or the environment falls upon those taking the action.

Protected Bike Lanes use curbs, planters, parked cars, or bollards to physically separate bicycles from vehicles and pedestrians on busy streets, enhancing safety and encouraging more people to bike.

Pop-Up Economy manifests itself through temporary events, shops, or planning activities. Its key benefits are risk reduction and the ability to try out new concepts with low upfront costs.

Ride Sourcing allows individuals to e-hail rides using a smartphone app. Global positioning system navigation software locates the nearest available ride-source vehicle and routes the driver to where the passenger wants to go. Financial transactions are handled electronically. Ride sourcing businesses are also known as Transportation Networking Companies (TNCs). Common ones include UberX and Lyft.

Sharing Economy allows owners and service providers to use Internet-based technologies to rent out goods and services. Along with ride sourcing and micro transit companies, Airbnb is another well-known sharing economy business.

Shared Housing allows two or more unrelated adults to share a single-family residence. This can reduce housing costs and provide companionship and support.

Shared Space eliminates road signs, signals, and markings in lower-speed settings, requiring drivers, pedestrians, and bicyclists to negotiate right-of-way via eye contact, inducing safer behavior.

Smart Grids apply IT, sensors, real-time information, computer-based remote-control, smart meters, and software to electricity networks that record data on energy use, and improve system reliability and efficiency.

Supportive Housing provides support services, including mental health or mental retardation services, HIV/AIDS support and medical care, assistance to physically disabled persons, and medical assistance and support for elderly residents or formerly homeless persons who require assistance with daily living.

Vision Zero sets a goal to eliminate fatalities and serious injuries on roadways, with a core belief that loss of life is not an acceptable price for mobility.

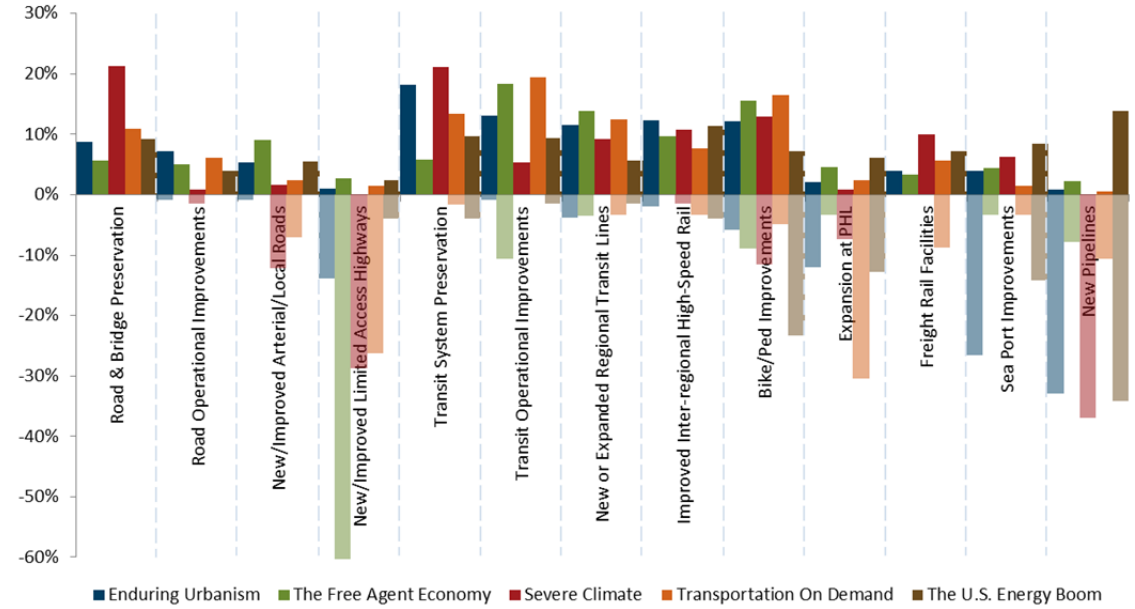
APPENDICES

A. Futures Group Regional Transportation Investment Priorities

Futures Group participants, members of the Regional Technical Committee, and other Delaware Valley Regional Planning Commission committees were surveyed to see how they would prioritize transportation infrastructure investments under each Future Force. Due to the large backlog of maintenance needs, it is anticipated that the vast majority (more than three-quarters) of the region's transportation funding will continue to go toward road, bridge, and transit system preservation. Partisan Paralysis, as a Background Force, suggests significantly higher transportation funding levels is unlikely. For each Future Force, the participants were asked to rank the highest and lowest priorities for transportation investments with the remainder of the region's limited transportation funding. The voting results were used to inform transportation infrastructure investments indicated in both the universal and contingent action steps. The project categories that were prioritized were:

- ☐ Road and Bridge Preservation—Provides additional maintenance funding, as current revenue projections will not achieve a state of good repair. Investments could also include climate resiliency projects, such as green streets. As of 2014, about 11 percent of the region's state-maintained bridge deck area was structurally deficient, while about 37 percent of the state-maintained lane miles were in poor condition.
- ☐ Roadway Operational Improvements—Projects include safety enhancements, traffic signal upgrades, weigh-in-motion stations, at-grade rail crossings, and Intelligent Transportation Systems to provide real-time travel information.
- ☐ New or Improved Arterial and Local Roads—Investments would, in particular, make better connections between freight centers and existing highways, as well as better connections between residential and commercial development centers and existing highways.
- ☐ New or Improved Limited Access Highways—New interchanges and highway widening would eliminate bottlenecks. Illustrative projects include US 1 bypass, I-95, US 30 bypass, US 422, and I-295 missing movements.
- ☐ Transit System Preservation—Provides additional maintenance funding, as current revenue projections will not achieve a state of good repair. Could also include climate resiliency projects. Current priorities include replacing 100+-year-old bridges, 80+-year-old substations, and rail and trolley vehicles that are well beyond their useful life.
- ☐ Transit Operational Improvements—Improvements Include projects that would enhance transit safety, speed up existing service, and increase service frequency.
- ☐ New or Expanded Regional Transit Lines—Investments would fund new fixed-guideway and bus rapid transit lines and extensions of existing lines.
- ☐ Improved Inter-Regional High-Speed Rail—Incrementally improve service along the Northeast Corridor, to accommodate higher-speed rail and growing demand for freight rail use on these tracks;
- ☐ Bike and Pedestrian Improvements—Investments could include completing The Circuit regional trail network; new sidewalks, bike lanes, and intersection safety enhancements; pedestrian plazas, Complete Streets; and shared space/living streets.
- ☐ Expansion at Philadelphia International Airport—Investments would increase runway capacity, improve landside access (people-mover, and/or Amtrak), and expand air cargo facilities.
- ☐ Freight Rail Facilities—Investments would address state of good repair on Class I and short-line railroads, such as the High-Line, 25th Street viaduct, and other facilities. They may also fund double-stack clearance, such as on the Keystone Corridor, yard expansions, positive train control, and capacity improvement projects.
- ☐ Sea Port Improvements—This investment would be targeted at new and expanded marine terminals along the Delaware River, and to support marine highway initiatives to and from the region.
- ☐ New Gas Pipelines—Expand new pipeline facilities to accommodate Utica and Marcellus Shale natural gas shipments for local manufacturing and use, as well as to meet export demand.

Figure A-1. Investment Priorities for Each Future Force



Source: DVRPC, 2015.

Universal Transportation Investment Priorities

The following investments were indicated as high priorities under all five future forces:

- ☐ Transit System Preservation.
- ☐ Road and Bridge Preservation.
- ☐ Transit Operational Improvements.
- ☐ New or Expanded Transit Lines.
- ☐ Improved Inter-Regional High-Speed Rail.

Table A-1. Futures Group Contingent Investment Priorities

Scenario	Top Investment Priorities	Lowest Investment Priorities
Enduring Urbanism	1. Transit System Preservation 2. Transit Operational Improvements 3. Bike and Pedestrian Improvements	1. New Pipelines 2. Sea Port Improvements 3. New/Improved Limited Access Highways
The Free Agent Economy	1. Transit Operational Improvements 2. Bike and Pedestrian Improvements 3. New or Expanded Regional Transit lines	1. New/Improved Limited Access Highways 2 (tie). Transit Operational Improvements 2 (tie). New Pipelines
Severe Climate	1. Transit Operational Improvements 2. Bike and Pedestrian Improvements 3. Transit System Preservation	1. Expansion at PHL 2. New/Improved Limited Access Highways 3. New Pipelines
Transportation on Demand	1. Transit Operational Improvements 2. Bike and Pedestrian Improvements 3. Transit System Preservation	1. Expansion at PHL 2. New/Improved Limited Access Highways 3. New Pipelines
U.S. Energy Boom	1. New Pipelines 2. Transit System Preservation 3. Improved Inter-regional High-Speed Rail	1. New Pipelines 2. Bike and Pedestrian Improvements 3. Expansion at PHL

Source: DVRPC, 2015.

The stark opinions about the U.S. Energy Boom, generally either strongly for it or against it, can be seen as participants voted 'new pipelines' as both the top and lowest investment priority.

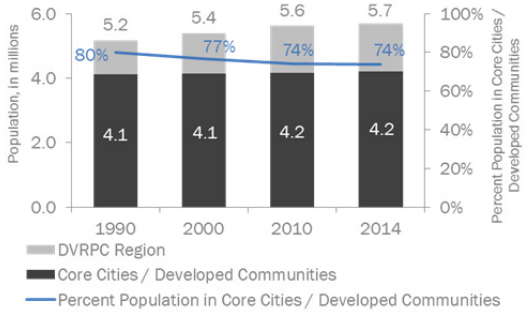
B. Leading Indicators

Leading indicators can help to tell whether or not a future force is happening. This is particularly relevant to determine which contingent actions and investments the region should pursue. The Futures Group helped to identify two or three leading indicators for each force. The most recent available baseline data is presented here for each indicator.

Enduring Urbanism

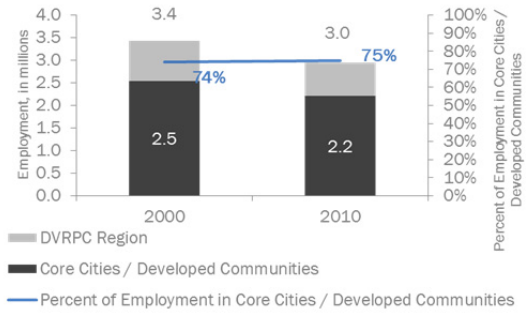
Under Enduring Urbanism, a larger percentage of jobs and population located in Core Cities and Developed Communities (as identified in the *Connections 2040* Long-Range Plan), decreasing annual vehicle miles traveled per capita, increasing transit trips per capita, and increasing alternative transportation commute mode share would be expected.

Figure B-1. Percentage of Population in Core Cities and Developed Communities



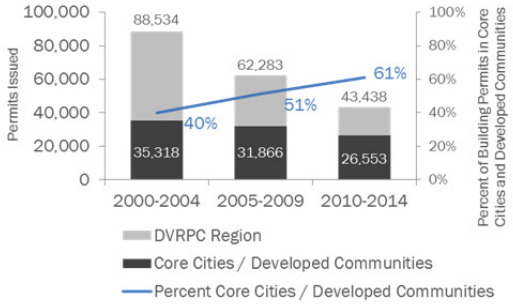
Source: U.S. Census Bureau.

Figure B-2 Percentage of Employment in Core Cities and Developed Communities



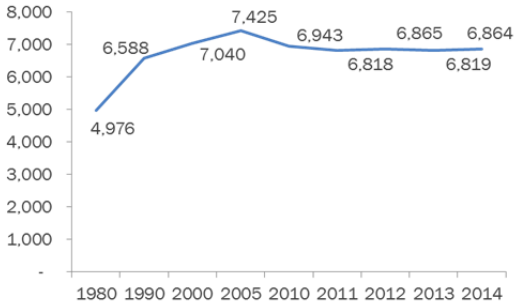
Source: National Establishments Time Series (NETS) database, as revised by DVRPC, 2012.

Figure B-3. Percentage of Residential Building Permits in Core Cities and Developed Communities



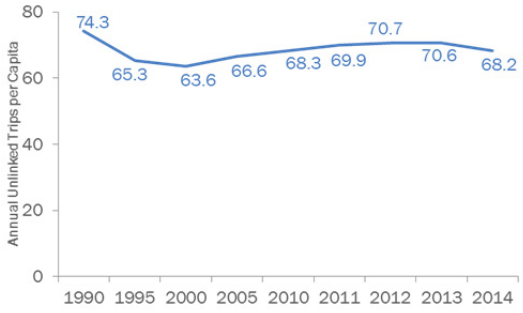
Source: U.S. Census, Construction Statistics Division, 2000–2014.

Figure B-4. Annual Vehicle Miles Traveled per Capita



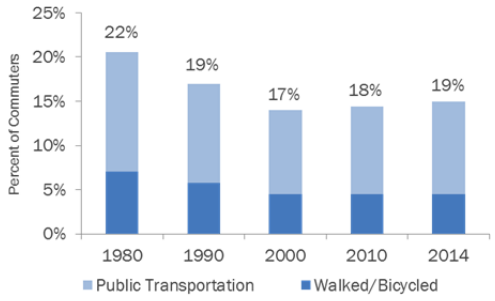
Sources: Pennsylvania Department of Transportation, 1980–2013; New Jersey Department of Transportation, 1980–2014; U.S. Census, 1980, 1990, 2000; American Community Survey, 2005 (1-year estimate), 2007 (1–year estimate), 2010–2014 (5–year estimates).

Figure B-5. Annual Transit Ridership per Capita



Sources: National Transit Database, 1990–2014; U.S. Census, 1990, 2000; American Community Survey, 2005 (1-year estimate) and 2010–2014 (5–year estimates).

Figure B-6. Transit, Walking, and Biking Commute Mode Share



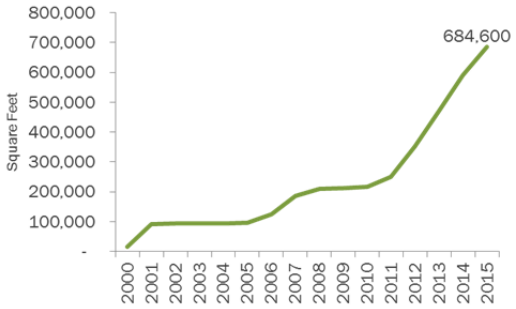
Sources: U.S. Census, 1980–2000; American Community Survey, 2010–2014 (5-year estimates).

The Free Agent Economy

The Free Agent Economy anticipates increasing amounts of coworking and shared office space, more small businesses, and a higher percentage of self-employed individuals. A permanently high unemployment rate is a sign of a weak market for labor, which may also point to The Free Agent Economy. This force suggests an increase in the number of renters, as homeownership becomes less desirable.

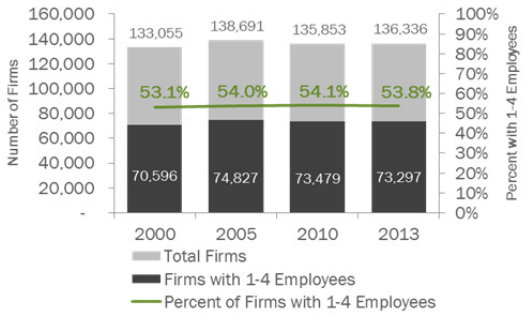
The first indicator tracks only space that is created specifically for use as coworking and shared office space. There is a large informal network of small businesses that lease out part of their unused office space to individuals or other small companies. This is impossible to track. A search of more formal coworking and shared office space found 65 facilities, and square footage was determined by sharing information with Jones Lang LaSalle, using CoStar real estate data, and by directly contacting a few facilities. The first shared office space facility opened in 2000. The first coworking space opened in 2007. By 2015, they accounted for nearly 700,000 square feet with more on the way. In 2016, Make Offices is planning to open three new facilities totaling more than 100,000 square feet, Benjamin's Desk will debut a new 58,000 square foot facility at the Pennovation Center, and WeWork has plans for two new locations in Philadelphia with 44,000 square feet.

Figure B-7. Coworking and Shared Office Space



Source: Jones Lang LaSalle, and Costar.

Figure B-8. Percentage of Businesses with Four or Fewer Employees



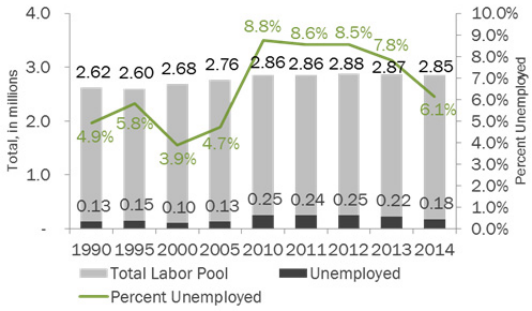
Source: U.S. Census, 2000–2013.

In the self-employed indicator, single-person businesses that are incorporated as a limited liability corporation or Subchapter SW corporation are not considered self-employed.

Figure B-9. Self-Employed Workers as a Percentage of All Population Over 16 Years Old

Sources: U.S. Census, 2000; American Community Survey, 2005 (1-year estimate), 2010–2014 (5-year estimates); Bureau of Labor Statistics, 2000–2014.

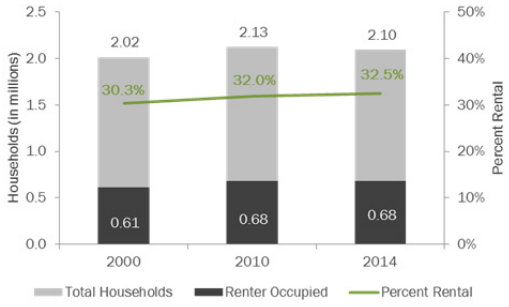
Figure B-10. Unemployed Workers as a Percentage of Total Labor Pool



Sources: U.S. Census, 2000; American Community Survey, 2005 (1-year estimate), 2010–2014 (5-year estimates); Bureau of Labor Statistics, 2000–2014.

Richard Florida's great reset theory suggests that the changing nature of the post-2007 recession economy will lead to an increase in renters, particularly in economically dynamic regions that attract creative class individuals. However, this may be more of a lagging indicator than a leading one.

Figure B-11. Percent of Households that Rent

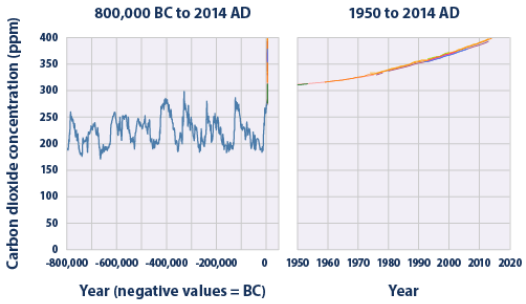


Sources: U.S. Census, 2000; American Community Survey, 2010–2014 (5-year estimates).

Severe Climate

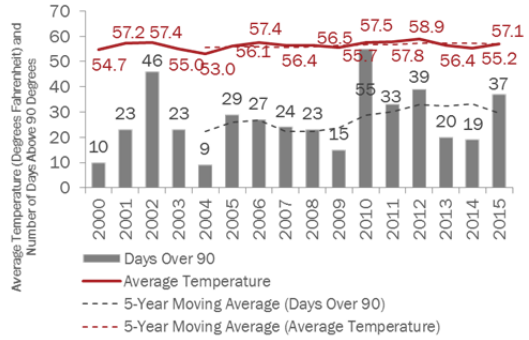
Severe Climate anticipates a continued increase in global atmospheric CO_2. In March 2015, the planet reached 400 CO_2 parts per million, which has generally been seen as the threshold to remain under in order to stave off the worst effects of climate change. Average annual regional temperature and precipitation, and regional sea level change, are all forecast to increase in this scenario. Regional weather data was only readily available back to the year 2000; a much longer time period is needed to establish definitive trends.

Figure B-12. Global Atmospheric CO_2 (Parts per Million)



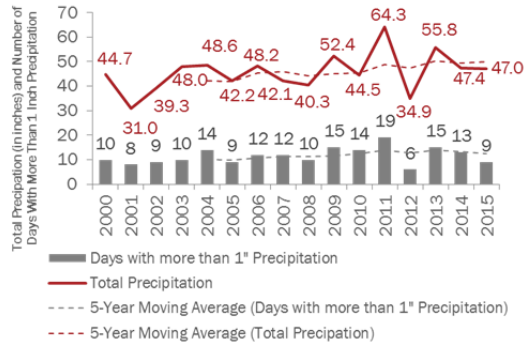
Source: U.S. Environmental Protection Agency [http://www3.epa.gov/climatechange/science/indicators/ghg/ghg-concentrations.html].

Figure B-13. Average Regional Temperature and Days over 90 Degrees Fahrenheit



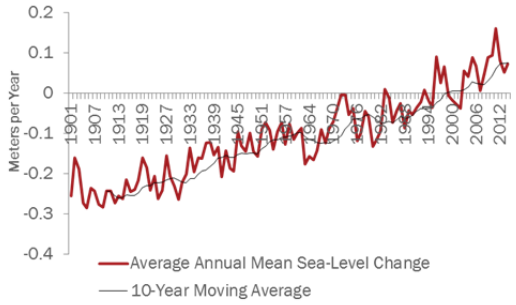
Source: U.S. Climate Data, 2000–2015 [http://www.usclimatedata.com/climate/philadelphia/pennsylvania/united-states/uspa1276].

Figure B-14. Average Regional Precipitation and Days with More than One Inch of Precipitation



Source: U.S. Climate Data, 2000–2015 [http://www.usclimatedata.com/climate/philadelphia/pennsylvania/united-states/uspa1276].

Figure B-15. Annual Regional Sea Level Change

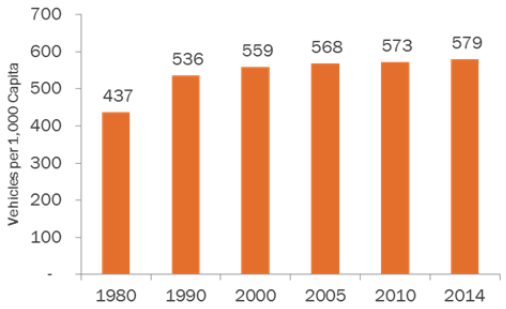


Source: National Ocean and Atmospheric Administration (NOAA) station 8545240, Philadelphia, PA [http://tidesandcurrents.noaa.gov/sltrends/sltrends_station.shtm].

Transportation on Demand

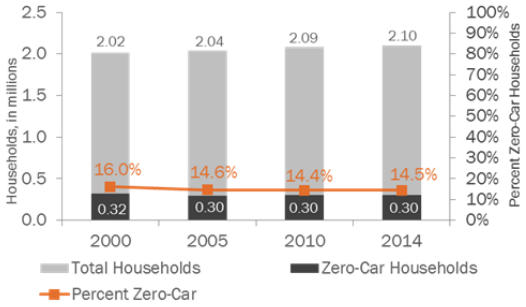
Transportation on Demand predicts lower levels of car ownership, an increase in zero-car households, and a higher alternative commute mode share. Tracking of new modes, such as ride sourcing or micro transit, in U.S. Census data may be another signal that this future is coming. Transportation on Demand largely looks to more efficiently use the number of empty vehicle seats in each trip. An increased vehicle occupancy rate or more efficient vehicle sizing that reduces the number of unoccupied seats could also be a sign that this future is occurring. Yet another indicator could be the growth of car sharing and bike sharing members or available vehicles.

Figure B-16. Regional Car Ownership per 1,000 Capita



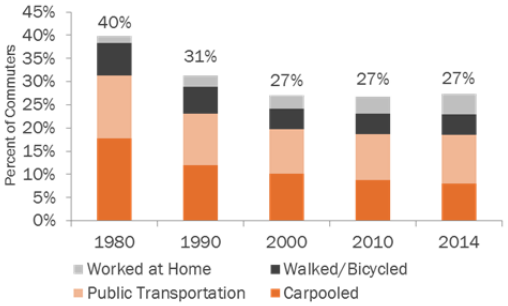
Sources: U.S. Census, 1980, 1990, and 2000; American Community Survey, 2005 (1-year estimate), 2010 and 2013 (5-year estimates).

Figure B-17. Zero-Car Households



Sources: U.S. Census, 2000; American Community Survey, 2005 (1-year estimate), 2010 and 2013 (5-year estimates).

Figure B-18. Non-Single Occupant Vehicle Commute Mode Share



Sources: U.S. Census, 1980–2000, American Community Survey, 2010–2014 (5-year estimates).

The U.S. Energy Boom

Depending on how the energy boom plays out, it is likely there will be increasing natural gas exports from the region and more petrochemical jobs located in the region. Natural gas exports data comes from the U.S. Census's Import and Export Merchandise Trade Statistics for the following products:

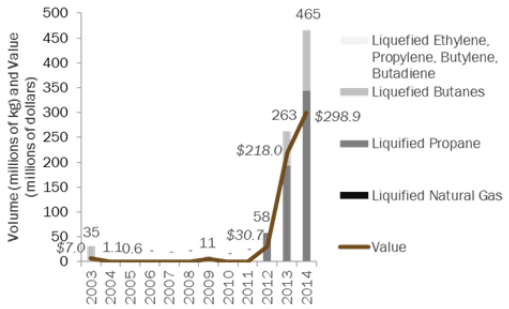
- ☐ 271111 Natural Gas, Liquefied.
- ☐ 271112 Propane, Liquefied.
- ☐ 271113 Butanes, Liquefied.
- ☐ 271114 Ethylene, Propylene, Butylene, Butadiene Liquefied.

Export value is determined on a free alongside ship (FAS) basis, which reflects transaction price, including inland freight, insurance, and other charges incurred in placing the merchandise alongside the ship at the port of export.

Shipping weight represents the gross weight in kilograms of shipments, including the weight of moisture content, wrappings, crates, boxes, and containers (other than cargo vans and similar substantial outer containers). Shipping weight information is available for non-low-value shipments by air and vessel only.

Another indicator that the Futures Group considered worth tracking is renewable energy generation as a percentage of total energy generation. This measure may test the disruptive nature of these energy sources to the natural-gas-reliant U.S. Energy Boom. This data is highly complex and is not currently available. Total energy generation is tracked, and may show how demand for energy is changing due to increasing energy efficiency or economic growth (expanding demand), etc.

Figure B-19. Annual Natural Gas Exports from the Region

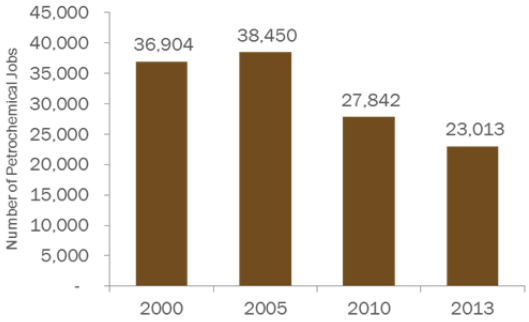


Source: U.S. Census, Import and Export Merchandise Trade Statistics, 2003–2014.

The petrochemical indicator tracks jobs corresponding with the following three- and four-digit 2012 North American Industry Classification System codes:

- 2212. Natural Gas Distribution.
- 324. Petroleum and Coal Products Manufacturing.
- 325. Chemical Manufacturing.
- 326. Plastics and Rubber Products Manufacturing.
- 4861. Pipeline Transportation of Crude Oil.
- 4862. Pipeline Transportation of Natural Gas.
- 4869. Other Pipeline Transportation.

Figure B-20. Regional Petrochemical Jobs



Source: U.S. Census, 2000–2013.

C. Annotated Bibliography

The following reports and articles is a review of what's happening and what's going on. It helped to inform the development of the Greater Philadelphia Future Forces and their what-if scenarios.

"Access to Public Transportation a Top Criterion for Millennials When Deciding Where to Live, New Survey Shows." Rockefeller Foundation, April 22, 2014.
http://www.rockefellerfoundation.org/newsroom/access-public-transportation-top **(accessed April 21, 2015).**

- A survey of millennials living in 10 cities across the United States conducted by the Rockefeller Foundation and Transportation 4 America, found:
  - Fifty-four percent of the millennial respondents would consider moving to a different city if it had more and better transportation options.
  - Sixty-six percent said that high-quality transportation was one of the top three considerations in deciding where they would live.
  - Forty-six percent of vehicle owners would seriously consider giving up their car if they could rely on different options to get around.
  - Sixty-four percent of millennials said that the cost of car ownership is a major reason for wanting to lessen reliance on cars.
  - 91 percent of millennials believe that investing in public transportation creates jobs and improves the economy.

Akers, Beth, and Matthew M. Chingos. "Is a Student Loan Crisis on the Horizon?" The Brookings Brief, June 24, 2014. http://www.brookings.edu/research/reports/2014/06/24-student-loan-crisis-akers-chingos **(accessed January 2, 2015).**

- Rising student loan debt and an economy ravaged by the recession have left many wondering if there is a student loan crisis brewing, where borrowers will be unable pay back their debt and taxpayers will have to bail them out. Akers and Chingos used data from the Survey of Consumer Finances from the Federal Reserve Board to compare student loan debt in 1989 and 2010. Their key findings:
  - About one-quarter of the growth in student debt in the United States over the past 21 years is due to individuals getting more education.
  - Average lifetime incomes of college-educated Americans have increased faster than the debt levels.
  - The average monthly payment has been about three to four percent of monthly income since 1992, while the mean payment-to-income ratio has fallen from 15 percent to seven percent.

  The final conclusion is that typical borrowers are no worse off than they were 20 years ago. There is no discussion in this article on the impact of interest rates, nor mention of what would happen if they rose dramatically.

Anderson, James M., Nidhi Kalra, Karlyn D. Stanley, Paul Sorensen, Constane Samaras, and Oluwatobi A. Oluwatola. *Autonomous Vehicle Technology: A Guide for Policymakers*. Rand Corporation, 2014.
Summary document:
http://www.rand.org/content/dam/rand/pubs/research_briefs/RB9700/RB9755/RAND_RB9755.pdf
Full report: http://www.rand.org/content/dam/rand/pubs/research_reports/RR400/RR443-1/RAND_RR443-1.pdf

- The push to develop autonomous vehicles (AVs) includes every major automobile company and has helped to develop a number of components already in many cars today: crash warning systems, adaptive cruise control, lane-keeping systems, and self-parking technology. AVs use sensors, LIDAR (light detection and ranging), radar, cameras, ultrasonic, and infrared technologies to collect data about the operating environment. Full AVs are predicted to be on the road within 10 to 15 years, if not sooner. There are, however, a number of issues that must be resolved before these cars are on the road en masse:

  - Better ability to turn sensor data into information about the operating environment—such as what is the obstruction on the road? A deer, a cardboard box, a bicycle?
  - Overcoming the challenges of different operating environments—from flat terrain in the Midwest to the Rocky Mountains, to dense, congested corridors on the East and West coasts.
  - Detecting sensor failures—as a result of physical damage, electrical failure, or age. The machine needs to be able to recognize when critical internal components are not working properly.
  - Communications—with nearby vehicles and infrastructure, which may require considerable investments; for example, every traffic signal may need radio to communicate with AVs.
  - Cybersecurity risks—which apply to all communications to and from AVs, which are likely to include Wi-Fi, cellular signals, and short-range communications; all of these systems will need to be able to detect failures and breaches.
  - Costs—ultimately, AV technology may prove to be too expensive for wide-scale adoption, particularly if insufficient demand does not allow for economy of scale to bring costs down.

  These issues probably mean the first AVs will require human operation of the vehicle above certain speeds, when traveling on specific types of roads, or during particular weather conditions. Re-engaging drivers—who may be asleep, watching a video, or using the Internet—could be a challenge. Despite these difficulties, there are substantial benefits to be realized:

  - Increased mobility—particularly for the disabled, young, and elderly. This can facilitate social capital, improve health, and enhance job access.
  - Reduced crash frequency—Automatic braking systems should reduce the incidence of rear-end crashes; the Insurance Institute for Highway Safety has estimated that installing forward collision and lane departure warning systems with sideview (blind spot) assist and adaptive headlights on all vehicles would reduce the number of crashes and fatalities by one-third, and full AVs could reduce the 39 percent of fatalities that involved alcohol use by one or more drivers.
  - Reduced congestion and its costs—AV technologies can increase road capacity through more efficient vehicle operations, reduce the number of crashes, and decrease the cost of driving; this potentially will increase vehicle miles traveled (and thereby potentially increase road congestion), but since vehicle occupants can do other activities in the vehicle, the time may be seen as less wasted.
  - Reduced energy use and emissions—meeting modern crash standards has required vehicles to become heavier over the last couple of decades. If crashes are significantly reduced, then vehicles could reduce their weights, which could also allow for alternative drivetrains such as fuel cells or electric motors.
  - AVs can optimize fuel efficiency by four to 10 percent through more even acceleration and deceleration.
  - Further fuel economy gains can be made with vehicle “platooning,” more closely spacing vehicles to reduce air drag.
  - Land use—AVs could be shared to reduce car ownership rates and could be used as taxis to reinforce urban centers; this could reduce parking requirements (which even in central business districts [CBDs] take considerable space—one study estimated that 31 percent of the land in 41 major city CBDs is used for parking).

- Reduced negative externalities—the costs of congestion and crashes have been estimated to be about 13 cents per mile. AV technology can significantly decrease both of these costs.

Saving thousands of lives annually is a major public benefit, but it may not be enough to convince individuals to pay for AV technology. The improved safety, reduced congestion and emissions, and potential changes to land use will not directly benefit the purchaser. Some public costs could increase, such as increased congestion or reduced transit service quality. The convenience of AVs may reduce transit ridership, and public support for transit. There may be a need to create a series of subsidies and taxes to help balance the public and private benefits from AV adoption, among other recommendations:

- Avoid premature regulation—more research and better information is needed about AV benefits and costs. A patchwork set of different state regulations on AVs would be uneconomical for manufacturers. Rather, the federal government should work with insurers, manufacturers, and consumer groups to develop standards as the technology warrants them. However, relying solely on the private market to bring this technology to fruition may not maximize social welfare, and without governmental support it could lead to market failure.
- Auto manufacturers may become liable for crashes, something that may not sit well with them; the federal government may consider a no-fault statute limiting tort or a regulation that says the operator is ultimately in control of the vehicle.
- Liability may also be overcome by selling the vehicle as a service rather than as a product.
- Update distracted driving laws—distraction needs to be permissible within AVs, at least while the vehicle is driving.
- Data Ownership and Privacy—AVs will create and potentially share large amounts of data (location, function, use, etc.), which raises privacy issues (such as, can this data be sold or used in legal proceedings?); this gap will need to be addressed.
- Compare AV performance to human—regulations and liability should proceed by comparing to the average human driver, as opposed to requiring near perfection before allowing the vehicles onto roads; if the technology is superior, then it should be permitted.
- Voluntary standards may need to be made between manufacturers to ensure system compatibility and that human–computer interaction functions in a similar method throughout all types of AVs.

Anderton, James. "Self-driving Vehicles by 2025…a Death Knell for Auto Manufacturing?" Engineering.com, January 14, 2015.
http://www.engineering.com/AdvancedManufacturing/ArticleID/9357/Self-Driving-Vehicles-a-42-Billion-Market-by-2025But-a-Death-Knell-for-Auto-Manufacturing.aspx **(accessed January 14, 2015).**

- The Boston Consulting Group (BCG) estimates that partially self-driving cars, equipped with highway and traffic jam autopilot, will be on U.S. roads by 2017. By 2022, cars will have an urban autopilot, and they will be fully autonomous by 2025. How this affects auto manufacturing is to be seen, but there are several other anticipated impacts. Ownership may continue with individuals buying or leasing their own vehicles or may shift to a world where self-driving vehicles shuttle people around, with no individual ownership. The latter option would dramatically reduce the number of vehicles on the road and lead to less planned obsolescence with a more utilitarian, shared fleet. Costs of these shared, autonomous taxis must be competitive with the individual ownership model in order for large numbers of individuals to make this shift. If the risks of cyberattacks can be mitigated, then a $42 billion market for AVs exists by 2025.

  BCG's effort in this study, titled *Back to the Future: The Road to Autonomous Driving*, included a survey of more than 1,500 drivers in the United States; analysis of AV technologies and economics; interviews with automobile executives, suppliers, and technology companies; and a review of industry publications. The survey found that 20 percent of drivers would be willing to pay up to $5,000 extra per vehicle for partially self-driving features (highway or urban autopilot).

These consumers cited the potential of self-driving cars to lower insurance and fuel costs, increase safety, and the ability to do other things with in-vehicle time as reasons why they would pay more. The additional price of AV technology is estimated to be between $2,000 and $10,000 initially, and will then decrease by 4 to 10 percent on a compound annual basis over the next 10 years. The report estimated that the 2035 vehicle fleet will consist of 25 percent AVs.

Andes, Scott, and Mark Muro. "Robots Are Infiltrating the Growth Statistics." The Brookings Institution, April 27, 2015. http://www.brookings.edu/blogs/the-avenue/posts/2015/04/27-robots-growth-statistics-andes-muro **(accessed April 29, 2015).**

- A recent report from London's Center for Economic Research tracked the use of industrial robots in 14 industries located in 17 different countries from 1993 to 2007. It found that robots have increased labor productivity by 0.36 percent per year and gross domestic product (GDP) by 0.37 percent annually. These figures represent 10 percent of total growth in GDP and 16 percent of growth in labor productivity, despite representing only 2.25 percent of the total assets possessed by these industries.

  This suggests that robots are becoming a **general purpose technology (GPT)**, which has a long and persistent impact across a number of unrelated industries. Past GPTs include the steam engine, which accounted for 0.35 percent growth in labor productivity each year from 1850 to 1910; and information technology (IT), which spurred 0.60 percent annual labor productivity growth and 1.0 percent GDP growth from 1995 to 2005. In the case of IT, annual capital investment rates were five times higher during these years than those in robotics from 1993 to 2007. This implies that robotics is going to be a major economic and labor productivity driver. The study found that workers in firms using robotics had higher incomes than what the average worker in that industry earned. So while robots will certainly displace workers in the future, they will reward those who work with them. Robots are going to play a major role in restructuring the workforce, increasing productivity, and determining future prosperity.

Arieff, Alison. "Driving Sideways." ***New York Times*****, July 23, 2013.**
http://opinionator.blogs.nytimes.com/2013/07/23/driving-sideways/ **(accessed August 11, 2015).**

- AVs seem so inevitable at this point that all we argue about is when they will arrive. But much of the dialogue surrounding them ignores their urban design and social equity impacts, not to mention the difficulty of bringing new automotive technology to the market (see hybrid and electric vehicles, for instance). Even if AVs increase road capacity by 100 to 300 percent, freeways have always operated at gridlock regardless of what has been tried to get them moving better (wider lanes, more lanes, or carpool lanes). Theoretically, AVs will handle more shared rides, so even more people can move in the same amount of space, and road space can be freed up for other uses, such as bike lanes or rain gardens.

  The embrace of AVs seems out of touch today, when Americans are driving less, purchasing fewer cars, and waiting longer to get their drivers' licenses. What if Google had spent all this effort reimagining mass transit? For instance, the TransMilenio bus system in Bogota, Colombia, has a 13-second combined headway at key stations and carries 1.4 million people per day [*edited from original article*]. Meanwhile, in the United States it seems that nearly all innovation ties into the car. App-enabled car and ridesharing helps with the problem of single-occupant vehicles, but it also threatens to undermine our belief that public transit is a public good. The app portion requires a smartphone to access the system, something that lower-income individuals are less likely to have. And if you can afford a luxury car now, then you can afford an autonomous luxury car service. If you can't afford a car now, then you are unlikely to be able to afford an AV car sharing service.

AVs are often assumed to encourage urban densification. But cars are not what make a city an interesting place, especially if the goal is to have faster traffic on local streets. By making freeways work more efficiently, they seem like a recipe for expanded urban sprawl. This is especially true if they make commute time into leisure time that is spent reading, playing video games, or even having a cocktail—then long commutes are no longer a disincentive.

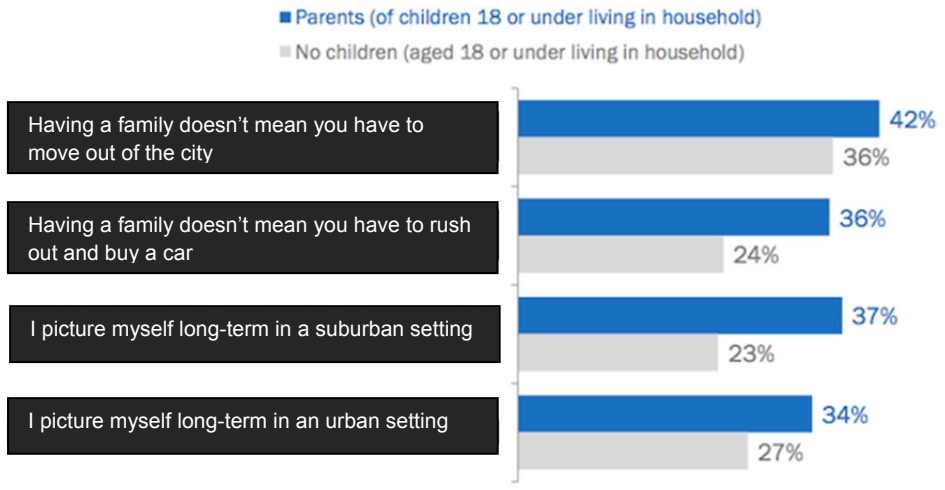
Lack of standardization is another risk with AVs. At a recent Smart Cities conference, there were eight different types of electric vehicle charging stations. If there were eight different types of fuel pumps, gas-powered cars would never have worked. Many of the AV benefits require that human drivers be taken off the road, but how exactly will this happen, and will people be okay with that? Ultimately, AVs seem like the worst kind of solutionism, where we are so enamored with a technology that we ignore all the benefits that would accrue by not having it, especially how much time is spent traveling simply due to how far apart everything is.

Badger, Emily. "What the Rise of Technology Has to Do with the Decline of Driving." ***The Atlantic CityLab*****, October 1, 2013.** http://www.citylab.com/commute/2013/10/what-rise-technology-has-do-decline-driving/7080/ **(accessed August 5, 2015).**

- New technologies have been subtly changing transportation behavior through teleconferencing, leading to more work at home, e-commerce reducing the need to drive to shop, real-time apps that make transit service more predictable, social media that has replaced trips across town to catch up with an acquaintance, and Wi-Fi networks and smartphones that make transit time more productive. A recent survey of 1,000 millennials, who are early adopters of new technologies, in Boston, Chicago, San Francisco, Portland, Seattle, and Washington, asked about their travel habits. While it provides further evidence that they are part of the reduced driving trend in the United States, it also shows they are not ready to ditch the personal vehicle altogether. In a question about preferred transportation mode, on average (1 being the most preferred):

  - 2.24 driving a car;
  - 2.73 walking;
  - 4.09 subway, light rail, street car, or trolley;
  - 4.34 bus; and
  - 4.34 bicycle.

Figure C-1. Where Will the Millennials Live as They Become Parents?



Source: APTA Millennials and Mobility survey.

Only 27 percent of millennials without children say they see themselves remaining in an urban neighborhood long term. This gives reason to caution tracing the millennial trend into the future. It also shows that cities need to embrace the technologies that millennials and younger generations prefer: public Wi-Fi, open data, and expanding car and bike sharing networks.

Badger, Emily. "What Will Happen to Public Transit in a World Full of Autonomous Cars?" *The Atlantic CityLab*, January 17, 2014. http://www.citylab.com/commute/2014/01/what-will-happen-public-transit-world-full-autonomous-cars/8131/ **(accessed August 5, 2015).**

- As self-driving cars become commonplace, they will not be owned. Instead, we will call them on demand, and they will act as a personal mass transit service. But as cars start to act more like transit, what happens to today's transit service? Jerry Lutin, a retired New Jersey Transit (NJ Transit) planner, thinks public transit needs to start promoting AVs as a replacement to many bus routes and paratransit services. This is particularly true for routes that run more than half-empty buses, which are wasting fuel and other expenses. Transit agencies are unlikely to be the operators of AVs, as their very structure limits what they are able to do, their unions are unlikely to support replacing drivers with self-driving cars, and it is unlikely that the government would compete with a profitable private industry for these services anyway.

  Instead, transit should focus on the services that will perform well in an autonomous world, where we will still need transit in dense urban areas. An autonomous car will still take up more road space per person carried than a bus, light rail, commuter rail, or heavy rail service will. Even if AVs are able to travel more closely together, there will still be a limit to how many can use a road lane per hour. Even more so, autonomous buses could also travel more closely together and begin to approach rail-like passenger volumes.

Badger, Emily. "The Suburbanization of Poverty." *The Atlantic CityLab*, May 30, 2014. http://www.citylab.com/work/2013/05/suburbanization-poverty/5633/ **(accessed September 15, 2014).**

- Currently, there are more people living below the poverty line in suburbs (16.4 million) than in U.S. cities (13.4 million). This is a trend that began before the recession and will challenge communities that are not used to meeting the needs of people in poverty well into the foreseeable future. The suburban safety net lacks public transit that can provide job access and does not have the network of service providers that have grown up over decades in urban areas. Transportation and other services are costlier and harder to provide in spread-out, suburban communities. Tackling these issues will require viewing them as regional problems.

Badger, Emily. "Now We Know How Many Drivers Uber Has—and Have a Better Idea of What They're Making." *Washington Post*, January 22, 2015. http://www.washingtonpost.com/blogs/wonkblog/wp/2015/01/22/now-we-know-many-drivers-uber-has-and-how-much-money-theyre-making **(accessed April 27, 2015).**

- As of December 2014, Uber had 162,037 active drivers, defined as those who had completed four or more trips during the month. This figure has doubled every six months over the past two years. A recent internal company report showed that drivers make as much $17 per hour in Washington, DC; $23 per hour in Los Angeles; and $30 per hour in New York City. However, these figures do not account for the costs that drivers must foot as part of the service, such as gas, insurance, and maintenance. As the company has lowered fares in order to lure more riders, drivers have seen their pay go down. This has led to organized driver protests in several cities.

  Two views have arisen about what employment at companies such as Uber means for the overall economy. The more optimistic view is that anyone with a service (and possibly a car or home) to sell can be their own manager, work the hours they choose, and make other pursuits more

possible. The more pessimistic view is that people cannot find better opportunities and must accept becoming an independent contractor with no benefits. Uber is working to improve conditions for drivers by reducing the amount of time they spend waiting for fares, which should happen with more ridership. This allows the driver's time to be more valuable.

Baker, George. "Repeal the Decades-old Oil Export Ban to Help Energy Renaissance." *The Hill*, March 11, 2015. http://thehill.com/blogs/congress-blog/energy-environment/235220-repeal-the-decades-old-oil-export-ban-to-help-energy **(accessed August 24, 2015).**

- The shale oil renaissance and sudden excess of natural resources is a gamechanger that has turned the energy world upside down. American consumers have benefited from lower-cost fuel, increased investments, and new jobs. In order for it to continue, policies need to keep up in order to ensure that resources are able to provide the maximum returns to the economy and promote strategic geopolitical ties. The issue to be addressed is a little-known law enacted 40 years ago during the Arab oil embargo that restricts export of crude extracted in the United States. While there were merits to this policy during that time, it is no longer needed in this time of abundant energy resources.

  Having just surpassed Russia and Saudi Arabia, the United States is now the global leader in oil and natural gas production, thanks to shale oil and light crude production. Much of what we are drilling is light crude, while much of what our refineries are set up to manufacture is heavy crude. With the inability to handle the refining needs for increased production, crude oil stocks are growing beyond our capacity to store them. This is the cause of the spread between Brent (international) oil prices and WTI (domestic). The restriction on exporting crude oil prevents U.S. drillers from accessing global markets, which is idling rigs, preventing job growth, and obstructing the supply chain. It also costs drivers at the pump, where the price of gasoline is more often determined by the higher price for Brent crude. ICF International estimates that removing the ban "could save American consumers up to $5.8 billion per year, on average, over the 2015–2035 period." In addition, putting U.S. crude into the global market would help our allies become less dependent on unreliable and inhospitable energy sources.

Bellafonte, Gina. "New York's Forecast: Rising Seas, Continual Heat Waves, and a Little Hope." *New York Times*, February 20, 2015. http://www.nytimes.com/2015/02/22/nyregion/global-warming-could-make-the-super-rich-jealous-of-rowhouse-residents.html **(accessed February 23, 2015).**

- A recent report by the New York Panel on Climate Change makes a number of unsettling predictions for the city:

  - Sea levels will rise from four to eight inches in the 2020s.
  - By 2080 the city's mean temperature may be similar to Norfolk, VA.
  - The number of annual heat waves could double by the 2050s, compared to the 1971–2000 time period.

  More than 70 percent of New York City's greenhouse gas emissions come from buildings, and it is much smaller on a per capita basis than just about anywhere in the United States (thanks largely to reliance on transit). In looking at housing sustainability, the Urban Green Council studied what would happen to different housing types after a one-week power outage in either extreme cold or heat.

  - A detached single-family house is the worst performing; it would fall below freezing within four days.
  - All or mostly glass high-rise apartments would not fare much better in the heat. Indoor temperatures would reach into the 80s by the third day.

- In both hot and cold conditions, a row house is the best performer. In extreme cold, a row house would still be above 40 degrees after a week.

New York City is looking to become the center for innovative reconstruction to make buildings more efficient.

Berg, Nate. "What Running Out of Power in a Tesla on the Side of a Highway Taught Me About the Road Trip of Tomorrow." *The Atlantic CityLab*, April 29, 2014.
http://www.citylab.com/tech/2014/04/what-running-out-power-tesla-side-highway-taught-me-about-road-trip-tomorrow/8978/ (accessed August 6, 2015).

- Tesla is building out a network of supercharging stations around the country. Often located in a hotel, shopping mall, or restaurant parking lot, they take about an hour to fully recharge an electric vehicle (EV)—as opposed to eight hours in a household garage—and are intended to convince EV owners to take the vehicles on road trips. There were about 80 of the stations at the time the article was published, with plans for 250 by the end of 2015. Mr. Berg was traveling between Los Angeles and Arizona and had an expected range of 247 miles to make a 209-mile drive between Barstow, California, and Kingman, Arizona. However, this is just an estimate, and the combination of high speeds and elevation drained the battery faster than the range indicated. His vehicle ran out of power about three miles from his intended destination. He then has a hard time finding a tow truck company willing to take his car to the supercharger station, due to its high value ($70,000–$100,000).

  The EV market is still just getting started. In 2013, 22,245 Teslas were sold, representing about 0.03 percent of all vehicles purchased that year. There are three major things holding back the EV market: battery capacity limitations, time needed to charge, and charging station availability. While Tesla is spending a lot of money building out the supercharger network (which cost from $100,000 to $175,000 each, in addition to maintenance), there is some question as to how important they will be in the future. An alternative view is that nearly everything will be a hybrid in the future, able to run off oil, electric batteries, natural gas, hydrogen fuel cells, and perhaps yet-to-be developed alternatives.

Blow, Charles M. "For Jobs, It's War." *New York Times*, September 16, 2011.
http://www.nytimes.com/2011/09/17/opinion/blow-for-jobs-its-war.html (accessed July 23, 2015).

- President Obama's proposed American Jobs Act at least turns the political discussion to the right topic: jobs. But it does too little to fix the problems highlighted by the fact that the poverty rate of 15.1 percent was the highest it has been since 1993. The problem is not so much that people do not have jobs, as three out of four people in poverty have a job. It is that they do not have good jobs that pay enough to lift them out of poverty. So it is not enough to create new jobs; we need more good jobs. A good job is one that averages at least 30 hours a week with an employer, a paycheck, and benefits.

  This battle to create good jobs cannot be won if we see it only as a skirmish between the two dominant political ideologies in the United States. Instead, it will be the source of the next major global confrontation, according to the book *The Coming Jobs War* by Jim Clifton. The world currently has 3 billion people who want to work, but only 1.2 billion jobs for them. The next world order will be led by economic forces, and particularly by countries that create good jobs and grow GDP. While China is vying to win this war, the United States does not even seem poised to fight. Our infrastructure is crumbling, our educational system is falling behind other Western nations, and rapidly growing healthcare costs are using capital that would be better spent on other investments. The problem is not lack of innovation, in Clifton's estimation, but rather lack of entrepreneurship to do something useful with our current oversupply of innovation.

Braunstein, Leslie. "How Changing Healthcare Delivery Will Affect Land Use." Urban Land, May 22, 2013. http://urbanland.uli.org/economy-markets-trends/how-changing-healthcare-delivery-will-affect-land-use/ **(accessed February 2, 2015).**

- As the Affordable Care Act (ACA) adds 30 million newly insured individuals to the healthcare system, there are a number of uncertainties as to what hospital and patient care facility needs will be. Hospitals are consolidating in order to achieve economies of scale for acute treatments. At the same time, outpatient care is being decentralized and spread throughout communities, as a result of both ACA requirements and new technologies. Demand is increasing from individuals as they age. Persons over 65 years old now average 6.9 doctor visits per year, versus just 6.1 visits in 1998. Even though there have been efforts to reduce healthcare costs, expenditures are forecast to increase from 17 percent of the GDP to 20 percent. This does not necessarily equate to an increased demand for space, however. Single-focus centers may also be on their way out, as diversity of care options becomes more important. The ACA also encourages health and wellness services, which is currently leading to the development of more on-site fitness centers, classes, and nutrition counseling.

Brown, Matthew. "U.S. Projects Fuel Train Accidents at 10 a Year." ***Boston Globe*****, February 23, 2015.** https://www.bostonglobe.com/news/nation/2015/02/23/trains-hauling-fuel-could-derail-year-according-projection-exclusive-fuel-hauling-trains-could-derail-year/4fw3G9qM5JrcXw2RA13n2N/story.html **(accessed August 19, 2015).**

- Using data on previous accident rates, expected volumes, and known rail routes, a U.S. Department of Transportation analysis considered the risks from trains moving large amounts of crude oil and ethanol. It estimates that there could be 15 derailments in 2015, declining to about five per year by 2034. Over this 20-year period, these crashes could cause $4.5 billion in damages and potentially the deaths of hundreds of people—particularly if an accident happens in a densely populated urban area. Up to 10 high-consequence events are forecast to cause more widespread damage and fatalities during this period. A single accident in a highly populated area could kill more than 200 and cause $6 billion in damages.

Bullis, Kevin. "Nano-Manufacturing Makes Steel 10 Times Stronger." ***MIT Technology Review*****, February 16, 2015.** http://www.technologyreview.com/news/534796/nano-manufacturing-makes-steel-10-times-stronger/ **(accessed February 23, 2015).**

- Modumetal, a startup company, has developed an inexpensive nano-engineering electroplating process to make materials, such as steel, up to 10 times stronger. This new material is currently being tested in oil fields. It could eventually be used in bridges and other infrastructure to extend their lifespan, and to create lighter-weight and more fuel-efficient vehicles.

Bunch, Will. "S. Phila. Refinery Creates Toxic Air as Well as Jobs." ***Philadelphia Inquirer*****, April 13, 2015.** http://www.philly.com/philly/news/20150412_S__Phila__refinery_creates_toxic_air_as_well_as_jobs.html **(accessed April 13, 2015).**

- As the Philadelphia region has raced to embrace the energy hub, there has been little discussion about the potential environmental impacts. The Philadelphia Energy Solutions (PES, formed through a partnership between Sunoco and the Carlyle Group) refinery is the city's largest stationary pollution source. It has been cited by regulators for adding to the area's problems with nitrogen oxides, which form smog and carbon monoxide. For neighborhoods such as Girard Estates, West Passyunk, and Southwest Philadelphia, which are near the PES refinery, there are health concerns, particularly asthma and other breathing problems, as a result of their proximity to the air pollution. PES has installed scrubbers and other environmental control equipment on its refinery, which has at least slowed the emissions rate.

As the refinery grows, and more oil and gas is shipped to the region, these health concerns will intensify. In the city's low-income neighborhoods, 27 percent of children are diagnosed with asthma—more than three times the national average. A U.S. Environmental Protection Agency test of pollution in South Philadelphia found the vast majority of emissions came from the refinery, and it found nearly 40 tons of known carcinogens, mainly benzene.

Burrus, Daniel. "Could Virtual Care Heal the Health System?" *Wired*, n.d. http://www.wired.com/2014/10/virtual-care-heal-system/ (accessed May 11, 2015).

- There are now two virtual doctor networks, Stat Doctors and Health Tap, where patients can log online to see a doctor with a 10-minute wait time. These doctors' visits are conducted over a secure video conference application and are available 24 hours a day, seven days a week. The cost is a modest fee charged by credit card. Health Tap is a monthly subscription program, in order to convince patients to use the service rather than taking the wait-and-see approach to health issues. Both programs give doctors access to a patient's electronic medical records, helping to enhance treatment. While these services cannot deal with all medical emergencies, especially ones that require physical treatment, they do give access to those who are dealing with lessor ailments such as rashes, infections, or other minor problems. This helps to reduce patient burdens in emergency rooms and urgent care centers, helping them to focus on those in need of serious medical care, while lessening the risks of infection or passing along illnesses between all patients using physical facilities.

Butler, Stuart M. "Reimagine College." The Brookings Institution, December 22, 2014. http://www.brookings.edu/research/opinions/2014/12/22-reimagine-college-butler (accessed December 29, 2014).

- Universities and colleges are increasingly under the threat of disruptive innovation from massive online open courses (MOOCs) and online colleges with low-cost degree options. While the higher-education establishment has tried to brush this off and dismiss it, the tide could be turning, and it could bring the following:

  - Tuition rates falling dramatically.
  - Information about college benefits and value added will be quantified and put into scorecard formats that help students make better, more informed choices.
  - Improved MOOCs will become more common.
  - New business models emerge, breaking up the traditional four-year college structure.

  Some examples include Southern New Hampshire University's College for America, which has a four-year online degree program that costs a total of $10,000. Georgia Tech has teamed with Udacity, a MOOC developer, to offer a master's degree for $7,000. Another MOOC, edX, is building relationships with Harvard and the Massachusetts Institute of Technology. MOOCs are trying out peer-grading, crowd-sourcing, proctored test facilities, and other ways for instructors to give students feedback. As fewer students go away for school, new options can be opened—blended education that customizes a degree to workplace needs. Eventually, colleges may reinvent themselves as educational "travel agents" that develop a customized set of online courses, study-abroad programs, externships, and one or two years on campus, at a much lower cost.

Carr, Steve. "UNM Researchers Take to the Skies to Assess Infrastructure Damage." University of New Mexico Newsroom, March 4, 2015. http://news.unm.edu/news/unm-researchers-take-to-the-skies-to-assess-infrastructure-damage (accessed March 6, 2015).

- Drones and other low-flying aircraft are being used to develop new remote sensors to detect small-scale damage to transportation infrastructure after natural disasters (such as earthquakes, floods, hurricanes). Being able to quickly detect danger is particularly critical for the safety of

search-and-rescue missions. Routine flights will determine existing infrastructure conditions, which can then be readily compared with conditions after a storm event, to quickly determine where damage has occurred.

Carter, Timothy. "Smart Cities: The Future of Urban Infrastructure." *British Broadcasting Corporation*, November 22, 2013. http://www.bbc.com/future/story/20131122-smarter-cities-smarter-future **(accessed August 12, 2015).**

- The infrastructure of the future will need to be better at anticipating and proactively responding to risks. It must act as an ecosystem, providing a variety of benefits rather than having only a single purpose. Such an example is a community garden, which provides food for participants and serves as a stormwater management system.

  Accurately modeling the future will require extensive sensor systems to gather accurate data and provide real-time feedback. Songdo, South Korea, is a highly networked city and is tracking everything from traffic to household waste. Using these technologies allows for more efficient systems to respond to demand where it exists, such as allocating electricity in a smart grid network.

  Beyond short-term response, infrastructure must also be able to take the long-term view. This will be necessary to make coastlines more adaptable in order to protect coastal cities from flooding. The traditional response has been to build expensive flood walls. New approaches are trying out the use of natural wetland and green infrastructure solutions.

  Another goal is to bring more multi-functionality to infrastructure. Rather than isolating waste, water, and transportation systems, there are opportunities to integrate them. Waste flows, in particular, could be rethought of as resources that can be used to better connect the city. In southern California wastewater is transformed into drinking water that is cleaner than what is found in snowmelt. Park-like wetlands can buffer against severe weather, provide aesthetic value, and even transportation through the provision of trails.

  Truly robust infrastructure cannot just rely on physical characteristics alone. Cyberspace is changing our relationship with the built environment through social networks, crowdsourcing, and mobile technologies. These are data sources, as well as social, political, and economic support systems that enhance the relationship between people and the city. Street Bump in Boston allows users to automatically notify the city where potholes are located. Big Apps in New York City serves as an open data portal and connects people to project developers. Cities need to do more to link non-physical technologies with the built environment in order to better connect communities.

Casselman, Ben. "Think Millennials Prefer the City? Think Again." Fivethirtyeight blog, March 20, 2015. http://fivethirtyeight.com/datalab/think-millennials-prefer-the-city-think-again/ **(accessed April 27, 2015).**

- There has been an ongoing media narrative that young people desire the walkable cities and are eschewing the suburbs. Census numbers, though, do not back up this narrative. In 2014, 529,000 Americans between 25 and 29 moved from cities to suburbs, while only 426,000 moved from suburban areas to urban ones. This trend is more pronounced for those in their early twenties: 721,000 left cities, versus 554,000 who moved into one. While urban populations are growing thanks to births and immigration, Americans are still more likely to move out of cities than move into them. It is worth noting that this trend is not as strong as it was in the 1990s, when young people were more than twice as likely to move out of cities than move in (compared to 1.25 times as likely today). However, it should be noted the Census Bureau does not distinguish walkable suburban areas from much lower-density, auto-oriented areas. Jed Kolko, chief

economist for the website Trulia.com, observes that the fastest population growth right now is in the lowest-density suburbs (the article does not say whether this is absolute numbers or rate).

[*Issues have been raised with the methodology used as the basis for this article. See: http://statchatva.org/2015/03/25/migration-data-misses-millennials-confuses-the-media/ or http://cityobservatory.org/twenty-somethings-are-choosing-cities-really/ - ed.*]

Center for City District and Central Philadelphia Development Corporation. *Philadelphia's Independent Economy: Implications for Office Space*. Philadelphia, PA: Center for City District and Central Philadelphia Development Corporation, 2015. http://www.centercityphila.org/IndyEcon/index.php

- This report analyzes trends in the independent economy and growth of coworking space in the City of Philadelphia. Some key findings:
  - Sixteen coworking offices have begun operations in Greater Center City and University City since 2007, comprising about 200,000 square feet of space.
  - Since 2000, the number of self-employed individuals in the city has remained constant at about 30,000 to 35,000, even as total employment has declined.
  - Forty-eight is the median age for self-employed individuals in the city.
  - Potential tenants for coworking space include fully independent freelancers, individuals who work for companies that locate in the space, individuals who work for regional companies that do not have an office in the city (and can thereby attract city residents to work for them without needing to reverse commute), and individuals who work for national or international companies that do not have an office in the city.
  - Since the tax abatement was created in 1997, 50 office buildings with more than seven million square feet of space have been converted to residential or hotel use.
  - This has grown Center City's pool of well-educated and talented workers, creating an opportunity for their employers to retain them in the city through coworking space.
  - Coworking space is also an opportunity for companies to open a "gateway" office in the city/region.
  - Coworking space can also help local firms connect with freelancers.
  - The growth of coworking space and the presence of independent workers can provide fertile ground for new firm development, and a pipeline for new companies that will eventually need traditional office space.

Center for City Solutions and Applied Research. *Cites, the Sharing Economy, and What's Next*. Washington, DC: National League of Cities, 2015.
http://www.nlc.org/Documents/Find%20City%20Solutions/City-Solutions-and-Applied-Research/Report%20-%20%20Cities%20the%20Sharing%20Economy%20and%20Whats%20Next%20final.pdf

- This report is intended for city officials to help them better understand and regulate the sharing economy. It is based on a number of conversations with urban leaders in 11 large and small U.S. cities, and it is organized around five key themes: innovation, economic development, equity and access, safety, and process and implementation.
  Innovation
  - It is very challenging to balance the sharing economy benefits for residents and visitors with regulation for public safety and well-being.
  - No city wants to be anti-innovation, but at the same time local officials face criticism if their actions are perceived to run counter to what is best for the local economy.

Economic Development

- The sharing economy threatens to disrupt existing services (taxis, hotels), while potentially replacing them with new and improved ones. This may have significant implications for revenue collection, job creation, and tourism.
- Transportation Network Company (TNC) regulations in Washington, DC, require the payment of one percent of all fare receipts; in Seattle a flat rate of 10 cents per ride originating in the city is required, while other cities have not levied taxes in the belief that they will benefit from increased economic activity.
- Many cities (Austin, Chicago, Madison, Portland, San Francisco, and Washington, DC, for example) have begun to require companies to include local hotel taxes in their home-sharing rates, either voluntarily or through regulations. In cities without such agreements, the host must remit the required taxes, something that most cities recognize rarely happens.
- There is potential for new job creation from the sharing economy, but there currently is not enough data to validate job claims.
- Indianapolis feels the city's acceptance of the sharing economy has helped it to attract large events and conventions.
- Taxi companies have complained that their need to purchase medallions and commercial insurance and to pay various tolls and taxes puts them at a disadvantage to the TNCs.

Equity and Access

- It remains to be determined how well the sharing economy serves disadvantaged neighborhoods, people of different abilities, or lower-income individuals.
- TNC drivers have been accused of avoiding neighborhoods due to "safety concerns."
- TNC opportunities may spur entrepreneurship within underserved communities and compensate for areas with inadequate public transit or lacking taxi service, thereby increasing access to wider opportunities for the residents of these neighborhoods.
- Shared-economy apps rely on reviews to build trust between renters and rentees, though the issue of bias that can arise in these reviews has not been thoroughly explored.
- Advocates for Americans with Disabilities (ADA) have called for TNCs to provide options for people with physical disabilities. Dallas has included a general clause in its transportation ordinance that a TNC could not deny service to anyone requiring special assistance. If the company is unable to provide the service, then it can refer the individual to another company that can. Several cities have passed legislation requiring data sharing on where wheelchair-accessible requests have been made, and how long it takes to arrive at the pick-up location after the request. A few locales have also passed ordinances requiring that TNCs collect per-ride fees to support wheelchair-accessible transportation.
- The impact of home sharing on affordable housing is a complicated issue. On one side, the ability to rent out a room in a house can make a home more affordable to homeowners who could not otherwise afford their house; however, short-term rentals can potentially be more lucrative to landlords than standard rentals, making the housing stock less affordable to low-income households. More research is needed to know how much, or even whether, home sharing is affecting housing affordability. A few ordinances have been proposed, but not passed, to deal with these issues. Portland proposed legalizing home sharing for owner-occupied units only; it also tried to tie revenue from home sharing to the city's affordable housing fund.
- There remain concerns as to whether low-income and senior populations have access to the Internet and the skills needed to participate in the sharing economy.
- The sharing economy threatens to shift the economic landscapes of cities and disrupt existing revenue streams that support transit and affordable housing.

Safety

- Cities have focused on additional safety protocols within the sharing economy, such as background checks, insurance, and inspections.

- To address TNC insurance needs, Dallas has created a three-tiered insurance system. Phase 1 is personal insurance for when the driver is using the car for personal, non-ride sourcing purposes. Phase 2 TNC company-contingent coverage is for when the driver has the app turned on and is awaiting a rider. Phase 3 is primary commercial insurance for when the driver has accepted a passenger and is either on the way to pick the rider up or has the person in transit.
- In many cities, insurance requirements are much higher for TNCs ($1 million minimum liability) than for taxis ($100,000 minimum liability). This is generally seen as reasonable.
- For home sharing, San Luis Obispo has required a Designated Responsible Party to be available within a 15-minute drive of a rented rental property, and available by telephone 24/7, to help alleviate neighborhood concerns. For larger cities, the administration of this ordinance is likely to be cost prohibitive or impossible to enforce.
- Finding companies to verify TNC background checks has proven difficult because very few of such companies are in existence today.
- City officials have used building codes as a way to promote safety within home sharing, particularly through compliance with building integrity, fire escapes, maximum occupancies, and energy use. Madison, Wisconsin, has an ordinance that spells out how many rentals a property can have before taxes must be remitted, and requirements for inspections to ensure adherence to the building code.
- TNCs may promote safety by reducing instances of drunk driving, and since payment is done online, drivers do not handle cash and are less susceptible to thefts.

Process and Implementation

- Most officials that were part of this study noted that cities should identify the key stakeholders that should be at the table when discussing how to regulate the sharing economy:
  - For TNC regulations, the taxi industry is a must.
  - Other key groups include airports, disability advocates, local university students and professors, the police department, and, of course, residents.
  - Stakeholder participation should be proactive and can be done through common outreach activities such as surveys.
- Feedback can be supplemented through public forums and educational workshops (to draft regulations), although this is easier to do and organize in smaller cities than in larger ones.
- Beyond the typical forums, some cities have collected data from the comments sections on local news articles.
- In drafting new TNC regulations, some cities have found it useful to incorporate them into their broader transportation ordinances. However, in Washington, DC, controversy over a single TNC measure threatened to sink an entire transportation reform bill—which led to the isolation of the ride-sourcing portion from the rest of the transportation bill.
- As ride sourcing gains popularity, metropolitan areas may want to consider regional regulations, which create a uniform and consistent approach to regulation and administration:
  - The degree of coordination required to implement this can be challenging.
  - TNCs and other elements of the sharing economy will also be subject to state regulations. Most local officials consider state regulations to be more industry friendly. This is because state government is rarely able to enforce and monitor highly detailed regulations, particularly for services that occur at the local level; and state regulations are more concerned with establishing legality and basic operating parameters; in doing so, they allow for more flexibility and less direct accountability for things such as background checks and commercial insurance;
- Regulations should be scaled based on how active a participant the individual is in the sharing economy. Someone who rents out a bedroom or drives for a TNC a few times a year should not have the same level of requirements as someone who continuously rents out a house or drives for a TNC on a routine basis.

- The complex nature of the sharing economy makes regulation and enforcement a formidable task:
  - Many cities avoid creating regulations due to the strain it will create on staff time and resources.
  - Dallas found it had to trade off on background checks in order to have more staff time for enforcement.
  - City agencies will need cross-collaboration to make oversight more manageable.
  - City agencies have not taken ownership of regulation, causing many to outsource it; for instance, in Seattle approved auto repair mechanics do vehicle inspections for the city.
  - In Philadelphia, the Philadelphia Parking Authority (PPA) has worked aggressively to stop TNC operations (ticketing drivers, impounding cars); the PPA is controlled by the state, which has allowed TNC operations everywhere else in Pennsylvania. The Philadelphia City Council has passed a resolution supporting the legalization of TNC operations, but the city has no jurisdiction without state action.

Cities are laboratories for fast-changing business models and technologies. Given that the sharing economy is likely here to stay, city policymakers are urged to keep an open mind about how the right regularity framework can better enhance economic growth and quality of life for their constituents.

Chattergi, Aaron K. "Don't Look to States for New Ideas." ***New York Times*****, January 11, 2015.** http://www.nytimes.com/2015/01/12/opinion/dont-look-to-states-for-new-ideas.html **(accessed January 11, 2015).**

- Supreme Court Justice Louis Brandeis called states "laboratories of democracy." Indeed, some of our most notable recent policy advances came from the states, including school vouchers, energy efficiency standards, welfare reform, and healthcare reform. However, a number of issues will likely slow the federal scaling of successful state policies because:

  - The states themselves are becoming more partisan (60 percent are completely controlled by a single party), so ideas coming out of them lack the bipartisanship needed for federal implementation.
  - Attempts to turn state policy innovations into federal policy have increasingly faced backlash, such as the Race to the Top program, where Common Core has become controversial on both the political right and left, or skepticism over expanding a successful Tennessee program to aid students going to community colleges.
  - Federal mandates set up to allow states to innovate on federal programs have not been able to produce anticipated results, such as the Supreme Court striking down the Medicaid expansion portion of the Affordable Care Act.
  - Many states are still digging out from the effects of the Great Recession and don't have the funding ability to undertake new economic or social programs.

Chin, Ryan. ***"Solving Transport Headaches in the Cities of 2050." British Broadcasting Corporation*****, June 18, 2013.** http://www.bbc.com/future/story/20130617-moving-around-in-the-megacity **(accessed August 10, 2015).**

- The Organisation for Economic Co-operation and Development forecasts there could be as many as 2.5 billion cars in the world by 2050. By that point Saudi Arabia estimates that domestic fuel consumption could top exports, and if China were to achieve U.S. levels of auto ownership, its citizens would use more oil than the total world output today. If we want to see what the future looks like, rapidly growing Asian cities could be a good model (as in the William Gibson quote, "The future is already here, it's just not very evenly distributed"). Beijing already has 20 million residents and will see more as the Chinese government plans to move another 250 million rural peasants into urban areas. Many Chinese cities have commutes that average two hours or more,

and air quality in Beijing had particulate matter levels similar to what is found in the worst wildfires.

Potential solutions to transportation pollution include electric automobiles; car sharing; self-driving vehicles; and low-energy transportation such as walking, biking, and transit. China is currently embarking on the construction of 87 new transit lines that are nearly 2,500 kilometers (1,550 miles) long. The University of Tokyo has developed an on-demand bus system, in place of fixed-route buses, while China has prototyped the 3-D express coach, which is an elevated bus that would straddle over automobile traffic. The first/last-mile transit problem also has some new technologies in the works. The A-MoD system is being developed to deliver a self-driving light electric vehicle to a user. Once that user is done, it will drive itself to the next one or go back to its parking space. CityCar, which is on the verge of being commercially available in Europe, is a foldable, electric two-passenger vehicle for on-demand use.

While new technologies can help to relieve transportation problems, they cannot fully solve them on their own—neither can public policy nor new business models. Instead, there must be a fundamental rethinking about how we structure cities, so that living and working spaces are closer together, and there is less need for motorized transportation to begin with. This requires walkable, high-density, mixed-use neighborhoods where daily needs can be found within a 20-minute walk.

Clewlow, Regina R. "Three Ways Mobile Transit Payments Will Change How Move in Cities." *Planetizen*, November 23, 2015. http://www.planetizen.com/node/82353/three-ways-mobile-transit-payments-will-change-how-we-move-cities **(accessed February 9, 2016).**

- San Francisco Municipal Transportation Agency (SFMTA) recently launched the MuniMobile app in partnership with GlobeSherpa, a subsidiary of RideScout. This is the first mobile ticketing app in the bay area and it allows users to buy, consume, and store fares on a smartphone. Due to the convenience of not needing to have exact change, and reduced stress in paying for transportation, a recent Accenture survey (see https://www.accenture.com/us-en/insight-acn-public-transport-survey.aspx) found that the majority of transit riders are willing to pay more for a smartphone ticket. These services are becoming common all over the United States, and they are changing how people move through urban areas. For example:

    1. Ease of payment will attract new customers – transit ridership has been on the increase, but ride-sourcing companies such as Uber and Lyft have been growing even faster. Ease of payment is often cited as the top reason why people use their services.
    2. Transit is more efficient with cashless payments – they allow passengers to board vehicles faster and use all vehicle doors to do so.
    3. Big data facilitates smarter transportation – allowing for tactical real-time decisions, and strategic long-term planning. Real-time incentives can help to balance peak demand.

Davies, Alex. "What Mass Transit Can Learn from Elitist Buses Like Leap." *Wired*, March 31, 2015. http://www.wired.com/2015/03/public-transit-can-learn-elitist-private-buses/ **(accessed April 16, 2015).**

- Leap is a privately run bus service that connects two neighborhoods in San Francisco. Other similar services include Via in New York City and Chariot, also in San Francisco. All of these startups share some similar traits: embracing new technologies and not fearing failure. As a result, they are willing to try new things, adjust, and iterate. These are things that risk-averse public transit services should try to emulate. [*editor's note: Leap was shut down by a public utilities commission cease-and-desist order one month after this article was published, largely because it failed to show proof of insurance.]*

Dawid, Irvin. "Urban Millennials Stuck in the Three Largest U.S. Metros." *Planetizen*, January 23, 2015. http://www.planetizen.com/node/73419 (accessed January 28, 2015).

- From 2004 to 2007, a net average of 50,000 adults between 25 and 34 years old left both New York City and Los Angeles. From 2010 to 2013, the net total dropped to 35,000 annually. Chicago's net departures dropped by about 60 percent in the same period. Demographers, such as William Frey at the Brookings Institution, fear that this is a sign of financial insecurity, especially due to student loan burdens. This could make the American economy less productive overall, if young people get stuck in jobs that are not good matches for them, and reduces the migration that helps to distribute human capital and economic demand and to allow states with weaker economies to grow along with stronger ones.

Dawid, Irvin. "The Far-Reaching, Lasting Effects of Low Oil Prices." *Planetizen*, February 24, 2015. http://www.planetizen.com/node/74494 (accessed February 24, 2015).

- Demand response is the term used for how consumers react to changing prices. As a result of the recent 50 percent decline in the price of oil, sports utility vehicle sales are increasing, car sales are decreasing, and people are driving more. Lower costs are anticipated to increase the demand for oil in developed countries by 1.3 percent in the near term and up to 4.7 percent in the long term, if the price stays where it is. The effects of these price changes can take years to fully play out but will show up in lower-density land use patterns and lower demand for transit.

Dervis, Kermal. "The Future of Economic Progress." The Project Syndicate, April 15, 2014. https://www.project-syndicate.org/commentary/kemal-dervi--homes-in-on-the-key-questions-surrounding-the-nature-and-measurement-of-contemporary-growth (accessed July 28, 2015).

- The conceptual debate among economists about the future of economic growth breaks into two main camps. The first believes future economic growth will be much slower in both developed and emerging economies as technological progress becomes sluggish. The opposition, called the new technologists, argue that we are on the cusp of the fourth industrial revolution, based around "intelligent machines" that will substitute for medium-skill labor. Intelligent machines include robots, the Internet of Things (IoT), self-driving cars, and 3-D printers. They will usher in new productivity gains, energy efficiency, and customized mass production.

  If these technologies arise, distribution of economic gains will be a significant concern. In this future, capital is a substitute for virtually all but the highest-skilled labor. Inequality is likely to worsen, as the return on capital grows higher than overall economic growth (see Piketty, Thomas). This is due to education needing a long time to turn out needed new skills. As inequality widens, and more and more income and wealth filters to the top, the political viability of our system could come into question.

  With imminent technological development to fuel productivity increases, what happens to workers in a world where there is little need for cashiers, toll collectors, or call operators and less need for accountants, travel agents, financial advisors, drivers, and others? If the future of work is a shorter week, with more leave time, why do so many argue that individuals should work more, and work later in life for economic competitiveness?

  Lastly, there are environmental concerns, such as climate change and natural resource limitations. These are factors that could impede economic growth or force a different economic paradigm around clean tech and green energy.

  As these changes arise, it becomes clearer that measuring economic progress around GDP is less and less useful. Instead, we need a new social contract, one that allows the power of technology

to be harnessed in a way that it serves everyone. Counteracting trends of widening inequality will require a variety of policies, especially taxes, and affordable healthcare and education.

DiStefano, Joseph. "Philly Jobs, Going and Coming." *Philadelphia Inquirer*, August 29, 2015. http://www.philly.com/philly/blogs/inq-phillydeals/Philly-jobs-coming-and-going.html (accessed August 31, 2015).

- Philadelphia has recently had two publicly traded corporate headquarters move into the city: Hill International and Axalta, a DuPont Company spinoff. But five have left the city over the past couple of years: Arkema, which moved to King of Prussia; Dow Chemical's Advanced Materials division, which went to Spring House; Sunoco, which is now in Newtown Square; Cigna; and Destination Maternity, which left for Moorestown, New Jersey. In addition, a number of factories have ceased operating in the city, such as Mondelez and Alkore in Northeast Philadelphia and Amoroso Baking Company, which moved to South Jersey. Banking jobs continue to decline—120 at Wells Fargo and 280 from Bank of New York Mellon—a decade after the last deal that left the city without a major regional bank.

  There is some good news, WuXi AppTec, a medical testing company, and Revzilla, a motorcycle accessory company, have both recently broken ground for new facilities at the Navy Yard. Dietz and Watson is building a new distribution facility in Northeast Philadelphia. Penn Financial, Iroko, and Franklin Square are all creating new jobs in their Navy Yard offices. Comcast's Innovation and Technology Center (soon to be the tallest building in the city) will add 1,500 jobs. HOK architects and the American Bible Society have both moved their headquarters here. Despite this, Philadelphia's overall employment remains below where it was in 2008 (U.S. Census Bureau).

Dubravac, Shawn, Ph.D. *Digital Destiny: How the New Age of Data Will Transform the Way We Work, Live, and Communicate*. Washington, DC: Regnery Publishing, 2015.

- The digital revolution—also known as the "Internet of Things (IoT)"—where more and more devices are being connected to the internet and are using radio frequency ID and sensors to collect data on everything is the most significant trend at the moment. In its simplest form, digitization is reducing the amount of friction and distance that exists between data and action. Digital technologies shape us, how we experience the world, and how we live. Access to more and better data allows for more customization of everything we produce. Digital also breaks down the last major barrier to data: distance, where entire libraries worth of information can now be transmitted instantaneously. Smartphones, tablets, and e-readers are further blurring the boundary that once existed between our online and offline personas.

  The most readily comparable historical expansion of data availability is Gutenberg's invention of the printing press around 1450 A.D., which is tied too much of the human progress and upheaval that has played out over the centuries since. The first two industrial revolutions improved manufacturing and production efficiencies that helped mankind to build all kinds of better widgets. While they led to major changes to nearly all aspects of our way of living, there was little change in how data is gathered and analyzed. Data collection in the analog world is a costly endeavor, which limits its usefulness. In a digital world, data is infinite and has very low transaction costs.

  New devices are constantly being connected to the IoT: coffee pots, crock pots, potted plants, toilets, toothbrushes, thermostats, watches, cups, livestock, Christmas trees, and even baby diapers. Each of these devices tracks data for us in an automated fashion. As of 2008, there were more devices connected to the Internet, than people on the planet. A market research firm, IDC, estimates there are more than 200 billion devices that could be connected to the IoT, but only about 10 percent (20 billion) currently are. This figure is expected to reach 30 billion connected 'things' by 2020. These things all run independently, but are able to communicate with each

other. All the data collected by these devices promises great opportunity to improve decision making, reduce loss and waste, increase productivity, and lower costs. Today the world is producing data faster than ever, and moving it about with more and more frequency.

- In 2013, the Norwegian research organization, SINTEF, estimated that more than 90 percent of the world's data was created in the previous two years.
- 205,000 new gigabytes are created every second, the equivalent of 150 million books.
- IDC publishes an annual estimate of all the bytes added to the digital universe. In 1986 there were 2.6 about exabytes (a quintillion bytes, or 10^{19}) of total hard drive space. Digital information storage then grew at a rate of 23 percent compounded annually until 2007. In 2005, there were 32 exabytes of data created, 15 times more than the total storage available in 1986. In 2013, the world created 4.4 zettabytes (a sextillion bytes, or 10^{21}). The digital world appears to be doubling in size every two years, consistent with Moore's Law.
- Per minute in 2014, there were 204 million e-mails sent, 4 million Google searches, 2.46 million Facebook content pieces shared, 277,000 tweets, 216,000 Instagram photos posted, 48,000 Apple Store apps downloaded, 26,380 Yelp reviews, 3,472 Pinterest images pinned, and 72 hours of YouTube videos added.
- Worldwide, about 3.6 billion people currently have a mobile internet connection, with 400 million new subscribers added each year. Mobile data traffic was 1.5 exabytes per month in 2013, and for the year it was 18 times greater than the entire Internet in 2000.
- Hard-drive space was a major constraint for a long time. In 1980, a 26MB Morrow Designs Hard drive cost $5,000, about $193,000 per GB. In 1985 the cost was down to $105,000 per GB, in 1990 it was $11,200, and in 1995 it was $1,120. By 2015, the cost per GB was just $0.05. Today computer and hard-drive manufacturers are less concerned with space, and more concerned with speed, reliability, and accessibility. With digital data, there are no physical storage space concerns. This allows for an abundance of new customizable offerings, that weren't possible in the analog world, which was constrained by scarcity of shelf space, the need to appeal to wide audiences, and other limitations.
- By 2020, the digital universe is expected to contain 300 sextillion bytes, about as many stars as there are in the universe.
- Data from embedded sensors currently accounts for two percent of all data created each year. By 2020, it is predicted that sensors will account for 10 percent of all data (IDC).

The above figures underscore the five key elements behind the digital revolution:

- Ubiquitous computing.
- Internet access.
- Proliferation of digital devices.
- The declining cost and rising capacity of data storage.
- The sensorization of objects.

Sensors gather information about the world around us, and process the raw data to turn it into actionable intelligence. Smartphones come with up to nine different sensors, depending on the model, each with a unique function:

- Proximity sensor—recognizes when we are using a smartphone as a phone and deactivates the touchscreen display.
- Ambient light sensor—adjusts the phone screen's display brightness based on lighting from the surrounding area.
- Accelerometer—senses the smartphone's orientation and changes the screen to suit, also used to play videogames.
- Gyroscopic sensor—a more advanced accelerometer, found on newer phones, it increases how many degrees of motion can be sensed and tracked.

- Magnetomer—detects the strength and/or direction of the magnetic field within the smartphones environs.
- Ambient sound sensor—cancels out all other nearby sounds except the smartphone user's voice.
- Barometer—measures the atmospheric pressure at the smartphone's exact location.
- Temperature/Humidity sensor—Works with apps to better record health and exercise data.
- M7 motion coprocessor—combines accelerometer, gyroscope, and compass readings to improve awareness of the smartphone's immediate vicinity and help the phone adapt to specific activities.

Creating order from the chaos created by all this data is one of today's major challenges. For instance, a simple search engine response for 'Obama' yields 1.6 million hits, far more than can possibly be sorted through. There are plenty of risks and unintended consequences that can arise from digital data:

- Data breaches—that lead to unauthorized access to personal data, or accounts. These are the bank robberies of the digital world.
- Social Media Blunders—some of which have destroyed lives and careers (see Anthony Weiner or #hasjustinelandedyet).
- Political Unrest—digital data can help a few dozen protestors grow into a network of hundreds of thousands. While this power has been used for mostly peaceful means in the U.S., less democratized nations have not been as tolerant of mass dissent (see many examples from the Arab Spring).
- Legislative and Regulatory Uncertainty—lawmakers have used regulation as a means of control over individuals and corporations, and laws written for an analog world are ineffective, or even innovation stifling. Digital data moves seamlessly throughout the world, and does not respect geographic boundaries, even national ones, adding new difficulty to legislation.
- Economic Upheaval—particularly for the workforce trained for lower skill jobs that technology is helping to outsource or automate. This workforce lacks the skills and/or knowledge needed to fill the jobs available in the new digital economy.
- The Digital Divide—as we digitize more information and become more reliant on digital technology, those without the skills or economic means to use them are left further behind. Over time, this heightens the socioeconomic, living condition, educational and employment opportunity divide between those who can access technology and those who cannot.
- Misplaced Sensorization—just because something can be connected to the internet doesn't mean that it makes sense and is useful.
- Digital Remorse—once a news article or something about us is up on the internet, it is potentially there forever, and can be incredibly hard to remove it, even if we want to do so.
- Loss of Privacy—as we digitize more about ourselves, what we do, and where we go, it is recorded and shared.

Digitization is increasing and accelerating the substitution of labor with capital, and is replacing low digital jobs with high digital ones. Data science will redefine virtually all jobs in the future, which means nearly all work will soon require some level of digital capabilities. Industries can readily scale up their business in a digital world, while greatly decreasing the magnitude of the cost for doing so. It allows companies to determine if there is a market for goods and services much more quickly. As digital speeds up everything it comes into contact with, it also accelerates the business cycle. There is evidence that this is already happening. The average length of time that companies have been listed on the S&P 500 has decreased from 75 years in 1937 to 18 years at present. Startups gain foothold in low-margin sectors through simpler, lower cost solutions, which are inferior initially. Established firms refocus around higher-margin core products and services with greater profitability. Over time, as the startup matures, it slowly moves into the higher-margin segments until it becomes the dominant company.

Multisided platforms are the new key to business and industry organization, and they have replaced disruption as the major theory behind change dynamics. Multisided platforms directly connect marketplace participants while providing network benefits. Analog examples include temp agencies (workers and employers), credit cards (merchants and cardholders), and shopping malls (shoppers and merchants). New and fast growing digital examples include search engines (advertisers and web users), Craigslist, Square, Tinder, Wechat, and sharing economy companies such as Uber (drivers and passengers), and Airbnb (travelers and room/apartment/home owners).

Digitization promises significant advances in healthcare. Digital data, the individual, and treatments will all reinforce each other leading to better outcomes through feedback loops that change behaviors. Personal data tracked with wearable devices can be combined with algorithms that will predict and prevent conditions before they happen, taking preventative care to a whole new level. Wearable devices may even be able to identify our current mood, play specific music or make recommendations to alter it, and share our mental state with identified loved ones. Drug companies will be able to develop personalized medicines that are specifically tailored to an individual's health and genetics. Better data will ensure that fresh produce, which currently perishes before reaching a market, will instead find its way onto more plates.

The pace at which digital technology is driving change means that laws and regulations are continuously outdated, ineffective, or dangerous even shortly after they are implemented. Public policy approaches will need to be made more fluid to keep up with a new normal of fast changing economic paradigms.

- Companies will need to be granted flexibility in determining how to protect sensitive data, and should develop an internal ethical code to guide the use of personal data.
- Companies should give consumers options to determine the level of privacy and security they are comfortable with.
- Consumers need more education about their existing privacy rights, and the benefits made possible through digital data collection.
- A national standard on data breach notification needs to be created.
- The Digital Millennium Copyright Act is outdated and needs to be reconsidered, as the average individual now regularly infringe on copyright over the internet by listening to music, through social media actions, or copying and pasting articles.
- The 1986 Electronic Communications Privacy Act (ECPA) currently determines how the federal government can acquire electronic communications from private citizens. This law was created before the internet and cloud computing, and as a result is outdated and needs to be updated, particularly with stronger privacy protections.
- The unlicensed radio spectrum, which includes WiFi and Bluetooth signals, needs to be increased in size and used more efficiently.
- An open internet (i.e., "net neutrality") should be promoted through media and watchdog scrutiny, competition, and further investments in broadband; rather than governmental mandates.
- The FDA will need to clearly distinguish between fitness and wellness medical devices, where the medical devices should be held to higher standards in terms of false positive/negative readings.

Random Notes:

- Metcalfe's Law – identifies a communications network value as the square of the number of connected users it has (n^2).
- "Half the money I spend on advertising is wasted. The trouble is I don't know which half." – John Wannamaker.
- "Thanks to science and technology, access to factual knowledge of all kinds is rising exponentially while dropping in unit cost. It is destined to become global and democratic. Soon it will be available to everyone on television and computer screens. What then? The

answer is clear: synthesis. We are drowning in information, while starving for wisdom. The world will henceforth be run by synthesizers, people able to put together the right information at the right time, think critically about it, and make important choices wisely." E.O. Wilson, *Consilience* (1998).

- "Getting information off the internet is like taking a drink from a fire hydrant." Attributed to Mitchell Kapor.
- Many of the concerns people currently have with the digital world now are part of the usual chaos that comes with the unleashing of massive quantities of new data. Kids growing up in the digital world today will see it as the new normal.
- Social networks and apps (following surfing and search engines) are the latest efforts to impose order on the internet. Enhanced algorithms (i.e. Netflix) are already coming online as the next method.
- After over-sharing information for the last decade, many web users are appreciating the chance to communicate in a more anonymous and fleeting way through new privacy minded apps and services such as Snapchat, WUT, Social Number, YikYak, Banter, Blink, Backchat, and ask.fm.
- Cloak is the antisocial network. It uses digital data to help avoid people that a person doesn't want to see.
- Digital will allow for more personalized politicking, which could significantly change campaigning and governance. No longer will individuals be clustered into demographic groups by race, income, and age, and instead real personal preferences can be identified and tracked.
- There are three ways in which the internet and social media influence politics: (1). Digital communications decrease the cost of collective action; (2) they help bring together individuals with similar viewpoints; and (3) they allow people to identify personal preferences that are less bound by societal expectation and allow for the expression genuine values with less fear of punishment (particularly from authoritarian regimes).
- Some auto insurance companies offer policies that allow you to lower your premiums in exchange for putting a GPS device in your vehicle to monitor how safe of a driver you are.
- Television producers long had to make shows that appealed to as large of an audience as possible. Digitization has increased audience fragmentation, and increased data collected on individual viewers. Now shows are geared for a specific audience, which has freed television from the constraints of mass media, unleashed creative genius, and led to a new golden age on TV.
- 3D printers allow for a medieval level of craftsmanship, while enabling individual customization with industrial production quality.
- Data is morally ambiguous.
- "The ability of digital data to allow millions of people to communicate with each other in near-instantaneous fashion is a power never before seen in human history." (page 94).
- "Questions about data sharing and privacy always involve tradeoffs." (pg. 153).
- Autonomous vehicles promise less congestion, which will allow people to have more freedom when choosing where to live, rather than basing this choice on where they need to go. In this way, autonomous vehicles offer more customization in where to live.
- The consulting firm Fehr and Peers predicts that autonomous vehicles will carry 50 percent of all vehicle miles traveled by 2040, and approach 100 percent by 2070.
- Highways in an autonomous vehicle future should have truck only lanes, with 1' thick pavement needed to carry them, and car only lanes with pavement only a few inches thick to meet their needs. Autonomous vehicle lanes can be much narrower, given their precise driving capability, allowing the same width of roadway to have more through-lane capacity. Speed limits can be greatly increased. Joining infrastructure into the IoT and an integrated transportation network should yield a considerable number of efficiencies.
- Kinze Manufacturing developed the first autonomous planting system in 2011, and autonomous agriculture systems are increasingly being employed in food production.

Dutzik, Tony, Jeff Inglis, and Phineas Baxandall. *Millennials in Motion*. Washington, DC: U.S. PIRG Education Fund and Frontier Group, 2014. http://www.frontiergroup.org/reports/fg/millennials-motion

- Vehicle miles traveled (VMT) per capita in the United States has steadily fallen over the past decade, following 60 years of continually increasing. Young people, in particular, are driving less, using transit, walking, and biking more to get around. They are reinforcing these choices by living in urban areas, where driving is optional. If they continue along these lines as they age, and future generations follow suit, then there are many benefits to be gained: less congestion, fewer road fatalities and injuries, lower costs for road construction and repair, and less pollution.

  There are several factors that may be driving these shifts: high gas prices, tougher requirements for obtaining a driver's license, the Great Recession, smartphone technology, delaying getting married and having children, rising college enrollments, and the emerging availability of ride sourcing, bike sharing, and car sharing.

  2001 to 2009 change in trips per capita, 16 to 34 years old:
  - transit +4%.
  - walking +16%.
  - biking +27%.
  - driving –15%.

  Car trips by young people were 6 percent shorter over this time period as well (from 10.1 to 9.5 miles). Likewise, millennials are much more likely to say their top preference is to live in a city.

  Pew survey, percentage for whom ideal community type is "city":
  - 18–29: 38%.
  - 30–49: 23%.
  - 50–64: 19%.
  - 65+: 18%.

  These changes may mean it is time to rethink transportation investments to better meet the needs and desires of future generations, while incorporating uncertainty into planning through the use of scenario analysis and other tools, and to provide a variety of transportation options.

Ebinger, Charles K., and Heather Greenley. *8 Facts about U.S. Crude Oil Exports*. Washington, DC: Brookings Institution, September 9, 2014. http://www.brookings.edu/research/reports/2014/09/09-8-facts-about-us-crude-oil-production **(accessed January 2, 2015).**

- Ebinger and Greenley, along with National Economic Research Associates, examined how rescinding the ban on exporting crude oil would impact the economy and national security. The key finding was that removing the ban would increase economic growth, wages, and employment in the United States. These impacts are greatest if the United States lifts the ban in 2015. Delaying, or allowing only specific exports, lowers benefits by about 60 percent compared to an immediate and complete elimination of the ban. Removing the ban even decreases the cost of gasoline over time, by increasing the total amount of crude oil in the market. Finally, removing the ban would increase U.S. global power by strengthening the nation's status as an advocate of free and open markets, creating secure energy supplies for international consumers, helping to minimize supply disruptions, better meeting growing energy demands in developing nations, particularly in Asia, and boosting the U.S. economy, which bolsters our global influence.

The Economy League of Greater Philadelphia. *2026: Future Histories of Greater Philadelphia*. Philadelphia, PA: The Economy League of Greater Philadelphia, 2011.
http://www.worldclassgreaterphila.org/uploads/media_items/2026-future-histories-of-greater-philadelphia-report.original.pdf

- The Economy League of Greater Philadelphia developed four plausible futures for the region, as a way to stimulate conversation about what issues the region should focus on, regardless of which future comes to fruition.

  - Global Village—developing nations boom, while the United States and Europe hold steady; cheap power is readily available anywhere, thanks to innovations in alternative energy and batteries.
  - America in the Driver's Seat—even though the Organization of the Petroleum Exporting Countries (OPEC) increases energy prices, newly discovered oil and gas reserves in the United States allows it to help drive global growth.
  - Tight Belts—power is increasingly consolidated within a few international conglomerates; the strive for efficiency has led to local government consolidation and little investment in infrastructure or education.
  - Partners in Hard Times—increasing resource scarcity and struggling international markets mean the United States has to do more with less to keep the economy going, meaning less government services and more public–private–philanthropic partnerships.

  Each of these futures presents different challenges and opportunities for the United States and its metro areas. While success is possible in all of them, it is certain in none of them. Regions must anticipate and adapt to how global and national forces play out. Greater Philadelphia's best ways of positioning itself for the future include:

  - Business creation and entrepreneurship—make the most of economic opportunities where the region has a competitive advantage; this may be services and advanced manufacturing in Global Village, innovation and life sciences in America in the Driver's Seat, professional services in Tight Belts, and government and nonprofits in Partners in Hard Times.
  - International Connections—connecting to international opportunities is crucial to economic vitality.
  - Education and Talent Development—ensure there is a pipeline of talent to fuel prosperity in the future; scenarios where business is in decline are generally due to a failure to improve education outcomes in science, technology, engineering, and math.
  - Higher Education—helps to grow workforce talent and leverage research, innovation, and business formation.
  - Infrastructure—in higher-cost energy futures, regions with a lower-cost transportation network gain a competitive advantage; in lower-cost energy futures regions must manage congestion and modernize infrastructure, including enhancing international connections.
  - Efficient Government and Public–Private Partnerships—governments still play a key role in driving economic growth and improving quality of life; governments that make the most efficient use of their resources and leverage them with external partners set the stage for success
  - Public Safety—domestic poverty and economic disparities as well as terrorism loom as public safety challenges. Maintaining public safety is critical, or else other regional economic and social opportunities will be thwarted.

Fagnant, Daniel, and Kara M. Kockelman. *Preparing a Nation for Autonomous Vehicles: Opportunities, Barriers and Policy Recommendations.* Washington, DC: Eno Center for Transportation, 2013. https://www.enotrans.org/etl-material/preparing-a-nation-for-autonomous-vehicles-opportunities-barriers-and-policy-recommendations/

- This report identifies a number of potential benefits from an AV future, including: improved safety, reduced congestion, less need for parking, providing more mobility to the elderly and disabled, shorter travel times, and reduced insurance and parking costs. They are also likely to substantially affect travel choices, land use patterns, infrastructure investment, goods movement, and other activities. In the shorter term, connected vehicles may yield considerable safety improvements relative to vehicles on the road today.

  Currently, the cost of the equipment needed for an AV is more than $100,000. Once these costs are down to about $37,500, some individuals will find the technology worthwhile to invest in. It will need to be less than $10,000 per vehicle to be a reasonable cost for mass production. Some other key findings include:

  - Through car sharing, a single AV could replace between 9 and 13 private vehicles.
  - While AVs will likely increase VMT, reduced braking and accelerating are likely to lower per-mile emissions.
  - Autonomous technologies can also be applied to the trucking industry. This would significantly reduce employment in the trucking field, and reduce fuel consumption and associated emissions. Truck platoons could draft off each other, further reducing energy use, increasing road capacity, and enhancing safety. Such platoons may need thicker and stronger concrete to handle their loads, and require designated truck-only lanes to prevent trucks from blocking highway on- and off-ramps.

  Though more study is needed to better anticipate these impacts, Eno considered three different levels of AV penetration into the marketplace: 10 percent, 50 percent, and 90 percent of the vehicle fleet being self-driving, shown in Table C-1. Each of these is a back-of-the-envelope estimate.

Table C-1. Estimated Autonomous Vehicles Impacts in the United States Relative to Conditions in 2013

	Percentage of Autonomous Vehicles in Total Fleet[a]		
	10%	50%	90%
Road Capacity	+1.0%	+21.0%	+80.0%
Reduced Fatalities	1,100	9,600	21,700
Percentage of Fatality Reduction[b]	–3.4%	–29.7%	–67.0%
Vehicle Miles Traveled	+2%	+7.5%	+9%
Number of Autonomous Vehicles (millions)	12.7	63.7	114.7
Total Number of Vehicles	–4.7%	–23.7%	–42.6%
Travel Time Savings (millions of hours)	756	1,680	2,772
Fuel Savings (millions of gallons)	102	224	724
Fuel Use (assumption)	–13.0%	–18.0%	–25.0%
Additional Cost of Autonomous Technology per Vehicle	$10,000	$5,000	$3,000
Annual Safety Cost Savings (billions)	$5.5	$48.8	$109.7
Annual Congestion Cost Savings (billions)	$16.8	$37.4	$63.0
Annual Parking Cost Savings (billions)	$3.2	$15.9	$28.7
Total Annual Cost Savings (billions)	$25.5	$102.2	$201.4
Annual Savings per Autonomous Vehicle	$2,000	$1,610	$1,670

[a] No year is estimated for these market penetration numbers.
[b] Assuming the 2011 total number of fatalities, 32,367 is the base-year comparison.
Source: Eno Center for Transportation, 2013.

Ferral, Katelyn. "Pa. Spared Earthquakes from Deep-Shale Drilling." *Pittsburgh Tribune*, June 27, 2015. http://triblive.com/state/pennsylvania/8353664-74/ohio-wells-pennsylvania (accessed September 15, 2015).

- Pennsylvania has been spared from the intensification of magnitude 3.0 or higher earthquakes nationwide, despite more than 19,000 shale-gas wells. Ohio has just under 2,000 natural gas wells in the Marcellus and Utica shale plays. In 2012, there was a magnitude 4.0 quake near Youngstown, Ohio, which rarely occurs. Geologists have determined that wastewater wells—which hold the salty, chemical laden brine that is the end product of fracking—are the cause of drilling-related tremors. Ohio has 203 wastewater wells, with 18 more on the way. Pennsylvania has only seven of them. Pennsylvania drillers are shipping much of their wastewater to Ohio for disposal. One reason for this is that Ohio's geology is more suited for wastewater wells than Pennsylvania's. This is due to salina, a thick layer of salt, which insulates drilling activity from disturbing fault lines at the base of Earth's crust. Basement faults, which are gaps at the bottom of the crust, are particularly dangerous to unsettle. The deeper a well goes into the crust, the greater the impact can be. Ohio has allowed drilling as deep as 10,000 feet, about 1,000 feet above the basement fault level. The average Pennsylvania Marcellus well is shallower, about 5,000 to 9,000 feet. Three-dimensional seismic imaging can help to map crust rock formations and identify the best shale-tapping spots. However, horizontal faults can be hard to see, even with this technology.

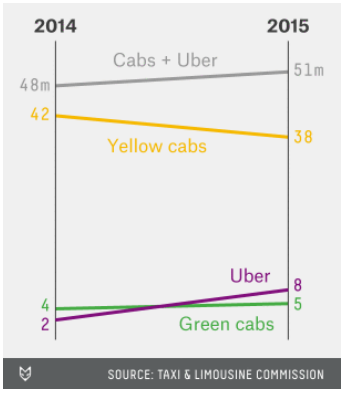
Ferris, Elizabeth. "Earth Day: Climate Change and Displacement across Borders." Brookings Institution, April 22, 2015. http://www.brookings.edu/blogs/planetpolicy/posts/2015/04/22-climate-change-displacement-ferris (accessed April 23, 2015).

- It is not known how many people will have to leave their communities across the world as a result of climate change. Most people who do will likely relocate within their own country. However, this will not be an option for some, such as Pacific Islanders. The various estimates for how many international climate refugees there will be ranges from the hundreds to the millions. Regardless of this number, it is time to start planning for how to handle cross-border climate change displacement, and the policies and programs that will be needed by those who are displaced. In international law there is no distinct category for climate change refugees—they would have to go through normal immigration channels. The Nansen Initiative is an effort to investigate this gap in international law.

Fischer-Baum, Reuben and Carl Bialik, " Uber Is Taking Millions Of Manhattan Rides Away From Taxis," *Fivethirtyeight*, October 13, 2015. http://fivethirtyeight.com/features/uber-is-taking-millions-of-manhattan-rides-away-from-taxis/ (Accessed January 29, 2016).

- Despite efforts by Mayor Bill Di Blasio to curtail it, Uber is aggressively growing in New York City. From 2014 to 2015 it quadrupled its ridership, while replacing taxi trips throughout the city.

Figure C-2. Change in NYC Pickups (April-June 2014 vs. April-June 2015)



Forum for the Future and Sony. *FutureScapes: The Scenarios*. London: Forum for the Future and Sony, November 2011.
http://www.forumforthefuture.org/sites/default/files/project/downloads/futurescapes-final-scenarios.pdf

- How can technology support sustainable lifestyles? To consider the question, a group of 50 experts with backgrounds in science, economics, business, nongovernmental organizations, and governments from around the world collaboratively developed four Climate Futures scenarios using an adapted version of the Field Anomaly Relaxation (FAR) method.[C-1] The four scenarios identified are:
  - Hyper-Innovation—A low-carbon world is created through rapid technological innovation. Lifestyles and business practices are little affected, but diminishing resources give rise to a concern about the long-term sustainability of the continuous innovation method.
  - Shared Ownership—Global governments have instituted a strict regime for limiting carbon emissions. This has led to high carbon costs and a new view on ownership. Both individuals and businesses have to be innovative in this future, with government encouraging new business and service models, but the economy is not centrally planned.
  - Centralized Survival—After a series of severe climate shocks, governments are taking strict measures to fight climate change, pushing new technologies that impose sustainable practices without placing significant restrictions on individual freedoms.
  - Prosperity Redefined—Following a prolonged recession, personal well-being and quality of life are the new priorities as more sustainable lifestyles emerge. Stronger community ties are built into this new sustainable framework, and technology facilitates local and global collaboration.

Freed, Benjamin. "Amazon Prime and Uber Are Changing the Map of Your City." *Washingtonian*, May 31, 2015. http://www.washingtonian.com/blogs/capitalcomment/transportation/amazon-prime-and-uber-are-changing-the-map-of-your-city.php (accessed June 9, 2015).

- There is a quiet revolution in the transportation realm that can be seen through a series of recent *Washingtonian* articles:
  - The opening of the Metro's Silver Line.
  - Bicyclists protesting a *Washington Post* column about bad bicyclist behavior.
  - A new 45-unit apartment building being approved in Washington, DC, that has just 16 parking spaces.
  - Northern Virginia and Washington, DC, residents badgering local governments about taxicab regulations and their impact on ride sharing services.
  - A September 2014 announcement by Washington, DC's Yellow Cab services that revenues had decreased by 30 percent over the past year.
  - An October 2014 article about how the U.S. Postal Service has begun to deliver goods ordered from Amazon in Washington, DC, on Sundays.

C-1 FAR is a systematic mapping of drivers of change, structuring them as sectors and factors that are used to create a complex and interconnected tree with branching scenarios. It is developed through a four-step process:
1. Identify an initial, imaginative view of alternative futures that could arise related to strategic decisions that need to be made.
2. Construct sectors and factors based on critical uncertainties and plausible ranges:
   a. Sectors are the dimensions within the strategic question.
   b. Factors are alternative states in each sector.
   c. Array the sectors and factors to form a whole field with all possible arrangements.
3. Eliminate pairs that are not logical or could not co-exist.
4. Position remaining pairs on a tree with branches representing plausible futures and transitions between them.

See also http://lib.fo.am/future_fabulators/field_anomaly_relaxation.

When these things make it easier to get by without owning a car, car ownership rates will decline. For example, the number of carless households in Washington, DC, increased by 12,612 from 2010 to 2012. This will lead to increased demand for public transportation, bicycle infrastructure, and denser development. This shift reinforces itself as more people change their behaviors, and it is not limited to Washington, DC. Suburban communities are redeveloping around walking and transit. Beyond the areas being redeveloped around the Silver Line, Montgomery County, Maryland, is converting Rockville Pike from a limited access, high-speed road to a multimodal corridor based on a long-term vision of transit-oriented development.

The 20th-century physical infrastructure of roads, bridges, and transit systems remains very important, while the new, private-market-driven digital infrastructure is causing these systems to be used in new and different ways, without being regulated and considering its wider impact. The longer-term effects are difficult to predict, and it is likely that a lot of these innovations are going to fail. However, as more people change their behaviors and expectations as a result of the new digital infrastructure, the politics and business environment around the infrastructure for getting around and getting stuff will continue to shift.

Frey, William H. "New Projections Point to a Majority Minority Nation in 2044." Brookings Institution, December 12, 2014. http://www.brookings.edu/blogs/the-avenue/posts/2014/12/12-majority-minority-nation-2044-frey **(accessed December 31, 2014).**

- New population estimates by the U.S. Census Bureau anticipate that the Caucasian population in the United States will make up less than 50 percent of the total by the year 2044. By that year, Hispanics are estimated to comprise 25 percent of the population, African Americans 12.7 percent, Asian Americans 7.9 percent, and multiracial individuals 3.7 percent. Two trends that will continue between now and 2060 will drive the growth in minority populations. The first is a long-term decline for the Caucasian population in the United States, which will peak in absolute numbers in 2025, then decline due to an aging population where the number of natural deaths will be greater than the number of births each year. Meanwhile, Asian Americans and Hispanics will more than double, due to high growth rates, while the multiracial population will triple. Due to these differing growth rates, there will be an even greater racial disparity between generations. By 2060 the youth minority population will increase to 64 percent of the total, compared to 48 percent in 2014, while Caucasians will still comprise the majority of the age 65 and older population in 2060.

"The Future of Work: There's an App for That." *The Economist*, January 3, 2015. http://www.economist.com/news/briefing/21637355-freelance-workers-available-moments-notice-will-reshape-nature-companies-and **(accessed October 21, 2015).**

- An increasing number of startup companies are developing around systems that match independent contractors with job opportunities in real time. Examples of these types of businesses include Handy (small household tasks), Homejoy (house cleaning), Instacart (grocery delivery), Washio (clothes washing), BloomThat (flower delivery), TaskRabbit (shopping and other tasks), Shyp (gift wrap and delivery), Fancy Hands (personal assistants), and SpoonRocket (restaurant food delivery). In the professional world there are similar business formations: Topcoder (freelance coding), Eden McCallum (consulting), Axiom (law), Medicast (online doctor visits), Business Talent Group (project management), Innocentive (corporate research and development), Tongol (video production), and Amazon's Mechanical Turk (any "human intelligence task"). Uber is the model, and each of these companies is trying to become the "Uber of X."

  Less well understood is how the use of smartphone technology to provide labor and services will create new challenges for capitalism, firms, and individual careers. The era of a good job being attached to a particular company lasted for about 100 years but came to an end in 1980. This era benefitted day laborers but was a step down for independent artisans who could no longer

compete with mass-produced goods. During this time period, jobs were clearly differentiated, which provided clear avenues for advancing one's career. The end of this model began with deteriorating worker and management relationships (and the loss of union power), globalization, and the rise of computers.

Firms are organized to reduce transaction costs through internal hierarchies, and form when they can produce something for less than the cost of buying it in the marketplace (this theory comes from Ronald Coase). The iPhone 6s sold in one weekend in September 2014 had 25 times more computing power than all the computers in the world did in 1995. Plus, today's smartphones are connected to each other and are further boosted by cloud computing. Since individuals now carry pocket computers that connect them with wider social networks, the transaction costs of finding people to provide goods and services is much lower. This has a myriad of effects that are clearly seen in the on-demand economy.

- Hyper-specialized division of labor.
- Ability to utilize underused capacity, both in time and assets (cars, extra bedrooms, etc.), which is an extension of the sharing economy.

On-demand companies work to take advantage of low transaction costs. One way to do this is to certify that workers will be trustworthy and able to do the job as requested. The workers want stable work and timely compensation. Job scheduling often aims to minimize transportation costs. Despite this, there are reasons for doubt that on-demand companies will be successful:

- In keeping costs as low as possible, they have a difficult time training, managing, and motivating their workers.
- If they become large enough to be noticed, they are beset with regulatory and political issues.
- Scale and network effects mean the largest company is the one most likely to be able to provide the service when it is needed. However, overcoming low barriers to entry and getting workers to be loyal to just one company is problematical (for instance, many drivers work for Uber and Lyft simultaneously).
- It is not clear that service companies can benefit from national or global economies of scale. People who view a local service as cool may disassociate with it when it goes national.

Critics note that these companies are outside the main components of the knowledge economy, and are likely to have only a marginal role in the marketplace. The knowledge economy is, however, subject to these same forces: routinization, division of labor, and outsourcing. Knowledge industry companies are beginning to outsource many routine tasks, both to save money and to free up their most highly skilled workers to concentrate on more valuable work. This work can now be parceled out to individuals, whereas it was previously the domain of professional services companies. The interactions between the on-demand economy and automation will be very complex. The on-demand economy may be a prelude to automation (think Uber and then AVs), but in some cases the cost efficiency of outsourcing may beat that of automation.

The on-demand economy will benefit outsiders and entrepreneurs. These groups will be able to link up with workers in the poor world. Those who will succeed in this new paradigm will need to value flexibility more than security. These groups include students who want to augment their incomes, bohemians who are able to go in and out of the labor market, young mothers seeking part-time work while raising children. Those who will struggle are middle-aged professionals with children and mortgages. It is fairly certain that the on-demand economy will reduce labor protections, due to a growing oversupply of workers who will waive sick pay, overtime, and other benefits. This will weaken the bargaining power of individuals working at traditional firms.

Workers who are successful will need to educate themselves, rather than relying on their employers to do it. They will need to undertake challenging projects, learn how to find new

business opportunities, and choose between spending and investment. Governments need to revise complicated regulatory systems designed for a time when most people worked for major institutions, not for themselves. They will need to help people take control of their healthcare and retirements plans, and educate self-reliant individuals instead of dedicated workers.

Galston, William A. *New Challenges to Market Democracies*. Washington, DC: Brookings Institution, October 2014. http://www.brookings.edu/research/reports2/2014/10/new-challenge-market-democracies

- The period since World War II could be called the liberal democratic bargain: where democratically elected governments brought about economic growth, which has brought about poverty reductions, improved living standards, and increased security and longevity. Now, due to economic stagnation and the remarkably fast rise of authoritarian market economy states such as China and Singapore, many Western nations are losing confidence in their ability to continue to deliver this bargain. Challenges are arising from within Western nations as well, as well-meaning social guarantees can undercut growth and lead to economic sluggishness. A second internal challenge is that workers are not sharing in economic growth, and government has been unable to slow rising inequality. Since the 2008 economic recession, wages have stayed constant with inflation, and most jobs being created are in the low-income service sector. The four principles for growth in a modern market economy are:

  1. Private investment—Governments that run large deficits may consume capital that could be used by the private sector. Also, investors may choose not to risk their capital if the long-term economic outlook looks unpredictable.
  2. Public investment in public goods—This can produce general benefits that private investors cannot create on their own. Examples include infrastructure and scientific research, without which business is more difficult to conduct, slowing growth.
  3. Innovation—New products can bring economic growth, but through the process of creative destruction they can disrupt existing industries and cause people to lose their jobs. As new processes become more efficient, fewer people are needed for the work. Individuals and groups that are at risk become aware of the danger and work together to resist change. In democratic societies, organized minority groups often make a valid point that they are shouldering too much burden. This can slow the pace of innovation, especially when the benefits are spread out. The more sympathetic society is to minority groups, the greater the social costs over time. Astute governments will recognize the risks and provide for compensation.
  4. A workforce that is skilled and growing—Societies that have high birth rates or levels of immigration have advantages over those who do not (see Europe or Japan, areas with low birth rates and highly restrictive immigration policies). Recessions often spark anti-immigrant feelings, as they are seen as competitors for a shrinking share of pie. Skills come from education and training, much of which needs to be completed outside the job. Technology often replaces low-skill labor in the workforce, while increasing the demand for higher-skilled workers.

  Globalization and technology have fundamentally altered the relationship between labor and capital, leading to the steady decline of the middle class, particularly as mid-skill jobs have become less and less common. Three steps that can reverse this trend are:

  1. Adopt full employment as a major economic policy goal.
  2. Use the tax code to restore the relationship between wages and productivity gains.
  3. Revise the tax code so that it no longer gives additional advantages to the top earners, particularly capital gains taxation and governmental expenditures that favor the upper class.

In rural societies, children are economic assets. In the modern economy, they are large expenses to their parents. Aside from emotional satisfaction, most of the benefit of having children accrues to society. Given this cost-to-benefit ratio, it is not surprising that many adults choose to have fewer children, which reduces the ability to fully enjoy all that the consumer economy provides. The real challenge facing democratic market societies is how to find a reasonable balance between the past (promises to retirees), present, and future.

Losing what one has enjoyed can generate bitterness and anger. This leads to the blame game: if something is wrong, someone must be blamed for it—the wealthy, government officials, immigrants, conspiracies. Unfortunately, this diverts attention from the real, underlying problems in society and slows the finding and creation of effective solutions. For the next generation to continue to achieve prosperity, it must find a way to share it equitably and generously, or else it risks a continuation of economic stagnation, and the zero-sum politicking that comes along with it.

Galston, William A., and Elizabeth McElvein. "Institutional Innovation: How It Happens and Why It Matters." Brookings Institution, April 22, 2015.
http://www.brookings.edu/research/papers/2015/04/22-institutional-innovation-galston-mcelvein
(accessed April 24, 2015).

- By default, every form of government works to maintain the status quo. This is especially true for constitutional republics with separated power structures. The reason is that the status quo is real and familiar, while imagined changes, which are different and untested, are seen as threatening. Overcoming systemic inertia and resistance is difficult, and there is no single pathway that leads to successful governmental innovations. While many reforms come as a response to an impending crisis, others seize fleeting opportunities to tackle long-standing problems. When innovations do happen, they are usually either acute (happening over a short period, with leadership from individuals who are closely tied to decision makers) or incubated (innovations that are slow to develop, often needing several years to take hold, and as a result tend to get slowed down by partisan bickering). The leadership to bring about change requires energy and unrelenting steadfastness. It can come from many different levels; in the past, it has come from social movements, the private sector, the executive branch, and Congress.

  Governing by crisis is expensive. Not having the foresight to anticipate recent intelligence and financial oversight failures has cost trillions of dollars, which will be paid by future generations. Looking ahead, if we cannot figure out how to fund infrastructure modernization and maintenance needs, our productivity will wane, and infrastructure failures will become increasingly common.

Geeting, Jon. "Stop Hand-Wringing about Pew's New Millennials Report." This Old City, January 23, 2015. http://www.thisoldcity.com/policy/stop-hand-wringing-about-pews-new-millenials-report
(accessed January 23, 2015).

- This post is written in response to a Pew Charitable Trusts survey that found about 50 percent of millennials in Philadelphia planned to leave Philadelphia at some point in the future. This comes on the heels of Philadelphia having the highest net population growth in millennials from 2006 to 2012, when about 44,000 more moved in than left. There are reasons why this is not as big of an issue as it may appear on first glance:

  - The city's cultural, dining, and entertainment options are getting better.
  - Neighborhoods around Center City continue to appreciate and build new amenities.
  - Crime rates continue to go down, thanks in part to the effect of the 10-year tax abatements on new development and data-driven policing.

  While the above is good news, there are still some long-term issues to be dealt with: allowing mid-rise residential buildings without requiring parking, which drives up the cost of housing; improving

urban schools, so parents do not feel pushed out of the city when their kids hit school age; and reforming the tax structure so that jobs do not keep leaving the city.

It is healthy and normal for there to be population churn in cities with "dynamic and innovative" economies. People will continue to come to Philadelphia for college. Some will stay a few years, and some will stay even longer. As they leave, new young people will be there to replace them in the city's population.

Geneva, Jane. "Northeast Blizzard of 2015—Implications for the Free Agent Economy." Speechwriter-Ghostwriter Blog, January 25. 2015. http://speechwriting-ghostwriting.typepad.com/speechwriting_ghostwritin/2015/01/northeast-blizzard-of-2015-implications-for-free-agent-economy.html **(accessed February 26, 2015).**

- The January 2015 Northeast blizzard was great for media ratings, granted a fun day off school for kids, and a paid day off for many salaried employees. However, for someone who is employed in the free agent economy, it means a day of lost wages, even if that person lives and works in the desert Southwest, very far from clients in the snowy Northeast. Lost wages weaken the position of freelancers when they are looking for new work. Perhaps Congress could authorize five paid days for independent contractors when they are impacted by the weather or other conditions. Given the size of the free agent economy, candidates may be surprised by how popular an issue this is (and how many votes it could help to win).

Geron, Tomio. "While BART Strikes Continues, Do Ride-Sharing Apps Complement or Undercut Public Transit?" *Forbes,* July 3, 2013. http://www.forbes.com/sites/michelinemaynard/2013/07/03/san-franciscos-bart-strike-is-ride-sharings-first-big-test/ **(accessed August 12, 2015).**

- As San Francisco's BART subway workers went on strike, affecting 400,000 daily commuters, ride-sourcing companies Lyft, Sidecar, and Uber added 50 percent more cars to the road and saw their ridership increase by 40 percent. These services offer an alternative way to get around, particularly in light of the lack of subway service, and reduce ownership, benefiting congestion, pollution, and parking problems. However, they also create an alternative private transit system, which primarily benefits the elite. This can undermine support for public transit in the long run, as the wealthy and educated do more to drive policy agendas.

  It would appear that ride-sourcing services are a lower-cost substitute for taxis and are not a replacement for transit. Corporate shuttles (such as Google's) have been noted to poach transit users, with an estimated 33 percent of their rides coming at the expense of transit. But ride-sourcing services act more like carpools. A Sidecar survey asking what other transportation their riders use found that 53 percent said public transit, and 28 percent said they drove. This would indicate that ride-source users are not a separate group from transit riders. If these services reduce auto ownership, transit and other alternative modes tend to benefit as people piece together different transportation solutions. Transit providers are searching for ways to incorporate ride sourcing, car sharing, and other new options with their services.

Girmay, Weenta. "Millennials Making Their Mark on Pennsylvania." *McCall*, March 14, 2015. http://www.mcall.com/news/nationworld/pennsylvania/mc-pa-millennials-influence-20150314-story.html **(accessed March 17, 2015).**

- In 2015, the millennials will become the largest U.S. generation, with a population of 75.3 million born between 1981 and 1997. Out of 2.8 million living in the Commonwealth of Pennsylvania, about 450,000 live in the City of Philadelphia, and 100,000 live in the City of Pittsburgh. Their influence is being felt with preferences for walkable communities and less driving. They are the most educated generation to date but face considerable student loan debt and high unemployment and underemployment from the recession. These could be reasons why they are

waiting longer to get married and do not connect marriage with having kids. They are optimistic about the future, and they are looking for meaning and fulfillment in their jobs.

Glaeser, Edward. *Triumph of the City: How Our Greatest Invention Makes Us Richer, Smarter, Green, Healthier, and Happier*. New York: The Penguin Press, 2011.

- "Cities are the absence of physical space between people and companies."
- "Workers in metropolitan areas earn 30 percent more than workers who aren't in metropolitan areas. These high wages are offset by high cost of living, but that doesn't change the fact that high wages reflect high productivity. Americans who live in metropolitan areas are, on average, more than 50 percent more productive than Americans who live in smaller metropolitan areas."
- "There is a near perfect correlation between urbanization and prosperity across nations."
- "For centuries innovations have spread from person to person across crowded city streets."
    - "An explosion of artistic genius during the Florentine Renaissance began when Brunelleschi figured out the geometry of linear perspective. He passed his knowledge to his friend Donatello, who imported linear perspective to low-relief sculpture. Their friend Masaccio then brought the innovation into painting."
- "Cities thrive when they have many small firms and skilled citizens."
    - "Detroit was once a buzzing beehive of small-scale interconnected inventors—Henry Ford was just one among many gifted entrepreneurs. But the extravagant success of Ford's big idea destroyed that older, more innovative city. Detroit's twentieth-century growth brought hundreds of thousands of less-well educated workers to vast factories, which became fortresses apart from the city and the world. While industrial diversity, entrepreneurship, and education lead to innovation, the Detroit model led to urban decline."
- "Public policy should help poor people, not poor places."
- "Cities don't make people poor, they attract poor people."
- "Many of the ideas in this book draw on the wisdom of the great urbanist, Jane Jacobs, who knew you that you need to walk a city's streets to see its soul. She understood that the people who make a city creative need affordable real estate. But she also made mistakes that come from relying too much on her ground-level view and not using conceptual tools that help one think through an entire system."
    - "Because she saw that older, shorter buildings were cheaper, she incorrectly believed that restricting heights and preserving old neighborhoods would ensure affordability. That's not how supply and demand work. When demand for a city rises, prices will rise unless more homes are built. When cities restrict new construction they become more expensive."
- "Cities enable collaboration, especially the joint production of knowledge that is mankind's most important creation. "
    - "Because the essential characteristic of humanity is our ability to learn from each other, cities make us more human."
    - "[Chicago] attracted a remarkable cluster of architects—Jenney, Burnham, Sullivan, Wright—who collectively invented the skyscraper."
- "Immigration is essential to urban success."
    - The immigrants are the largest beneficiaries.
    - "Cities benefit from an influx of talent, because foreigners help urban areas play their crucial role of connecting countries."

- "A diversity of cultures also helps make a city more fun."

- "Education is, after January temperature, the most reliable predictor of urban growth, especially among older cities."

  - "Cities and schools complement each other, and for that reason, education policy is a vital ingredient for urban success."
  - "Giving poor children a good education may be the best way to help them become prosperous adults."
  - "Cities succeed by encouraging competition and diverse innovations. Public school monopolies destroy both of those advantages."
  - "The move to increased math and science training, which began in the 1980s, seems to have improved the performance of students, especially poorer ones."
  - "For cities investing in schooling yields two payoffs. Students acquire more skills, which eventually makes the place more productive. Better schools also attract better educated parents, who make the place more productive right away."

- "Over the last 20 years, transportation funding for the ten most densely populated states has been half as much, on a per capita basis, as the 10 least dense states."

Glaeser, Edward, and Matthew G. Resseger. *The Complementarity between Cities and Skills*. Cambridge, MA: National Bureau of Economic Research, June 2009.
http://www.nber.org/papers/w15103.pdf

- Glaeser and Resseger study the basis of agglomeration economies through a series of regression analyses. Agglomeration economies can be seen through the strong correlation of worker productivity and metropolitan area population. This connection suggests that cities will become more important as civilization continues to increase knowledge, unless technology eliminates the urban advantage in transferring information. Their key finding points to knowledge accumulation in big cities underscoring agglomeration economies, rather than alternative theories in geographic advantages or ease in moving basic commodities. There is little direct evidence of this, and empirical research has yet to identify how exactly agglomeration economies function. There is evidence that shows knowledge transfer effects are strongest in urban areas with highly skilled workforces. Glaeser and Resseger's speculative interpretation is that workers do learn from one another faster, and technological change is occurring more swiftly. Other interesting findings:

  - There is almost no agglomeration effect in less educated regions, while in the best-educated areas, population size is responsible for 45 percent of productivity variation.
  - Income rises with skills, which is reasonable because skilled individuals produce more (i.e., high wages must be offset by making firms more productive), and there is a positive correlation between city size and income levels.
  - Since all analysis points to positive interaction between skills and metro areas, amenities do not seem to be a reason why more skilled people locate in urban locations.
  - Today, very few urban theorists think that geographic advantage has much impact on productivity; cities now specialize in business services and knowledge, and it is difficult to see how locating near a harbor or coal mine gives them an advantage.
  - There is no evidence that links living in an urban area with measurably higher skill accumulation.

The Global Commission on the Economy and Climate. *The New Climate Economy: Better Growth, Better Climate*. Washington, DC: The Global Commission on the Economy and Climate, 2014. http://newclimateeconomy.report/misc/downloads/

- Thanks to structural and technological developments in the global economy, it is possible to achieve economic growth while reducing the enormous risks associated with climate change. What is most needed is political will and coherent policy to support the capital that is ready to invest in the new economy. This economy promises far greater efficiency and holds immense potential for innovation.

  Over the next 15 years, the global economy will grow by 50 percent, a billion more people will live in urban areas, and technological advances will continue to drive change. During this period, 90 trillion dollars will be invested in infrastructure. How technological change is managed, and the types of infrastructure invested in, will reshape future growth, productivity, and quality of life. This will also determine the future of the planet's climate. It is critical that global actions ensure that greenhouse gas emissions peak and then fall over the next 15 years. It is already near certain that average temperature increase will exceed 2 degrees Celsius. If current trends continue, temperatures could increase by 4 degrees Celsius, leading to severe and possibly irreversible outcomes. Delaying emissions reductions will make it even more expensive to move to a low-carbon economy in the future. Three key economic systems have potential to generate more energy-efficient economic growth:

  - Cities – Cities are economic development engines but suffer from largely unplanned and unstructured growth, leading to high economic, social, and environmental costs. More compact, connected, urban areas developed around transit can build dynamic and healthier cities while reducing emissions. This approach could reduce infrastructure costs by three trillion dollars over the next 15 years.
  - Land use – The world will need to feed another billion people by 2030, while maintaining natural environments. New technologies and approaches to soil and water management are needed, along with increased crop and livestock productivity. Restoring 12 percent of the planet's degraded agricultural land could feed 200 million people, while enhancing resilience and lowering emissions. Slowing and ultimately stopping deforestation can be accomplished with strong international support combined with domestic dedication to forest protection and rural economic development.
  - Energy systems – Energy systems are on the verge of a clean energy revolution due to the falling costs of wind and solar power. Investments in energy efficiency for businesses, buildings, and transportation could manage and even reduce demand. In developing countries, decentralized renewables could bring access to more than a billion people who currently lack it.

  There remain market, policy, and institutional barriers to the low-carbon economy. Overcoming them will require:

  - Increasing resource efficiency – Both market and policy failures distort efficient resource allocation. For example, subsidies for clean energy amount to 100 billion dollars per year, while fossil fuels are estimated to receive subsidies of 600 billion dollars per year. Phasing out fossil fuel subsidies could generate growth and reallocate resources to low-income individuals. Carbon pricing could further improve energy productivity and provide new revenues that could cut other taxes. Carefully designed regulations for appliances, vehicles, and other major energy-consuming goods could further improve performance.
  - Infrastructure – Investments support economic growth. Low-carbon infrastructure, particularly for electricity, is needed to reduce emissions. National and international banks could be strengthened and expanded, along with green bonds, which align investors and financing needs, while reducing the cost of generating low-carbon electricity.

- Innovation – Technology, business practices, and social customs can simultaneously generate economic growth and emissions reductions through digitization, new materials, life sciences, and production processes. Technology will not follow a sustainable path on its own. It requires clear policy and market incentives, along with reduced regulatory barriers and targeted public investments. Public research and development in the clean energy sector should be tripled.

Low-carbon policies can generate co-benefits such as improved energy security, reduced traffic congestion, better health and quality of life, more resilient communities, and environmental protection. The cost of high-carbon economic development can be seen in the fact that damage to health from poor air quality, due to the consumption of fossil fuels, has societal costs of about four percent of the GDP. Creating a lower-carbon infrastructure system costs about five percent more than traditional infrastructure but could be offset by lower operating costs (in addition to reduced health and climate change costs).

10-point Global Action Plan:

1. Accelerate low-carbon transformation by integrating climate into core economic decision making.
2. Enter into a strong, lasting, and equitable international climate agreement.
3. Phase out subsidies for fossil fuels and agricultural inputs and incentives for urban sprawl.
4. Introduce strong, predictable carbon prices.
5. Substantially reduce capital costs for low-carbon infrastructure investments.
6. Scale up innovation in key low-carbon and climate-resilient technologies.
7. Make connected and compact cities the preferred form of urban development.
8. Stop deforestation of natural forests by 2030.
9. Restore at least 500 million hectares of lost or degraded forests and agricultural lands by 2030.
10. Accelerate the shift away from polluting coal-fired power generation.

Implementation of these 10 policies and investments could bring about 50 to 90 percent of the emissions reduction needed by 2030 to decrease the grave climate change risk. At the same time, these approaches could bring about many additional economic and societal benefits. Fully reducing the serious risks of climate change will need additional actions, such as carbon capture, use, and storage technologies. After 2030, net global emissions need to be reduced to near zero, and even below it in the second part of the century. Not all policies are clear win–wins for all parties—there will have to be tradeoffs. If the foundation of a low-carbon economy is put into place now, it will cost less and have greater growth opportunities.

Gobry, Pascal-Emmanuel. "How Computers Will Replace Your Doctor." *The Week*, December 15, 2014. http://theweek.com/article/index/273612/how-computers-will-replace-your-doctor (accessed January 7, 2015).

- While there has been much ongoing discussion about how technology is splitting the world between high-skill and low-skill jobs, the reality is that the high-skill jobs are also in trouble. For instance, the general practitioner of medicine is threatened by software that can more accurately diagnose illnesses. Drugstores will assist this software with low-cost blood tests and mobile apps that help with prescriptions and refer patients to specialists. While the high-skill doctors are replaced in this trend, the nurses and other "low-skill" health workers come out okay, and hopefully the patients are better off.

  [*Editor's note: Often a combination of human judgment and machine analysis beats just rote machine analysis—it seems like there is still room for doctors in this scenario.*]

Goetz, Thomas. "Harnessing the Power of Feedback Loops." *Wired*, June 19, 2011. http://www.wired.com/2011/06/ff_feedbackloop/ (accessed December 30, 2014).

- Feedback loops give individuals real-time data on their actions to generate behavior change (action, information, reaction). Examples include:
  - Use of dynamic speed signs to remind people they are speeding.
  - Vehicle fuel consumption displays to show how to drive green.
  - Thermostats that set indoor air temperatures.

  The data on the action must be captured and stored, then translated into information that the individual can process and understand as consequences; lastly, the individual must act on the information to gain better outcomes. A number of fields have researched and validated feedback loops and their ability to change behavior: psychology, epidemiology, military strategy, environmental studies, engineering, and economics. The cost of collecting data and analyzing it has kept feedback loops from becoming more commonplace. These equations are quickly changing thanks to sensor technologies, which are dramatically lowering the cost of collecting and analyzing data. Examples of these technologies include accelerometers, Global positioning system (GPS) sensors, inductance sensors, and radio-frequency identification (RFID) chips. These technologies can help individuals deal with chronic diseases, reduce personal energy consumption, be more productive with their time, or facilitate group collaboration. Sensors connected to the IoT will soon inform all facets of our daily routine.

  One major challenge for feedback loops is to make sure that their message is not so subtle that it blurs into the background of day-to-day living, while making sure it is not so loud or fearful that it turns into noise that gets ignored. Although fear works well in the short term, if nothing happens, we start dismissing the warnings. Feedback loops work because they speak to our aspirations. They can work better through "gamification," where game-like elements of points or levels can be applied to our routines, making them more enjoyable.

Goldsmith, Stephen. "How NYC is Mainstreaming Data-Driven Governance." *Governing*, September 16, 2015. http://www.governing.com/blogs/bfc/gov-new-york-city-data-driven-governance.html (accessed December 1, 2015).

- The author is the former director of NYC's Office of Operations, which coordinates agencies and leads the city's business and government innovation agenda. Within the operations unit, the Mayor's Office of Data Analytics (MODA) has tapped into the city's vast data across multiple agencies to generate new insights, and turn the analysis into action steps. MODA has a team of data scientists has been paired with operations officials who have a strong knowledge of how the city functions, and has become the city's "civic intelligence center," which has become a standard of data-driven governance. The Office of Operations and MODA have developed tools to enhance performance management, measure outcomes, and monitor activities. The datasets used by MODA help to understand the city's metabolism, find correlations, and identify emerging trends. The Office of Operations now also houses the Center for Economic Opportunity, which measures the effectiveness of the City's antipoverty programs; and NYC Open Data, which makes data publicly available. Another effort, Databridge, combines the city's 311, geographic data, and 50 more real-time datasets from 20 different city agencies and other entities into a single platform. Now there is recognition that data both enhances government, and transforms it.

Goldwyn, Eric. "The Most Important Transportation Innovation of the Decade Is the Smartphone." *The Atlantic CityLab*, September 4, 2013. http://www.citylab.com/commute/2014/09/the-most-important-transportation-innovation-of-this-decade-is-the-smartphone/379525/ (accessed September 29, 2014).

- Smartphones and apps now aid individuals with their transportation needs in getting around from routing options, to locating transit buses, to hailing taxis or ride-source vehicles. Although many cities have open data and encourage innovation with hackathons and other contests, none has developed an app that can plan and pay for multimodal trips. The private market has filled this niche so far (Uber, Google Maps, CityMapper, and RideScout, for instance). However, there are missed opportunities to make urban transportation networks more seamless, gather data on where and how people travel, and more efficiently use existing transportation infrastructure. This travel data could allow agencies to reroute buses to better serve demand and identify where bike sharing stations should be located. This would allow users and infrastructure to be a dynamic system, with each responding to the other. An app that allows users to plan, book, and pay for a trip across multiple modes requires more planning and problem solving than a simple ride-hailing app but would allow an area to be proactive about the future of transportation and would build an integrated system that lowers transportation costs while expanding access to a wide range of people.

Gomes, Lee. "Driving in Circles: The Autonomous Google Car May Never Actually Happen." *Slate*, October 21, 2014.
http://www.slate.com/articles/technology/technology/2014/10/google_self_driving_car_it_may_never_actually_happen.2.html (accessed October 22, 2014).

- There is a surprisingly long list of things the Google self-driving car still cannot do: avoid potholes, drive in heavy snow, find a parking space, or avoid coned-off construction sites. Its cameras can be blinded by the sun, and it cannot tell the difference between a large rock and a crumpled-up piece of paper. Today's computing systems may not be able to handle the challenges of driving, and they may not be able to do so for many years. One of the first necessities for self-driving cars is a sophisticated mapping system. While Google Maps and Google Earth are a good start, mapping requirements for self-driving cars require scans of every square foot of the road area, which must then be carefully digitized with computing technology and human review to ensure that everything is included. This has to be loaded into the vehicle's on-board computers. The real challenge is ensuring that any change—traffic signals, signs, lane markings, crosswalks, construction—in the road's right-of-way is kept current in this map. This process is too involved to map all four million miles of roads in the United States. What is missing are the skills that humans master in childhood: understanding how to react to the unexpected and having situational awareness. This is artificial intelligence (AI), and it won't be available anytime soon. Without it, it is difficult to see a fully AV ever hitting the road. Until then, there will be self-driving components built into cars, such as adaptive cruise control, but this is not the same as having a personal, computerized chauffeur.

Gorsht, Reuven. "Can Unemployment Be Eradicated by Rethinking Jobs?" *Forbes*, February 2, 2014.
http://www.forbes.com/sites/sap/2014/02/02/can-unemployment-be-eradicated-by-rethinking-jobs/ (accessed March 2, 2015).

- The U.S. workforce is undergoing a massive restructuring, as traditional jobs continue to be phased out and outsourced to countries with lower-cost labor. Work is increasingly connected, mobile, and global scaled. A freelance economy, powered by online marketplaces, gives employers access to immense potential workforces, which can take on small tasks at a fraction of the price that a regular employee would cost. Successful organizations in this new economy will tap into these markets to extend their workforces in order to use their specialized skills to help

quickly innovate. Companies that are powering these online workforces include Gigwalk, TaskRabbit, Fiverr, and oDesk. They may not completely solve unemployment, but they provide new opportunities for both businesses and workers. Rather than working in a traditional, full-time job, workers will get work on a day-to-day basis, using the Internet to connect with employers. Specialized skills and the ability to be flexible with work will be the keys to success.

Green, Jeffrey, and Keith Naughton. "Woes of Megacity Signal Dawn of 'Peak Car' Era." *Bloomberg*, February 24, 2014. http://www.bloomberg.com/news/2014-02-24/woes-of-megacity-driving-signals-dawn-of-peak-car-era.html **(accessed January 5, 2015).**

- As more people move into large cities around the world, traffic congestion, pollution, and other problems mean the car is no longer the most convenient way to get around. A number of auto industry analysts are predicting that the global economy will hit "peak car"—where sales growth will begin to decline each year—sometime in the next 10 years. Car sharing is a key trend, which self-driving vehicles will eventually strengthen, that will undermine sales. Auto manufacturers need to rethink their business strategy to move away from selling cars to selling mobility.

  China's 1.3 billion consumers are a counterpoint to peak car theories. They continue to buy cars at an impressive pace: 22 million vehicles in 2013, and they are a big reason why auto sales have increased 46 percent globally since 2000. However, congestion and poor air quality, particularly in Shanghai and Beijing, have led to increasing restrictions on vehicle licensing in order to slow down sales.

  Some other interesting factoids:

  - Cars are lasting longer; the average vehicle age is now 11.4 years (R. L. Polk & Co.).
  - One in 10 households in the United States does not own a car, up 5.7 percent in the last five years.
  - In 2010, only 69.5 percent of 19-year-olds had a driver's license, down from 87.3 percent in 1983.
  - Forty-four percent of the U.S. population would prefer to live in a city with congestion-reducing self-driving cars.
  - Every car sharing vehicle costs a car company 32 automobile sales (AlixPartners).

Greenfield, Adam. "Helsinki's Ambitious Plan to Make Car Ownership Pointless in 10 years." *The Guardian*, July 10, 2014. http://www.theguardian.com/cities/2014/jul/10/helsinki-shared-public-transport-plan-car-ownership-pointless **(accessed January 23, 2015).**

- Finland's capital city is developing a mobility on-demand platform that can deliver people from any point to any destination in its region. The system will be coordinated through a smartphone app that seamlessly blends together cars, small buses, bike shares, and ferries into a single trip planner and fare payment instrument. A key portion of the plan has already been introduced, the Kutsuplus minibus service. Kutsuplus allows riders to identify their pick-up and drop-off points, and the app aggregates requests to optimize a route that most quickly satisfies all requests. The system's costs will be higher than a transit fare but lower than a taxi ride. To be equitable (which is less of an issue in a country like Finland), the service and smartphone costs must be affordable to even those with the lowest incomes. It is also to be seen how well the service can work in lower-density areas of the region, such as Espoo and Vantaa.

Gullo, Joe. "Report: VT Lacks Transportation Service to Attract Young Adults." *My Champlain Valley,* January 29, 2015. http://www.mychamplainvalley.com/story/d/story/report-vt-lacks-transportation-services-to-attract/17198/jxlac5jEMUeTFdF89EwFVQ (accessed January 30, 2015).

- The Vermont Transportation Board's 2014 annual report on a series of hearings on college campuses around the state noted that young adults were dissatisfied with their transportation options. In addition, those surveyed felt the lack of public transit, walking, and biking facilities was a reason why many young adults are leaving the state.

Hakim, Danny. "Aboard a Cargo Colossus." *New York Times*, October 3, 2014. http://www.nytimes.com/2014/10/05/business/international/aboard-a-cargo-colossus-maersks-new-container-ships.html (accessed October 10, 2014).

- The Mary Maersk is a 1,300-foot-long Triple-E class container ship that is currently the largest in the world. Costing $190 million, it can carry 18,000 twenty-foot equivalent units (TEUs), more than three times what the largest ships carried 20 years ago. Its 194-foot-wide hull is too large for the Panama Canal, or any U.S. ports. Due to its size, there are a number of economies of scale: it uses only six percent more fuel than a container ship holding half as much cargo, while using about the same size of crew of a smaller ship, about 20–30. The current Triple-E route includes stops in Poland, Sweden, Germany, the Netherlands, Morocco, Egypt, Singapore, China, and South Korea, and it takes more than 34 days to complete. The economy of scale provided by this type of ship works only if it is full of containers. As a result of globalization, container traffic has been growing by about two and a half to three times the global GDP. A competitor of Maersk, China Shipping Container Lines, recently purchased five ships that will carry 19,000 TEUs. However, there is already an oversupply of container ships, and there are risks with the current route. Europe has been threatening to fall back into recession, while China's growth has been slowing. Manufacturing has been returning to local markets, which could further slow the growth of container movements.

Hall, Ralph P. *Understanding and Applying the Concept of Sustainable Development to Transportation Planning and Decision-Making in the U.S.* Cambridge, MA: Massachusetts Institute of Technology, 2006.

- Sustainable transportation can only occur within a broader sustainable development paradigm, and moving toward a sustainable transportation system is a process, not an end state. This process is based on decision making that removes contradictory incentives, and ending and preventing clearly unsustainable activities and actions. Sustainability is generally defined in two different ways:
  - Weak sustainability – represents the substitutability paradigm where it is acceptable for natural capital to decline if human-made capital makes up for the loss.
  - Strong sustainability – supports a constant level of natural capital, through a steady state economy where renewable resources are used at their maximum sustainable yield; the environment's ability to absorb pollutants does not deteriorate, and nonrenewable resources are used minimally.

  The need for sustainability arises from four interrelated environmental concerns:

  1. Ecosystem disruption, the loss of biological diversity, and their indirect effects to human health and well-being.
  2. Nonrenewable resources and energy depletion.
  3. The direct impacts of toxic pollution on the health of humans and other species.
  4. Global climate change.

The transportation sector has particular relevance to sustainable development. In the first environmental concern, transportation has a wide range of impacts that directly affect ecosystem integrity and biological diversity, and indirectly affect public health. In the second concern, it relies on nonrenewable resources and energy to build and maintain infrastructure, manufacture vehicles and equipment, and to power itself. In the third concern, it leads to the release of toxic chemicals in manufacturing and disposal processes, and through vehicular exhausts that directly affect the health of people, fauna, and flora. In the fourth concern, motor vehicle and construction equipment release ozone-depleting substances and greenhouse gases that are a major cause of climate change. Sustainable development is comprised of an expanded version of the triple bottom line:

1. Peace and security.
2. Economic development.
3. Social development that includes employment with adequate purchasing power.
4. National governance that ensures peace and development.
5. Environmental protection.

Hall adds a third principle to John Rawls's two principles for establishing a just society and adjusting social institutions to favor the disadvantaged:

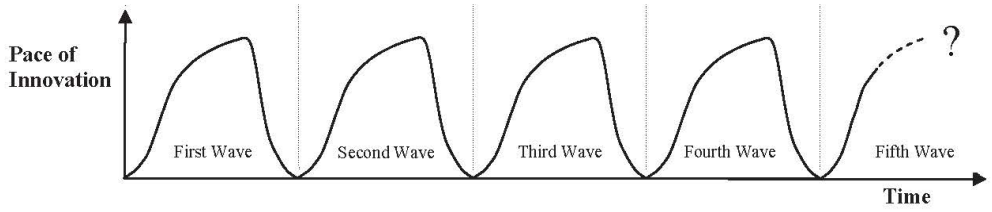
1. "Each person is to have an equal right to the most extensive total system of equal basic liberties compatible with a similar system of liberty for all."
2. "Social and economic inequalities are to be arranged so that they are both (a) to the greatest benefit of the least advantaged, consistent with the just savings principle, and (b) attached to offices and positions open to all under conditions of fair equality of opportunities" (Rawls, 1971).
3. "Social arrangements are to be organized so that they (a) protect and continually improve the environment, especially for those individuals and species most heavily affected by environmental degradation/pollution, and (b) do not result in activities that exceed the ecological carrying capacity of the environment."

Sustainable development must be understood within two key driving forces of rapid technological change and globalization. Technology plays a number of important roles in society, through the production of goods and services in the economy, as a determinant of how labor and capital are employed in production, quality of life (such as using technology to get around and for other purposes), and for economic competitiveness where technology helps organizations produce high-quality goods and services. Achieving sustainable development requires unleashing disruptive technological change. However, this change is unlikely to move in a sustainable direction or address social problems if left to its own devices. In the modern era, there have been four major Kondratieff Waves (K-waves) that have each occurred over a 60–70 year period, see Figure C-3.

Technology has unquestionably improved the lives and well-being of many individuals, but it has had many negative impacts on society, health, and the environment. The disruptive technological changes needed to achieve sustainability include product changes, process changes, replacing products with product-services, and more far-reaching system change. Incremental or sustaining innovations lead to improvement of existing products or processes. Disrupting innovation replaces existing products and processes with new ones. Disrupting technologies nearly always come from outside firms. There is research (Christensen 1997) that questions whether a firm is capable of disrupting its own product. While technological optimism makes the case that technology can solve all problems, cultural fix paradigm contends that technology is part of the problem, and solving big problems will require societal change.

Figure C-3. Characteristics of Major Technological Complexes

	1770-1830	1820-1890	1880-1945	1935-1995	1985-2050
Growth sectors	Water power Ships Canals	Coal Railroads Steam power Mechanical equipment	Cars Trucks Trolleys Chemical industry Metallurgical processes	Electric power Oil Airplanes Radio and TV Instruments and controls	Gas Nuclear Information Telecommunications Satellite and laser communications [NBIC]
Emerging technologies	Mechanical equipment Coal Stationary steam power	Electricity Internal combustion Telegraph Steam shipping	Electronics Jet engines Air transport	Nuclear Computers Gas Telecommunications	Biotechnology Artificial intelligence Space communication and transport [Nanotechnology Ubiquitous computing]
Management		Economy of scale Interchangeable parts	Administrative management	Professional management	Participatory and interconnected systems management
Industrial organization	Concept of the industrial firm Division of labor	Concept of mass production Interchangeable parts	Concept of management structure and delegation	Concept of decentralization	Concept of systems structure



Source: Hall, 2006; adapted from Grubler and Nowotny, 1990, NRC, 2002, and Jowitt, 2004.

The forces of globalization can be seen as both a constraint and a tool for pursuing sustainable development. It is a constraint in that the policy making is more challenging in an open, dynamic, and interconnected environment than in one that is stable and isolated. It is unclear whether globalization will improve or worsen trends in environmental depletion, economic growth, or society. It is possible that globalization may be the only way to create more equitable income distribution. The three main types of globalization are:

- Internationalization—the expansion of product/service markets from the company's parent country into another county; this is aided by information and communication technology and e-commerce.
- Multinationalization—where a multinational company establishes production or service facilities in the host country to gain access to its markets, and/or benefits from looser labor, environmental, or tax policies than found in the company's parent country; innovation and research and development activities usually remain in the parent country.
- Transnationalization— occurs from the creation of strategic alliances where two or more enterprises, initially located in different countries, merge to share their research and development and other proficiencies to create new products, lower costs, or open up markets.

Transnationalization is the only form of globalization that can potentially lead to positive environmental and social outcomes for both countries. Globalization has been driven by the rapid lowering of transportation and communication costs; the gradual removal of trade barriers; and increasing allowance for the movement of capital, services, knowledge and (to a lesser extent) people between nations. This has brought nations, people, cultures, and markets closer together, and led to a broad set of impacts to the international division of labor, increasing purchasing power and enabling capital mobility. The global communication network allows companies to

easily outsource jobs to other nations, which then weakens trade unions and worker protections in the process. At the same time, the knowledge economy reduces the need for unskilled or low-skilled workers, as unskilled labor is being replaced by technology. This in turn increases the importance of a highly educated and skilled workforce.

Industrial workers are being replaced by "technologists" who can work with their hands and theoretical knowledge at the same time. Examples include dentists and computer and x-ray technicians. The key skills for technologists and knowledge workers are learned with a formal education, which then requires continuous learning in order to bring value to his or her employer. This is because the knowledge worker must be able to continually respond and adapt to new information. Incorporating traditional workers into the knowledge economy has proven challenging because these workers lack the education, skills, values, and beliefs necessary to make such a transition.

The ability to easily move capital between countries means it can be put into places where tax rates are lower in order to generate higher rates of return. Unwillingness to tax capital means that laborers and workers have a higher burden of tax payments. Despite this, governments have increased social well-being expenditures as national economies have opened up to globalization. Thus the welfare state is largely seen as a product to protect workers in the global economy.

A complex series of forces are shaping cities. The decreasing cost of moving freight means that cities no longer need to be located close to natural resources or water bodies as transportation hubs. This is changing their primary purpose from manufacturing and goods movement to providing services. High congestion costs for individuals are causing service firms to locate in dense CBDs, to lower transportation expenses. This means cities are becoming centers of service provision and consumption. This risks individuals being too separated from the externalities of the things they consume (Glaeser and Kolhase 2003). Three factors are likely to create pressure for change in transportation policy over the coming decades: increasing congestion, the federal deficit, and climate change.

Funding for public goods is an essential ingredient for sustainable development. For example, if transitioning to a hydrogen economy is seen as being critical to achieving sustainability, then having the ability to finance the infrastructure needed for implementing it is critical. Without the required funds, the unsustainable petroleum-based economy will continue. Given current funding constraints, the federal government will need to emphasize performance-based, rather than process-based, planning in order to maintain the transportation system with limited resources.

Given these forces, governments must play the critical role of ensuring a country and its citizens adopt development patterns that support the basic principles of sustainability. A sustainable development platform should put forth policies and programs that seek technological innovation, prevent pollution, reduce reliance on nonrenewable energy, and identify meaningful employment for all. Governments must use markets as a tool, while acting as a protectorate of minority interests and future generations (intergenerational equity), and guiding innovation through regulatory, industrial, employment, and trade policies. Some key approaches that governments should use include: environmental, resource, and ecological economics; hybrid trade-off/positional analysis as a decision-making tool; stimulating and bending technological innovation toward sustainability; using trade within international and national/regional markets as driving forces of change; financing sustainable development; and stakeholder participation and backcasting to identify a road map for achieving sustainability.

Moving from an unsustainable petroleum-based economy to a sustainable hydrogen- and solar-based one is this century's biggest challenge. Decision-making tools have an important role in supporting sustainable transportation. The traditional benefit–cost analysis (BCA) has a number of shortcomings:

- Complexity hidden beneath veil of simplicity.
- Assumes environmental impacts can be represented monetarily.
- The environment is not a commodity that can be traded.
- The morally "right" decision may not be the highest BCA.
- It ignores distributional effects.
- Technological innovation is expensive at first, but costs decrease over time.
- Policies that internalize externalities affect costs and change consumer behavior.
- Disagreements about discount rate.
- Obscures more democratic problem-solving tools.

More democratic tool suggestions are positional and trade-off analysis, which can be combined into a singular hybrid of the two. The positional analysis illustrates a many-sided issue through its different options or alternatives, potential impacts, affected groups and any conflicts between them, and ideological orientations that may be useful for valuation and decision making. Trade-off analysis is similar to a BCA, except that it keeps all values in their natural units rather than monetizing them. Keeping these units allows the beneficiaries and those who are made worse off as the result of a policy, program, or project to be seen more explicitly. Hall suggests a hybrid version combining positional and trade-off analysis, as shown in Table C-2.

Table C-2. A Sample Positional Trade-off Analysis Matrix

Group	Economic Effects	Health / Safety Effects	Environmental Effects
Producers	$\triangle B_{\$}$, $\triangle C_{\$}$		
Workers	$\triangle B_{\$}$,$\triangle$ $C_{\$}$	$\triangle B_{H/S}$, $\triangle C_{H/S}$	
Consumers	$\triangle B_{\$}$, $\triangle C_{\$}$	$\triangle B_{H/S}$, $\triangle C_{H/S}$	
Others	$\triangle B_{\$}$, $\triangle C_{\$}$	$\triangle B_{H/S}$, $\triangle C_{H/S}$	$\triangle B_{Env.}$, $\triangle C_{Env.}$

Source: Hall, 2006; adapted from Ashford, 1978.

The process for conducting the positional/trade-off analysis is as follows:

- Describe the societal or technical problem in need of attention (e.g., unmet needs or technical/institutional failure).
- Describe institutional context, identify stakeholders.
- Identify the problem:
  - ☐ How is it perceived by the different stakeholders?
  - ☐ Describe any prior attempts to resolve/improve the problem, and discuss their inadequacy/failures in terms of:
- Economics and markets—Are there inadequate and/or perverse incentives, prices, markets, institutional/organizational structure and behavior, free-rider problems, or unrecognized/unmet needs and demands?
- Legislation and political process—Is there an inadequacy of existing legislation/regulations, lack of knowledge/enforcement thereof, and inadequate stakeholder involvement?
- Public/private sector management—Is there a lack of adequate incentives or perverse incentives for, or commitment to, management of the problem?
- Technical system capabilities.
- Represent initial problem in trade-off matrix.
- Formulate policy alternatives.
- Use trade-off matrix to assess likely outcomes from each policy alternative.
- Inform decision makers of different values and ideological orientations.

The Porter Hypothesis challenges the notion that stringent regulations increase production costs. "[S]trict environmental regulations do not inevitably hinder competitive advantage against foreign rivals; indeed, they often enhance it. Tough standards trigger innovation and upgrading …

[p]roperly constructed regulatory standards, which aim at outcomes and not methods, will encourage companies to re-engineer their technology. The result in many cases is a process that not only pollutes less but lowers costs or improves quality. … Strict product regulations can also prod companies into innovating to produce less polluting or more resource-efficient products that will be highly valued internationally" (Porter 1991).

Backcasting starts with identifying a desired future, then working back in time to determine what programs and policies are needed to achieve it. The basic idea is that the future is a function of existing policies and choices. Backcasting is more proactive than scenario planning and is more useful for decision makers, in that it actively tries to transform systems.

A sustainable transportation system decision-support system:

- Conceptualization—Holistic Systems Approach: the transportation system is viewed as an interconnected socio-technical system that functions like biological and ecological systems. A healthy system has a diverse set of modes for people and goods, which increases with population level.
- Transportation Planning—Maximize transportation efficiency through an interconnected, multimodal system. Promote accessibility instead of mobility. Land use considerations are a vital component of transportation planning.
- Stakeholder Involvement—A high level of involvement grants stakeholders a more influential role in transportation planning and decision-making processes and makes them more aware of the distributional impacts of transportation policies, programs, and projects. Stakeholders are more involved in participatory backcasting and/or scenario planning processes.
- Mode Choice—Apply a more balanced approach to transportation and seek innovative ways to bridge the gap between public and private transportation;
- Funding—Funding is directed to enhancing modal diversity and is not constrained to a particular mode. In areas where the transportation system is built out, funding focuses on operating, maintaining, and transforming it toward a more sustainable form. More funding is directed to research on sustainable transportation.
- U.S. Department of Transportation Strategic Objectives—The system should find ways to achieve transformative improvements in the following areas: safety, accessibility, multimodality, economic development, environmental protection and enhancement, and security.
- Equity—Federal law and guidance is adhered to, the principals of ethical transportation policy are applied: maximum public benefit, substantive equity (distributive), polluter pays principle (preventing harms), land use rights, environmental duties, obligations to future generations (intergenerational equity), livable communities, transparency and accountability, privilege of land-ownership and use, interjurisdictional land-use obligations, fair and equitable political process (including stakeholder participation) (Beatley, 1994).
- Employment—Seek out radical improvements in the interface between humans and technology; adhere to worker health and safety standards.
- Economics and Policy Development/Analysis—Use ecological economics principles; base policy development on dynamic efficiency (which considers how change occurs over time); use hybrid trade-off/positional analysis as a primary decision-support tool.
- Competitiveness/Innovation—This is achieved by meeting market needs through disruptive innovation. This occurs through technological, institutional, social and behavioral, and organizational changes. Government policy is designed to achieve a multiple set of objectives and incentives, including the use of more stringent environmental regulation (i.e. the Porter Hypothesis).
- Externalities—These are identified and a significant effort is made to prevent or internalize their social costs using either mandates or economic incentives. A careful balance is weighed between equity and efficiency.

- Pollution and Waste—Streams are kept within ecological limits, and system changes are implemented to prevent pollution and waste wherever possible.
- Energy and Resources—Transition resource and energy dependence away from nonrenewable resources toward renewable ones and dematerialize.
- Trade—The international transportation system supports trade while protecting social and environmental interests. Trade is analyzed from multiple perspectives and with the use of ecological economics and the triple-bottom line.
- The Environmental Drivers of Concern for Sustainable Development—Governments provide a more balanced approach to addressing the four major environmental concerns.

A particular decision-making challenge comes from the rate at which the transition to sustainable development occurs. It will be important to establish environmental limits, which use indicators with thresholds not to be exceeded. The real risk is in waiting for a crisis to unfold before taking action, which could lead to a case of overshoot and collapse where once the symptoms become clear it is too late to take action.

Hallock, Lindsey, and Jeff Inglis. *The Innovative Transportation Index: The Cities Where New Technologies and Tools Can Reduce Your Need to Own a Car*. Washington, DC: U.S. PIRG and The Frontier Group, 2015.
http://www.uspirg.org/sites/pirg/files/reports/Innovative_Transportation_Index_USPIRG.pdf

- Technology and access to data are bringing new types of transportation services to regions all over the United States. These technologies are spreading fast and reducing the need to own an automobile in order to move around. They include:

  - Ride Sourcing—Users can find a ride from their location using a smartphone app. Drivers from companies such as Uber, Lyft, and Sidecar are not commercially licensed and therefore cannot pick someone up off the street.
  - Car Sharing—This allows for vehicle access on demand, while lowering total automobile costs.
  - Round-Trip Car Sharing—This is a fleet-based service through a company similar to Zipcar: the car is picked up and dropped off at the same location.
  - One-Way Car Sharing—A car is picked up at one car sharing station and dropped off at another.
  - Peer-to-Peer Car Sharing—This allows individual car owners to share their vehicles and may be particularly useful in suburban and rural settings.
  - Ride Sharing—This provides a way for riders to find drivers who are already making the same or a similar trip.
  - Taxi-Hailing Services—These allow users to hail a commercially licensed taxi from their current location, and in some cases they can pay for the ride with a smartphone, removing the need to make a cash transaction.
  - Bike Sharing—Programs make bicycles available for one-way or return trips at stations dispersed throughout an urban area. Pricing is usually set up to support intermediate trip lengths, commuting, or running errands, while discouraging longer riders.
  - Open Static Data—This enables users to access transit schedule and route information with an Internet-connected computer or smartphone, facilitating easier system navigation.
  - Real-Time Transit Information—This provides real-time information on bus and/or train arrival times and delays.
  - Multimodal Apps—These help to tie the transportation system together by allowing users to see side by side different mode choices (bike sharing, car sharing, transit, ride sourcing, ride sharing, or walking), along with travel times, and possibly costs, for each.
  - Virtual Ticketing—Users can purchase tickets through Internet-connected devices, allowing them to skip ticket counter lines and avoid the risk of lost tickets. Apps can help to track ticket use and availability and reduce the need to have exact change for cash fares.

Austin, Texas, is the only city that currently offers all 11 of these choices, while San Francisco and Washington, DC, each have 10 available. Philadelphia has 12 providers for six of these services, as of the report publication date. The region has ride-sourcing services through Uber; round-trip car sharing through Zipcar and Enterprise; peer-to-peer car sharing through RelayRides and Flightcar; open static data through Google Transit and HopStop; real-time information through Moovit, Transit App, and through regional transit authorities; and a multimodal app from Ridescout [*Editor's note: Indego launched shortly after this report's publication*].

Some services are already starting to blend these 11 elements together in their service models, such as Lyft Line, Via, Bridj, and Loup. "The goal of Bridj, in Boston, and Loup, in San Francisco, is to create living transit systems that can easily adapt to changing commuter patterns, allowing for quicker rides and the creation of new services to meet changing needs." A bike sharing company, Social Bicycles, has put bike sharing station technology into each bike it shares, allowing any bicycle rack in an urban area to become a bike share stand. Users can then locate the bikes through an app and can borrow them for a longer period than the typical bike share system allows. Scoot Networks is a network of electric scooters for rent in San Francisco.

These are services that are sought after by millennials, useful for travelers, and work together symbiotically such that their whole is more than the sum of their parts. The more of these options a city or region has, the more their residents can adopt car-free or car-light (households with fewer vehicles than adults) lifestyles. Car sharing and ride sharing can reduce vehicle ownership rates and the corresponding amount of VMT. Real-time transit info can improve the transit experience and provide a modest ridership increase. Other options can be used to improve last-mile transit connections or provide transportation when weather or need to transport large items makes transit, biking, or walking less feasible.

All levels of government should work to expand access to these tools and use them to help reduce congestion and negative health and environmental outcomes. Policy makers should work to:

- Expand cellular networks, Wi-Fi, and electric outlets in transit vehicles and stations.
- Provide static and real-time transit data to the public.
- Negotiate data-sharing agreements with ride-sourcing, ride sharing, car sharing, and bike sharing companies and share this data with the public.
- Create transportation hubs around transit stations that support new mobility technologies.
- Adopt clear regulations for ride-sourcing providers that protect public safety, while authorizing these services to legally operate.
- Implement electronic ticketing for transit systems.
- Integrate technology tools, to address challenges such as congestion or parking, into transportation planning.
- Revise planning and zoning to accommodate new mobility tools and their outcomes—for example, through reduced parking costs for car share vehicles using on-street spaces or allowing less parking for developments that incorporate car sharing.
- Realize the potential for new mobility technologies to better serve young, elderly, and low-income individuals, all groups that are poorly served by the traditional transportation system.
- Research the impact of new mobility tools, on their own and in combination, and integrate the results into travel demand models.
- Adopt open-data and open-source software policies.

Halverson, Nathan. "How China Purchased a Prime Cut of America's Pork Industry." Reveal News: The Center for Investigative Reporting, January 24, 2015. http://www.revealnews.org/article/how-china-purchased-a-prime-cut-of-americas-pork-industry/ **(accessed February 2, 2015).**

- In 2013, a Chinese firm, WH Group (formerly Shuanghui International), purchased Smithfield Foods, based in Smithfield, Virginia, for $7.1 billion in the biggest Chinese buyout of a U.S.

corporation to date. This is part of a Chinese strategy to acquire assets based around the one commodity—food—that groups, from climate scientists to economists and governments, all agree will be increasingly lacking in the not-too-distant future. "Food is poised to become the oil of the 21st century, with scarcity and demand creating a situation ripe for wars, riots, and uprisings." This is because demand is rising faster than supply. Climate change is ruining up to 2 percent of the planet's agricultural production every decade, while the planet's population grows by 220,000 new people each day.

In 2011, China signaled its intention to buy up international agricultural operations as part of its five-year plan, which is basically a guidebook for the country's economic development. At that time, China's citizens and companies owned $81 million of American farmland. By the end of 2012, that figure had increased to $900 million, and the Smithfield purchase increased this amount by another $480 million. In the 1950s, the Chinese government overhaul of the countryside led to the starvation death of 37 million, and another 200 million nearly died. This event caused China's leaders to place a great emphasis on food security. Geographically, China and the United States are nearly the same size. But China has four times as many people and less arable land.

The Smithfield purchase also gives WH Group the most advanced animal rearing, slaughtering, processing, and distribution technologies. The United States will continue to be hog producers, which is among the highest-polluting industries. The hogs will be slaughtered in the United States, and then shipped to China in refrigerated containers. This is another part of China's strategy: import the technology from developed countries, raw materials from wherever they are found, and then process them with lower-cost labor for export back to developed countries. By combining imported technology with governmental subsidies, China has been outcompeting industries around the planet.

Hamilton, Clive. "The Risks of Climate Engineering." *New York Times*, February 12, 2015. http://www.nytimes.com/2015/02/12/opinion/the-risks-of-climate-engineering.html (accessed February 12, 2015).

- The National Research Council (NRC) has recently published a two-part report on the state of geoengineering the climate as a way to slow global warming. Though there are a variety of possible technologies, the two that garner the most attention are removing carbon dioxide from the atmosphere and encircling the planet with sulfate particles that would block out some of the sunlight it receives. The first is impractical due to the cost and inability to remove enough carbon to have a significant effect. The NRC is opposed to the second option, out of fear of the long-term, potentially unforeseen consequences that could occur with such a permanent action. The report notes that geoengineering is not a substitute for reducing greenhouse gas emissions in order to slow climate change and prevent ocean acidification. It does, however, recommend more research into both approaches, in order to keep future options open. Although, by moving geoengineering out from the fringes, it may legitimize what is most likely a very risky way to tackle climate change.

"Hands-Free, Mind-Free: What We Lose through Automation." National Public Radio, September 29, 2014. www.npr.org/sections/alltechconsidered/2014/09/29/352496605/hands-free-mind-free-what-we-lose-through-automation (accessed September 29, 2014).

- Nicholas Carr's book *The Glass Cage* cautions that as computers carry out more and more of our decision making, we risk being unable to make our own decisions in the future. Automatic navigation systems are showing up in cars on the road today. These systems show how technology gives to people while at the same time taking things away from them. As automated driving, flying, medical, and other systems take over mundane tasks, they make things safer and lead to better outcomes, but when something goes wrong, the skills of drivers, pilots, and doctors have

atrophied, potentially leading to bigger mistakes. Connected cars that alert us to every potential road danger risk alert fatigue, where we become distracted just by dismissing all of the warnings. Also of concern is the question of how autonomous cars will make decisions when a crash is inevitable. Would it risk injuring the vehicle occupant(s) by running off the road, or harm the pedestrian in the way? Codifying these quandaries into an algorithm brings up very serious moral issues. As we take moral decision making away from people and put it into the hands of machine programmers, we are losing something that is essential to the human experience.

Harford, Tim. "How to See into the Future." ***Financial Times Magazine*****, September 5, 2014.** http://www.ft.com/cms/s/2/3950604a-33bc-11e4-ba62-00144feabdc0.html **(accessed September 15, 2014).**

- Through the Good Judgment project, around 20,000 individuals have given their forecasts of the future, conducted tournament-style. This effort has found that having some understanding of probabilities improves performance. The project identified the most successful forecasters as super forecasters, who were right more often than chance alone would suggest. Gathering them together in teams to discuss and argue led to even better results. Individuals who are open minded and who have a willingness to change their mind tend to be better forecasters. The last bit of forecasting advice can be summarized with the acronym CHAMP:
  - Comparisons—use relevant ones as a starting point.
  - Historical trends—look for past examples, unless you expect major change.
  - Average opinions—experts disagree, but you can pick midpoint of what they think.
  - Mathematical models—when they exist, take them into account.
  - Predictable biases—these exist and can be accounted for; a forecaster should not let hope influence their predictions and should not cling to old forecasts in the face of clear evidence against them.

Hathaway, Ian, and Robert E. Litan. ***Declining Business Dynamism in the United States: A Look at States and Metros*****. Washington, DC: Economic Studies at Brookings, May 2014.** http://www.brookings.edu/~/media/research/files/papers/2014/05/declining%20business%20dynamism%20litan/declining_business_dynamism_hathaway_litan.pdf

- The progression whereby businesses are created, expand, contract, and fail, and in which new jobs are created while others are lost, is called business dynamism. This process is fundamental to sustaining productivity and economic growth. Entrepreneurs are at the center of this process, where more productive firms oust less productive ones, new firms upset older ones, workers find better matches for their skills, and new jobs are created. In a robust, dynamic, and competitive economy, labor and capital are constantly forced to be put to better use. Research in this article shows that over the past 30 years, this process has been slowing down:
  - The firm entry rate, or percentage of firms less than one year old out of all firms, has decreased by nearly 50 percent from 1978 to 2011.
  - Business deaths exceeded business births from 2009 to 2011, the only time this has happened over the 33-year study period.
  - Job reallocation, a measure of labor market turnover due to business births, expansions, contractions, and deaths, has declined consistently during these 33 years, and has sped up over the last 10 years;
  - Business dynamism is down across nearly all U.S. metro regions (up in just 12 out of 366) and states.
  - A cursory review of broad, aggregate data shows that business dynamism is declining across a broad range of firm sizes and industrial sectors, including high tech.

To combat this decline, all levels of government should enact policies that encourage entrepreneurship, such as:

- Federal—Expand the number of permanent immigrant work visas for entrepreneurs.
- State and local—Educational institutions, foundations, governments, entrepreneurs, and investors should experiment with techniques to foster business creation. Business accelerators are a welcome development that should be cultivated.
- Policy makers, citizens, owners, employers, and entrepreneurs should not fear change or settle for the status quo. Rather they should strive for a world where there is constant improvement of skills, products, and services.

Hausman, Catherine, and Ryan Kellogg. "Welfare and Distributional Implications of Shale Gas." Brookings Papers on Economic Activity, March 19, 2015. http://www.brookings.edu/about/projects/bpea/papers/2015/welfare-distributional-implications-shale-gas **(accessed March 20, 2015).**

- As horizontal drilling and hydraulic fracking technologies have unleashed the natural gas boom in the United States, this article reviews the implications of this additional supply for residential, commercial, industrial, and electricity generation consumers; impacts on gas producers; and considerations of the environmental externalities.

  - Supply expansion has reduced costs by $3.45 per 1,000 cubic feet at the wholesale level, which has been passed along to consumers.
  - For the average residential gas consumer, cost savings are estimated at $200 per year per household.
  - All energy consumers—residential, commercial, industrial, and electricity—have benefited to a total $74 billion.
  - Natural gas producers have not benefited, as the surplus of supply has not kept up with falling natural gas prices. This has most negatively impacted areas that have long produced natural gas using conventional methods.
  - Consumers in Arkansas, Louisiana, Oklahoma, and Texas have benefited the most from the gas boom, followed by Illinois, Indiana, Michigan, Ohio, and Wisconsin. The Pacific states (California, Oregon, and Washington) have benefited the least.
  - Natural gas is used in chemical and cement manufacturing and is an indirect input in all industrial activity, via electricity production. U.S. manufacturing has expanded as a result of the gas boom, with fertilizer production experiencing the greatest benefit.
  - Regulators have not kept up with environmental impacts and lack the data needed to track them. Lack of data means that regulators have not been able to identify where there is the most concern, how to regulate in a cost-effective manner, and ascertain fracking pollutants and their long-term effects.

  The issue of permitting overseas export of LNG needs to be addressed. Expanding exports will increase domestic gas prices, benefiting producers and increasing consumer costs. The researchers estimate the producer gains of such a move would outweigh the added consumer costs.

Hertzler, Lauren. "Study: Mariner East Project Will Create 30,000 Jobs." *Philadelphia Business Journal*, February 6, 2015. http://www.bizjournals.com/philadelphia/news/2015/02/06/study-mariner-east-project-will-create-30-000-jobs.html **(accessed February 10, 2015).**

- Sunoco is planning to build a 50-mile pipeline that connects to an existing pipeline, then another 350-mile pipeline into its Marcus Hook Industrial Complex, which will be revamped as part of the $3 billion project. The pipeline will carry natural gas liquids (NGLs) from western Pennsylvania,

West Virginia, and Ohio. A study from E-consult Solutions, Inc., predicts that the Mariner East pipeline project will bring an additional $4.2 billion in economic activity, support 30,000 jobs during construction, create between 290 and 440 permanent jobs, and generate between $800,000 and $1.2 million in annual state tax revenues.

Hertzler, Lauren. "Houston: You Have a Rival." ***Philadelphia Business Journal*****, February 6, 2015.** http://www.bizjournals.com/philadelphia/print-edition/2015/02/06/houston-you-have-a-rival.html **(accessed February 10, 2015).**

- The reasons for PES's investment in the former Sunoco refinery in Marcus Hook, Pennsylvania, are simple: the site is 1,500 acres, with rail and ship infrastructure; is near major population centers; and is just over 100 miles from the Marcellus Shale gas fields—which may be the largest in the United States. After bringing natural gas to the facility, there are countless ways to refine it. Propane can be used for home heating or turned into propylene, which is a basic ingredient in shampoos, paint, and antifreeze. Ethane can be made into ethylene, which can then be used in textiles, inks, and solvents. Butane can be processed into plastic and tires. Regardless of how it is used, this natural gas is seen by its supporters as powering a job-creation machine. Workers will be needed for all sorts of areas, from truck drivers to construction.

  Other viewpoints are missing from much of the discussion around the proposed energy hub. There are those who want to use natural gas as a bridge to a more sustainable future. The proponents of this view are realistic: society will not turn on a dime to a fully renewable energy future. To get there, it would be nice to have a better plan of where the region is going with energy production and consumption. Other views are completely opposed to the energy hub and would like to see fracking banned and investment to go into renewables only. This view notes that if employment is the goal, then per million dollars of expenditure, natural gas and oil create only 0.8 jobs, and coal generates 1.9 jobs, whereas wind produces 4.3 jobs, and solar gives rise to 5.4 jobs.

Hilario, Fran. "Tax Reform Could Create 100,000 New Jobs in Philadelphia, Group Says." ***Philadelphia Business Journal*****, April 22, 2015.** http://www.bizjournals.com/philadelphia/news/2015/04/22/tax-reform-could-create-100-000-new-jobs-in.html **(accessed April 23, 2015).**

- The Philadelphia Jobs Growth Coalition has launched a campaign to reform the city's tax code, which could help invigorate employment growth, with 50,000 to 100,000 new jobs by 2025. The proposal would create a separate, higher tax rate for commercial buildings, reduce the city's wage tax to under three percent, and lower the income portion of the Business Income and Receipts Tax by 50 percent. Changes are intended to be revenue neutral, at least at the beginning, while growing employment would expand the total tax base, generating around $42 million for the Philadelphia School District in the first five years. Though it helps to address the problem of the wage tax in the city's competitiveness, these changes will require an amendment to the Pennsylvania Constitution in order to legalize different real estate tax rates for commercial and residential properties.

Hill, Taylor. "Cycling Is Creating More Jobs in Europe Than Automakers Are in the U.S." Takepart, December 4, 2014. http://www.takepart.com/article/2014/12/03/not-just-health-and-fitness-cycling-has-created-650000-jobs-europe **(accessed December 29, 2014).**

- The first far-reaching study of Europe's cycling industry finds that it employs 655,000 people in the retail, manufacturing, infrastructure, and tourism industries. This study shows that bicycling benefits extend beyond health, recreation, and the environment. Jobs in the cycling industry often benefit local economies, have more stability than other sectors, and offer opportunity to lower-skilled workers. The European Cyclists Federation recommends spending 10 percent of transportation infrastructure funds on biking infrastructure, and particularly recognizes that getting people to ride bikes means separating them from traffic.

Hoffman, Johanna. "5 Cities That Will Benefit from Climate Change." *Next City*, August 12, 2014. http://nextcity.org/daily/entry/5-cities-that-will-benefit-from-climate-change (accessed January 16, 2015).

- While most of the world's cities view climate change with trepidation, cities in the far Northern Hemisphere, such as Hofn, Iceland; Nuuk, Greenland; Churchill, Canada; Yakutsk, Russia; and Rovaniemi, Finland, stand to benefit from new arctic shipping routes, access to mineral and energy resources, and farmland with longer growing seasons emerging from melting permafrost. While these cities appear to be well suited for a world with a changing climate, there is still much unknown about how people and economies will shift and move as a result. Cities that do not have this far northern geographic advantage will need to be adaptable to change in order to win the future.

Holmes, Jeremy. "Uber, Lyft May Add Convenience … and Traffic Jams." *Mobility Lab*, September 24, 2014. http://mobilitylab.org/2014/09/24/uber-lyft-may-add-convenience-and-traffic-jams/ (accessed October 10, 2014).

- The author wonders what new ride-sourcing companies are doing for making transportation more sustainable. One recent study, by Shaheen et al., found that 49 percent of users of these services would have taken an alternative mode or not taken the trip at all. If they are inducing additional trips, they are adding congestion to the system rather than removing it. At the same time, taking transit users away raises concern about the economic sustainability of transit services. However, these services are able to pick up passengers in half the time of traditional taxis and may be using cleaner, more fuel-efficient vehicles, benefiting air quality. Their best outcome may be improving regional mobility, particularly for elderly and disabled individuals who currently have large barriers to transportation.

"Innovation Pessimism: Has the Ideas Machine Broken Down?" *The Economist*, January 12, 2013. http://www.economist.com/news/briefing/21569381-idea-innovation-and-new-technology-have-stopped-driving-growth-getting-increasing (accessed September 9, 2014).

- The world may have reached a technological plateau, which the Great Recession and financial collapse is masking. Those who fear this to be the case rest on three arguments:

    1. Growth statistics are divided into extensive and intensive growth:

        a. Extensive growth comes from increasing the size of the labor pool, making it better trained; capital formation; and increased use of natural resources.
        b. Intensive growth comes from making workers and resources more productive per unit. Intensive growth peaked at 2.5 percent after World War II. It declined to just over 2 percent in the 1970s and has continued to decline since then, and it has been just 1.33 percent since 2004.

    2. It may be that rather than ushering in an era of continuous growth, basic innovations such as electricity, heating and cooling, motorized transportation, and communications technologies were simply a large wave of growth. While there will be innovations in the future, they are less likely to have as big of an impact, due in part to the law of diminishing returns.

        a. Charles Jones, of Stanford University, researched different growth factors in U.S. per capita incomes from 1950 to 1993, finding that about 80 percent of income growth was a result of increased educational attainment, and a higher percentage of the workforce engaged in idea-generating industries. Neither of these factors can continue endlessly, and without a major catalyst for growth, some slowdown is likely.

3. The last argument is based on looking at the world. For example, a kitchen in 1900 was very rudimentary even in the wealthiest of households. By 1970, however, most middle-class kitchens had refrigerators, stoves, microwaves, and dishwashers. Moving ahead to 2010, these devices remain in middle-class kitchens, with some technological improvements, but cooking in them would be recognizable to someone in 1970 (but not to someone from 1900). Similar examples can be found in transportation and medicine.

There are some other factors that could hinder technological growth, such as regulations and the role of government, energy, and globalization. Environmental protection has led to cleaner air and water and improving lives, but poorly conceived regulations can stifle research and innovation. Government investment in technology and innovation has waned, particularly since the Apollo program ended. This investment had a duplicative effect of improving market demand for and human capital development related to technology development. Economic slowdowns in the 1970s and 2000s both can be partially attributed to energy price shocks. This industry, in particular, has a poor record for innovation. Working through the aftershocks of globalization may take time. Rather than make workers more productive, it has been easier to ship jobs overseas to lower-wage countries. Over time, low-wage countries will begin to catch up with higher-income countries, and this should eventually increase the need to improve labor productivity. Despite this, a larger world market means more people can benefit from improved technology, potentially expanding its overall impact. Healthcare, education, and government are three sectors of the economy that have been especially immune to innovation, particularly due to a lack of market pricing mechanisms that increases pressure for cost reductions.

Although airplanes are no faster than they were in 1970, and we do not have flying cars, computers are infinitely faster than they were 40 years ago. It is estimated that it takes between five and 15 years for improvements in IT and communications to show up in productivity statistics, so it may still be too early to see gains from the Internet or mobile technologies. And employing the full benefit of technology can take much longer than that. It took a century for the steam engine's impacts to be fully realized in Great Britain. Computers are starting to understand spoken language and can be controlled simply by using body movements. Three-dimensional printing can make increasingly complex objects and could soon be used to create human tissue and other organic materials. It would appear to be a mistake to think technology must always progress in a linear fashion, as history shows it tends to ebb and flow. Generating technological innovations may be less challenging then achieving institutional innovations in places that have become too rigid to adapt to revolutionary changes. These advances could produce massive societal welfare gains.

Irwin, Neil. "Uber, Lyft and a Road Map for Reinventing the Ride." ***New York Times*****, July 11, 2014.** http://www.nytimes.com/2014/07/12/upshot/uber-lyft-and-a-road-map-for-reinventing-the-ride.html **(accessed July 20, 2014).**

- Uber has recently slashed its UberX ride-sourcing service prices by 20 percent across the United States and abroad, to a point where it is potentially taking a loss on each ride. However, the company is aiming to get its prices below the cost of owning and operating a car and betting that, with increased use of the service, it can become more profitable. This leads to a different picture of Uber, Lyft, and their rivals—they are not competitors to traditional taxi services; instead, they are trying to dramatically change how people get around.

Jaffe, Eric. "Has the Rise of Online Shopping Made Traffic Worse?" ***The Atlantic CityLab*****, August 2, 2013.** http://www.citylab.com/commute/2013/08/has-rise-online-shopping-made-traffic-worse/6409/ **(accessed August 6, 2015).**

- It is not clear whether ordering goods online helps to reduce congestion. On one hand, there are fewer trips to the store by individuals in vehicles; on the other, there are more medium-sized

trucks making deliveries. Beyond this, most people have a fixed daily travel-time budget. If they are making fewer trips to buy things at the store, they may instead substitute other trips, such as to visit friends. In this way, there is no net change in vehicular traffic on the roads, but there is an increase in delivery truck traffic. In dense urban areas, these trucks often double park because there is not adequate space for them. This creates safety hazards for drivers, bicyclists, and pedestrians. Some potential solutions to urban delivery challenges include overnight deliveries, bicycle deliveries, small freight villages where trucks can park for as long as needed, priced parking, and better loading zone enforcement.

Jaffe, Eric. "How the Trucking Industry Could Be Vastly More Efficient." *The Atlantic CityLab*, January 21, 2015. http://www.citylab.com/tech/2015/01/the-trucking-of-tomorrow-is-here-and-its-a-huge-win-for-city-traffic/384672/ **(accessed February 3, 2015).**

- Transfix is a trucking industry app that matches truck drivers and freight loads, modeled after Uber. A shipper identifies where a shipment needs to go from and to, and the app automatically locates the nearest available truck driver, while minimizing the amount of empty truck miles. The article has an example of 25 freight movements in New Jersey. Using traditional manual pairings of drivers and freight required 1,752 truck miles to complete. Using the app's algorithms, Transfix was able to pare that down to 274 truck miles. Transfix's founder estimates that commercial trucks drive a needless 19 billion empty road miles each year, contributing to congestion, pollution, and added consumer costs. Truck drivers benefit, too, by reducing how much time they spend hunting for freight to move and by making electronic payments within one day—rather than the days to weeks the current system takes to pay.

Jaffe, Eric. "The Company That's Helping Mass Transit Stand up to Uber and Leap: TransLoc Is Building an On-Demand System for Transit Agencies." *The Atlantic CityLab*, April 10, 2015. http://www.citylab.com/tech/2015/04/the-company-thats-helping-mass-transit-stand-up-to-uber-and-leap/390075/ **(accessed April 16, 2015).**

- Transit agencies are paying attention to the new on-demand private transportation services that are arising around the country, such as Uber, Leap Transit, and Bridj. Riders are showing interest in flexible transit services that cater to them directly, as opposed to fixed-route services that expect riders to come to them. TransLoc is building a technology platform that can empower traditional fixed-route transit services with an on-demand transit platform. The first tool for this, called Traveler, shows riders where transit vehicles are and shows agencies where riders are (with their permission). This gives agencies much more information about how riders are using the transit system and serves as a basis for identifying areas with unfulfilled travel demand. By figuring out how many potential riders there are between two locations, a transit agency could start a new route with a right-sized vehicle—such as a 10-seat van—to meet the unserved demand.

Kanter, Zach. "How Uber's Autonomous Cars Will Destroy 10 Million Jobs and Reshape the Economy by 2025." CBS.com SF Bay Area, January 27, 2015. http://sanfrancisco.cbslocal.com/2015/01/27/how-ubers-autonomous-cars-will-destroy-10-million-jobs-and-reshape-the-economy-by-2025-lyft-google-zack-kanter/ **(accessed February 5, 2015).**

- Kanter predicts that AVs will burst onto the scene much faster than most experts are currently expecting. He thinks they will be commonplace by 2025 and will make up nearly the entire fleet by 2030. Such sweeping changes will lead to a massive restructuring of the economy, job losses, and improvements to the environment; and will save lives, reduce congestion, increase productivity, and bring about new industries.

  The high cost of owning and operating an automobile is the main reason why AVs will transition quickly. Personal cars are in use about four percent of each day but cost an average of around

$9,000 per year. Already, individuals who live in a city and drive less than 10,000 miles per year can save money by not owning a car and using ride sourcing and car sharing services.

Columbia University has reported that a fleet of 9,000 AVs could replace all 171,000 taxis in New York City, and that passengers could be picked up within an average of 36 seconds and pay $0.50 per mile for their trip. Beyond displacing car ownership, it would likely draw many passengers away from transit. Across the country, PricewaterhouseCoopers has estimated a 99 percent reduction in the U.S. automobile fleet as a result of AVs. This level of disruptive change will likely be the end for older, entrenched auto manufacturers such as GM, Ford, and Toyota, while threatening the livelihood of many ancillary industries such as automobile dealers, automobile insurers, automobile financiers, parking, automobile service and repair, and rental car companies. An estimated 10 million jobs are involved in these industries. Beyond these more direct industries, recycling millions of vehicles could lead to a surplus of raw materials and reduce the demand for mining.

Katz, Bruce. "How Universities Can Renew America's Cities." *Fortune*, November 3, 2014. http://fortune.com/2014/11/03/how-universities-can-renew-americas-cities/ (accessed December 31, 2014).

- Universities can facilitate what the Brookings Institution has called the "new geography of innovation" by locating key graduate programs and research centers in city cores. This aligns with more young people desiring to live in walkable urban areas and helps form a symbiotic relationship between the school and the city, whereby both can better attract talent, spread ideas, and connect with regional industries. Students are provided with increased opportunities and larger networks that can convince them to stay in the area and reduce the brain drain problems that have long been associated with cities. New university investments are often some of the largest-scale redevelopment projects in cities, which can leverage investments, helping reinvent the urban landscape.

Kerkstra, Patrick. "Analysis: What the PGW Flop Means." *Philadelphia Magazine*, October 29, 2014. http://www.phillymag.com/news/2014/10/29/analysis-pgw-sale-uil-holdings-city-council-darrell-clarke/ (accessed December 16, 2014).

- The City of Philadelphia's energy hub sales pitch is based on three things: first is proximity to Marcellus Shale, the largest gas reserve in the United States; second is rail, port, and refinery infrastructure, along with access to large markets; and third is a supportive political climate that wants jobs and development. City Council's rejection of the plan to privatize Philadelphia Gas Works (PGW) hurts the third aspect. Rather than selling the asset, City Council proposes to look into public–private partnerships that could take advantage of opportunities that PGW cannot, such as developing a gas export facility or transporting and selling LNG. These are tasks outside the public corporation's core responsibilities, would require skills that it does not currently have in house, and could impose financial risks that could undermine it. While the decision not to sell PGW may confuse some energy hub proponents and does not send a positive signal to oil, gas, and petrochemical industries, it probably is not a major blow to the vision. While City Council drew a lot of ire, there are some good reasons for its decision:
  - City Council was shut out of the entire effort to sell off PGW, aside from voting to approve it.
  - Concern over how a private gas company treats the city's low-income households over the long run.
  - Union pressure, especially after criticizing the School Reform Commission's treatment of the teachers' union.

Kerkstra, Patrick. "Center City's Housing Market Is Surging, but for How Long?" *Philadelphia—Citified*, February 17, 2015. http://www.phillymag.com/citified/2015/02/17/center-city-housing-market-surging-but-for-how-long/ **(accessed February 24, 2015).**

- While the Center City District's (CCD) Annual Report shows that 1,983 new housing units were built in Center City in 2014, and another 3,681 units are planned or underway, the CCD's executive director is worried about the future. The two fundamental problems that must be solved in the next four or five years are slow employment growth and the school system. While residential growth has been robust, the downtown area is failing to keep people once they are in their forties, and this shows up by ongoing declines in the number of school-age children. As the millennials start to have children of their own, they will begin to leave the city, and the generation that follows them is smaller in size. This means there may not be people to fill the demand for Center City residences post-millennials. One other interesting finding in the Center City Annual Report is that Market East is emerging as a development hot spot.

Kessler, Sarah. "Pixel & Dimed: On (Not) Getting by in the Gig Economy." Fast Company, March 18, 2014. http://www.fastcompany.com/3027355/pixel-and-dimed-on-not-getting-by-in-the-gig-economy **(accessed March 2, 2015).**

- The basic sales pitch of the gig economy (which combines aspects of collaborative consumption and the sharing economy) is that you can work for yourself on a project-by-project basis, and that work will be easy to come by simply by using an app on a smartphone. As a result, you will become a micro-entrepreneur and get to decide when and how much you work. Promoters of the gig economy claim that it can help to put Americans back to work, given the context of the Great Recession, and allow them to earn far more money than in a minimum wage job. To test these claims, the author spent one month working in the gig economy to see if she could out-earn a proposed increase of the federal minimum wage to $10.10 per hour.

  While signing up at TaskRabbit, the author had to undergo a background check and answer 10 true or false questions. At Fiverr she posted a willingness to proofread documents, and then discovered there are nearly 4,800 similar entries. Many other sites summarily rejected her applications, including Zirtual (a personal assistant site), FancyHands (independent contractor assistants), ChaCha (question-and-answer service), Exec (cleaning service), and DogVacay (pet sitting). Nor did attempts to bid on existing jobs work out. She failed to win bids to test a website, write a social entrepreneurship proposal, photograph and post items on eBay, help out at an event, pick up and forward mail, and wake up at 6 AM and wait for a cronut. Another job would have lasted for eight hours and paid $40, well below the state minimum wage. Meanwhile, none of the jobs provided workers' compensation or health insurance coverage, and if you are hurt on the job you are on your own. Risks could expand for, say, a ride-source driver. Ride-source companies' cover up to $1 million in damages, but it is not clear what would happen for larger claims, meaning a driver's savings, house, and other assets could be put at risk.

  In the author's best day over the course of the month of hustling for work, she earned $95, or about $11 per hour once factoring in the time spent traveling in between tasks. During this time she was offered several jobs—it appears that employers are using gig economy apps as a way to find and test potential employees. Her experiences do point out that the legal system has not caught up to task-based employment, and that society needs to reconsider what it means to be an employee and how to make sure that people have appropriate workplace protections.

Kodransky, Michael, and Gabriel Lewenstein. *Connecting Low-income People to Opportunity with Shared Mobility*. New York, NY: Institute for Transportation Development & Policy and Living Cities, 2014. https://www.livingcities.org/blog/740-how-can-shared-mobility-help-connect-low-income-people-to-opportunity

- Though shared mobility (car sharing, ride sharing, ride sourcing, and bike sharing) has the potential to expand mobility and increase options for low-income individuals, a variety of barriers have reduced their access to these services, and they use these platforms at a much lower rate than the population as a whole. Private or nonprofit companies often are the operators of many car sharing, ride sharing, ride-sourcing, and bike sharing options, with fixed costs that must be recouped in order to be financially sustainable, and serving low-income populations is not generally the major business objective.

    - Structural barriers include user barriers that deter access to these systems and operator barriers that deter mobility companies from expanding into low-income neighborhoods: i.e., stations placed beyond the reach of low-income populations.
    - Financial barriers include how users pay for the system: i.e., requirement of a bank account, debit or credit card, which many low-income individuals do not have access to.
    - Information/cultural barriers include how low-income individuals comprehend the systems, particularly for non-English speakers.
    - Logistical barriers are most often due to lack of Internet access, a smartphone, or a valid driver's license. The driver's license is particularly important for undocumented populations. There is a growing trend of low-income people using smartphones to access the Internet.

    Often, mobility needs of low-income individuals beyond accessing a job are poorly understood. Government and nonprofit organizations have important roles in overcoming these barriers.

    - City Council tied a grant authorization to a Boston Hubway plan to expand into low-income areas; in addition, Hubway charges low-income individuals a $5 annual subscription, rather than $85.
    - Washington, DC, tied car sharing curbside space leases to placing stations and vehicles in low-income neighborhoods.
    - Denver required car sharing companies to put vehicles in parts of the city where more than 30 percent of the population is below the poverty line.
    - New York City crowdsourced CitiBike locations, leading to placing several stations in the Lower East Side and Bedford-Stuyvesant, both containing large low-income populations.
    - Ithaca car share has an Easy Access Plan, with paper processing, for applicants who do not have Internet access.
    - Several operators have partnered with banks or credit unions to reach unbanked populations within their cities; other efforts have created alternative payment programs through cell phones or through money orders.
    - Overcoming language and cultural barriers has required targeted outreach specifically aimed at low-income or immigrant populations.

    Some other key findings in the research:

    - Different shared mobility platforms address different trip needs.
    - Bike sharing works best locally and to access transit trips under five miles for jobs, education, and healthcare.
    - Car sharing works best for special round trips over five miles for healthcare, groceries, or child care.
    - Ride sharing works best for recurring trips over five miles, whether for work, education, healthcare, groceries, or child care.

- Ride sourcing works best for special trips over five miles, such as for healthcare and groceries.
- Shared mobility works best if it complements public transit systems. It can help to fill the gaps in service coverage, but these programs are generally low-volume alternatives that cannot efficiently move large numbers of people in the same way that transit can.
- Shared mobility is not a one-stop shop that can fill all of the transportation needs of low-income communities. The reasons that low-income individuals are not using shared mobility are systemic and multifaceted; no single program will be enough on its own to generate higher use rates.
- The key strategies to improve access are similar across shared mobility platforms, including targeted siting, logistical fixes, discounts or subsidies to lower costs, improving access to financial services, and outreach programs.
- The shared mobility market is still in its infancy. The business models and markets are still feeling their way around and figuring out how to meet demand in a financially feasible manner.
- The government can help to improve shared mobility service in low-income communities and use incentives to do so. It can guide expansion within the urban area and require companies to serve low-income areas, particularly in return for operating rights, and it can subsidize to fill the gap between ability to pay and the cost of providing the service.
- Intermediaries can help connect users and shared mobility companies, particularly agencies that have been working in the communities. They can help with messaging and marketing in particular.

Recommendations for more equitable shared mobility:

- Pilot projects based on real identified transportation needs of low-income populations.
- Research shared mobility business models, particularly cross-sector partnerships, focusing on how to be more inclusive of low-income communities.
- Integrate shared mobility to long-range transportation plans—particularly using ride sharing to better connect low-income communities and jobs and to extend transit coverage, and finding ways to better incorporate transit and shared mobility.
- Develop comprehensive and collaborative approaches to barrier reduction.
- Work with intermediaries to address barriers and increase demand for shared mobility.

Kolson-Hurley, Amanda. "How Bremen, Germany, Became a Car-Sharing Paradise." ***The Atlantic CityLab*****, December 11, 2014.** http://www.citylab.com/commute/2014/12/how-bremen-germany-became-a-car-sharing-paradise/383538/ **(accessed December 16, 2014).**

- Bremen, Germany, became the first city with a car sharing action plan. It aims to have 20,000 car sharing users by 2020 by:
  - Building 20 more mobil.punkt stations (on top of the 14 it already has), which combine a transit stop with car sharing and bike sharing stations.
  - Providing incentives for developers to replace regular parking spaces with car sharing spaces.
  - Improving fleet options so users can get exactly the car they need.

  The Bremer Karte plus AutoCard is a combination transit fare card and car sharing access card. Interestingly enough, the city has high alternative transportation use: mass transit accounts for 14 percent of trips, walking 20 percent, and biking 25 percent. Only around 40 percent of trips are made by car, but Michael Glotz-Richter, Bremen's sustainable mobility director, notes that "the paradox of car sharing is that it works best in the places where you don't really need to drive."

Leber, Jessica. "Looking More Closely at the Way People Move through Cities." *MIT Technology Review*, undated. http://www.technologyreview.com/lists/innovators-under-35/2013/visionary/laura-schewel/ (accessed August 10, 2015).

- Shopping trips are estimated to account for 30 percent of all VMT.

Levinson, David. "What Happened to Traffic?" Transportationist, November 11, 2013. http://transportationist.org/2013/11/07/what-happened-to-traffic/ (accessed August 10, 2015).

- This article is set in the year 2030 in a future where congestion is a thing of the past. The problem was solved by technology restructuring how people need to and do travel. Office-based work weeks were steadily shortened, to a five/four work week (every other Friday off), to a four-day work week, to a four/three schedule (every other Monday off), down to a three-day work week, and by the year 2030 most workers work only a half-day on Wednesday. Most workers now do their routine work at home, and use time in the office for interaction and collaboration with colleagues. Careers have been shortened as well, as most people enter the workforce around 30 and retire from it around 60. Firms are not interested in paying for training, so most people in their twenties spend 10 years doing unpaid internships and taking online classes. Society has become less materialistic. What shopping is done is conducted almost entirely online and is delivered by robots.

  Real estate value has crashed in both urban and suburban areas—both of which continue to gain population—and former office buildings are being converted into housing (with much less demand for commercial space). Skyscrapers have particularly declined and are now the target of artists, similar to how they once moved into abandoned factory and warehouse buildings. Former suburban McMansions have been subdivided by many immigrant families into multigenerational housing. Suburban garages are now often used as workshops, small stores, or as accessory dwelling units.

  As many urban residents no longer own cars and instead rely on car sharing schemes and alternative transportation, it has become easy to ban cars from urban cores. Autonomous buses have helped transit agencies achieve all-time record transit ridership.

Lindsay, Greg, and Anthony Townsend. "Forget Self-Driving cars; We Should Be Focusing on Self-Driving Buses." *Quartz*, November 2, 2014. http://qz.com/290281/forget-self-driving-cars-we-should-be-focusing-on-self-driving-buses/ (accessed November 24, 2014).

- Self-driving cars have struggled to pass other vehicles on closed courses, have needed human aid to make turns, and have surrendered vehicle control when encountering construction. They have yet to be tested at railroad crossings; going through roundabouts; or in snow, ice, or fog. Once they actually take to the road, they will have to deal with other self-driving cars (including those developed and programmed by different manufacturers) and people who do not want to give up driving (a recent University of Michigan survey of 1,533 U.S., UK, and Australian drivers found a majority "had serious concerns about riding in autonomous cars" and, more importantly, would not pay extra for them). Not often considered is how a bunch of overly cautious self-driving cars will react to each other in traffic, needing to overcome technological incompatibilities and other glitches, potentially slowing each other down and causing significant congestion. Meanwhile, with public transit ridership ballooning to all-time highs, we may be looking at the problem all wrong. Jerry Lutin, formerly of NJ Transit, and Alain Kornhauser, from Princeton University, have estimated that if autonomous buses could be platooned with six-foot spacing between them, 200,000 people could cross through the Lincoln Tunnel bus lanes per hour, five times the current capacity. We should be thinking harder about a vision for how these new technologies can reinvent transportation systems, instead of just trying to repair the current paradigm.

Lloyd, Linda. "Jones Act Debate Aimed at Shipping Crude Oil on Domestic Vessels." *Philadelphia Inquirer*, March 2, 2015. http://www.philly.com/philly/business/homepage/20150301_Jones_Act_debate_aimed_at_shipping_crude_oil_on_domestic_vessels.html (accessed March 2, 2015).

- The Jones Act is a federal law that allows only domestically built and flagged ships to transport cargo between two U.S. ports. This law was passed in 1918 and has effectively protected the U.S. maritime fleet, shipbuilders, and marine merchants in the name of national security and the economy. However, for oil refiners, such as PES, this increases the cost of shipping between ports on the East Coast. Critics claim the law is no longer necessary, as it hampers free trade and forces businesses to be less efficient. Those who want to see the law maintained include industry groups, who say that the U.S. shipping industry would be put out of business (including Philly Shipyard, Inc.—formerly Aker Shipyard) without it.

  Exporting crude oil from the United States is also banned by federal law. With the growth of fracking and new drilling technologies, there has been talk of removing this ban. This would require some reworking of the Jones Act, at a minimum, in order to allow more foreign flagged vessels to come to ports. This is because other studies have shown that European refiners could buy U.S. crude oil, ship it over for refining, and then back to the United States for a lower cost than U.S. refiners could produce it if they have to use Jones Act ships. This could threaten the U.S. refining industry as a result.

Luis, Michael. *A Tale of Ten Cities: Attracting and Retaining Talent*. Seattle, WA: International Regions Benchmarking Consortium, 2009. http://www.psrc.org/assets/5585/IRBC2-Talent1109.pdf

- This report focuses on the willing movement of high-skill labor to metropolitan regions for career and/or lifestyle reasons. Movement of these individuals is of particular interest because they are assumed to have the skills and ability to locate in any number of areas around the world, and they also represent the global economy, as their worth transcends variations in cultural and business practice. It considers what local and regional actions can be taken to make an area more attractive for relocation. It finds that amenities by themselves will not make for a dynamic economy, but it cannot be ignored that most thriving economies are located in places that are pleasant to live in.

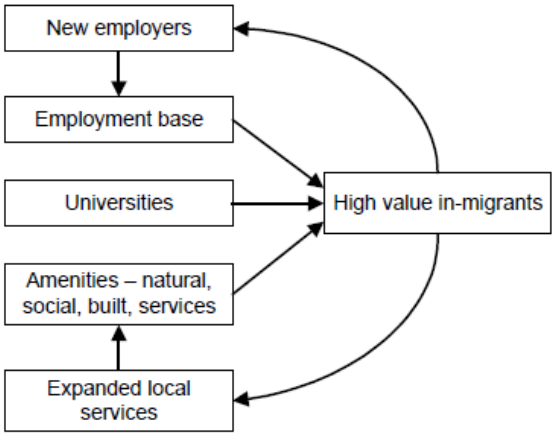
  The talent attraction strategy:

  1. Migration is critical for future economic success.
     a. With natural population growth being virtually nonexistent in the developed world, the only way to grow is through in-migration.
     b. Studies have found that there is a link between the size of an economic region and its productivity (agglomeration economy), where larger regions are generally more productive and have higher nominal wages as a result.
     c. Agglomeration effects occur due to the sharing of knowledge and information between individuals living in close proximity.
     d. Population growth is an indicator of a strong economy.
  2. Economic opportunity takes precedence over lifestyle.
     a. Labor mobility is a factor of economic opportunity and lifestyle preferences.
  3. Competition for talent is conducted between high-productivity regions.
     a. "Knowledge-based" economies—where information is the primary output such as media, software, or architecture; or bringing new technologies to traditional industries—are growth areas, while resource industries and low-skill jobs are in decline.
     b. Very few regions have sufficient talent from just their local population and educational institutions and must attract more talented individuals from within or outside their nation.

c. In-migrants will usually bring high levels of education and skills, increasing the regional workforce talent level.
d. Regions with top-ranked universities have a competitive advantage in attracting talent, and strategies to retain graduates—who have the choice of staying in the region, returning to where they came from, or moving to a new place—are similar to the strategies used to draw new residents.
e. Research has shown there is little correlation between quality-of-life amenities and population growth, while there is a strong link between productivity and population growth. Productivity and the availability of a skilled workforce is the precondition for growth.

4. "Superstar" regions have both high productivity and high quality of life.

Figure C-4. A Superstar Region's Virtuous Cycle



Source: International Regions Benchmarking Consortium, 2009.

a. Superstar regions develop a virtuous cycle, shown in Figure C-4, which starts with attracting adept individuals through existing organizations, universities, and appealing lifestyles. As the talent pool expands, employers seeking a skilled workforce are enticed to the area. Local governments are able to use the growing tax base to invest in improved schools, amenities, and safety. Local entrepreneurs tap into growing regional wealth to build housing and open new entertainment options (restaurants, services, venues). These amenities then attract more skilled workers, in a process that repeats itself.
b. Downward spirals consist of stagnant and shrinking industries leading to a lack of regional opportunity for young people, and the smartest individuals leave. As university graduates and the most gifted individuals leave the region, employers have no incentive to locate there. A declining tax base reduces local services, school quality, and quality of life, while making it difficult to maintain private-sector entertainment services. Unattractive industrial areas become even less appealing (and less safe) as they are abandoned. As residents leave the region, half-empty neighborhoods attract crime and other problems that cannot be addressed with a diminishing tax base.
c. Solid performers retain their productivity through government, business service centers, or traditional industries that have maintained their competitiveness. These regions may struggle due to poor weather, or unexciting natural or built environments, or cultural scenes. They may have high income levels, but they have a difficult time attracting and retaining workers who have many options in where they live.
d. Retirement havens offer high quality of life but lack economic opportunity. They often do not have economic drivers such as major industry, research universities, or international airports. Lifestyle appeal comes from weather, natural beauty, or the built environment rather than from cutting-edge cultural scenes. Their moderate housing costs make them affordable for service-industry workers.

5. Migration decisions have a push and a pull component (see Table C-3).

a. While push factors are mostly related to economic opportunity, cultural and lifestyle factors are also considered.
b. Community tolerance and weather can also play a role in pushing or pulling individuals between regions.

Table C-3. Push-Pull Components of Migration Decisions

Migration Decisions	Push	Pull
Employment	Lack of job or career opportunity; low productivity and earnings	Growing employment levels and/or career opportunities; ability to leverage labor with capital to increase earnings
Lifestyle	Lack of cultural or recreational opportunities; unwelcoming or intolerant attitudes; poor weather and unremarkable natural or built environments	Exciting cultural scenes and/or recreational opportunities; Enjoyable climate and physical surroundings; open and tolerant mindsets

Source: International Regions Benchmarking Consortium, 2009.

6. Households trade housing costs and commute times with wages and amenities.
   a. The Rosen-Roback model is central to urban economics and takes into account four key factors that cannot be traded and vary between regions as a result:
      i. Wages—the more productive a region is, the higher its wages.
      ii. Amenities—these are central to the notion of quality of life; they include the natural and built environments, services, and cultural and entertainment opportunities.
      iii. Housing Cost—housing stock and prices will vary widely (since it cannot be traded between regions) and depend on population growth and supply elasticity.
      iv. Transportation Cost—development patterns, the housing market, and existing infrastructure all determine regional transportation costs; commute trips are the biggest concern; and travel time is also taken into account.
   b. Some dynamic examples of the tradeoffs between these key factors:
      i. Rise in wages—come as a result of new employers arriving and will likely increase housing prices.
      ii. Increase in amenities—for example, after hosting an Olympic Games, the region will attract residents, which brings wages down and increases housing costs.
      iii. Decline in housing prices—if the region allows more homes to be built, particularly affordable units, more workers will be attracted and wages will decrease.
      iv. Shorter commute times—a new rail line lowers commute costs from farther-out areas, making them more attractive and increasing housing costs.
   c. In superstar regions, this decision process often leads to a low housing supply elasticity as a way to reduce urban sprawl. Compact, center-based regions are generally preferred by high-wage knowledge workers. High housing costs in successful economic regions are the result of the political preferences of the residents, not due to economics. Continued increases in housing and commute costs are manageable in these areas as long as high-wage industries continue to grow, and these regions are able to continue to attract more than their share of them.
   d. The downside is that superstar regions become inhospitable for service workers due to high housing costs, and failure to increase housing supply will lead to a lack of service workers who may prefer to locate in solid performer or retirement haven regions, while low-skill individuals who are from superstar regions may find themselves priced out of their birthplaces by the region's economic success.
7. Amenities can be packaged into "scenes" that appeal to specific demographic groups.[C-2]

A talent attraction strategy includes:

[C-2] Scenes are designed to appeal to specific demographic groups through the built environment, social attitudes, and cultural and commercial features. For example, Florida has emphasized bohemian lifestyles.

1. Conduct a strengths, weaknesses, opportunities, and threats (SWOT) analysis.
    a. Strengths: universities, global recognition, favorable image, economic growth and job opportunities, cutting-edge industries, high productivity and wages, attractive central city, wide range of cultural and entertainment offerings, varied and affordable housing, easy commutes, open and welcoming culture, pleasant climate and natural setting, strong expatriate networks and institutions (such as schools).
    b. Weaknesses: stagnant economy, prevalence of traditional manufacturing industries, low global recognition, poor or outdated image, cold and/or wet climate, few interesting natural features, emphasis on traditional cultural offerings, high housing prices, difficult commutes, unwelcoming culture to outsiders or nontraditional lifestyles, land and cultural barriers (region-specific language), lack of opportunity for spousal employment.
    c. Opportunities: retain graduates, attract university students, target migrants from solid performer and downward spiral regions, package high location quotient industries to enhance identify, improve existing "scenes" to build national and international identity, create new "scenes" from existing assets, utilize social and professional networks to provide support for new migrants, learn from multinational firms' employee transfer practices.
    d. Threats: brain drain, competing superstar regions, losing high-productivity employers and becoming a downward spiral region, negative media images and uncontrollable events, image-builders with short lifespans/becoming yesterday's news, nativist/anti-globalist sentiments, anti-growth movements (leading to restrictive housing policies), political friction due to high housing prices and social inequity;
2. Define the economic opportunity the region offers.
3. Identify potential talent sources—who is experiencing a "push"?
4. Catalog the region's positive pull factors—the strengths in the SWOT analysis.
5. Identify the region's barriers to "pull"—the weaknesses in the SWOT analysis.
6. Assess the region's current image and positioning and describe the preferred image—branding a new image must be based on a realistic assessment of the region's strengths and must be unique enough to stick in people's minds to distinguish it from other competitor regions.
7. Communicate.
8. Be prepared for unintended consequences—if the strategy is successful, there will be negative impacts to housing, transportation, and public services. Social tensions may mount if new high-wage arrivals displace long-term residents.

Marshall, Alex. "The Real Root of Broken Infrastructure: Broken Governance." ***Governing*****, December 2014.** http://www.governing.com/columns/eco-engines/gov-broken-infrastructure-broken-governance.html **(accessed December 5, 2014).**

- "Fractured infrastructure usually reflects fractured political infrastructure." A recent Eno Transportation Center and TransitCenter report, *Getting to the Route of It*, highlights how the problems with transit more often than not are in how it is governed. However, the report's findings are applicable to virtually any other physical infrastructure in the United States: roads, power grids, or water. In San Francisco, there are 26 different transit operators, leading to a disjointed system. In Dallas, DART has built 90 miles of light-rail infrastructure in short order but does not have any control over land use around its stations. In Chicago, there is a very complicated flow of money passing through various agencies from counties, cities, state, and various transit providers. Minneapolis–St. Paul had a good system through the Metropolitan Council, until an anti-transit governor led to the creation of a new regional transit funding board, potentially creating a new funding silo separate from the rest of the transportation system. If we are to improve our fragmented system, regional entities tend to function more effectively than fragmented ones. Also, who serves on the boards, and who appoints them, is very important. Governance systems need to be revisited frequently, as yesterday's solutions tend to become tomorrow's problems. For

example, the New York Port Authority was created 100 years ago to be beyond the reach of politics. Today, it is seen as a problem because it is not responding to the desires of the electorate. For efficiency and effectiveness, users should have access to the elected officials who have authority over the system, in order to ensure better coordination and culpability.

Masur, David, and Chloe Coffman. *Danger around the Bend: The Threat of Oil Trains in Pennsylvania*. Philadelphia, PA: PennEnvironment, 2015.
http://www.pennenvironment.org/sites/environment/files/PAE_REPORT_OilTrains_PRINT_v3.pdf

- There is a dangerous confluence around Philadelphia thanks to the recent arrival of oil trains, which are transporting millions of gallons of highly combustible Bakken crude oil through populous cities and regions and near major sources of drinking water. The nation's laws to protect the public and emergency responders do not do enough to protect against a potential disaster involving one of these trains. There is no requirement for freight rail operators to notify local governments when oil trains will be traveling through their communities so emergency responders can be ready. The disaster at Lac Magentic, Canada, which killed 47 people, led to $400 million in damages, but the operator was bonded for only up to $25 million. Freight rail infrastructure is often in poor condition, increasing the risk of derailments. And even the newer and safer CPC 1232 cars have failed on four occasions, most recently in Mt. Carbon, West Virginia.

  Some 3.9 million Pennsylvanians—including 710,000 Philadelphians—reside within a potential half-mile radius evacuation zone near active freight rail tracks. Oil companies are not paying high enough rates to freight rail shippers, which are cutting corners, and at the same time, long-deactivated tracks are being brought back into service. These trains further illustrate the problem of continuing to be over-reliant on fossil fuels. The United States should ban them until the transport of Bakken crude can be proven to be safe, rather than waiting for a catastrophe to occur. In addition, there needs to be more transparency to the public, decision makers, and emergency responders about oil train movements, and these should be routed around major population centers whenever possible.

Maykuth, Andrew. "Planned Sunoco Pipeline Will Quadruple Gas Liquids Traffic." *Philadelphia Inquirer*, November 6, 2014.
http://www.philly.com/philly/business/20141107_Sunoco_Logistics_annouces__2_5B_pipeline_project.html **(accessed December 16, 2014).**

- Sunoco Logistics Partners L.P. is planning to build Mariner East II, a $2.5 billion pipeline that will carry 275,000 gallons per day of NGLs (ethane, propane, and butane) to its Marcus Hook refinery. These liquids are used mainly in petrochemical manufacturing and will be shipped mostly to markets around the world. The 350-mile long pipeline will originate in Scio, Ohio, and take in natural gas from producers in eastern Ohio, West Virginia, and western Pennsylvania. The pipeline will be subject to safety regulations set by the Pennsylvania Public Utility Commission and the Hazardous Materials Safety Administration. Its routing will be reviewed by the U.S. Fish and Wildlife Service, the Pennsylvania Department of Environmental Protection, and the U.S. Army Corps of Engineers (USACE). The Federal Energy Regulatory Commission will regulate the rates to use the pipeline once it is in operation. It faces significant opposition in some of the region's municipalities through which it is proposed to run and concerns that it will worsen regional air quality. As a public utility corporation, Sunoco can use eminent domain to secure right-of-way.

Maykuth, Andrew. "Summit's Message: Pipeline Key in Shale-energy Revolution." *Philadelphia Inquirer*, December 7, 2014. http://www.philly.com/philly/news/breaking/20141206_Summit_s_message__Pipeline_is_key_to_Philadelphia_s_role_in_shale-energy_revolution.html (accessed December 8, 2014).

- Greater Philadelphia must improve its connection to the Marcellus Shale gas region, or else it may be bypassed by this growing market. Philadelphia is currently served by three pipelines, which are not sufficient to deliver the gas being produced 100 miles away. A new 110-mile, $1 billion pipeline is needed to ensure there is enough capacity. This pipeline would strengthen the region as an energy hub, creating manufacturing, power plant, petrochemical, and fuel-production jobs, while also attracting engineering, research, technical, and financial employment. The region is already well suited to become an energy hub, with available manufacturing sites, a well-trained and highly suitable workforce, and a considerable transportation network with road, rail, and port facilities. The region is particularly equipped to be a center for transshipping, where goods and energy products can be transferred between two or more vehicles or vessels.

  Opponents of the energy hub do not want the pipeline built, or more oil and gas shipped into the region, which has more than its share of these facilities. They would prefer investments be made into renewable energy, rather than build more infrastructure for the fossil fuel industry.

Maykuth, Andrew. "Can a Public–Private Partnership work for PGW?" *Philadelphia Inquirer*, December 16, 2014. http://www.philly.com/philly/business/20141215_Can_a_public-private_partnership_work_for_PGW_.html (accessed December 16, 2014).

- Following Philadelphia City Council's decision to not vote on privatizing PGW, Council President Darrell Clark said he preferred a public–private partnership municipal utility structure, perhaps similar to ones in Jacksonville, Memphis, San Antonio, or Allentown, Pennsylvania. Unfortunately, two of these four examples (Jacksonville and Memphis) have already failed in their mission. Some of the advantages of a municipal authority include being supported by service revenue rather than taxes, the ability to engage in longer-term contracts, and issuing bonds to help finance projects. One potential workaround may be to use the Philadelphia Energy Authority, created by the city government in 2010, to reduce energy use and develop renewable energy.

Maykuth, Andrew. "Oil-train Accidents Raise Concern in Phila." *Philadelphia Inquirer*, February 23, 2015. http://www.philly.com/philly/business/20150222_Oil-train_accidents_raise_concern_in_Phila_.html (accessed February 24, 2015).

- There have been a series of dramatic rail incidents in North America over the last two years, most recently near Mount Carbon, West Virginia. In Philadelphia, there have been two notable incidents, including a CSX train derailing over the Schuylkill River, leaving several cars dangling off the bridge; and a second CSX oil train that derailed in a rail yard in the vicinity of 11th Street, south of I-95. Every week there are somewhere between 45 and 80 oil trains traveling through Philadelphia, with more than 700,000 people in the region, and 400,000 in Philadelphia, living within a half-mile evacuation zone along the rail lines they use. Unit trains, with more than 100 rail cars, take five days to travel from North Dakota to Philadelphia. Typically, these trainloads contain about 70,000 barrels, or approximately three million gallons, of crude oil.

  The City of Philadelphia has elaborate emergency plans, including evacuation routes, and is ready to respond to any type of hazardous material incident. Much of this information is available on the city's website. However, some specifics have not been shared, in an effort to balance between being transparent with the public and protecting the public from a security standpoint. Freight rail carriers are enhancing safety by conducting more training exercises with first responders and sharing their databases with locations of all hazardous materials with the city. Pennsylvania Governor Tom Wolf is also calling for better public protections through more safety measures and

inspections, along with better preparedness. In December 2014, North Dakota passed regulations that take effect on April 1, 2015, requiring all crude oil produced to be processed to reduce explosive vapors. Critics contend that these measures do not go far enough. They would like to see the trains rerouted away from population centers, but this would require relocating the refineries that are the trains' final destination.

Metcalfe, John. "The U.S. Cities with the Worst Climate Change-Related Flooding." *The Atlantic CityLab*, July 29, 2014. http://www.citylab.com/weather/2014/07/the-us-cities-with-the-worst-climate-change-related-flooding/375212/ **(accessed January 21, 2015).**

- The number of nuisance flood days has increased significantly since the 1950s, with more than nine times as many days in Annapolis and Baltimore. Ongoing swamping of coastal cities, particularly along the East Coast, may be the greatest climate change threat the United States is facing. Flooding is becoming more frequent with high tides, as a result of sea level rise, land subsidence, and the loss of natural barriers. The area around the Chesapeake Bay is doubly hit, as the land there is sinking, partly due to groundwater pumping. Nuisance flooding in Philadelphia has increased from 1.6 days per year from 1957 to 1962 to 12.0 days per year from 2007 to 2013, a 650 percent increase. Other top cities in the United States for nuisance flooding include Atlantic City, New Jersey; Sandy Hook, New Jersey; Port Isabel, Texas; Charleston, South Carolina; Washington, DC; San Francisco, California; and Norfolk, Virginia.

Muro, Mark, Jonathan Rothwell, Scott Andes, Kenan Fikri, and Siddharth Kulkarni. *America's Advanced Industries: What They Are, Where They Are, and Why They Matter*. Washington, DC: Brookings Institution, 2015. http://www.brookings.edu/research/reports2/2015/02/03-advanced-industries

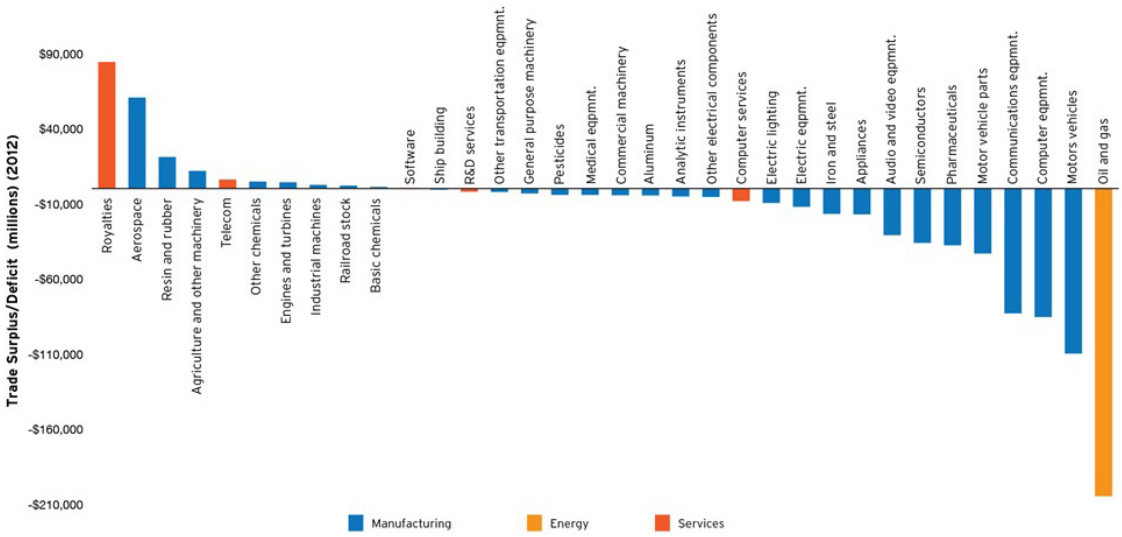
- This Brookings Institution report identified the top 50 advanced industries in the United States based on each industry that spends more than $450 per worker on research and development (falling into the 80 percentile of all industries). These industries account for a 21 percent share of science, technology, engineering, and math (STEM) workers (twice the national average). They promote innovation, enhance workforce skills and knowledge diffusion, improve productivity, and are vital to the nation's prospects for future economic competitiveness, growth, and prosperity. Key findings in the report follow.

  Advanced industries employ about nine percent of U.S. workers and generate about 17 percent of GDP, approximately $2.7 trillion per year. They employ 80 percent of the country's engineers, undertake about 90 percent of private-sector research and development, develop 85 percent of annual U.S. patents, and produce 60 percent of all exports. Each advanced industry job supports around 2.2 additional U.S. jobs, 0.8 within the region it is located in, and 1.4 outside it.

  Advanced industries are clustered in urban areas: 70 percent of their jobs are located in the 100 largest U.S. metropolitan regions. In some areas, the cluster is focused on a single manufacturing industry; in others, there is a strong energy concentration, and some regions contain a broad range of advanced industries. However, the amount of intense concentrations of industry has declined from 1980, when 59 percent of the top 100 metro regions had 10 percent or more of their workforce in advanced industries, to 2013 when only 23 percent of metro regions had this level of intensity.

  International competitors are gaining ground on U.S. advanced industries. While the United States still has the second-most productive advanced industries in the world (behind Norway), our competitiveness is declining. Advanced industries accounted for $1.1 trillion in exports, but our trade deficit in these areas was still $632 billion in 2012. The United States is falling behind in its share of global research and development and patent granting. And these industries face labor shortfalls, due to the lack of STEM graduates.

Figure C-5. U.S. Advanced Industry Trade Surplus/Deficits



Source: Brookings Institution, 2015.

Strategies to improve advanced industries competitiveness include:

- National actions should include corporate tax reform and strategic trade liberalization and enforcement.
- Commit to innovation through increased research and development funding, along with more open or networked innovation models.
- Develop the workforce, with industries becoming more involved in developing sector-specific regional skills initiatives and governments becoming more responsive to firm needs.
- Renew the vitality of regional advanced industry ecosystems. The agglomerative effects of industry concentrations have been diluted through decades of outsourcing or disinvestment. Geographic proximity between firms helps to build skills, reduce shipping costs, add value through local knowledge flows, provide access to a larger skilled workforce, and benefit from a variety of regional suppliers. Governments should work to support both anchor institutions and the smaller firms that enhance the cluster, while local firms should support the local economic environment.

In 2013, the Philadelphia-Camden-Wilmington (PA-NJ-DE-MD) metropolitan region had:

- 249,600 advanced industry jobs (13th out of 100), which accounted for 8.9 percent of all jobs (43rd out of 100).
- From 2010 to 2013 an increase in the amount of jobs by 0.7 percent per year (76th out of 100), and total employment by 0.7 percent in the same period.
- 199,680 jobs indirectly supported by advanced industries.
- Advanced industry output of $47.7 billion (13th out of 100), which accounted for 14.9 percent of total output (59th out of 100).
- From 2010 to 2013 an increase in the amount of output by 0.2 percent per year (90th out of 100), and total output by 0.9 percent in the same period.
- The top five advanced industries in the region:
  - Computer systems design and related services (42,660 jobs in 2013, growing 3.8 percent annually from 2010 to 2013).
  - Management, scientific, and technical consulting services (33,060 jobs in 2013, growing 3.8 percent annually from 2010 to 2013).
  - Scientific research and development services (27,250 jobs in 2013, growing 2.5 percent annually from 2010 to 2013).

- Architectural, engineering, and related services (26,770 jobs in 2013, growing 0.4 percent annually from 2010 to 2013).
- Pharmaceutical and medicine manufacturing (14,820 jobs in 2013, declining 4.0 percent annually from 2010 to 2013).

- The average advanced industry worker in the region earned $98,730 in 2013, compared to the average earnings for workers in all industries of $57,220.

National Highway Cooperative Research Program. *NCHRP 750 Volume 2: Climate Change, Extreme Weather Events, and the Highway System*. Washington, DC: Transportation Research Board of the National Academies, 2014. http://onlinepubs.trb.org/onlinepubs/nchrp/nchrp_rpt_750v2.pdf

- The National Highway Cooperative Research Program (NCHRP) Report 750 Volume 2 is a guide for transportation agencies to incorporate adaptation into their activities. By adapting to climate change, agencies are taking actions to reduce the vulnerability of natural and human systems and to increase transportation resiliency in advance of anticipated changes to the climate and increased extreme weather events. The eight-step diagnostic process is:

  1. Identify key goals and performance measures for the adaptation planning effort.
  2. Define policies on assets, asset types, or locations that will receive adaptation considerations.
  3. Identify climate changes and effects on local environmental conditions.
  4. Identify vulnerabilities of asset(s) to changing environmental conditions.
  5. Conduct risk appraisal of asset(s) given vulnerabilities.
  6. Identify adaptation options for high-risk assets and assess feasibility, cost-effectiveness, and defensibility of options.
  7. Coordinate agency functions for adaptation program implementation (and optionally identify agency/public risk tolerance and set trigger thresholds).
  8. Conduct site analysis or modify design standards (using engineering judgment), operating strategies, maintenance strategies, construction practices, etc.

  The report has an equation for asset risk due to climate change:

  $$Risk = Probability\ of\ Climate\ Event\ Occurrence \times Probability\ of\ Asset\ Failure \times Consequence\ or\ Costs$$

  The report summarizes potential climate change impacts to transportation infrastructure and how it is operated and maintained. Relevant impacts for Greater Philadelphia follow.

  Change in Extreme Maximum Temperature:
  - Premature deterioration of infrastructure.
  - Damage to roads from buckling and rutting.
  - Bridges subject to extra stresses through thermal expansion and increased movement.
  - Safety concerns for workers, limiting construction activities.
  - Thermal expansion of bridge joints adversely affecting bridge operations and increasing maintenance costs.
  - Increased risks of vehicle overheating and tire blowouts.
  - Rising transportation costs and increased need for refrigeration.
  - Materials and load restrictions limiting operations.

  Greater Changes in Precipitation levels:
  - Increasing risk of floods, causing road washouts and closures as well as increasing need for road repair and reconstruction.
  - Increasing precipitation at risk of leading to soil moisture levels becoming too high, compromising the structural integrity of roads, bridges, and tunnels and leading to accelerated deterioration.

- Road embankments at risk of subsidence/heave.
- Regions with more precipitation at risk of increased weather-related accidents, delays, and traffic disruptions (loss of life and property, increased safety risks, increased risks of hazardous cargo accidents).
- Heavy winter rain with accompanying mudslides damaging roads (washouts and undercutting), which could lead to permanent road closures.
- Heavy precipitation and increased runoff, causing damage to tunnels, culverts, roads in or near flood zones and coastal highways.

Sea Level Rise:
- Erosion of coastal road base and undermining of bridge supports due to higher sea levels and storm surges.
- Temporary and permanent flooding of roads and tunnels due to rising sea levels.
- Encroachment of saltwater, leading to accelerated degradation of tunnels (reduced life expectancy, increased maintenance costs and potential for structural failure during extreme events).
- Coastal road flooding and damage resulting from sea level rise and storm surge.
- Increased exposure to storm surges.
- More frequent and severe flooding of underground tunnels and other low-lying infrastructure.

Increased Intense Precipitation, Other Change in Storm Intensity (Except Hurricanes):
- Bridges more prone to extreme wind events and scouring from higher stream runoff.
- Bridges, signs, overhead cables, and tall structures at risk from increased wind speeds.
- The number of road closures due to flooding and washouts likely to rise.
- Erosion occurring at road construction project sites as heavy rain events take place more frequently.
- Increasing wind speeds resulting in loss of visibility from drifting snow, loss of vehicle stability/maneuverability, lane obstruction (from debris), and treatment chemical dispersion.
- Increases in weather-related highway accidents, delays, and traffic disruptions are likely.
- Lightning/electrical disturbance disrupting transportation electronic infrastructure and signaling, posing risk to personnel, and delaying maintenance activity.

Increased Hurricane Intensity:
- Increasing infrastructure damage and failure (highway and bridge decks being displaced).
- More transportation interruptions (storm debris on roads can damage infrastructure and interrupt travel and shipments of goods).
- More evacuations.

The report lists a series of best practices from state departments of transportation (DOTs) that can be taken to better prepare for future emergency situations. Pre-event planning:

- Develop a timeline of likely agency response actions.
- Establish clear command and control structure for emergency response; develop lines of authority with other agencies.
- Develop an emergency response manual, inventory lists, contact information, and three-tiered response; distribute “smart technology” with required forms and software in order to be better prepared for the next emergency.
- Compile a contractor registry database, develop a standardized electronic contract processing system, develop an emergency administrative packet for incident command centers, develop an emergency administrative packet for contractors, develop an emergency waiver process, explore alternative emergency contracting processes, and review and standardize the process for paying contractors.

- Develop and maintain an active distribution list of cell phones, explore the use of cloud technology, formulate a recommendation for data storage during emergency response, explore and develop connectivity with data sets, explore the use of information technology applications (511, Google, etc.) for emergency response, develop a process to track equipment and materials from contractors, and standardize data collection and data integration.
- Pre-purchase (e.g., traffic cones for police vehicles) and pre-position (e.g., replacement culverts).
- Review administrative policies for staff activities (e.g., hotels/food/local transportation charges).
- Develop contingency plans for specialized equipment (e.g., expanded number of contracts for critical roads and essential supplies such as road salt for winter storms).
- Improve agency-wide situational awareness of weather event and its impacts.
- Increase emphasis on storm drainage maintenance and debris removal.
- Increase public awareness of what they should do in an extreme weather event.
- Partner with other agencies and/or conduct a workshop on how to respond to an extreme weather event.
- Establish protocol for use of traveler warning strategies (e.g., 511 traffic information system for online and phone, overhead electronic message boards, Twitter and Facebook, wireless emergency alerts, mobile apps, and real-time roadside alert systems);
- Provide emergency response training to agency staff.
- Coordinate with other states to establish multi-state strategy for responding to weather events.
- Implement maintenance decision support systems for extreme weather event planning.
- Establish clearly defined detour routes and detour route operations strategy.
- Develop and/or understand evacuation procedures.

During event system management:

- Document actions taken and resources used (will be needed for post-event reimbursements).
- Establish or use a current incident command center.
- Establish close coordination with law enforcement to close roads.
- Have a strategy in place for using resources that come from other jurisdictions.
- Use tactical response teams to investigate seriously impacted area.
- Utilize a variety of communications strategies for the traveling public and other stakeholders (e.g., media releases and interviews, Internet announcements, e-mail alerts, local meetings and briefings, site impact tracking tool, and road closure maps on the Internet).
- Establish corridor DOT staff patrols to monitor road damage.
- Prepare “Road Closed” signs and place them in consultation with law enforcement and communications specialists.
- Utilize resources to provide real-time monitoring of the extent of damage or threat (e.g., Minnesota used state police helicopter to monitor flood levels).
- Use Google Earth with custom layers (inundation levels, LIDAR, historical imagery, etc.).
- Engage the resource agencies, USACE, and the Federal Highway Administration (FHWA) early and throughout the event.
- Coordinate with emergency responders and keep them updated on closures and openings throughout the event.
- Utilize an electronic Detailed Damage Inspection Report.

Post-event recovery:

- Re-examine incident response plans and update based on experience.
- Use project development and joint engineering/maintenance teams to perform early assessments of damaged infrastructure and to assess newly vulnerable areas (e.g., new erosion patterns due to fire impacts).

- Conduct debriefs with key stakeholders.
- Re-examine agency contingency plans in light of event response and document lessons learned.
- Implement training programs for front-line responders (e.g., snowplow simulator training).
- Examine technology strategies that could be used to improve response efficiency (e.g., automatic vehicle location monitoring).
- Install monitoring technology to provide alerts to maintenance staff of weather-related threats (e.g., wireless connected rain gauges).
- Install roadside traveler alert systems.
- Examine standard operating procedures for both design and maintenance to determine if different approaches might be better (the new design manual will be focused on risk-based design, and slope designs are being redefined).
- Expedited contract for inspection and reconstruction of major interchange.
- Hire consultants to augment staff and reduce recovery time.
- Understand and track the timing of a Presidential Disaster Proclamation: the 180-day clock starts immediately.
- Develop electronic "as builts" that utilize survey grade accuracy LIDAR to expedite future plan development (e.g., all survey control points on a major interstate in Iowa were lost in a flood).

National Highway Cooperative Research Program. *NCHRP Report 750 Volume 4: Sustainability as an Organization Principal for Transportation Agencies.* Washington, DC: Transportation Research Board of the National Academies, 2014. http://www.trb.org/Main/Blurbs/170762.aspx

- NCHRP Report 750 Volume 4 defines sustainability through an integrated triple bottom line with a long-term view. Sustainable transportation will be achieved through a series of phases and an evolution in how we think about transportation.

  - Level 0—Safe Mobility (1954–1970).
  - Level 1—Compliant Transportation (1970–2000).
  - Level 2—Green Transportation (1985–2015).
  - Level 3—Sustainable Transportation (2010–2030).
  - Level 4—Triple Bottom Line Sustainability (2030–?).

  For best societal outcomes in triple–bottom-line sustainability, the total value of all three stores of capital—environment, social, and economy—should be maximized, while maintaining balance between them. All three forms are considered flexible and renewable (or replaceable through alternative energy supply, better environmental remediation technology, or improved recovery of resources). Getting there will require policy changes. Historically, the U.S. policy system and decision making has worked to limit change and maintain the status quo, thanks in part to its highly decentralized, complex, multifaceted nature and numerous competing interests. Understanding how societal change occurs is critical to achieving sustainable transportation.

  - Path dependence attempts to show why change is slow, based on rational and pragmatic approaches given existing conditions, and the view that current institutions, rules, and laws limit the range and extent of what are possible policy changes.
  - Incrementalism is slow change, while decision making is based on low risk and consensus building.

  Path dependence would suggest that change never happens or always happens very slowly, which is not always true. Different types of stressors put pressure on existing organizational arrangements and dominant paradigms.

  - Exogenous Stressors—These arise from outside the policy system either from sudden shock (e.g., Hurricanes Katrina or Sandy, 9/11 attacks), or gradual, external, long-term change that

increases the stress within a system to the point when it suddenly appears to make it impossible to maintain the status quo.
- Endogenous Stressors—These come from within the system either from changes in demands and resources produced by feedback in the policy system (e.g., the rise of the automobile leading to growing pressure for new roads early in the last century); and/or learning within the system as society tests out policies to identify what does and does not work (e.g., the freeway "revolt" in the 1960s, or the revival of transit late in the 20th century).

They raise the visibility of critical problems, and as policies come under stress, a new narrative is needed to adequately understand and respond to events. The new model that attempts to better reflect the slow nature of change with sudden and dramatic shifts is **Punctuated Equilibrium**. This model recognizes that, for the most part, there are long periods of stability with minor incremental change. Existing approaches are undermined when instability arises, caused by either endogenous or exogenous change, and the prevailing consensus is broken, which destroys key political alliances and undermines long-held assumptions or beliefs.

Given the growing uncertainties about the future, changing state and federal budget priorities, potential regulatory changes to reduce greenhouse gas emissions, and new technologies, state transportation agencies face growing uncertainty about the future. Given this, scenario planning has emerged as a way for these agencies to consider vastly different operating conditions in the near future. It helps to look into the future and anticipate events and trends, provide ideas to respond to them, and break out of established viewpoints by becoming more aware of potentially different futures. The NCHRP 750 Volume 4 research team analyzed futurist literature, interviewed subject matter experts, and held discussion and panels to identify a series of future scenarios that will affect long-term development and transportation agency operations.

This effort identified five future scenarios:

- Crisis World— Environmental crises and resource depletion are occurring much sooner than currently expected, and the economy remains in long-term recession.
- Mega World— Economic and population growth are clustered in 11 megaregions in the United States as technology develops as expected, while new transportation funding mechanisms take shape.
- Suburban World—Economic and population growth continue in the longer-term suburban trends, technology develops as expected, but new transportation funding mechanisms take shape more slowly.
- Wonder World— Better-than-expected economic growth occurs thanks to rapid technological development. This leads to higher population growth, increasing household wealth, and more dispersed development patterns.
- Green World— Social and political consensus to build a greener economy is achieved. This leads to higher population and technological and economic growth, in spite of higher levels of regulation.

Suburban World, in particular, may highlight the paradox of radical decentralization. As the number and nature of local governments vary and their power is increased, there may be more resistance to change. This may lead to a wider range of outcomes, where wealthy communities may be dedicated to sustainability, while poorer ones may relax environmental standards in order to attract economic development.

Decision making and change response should be guided by the following in a triple-bottom-line sustainability program:

- Adopt a precautionary approach to policymaking.
- Choose flexible or adaptive management options and build internal adaptive capacity.

- Use no- or low-regrets options.
- Avoid burden shifting.
- Deal with "messy" futures by collaborating with citizens and enabling innovation.
- Make public participation a more positive force.

Other tools that should drive triple–bottom-line sustainable decision making include:

- Quantifying the full life-cycle cost of transportation programs (not necessarily projects).
- Total cost accounting at program levels.
- Linking transportation performance and services to economic, environmental, and social bottom lines in simple and data-driven ways.
- Valuing future (generational) transportation performance and triple–bottom-line impact.
- Sustainability rating systems and performance measures [FHWA's INVEST, Parsons Brinkerhoff's PRISM, and HDR's sustainable return on investment (SROI)].
- SROI estimators.
- Life-cycle cost analysis, life-cycle assessment, and various sustainability cost–benefit measures.

Given the pluralist nature of American society, even a broad consensus will not be shared by a number of individuals. Ensuring that a wide range of interests support a program or policy is why planners spend so much time on consensus building. This can help to ensure it continues, even if it is not an instant success. Some regions will invest in technologies that are not successful (e.g., Betamax). Even worse would be to not make investments at all due to fear of failure and falling behind other early-adopter regions.

National Highway Cooperative Research Program. *NCHRP Report 750 Volume 5: Preparing State Transportation Agencies for an Uncertain Energy Future.* Washington, DC.: Transportation Research Board of the National Academies, 2014. http://www.trb.org/Main/Blurbs/170763.aspx

- "As public institutions, state DOTs must evolve and adapt to changing travel demand, emerging technologies, current policy priorities, and shifting external economic and development patterns." (13). State DOT roles are evolving: even as they remain concerned primarily with highway travel, they are becoming more involved in the planning, funding, and oversight of transit, rail, aviation, and marine transportation. Within their planning efforts, they are expected to address a broader range of policy goals, particularly economic development, equity, air quality, reducing greenhouse gas emissions, improving quality of life, and extra attention to road safety. Meanwhile, state DOT funding has not been able to keep pace with inflation and increasing vehicle fuel efficiency. Some plausible futures identified in this report include:

  - Oil prices out to 2050 range from $70 to $250 per barrel, with corresponding per gallon gas prices ranging between $2.50 and $7.00.
  - More stringent corporate average fuel efficiency (CAFE) standards suggest that vehicle fuel efficiency should at least double by 2050, and could quadruple.
  - Electricity, natural gas, biofuels, or hydrogen could displace oil to claim a substantial market share by 2050. For this to happen would require major technological advances and investment in distribution and refueling infrastructure. If this happens, per-mile fuel costs could decline to one-half or even one-third of what they currently are.
  - Vehicle prices are likely to increase in the future, as technology needed to meet increased CAFE standards will likely cost several thousand dollars. Alternative fueled vehicles could cost up to $10,000 more to produce.
  - Energy costs per unit of travel may be much lower. Though there is some possibility that energy costs rise faster than fuel efficiency reduces energy demand, a stable oil price would mean this is unlikely to happen.

- Transit seems unlikely to reduce its current mode share (about 2 percent of trips). With major investment, the report considers the possibility that mode share could rise up to 10 percent of all trips.

Federal energy and climate policy scenarios are a mixture of subsidies and regulations aimed at the somewhat incompatible goals of keeping energy prices low, maintaining security, and reducing greenhouse emissions. Future scenarios for federal policies could aim for further reducing energy costs, thereby supporting more domestic energy production; or where climate mitigation is the overriding concern, policies such as carbon pricing could arise. In addition, if federal fuel tax rates are not raised, more responsibility for funding and maintaining transportation infrastructure could shift to state and local governments. In fact, more stringent CAFE standards threaten the viability of not only federal gas taxes but also most state gas taxes as well, potentially putting transportation infrastructure at risk. A scenario where fuel taxes are increased or new types of taxes are introduced (through tolling, VMT fees, weight-distance truck tolls, or congestion pricing) could both raise revenue and increase efficiency.

National Highway Cooperative Research Program. *NCHRP Report 750 Volume 6: The Effects of Socio-demographics on Future Travel Demand.* Washington, DC: Transportation Research Board of the National Academies, 2014. http://www.trb.org/Main/Blurbs/171200.aspx

- Developing the socio-demographic assumptions that go into metropolitan planning organization (MPO) and DOT long-range plans is fraught with uncertainty. It is unclear how trends will play out in the future, the relationships between the factors, and other model inputs. To help fill the gaps in analytical tools, the NCHRP 750 Volume 6 research team developed the Impacts 2050 tool. It develops scenarios that represent plausible futures and a system dynamics model for analyzing possible futures, particularly relationships between socio-demographics and travel demand.

  Travel demand models have a poor record of making precise forecasts for the evolution of complex systems, such as the transportation system. They are, however, very valuable for considering the impacts of different potential futures, through scenario planning. Barabba's Law states that important decisions should never be based only on a quantitative model's results. Scenario planning can help to formally consider uncertainty and facilitate public participation in the planning process. Starting with key trends in population size and growth, the geo-demographics of population size and growth, population structure and composition, household-based economic activity, cultural and social diversity, and external factors intertwined with socio-demographics (i.e., urban form, technology, and infrastructure investment), the report identifies eight key socio-demographic trends that are already affecting travel demand:

  1. The next 100 million—The population is growing more slowly. It is aging, with decreasing mortality and longer lifespans. Fertility rates are declining, particularly among Caucasian women, and immigration rates are lower.
  2. The graying of America—The population is aging, with extended lifespans and boom-and-bust birth rates.
  3. The browning of America—There is more racial diversity among the population, higher fertility rates for Hispanic women, and continuing immigration, particularly from younger age groups:
     a. Hispanics accounted for 56 percent of U.S. population growth from 2000 to 2010.
     b. By 2050, nearly one in three Americans (29 percent) will be Hispanic.
  4. The changing American workforce—The workforce is becoming older, with higher diversity, and consists of a greater percentage of female workers.
  5. There is blurring of city and suburb.
  6. Slow growth in households—New household formation rates have plummeted since 2006, creating more single-person and multigenerational and larger households.
     a. Average household size has shifted from 4.6 in 1900, to 3.3 in 1960, to 2.59 in 2000, to 2.63 in 2010.

b. The number of 25–34-year-olds living with their parents increased from 15 percent in 2000 to 18 percent in 2010.
c. In 1980 about 12 percent of the U.S. population lived in multigenerational households, and by 2008 this figure was 16 percent.

7. The Generation C—Mobile and broadband technologies will become more ubiquitous, as technology shapes lifestyle choices for all connected, communicating, content-centric, and community-oriented individuals (Generation C):
   a. Apple sold its first iPhone in 2006, and by 2012 it sold over 250 million of them.
   b. The ability to perform activities remotely may be displacing the perceived freedom granted by automobile ownership.
   c. The 21–30 age group went from over-indexing as a proportion of total VMT in 1995 to under-indexing for total VMT by 2009.
8. The salience of environmental concerns—The generational divide over energy and environmental priorities is decreasing over time.

The research team identified a key feedback loop, where demographic and socio-economic factors impact travel behavior, and in turn, travel behavior can influence a region's socio-economics and demographics. Though DOTs and MPOs apply a wide range of travel demand models to their planning efforts—project-specific models, regional models, statewide models, strategic models, and land use models—none of them use a detailed demographic evolution model. Travel demand models are very good with **statistical accuracy**, having exact numerical parameters and functional forms used to define model relationships. This is appropriate for short- and medium-term analysis. What they are not good at is (long-term) **structural accuracy**, which is having a correct set of variables and the causal relationships that link them. For longer-term forecasts, it is difficult to predict how relationships will change over time. This is why scenarios, which can test out the impact of changing relationships, are so important.

In developing scenarios, the research team worked to identify predetermined elements and uncertainties. Predetermined elements are considered to be highly likely outcomes over the scenario time period. Uncertainties are things that could potentially change in the future, but the direction, pace, timing, and resulting outcomes are less assured. The research team used the strategic assumptions surfacing and testing (SAST) technique to develop the scenarios analyzed in this report.[C-3] The four scenarios developed were:

- Momentum—gradual changes without radical shifts.
- Technology Triumphs—technology solves problems.
- Global Chaos—collapse in globalism and sustainability.
- Gentle Footprint—widespread shift to low-impact living.

NCHRP Report 750 Volume 6 suggests defining key indicators as a way to track if a scenario is coming to fruition, and particularly to see if changes in travel behavior are occurring. It recommends setting up a cross-impact matrix between system dynamics model measures in

[C-3] SAST applies systems thinking to wicked or ill-structured problems (where possible solutions rest on assumptions that conflict with each other). SAST is used in a workshop format that is adversarial, participative, integrative, and managerial mind supporting. This method brings underlying assumptions that people have about the world and problematic situations to the surface and challenges them. This is done in four stages:

1. Group formation—This involves bringing together a wide variety of stakeholders, split into smaller groups according to like-minded viewpoints. Intra-group conflicts should be minimized, while intergroup conflict should be maximized.
2. Assumption specification—Each group identifies a preferred strategy, while quantifying its underlying assumptions.
3. Assumption integration—Each group reveals its preferred strategy to the larger group, which then debates employing multiple perspectives on underlying assumptions.
4. Composite strategy identification—Consensus is achieved through collaborative problem solving, where the participants' views are integrated and a new strategy is developed. If consensus is not achieved, the participants may agree on a research program or another action to clarify the assumptions or to evaluate one or more particular strategies. Understanding obtained by this method can increase insight into conflicting assumptions, helping to facilitate consensus building in the future.

More info: http://press.anu.edu.au/dialogue_methods/mobile_devices/ch04s03.html.

Impacts 2050 to establish the interconnectedness between them. Though this is a subjective effort, it can identify whether a variable is active, in that it affects many other variables downstream; or passive, meaning that it is affected by other variables upstream. Variables that are highly active and have low passivity (meaning they are not driven by other indicators) are the best type of leading indicators. For the above scenarios, the following leading indicators were identified: job creation (number of jobs, rate of job loss, and rate of job creation), population age structure (total population, more young people, or more old people), percentage of population foreign born, total number of road lane miles, pro-environment attitudes, and whether or not a carbon tax is introduced.

Key challenges facing state DOTs and MPOs include:

- Insufficient funding.
- Tying transportation investment and policy decisions to broader goals.
- Lack of influence with regard to how transportation funds are spent.
- Uncertainties in the amount and source of transportation funding.
- Need for better tools to support expansion of multimodalism.
- Differences between urban and rural interests.
- Moving beyond 20-year plans.

In addition, the following are changes that almost everyone can agree will happen and can be expected:

- Increased customer/citizen and market/community diversity.
- More transparency with increased information leading to more knowledgeable customers/citizens.
- More rapid technological change.
- Fiscally constrained operating environment.
- Less time to respond to market/constituency requests.
- Less ability to forecast market conditions and constituency needs.
- The source of funding and how things are done under constant pressure for change.
- The diffusion of communications meaning less ability to reach mass markets and control messages through large, singular communication mediums.

National Highway Cooperative Research Program. *NCHRP Report 798: The Role of Planning in a 21st Century Department of Transportation-supporting Strategic Decisionmaking.* Washington, DC: Transportation Research Board of the National Academies, 2015.
http://onlinepubs.trb.org/onlinepubs/nchrp/nchrp_rpt_798.pdf

- Planning in the 21st century is shifting from being process based to supporting strategic decision making and problem solving. The report looks at what are driving forces of change that affect transportation, including unpredictable funding, public financing, increasing gap between transportation system needs and available revenue, private financing, global financial pressures, political deadlock, megaregion and multistate issues, divesting system responsibilities, shifting roles and responsibilities, changes from the post-Great Recession economic recovery, economic bifurcation, the growing middle class in developing countries, just-in-time freight delivery, communications technology, big data, intelligent transportation systems (ITS) and new vehicle technologies, the need for resiliency, climate change, energy efficiency, shifting population and travel patterns, aging population, and land use changes.

  In addition, the report focuses on 12 strategic decision-making areas to respond to the challenges being created by these driving forces. They are:

  1. Aligning DOT and Statewide Goals, Priorities, and Performance.

2. Agency Visioning and Goal Setting.
3. Identifying Performance Outcomes.
4. Defining State, Regional, and Local Roles.
5. Internally Integrated Planning.
6. Externally Integrated Planning.
7. Revenue and Financial Planning.
8. Investment Strategy Resource Allocation.
9. Linking Performance Measures to Outcomes.
10. Program-Level Resource Allocation.
11. Aligning Project-Level Decision Making.
12. Feedback—Monitoring and Reporting Agency Performance.

Finally, NCHRP Report 798 contains a three-step agency self-evaluation program:

1. Screen the 12 Strategic Decisions to Assess Your DOT and Planning Office.
2. Identify the Priority Strategic Decisions that DOT Executives Are Most Likely to Support.
3. Develop a "Case for Change" and a "Change Management Plan" for Meeting with DOT Executives.

Naughton, Keith. "Humans are Slamming Into Driverless Cars and Exposing a Key Flaw." ***Bloomberg*****, December 17, 2015.** http://www.bloomberg.com/news/articles/2015-12-18/humans-are-slamming-into-driverless-cars-and-exposing-a-key-flaw **(accessed December 21, 2015).**

- Autonomous vehicles (AVs) have been programmed to follow the law at all times, causing problems as they try to drive in chaotic traffic, often traveling well above the speed limit. The result is AV crash rates are currently twice that for human-driven vehicles. Google cars have been involved in 17 crashes while driving more than 2 million miles. No AV has been at fault for a crash, nor have they been involved in crash that led to a fatality. Many of the crashes have been low speed rear enders, where computers have faster braking reactions than humans do. One solution may be to program AVs to be more aggressive in the appropriate situations.

Newcombe, Tod. "Scaling Up Sensor-Based Smart Cities Proves Difficult." Government Technology, June 3, 2014. http://www.govtech.com/data/Scaling-Up-Sensor-Based-Smart-Cities-Proves-Difficult.html **(accessed January 22, 2015).**

- Sensor technologies could help to address a variety of urban problems: traffic and transportation, energy, public safety, and the environment. While touted as a money saver, they may not be appropriate in areas with high levels of unemployment. For instance, in Spain, with a more than 25 percent unemployment rate, a project to use sensors to identify when it is time to water a city garden was hard to defend when someone could be given the job instead.

  Finding an economic model for using sensor technologies has proven to be difficult. While the individual sensor unit itself is cheap, implementing it into a problem-solving technological solution is not. Constrained city budgets have also limited sensor applications because the projects have not been able to show the ability to produce cost savings or other efficiencies over the long run. Before sensors can be adopted into urban solutions, there is a lot of behind-the-scenes governmental coordination that is needed to share services across departments and to integrate data into business practices.

  As sensor technologies grow and become more commonplace, there are risks that may not have been considered as fully as they should. Something can go wrong with the code behind the sensor, giving faulty information or leading to non-optimal decisions. Fixing code issues can be costly, such as the Y2K bug. Sensors are often connected to the Internet and are therefore in danger of being hacked. It is unclear what happens when there is system overload—can the

sensor safely shut the system down, or could it lead to a catastrophic failure? As sensors watch and track more and more of our daily routines, there are privacy issues that have not been addressed. There are issues with how the government uses the data for decision making. The data itself could suggest that everything is a technical problem with a technical solution, and other possibilities are not considered. Lastly, a more repressive government may use sensor data for surveillance against its own people.

Nichols, Bruce. "The Uncertain Future of Automated Vehicles." i/o the psrc data blog, December 11, 2014. http://psrc.github.io/2014/automated-vehicles-2/ **(accessed December 15, 2014).**

- A popular question right now is how AVs will impact the transportation system. The simple and honest answer is that we do not know. As AV technology is still in its infancy, there are many more questions than answers:

  - Will they be the magic bullet that solves congestion?
  - Will they induce sprawl?
  - How successful will they be?
  - How affordable will they be?
  - How widely accepted will they be?
  - How will they change over time?
  - Will people own them, or rent them like taxis?
  - Will they safely operate at 150 mph?
  - How will they interact with bicycles and pedestrians?
  - Will parents be comfortable letting them chauffeur their children around?
  - How will they impact how we pay for roads in the future?

  Travel demand modelers regularly struggle with major technological and cultural changes. No one anticipated we would be walking around with personal computers in our pockets 20 years ago. And while smartphones are a wildly successful technology, many others have not infiltrated the market as expected, such as electric vehicles. When we are uncertain about the future, we anticipate a range of possibilities that represent the most likely outcomes. The Puget Sound Regional Planning Council recently modeled four future scenarios for AVs:

  1. AVs increase network capacity (30 percent capacity increase on freeways and major arterials).
  2. Important trips are in AVs (30 percent capacity increase on freeways and major arterials; travel time is perceived at 65 percent of actual travel time for high-value household trips [$24/hr.]).
  3. Everyone who owns a car owns an AV (30 percent capacity increase on freeways and major arterials; travel time is perceived at 65 percent of actual travel time for high-value household trips, 50 percent parking cost reduction).
  4. All cars are autonomous and priced per mile to recoup the entire cost of the road network (cost per mile is $1.65).

Table C-4. Puget Sound Regional Council AV Scenario Modeling Results

Measure	Value	Base	Alt 1	Alt 2	Alt 3	Alt 4
Trips	Trips/Person	4.1	4.2	4.2	4.3	4.1
Distance	Average Trip Length	6.9	7	7.2	7.9	5.8
Speed	Daily Average	27.9	30	29.9	28.4	30.4
Mode Share	Single-Occupant Vehicle Share	43.7	43.7	42.7	44.8	28.7
Mode Share	Transit Share	2.6	2.7	2.7	2.4	6.2

Source: Puget Sound Regional Council, 2014.

Scenario 3 finds a 20 percent increase in VMT compared to the base, as driving becomes easier, less expensive, and more enjoyable for all users. While there are accessibility benefits for residents, it may come at the cost of compromising regional goals of reducing greenhouse gas emissions and containing growth to existing urban areas. More importantly, the modeling shows that varying the assumptions based on plausible outcomes from AVs can lead to highly differentiated futures. While more data is needed before accurate forecasts can be fashioned, our existing travel demand models are insufficient. Here are some needed improvements:

1. Modelers need to better understand how new technology such as smartphones, car sharing, and real-time transportation data is already impacting transportation choices.
2. A stated preference survey needs to be conducted to understand how people think they will react to AVs when they arrive.
3. A new AV mode with unique characteristics needs to be part of the choice and routing steps of the model.
4. Ride sourcing and other ride sharing options need better modeling capabilities as well, by extending either the existing taxi or shared ride modes.

Nisenson, Lisa. "Uber's New Wave of Urban Design. Are Cities Ready?" *Mobility Lab*, September 8, 2015. http://mobilitylab.org/2015/09/08/ubers-new-wave-of-urban-design-are-cities-ready/ **(accessed January 7, 2016).**

- Concerns about Uber's plans for driverless vehicles, smart routes, and shared rides have been largely centered on equity issues, low wages, and reduced transit ridership. Although many have focused on what can go wrong, it is important to get ahead of emerging trends to consider how to realize significant benefits from "tech-enabled mobility." Here some things that municipalities should be doing to prepare for shared driver and autonomous vehicle (AV) transportation:

  - Understand what is happening. Transportation network companies (TNCs) will move forward with or without governmental partners. TNCs are working with any willing collaborator, from universities, to states, to cities. The key question is how and when these services will operate.
  - Develop a vision and expectations, particularly to address equity, data sharing, and use of public assets. Municipalities need to consider what role each existing and future (i.e. AVs) mode plays in a unified, multimodal network.
  - Prioritize transit, recognizing the agglomerative effects of larger, and more land efficient modes. Discussions about AVs should be framed around the economic advantages of an efficient and integrated land use and transportation system.
  - Design new nodes along the lines of transportation-oriented development for flexible transportation. For instance, Uber's new *Smart Routes* will collect multiple riders at specific locations. These new nodes and the ability to access them are critical. TNCs will make urban areas that currently lack transit access more appealing to new development. Slightly denser, mixed use, and more pedestrian friendly locations in these areas may become new nodes, where transit comes to people rather than people coming to transit.

  TNCs impacts will be felt well beyond transportation across the region, bringing about new challenges to urban planning. Municipalities will also need to:

  - Rethink infrastructure, as curbsides become the new pickup stations, how can the use of public right-of-way be fairly and safely used, while not significantly worsening congestion as more and more people trade personal vehicles for ride-sourcing.
  - Data and performance. Benchmarks related to equity, congestion, and other concerns should be established as part of the thinking around what could go wrong.

  The sharing economy tries to find underutilized assets and put them to higher and better use. In the case of ride sourcing this is empty seats in vehicles and/or roadway space. Even so, at some

point congested roads will require more efficient transit systems. What do these systems look like in a world of fast evolving technology, particularly in lower density suburban areas?

Nocera, Joe. "College for a New Age." *New York Times*, March 10, 2015. http://www.nytimes.com/2015/03/10/opinion/joe-nocera-college-for-a-new-age.html (accessed March 11, 2015).

- *The End of College* by Kevin Carey predicts that the university's role in society is about to undergo major changes driven by online learning, big data, AI, and the rising cost of tuition. Carey notes that universities traditionally have three major functions: practical training, research, and liberal arts education. Over time, research has become the most important of these roles, while education too often is overlooked. Over time, online learning will lead to a "University of Everywhere," and eventually employers will come to accept all types of new credentials, lessening the need for a traditional degree.

Nussbaum, Paul. "SEPTA Fights a Changing Climate's Threats to Sink It." *Philadelphia Inquirer*, March 23, 2015. http://www.philly.com/philly/business/20150322_SEPTA_fights_a_changing_climate_s_threats_to_sink_it.html (accessed March 26, 2015).

- A recent federal report predicts that climate change will lead to average temperatures rising by 3 to 6 degrees in Philadelphia by 2050, with an increase in rainfall and more frequent heavy precipitation events. Already climate is taking a toll on SEPTA operations: 2010 was the highest annual snowfall in the region, 2011 had the highest annual rainfall, 2012 was the warmest year on record, 2013 had the most summer rainfall, and since 2003 there have been 13 of the 21 highest floods in Norristown from the Schuylkill River. As result, SEPTA must be prepared for more flooding, mudslides, felled trees blocking tracks and knocking out catenaries, and washed-out rails.

  Other transit agencies have struggled with climate change as well. Massachusetts Bay Transportation Authority was shut down by Boston's snowiest year ever. Hurricane Sandy damaged about one-third of NJ Transit's rail vehicles and overwhelmed the Metropolitan Transportation Authority (MTA) in New York City, leaving bridges, subway tunnels, and stations out of commission for weeks.

  SEPTA has received an $87 million grant from the federal government to help fund seven projects (total cost $116 million) to prepare for more extreme weather. These projects include:

  - Power reinforcement to the regional rail lines by insulating nearly 100 miles of cables, upgrading motor generators, and building a new signal substation.
  - Stabilizing 19th-century rail embankments along the Warminster, West Trenton, Lansdale/Doylestown, and Media/Elwyn lines.
  - A new culvert and water retention basin near Jenkintown Station.
  - An ancillary control center at Frankford Transportation Center, in case there is a failure at the main control center.
  - Shoreline stabilization along the Manayunk/Norristown Line.
  - Emergency power generators for subway pumps.
  - A pump drainage system for the Sharon Hill Line (Route 102), where it goes under a freight rail bridge.

  The oldest assets are targeted in these projects because they are the most vulnerable.

Orange Business Enterprise Coalition. *The Way to Work: Space, Place and Technology in 2016*. London, UK: Orange PCS and HenleyCentreHeadlightVision, 2006.
http://business.orange.co.uk/documents/ice/business/the_way_to_work.pdf

- While the future cannot be predicted, businesses have more pressure than ever to be better prepared for it. Futures work is about rehearsing for the future, not predicting or forecasting it. Done well, it makes organizations—private, public, or nonprofit—more responsive to changes in the operating environment.

  The working world is undergoing major transformations as long-standing business models are becoming outdated, and the unyielding rate of change makes it challenging to adapt to the new environment. Business management is vital; it must successfully balance the supervision over employees and intellectual property with developing a people-oriented, flexible organization. Changes to the working world will reach far beyond the workplace. To better identify how businesses will evolve over the next decade, the Orange Business Enterprise Coalition identified four scenarios for the future. It is not likely that the world will go in the direction of just one of these scenarios; rather, some elements of each are likely to be realized:

  - Disciples of the Cloud—The long-predicted high degree of data and employee mobility has not come about; rather, businesses recognize the importance of face-to-face interactions, while a competitive environment is leading to a focus on efficiency. Geography, place, and simultaneous work schedules are all critical in this future.
  - Electric Cottages—High transportation costs (due to increasing oil prices and green taxation), along with the ready availability and decreasing cost of communications technology, has made offsite working desirable and practical. Employment regulations are not keeping up with changing working conditions, particularly for employees working out of their homes. Court cases and rights groups both highlight the issue of overhead costs for home-based employees, especially for low wage earners whose pay is further reduced by the cost of workplace operations;
  - Mutual Worlds—As the world becomes mutually networked, new connections between people, services, and the built environment give rise to new peer-to-peer business models with little higher-level organization, and where altruistic behavior is both documented and reciprocated. Quality pays as workers are very concerned about their reputation and seek to distinguish themselves through customer service. For instance, people will wait longer and pay more for a carpenter with a good electronic rating.
  - Replicants—The prevailing business model is distributed open source, as businesses have become more flexible and adaptable by being less top-down. Innovation and new product development is now largely outsourced or spun off. Individuals are participants, rather than employees, of a company. They can choose the amount and the way to work with the organization. Lower-skill employees increasingly struggle to compete with lower-cost labor countries, leading to a more divided society where knowledge workers are part of the global elite with pay levels and working conditions that are unrelated to local circumstances.

  These scenarios highlight a number of challenges that entities will face in the near future.

  - Innovation Strategies—need to consider a range of potential growth areas. Businesses must consistently develop pertinent new products and services and respond swiftly to disruptive technologies. They need to identify what functions are best completed internally, and what can be sourced outside using technology. Companies need to revise strategies for creating, applying, and preserving intellectual capital:
    - ☐ If possible, share costs and yields of innovations with strategic partners.
    - ☐ Give business units freedom to experiment and enhance innovations on smaller scales.
  - Culture—As the ability of employees to think becomes more critical to the bottom line, companies must figure out how to foster a culture that attracts talented employees:

- Empower employees at all levels.
- Recognize and respond quickly when things or processes can be improved.
- Move toward a consensual engagement style.

- Leadership—Leaders must be able to persuade and influence staff that is more independent, while at the same time deal with uncertainty and opportunities that arise from increasingly fluid and fragmented enterprises. They must rethink who and where strategic decisions are made and managed, centrally or on the ground:
  - Leaders need to be collaborators and connectors.
  - Management should enable action throughout the organization, rather than be the sole decision makers.
- Operations and Technology—Even while responding to changing market conditions and business models, operations must continue. New technologies must be deployed rapidly and seamlessly. Making sure that appropriate staff members have access to critical information, while maintaining security at the same time, is likely be complicated and expensive in terms of both time and money:
  - Organizations need to understand how the world is changing, and why. This is a critical step in determining what actions to take.
  - Develop "Futures Road Maps" that capture technological, regulatory, societal, and consumer change agents, and how this will affect markets and how the organization should respond.
- Brand—Strategies that deal with rapid change will make it difficult to maintain consistent brand management: decentralized decisions, innovation, and customization can make for conflicting messaging. With more outsourcing, organizations need to think ahead about how to manage the effect of outside entities on the brand's reputation:
  - Recognize which model matches the companies' value: close-knit innovation teams with tightly controlled intellectual property or open source.
  - Have a risk-management plan to anticipate where conflict is likely to arise.
- Quality—While managing rapid change and working with more external actors, companies will still need to maintain the quality and consistency of their products and customer service.
- Regulatory—The changing nature of work environments will lead to calls to amend employment laws and how they are enforced. Changes in how intellectual property is created, used, and protected are already instigating high-profile problems, particularly in the patent realm.

Random Notes:

- Being too fixated on a singular view of the future can lead to disastrous results [*Editor's note: Similar to putting all your eggs in one basket*]. Coming innovations will leave few sectors unscathed.
- The Internet's spreading of knowledge beyond university classrooms has reduced the competitive advantage that elite schools used to have. Where leading universities benefited from having clusters of top professors, fast information flows have lowered the importance of location.
- The number of U.S. jobs that utilize "tacit" dealings (requiring employees to make high-level judgments) now makes up 40 percent of the labor market. These have grown 250 percent faster than "transactional" jobs (which can be automated or scripted) and 300 percent faster than total employment.
- "Talented people need organizations less than organizations need talented people" (Daniel Pink, *Free Agent Nation*).
- Successful organizations must do three things: motivate workers; coordinate the work of many to ensure that all the pieces come together in the correct manner; and innovate by seeking opportunities for change and learning, adapting, and evolving with the operating environment (motivate, coordinate, and innovate).

- "Across our lifetimes what used to be called careers may well become more complex, with many more stages and fragments" (Charles Leadbeater).

Panaritis, Maria. "The Decline of the Middle Class in Philadelphia." *Philadelphia Inquirer*, February 24, 2014. http://www.philly.com/philly/news/Decline_of_the_Middle_Class_in_Philadelphia.html **(accessed April 24, 2014).**

- In 1970, Philadelphia was very much a middle-class city, as defined by income, with 81 percent of census tracts majority middle class. From 1970 to 2010, the middle-class population in the city declined by 43 percent, more than twice its 22 percent total population loss, as the percentage of the adult population defined as middle class decreased from 59 percent in 1970 to 42 percent in 2010. At the same time, lower-class population increased from 30 percent of the total in 1970 to 47 percent in 2010.

  In Philadelphia's suburbs, the middle class has declined from 68 percent of the population to 52 percent of the population, while the upper class grew from 16 percent of the population to 27 percent of the population.

  Middle-class employment in Philadelphia was based heavily on manufacturing in 1970, and the effects of these jobs going away is reflected in the city's shifting income demographics. As the city loses middle-class households, there is less revenue to help foot the bills, meaning higher tax rates, worse school quality, and a struggling business climate. While Center City's renewal is a recent success story, there is concern that it may prove to be only a temporary blip, and the city could sink back into financial trouble as more and more large sections beyond the core slip deeper into poverty. The schools remain a particular challenge, as numerous Pew surveys continue to find them to be the top reason why people move out of the city.

Panaritis, Maria. "Center City District: Housing Boom Continues." *Philadelphia Inquirer*, February 19, 2015.
http://www.philly.com/philly/news/20150218_Center_City_District__Housing_boom_continues.html **(accessed February 19, 2015).**

- According to the Center City District's *State of Center City Philadelphia 2015* report, 1,983 new residential units were built in Center City, Philadelphia, in 2014. Expansion continued to come from empty nesters and young professionals. While the growth forecast remains strong in the short term, there are some concerns in the medium term. People continue to leave Center City in their thirties and early forties, particularly once they have school-age children. The number of jobs in Center City continues to decline, even as the region recovers from the recession. In 2000, there were 157,000 office jobs in Center City, but by 2014 that number had declined to 132,000. To sustain the recent surge in demand for Center City, there needs to be action to grow the number of jobs and to enhance the quality of the schools.

Philadelphia Association of Community Development Corporations. *Beyond Gentrification: Toward Equitable Neighborhoods*. Philadelphia, PA: Philadelphia Association of Community Development Corporations, 2015.
http://www.phillylandbank.org/sites/phillylandbank.org/files/u3/PACDC_EcDevPlat_Full%20Platform.pdf

- While the City of Philadelphia has seen massive investment in renewal in and around Center City, many neighborhoods continue to struggle with vacancy, blight, disinvestment, and economic decline. Lower-income residents and some long-time businesses, located in areas where there has been major redevelopment activity, are struggling to stay in their homes and neighborhoods of choice due to rising rents and property taxes. This report identifies a pro-development strategy that proposes structural and institutional reforms to create more equitable housing, health,

educational, and economic opportunities for low- and moderate-income households and organizations, through ensuring they:

- Have influence over the decision-making process that shapes their neighborhoods.
- Benefit from improved neighborhood conditions.
- Can access community resources and services that improve their quality of life and fulfill basic needs close to where they live.
- Have choices about where they live and work.
- Are not displaced involuntarily from their preferred neighborhood.

To achieve these goals, the Philadelphia Association of Community Development Corporations and its members have identified five policy recommendations:

1. Strengthen the ability of neighborhood groups and residents to create inclusive communities:
    a. Use the Philadelphia Planning Commission's Citizens Planning Institute to transfer the knowledge and tools needed to participate in the Registered Community Organization process, and other planning and zoning decisions in effective, inclusive ways.
    b. Improve nonprofit community, civic, and neighborhood association resources by increasing the city's annual investment in Neighborhood Advisory Committees and other neighborhood groups that engage the community by $4 million per year.
    c. Market-rate projects that receive public subsidies should be required to meaningfully expand equitable development.
2. Create and preserve quality, affordable housing in every part of the city:
    a. Identify a comprehensive housing strategy to fill the need for quality, affordable homes, with at least a doubling of dedicated funding ($25 million per year) for the Philadelphia Housing Trust Fund.
    b. Advance strategies to end homelessness, build and preserve more affordable homeownership and rental units in all city neighborhoods, induce more market-rate development, and safeguard that residents are not involuntarily displaced from their neighborhoods.
    c. Review the 10-year property tax abatement to determine if it needs to be updated.
3. Expand economic opportunities in neighborhood corridors and increase local hiring and sourcing by major employers and developers:
    a. Fund programs that improve conditions of commercial and retail structures, clean and green corridors, and organize store owners; at least $4 million per year using a mix of local and federal funds.
    b. Allocate $3 million in local funds to leverage $1.5 million in state funds to finance mixed-use development in neighborhood corridors that can benefit both small businesses and residents.
    c. Expand the Philadelphia Community Development Corporation Tax Credit Program to support neighborhood economic development.
    d. Improve efforts to increase hiring of minority-, women-, and disabled-owned business enterprises and workers in projects with public funding through commitments to Equal Opportunity Plans (EOPs), and expand EOPs to include goals for hiring city residents.
    e. Use mayoral leadership to gain commitment from developers and contractors to create EOPs for large projects, even if they are not publicly financed or subsidized.
    f. Large employers should also do more to promote equity, and they should be encouraged to source more services locally and prioritize hiring residents for their workforce.
4. Understand the threats and impacts of displacement and expand assistance programs:
    a. Policy makers need to collect more and better data to understand what is happening in neighborhoods and to craft effective policy solutions—particularly residential renters and small businesses that have few protections in place.

b. Better promote existing measures intended to protect homeowners from displacement due to increasing property taxes. Homeowners need to be educated about the value of their home and how to manage it in their interest.
c. Give residents and small businesses more notice when the rents will be increasing.

5. Attack blight, vacancy, and abandonment in all neighborhoods:
   a. The city recently took major steps in this direction with the creation of the Philadelphia Land Bank and through improved code enforcement on vacant properties in order to make owners accountable to their neighbors.
   b. The next council and mayor must remain committed to both of these strategies, while ensuring that the Department of Licenses and Inspections has adequate resources to hold landlords accountable for property conditions and to help low-income homeowners become code-compliant by assisting them with needed repairs.

In addition, the city needs to shore up its struggling public schools, which are another symptom of inequality. Families who can afford to send their kids to private schools or move to the suburbs do so, while those who cannot are left with little choice but to send them to schools that cannot even offer the most basic necessities—supplies, nurses, guidance counselors—let alone the high-quality education needed to compete in today's economy. This hurts the city's economy as those who are deterred by the school system move out, taking their incomes and tax revenues elsewhere.

Solving the problems set about by inequality is a major undertaking, and it will take long-term commitment from elected officials, business and institutional leaders, nonprofits, and others many years to reverse the course. It will require technical assistance for low-income communities, partnership building, and skills and leadership development. In addition, there need to be tools to measure and track whether the city is making progress and to analyze the outcomes of public investments and programs to see if they are having their intended effects.

Phillips, Shane. "Uber and Lyft Are Dragging Traditional Taxi Companies into the 21st Century." ***Planetizen*****, January 5, 2015.** http://www.planetizen.com/node/73096/uber-and-lyft-are-dragging-traditional-taxi-companies-21st-century **(accessed January 9, 2015).**

- Part of the reason for the nearly instant success of ride-sourcing services is that taxis traditionally have not been very good. A recent Seattle Taxi survey found:
  - Around 70 percent of ride-source drivers arrived within five minutes of being requested, while under 40 percent of taxis did.
  - About 80 percent of ride-source customers rated the service as "very good," while only 10 percent of taxi customers rated the service that highly.
  - More than 90 percent of ride-source customers rated ease of payment as "very good," compared to just 10 percent of taxi customers.

The good news is that taxis are listening and improving their service in response to more competition. For instance, the Los Angeles Taxicab Commission plans to require all licensed taxi operators to use e-hailing apps. These should shorten wait times, simplify payments, and increase driver accountability. The goal is to offer the same convenience as ride-source services, without the issues of driver background, insurance, or "surge" pricing. In Seattle, the Yellow Cab service has a GPS-based e-hailing app, which has cut waiting times nearly 50 percent since launching.

Even as formerly stagnant taxis are modernizing and upgrading to deal with new competition, there are still real structural issues with the industry. Taxi companies purchase medallions from city regulators, which were designed to restrict the number of vehicles on the road and ensure decent wages through a scarcity of supply. This model no longer works when faced with a nearly boundless quantity of ride-sourcing vehicles. For drivers who prefer part-time work, the surge

pricing opportunities make them more attractive to work for. A better model may be a hybrid of both services.

Ride-sourcing companies should perform more stringent background checks and ensure that drivers have the appropriate tailored insurance and wage protection, especially given that the drivers themselves put up a lot of the capital through their personal vehicles. Taxis should be required to have GPS-based dispatching with e-hailing and e-payments, along with better maintained and cleaner vehicles and improved customer service through training. Taxis, in particular, will need to differentiate their service if they wish to survive the ride-sourcing onslaught. Regardless of what happens, trying to regulate ride-sourcing services out of existence will mean relying on stagnant, anticompetitive taxi companies, which will not serve consumers or drivers well.

Phillips, Susan. "Governor Wolf Asks Obama to Strengthen Oil Train Safety." *State Impact Pennsylvania*, February 27, 2015. http://stateimpact.npr.org/pennsylvania/2015/02/27/gov-wolf-asks-obama-to-strengthen-oil-train-safety/ **(accessed March 2, 2015).**

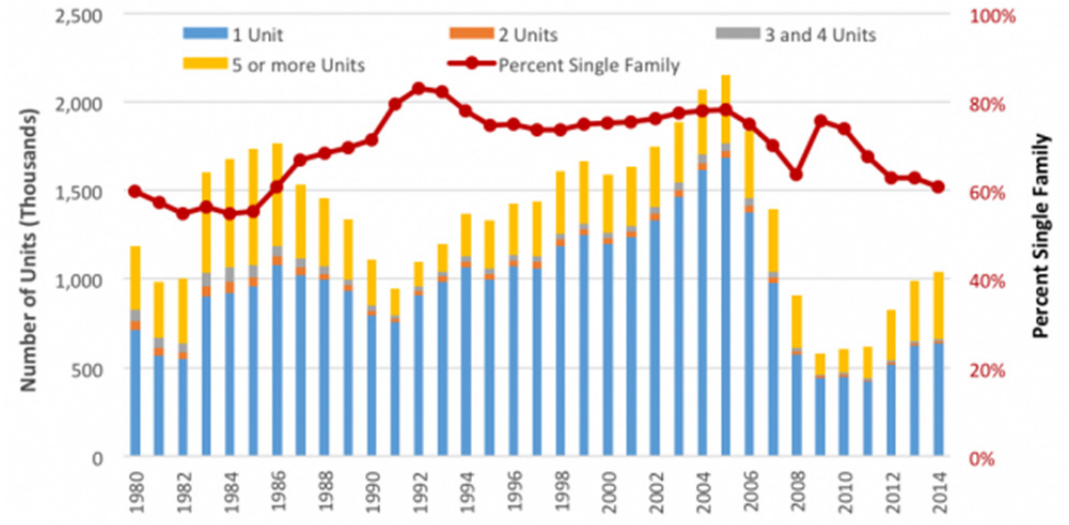
- With 60–70 oil trains traveling through Pennsylvania each week, and limited options for protecting public safety, Governor Wolf sent four requests President Obama:
  - Federal standards must ensure that all crude oil is treated to remove volatiles prior to traveling by train.
  - Federal standards should be reviewed to limit train speed limits to ensure against explosive derailments in high-density areas, recognizing that they have occurred while traveling at the current 40 mph speed limit.
  - There need to be more government inspectors of track infrastructure. Pennsylvania currently has six inspectors for about 5,000 miles of track.
  - Braking systems and tank car standards need to be increased in order to lower risk.

  The letter was sent against the backdrop of a recent U.S. DOT estimate that there could be 5–15 crude oil train derailments annually in the United States.

Polzin, Steven. "Things Don't Change That Fast—Including the Housing Market." *Planetizen*, July 9, 2015. http://www.planetizen.com/node/79334/things-dont-change-fast%E2%80%94including-housing-market **(accessed July 21, 2015).**

- Despite headlines about rapid urban growth and suburban decline, a closer look at actual data, rather than anecdotes, shows that most likely little change will occur. This is because infrastructure, whether housing or transportation, is very slow to change. From 1980 to 2014, single-family housing has consistently been between 60 to 80 percent of all new houses built. This was true even during the economic downturn, where the annual number of new housing starts declined dramatically from more than two million in 2005 to just over 500,000 in 2009.

Figure C-6. Annual Housing Unit Construction in the U.S., 1980-2014



Source: http://www.census.gov/construction/bps/stateannual.html

There are about 133 million housing units in the United States, of which 71 percent or 90 million are single-family homes. The current rate of new housing construction is about one million units per year, less than one percent of the existing inventory. If single-family homes are built at the historically low rate of 60 percent of new housing units, the rate of change will be minuscule. If no new single-family homes are built, then the percentage of single-family homes in the residential inventory would decline by only about 10 percent per decade.

Price, Andrew. "Fine Grained." Strong Towns Blog, December 1, 2014.
http://www.strongtowns.org/journal/2014/11/19/fine-grained **(accessed January 9, 2015).**

- Small-scale buildings and plots of land help to diversify ownership and allow small businesses to have easy opportunities to start up, own the building they use, and grow wealth and the middle class in a community. This can build a fine-grained economy, where it does not take a lot of capital or risky debt to start a business. Someone can obtain a permit from the city and start a business simply selling from a street cart, food truck, or stall in a public market. These types of cities were found in early U.S. towns, where streets were gridded and lots were small and narrow.

  In contrast, a polarized economy requires considerable wealth in order to start a business, and this leads to more accumulation of capital into fewer hands. Polarized economies build around large, highly subsidized buildings on square-block-sized lots. They often have a faux urban feel and tend to create economies where low-skill, low-paid employees work for service parent companies, often headquartered far away from the town or city. In this case, much wealth is transferred out of the local area.

Profeldt, Elaine. "Intuit Targets On-Demand Economy, Partners with Uber." *Forbes*, January 31, 2015.
http://www.forbes.com/sites/elainepofeldt/2015/01/31/intuit-targets-newbie-free-agents/
(accessed February 26, 2015).

- Turbo Tax developer Intuit has recently launched a new cloud-based software, QuickBooks Online Self-Employed, for people working in the free agent economy. It is set up to make tax preparation easier by tracking business expenses throughout the year, and it is connected to the bank account where payments come in. Intuit developed this software in recognition that many freelancers do not have anywhere to turn for advice. The companies they are working for are unable to give them too much advice, or else they will appear to be employees—not independent contractors—in the eyes of the Internal Revenue Service. As a result, many do not realize that they

should set up an LLC, have a separate bank account for their business, and take other steps typically suggested by business advisors. It also recognizes that this is a growing sector within the economy. In 1989, Intuit estimates that only six percent of workers were self-employed, while by 2020 it anticipates that 40 percent of workers will be.

Pyper, Julia. "Self-Driving Cars Could Cut Greenhouse Gas Pollution." *Scientific American*, September 15, 2014. http://www.scientificamerican.com/article/self-driving-cars-could-cut-greenhouse-gas-pollution/ **(accessed September 18, 2014).**

- An Intelligent Transportation Society of America report estimates that emerging transportation technologies could reduce oil consumptions and greenhouse gas emissions by two to four percent annually over the next decade as they infiltrate the market. These technologies include adaptive cruise control, eco-navigation, and wireless communications to improve infrastructure efficiency, such as traffic light synchronization. These can help to step down the carbon curve in the intermediate timeframe, in advance of a longer-term move to low-carbon fuels and/or battery-powered vehicles. For example:

  - The Smithsonian Institution used GPS tracking and wireless communication to better manage its 1,500 vehicles and reduce fuel use by 53 percent.
  - Ellicott City, Maryland, has a smart parking system that detects when spaces are available and directs drivers to them in real time, reducing time spent looking for parking by 21 percent.
  - Los Angeles County, California's signal synchronization program has improved vehicle throughput, helping to save 31 million hours of travel time, 38 million gallons of fuel, and 337,000 metric tons of CO2 annually.

  Vehicle-to-vehicle (V2V) and vehicle-to-infrastructure (V2I) have also demonstrated increasing efficiency and emissions reductions. Honda Motor Company demonstrated its virtual tow technology at the Intelligent Transportation Society of America's 2014 World Congress that allows a driver to virtually link up with and draft a lead vehicle. Oak Ridge National Laboratory researchers are working on algorithms that would exchange information between vehicles and infrastructure, coordinating vehicles so that they would never have to come to a stop or even need traffic signals.

Rajaraman, Sunil and Boris Vassilev. "What Is the Impact of Uber, Homejoy and Others on the Transportation and Housekeeping Industries?" *Huffingtonpost*, April 16, 2014. http://www.huffingtonpost.com/sunil-rajaraman/what-is-the-impact-of-uber_b_5157459.html **(accessed August 12, 2015).**

- Average hourly wages in both the transportation and housekeeping (including babysitting, handiwork, and cleaning) industries over the last 10 years have lagged growth in average wages overall (which have not kept up with inflation since the late 2000s economic recession). While it is unclear why these industries were in decline, the authors speculate that it probably has to do with the fact they are heavily regulated. Taxi medallion prices in New York City have increased from $300,000 in 2004 to $1.3 million in the latest offering. Entrepreneurs have entered into these areas due to heavy regulation and fragmented supply. Any industry with similar characteristics is at risk of a similar type of disruption. Startups such as Uber, Lyft, and Care.com have raised hundreds of millions of dollars, which hopefully will help to increase the size of the pie and allow other people to make money as well. However, this may come at the expense of those who have been playing by the rules. While the startups are far from supplanting established players, this new competition will force traditional companies to innovate in order to remain competitive. Ultimately, this will be good for consumers, and hopefully it will benefit those who work in these industries.

Rayle, Lisa, Susan Shaheen, Nelson Chan, Danielle Dai, and Robert Cervero. *App-based, On-Demand Ride Services: Comparing Taxi and Ridesourcing Trips and User Characteristics in San Francisco*. Berkeley, CA: University of California Transportation Center, 2014.
http://www.uctc.net/research/papers/UCTC-FR-2014-08.pdf

- This summarizes a survey conducted with ride-sourcing riders in San Francisco to provide some initial data on how it is being used. It represents a very limited sample of data from individuals intercepted during the evening in three San Francisco neighborhoods, and it is not representative of all ride-sourcing users, such as those who use it to commute, for trips to the airport, or to run other errands. The survey results were compared to American Community Survey 2012 one-year estimates, a San Francisco Municipal Transportation Agency survey of taxi riders, and a San Francisco-based, medium-sized taxi company's trip logs. Respondents tended to be younger and wealthier than San Francisco as a whole. Some findings:

  - Origins and destinations were compared with the transit network. It was found that most trips could have been completed on transit (meaning there is a transit stop within a quarter-mile of the origin and destination), but many of them would have required a transfer.
  - Given that the survey was conducted in the evening, it is not surprising that about two-thirds of the trips were for social purposes.
  - The average ride-source trip length was about 3.1 miles, versus 3.7 miles for taxis.
  - Vehicle occupancies in ride-source trips were higher, 1.8 passengers per trip on average in the survey. This compares to matched trip taxi averages of 1.1.
  - About 90 percent of ride-sourcing survey respondents reported a wait time of less than 10 minutes, while only 35 percent of San Francisco residents said they waited less than 10 minutes when calling a taxi to their home.

  Table C-5 shows modal shift and induced demand estimates from the survey.

Table C-5. How Would You Have Made This Trip if Uber/Lyft/Sidecar Were Not Available?

		Do you have a car at home?	
	All Respondents	Yes	No
Taxi	39%	41%	35%
Bus	24%	17%	33%
Rail (BART, streetcar, Caltrain)	9%	7%	10%
Walk	8%	9%	6%
Bike	2%	2%	3%
Drive my own car	6%	10%	0%
Get a ride with friend/family	1%	1%	2%
Other*	11%	12%	10%
Total	100%	100%	100%
Number	302	175	124

*"Other" includes several responses indicating the respondent would have used another ride-sourcing service, even though they were instructed not to.
Source: Rayle et al., 2014.

The top reasons why respondents used ride sourcing were ease of payment (conducted with the app online), short wait times, and fastest way to get there. Cross-tabulating alternative mode and reasons why the respondent chose ride sourcing include:

- Bus and rail: fastest way to get there, short wait time.
- Taxi: ease of payment, short wait time.
- Walk: fastest way to get there, easy to call car, short wait time.
- Bike: fastest way to get there, cost (cheaper than alternatives).
- Drive: do not need to park, do not want to drink and drive, ease of payment.
- Get a ride: no public transit option, could not get taxi.

The findings indicate that ride sourcing enhances mobility, particularly in large, dense cities where parking is limited and expensive and public transit has gaps. It suggests that ride sourcing is meeting a latent travel demand, particularly with young, well-educated individuals who are most concerned with short wait times and fast door-to-door service, while avoiding parking and drinking-and-driving inconveniences. Ride sourcing has been shown to have shorter wait times than taxis, while both complementing and drawing some individuals away from transit. Its overall impact on VMT and traffic volumes is unclear without more data. More research is needed to better understand the positive and negative impacts, but any attempt to ban ride sourcing would reduce mobility and is not recommended.

Reyes, Juliana. "In the Last 5 Years, Tech Job Growth in Philly has Outpaced the Suburbs: Report." ***Technical.ly Philly*****, February 17, 2015.** http://technical.ly/philly/2015/02/17/philly-tech-job-growth-city-suburbs-cbre-report/ **(accessed October 20, 2015).**

- 57 percent of the region's tech jobs are located in Montgomery and Chester counties, but Philadelphia has seen tech jobs grow by 30 percent over the past five years. This is greater than the Pennsylvania suburbs, which have had just over a 10 percent increase, and the New Jersey suburbs, which have decreased by more than 20 percent. The city's Startup PHL program is just one of many examples where it has worked to attract tech businesses. While many venture capital funds are still located in the suburbs (Safeguard Scientifics, Osage Partners, New Spring Capital), some have begun to relocate to the city, including Robin Hood Ventures, Keiretsu Forum, First Round Capital, and SeventySix Capital. Montgomery County remains the tech jobs leader due to major employers such as Unisys, eBay Enterprise, and Lockheed Martin. However, the county has fewer tech workers living in it than jobs, and is struggling to find workers as a result. The city has more tech workers than available jobs. Despite this city–suburb split, many tech workers and companies prefer to think of the community as a cohesive region.

Roberts, David. "Sometimes a Driverless Car Is Not Just a Driverless Car: Thoughts on Widgets and Systems." ***Grist*****, February 1, 2013.** http://grist.org/business-technology/sometimes-a-driverless-car-is-not-just-a-driverless-car-thoughts-on-widgets-and-systems/ **(accessed August 12, 2015).**

- Widgets are pieces of technology, while systems are the culture, economy, and infrastructure that the widgets (technologies) are formed in. For a lot of issues, such as sustainability, it is much easier to think in terms of widgets. To use less energy, we trade out a widget for one that is more efficient. We can compare widgets on an apple-to-apple basis, such as the fuel efficiency of one type of car compared with another. Unfortunately, the more efficient (or sustainable) widget is often more expensive as well. One reason is that some of the benefits of a more sustainable widget—things such as reduced carbon emission, cleaner air, or reduced resource use—are not included in market competition. When something such as carbon is not priced in when you buy a more efficient—but more expensive—widget that uses less carbon-based energy, you are, in fact, wasting money.

  It is considerably more difficult to envision and compare different systems where habits and behaviors change, markets perform differently, and alternative types of infrastructure are built. Because of this, it is hard to compare with the status quo, and there are not readily available metrics to measure which is better. It is also challenging to find a path from the present conditions to the desired change.

  AVs make for an interesting case study, in that they promise many benefits: closer spacing and steadier speeds to improve traffic flow and reduce fuel use; cars can be of lighter weight, since they are less at risk to crash; they will be easier to power with electricity, improving air quality and perhaps leading to ubiquitous induction roadway charging capabilities, eliminating travel range limitations; car sharing that replaces ownership, saving people money, reducing land needed for parking, and more efficient resource use; can free up the 100 hours per year the average

American spends commuting for more productive use of time, while reducing stress levels; autonomous cars would be safer for bicyclists and pedestrians as well; and through the creation of some sort of user fee for each time someone accesses a driverless car, road maintenance costs can be more fairly applied.

The decision of whether or not to pursue a major shared AV network will likely come down to two key questions. The first is how much will it cost, and will it be worth it? Many of the promised changes are hard to quantify: behavior, public health, productivity, and land use. Any attempt to sum it definitively will likely be a tad better than a wild guess. The costs side is usually easier to estimate. But since the benefits are almost always harder to sum, especially the second- and third-degree benefits, the traditional BCA almost always comes out against long-term systematic change. Since we cannot estimate the benefits with any precision, economic models cannot alone settle the question of whether or not systematic change is a good investment. Rather, our thinking should be driven by our values: What type of society/culture do we want to build, what are our goals, and what do we owe to future generations?

The second question is, if we want to create a new system, how do we get there from here? System change often suffers from chicken-and-egg problems. Do we build electric vehicles or charging infrastructure first? Driverless cars can be of lower weight if all cars are automated, but what about when they are sharing the road with the current heavyweight, person-driven vehicles? How do you get the public to demand things they do not know about yet? Systemic change is badly needed, particularly to push in a more sustainable direction. Society needs to figure out how to use all of the tools in the toolbox to push for change: better widgets, activism, policy, behavioral science, etc.

Robertson, Gregor. "Cities Can Lead on Climate Change to Build a More Resilient Future." The World Bank Blog, September 15, 2014. http://blogs.worldbank.org/climatechange/cities-can-lead-climate-change-build-more-resilient-future **(accessed January 15, 2015).**

- "The successful cities of the future will be those making the investments and changes necessary to adapt to the impacts of climate change." As climate change threatens to undermine the global economy and social stability, resilient cities will attract people and capital. Forward-thinking businesses are already internalizing the price of greenhouse gas emissions to gain a competitive advantage in the future. These businesses, and regions that price carbon early, will be more prepared to respond to future uncertainty. Vancouver, Canada, is attracting alternative energy companies by being an early carbon-tax adopter. While a post-carbon global economy is desperately needed, high-carbon infrastructures such as pipelines and thermal coal ports are still constantly being proposed. Allowing these investments to happen further delays the transition to a post-carbon global economy; will make the eventual move more expensive; and wastes capital needed for green energy and transportation projects, energy-efficiency retrofits, and other strategies.

Romem, Issi. "How Will Driverless Cars Affect Our Cities?" *Cityminded*, March 25, 2013. http://cityminded.org/how-will-driverless-cars-affect-our-cities-6526 **(accessed August 7, 2015).**

- Driverless cars will cause cities to further expand, much in the same manner that they did around new rail lines in the 20th century and through mass automobile ownership in the 21st century. New buildings and parking will be decoupled from each other, allowing for new land uses and development. Driverless cars will reduce travel costs by freeing up time spent driving to engage in other activities, provide more efficient route choices, and as they make up a larger portion of the fleet, they will be able to drive faster than humans can today. Just how far cities grow will be determined by how much travel time is reduced. The faster and more efficiently traffic can move, the larger the area will become in each region where it is feasible to live and work. This can help fulfill the wish that the neighbor's home is out of sight. Estimates are that driverless vehicles will

be on the roads within a decade. The process of further city growth will then play out over the next several decades. The future housing stock will come to resemble mansions compared to today's suburban houses, on the scale to which they are much larger than the tenement houses of the past.

While cities will continue to spread farther and farther out, there is good news for urban dwellers. As the need for parking is alleviated through shared driverless vehicles, parking lots will become prime infill development locations. Urban areas can then become denser or more walkable. Some suburban centers will begin to take on a more urban feel. And contrary to the general thought that more suburban sprawl equates to environmental degradation, new forms of sustainable energy could divorce suburban development patterns from high levels of greenhouse gas emissions. The critical question, then, is whether or not this new green energy will develop before the next wave of city expansion.

Romem, Issi. "Self-Driving Cars: A Force for Urban Densification or Expansion?" *Cityminded*, June 11, 2013. http://cityminded.org/self-driving-cars-a-force-for-urban-densification-or-expansion-7483 **(accessed August 7, 2015).**

- There are two factors that prevent construction in the rural fringe of urban areas: open space preservation policies and lack of demand. While these areas are often too far away from urban areas for people to want to live there now, self-driving cars will increase development pressure on them by changing transportation patterns. Self-driving cars will reduce congestion, shorten travel times, and make time spent in a vehicle more pleasant. Where well-intended efforts at land preservation have successfully preserved land along the urban fringe, environmentalists may cringe when future development leapfrogs well beyond the protected land area, where lower-cost housing can be bundled with more feasible long-distance commutes.

Rose, Jonathan F.P. "5 Crucial Principles for 21st Century Transportation Systems." *The Atlantic CityLab*, May 29, 2014. http://www.citylab.com/commute/2014/05/5-crucial-principles-for-21st-century-transportation-systems/371782/ **(accessed August 5, 2015).**

- In the future, urban areas must contend with mega-forces such as population shifts, risks embedded in the global economic system, scarce resources, increasing inequality, and all of the impacts that climate change will bring (droughts, floods, heat eaves, cold waves, sea level rise, and storm surges). Preparing for all these forces will not be easy, but it is critical to identify and work to mitigate vulnerable urban infrastructure. To do this, we should rethink how we plan, finance, construct, and renovate our transportation systems that are critical to our connectivity to each other and the global economy.

  1. Plan for an uncertain future.
  2. Design robust, repairable, resilient, and responsive systems.
  3. Shift from lines to networks.
  4. Personalize mass transit.
  5. Change oversight.

  New York City's MTA's South Ferry subway station is an example of where better planning for an uncertain future would have been useful. In 2005, work began on a $530 million project to fix ADA issues, extend the platforms to serve longer trains, and improve connections between different lines. Unfortunately, due to the length of the planning, engineering, funding, and procurement phases, the project did not adequately account for the mounting risks of climate change and sea level rise. Just three years after it opened, the station was badly damaged by Superstorm Sandy. Repairs will cost $600 million and keep the station closed for four years. The lesson is not only to plan for storm surges but also to anticipate a wider range of extreme future scenarios.

Rebuilding of the San Francisco-Oakland Bay Bridge, after the Loma Prieta earthquake in 1989, is an example of designing robust, resilient systems. The replacement bridge is designed to be ductile, strong, and flexible in order to withstand nearly any kind of jolt. It can also be easily repaired after an earthquake. It has shock absorbers than can be repaired shortly after an event, with needed spare parts stored under the bridge.

As suburban development patterns spread after World War II, most destinations are easiest to access by car because automobiles can travel in all directions. However, many citizens now want more options to get around, and transportation systems need to be reordered to work as "integrated networks," not just a series of routes. European systems, which link airports, long-distance high-speed rail, regional rail, light rail, buses, bike systems, and walking trails, are a good example of what is needed in the United States.

The millennial generation has shown strong preferences for biking, walking, and mass transit over driving. Services such as regional bus lines, bike sharing, car sharing, and ride sourcing show a yearning for lower-cost, more personal, and a broader range of transportation options. Mobile apps are increasing access to transportation information and are, in turn, increasing ridership and user satisfaction. What is needed is to take the data that these apps are generating and use it to adjust transportation services in real time to meet demand, comparable to how Uber can show the location of both drivers and customers to each other. Smart parking and congestion pricing are two examples of these types of systems.

Inflexible planning, design, construction, operating, and funding of transportation systems constrain the ability to respond to emerging technologies and other trends. To better serve our metropolitan areas, we need more flexible governance and operating systems so that our transportation networks are better able to fulfill the needs of a fast-changing future.

Russell, Patrick. "Ride Sharing Will Give Us Back Our Cities." ***Techcrunch*****, October 30, 2015.** http://techcrunch.com/2015/10/30/ride-sharing-will-give-us-back-our-cities/ **(Accessed January 29, 2015).**

- Ride sourcing companies such as Uber and Lyft are making it easier than ever to get around without car ownership. Households that have tried it have found not only can they save money, but they also have more enjoyable transportation experiences. Each ride source vehicle is estimated to be able to remove up to 10 private vehicles. If more people choose to live car free, then there is an opportunity to drastically rethink urban fabric. "If the 20th century was devoted to building the infrastructure to service the personal automobile, then perhaps the 21st century will be devoted to undoing most of it." Some things each city could do include:

  - Give a road diet to every road wider than four lanes.
  - Narrow roads and return the right-of-way to landowners and businesses.
  - Widen sidewalks and put in green infrastructure.
  - Turn six-lane plus wide highways into complete streets lined with row houses.

  Now is the time to completely rethink our cities and reclaim underused space.

Sadowski, Jathan. "Delivered by Drones: Are Tacocopters and Burrito Bombers the Next Pony Express?" ***Salon*****, August 6, 2013.** http://www.slate.com/articles/health_and_science/transportation/2013/08/drone_delivery_system_tacocopters_burrito_bombers_beer_and_sushi.html **(accessed August 10, 2015).**

- Civilian drones are entering the world of consumer products and business operations in a variety of ways that may dramatically reshape transportation: from pizza deliveries to getting medicine and equipment to remote areas. While many of the current operations of civilian drones are

largely novelty, such as a London restaurant using drones as waiters (video: https://www.youtube.com/watch?feature=player_embedded&v=y9RKXO1rr7g), the long-term delivery uses may be similar to the Pony Express. A package is loaded on a specialty drone, which flies to the nearest relay station along the destination path. Its batteries are then exchanged with a charged replacement set in a repeating method until it reaches its destination. Inroads will most likely be gained in medical products and in high-congestion areas. Real benefits could be achieved in hard-to-reach, rugged terrains. A case study in Lesotho, reported by the *Economist*, found that a network of 50 base stations and a fleet of 900 drones would cost about $900,000 compared to $1 million for a two-kilometer, one-lane road.

There are a number of logistical, technological, and legal hurdles that will need to be overcome if drones are to achieve widespread use in the United States. Strict regulations and licensing requirements to operate a commercial drone are already in place here. Future operators will have to respect private property ownership rights. Drone malfunctions could be very dangerous, resulting in the severe injury or death of individuals who are hit by the falling vehicles themselves, or cargo that they drop. And, lastly, they must overcome the extreme dislike that much of the American public has for them, particularly as a result of their military use and out of privacy concerns.

Saha, Devashree, and Mark Muro. "Falling Oil Prices Won't Hurt Clean Energy." Brookings Institution, January 23, 2015. http://www.brookings.edu/blogs/the-avenue/posts/2015/01/23-oil-prices-clean-energy-saha-muro **(accessed January 26, 2015).**

- Contrary to common belief, low oil prices have only a marginal effect on clean energy. Oil is largely used in transportation, while renewables are used for electricity generation. The long-run cost of renewables declines with technological innovation, manufacturing, and efficiency improvement. Commodities such as oil are expensive to find, drill, ship, and refine. Recent oil price declines may slow the development of electric vehicles, which could be powered with renewables, but they also highlight the instability of petroleum production and demand.

Sahadi, Jeanne. "Gig Economy: A Third of US Workers Say They're Free Agents." CNN Money, September 3, 2015. http://money.cnn.com/2015/09/03/pf/gig-economy-free-agents/index.html **(accessed September 30, 2015).**

- A recent Kelly Services survey found that 31 percent of U.S. workers consider themselves free agents (independent contractors, freelancers, small business owners, or moonlighters), in that they receive their income from more than one employer. Free agents most commonly work in IT, finance, accounting, engineering, and education. The survey also found:
  - Only 10 percent of free agents said they were forced into it due to economic conditions.
  - Feelings of job security were equal between free agents and those in traditional jobs.
  - A majority of free agents did not want to be tied to one boss and willingly entered the free agent economy.
  - 36 percent of baby boomers identified as free agents, compared to 26 percent of millennials.

Salmon, Felix. "How Roads Could Beat Rail." Reuters Blog, January 24, 2013. http://blogs.reuters.com/felix-salmon/2013/01/24/how-roads-could-beat-rail/ **(accessed August 10, 2015).**

- Smart-car technology is developing so fast that it may be the optimal solution to today's transportation problems. A big reason for this is the fiscal component, where these technologies move costs to companies and individuals buying smart cars rather than state or national governments. While subways and other rail investments, along with pedestrian and bicycle facilities, will continue to make sense in dense urban areas, in the rest of the places, roads

equipped with smart cars alone may suffice, reducing the need for new rail investments in suburban and rural areas. While roads are undoubtedly less safe and energy efficient than rail right now, looking into the future platooning (see Europe's Sartre project) and self-driving cars promise significant safety and efficiency benefits. Similarly, as self-driving cars arrive, people are likely to move away from the auto ownership model and into the shared vehicle taxi model. This will free up large amounts of land dedicated to parking to new uses.

This also creates a number of dilemmas about how we invest in transportation infrastructure now to prepare for the future. Should we avoid investing in suburban commuter rail and assume self-driving cars will solve congestion problems? Should we build out the infrastructure to support electric vehicles? There is a lot of risk in any investment right now, which could end up becoming obsolete much sooner than we realize.

Schlake, Bryan W. "Despite Disasters, Oil-by-Rail Transport Is Getting Safer." Theconversation, April 14, 2015. http://theconversation.com/despite-disasters-oil-by-rail-transport-is-getting-safer-38085 **(accessed April 16, 2015).**

- Hydraulic fracking and horizontal drilling have helped oil and gas production increase by 170 percent from 2008 to 2014, topping three billion barrels for the first time since 1987. This has caused pipelines to reach capacity and has led oil and gas producers to ship by rail. Rail does have some advantages over pipelines, including more flexible routing and faster travel speeds. Although rail is one of the safest modes for the shipment of hazardous materials, and safer than pipelines, in 2013 and 2014 there were eight derailments in the United States, leading to the spilling of more than 1.1 million gallons of oil. There were no fatalities as a result of these derailments, though four injuries were reported. Demand for oil shipments has caused railroads to move to unit trains, where every car is carrying oil, as opposed to manifest trains, which mix payloads and car types. This has resulted in derailments with larger spills and has caused three evacuations between 16 and 1,000 people.

Schlake, Bryan W. "Shipping Oil by Rail Is Booming. Technology Can Make It Safer." Theconversation, April 15, 2015. http://theconversation.com/shipping-oil-by-rail-is-booming-technology-can-make-it-safer-39165 **(accessed April 16, 2015).**

- In 2014, trains were transporting one million barrels of oil per day in the United States, up significantly from 55,000 barrels per day in 2010. After a series of high-profile derailments, freight rail companies are turning to new technologies to ensure better safety in the future. Railroads are improving braking systems and track infrastructure, performing better track inspections, implementing speed restrictions, and routing oil trains away from population centers. Train detectors alongside tracks are able to identify railcar defects based on force, temperature, sound, and visual measurements. Research is underway to identify improved tank car design; enhance track and infrastructure inspections using ultrasound and ground penetrating radar; create frameworks to assess routing, rail, and train car condition risks; develop automated condition monitoring for freight car components such as wheels, bearings, air hoses, and broken or missing safety equipment; install electronically controlled pneumatic (ECP) brakes, which allow for faster application of brakes on all cars by using electric signals instead of air signals to initiate braking; implement positive train control on freight rails; and better prepare for emergency response. As lower-cost alternatives to ECP brakes, operators may consider distributed power, where locomotives are distributed throughout the train length (front, center, end) and two-way end-of-train devices, which allow brake signals to be initiated from the rear of the train. Both of these help to deal with the problem of the back cars running into the front cars, as the front cars begin to brake sooner. Other technologies are being developed to speed up environmental cleanup and make it more effective.

Seidman, Andrew. "Cabdrivers Press N.J. Lawmakers to Rein in Ride-Sharing Services." *Philadelphia Inquirer*, February 11, 2015. http://www.philly.com/philly/business/homepage/20150210_Cabdrivers_press_N_J__lawmakers_to_rein_in_ride-sharing_services.html (accessed February 11, 2015).

- Cabdrivers are calling for New Jersey lawmakers to regulate ride-sourcing services with the same rules as taxis. These requirements include collecting sales taxes, undergoing driver background checks, and purchasing commercial insurance. One bill that has been proposed would regulate ride-sourcing companies such as limousines. This would require state licensing, criminal background checks through the state police, and $1.5 million insurance policies. The ride-sourcing companies counter that these regulations would restrict their ability to function in New Jersey, leaving residents with fewer transportation options and work opportunities. One issue for the ride-sourcing companies is that they consider their drivers to be independent contractors, not employees. It is not feasible to have part time workers take drug tests.

  Taxi companies have been put at a competitive disadvantage with the unregulated ride-sourcing services. Taxis have to pay business taxes and workers' compensation, and they are not allowed to increase prices when demand rises, as the ride-sourcing providers do.

Shaheen, Susan, and Matt Christensen. "The True Future of Transportation Has Two Big Barriers to Entry." *The Atlantic CityLab*, April 25, 2014. http://www.citylab.com/commute/2014/04/true-future-transportation-has-two-big-barriers-entry/8933/ (accessed August 8, 2015).

- The next major shift in urban transportation will likely be defined by the "digitization of mobility," with an embrace of transit and vehicle sharing. Shared-use mobility provides seamless, short-term access to a variety of modes: transit, car sharing, bike sharing, car- and vanpooling, on-demand ride sourcing, and private shuttle services. The ability to develop a single platform that integrates and optimizes all of these options must overcome a number of barriers. Successfully promoting digital urban mobility requires public and private transportation providers to collaborate, share data, and support innovation. Open data is needed to develop an ITS to understand the complete transportation network. While public agencies have shown a willingness to share data, many private operators have been hesitant. Private companies that do share data can benefit from increasing efficiency, innovating their service, and being transparent.

  Even if private companies do not share their data, smartphones may be another way to aggregate it. Using mobile apps, they can record trip data from a variety of transportation providers and then present it back to users in a clear, coherent way. Even though there are multimodal trip planner applications, such as RideScout, they are still constrained by not being able to plan a trip that uses multiple modes (intermodal or mixed-modal commuting). With more individuals looking to transportation alternatives, there is an increasing need to address the first- and last-mile transit problem through intermodal trip planning. Challenges go beyond apps, as it will be difficult to retrofit transit agency fare payment systems to accept smartphone payments. In addition, individuals earning less than $30,000 per year have significantly lower smartphone ownership rates. Integrated RFID technology is likely to play a role in intermodal transportation. RFID chips make payments or allow use of different transportation services, such as bike share, transit, and car sharing. Having a single fare payment card for all, or as many as possible, modes will enhance the user experience.

Sichelman, Lew. "'Micro Unit' Developers See Big Future." Urban Land, May 20, 2013. http://urbanland.uli.org/industry-sectors/residential/micro-unit-developers-see-big-future/ (accessed February 2, 2015).

- Kauri Investments has completed six micro unit projects in Seattle, Washington. Each unit is somewhere between 100 and 150 square feet. Making apartments this small requires putting

only a small kitchenette inside them, with a shared, central kitchen for all residents. They generally have very little parking and offer only limited amenities.

Silverman, Stan. "'Educational Ecosystem' Is Driving Philadelphia Entrepreneurship." *Philadelphia Business Journal*, December 1, 2014. http://www.bizjournals.com/philadelphia/blog/guest-comment/2014/12/educational-ecosystem-is-driving-philadelphia.html **(accessed December 5, 2014).**

- Drexel University's Close School of Entrepreneurship, the University of Pennsylvania's Pennovation Center, and Temple University's Innovation and Entrepreneurship Institute are key parts of Philadelphia's entrepreneurial ecosystem. These centers give opportunities for students to develop ideas; learn leadership and acquire other skills needed for an entrepreneurial mindset, such as persistence, self-reliance, risk taking, innovating, and getting results. These skills are useful in both the startup and established business worlds. A big key for entrepreneurs is to not fear mistakes or failures, as startups often fail. Rather, failures are opportunities to learn, and through resiliency, entrepreneurs can find success. Innovation is what will drive economic health and vitality of the region, and the United States as a whole. This mindset has not always been a part of Philadelphia, but it is increasingly present here now.

Singer, Natasha. "In the Sharing Economy, Workers Find Both Freedom and Uncertainty." *New York Times*, August 16, 2014. http://www.nytimes.com/2014/08/17/technology/in-the-sharing-economy-workers-find-both-freedom-and-uncertainty.html **(accessed February 26, 2015).**

- The gig economy is billed as allowing people to manage themselves, work on their own terms, and determine their own schedules. The lower cost it delivers is a good deal for consumers, making luxury services more widely available through amateur chefs, chauffeurs, and personal assistants. Some of the main Gig Economy companies include:
  - Fiverr—Creative and professional services marketplace:
    - Countries: 196.
    - Freelancers: about three million.
    - Venture Financing: $50 million.
  - Postmates—Delivery service platform:
    - Cities: 12 in the United States.
    - Messengers: more than 4,000.
    - Venture Financing: $23 million.
  - Favor—Delivery service platform:
    - Cities: Austin, Texas; and Boston.
    - Messengers: 225.
    - Venture Financing: undisclosed.
  - Instacart—Grocery delivery platform:
    - Cities: 12 in the United States.
    - Personal Shoppers: more than 1,000.
    - Venture Financing: $55 million.
  - Lyft—Ride broker:
    - Cities: 68 in the United States.
    - Drivers: more than 60,000.
    - Venture Financing: $333 million.
  - Sidecar—Ride broker:
    - Cities: 9 in the United States.
    - Drivers: 6,000.
    - Venture Financing: $20 million.
  - TaskRabbit—Chore marketplace:
    - Cities: 19 in the United States.
    - Freelancers: about 30,000.

- Venture Financing: $38 million.
- Uber—Ride broker:
  - Cities: 70 worldwide.
  - Venture Financing: more than $1.5 billion.
  - (Uber did not respond when asked how many drivers use its platform).

Whether called the sharing economy, collaborative consumption, the peer economy, or the gig economy, this trend seems like a shiny rebranding of piecemeal work. Labor economists see growth in these companies as a sign that workers cannot otherwise find stable employment and have little choice but to take on impromptu projects. In July 2014, more than 17.2 million Americans were either unemployed or underemployed. While there is no definitive measure of the number of workers in the gig economy, MBO partners, which is a freelancer consultant, estimated that in 2013 about 17.7 million worked more than half of the time as independent contractors, including those who performed gigs. This is part of a worldwide trend where people are encouraged to work on a contingent basis, without any benefits or basic protections. The brokers of this economy pit workers against each other for one-time projects, rewarding those that are the fastest taker or lowest bidder. While many low-income employers keep more rigid work schedules or, worse, post different hours for their workers each week, they do at least offer benefits such as disability or commuter discounts.

There is starting to be a movement by gig economy companies to improve working conditions for their "independent contractors." Uber has instituted a $15 per hour minimum wage and has a $1 million insurance policy to cover both the drivers and riders for property damage or bodily harm as part of the service. However, these companies can also alter the terms of the contract with impunity. And workers are often unwilling to fight these changes, because the company can drop, or deactivate, them anytime. And there are other things that freelancers do not have: health insurance, retirement savings plans, tax withholding, and even office space camaraderie and mentoring.

Smith, Sandy. "Philadelphia Doesn't Have to Choose Between Millennial Singles and Families." ***Next City*****, October 30, 2014.** http://nextcity.org/daily/entry/philadelphia-family-friendly-city-millennials-parents **(accessed July 28, 2015).**

- Despite the fact that families with kids cost cities financially, residents resoundingly say that the city of Philadelphia needs to do a better job or retaining families with children. There are plenty of ideas for how to do just that:
  - Develop fair school funding formulas at the state level—suburban communities struggle with the additional kids who arrive from the city when they hit school age.
  - Schools should be used as a community gathering place for town meetings, cultural activities, and other events.
  - Rebrand public schools and education.
  - Fund early childhood education, which can improve children's readiness for school and give parents more opportunity to work outside of home and create jobs.
  - Convert paved schoolyards into green open space.

While there is no silver bullet for achieving all of this, it will require continued effort from activists who have been fighting for better schools and millennials (those who are already parents, as well as those who are not yet) to join the cause.

Soll, Jack B., Katherine L. Milkman, and John W. Payne. "Outsmart Your Own Biases." *Harvard Business Review*, May 2015. https://hbr.org/2015/05/outsmart-your-own-biases **(accessed April 20, 2015).**

- This article considers how to improve decision making with alternatives to system 1 thinking, which is using intuition or associations of past memories to guide decision making; or system 2 thinking, which is going amiss with careful reasoning. In addition, most people have too narrow a view of potential future outcomes. Suggested ways to overcome these biases include:
  - Make three estimates: low, medium, high.
  - Think twice: develop two completely separate forecasts and average them—this helps to harness the wisdom of crowds at the individual level.
  - Use pre-mortems: imagine a failure in the future and trace back to what caused it; this can you help to temper optimism and think about risks, and also helps to prepare and identify strategies for a Plan B.
  - Take an outside view: consider how comparable efforts have turned out and the suggestions you would give to someone involved in it. This can help to avoid the "planning fallacy," which thinks only about the rewards and minimizes what are actually high degrees of risk.

  In decision making, you want to consider your objectives as well. At the beginning you want to generate as many goals as possible, and then identify which ones are most important. In doing this, it is a good idea to seek advice of other key members of the team and have them identify their goals. As goals are identified, it is more useful to consider them one at a time rather than all at once. This can help to identify additional goals.

  When considering different options, the decision maker needs two at a minimum, but three to five is better. Framing options as yes/no should be avoided, because it minimizes other possibilities. We often limit ourselves to what we consider to work and not work, and then focus on only one solution to a problem. When a solid-seeming option has been found, individuals may fail to consider potentially better alternatives. When this happens, the "vanishing options" test can help to reconsider what else could be done. This is related to opportunity cost in economics.

  General rule of thumb for decision making: anticipate three potential futures, identify three key goals or objectives, and produce three viable alternatives for each decision.

"Special Report: Robots: Immigrants from the Future." *The Economist*, March 29, 2014. http://www.economist.com/news/special-report/21599522-robots-offer-unique-insight-what-people-want-technology-makes-their **(accessed September 9, 2014).**

- The Defense Advanced Research Projects Agency (DARPA) has made robotics a priority because it considers the area to be on the cusp of major innovations. At the recent DARPA Robotics Challenge, held in Miami, Florida, in December 2013, robots competed to complete basic emergency tasks that included driving a vehicle on a short, twisty course; walking over ramps; stairs, and debris; getting through different types of doors; cutting a hole through a wall with a power tool; connecting a fire hose; shutting off valves; and climbing a ladder. Such skills could prove useful in a situation such as the Fukashima nuclear power plant meltdown.

  Robot drones have recently captured much public attention in warfare in Iraq, Afghanistan, and other parts of the world. This has shown both what these machines can do and stoked fear about what they could do next. Beyond military concerns, robotics could have major economic impacts. They could help industrialized countries bring back manufacturing jobs that would otherwise be located in lower-income countries. Many labor economists expect the old adage to hold true that for every job that technology displaces, it will create a new job somewhere else. However, the economists warn that it is likely to dislocate many moderately skilled workers in the coming years,

through the combination of automation and growth in computing power, increasing digitization of much of what we work with (maps, legal texts, spreadsheets), and an ever-growing supply of innovation (in things, ideas, and processes). While this will create new products and services, there is a downside. The jobs most at risk no longer require manual labor—rather, they involve sitting at a screen. As more and more skills are needed for employment, there may not be entry-level opportunities for those who are just starting out and have not had a chance to hone their craft. These individuals may then never get an opportunity to develop the skills needed, creating destructive effects that will reverberate through the years. On the flip side, if productivity is equitably distributed throughout society, then people could work less and spend more time doing the things they enjoy.

The problems of aging societies plague many industrial nations. Caretaking for the elderly is a growing concern. Paro is a seal-shaped robot that is being used in nursing homes in Japan that likes to be petted. It has offered companionship to the elderly and seems to be particularly helpful in caring for individuals with dementia, as well as other health problems. Since it requires little upkeep (no housebreaking, feeding, and it won't die), it is practical for elderly facilities. Caring for elderly people may become easier with robotics. Beyond Paro, which serves primarily as a mood enhancer, wearable systems offer the possibility of helping older people walk and lift things.

Spector, Julian. "Coming Soon to America: One Fare Card for All Transit." ***The Atlantic CityLab*****, August 7, 2015.** http://www.citylab.com/cityfixer/2015/08/coming-soon-to-america-one-fare-card-for-all-transit/400706/ **(accessed August 10, 2015).**

- While the United States has lagged behind in transit fare payment technologies, many great cities around the world have modernized them with a single rechargeable pass that accesses trains, subways, buses, taxis, and other uses. Mobile phones can be tapped, not only as a fare payment instrument but also as a way to digitally integrate transit systems in a seamless fashion. Not only can this improve quality of life, but it can also save time and money for both passengers and operators. Mobile phones can be used to instantly give travel options, costs, time to complete the journey, and account for other things such as reliability. Passengers no longer have to worry about having the correct change, or missing a train while waiting in line to buy a ticket. Operators can save from less need for collection machines, or sending out armored vehicles to collect fare money. In addition, digital systems can quickly collect massive amounts of rider data, allowing for more strategic service management. The end goal is to do for in-city transportation options what Kayak and Orbitz have done for long-distance travel. GlobeSherpa, currently offered in 11 U.S. cities, is one such app; it lets you pay for different transit operators in a single place. It was recently acquired by RideScout, which is a multimodal trip route finder and cost estimator.

Stirling, Stephan. "Diamonds to Dinosaurs: NJ Towns Struggle under Weight of Massive Office Park Vacancies." ***NJ.com*****, June 29, 2014.**
http://www.nj.com/news/index.ssf/2014/06/diamonds_to_dinosaurs_nj_towns_struggle_under_weight_of_massive_office_park_vacancies.html **(accessed September 15, 2014).**

- About 25 percent of New Jersey's office space is vacant. Vacancies are especially high for large office parks, such as the former Bell Labs campus in Holmdel, and the Hoffman La-Roche main complex in Nutley and Clifton, among others. As a result, municipal tax bases have been reduced by millions of dollars. Finding new tenants to fill million-square-foot suburban office buildings is challenging in today's real estate market. As these suburban campuses are being abandoned, companies are moving into compact, collaborative offices located in downtowns.

  Suburban areas have to reinvent themselves. The 440-acre, two-million-square-foot former Bell Labs complex is being transformed into a mixed-use walkable development, with a healthcare center, hotel, retail, and office space. A 110-acre, former Sanofi-Aventis campus in Bridgewater is being turned into a new town center. For those communities that do not or cannot remake

themselves, there is a risk of fiscal distress, as jobs and retail move from rural and outlying suburban areas following millennials and other demographic groups to urban areas. As demand for retail and office space decreases, suburban properties will lose value and shift tax burden to residents. As their taxes go up, residents may be pushed out as well. This may just be the beginning of major changes, leading to all kinds of challenges for people trying to figure this all out for their communities.

Stromberg, Joseph. "These Startups Want to Do for Buses What Uber Did for Taxi Rides." *Vox*, July 7, 2015. http://www.vox.com/2015/7/7/8906027/microtransit-uber-buses **(accessed July 21, 2015).**

- Although there is no formal name for new transportation service companies such as Chariot, Bridj, or Split, some are calling them "micro transit." There are actually two distinct approaches that these companies are taking to delivering transportation services, which blend aspects of the convenience of taxis with lower costs of transit:

  1. Commuting shuttles that operate in certain areas based on user demand; examples of these companies are Chariot and Bridj.
  2. Services that allow you to share a ride with people who are going to the same or nearby locations; examples of companies offering these services include Split, CabCorner, Via, UberPool, and Lyft Line.

  Backers of these startups hope that they will become a successful bus version of Uber. Some of them offer door-to-door services, or flexible routes that go where people need them to, as opposed to transit that has more fixed service patterns that require people to come to it. By reducing transaction costs, they could make carpooling, which has been in decline for decades, much more viable. If they are successful, they could reduce driving levels and resulting greenhouse gas emissions and congestion. If they work with transit agencies, they could help to solve the critical "last-mile" problem of getting a rider from the transit station or stop to their actual destination. Transit-poor communities could see new service, bringing much-needed new travel options.

  However, it is far from certain that these companies will be successful. They will need to lure a large number of regular riders, which will require low costs, in order to turn a profit. Spread-out development patterns in the United States are not well suited for these types of services, which need people and destinations to be relatively close to each other in order to efficiently pick up and drop off groups. Micro transit may run into the same legal and regulatory hurdles that have plagued Uber to date. Another service, Leap, ran into legal problems with the California Public Utilities Commission in May 2015 and began selling its buses in June. There is concern that these services are stealing riders from transit agencies, particularly those with higher discretionary incomes. This could reduce political support for transit, and create a tiered network of faster demand response transit for those who can afford it and slower, less frequent service for those who cannot. While there is currently no socio-economic ridership data, a glance at where these services are operating shows that they tend to be in higher-income communities. They also require credit cards and smartphones, which lower-income people may have less access to.

  Where these services are starting up, cities should try to coordinate with them now instead of trying to ban them or allowing them to develop on their own. A unified payment system between transit and micro transit could help to integrate the systems. Lower-income passengers could also be subsidized to promote more equitable outcomes.

Supply Chain Quarterly. "Are the Days of Global Supply Chains Numbered?" June 24, 2015. http://www.supplychainquarterly.com/news/20150624-are-the-days-of-global-supply-chains-numbered/ (accessed July 21, 2015).

- According to Standard Chartered Bank in a report titled *Global Supply Chains: New Directions*, the global supply chain is likely to see slower growth over the next couple of decades than it has during the past two, due to:

  - Automation and robotics, which could flatten labor costs and bring more manufacturing back to regional and local scales.
  - Efforts to become more sustainable and reduce carbon footprints.
  - Reduce risk from having centralized operations be impacted by natural disasters or civil unrest.

  The report anticipates some future trends in global supply chains:

  - Low-cost manufacturing will move to inland China, other Southeast Asia nations, India, and then to Africa.
  - China will emerge as a "megatrader," expanding supply chains and trade across Eurasia, along with Australia, Japan, and New Zealand.
  - Service supply chains will grow as information technology and communications allow businesses to outsource work in technology, finance, and business. Services probably already comprise more than half of global trade value and will continue to increase as technology improves.
  - More trade will occur between developed countries, particularly as emerging markets continue to grow. This constitutes a major change from how we have thought about global supply chains, where the focus has been on manufacturing goods in low-wage countries and selling them in developed markets.

Terrapin Bright Green. *The Economics of Biophilia: Why Designing with Nature in Mind Makes Economic Sense*. New York, NY: Terrapin Bright Green, 2012. http://www.terrapinbrightgreen.com/wp-content/uploads/2012/06/The-Economics-of-Biophilia_Terrapin-Bright-Green-2012e.pdf

- Biophilia is the instinctive human connection with nature and implies that people have physical, mental, and social biological needs to interact with other living things. It is a concept that has been long recognized in the scientific and design worlds. While biophilic design is often considered a luxury item, the reality is that it can improve business productivity and profitability, speed up healing times, improve learning and comprehension, increase retail sales, and create safer urban neighborhoods. The three main tenets of biophilic design are:

  - Nature in the space—incorporating plants, water, and animals into the built environment.
  - Natural analogues—materials and patterns that evoke nature through artwork, ornamentation, biomorphic forms, and the use natural materials.
  - Nature of the space—our species' origination in African savannahs still imprints a preference for low-growing grasses, clusters of trees, and broad panoramas both indoors and out.

  Case studies have documented a variety of benefits from biophilic interactions, such as lowered stress rates, reduced blood pressure, increased cognitive function, improved mental stamina and focus, lowered crime rates, better moods, and heightened learning rates. Direct measures of productivity in biophilic environments can be quantified, such as the number of customer service calls completed in a certain amount of time. Indirect measures, such as absenteeism, tardiness, and safety violations, can also be translated into business expenses. In looking at a wide range of industries, from hospitals to corporate offices, they spend an average of 90.3 percent of their

operating budget on salaries, 8.9 percent on rent or mortgage, and 0.8 percent on energy. Given that people cost 112 times more than energy costs, the smart money should be invested in making employees more productive and satisfied, which will go a much longer way in improving the bottom line than reducing energy costs.

On average, the private-market employee is absent three percent of the year at a cost of more than $2,000 (public workers were higher at four percent absenteeism). There is a study of a University of Oregon administrative building with views of trees and landscape in two directions enjoyed by 30 percent of workers; a view of a street, parking lot, and building in two directions with 31 percent of employees; and the remaining 39 percent working in a windowless portion of the office. Employees with the view of the trees and landscape took the least amount of sick leave per year (an average of 57 hours). The employees with no view took the most (an average of 68 hours). Those with the view of the building, street, and parking lot were in between the two.

Researchers found that call center employees with a view of nature handle calls six to seven percent faster than those with no view of it. In 1978, ING built a new headquarters building that maximized natural lighting and included organic artworks and water features to enhance worker productivity. Absenteeism declined by 15 percent, in addition to saving another $2.6 million per year in energy cost savings. Its image as a progressive company led to a growth in depositors, bumping it from the fourth largest bank in the Netherlands to the second.

A 1984 study of patients recovering from gall-bladder surgery found that those patients with day-lit rooms and views of nature needed 8.5 percent less time to recuperate. Less in-hospital time saves patients and hospitals money. Other studies have found biophilic design to cut medication needs for convalescing patients. Benefits spread to family members and other visitors as well, as they have reported being more relaxed and positive about visiting friends and loved ones.

A study of hedonic pricing found that shoppers accept higher prices in greener retail settings compared to locations that lack natural amenities. For convenience shopping, such as a sandwich for lunch, it was 20 percent higher. For general shopping, such as a new jacket or watch, it was 25 percent. For specialty shopping, such as a gift, it was 15 percent. A study of day lighting a chain of 73 stores in California found that the stores' gross sales increased by 40 percent after they installed skylights. Energy costs decreased by 24 cents to 66 cents, and per-square-foot profit increased by $4.56 to $12.54.

Research has shown that schools incorporating biophilic design help students achieve higher test scores (7–26 percent), be in better health, and learn easier. Recess time in playgrounds with nature has indicated that students feel more mentally restored, behave better, and are more focused.

Transportation Research Board. *Special Report 319: Between Public and Private Mobility: Examining the Rise of Technology-Enabled Transportation Services*. Washington, DC: Transportation Research Board of the National Academies, 2015. http://www.trb.org/main/blurbs/173511.aspx

- Innovative shared mobility services—including Transportation Network Companies (TNCs), microtransit, carsharing, and bikesharing—are creating new transportation options and enjoy mass appeal.
  - They are expanding rapidly in the U.S. both in terms of the number of trips they provide, and the number of companies that provide them.
    - In January 2014, there were 45 carsharing operations in the U.S. with 1.5 million members and 22,134 vehicles (Shaheen and Cohen, 2015).
    - In 2015, 72 cities in the U.S. provided bikesharing at 2,440 stations with 24,700 bikes.
    - In June 2015, Uber provided more than 1 million daily rides worldwide, operating in 311 cities with 162,000 drivers. Lyft was operating in 60 cities with over 100,000 drivers.

- In the U.S. in 2012, there were approximately 7,500 taxi companies with 76,000 employees providing 738 million annual trips with $6.6 billion in revenues. These services account for 0.30 percent of all person trips and 0.20 percent of household vehicle miles traveled (VMT).
- A travel expense management company, Concur, reported its clients increased their use of Uber by 900 percent from 2013 to 2014. Average fares for different services were reported at $22.51 for Lyft, $30.03 for Uber, and $34.48 for taxis.
- December 2014, Uber added 40,000 new drivers capping off a two-year period where its total number of drivers doubled every six months. The number of annual trips had tripled in San Francisco, and quadrupled in New York City, and the company's gross revenue had doubled. Net income in 2014 was $400 million, and this was projected to increase to $2 billion in 2015.
- A June 29-31, 2015 national tracking poll conducted by Morning Consult found 3 percent of registered voters reported near daily use of ridesharing services, and 5 percent used them once or twice per week or once or twice per month, these figures corresponded with the amount of use of taxi services, suggested the TNC market is currently on-par with the taxi market.
- The Washington, DC, taxi commission reported a 10 percent decrease in taxi trips in the first of year of TNC operations. Similar drops were reported in San Francisco (11 percent) from FY 2013 to FY 2014, and Los Angeles DOT (9 percent) between 2014 and 2015. Anecdotal evidence suggests taxi trips are also becoming shorter, further reducing revenue.

- Regulated taxis provide vital transportation services for disabled individuals, but they are threatened with disruption by TNCs.
  - Taxi regulations vary widely and are often enforced by an assortment of regulatory bodies across many jurisdictions within a single region. Regulations create rules that govern or prohibit the ability of a cab to pick up and drop off passengers within a specific area or airport, set fares to ensure predictable charges and eliminate price gouging, limit market entry through medallion, certificate, or franchise systems, and provide accessibility for those with disabilities. Regulations do not allow taxis to decrease their fares in order to compete with TNCs, or increase their fares to attract more drivers during peak demand periods.
  - Medallion prices grew faster than the Standard and Poor's 500 Index from 2009 to 2013, doubling to $350,000 in Chicago during this time, reaching $700,000 in Boston, and $1.1 million in New York City. Prices have since fallen significantly, up to 28 percent in NYC, with lower volume as well. Drivers pay medallion owners a lease rate, and the interests of these two groups are not well aligned. Declining medallion values would mean financial loses for their owners, but could lower lease rates, and therefore higher incomes for drivers.
  - Taxi service was deregulated in many cities during the 1970s, which did not bring about the predictions that it would spur innovations and create new transportation markets. Deregulation had many unanticipated costs such as an expansion in individual owner-operators that primarily served taxi stands at airports and dense downtowns, but did not improve service to wider urban areas. This weakened dispatch services, led to longer wait times for passengers, and a reduction in driver productivity and earnings, which led to increasing driver solicitation of passengers, price gouging, and driver confrontations for fares.
  - Standard microeconomic theory submits that price controls, location and quantity restrictions, and a monopolistic structure create inefficiency and poor service.
  - Many regulated taxi prices include a subsidy for accessible ride services, although tradition appears to be the only rationale for this. Low-income individuals (who have lower car ownership rates) use taxis about as often as the affluent and highly educated, these two groups comprise the primary taxi market. In some instances then low-income individuals are subsidizing disabled individuals use of taxi services, even though the disabled individual may have a higher income.
- Technology enabled mobility simultaneously confers benefits and costs, creating distributional effects. If TNCs weaken or bankrupt taxi services, than those that are unbanked or lack access to credit cards or smartphones, or are low-income or elderly may find

themselves with fewer mobility options. Multinational TNCs operate at a vastly larger scale than local taxi companies, raising new regulatory considerations.

- Improvements to mobility create economic benefits to society—through reduced travel time, cast, risk or uncertainty of access, congestion, crashes, and emissions—as people have more access to jobs and businesses, customers, services, friends, and opportunities.
- Since TNCs are not restricted from picking up and dropping off passengers in specific jurisdictions, they can avoid the inefficiency that occurs after dropping off a passenger outside their service area and having to deadhead back to their designated zone.
- Since they are not subject to pricing controls, TNCs can use surge pricing to adjust costs based on real-time supply and demand. Their disbursed and flexible employment allows them to have a large pool of cars and drivers on call at any time, and they do not have a limit on the number of vehicles they can have on the road at any given time.
- Surge pricing is seen as a best practice by economists, who see little evidence that TNCs are price gouging, as their customers see the cost of the trip in advance and are not being coerced into paying it.
- Drivers and passengers can rate each other after the trip is completed. These systems help all parties to police each other, and ensure good service.
- Since TNCs do not generally receive any public funding, governments lack a major tool used to ensure more equitable outcomes, conditioning public investment on a redistributive function.
- It is not clear whether TNCs will provide better service to racial minority groups, but they are trying to do so by not providing a picture of the driver or passenger, or the destination to the driver in advance of the trip. However, user generated rating systems and shared profiles are at risk for bias and abuse.
- Studies and surveys have found that 87 percent of carshare users in 13 markets were white, bikeshare users in Washington, DC, Minneapolis, Toronto, and Montreal were 79 percent white. Similar data is not available for TNC customers.
- TNC services are not regulated under the Americans with Disabilities Act. It is not clear what role, if any, they should play in providing paratransit service. If TNCs weaken taxi service, then transit agencies ability to provide paratransit will also be undermined. TNC apps improve automobile access for the blind, but there have been problems in accommodating guide dogs. TNCs are the subject of lawsuits in Texas and California due to concerns about wheelchair passenger access.
- By reducing the need for automobile ownership, TNCs can help low-income households reduce their total transportation costs. However, there are several barriers to use of these services, including access to credit cards and smartphones, lack of information, and even cultural factors that create uneasiness with shared mobility.
- TNCs have done little to address the unbanked population, though Uber is currently testing cash prepayment options in India. Public transit agencies and bikesharing can serve as a model for improving access to service for those without bank accounts. Greyhound Bus Lines uses a private electronic payment service, PayNearMe, which allows transactions to occur at a local convenience store. A number of bikeshare operators off debit cards that can have cash value placed on them.
- 36 percent of the population still does not have access to a smartphone.
- Common regulations for TNCs, where they exist, require drivers to be licensed, to have a relatively new vehicle (with widely varying standards) which undergoes regular inspections (usually by state licensed entities), display a company emblem when in service, carry a minimum of $1 million in incident liability insurance whenever a passenger is in the vehicle or when the driver is in route to pick up a passenger, and TNC drivers are forbidden from picking up individuals hailing them on the street as all rides are required to be handled in advance using an app.
- TNCs are not restricted in the geographic nature of their operations in the same way that taxis are.
- TNCs aren't usually required to have business licenses, but do pay widely varying fees for operations.

- Public safety is paramount, and shared mobility services have not been fully addressed within the public policy realm.

- Driving a taxi is a particularly dangerous occupation. According to the Census of Fatal Occupational Injuries, drivers and chauffeurs have a violent death rate that is four or five times higher than the average across all industries (15 to 20 deaths versus an average of 3 to 5 deaths per 100,000 workers). Some of the reasons for this include that passengers are picked up off the street and aren't vetted like drivers are, drivers often carry large amounts of cash, and many vehicles lack secure partitions between the driver and passenger(s).
- TNCs help reduce violence risks against drivers by reducing passenger anonymity, using cashless transactions, and tracking vehicle location.
- Passengers are at risk from reckless driving and driver assault. Media reports indicate that both TNC and taxi drivers have had several high-profile passenger assaults in the past year. There is not enough data to determine whether there is a higher assault rate in one service or the other.
- Both TNCs and taxi companies screen drivers by checking criminal records. However, a criminal record does not necessarily mean an individual will commit a crime again in the future (though it has been shown to be an indicator for repeat offenses), and lack of a criminal record does not mean a person won't commit a crime at some point. Taxi companies usually require fingerprints that can be checked against the FBI's national criminal database. TNCs use private third parties to check names against county, state, and federal courthouse records, the National Sex Offender Registry, social security traces, and motor vehicle accounts.
- Taxi vehicles undergo more frequent and detailed inspections than those required for private passenger vehicles. Where TNC operations have been legalized, vehicles are generally required to be inspected before entering service, and then are reinspected on an annual basis.
- TNC operations use of smartphones raises the question of driver distraction. Drivers must continually check their phones and quickly respond in order to win fares. Similar apps are now frequently being used in taxis as well. No research has been conducted on the risk of smartphone ride calling apps to date.
- An Uber and Mothers Against Drunk Driving analysis found that that ride sourcing demand spikes when bars close, and after Uber entered a market vehicle fatality rates decreased by 3.6 to 5.6 percent.
- Carsharing users are charged based on vehicle use time and sometimes assess additional penalties for returning a vehicle late. This may lead to more aggressive or dangerous driving, particularly speeding, in order to beat the clock. Driver unfamiliarity with carsharing vehicles may portend additional safety risks.
- Only 38 percent of taxi passengers in New York City report using a seatbelt, even though it is one of the most cost-effective safety regulations.
- Bikesharing has not been implemented with requirements wear a helmet, out of fear that they will be a barrier to use.

- TNC and most taxi drivers are a part of the sharing economy, and are generally classified as independent contractors, with very few benefits.
  - Market disruption from TNCs will likely provide benefits to consumers, but can harm people who drive taxis and the owners of taxi companies.
  - Continued growth of TNC operations could lead to worker displacement in the taxi industry. Taxi drivers can potentially shift to driving for TNCs, though some that are able to drive taxis may not be able to meet the TNC screening (due to past felonies, moving violations, etc.).
  - Full-time taxi drivers and chauffeurs averaged $12.85 per hour according to 2007-2011 U.S. Census data. These incomes vary considerably between different geographic markets. Adjusted for inflation, incomes were down about 11 percent over the previous 10 years.
  - Take home pay for TNC drivers is harder to estimate. Advertised hourly pay rates are often gross, not net, and don't account for vehicle operating costs (insurance, maintenance, upkeep, fuel, and depreciation). Slate.com estimated that take home pay for UberX drivers was about $12 per hour, after accounting for vehicle expenses (Griswold, 2014). Uber recently guaranteed drivers in select markets $12.80 per hour when it recently lowered fares across the board.

- Neither traditional taxi companies nor TNCs provide benefits such as sick leave, vacation, health insurance, or retirement. Limousine companies, however, do typically offer these benefits.
- Taxi companies lease vehicles to drivers for a flat weekly lease payment. Taxi drivers must then produce enough fare revenues to make up for this leasing fee, along with gas costs before they take home any pay. On bad days, the driver can make very little money, or can even lose money. The lease arrangement makes it difficult to work only part of a day, and encourages drivers to work extremely shifts in order to increase their take home pay.
- TNC companies take a 20 percent or more cut of each driver's earnings. By working on commission, drivers can work only part of a day. On a bad day, both the TNC and driver share in the pain. Many TNC drivers use the work as a bridge to other employment options.
- In general, neither TNCs nor traditional taxi drivers are unionized, and they are generally classified as independent contractors. Taxi drivers are often organized within associations that advocate for improved working conditions. In other instances, such as the Greater Philadelphia Taxi Association, are organized to represent taxi companies, medallion owners and operators, along with related industries, but do not speak for the drivers.
- Several recent lawsuits by TNC drivers have been brought forward under the Fair Labor Standards act, questioning whether they can fairly be categorized as independent contractors rather than employees. In June 2015, the California Labor Commission ruled against Uber, finding that the plaintiff driver is indeed an employee, given that "drivers' services are 'integral' to the company's business model and that Uber is involved in 'every aspect of the operation.'" In October 2015, the Oregon Bureau of Labor and Industries made similar ruling. Uber has appealed these rulings. If these lawsuits are settled in favor of the drivers, than TNCs will have to handle taxes, social security, pay for benefits, and reimburse drivers for operating costs (such as gas and vehicle maintenance). These outcomes of these verdicts could cause dramatic changes to TNC company operations, and profit potential, with reverberations to the wider sharing economy, and could also extend to taxi company operations.

- If TNCs become pervasive in the long run, there are significant implications for future development patterns, automobile ownership, and public transit use.
  - Millennials living in urban areas are the primary market for TNCs, but it is unclear whether they will continue to use them as faithfully if and when they have children and move to low-density suburban areas. Likewise, as empty nesters and retirees move to urban areas will they increase their use of these services (currently they are the lowest use group by age).
  - TNCs may reduce personal vehicle trip rates, but increase mileage due to the pick-up/drop-off portions of each trip.
  - TNCs may encourage higher vehicle occupancy rates, and otherwise shift travel away from single-occupant vehicle due to lower auto ownership levels, both of which could reduce VMT.
  - Reduced vehicle ownership could create a positive feedback loop, where car owners have very low marginal costs per trip, whereas ride source trips make the full marginal costs of each trip more readily apparent.
  - Reduced vehicle ownership could also result in less need for parking in urban areas, allowing for increased densification and create community support for converting parking space to other uses. This can then facilitate increased transit and active transportation options.
  - This could impact the ability to achieve an environmentally friendly, resource-efficient transportation system. More data and research is needed before any definitive statements can be made one way or another.
  - The sum of all these potential changes could yield drastic reductions in VMT, air pollution, greenhouse gas emissions, congestion, and road and parking infrastructure needs.
  - It is possible that these new services will have the opposite effects, where convenient and inexpensive ride sourcing undercuts transit services, induces additional and/or longer trips, which then increase VMT, congestion, and greenhouse gas emissions.

The rapid growth and fast evolution of TNCs is shifting opinions about their overall potential market size, which will come from both creating new travel, and by taking a share away from other modes, be it private vehicles, transit, or even walking. Transit agencies are watching this trend very closely, in order to understand how the evolution of these services may affect transit use. In particular, lightly regulated TNCs are disrupting heavily regulated traditional taxi services, and creating new regulatory and policy challenges in the process. Policy makers at the local, state, and federal levels must find ways to foster and enable mobility innovations. It is possible for TNCs and taxis to coexist, if the regulatory treatment between them can be made into a more level playing field. The report makes a number of recommendations to help ensure that TNCs can enhance mobility, while generating wider societal benefits.

1. Public policy and regulations should guide shared mobility services toward improved mobility, safety, and environmental sustainability.
    a. Reassess existing taxi, limousine, and, where adopted, TNC regulations that restrict market entry, geographic coverage, span of service, and similar regulations. Determine where technology—particularly service quality information available to drivers and passengers—can accomplish customer service protections that formerly required governmental intervention.
        i. The street hailing market is probably not a good area for reduced regulation, as this has previously led to oversupply and excess competition for these services.
    b. Public safety requirements for drivers and vehicle inspections should be applied in a similar manner across shared mobility industry segments for consistency and to level the playing field.
        i. State and federal regulators should direct a systematic evaluation of safety requirements, particularly to determine best practices and find ways to lower costs.
        ii. Given what is known about the risk of phone use while driving this issue with respect to TNC operations warrants further study.
    c. Evaluate how different shared mobility industry regulations compare across multijurisdictional areas, especially given the national/international operations of TNCs. This may require some consensus building as to whether all shared mobility services are best regulated at the state, regional, or local level.
    d. Ensure that individuals with disabilities, particularly for those in wheelchairs, have full access to shared mobility services.
        i. Concern about low-income individuals being able to access these services should be addressed with targeted programs and not efforts to lower prices for everyone.
2. Planners, policy makers, and regulators should identify the data needed to develop policies on, plan for, and regulate shared mobility services, and require it from all enterprises.
    a. Some jurisdictions have required routine data sharing from TNCs, such as: provision of accessible vehicles, service provision by zip code, problems reported about drivers, hours logged by drivers, miles logged by drivers, drivers completing training courses.
3. The advantages and disadvantages of TNC and taxi driver employment classifications should be more fully studied.
4. Innovative shared mobility services should be integrated into existing transportation networks in ways that leverage and build upon their strengths.

Torbett, Roy, and Blake Herrshaft. "Driving Miss Hazy: Will Driverless Cars Decrease Fossil Fuel Consumption?" Rocky Mountain Institute Blog, January 25, 2013.
http://blog.rmi.org/blog_2013_01_25_Driving_Miss_Hazy_Driverless_Cars (**accessed August 10, 2015).**

- Computers are outperforming humans in areas such as *Jeopardy!* and chess, and now automobiles. Achieving a greener transportation system has centered on increasing fuel efficiency and developing hybrid and electric vehicles. In the future, driverless cars offer a number of

potential fuel-efficiency improvements through connections with smart infrastructure, closer spacing to reduce drag, and hypermiling. Hypermiling saves fuel by accelerating, braking, and approaching hills and traffic lights in the most fuel-efficient manner possible. Other benefits could include car sharing systems, reduced drowsy and intoxicated driving rates, and even tracking potholes, allowing the vehicle to avoid them and sending information about their whereabouts to the appropriate maintenance agency. AVs can locate the nearest parking space and lower the 30 percent of traffic in downtown areas that is searching for a place to park.

There are potential downsides, however. Driverless cars could substantially increase VMT, even driving passengerless to run errands. The rebound effect could reduce the fuel efficiency savings that AVs offer. It is within the realm of possibility that driverless cars actually increase total fuel consumption, due to higher VMT, over and above the significant per-mile fuel efficiency gains they promise.

Torchinsky, Jason. "Here's How to Prank Autonomous Vehicles When They Come." Jalopnik, July 25, 2013. http://jalopnik.com/heres-how-to-prank-autonomous-cars-when-they-come-874123410 **(accessed January 28, 2015).**

- While not recommending hacking or destructive activities, there could be an opportunity to trick AVs. This illustrates the types of unanticipated actions that people may take with AVs, particularly when they are driving passengerless:
  - Car Herding – Surround an AV with a group of friends (six or more), have individual group members approach crash-avoidance sensors to force the car to stop, start, and change directions. With teamwork, the AV could be herded like livestock.
  - Instant Unwanted Autocross – As an AV is approaching, place a bunch of cones or objects in its way to create a quick autocross or slalom course.
  - Roller Skiing – While wearing roller skates, grab onto an AV and hold on for a ride.
  - Auto Sumo – In a large parking lot, herd two AVs close together and surround them with a ring of cones; try to get them to circle and chase after each other by blocking and revealing collision sensors.
  - The Trap – Surround an AV with objects so that it stops and has nowhere to go.

Townsend, Anthony. *Re-Programming Mobility: The Digital Transformation of Transportation in the United States.* New York: NYU Wagner Rudin Center for Transportation Policy and Management, 2014. http://reprogrammingmobility.org/wp-content/uploads/2014/09/Re-Programming-Mobility-Report.pdf

- Transportation innovation is shifting from public-sector-driven major infrastructure projects to private-market-developed digital technologies that help individuals plan their trips and enhance goods movement logistics, and help transit operators design and manage their system. As of 2014, mobile carriers had spent $500 billion building out the nation's wireless networks, roughly the same amount as has been spent on the Interstate Highway System. These information technology systems make transportation safer, smarter, and more efficient. Given this, here are some key questions for future transportation research:
  1. What new technologies and services will have the broadest impact on mobility? Which will have focused but transformative impacts on niche markets?
  2. How will new mobility technologies effect land development patterns?
  3. What kinds of organizational changes will transportation regulators, funding agencies and planning institutions need to begin preparing for now, and what kinds of skills and practices will transportation planners need in the future?

The research team scanned a variety of articles, case studies, news reports, and opinions to identify emerging themes and insights into new transportation technologies. The team identified a few shortfalls from these resources:

- Too-short timeframes—Even overnight success stories need time to develop. Many reports are too optimistic about the rate at which new technologies will penetrate the market and displace existing paradigms. Often, these reports miss the public policy decisions that could lead to different outcomes.
- Too-long timeframes—Conversely, many scenario analyses are set too far into the future, where they are disconnected from today and any action we may take in the present. In addition, they often assume technological breakthroughs for which there is no clear path for them to occur.
- Too dependent on a single technology or actor—This ignores the vast legacy infrastructure, business opportunities, and the range of technologies being applied to exploit them. This suggests a midterm horizon of 15 to 20 years is a more appropriate timeframe to analyze. The best scenarios do not include a clear winner and allow tensions to amplify rather than be resolved. These scenarios can allow planning and policy to help choose winners or create conditions to encourage specific technologies over others, or spur an array of different networks to build a more resilient system, which may be more strategic than having a single, highly efficient one.

To stimulate thinking about the future, scenarios should be:

- A good story, with a beginning, middle, and end.
- Plausible, where future events must be reasonable given existing conditions and current trends.
- Specific, where causes and events should be clear.
- Relevant, where they should address the most significant and uncertain Future Forces at both the local and macro levels.
- Distinct, where each one should be different so that the set has a wide range of possible outcomes.

In crafting alternative futures, the research group followed an approach pioneered by the University of Hawaii where any story about the future can be grouped into one of four forms:

- Growth—Current conditions persist, including historical exponential growth rates in domains such as economics, science and technology, or cultural complexity.
- Collapse—Some conditions deteriorate from present favorable levels, and some critical systems fail, due to a confluence of probable, possible, and wildcard factors.
- Constraint—Resource-based limits to growth are encountered. As a new sustainability regime takes shape, growth slows and society reorganizes around traditional and natural values.
- Transformation—Disruptive technologies emerge, ending some current patterns or values, which are replaced with new ones. Innovations lead to higher growth rates than in the "Growth" scenario.

In developing alternative futures, AVs stand out as the 800-pound gorilla in the room. Predictions about cars that drive themselves go back to at least the 1930s. In the 1970s, the U.S. government forecasted that self-driving cars would be on the road by the year 2000. The speed in which the current technology is evolving suggests that they are likely to be on the road by 2030, the horizon year of this effort. Each of the four scenarios developed in this report will consider their impact differently. In Growth, Google has consolidated Waze, Nest, Fiber, and Maps with its self-driving cars into a public–private partnership with the Georgia Department of Transportation to create a separate road network in Atlanta, restricted to AVs. In Collapse, lack of regulation and the arrival of low-cost AVs from China and other Southeast Asian nations leads to a patchwork of

assistive and full AVs on the roads, which are unable to efficiently communicate with each other. While the safety benefits of AVs are achieved, the cars are highly defensive with each other, failing to reduce congestion. Constraint envisions a high-speed autonomous bus network arising, fed by local and paratransit jitneys. In transformation, a network of autonomous e-bicycles can be summoned on call, and the system is able to constantly rebalance its docking stations.

Growth: Atlanta 2028

Atlanta made the decision to double down on sprawl, which led to the seemingly unlikely designation of it becoming the greenest city in America. This happened through a combination of solar power, which has been most effective in low-density areas, electric AVs and a distributed energy grid. Enough power is generated to fuel suburbanites' electric vehicles and supply electricity back to the power-hungry central city. By 2022, a consensus around Washington, DC, was reached to allow Google to rebuild the nation's entire transportation system around solar power and electric AVs. While open-source data had created a variety of apps to promote multimodal transportation, Google increasingly pointed people to use its services at the expense of others. This led to a mobility monoculture.

Edge cities have become the focal points for new development, while telecommuting, distance learning, telemedicine, and e-commerce continue to grow. As people spend less time shopping, they are freed up for other activities relating to entertainment, education, and health. The reduction in parking needs in edge cities has freed up land for infill development, allowing them to become more pedestrian-friendly. These areas are experimenting with alternative transportation modes such as bike sharing and on-demand circulator jitneys.

Since AVs are more expensive, they are seen as serving the elite. Many gated communities can be accessed only by an AV. Meanwhile, many parts of the region are underserved by these new transportation technologies. It is not clear if drivers and AVs are being steered away from low-income communities or if there is an unintended redlining that is built into the algorithms that match supply and demand. Although solutions to the energy and transportation problems exacerbated by sprawl have been engineered into this future, other problems have significantly worsened. Residential development is eating up open space and farmland at an alarming rate, and the region is seriously considering growth management options.

Collapse: Los Angeles 2030

AVs were seen as the salvation of Los Angeles. They were expected to upgrade the road network, allowing it to move more cars, while improving traffic flow at the same time. As automakers successfully lobbied to block Google's autonomous car, the nation focused on assisted driving systems. Standards were either low or nonexistent, and Chinese brands were able to move into the marketplace, having reproduced American technologies on a mass scale, bringing costs down rapidly. As a result, the nation wound up with a fleet of smart cars that could not talk with each other.

Nearly one million visually impaired drivers are purchasing their first car. AVs are filled with digital entertainment, attracting young drivers who had previously eschewed vehicles. Parents purchase AVs to protect teenagers. Zero-occupancy vehicles became particularly troublesome, as individuals sent their cars to run errands and businesses gladly served them. AVs often circle in traffic, so their owners could avoid paying for parking. As AVs flooded the roads, walking became uncomfortable, and people find it easier to hail an e-taxi than to make a pedestrian trip. Immigrants in low-income communities built their own fully autonomous van networks, as an informal alternative to struggling transit networks. They provide a critical connection between workers' homes and jobs, with a safer, faster, and less expensive option. For the first time in decades, there is significant individual VMT growth. With so much more traffic, the average 20-mile commute now takes three hours.

The collapse of Los Angeles' transportation system came from too much innovation—rather than a lack of it—combined with poor federal regulation and uncoordinated regional planning.

Constraint: New Jersey 2029

As New Jersey was increasingly built out, a myriad of transportation issues continued to play out: lack of transit between suburbs (commuter rail focused on getting people in and out of Manhattan), a road network operating at capacity, slow adoption of AVs that left them unlikely to solve congestion problems, and ongoing population growth in the New York metro area. As MPOs were limited in their capacity to effect change, state efforts focused on the Port Authority. A plan was devised to develop a system of high-speed autonomous bus lines, which would be fed by a number of smaller on-demand autonomous feeder routes. By rethinking the entire transportation system, New Jersey was able to create a system that satisfied the desire for connected, on-demand social transportation.

Local jitneys serve short trips from the closest pick-up point. Longer trips often require a transfer to an express bus. Payments are transparent and are conducted through smartphone apps. Digital displays indicate the estimated pick-up time for each passenger. The system is efficient and resilient, with the ability to reroute vehicles in real time to avoid sinkholes, power outages, and flooding—all of which have been exacerbated by climate change. The result is that hundreds of thousands of vehicles have been taken off the roads. By 2030, VMT was 50 percent of 2015 levels.

While the autonomous buses were the most visible Port Authority investment, three key technologies played a critical behind-the-scenes role. Electric autonomous buses were allowed to be closely spaced together not only for fuel-saving drafting effects, but also to allow more of them to pass through the Lincoln Tunnel at any given time. An intelligent bus traffic system was implemented at the Port Authority Bus Terminal, allowing it to triple the volume of passengers it could accommodate daily. Last, a grant from the U.S. DOT was used to pay people to telecommute, similar to how farmers are paid not to grow a crop when its prices are too low. Planners also learned how to mine big data and anticipate how changing life events would possibly impact transportation patterns, using similar techniques as marketers. They could use this information to alter development patterns, such as the placing of additional family housing near transit hubs, as well as use a series of personal nudges to keep people on transit.

Additional benefits were realized when parking demand was reduced around commuter train stations, which were redeveloped as new mixed-use transit villages. This increased municipal ratables, generating more property tax revenue. Unexpectedly, telecommuting strengthened downtown areas. As people went into the office less frequently, they sought out walkable areas located near a variety of retail and entertainment options. Telecommuters particularly enjoyed having third-place options, such as coffee shops, to work in within walking distance of their homes. As people spent less on transportation, they had more disposable income to spend in the local economy.

Transformation: Boston 2032

The economy remained weak well beyond the 2007 economic crash. Young people struggling with debt could afford to own very little. Meanwhile, the digital revolution meant that almost anything could be summoned with the swipe of a phone. This led to changing attitudes about ownership. The Boston Closet, a micro apartment between 135 and 160 square feet, became wildly popular. Inhabitants had almost no stuff in them. They did have entire walls covered with large, editable video screens. As the city further densified, alternative transportation was strengthened. Walking was upgraded by apps that could direct you on the route best liked on Facebook, or using crowdsourcing to determine the directions with the most beautiful architecture. E-bikes commonly fed transit lines and have become the preferred first-mile/last-mile solution. While this initially overwhelmed the already overburdened "T," retrofitting the system with autonomous trains

allowed service frequency to increase. With reduced need for cars and parking, the city began to reclaim entire streets for pedestrians and other alternative uses. A plan is underway to completely eliminate the car within the city limits within two years.

In 2032, Boston's economy is firing on all cylinders, thanks to the agglomeration effects of a dense city, flexible architecture, and human capital. A "cognitive surplus" has been unlocked, thanks to reduced commutes and more time for productive activity. The role of urban planners has become to facilitate public interaction and understanding of the incredibly complex AI that plans, designs, and manages the region.

Meanwhile, an entire second city has sprung up parallel to the human one, which simply stores everyone's stuff. The average Boston Closet occupant receives 10–12 deliveries per day, for food, e-commerce, services, and remote storage. As streets were clogged all day long, deliveries largely shifted to the nighttime. All of these deliveries offset the reductions in carbon emissions from reduced passenger vehicle travel. And the city was facing a midcentury sea level rise of 25–30 inches, which would permanently flood up to 30 percent of its land area. With ongoing flooding risks on the roads, plans are being drawn up to turn the entire delivery fleet over to drone operations to reduce risk of damages.

- See also literature review at http://reprogrammingmobility.org/wp-content/uploads/2014/09/ReProgrammingMobility-LitReview-08.04.2014.pdf and trend notes at http://reprogrammingmobility.org/wp-content/uploads/2014/09/ScenarioNotesSignals.pdf

Treuhaft, Sarah. "Can We Bend the Sharing Economy toward Equity?" Rooflines Blog published by the National Housing Institute, February 19, 2015.
http://www.rooflines.org/4049/can_we_bend_the_sharing_economy_toward_equity/ **(accessed February 27, 2015).**

- The sharing economy (also known as the gig economy, the collaborative economy, the peer economy, or the on-demand economy) and its app platforms will not include low-income and minority communities in these new economic opportunities on their own. For those concerned about making cities and regions more equitable and resilient, there needs to be more dialogue about how to ensure that this new economy can provide benefits for the most disadvantaged in society. The sharing economy is growing fast (25 percent since 2013) and offers variety and flexibility without the regular working hours, benefits, or protections found in full-time jobs. An estimated 34 percent of workers participate in the gig economy (as independent contractors, moonlighters, diversified workers, temporary workers, or freelance business owners).

  The online apps that are powering the gig economy help to link independent contractor workers with labor buyers. The fear is that this puts too much risk on the workers, who have little protections, and could potentially drive down wages—though, to be fair, some companies have taken steps to ensure their independent contractor workers are well paid, have benefits, and have access to training that allows them to deliver higher-quality work. There are other problems as well; research has found that African-American Airbnb hosts charge about 12 percent less for comparable properties. Access to car, ride, and bike sharing is lower for those in low-income communities, either due to lack of Internet access or lack of facilities.

  With a growing labor pool becoming more reliant on the gig economy, there should be consideration of how to ensure that workers are protected against wage theft and other violations; provided a living wage, health, retirement, paid time off and other benefits; a strong safety net; and the right to organize. Municipal regulatory frameworks need to be overhauled to adapt to the changes being brought about by the Internet and the sharing economy.

Tufekci, Zeynep. "The Machines Are Coming." *New York Times*, April 18, 2015. http://www.nytimes.com/2015/04/19/opinion/sunday/the-machines-are-coming.html (accessed May 5, 2015).

- Machines continue to become smarter, and they are being used to perform more and more jobs. Today's machines can understand spoken language, recognize human faces, and read their expressions. Machines can harness big data to figure out who would pay more for a product, who is the best candidate for a job, whether someone is lying, know a person's mood, or who they would vote for in an election. Advanced diagnostic systems allow them to perform medical and legal analysis. As their skills improve, they are used to automate and outsource. Machines give more power to employers and help to lower wages for workers—they do not get sick, pregnant, ask for raises, have bad days, or quit. They threaten not just those with low-income jobs but also those higher up on the economic ladder, leaving employees with fewer bargaining chips.

  The coming machine age is compared to the industrial revolution by optimists, who think higher education levels and increasing worker skills will solve the problems of the day. However, it is unlikely humans will be able to compete with machines in the future. Rather, we must find ways to use machines to empower each other. This will require redefining the issue away from people versus machines to how we value each other as humans.

U.S. Department of Transportation. *Beyond Traffic 2045: Trends and Choices*. Washington, DC: U.S. Department of Transportation, 2014. https://www.transportation.gov/sites/dot.gov/files/docs/Draft_Beyond_Traffic_Framework.pdf

- The first part of *Beyond Traffic* looks at major trends that are occurring in transportation, and broader exogenous forces, such as population growth and climate change, that are likely to shape transportation going forward. The second section considers the effects on highway, transit, pedestrian and bicycle, intercity and freight rail, aviation, maritime, and pipeline systems. The next section portrays a future baseline scenario, which could materialize from these trends. Finally, it identifies policy options for addressing the future trends.

  How we move:
  - By 2045 there will be 70 million more people using the nation's roads, rails, and airports.
  - Seniors will be the largest growth group, increasing by 77 percent.
  - Population growth will occur primarily in 11 megaregions, particularly those located in the South and West of the United States.
  - Congestion is forecast to increase to 40 hours of delay per person annually.
  - Millennials are driving 20 percent less than the previous generation when it was the same age (18–34 years old).
  - Income inequality remains a major issue, as the top 10 percent of the population receives more than one-third of all income, while poverty is increasing in the suburbs (but poverty rates remain higher in central cities).
  - Despite recent growth in urban area populations, much of the growth forecast is expected to continue to occur in the suburbs, where land less expensive.

  Policy options for reducing congestion and improving how we move include:
  - Increase investments in roadway capacity to address congestion in metropolitan areas.
  - Restructure federal surface transportation programs to allow for more targeted, demand-driven, mode-neutral investments.
  - Expand and/or improve the quality of transit services.
  - Strengthen the coordination of human service transportation services to meet the needs of older adults and people with disabilities.
  - Subsidize car ownership for the working poor.
  - Promote integrated transportation and land use planning.

- Support services such as bike sharing, car sharing, and ride sourcing.
- Integrate land use and transportation planning to support sustainable and efficient development patterns.
- Support design and planning choices that support alternatives to vehicle travel.
- Adopt congestion pricing.
- Remove the federal restriction on the tolling of interstate highways.
- Encourage companies to adopt telework policies.
- Sustain investments in transportation technologies and operational strategies that can reduce congestion.

How we move things:

- The U.S. GDP is projected to be $36.7 trillion in 2045, an increase of 115 percent; transportation will account for $1.6 trillion of GDP.
- U.S. exports were $2.3 trillion in 2013, the largest single-year total to date, and the fourth straight year of a new record ($1 billion in exports = 5,000 U.S. jobs).
- Crude oil production increased by 50 percent between 2008 and 2013 to 260 million barrels of oil per month, and the United States became the largest oil-producing country, bypassing Saudi Arabia.
- Rail carried 400,000 carloads of oil in 2013, 42 times as many as in 2008.
- Shale gas production in the United States increased fivefold to 10 billion cubic feet between 2007 and 2013.
- Freight volume is projected to increase by 45 percent to 29 billion tons in 2040, with a $39 trillion value, an increase of 125 percent.
- Freight movements are increasingly multimodal:
  - Trucks are forecast to increase 43 percent (13.2 billion tons to 18.8 billion tons).
  - Rail is forecast to increase by 37 percent (2.0 billion tons to 2.8 billion tons).
  - Water-based freight is forecast to increase by 10 percent (1.0 billion tons to 1.1 billion tons).
  - Air is forecast to increase by 250 percent (15 million tons to 53 million tons).
  - Congestion on the nation's roads will cost trucks $27 billion in 2040.

Policies options to address freight movement include:

- Establish strategic freight-funding programs that target freight bottlenecks.
- Encourage private investment in freight infrastructure.
- Adopt policies that shift freight demand to safer, more environmentally sustainable modes.
- Use congestion pricing to manage demand.
- Invest in ports and intermodal facilities to make intermodal shipping more efficient.
- Incorporate freight planning into transportation planning and regional economic development decisions.
- Incentivize the adoption of alternative fuel and electric vehicles by freight companies.
- Support research into automation technologies.
- Invest in infrastructure to support the safe and efficient movement of energy supplies.

How we move better:

- "More and more, the transportation sector is relying on data to drive decisions, and on technology to reimagine how we move people and goods."
- Connected vehicles and crash avoidance systems could reduce crashes between unimpaired drivers by 81 percent.
- Robots will impact transportation in a variety of ways, potentially changing vehicle operations and performing inspections of critical infrastructure.
- NextGen, using GPS technologies, will enhance the safety and efficiency of the skies.
- 90 percent of U.S. adults own a cell phone, and 20 percent use them for real-time transit or traffic data.

- Big data is expected to grow 40 percent per year, globally, and can help enable innovation transportation solutions such as car sharing, ride sourcing, pop-up buses, and more efficient goods movement.
- Governments should incentivize innovation, while understanding and helping to manage the risks associated with it, such as becoming more dependent on complex systems.
- Three-dimensional printers could decentralize manufacturing and disrupt supply chains—the first 3-D printed car was made in 2014.
- Annual expenditures in drones and unmanned aircraft is anticipated to double over the next decade, reaching $11.5 billion.
- Motor vehicles are undergoing three different, but related, technological advancements at the same time:
  - In-vehicle crash avoidance systems, which generate warnings and some limited automatic control of safety operations.
  - Connected vehicle technologies (V2V and V2I) that help to support crash avoidance systems.
  - AVs which must overcome issues with costs, uncertain emissions impacts, public safety and privacy concerns, regulatory and legal liability problems, and security questions. They could provide a number of benefits, such as:
    - Significantly reducing crashes, thereby improving safety and travel time reliability, while reducing associated nonrecurring congestion.
    - Enabling real-time route planning, further improving travel time and reliability.
    - Synchronizing traffic flows, which increases the ability of existing infrastructure to accommodate vehicle throughput.
    - Improving transportation access for youths, elderly, and people with disabilities;
    - Reducing freight delivery costs.
    - Allowing individuals to free up more productive and recreational activities, by reducing the amount time spent driving.
- AVs could take the form of an on-demand service, reducing car ownership levels. They could also transform transit, allowing for route expansion due to lower operating costs. Transit operators may also seek to create flexible, demand-based routes. Rail transit will continue to play an important role in serving dense, central business districts but could see ridership declines elsewhere. However, on-demand services could help make critical last-mile connections and work in combination with transit to make the entire system more efficient.
- AVs may allow people to live farther away from dense, urban areas, and this would lead to increased low-density development and would reduce the amount of agricultural land and open space in the United States.
- Increasing levels of vehicle (including trains, water-vessels, and aircraft) automation could diminish the ability and awareness of operators to respond to incidents when they happen. Greater amounts of information from on-board or independent systems create more complexity and increase the risk of operator error. Increasingly complex systems could make it more difficult to detect defects and/or vulnerabilities before potentially harmful events occur.

Policy options for improving how we move include:

- Encourage innovation within the regulatory framework instead of hindering it, while making transportation safety the top priority.
- Foster proactive engagement with those in technology-related industries to help the public sector anticipate future technology enhancements.
- Incentivize a skilled transportation workforce that is increasingly competent in the fields of science, technology, engineering, and mathematics.
- Require that privacy and cybersecurity concerns are sufficiently considered prior to adopting new technologies.

How we adapt:

- By 2080, 100-year storms could occur every three to 20 years; much transportation infrastructure has been designed to withstand a 100-year storm.
- By 2040, average temperatures are predicted to rise by 2.5 degrees F, above the 2 degree F threshold that scientists say we need to stay under in order to avoid the worst climate change outcomes.
- These higher temperatures will increase infrastructure maintenance costs for all modes by accelerating pavement deterioration (roads and runways), increasing the frequency of heavy truck tire blowouts, restricting or impairing aviation operations, and buckling of railroad tracks (which could lead to more rail derailments).
- Sea levels are predicted to rise 1 foot by 2045, and 4 feet by 2100.
- This threatens Louis Armstrong Airport in New Orleans (1.7 feet below sea level), and Philadelphia International Airport and Newark International Airport are both not much higher.
- Flooding from rising sea levels and increased storm frequency could imperil tunnels, subway stations, low-lying roads, and rail lines.
- Even small amounts of sea level rise greatly increase the risk of damage from storm surges, which bridges and low-lying infrastructure (including ports, rail yards, and roads) are particularly vulnerable to.
- Transportation emits 28 percent of all U.S. greenhouse gas emissions, the second highest of all sectors (electricity generation at 32 percent was the highest), though this does not account for emissions from manufacturing vehicles or constructing transportation infrastructure.
- CAFE fuel economy standards will double new-vehicle fleet efficiency to 41.1 MPG by 2021.
- Standards were updated in 2011 for the first time in 25 years and are scheduled to increase from 32.7 mpg in 2012 to 47.2 mpg in 2025.
- Heavy trucks account for 22 percent of transportation emissions.
- Status of alternative fuels:
  - About one out every 30 light-duty vehicles sold in 2013 was a hybrid (500,000).
  - Plug-in electric vehicles travel about 100 miles on 30–40 KW hours of electricity, the equivalent of over 100 mpg.
  - Biofuels can power any mode of transportation and can be produced from a variety of crops or vegetable oils, animal fats, and even used restaurant grease. However, depending on the feedstock used and the method of production, some biofuels may emit higher levels of greenhouse gas emissions than fossil fuels.
  - Toyota is starting to sell hydrogen fuel cell cars in Japan. Substantial investments in production, distribution, and refueling facilities are needed for it to become a viable transportation fuel. Technical challenges remain, such as safe fuel storage and producing reasonably priced fuel cells.
  - LNG and compressed natural gas are cleaner-burning fossil fuels, and the recent boom in natural gas production has brought their prices down to half the cost of diesel, leading to the manufacture or conversion of existing buses, trucks, and marine equipment to use natural gas fuels. However, natural gas extraction can lead to methane leakage (contributing to climate change) and pollute water bodies.

Policies to reduce greenhouse gas emissions from transportation include:

- Invest in alternative fuel research and infrastructure, and the development of fuel-efficient technologies.
- Create subsidies for electric and alternative fuel vehicles.
- Tax carbon emissions.
- Support pricing and operational strategies that reduce congestion on roadways.
- Increase and extend fuel efficiency standards across all modes.
- Support zoning and development policies that discourage sprawl.
- Encourage companies to adopt telework policies.
- Invest in transit, rail, and maritime infrastructure to support mode shifts.

- Engage international governments and pursue joint commitments to regulate greenhouse gas emissions.

Policy actions to adapt to climate change include:

- Integrate climate change considerations into asset management and transportation plans.
- Harden or abandon flood-vulnerable infrastructure.
- Increase resiliency standards when constructing new infrastructure.
- Create redundancies to increase network resiliency.
- Use zoning, insurance, and disaster recovery policies to discourage development in vulnerable areas.

We need to better align decision-making investments and transportation goals:

- Improving transportation system condition and performance will cost $120 billion per year from 2015 to 2020, compared to $83 billion in total expenditures by all levels of government; and $43 billion annually for transit versus current capital spending of $17.1 billion.
- Sixty-five percent of U.S. roads are in less than good condition, and 25 percent of bridges need significant repair or cannot handle current traffic levels.
- The quality of U.S. roads has dropped from eighth in the world in 2008 to sixteenth in 2014.
- Oregon is piloting road user charges of 1.56 cents per mile instead of 30 cents per gallon; over the next 10 years, increasing fuel economy standards will lead to $50 billion less in gas tax collections.
- Governments will need to be more resourceful, responsive, and adaptive to meet emerging challenges and to build and maintain a transportation system that meets transportation needs for today and the future.
- As transportation decision making has devolved to the local level, the number of governments and authorities has grown, making coordination between programs increasingly difficult.
- In California, regional and local governments account for 49 percent of transportation funding, while the federal government provides less than a quarter of funding.
- Outside observers propose consolidating federal programs into a competitive, non-modal pot and setting performance standards to incentivize improved outcomes.

All transportation agencies are facing serious financial challenges that restrict their ability to maintain the system as is, never mind build the transportation system of the future. While the public understands the importance of transportation, it has not been willing to pay for it, either out of concern that government will not efficiently use tax dollars, or they want to be assured the funds will go to projects near where they live or be invested in their mode of preference.

Options for improving transportation finance and governance include:

- Develop measurable national transportation objectives that link performance to incentives and/or consequences for federal funding recipients.
- Incentivize coordination across jurisdictions and the development of local revenues.
- Strengthen regional planning and project development.
- Improve data collection and analytical capabilities to enable more performance-based transportation programs.
- Quantify the economic benefits and lifecycle costs of projects to aid in maintenance and investment decisions.
- Develop revenue sources that provide sustainable, predictable revenue streams, and support efficient, long-term planning decisions for both capital and operating expenditures.
- Facilitate access to credit assistance for transportation projects and establish policies that level the playing field for states and municipalities seeking to deliver transportation infrastructure through public–private partnerships.
- Reform the project delivery process by improving coordination and streamlining permitting and oversight.

- Use pricing and market-based solutions to efficiently manage demand and to reduce regulatory burdens on travelers and industry.

Part 2 of *Beyond Traffic* looks at each individual mode. Key issues for highways and bridges include aging infrastructure, increased congestion, and reduced fuel tax revenues. In addition:

- Population and economic growth will increase motor vehicle travel, particularly in metropolitan areas, creating more congestion.
- Over the long run, FHWA projects vehicle travel to grow at an average annual rate of 0.69 and 0.82 percent. This is in line with or slightly higher than the population growth rate.
- Aging highways and deficient bridges require reconstruction or replacement, and will require more funding to maintain our roadway infrastructure in a state of good repair.
- Poor road and bridge conditions will increase vehicle operating costs, delay, and crash frequencies.
- Increased fuel-efficiency standards will lower fuel consumption, decrease fuel tax revenues, and force policy makers to consider alternative methods for funding transportation.
- Vehicle automation will improve safety and enhance transportation system productivity and result in challenges for planners, regulators, and policymakers.
- Safety advances will save thousands of lives.

Policies to enhance road and bridge conditions include:

- Identify sustainable funding mechanisms to compensate for the decreasing purchasing power of motor fuel taxes and increase federal credit assistance and private financing options for roadway enhancements.
- Use technology to make seamless intermodal travel routes, schedules, payment systems, and traveler information.
- Improve access to current and emerging shared transportation modes (bike share, car share, transit, etc.) through public education, affordability, and infrastructure investment.
- Prioritize investments in key transportation corridors to ensure reliable freight and passenger movement.
- Take steps to reduce distracted driving through the states and law enforcement agencies.

Public transit is currently experiencing a resurgence of ridership but still accounts for less than five percent of all work trips and about two percent of all trips:

- Population growth in metropolitan areas and changing attitudes toward travel will increase demand for transit.
- Decreasing fuel tax revenues could hinder federal support for expansion and maintenance of aging transit systems, which could lead to increased maintenance backlogs and transit fares.
- Information and communications technologies make transit more convenient and increase service efficiency and responsiveness.
- Emerging technologies are improving the safety and fuel efficiency of new transit vehicles.
- Climate change is increasing the vulnerability of transit systems to flooding, particularly those in low-lying areas.

Public transit is likely to increase mode share use in the United States over the next three decades.

Policy options for enhancing transit in the United States include:

- Invest in the reconstruction and rehabilitation of existing public transit assets that are badly in need of repair.
- Decrease total travel time and increase the reliability and frequency of public transit services.

- Invest in bus rapid transit services and convert existing general-purpose travel lanes into connected regional networks of dedicated bus-only right-of-way to greatly improve safety, access, travel speeds, frequency, and reliability.
- Identify sustainable funding mechanisms to compensate for the declining fuel tax purchasing power.
- Increase the use of performance measurements to prioritize funding for state of good repair.
- Promote common technologies and platforms that make transit payments more seamless and convenient.

Walking and biking account for nearly half of all trips under one mile and 10 percent of total trips. Key trends shaping these modes in the future include:

- Cycling and walking will continue to grow in popularity as metropolitan areas grow in population, lifestyle preferences change, and infrastructure is adapted to accommodate their use.
- Cities and towns across the country will increasingly invest in pedestrian- and bicycle-friendly infrastructure to accommodate growing demand for these modes.
- As people bike and walk more frequently, pedestrian and bicyclist safety will become an increasingly pressing issue for policymakers, particularly in urban areas.

The following policies can help to improve the growth and safety of walking and biking over the next three decades:

- Incentivize and improve pedestrian and bicycle infrastructure and create mixed-use development around multimodal transit hubs to promote car-free transportation.
- Design and retrofit roads to allow for safe, harmonious passage for all modes: vehicles, bicycles, and pedestrians, including individuals who use assisted-mobility devices.
- Educate drivers, bicyclists, and pedestrians on legal responsibilities and sound practices to safely share public streets.
- Promote safe and independent mobility for people with disabilities and older adults.

The last part of *Beyond Traffic* describes a scenario, "Drifting toward Gridlock," where there is a continuation of current policies at all levels of government. The results of this scenario would mean that highway congestion increases in major metropolitan areas and air travel delays become more frequent. Transit services become increasingly expensive, while intercity rail service is reduced. Goods movement becomes increasingly unreliable, making American exports less competitive due to increasing shipping costs. Climate change increases the cost of infrastructure maintenance, with more frequent travel disruption. The nation's regulatory system fails to keep up with technological evolution, holding back potentially transformative transportation and safety advances. Government is unable to provide the funding needed to preserve our infrastructure, while a patchwork of state policies leads to escalating interstate commerce costs. Due to an inability to make difficult decisions, the transportation system's performance and condition declines, becoming a drag on the economy and constraining growth.

The key principles that can guide policy development to set us on a better path include:

- Recognize the dangerous forces that threaten our transportation system and address them honestly, transparently, and in a fact-based manner framed by data and analysis.
- Develop new mechanisms to adapt to changing circumstances and advancing technologies with speed and flexibility.
- Re-evaluate and simplify the roles of various levels of government and engage the private sector to foster collaborative solutions and partnerships to achieve common goals.
- Ensure adequate resources to preserve, sustain, and build transportation assets and support options for funding and/or financing new investments in 21st-century assets.
- Advance balanced and sustainable economic growth without exacerbating income inequality or social division.

- Support technological innovation while ensuring the preeminence of safety, security, and privacy.

U.S. Department of Transportation. *The Smart/Connected City and its Implications for Connected Transportation*. Washington, DC: U.S. Department of Transportation, 2014.
http://www.its.dot.gov/itspac/Dec2014/Smart_Connected_City_FINAL_111314.pdf

- A smart connected city interconnects its employment, healthcare, retail, entertainment, public services, housing units, energy, and transportation systems. There are three primary ways in which smart interconnected cities differ from traditional ones. Smart connected cities:

  1. Have intelligent infrastructure which sense the environment, track conditions, and can send data and receive instructions.
  2. Use analytical techniques that have been made possible by advances in information and communications technology.
  3. Employ a smart grid to efficiently and dynamically transmit and distribute electricity in response to demand.

  There are a number of opportunities for how the emerging connected transportation system can intersect with smart connected cities:

  1. Intelligent infrastructure:
     a. IoT—Private and transit vehicles interact with other networked devices such as smartphones, streetlights, traffic signals, and building systems.
     b. Machine-to-Machine—Vehicles can send data about infrastructure condition.
  2. Process Innovation:
     a. Big Data Analytics—These predict unsafe operators, crashes, and congestion, and provide insight to real-time multimodal travel demand.
     b. Crowdsourcing—This improves real-time understanding of transportation system travel conditions and real-time influence over travel choices (apps such as Waze and StreetBump).
     c. Gamification—This creates new reasons and ways for transit use, real-time influence over travel choices, and personalized travel experience (apps such as Chromaroma).
     d. Smart Energy—Electric vehicles will be an essential component to the electrical grid (vehicle-to-grid, V2G).

  Two key trends will shape how the emerging connected transportation system intersects with smart connected cities:

  1. Connected vehicles, individuals, and equipment will share all types of data, and can serve as nodes within the IoT.
  2. Individuals can increasingly transition mobility from an asset-ownership to a pay-for-service model.

  Big data uses advanced techniques to capture, manage, and analyze large and diverse datasets, and is a new approach to generating knowledge. It is usually talked about in terms of the 5Vs: volumes of data, substantial variety of data, collected and analyzed at high velocity—enabling real-time decision making—veracity, and value. Big data capture differs from traditional approaches by:

  1. Measuring nearly an entire population or system rather than statistical samples.
  2. Due to the volume of data collected, not requiring the careful planning to capture the right place, time, and conditions.
  3. Often using multiple and diverse data sources.

Analyzing big data encompasses a number of fields related to data science, including: advanced statistics, signal processing, machine learning, and pattern recognition. Common uses include insurance fraud detection, predicting mechanical failures, and market segmentation. UPS used to replace certain failure-prone parts on its delivery vans on a regular schedule. This often meant replacing parts that were still useful, and doing so was a waste of money. Now a sensor equipped on vehicle undercarriages is used to identify patterns that correlate with part failure.

Crowdsourcing is the practice of obtaining needed services, ideas, or content by soliciting contributions from a large group of people and especially from the online community rather than from traditional employees or suppliers. This has become a widespread, low-cost technique for collecting data and insights, such as brainstorming ideas or finding solutions to issues from inclined individuals. The General Services Administration's Challenge.gov is a good example of a crowdsourcing platform.

Gamification applies the principles of gaming elements (competition, cooperation, status, and achievement) to non-game endeavors, offering incentives for participation through entertainment and competition. London's Chromaroma is a good example that encourages the use of alternative transportation. Individuals score points for themselves, or their team, by visiting different check-in spots and sharing the exploits on social media.

The SmartGrid incorporates information and communications technologies (ICT) to use real-time energy flow information for more efficient energy distribution. There are a number of challenges in implementing SmartGrid technologies:

- Linking distant energy supplies to local demands requires efficient transmission. High-voltage DC lines can more effectively transmit electricity thousands of miles than the predominant AC lines can. DC lines can also better connect renewable wind and solar energy resources to where the demand is.
- To match time-of-day supply and demand needs, advanced energy storage such as fuel cells, flywheels, pumped air, pumped water, batteries and other technologies can smooth out power generation with the spikes and drops in demand that occur throughout the day.

Electric vehicles are increasingly becoming key nodes in managing the SmartGrid. Plug-in electric and fuel-cell vehicles can help to improve complex energy flows in the V2G infrastructure in what is becoming a highly interdependent system. V2I and V2V technology offers real hope for congestion relief and safety. Connected vehicles will transmit real-time location, speed, and other data to traffic management systems that are significantly more precise and in depth than what is currently available. External sensors can use real-time data to monitor for roadway hazards such as ice, sharp curves, or other vehicles, and issue warnings to the driver. Connected individuals with smartphones can greatly enhance their ability to foresee and alter travel behavior. A household on the IoT may transmit which room its occupants are in (the kitchen or the bedroom, for example), to give an estimated time at which a commuter will depart. Transit agencies may be able to directly market to individuals stuck in traffic with incentives to try taking the train or the bus as a commute alternative. Intelligent transportation infrastructure can monitor parking space availability to help reduce how much time and distance is spent searching for parking.

Achieving all of this will require overcoming several non-technological challenges.

- Privacy and security issues that come with connecting to the IoT, particularly for connected vehicles and individuals.
- Interoperability between vehicles and the rest of the IoT.
- Increasing systematic risks from interconnected systems that could possibility lead to cascading failures.

Mobility is more and more about reaching destinations efficiently, rather than simply relying on a single mode (the automobile). This has come about due to advances in vehicle and communication technologies, including connected vehicles and AVs. Mobility is shifting to being provided through a service, rather than via asset ownership. This is being brought about by:

- Seamless modal integration through data, data sharing, and real-time information.
- New transportation models such as vehicle and ride sharing.
- Smartphones and apps that readily access data.

The *Washington Post* has recommended ways to make ride-sourcing policies that are fairer to all passengers:

- Limit the number of hours ride-sourcing drivers can operate.
- Require higher-level background checks on drivers.
- Ensure proper insurance coverage.
- Regulate demand-based pricing.
- Provide driver training.
- Create a new class of drivers' licenses and renewal.
- Perform vehicle inspections.
- Have drivers check in.
- Standardize pricing.

Bike sharing has a benefit of allowing its users to go from one destination to another, as opposed to requiring a round trip. As of 2013, the United States had 22 public sharing programs with 17,000 bikes, and these numbers are growing rapidly. The Vélib system in Paris shows the large potential for these systems to produce significant change. This system opened in July 2007 with 21,000 bicycles. Bicycling volumes then increased by 70 percent in the first year of operation, while VMT declined by five percent. Taking cues from bike sharing systems, new car sharing systems are offering similar one-way, station-to-station trip making. Advances in ICT are powering new app-based ride sharing programs, which pair like-minded people traveling along similar origins and destinations. The app calculates the fare, bills the passenger, and pays the driver when the trip is complete.

Connected vehicles are forecast to make up 60 percent of the vehicle fleet by 2017 (it was 11 percent in 2014), and there will be five billion smartphone users by 2020. Forecasters predict that these two technologies will help to create an autonomous mobility-on-demand (A-MoD) network that works with transit systems to solve the accessibility and mobility conundrum, particularly the first-mile and last-mile gap between transit stops and final destinations. Intelligent demand calculations will move these cars to where they are needed, and idle time will be used for logistics or connecting to wireless charging stations. By 2050, there may be 2.5 billion cars in operation, which suggests that there will be much more need for walking, biking, and better transit, for the good of the planet.

Lastly, there is a series of recommended future research objectives:

- "Identify how cities (of all sizes) and city agencies (of all types) can harness the power and potential of connected vehicle data, technologies, and applications and leverage these effectively and efficiently to help achieve mobility, economic, social, and other goals."
- "Explore how cities and city agencies might leverage the opportunities presented by Internet-connected mobile communications technologies—and the data they collect and generate—to connect to citizens, influence traveler behavior in the short and long term, and affect public policy and decision making."
- "Identify the implications of shared-use mobility, mobility-on-demand, and mobility rightsizing on driver behavior and the changing socio-economic views of driving and mobility."

- "Identify how connected vehicle data can be integrated with a wide variety of other data to create the most effective, innovative, and informative real-time (and predictive) data visualizations to support effective and efficient decision making by a variety of public agencies and also by connected travelers."
- "Identify the most effective crowdsourcing, gamification, [incentives,] and applications to address and solve transportation issues/problems and explore how connected vehicle data, technologies, and applications can contribute to support agency and traveler needs."
- "Identify how electric and other alternative fuel vehicles will (or will not) affect mobility decisions in the future (including the economics and purpose of driving), and how these changes might affect the deployment of connected vehicle technologies and applications."
- "Evaluate the benefits of connected vehicle technologies and applications at three levels—overall societal impacts, advancement of cities' particular missions, and personal financial savings—within an overall framework of integrated city activates and services."
- "Identify core stakeholders/partners in the public and private sectors to develop strategies and best practices to leverage connected vehicle technologies, data, and applications, and push forward the state of the practice and the state of the art."

Vock, Daniel C. "7 Ways Self-driving Cars Could Impact States and Localities." *Governing*, January 15, 2015. http://www.governing.com/topics/transportation-infrastructure/gov-driverless-cars-impact-states-localities.html **(accessed February 3, 2015).**

- A future where cars drive themselves will require a massive restructuring of how governments at all levels work to finance, design, build, maintain, and operate streets and roads. Some of these changes could be:
  - More rumble strips on roads not only enhance safety for drivers, but they can also help driverless vehicles stay in their lane.
  - Standardized signs could be read by AVs using cameras. It would help if all types of signs were the same from one state to another.
  - Regulations may spur innovation. When government and the private sector work together, new technology can be better tested and eventually brought to the market sooner.
  - The fast pace of technology could shorten infrastructure lifespans and would require finding new ways to finance vehicle and infrastructure communications technologies (for example).
  - As new systems track more personal information and perform many tasks within the maintenance and operation of the transportation system, cybersecurity becomes more important.
  - With the rise of bike sharing, Uber, and eventually AVs that operate as taxis, individuals may not own cars anymore. This could significantly impact transit use, state budgets, insurance, and local taxi and ride-source regulations.
  - Speeding tickets, speed limits, and drunken driving could all disappear, leading to safer and more efficient roads. Although less revenue may be generated for local police, they would also be freed up to focus on other duties.

Volpe Transportation Center. *Transportation Drives Economic Competitiveness in Megaregions*. Cambridge, MA: Volpe Transportation Center, November 13, 2014.
http://www.volpe.dot.gov/news/transportation-drives-economic-competitiveness-megaregions
(accessed January 5, 2015).

- Dr. Catherine Ross, director of the Center for Quality Growth and Regional Development at the Georgia Institute of Technology, notes that cities are the anchors of megaregions, and because they are more interconnected with each other and their suburbs, they are operating in a very different way economically. As technology and globalization march on, the world grows more complex and intertwined through trade, communication, and transportation networks.

Megaregions cross geopolitical boundaries, and each one has its own unique role within the national and global economy. The key is to understand the economic functions of megaregions, then consider whether or not transportation is effectively supporting those functions. The Northeast Megaregion, for example, grows around technology, international trade, and manufactured goods that are shipped all over the United States. However, it is made up of a number of states, each with their own DOT, that need to collaborate together and prioritize projects that help to strengthen the megaregional economy. Planners need to do a better job of understanding how goods, people, and ideas flow within and between megaregions. Transportation funding and financing should be able to cross state lines, account for environmental concerns, and provide for a holistic approach.

Walker, Jarrett. "Microtransit: Good or Bad for Cities?" Human Transit, April 28, 2015. http://www.humantransit.org/2015/04/microtransit-good-or-bad-for-cities.html **(accessed August 25, 2015).**

- Microtransit operators are private companies seeking to create a service between public transit and a personal vehicle. An important question is whether they will work with public transit systems or try to undercut them.
  - If these systems are coordinated, we would have less VMT, congestion, and emissions; increased demand for transit-supportive development patterns; and more charitable and welcoming cities.
  - If they compete with each other, then the playing field between these new micro transit services and public transit, with workforce compensation and regulatory civil rights and other requirements, needs to be leveled:
    - Paratransit service comprises 20 to 40 percent of most transit agency budgets.
    - Should micro transit companies be required to submit Title VI plans to prove they do not discriminate?

  In a fair fight, public transit would win because it is the most efficient use of labor and scarce and valuable urban space. In an unfair fight, micro transit will win while the environment (low-wage contractors replacing large, efficient vehicles with smaller ones) and justice will lose out. A collaborative process has a difficult path forward, as micro transit companies see public transit as the enemy, while transit and its unions must overcome defensiveness and territoriality. A successfully coordinated system would mean less expensive transportation options and improved service in suburban areas where transit service is not feasible. The good news is that micro transit companies' messaging is becoming more inclusive and pragmatic, an indication that they do want to be a part of a sustainable, efficient, and inclusive region.

Walsh, Ben. "Self-driving Cars Are Still Cars—Which Means They Won't Improve Your Commute." ***The New Republic*****, May 29, 2014.** http://www.newrepublic.com/article/117943/googles-self-driving-cars-miss-problem-mobility-america **(accessed August 6, 2015).**

- Google's latest self-driving concept car does not have a steering wheel or any pedals—which means it requires no human intervention. While Google boasts that this is the next step in a transportation revolution, the corporation is choosing the wrong medium if it really wants to improve how people get around. Driving is expensive and has hidden costs that it imposes on others. Cars are inefficient in their use of space and energy and have transformed our communities in a number of negative ways. They inhibit social interaction, entrench class boundaries, and reduce the rate of walking—which has been shown to be good for local economies. When people walk around, they can easily step into a store to purchase something, and they have more disposable income due to lower transportation costs.

For the 86 percent of commuters who drive alone to work each day, driving is a miserable experience. This is largely due to congestion from other vehicles. And even though Americans largely do not enjoy driving, the one aspect they do enjoy is being in control of a powerful machine. Take this away, and you take away whatever is left that makes driving enjoyable. While cars work fine in rural and suburban areas, they are a problem in urban areas. This is a problem that must be solved, not just tinkering around the edges. To really transform transportation, we must solve the problem of space—there is not enough of it where you want to go, at the time you want to go there. The Hyperloop is a better proposed innovation that can help to solve the problem of efficient use of time, space, and energy, while making mass transit more fun and exciting.

Weissman, Jordan. "Don't Fear an Oil Bust." *Slate*, December 5, 2014. http://www.slate.com/articles/business/moneybox/2014/12/falling_oil_prices_why_an_oil_bust_won_t_hurt_the_american_economy_or_energy.html **(accessed December 5, 2014).**

- Thanks to new drilling technologies, the world is producing more oil than it can use, and the cost of oil has sunk to under $70 per barrel. OPEC could cut production to reduce the oversupply but is instead waging a price war to protect its market share from shale gas producers in Texas and North Dakota. While no one is sure what price would make shale drilling unprofitable, some believe the new techniques would allow for profitable production at oil prices as low as $25 per barrel. Despite that, permits are down, and before long the United States will be producing less crude than it has been, particularly since shale wells have short lifespans, and companies need to continuously drill to maintain production. This could be bad news for the states that have been relying on gas and oil production, but it may be good news for the United States as a whole. These benefits may include:

  - Inflation concerns may ease, allowing the Federal Reserve to keep interest rates low.
  - Increased economic activity may result as consumer cost savings are already about $75 billion. This is more likely to be spent sooner by consumers (than if it went to an oil company) and is less likely to end up in the pocket of a foreign investor.
  - The low point in the economic cycle will shake out the most inefficient oil and gas producers.
  - The less fracking there is, the less negative environmental impacts there are, and the oil and gas will still be in the ground if we need it.
  - Investors may benefit from a more careful industry, with less money spent on failed wells.

  Prices will probably stay low for a few years, and then rise back up to around $100 per barrel. The United States will continue to drill but probably at a slower pace than during the recent boom years.

Wines, Michael. "Oklahoma Recognizes Role of Drilling in Earthquakes." *New York Times*, April 21, 2015. http://www.nytimes.com/2015/04/22/us/oklahoma-acknowledges-wastewater-from-oil-and-gas-wells-as-major-cause-of-quakes.html **(accessed April 27, 2015).**

- For decades, the state of Oklahoma averaged 1.5 earthquakes of magnitude 3.0 or greater per year. That figure has grown exponentially, coinciding with increased natural gas fracking. It was 585 in 2014, and it is on pace to top 900 in 2015. After years of skepticism, the Oklahoma Geological Survey (within the state government) has embraced the scientific consensus that the earthquakes are largely caused by disposing oil and gas well wastewater underground. It has set up a website detailing the evidence at http://earthquakes.ok.gov/.

  The Oklahoma Oil and Gas Association disagrees with this conclusion, saying more study is needed to determine how the wastewater impacts underground faults. It also alleges there is no evidence that stopping the disposal of wastewater would reduce the number of earthquakes. The state is taking steps to protect homeowners, especially in the regions that have been hardest hit,

principally by directing them to purchase earthquake insurance, though some have already suffered damage, and policy coverage has been narrowed as the number of tremors has risen.

Wink, Christopher. "Philly's City Wage Tax Just Turned 75. Here's Its Dubious Legacy." *Technical.ly Philly*, December 12, 2014. http://technical.ly/philly/2014/12/12/philadelphia-city-wage-tax/ **(accessed March 3, 2015).**

- In December 2014, the Philadelphia city wage tax turned 75 years old. Today it is the source of two-thirds of the city's budget. The structure of the wage tax is not prohibitive against starting a company in the city, but it does help to push larger companies out. Many blame the wage tax as a reason why Philadelphia has continued to lose jobs since the 1970s, while other large Northeastern cities have gained them. This goes back to the old adage: do not tax things that can move (such as businesses and jobs); rather, tax what you do not want or cannot move (land and buildings). Meanwhile, low property taxes, which comprise 17 percent of the city's revenues, lead to commercial rents that are low enough to stifle development.

  Recent thought is that the wage tax may have never played all that strong of a role in locational decisions. Up until the last 10 years or so, the location decisions were about suburban preferences, and the wage tax was just another excuse to not be in the city. Now, as more young professionals are showing preferences for living in dense, walkable communities, the wage tax does not appear to be factoring heavily into their locational choices, either. Instead, there are more complaints about how complicated it is to set up and be compliant with city business regulations. And the even bigger issue is that although they would prefer to stay, they fear being pushed out by the quality of the schools once their children hit school age.

  Post-recession, sole proprietorships have grown by 52 percent in the United States, and by more than twice that rate in Philadelphia. This is one reason for the dramatic growth in co-working space in the city. However, Philadelphia has not been successful in turning entrepreneurship into large companies. The business community still sees that reducing the wage tax to a reasonable rate is necessary for longer-term viability. One tax proposal to help reduce the wage tax is to tax commercial and residential properties at different rates. This will require state authorization. This would also raise commercial rents, which make development more feasible. Lowering the wage tax would mean lower tax revenues for the city, which is already fiscally constrained. Another idea to bridge the revenue gap in the short term is to sell an asset, such as PGW. Though there is not consensus on what a reasonable rate is, Wharton School of Business has identified a rate of two to three percent (versus the current 3.92 percent for residents and 3.4912 percent for nonresident employees) as competitive.

Wink, Christopher. "If Philly Becomes an Investment Hub, It's Because of These 2 Tiny Tax Changes." *Technical.ly Philly*, January 26, 2015. http://technical.ly/philly/2015/01/26/philadelphia-tax-code-investment-clarification/ **(accessed January 26, 2015).**

- In 2008, Philadelphia's Revenue Department Commissioner clarified that the city tax code for private equity, venture capital, and other investment funds is only pass-through and not taxable business. This was followed up by a council bill that amended the city tax code to clarify that neither management fees nor businesses' financial performance would be subject to the net profits tax for compensation. This change has particularly benefited venture capital firms, which are following the tech community to the city where young people want to work. While a number of firms have already moved into the city, it will take at least 10 years for the full impact of these legal changes to take effect. This has to do with the nature of the venture capital business cycle, that startups may begin in the suburbs and move into the city as they grow, and that many firms have 10-year leases that need to expire before they relocate.

Wladawsky-Berger, Irving. "The Continuing Evolution of the On-Demand Economy." CIO Journal of the *Wall Street Journal*, July 24, 2015. http://blogs.wsj.com/cio/2015/07/24/the-continuing-evolution-of-the-on-demand-economy/ **(accessed December 7, 2015).**

- Numerous articles are tracking the ongoing growth of the on-demand (or collaborative, sharing, or peer-to-peer) economy. Some articles note that these technology-based models empower individual workers, who can choose to work when and how they want. Others are concerned with how it is changing the nature of work, where individuals need to be ready to work at any time for low pay and little or no benefits. Particularly, as this emerging economy is increasingly owned by the top one percent of the Silicon Valley.

  The on-demand economy is allowing goods and services to be exchanged directly between individuals, and thereby reducing the need for businesses. The ability to communicate in real-time and reduced transaction costs continues to give rise to new companies, with highly scalable platforms and a freelance workforce, that efficiently bring consumers and producers of goods and services together. This is a culmination of a trend that has been going on for more than a generation. With growth slowing in the 1970s, firms wanted to become more flexible, while outsourcing nonprofitable and noncore competency tasks. In the 1990s, the internet accelerated these transformations, and gave access to a global supply of labor. Over all this time, companies have grown competent at dealing with a highly fragmented workforce.

  Here are two suggestions for improving worker conditions in the on-demand economy:

  - Create a new worker category, dependent contractors, for those who are largely employed by a single firm that has substantial control over their work. This classification would enable more protection than independent contractors or freelancers, but still be separate from direct employees.
  - Give freelance workers access to entirely transferable digital credentials and reputations. If an independent contractor moves from one platform to another, they should be able to maintain the credit they have earned, and not have to start from scratch. Third party entities may be needed to ensure this transferability.

Wood, Graeme. "The Future of College?" *The Atlantic*, September 2014. http://www.theatlantic.com/features/archive/2014/08/the-future-of-college/375071/ **(accessed October 22, 2014).**

- Minerva University is a for-profit startup located in San Francisco, California, that will soon expand to a number of other cities around the world. Unlike traditional colleges, Minerva does not allow lectures or grant tenure. Instead, classes are taught over a highly interactive online platform. Students will attend the university in a different location each year, giving them an international experience that very few other universities offer. With all of its classes being taught online, Minerva will have very few facilities outside of its dormitories where its students will live. Much learning will take place outside of the classroom, with cultural offerings and extracurricular activities integrated into the program. The professors can live anywhere as long as they are connected to the Internet. This will likely be a major advantage for recruiting faculty members.

  Lectures have survived as the main form of teaching for hundreds of years because they make economic sense—one employee for dozens, or more, of tuition-paying students. However, there is not much evidence that they are an effective method for learning. Beyond that, university costs have been rising well above inflation for years, and the average student loan debt for graduates continues to climb as a result. Recent higher education innovations have not come from established universities, but from online courses—MOOCs—from Khan University and Coursera. As these lecture courses continue to improve over time, the university lecture model is threatened. If the best online courses are consistently better than what you find at a university, why pay

thousands of dollars to attend one? Minerva views these online courses as the new "library." Minerva offers seminars that are based on pedagogical practices. Students attending them will need to be ready to discuss and defend their positions on class topics. If they need background materials, they should find them online. The founder of Minerva hopes to show traditional colleges and universities how to improve learning practices. However, there is some possibility that this could become a disruptor of the entire college and university system, leading to its total reconceptualization.

Zax, David. "A World without Car Crashes." ***The Atlantic CityLab*****, February 11, 2014.** http://www.citylab.com/commute/2014/02/world-without-car-crashes/8353/ **(accessed August 12, 2015).**

- Over the last 18 months Ann Arbor, Michigan, has been the site of the largest connected vehicle (or Internet of cars) trial completed to date. Some 1,800 cars were fitted to V2V technologies, which communicate to each other and warn their drivers of impending danger. Another 400 cars were connected with V2I technologies, where devices along the road communicate upcoming road dangers, such as a sharp curve, approaching train, or a car stopped ahead. These technologies are expected to make the road much safer, with an estimated 80 percent reduction on the nonimpaired (crashes involving only sober drivers) crash rate. This would have a bigger impact than seatbelts or airbags. Given the success of this study and others like it around the country, the National Highway Traffic Safety Administration will make these technologies mandatory for all vehicles sold in the United States at an unspecified future date. Safety benefits are just the start. Once an Internet of cars is created, all road vehicles will be sharing data in real time with roads, traffic signals, and transportation authorities. The outcomes from this could be as far reaching as they have been from the original Internet. These effects could include:

  - Dynamic traffic signals that optimize traffic flow.
  - Variable priced parking.
  - Better travel directions and time estimates.
  - Narrower lanes that allow more lanes in the same right-of-way.
  - Platooning to save fuel through drafting.
  - Lower vehicle weights.
  - Rethinking of business models.

  There are skeptics who fear this is the wrong technology (e.g., Betamax), and the government is making a bad investment. But if someone does not invest in developing technologies, they will not be able to mature. If no one purchased the first cell phones, we would not have that industry today. There are also concerns that Americans will not be willing to cede control of the vehicle to a machine—even if it makes them safer—given their love affair with driving. Other risks come from hacking potential and concerns over personal freedoms as more data is recorded about everyone's whereabouts.

Zmud, Johanna, Liisa Ecola, Peter Phleps, and Irene Feige. ***The Future of Mobility: Scenarios for the United States in 2030*****. Santa Monica, CA: RAND Corporation, 2013.** http://www.rand.org/content/dam/rand/pubs/research_reports/RR200/RR246/RAND_RR246.pdf

- Long-range planning requires making difficult decisions, especially in the current time of limited resources. Which mode(s) should we prioritize? What projects should we fund? What trends should be monitored? How are demographics, travel behavior, and economics going to evolve and interact with each other? These questions are important, because transportation decisions made today will impact the future over the next 30 to 50 years.

  Understanding the future cannot be done simply by projecting trends or better travel demand models. So RAND gathered a group of 37 experts from government, academia, nonprofits, and

private firms and developed plausible future mobility scenarios with them. An outside panel of 27 additional experts reviewed the scenario, using an online Delphi Technique[C-4] tool called ExpertLens. Scenarios can be used in a number of ways: to provide an assessment of current strategic planning or policies; to facilitate unconventional thinking and consider a range of different futures (rather than a single view of it); and to better prepare planners and decision makers for change.

A six-step process was used to develop the scenarios:

1. Identifying influencing areas—topic, geography, and time period.
2. Projecting descriptors—such as the price of a barrel of oil.
3. Building scenario frameworks—using cross impact and consistency analysis to identify the relationships between descriptors and the scale to which any two descriptors impact a third.
4. Constructing scenario narratives—experts invited to read and critique the draft narratives; critiques were then used to sharpen the content.
5. Discerning mobility outcomes—estimates developed for future passenger miles traveled and mode share.
6. Generating wild-card scenarios—identifying what might profoundly impact the estimates that were produced in the process.

Two scenarios were developed. These scenarios are illustrative, not normative. Neither is an ideal path for the future of transportation.

- No Free Lunch—Evidence of a changing climate combined with high oil prices leads to changing attitudes on greenhouse gas regulations.
  - Increasing regulation of greenhouse gases increases, rather than inhibits, economic growth.
- Fueled and Freewheeling—Inexpensive and plentiful energy combined with a lack of regulation leads to more transportation and increased suburban development patterns.

These scenarios illustrate the interconnections between markets, policies, and consumer preferences. Two wildcards were also considered:

- Red Dusk—China undergoes a debt crisis that leads to economic stagnations, profoundly impacting U.S. demographics and economics:
  - As China is the largest foreign holder of U.S. debt, the United States has a hard time finding a source of cheap foreign capital following a Chinese economic downturn.
  - Other spillovers include an increase in immigration to the United States, more trade protection battles between the two nations, and a corresponding economic slowdown in the United States.
- AV Revolution—AV costs decline to the point where they are available to the market prior to 2030, with related transportation impacts:
  - If AV market penetration were to happen sooner and more quickly than generally anticipated (at least two decades off, according to this RAND report), a state may want to preemptively develop insurance regulations that account for this new technology.

The analysis identified three significant driving forces:

1. The price of oil.
2. Environmental regulation.
3. Strategic options that arise from these scenarios.

[C-4] The Delphi process is an interactive, expert-driven forecasting procedure in which the experts anonymously answer facilitated questions. The facilitator summarizes these answers and the reasons for them to the group, which then revise their initial responses based on hearing what everyone else thought. This process should converge toward a consensus estimate, which may take several rounds to achieve.

The report notes a number of ongoing trends related to demographics, economics, energy, transportation funding and supply, and technology. Some highlights:

- "Much of the increase in [VMT] and vehicle ownership over the past 50 years has been attributed to women's increasing participation in the labor force."
- Manufacturing accounted for about 25 percent of all non-farm employment in 1970; by 2010 it was less than 10 percent.
- Between 1980 and 2007, freight ton miles (one ton of freight moved one mile) increased by about 1.1 percent per year (Bureau of Transportation Statistics, undated).
- In 2010, about 80 percent of Americans had Internet access (World Bank, 2011).
- In 2009, China overtook the United States to become the world's largest car market.

Common projections between the two scenarios include:

- Demographics:
  - U.S. population increases by 0.8 percent annually; the 2040 population is 360 million; the population is older and contains a higher percentage of Latinos.
  - Household size is 2.6 persons, unchanged from 2012 due to two opposing trends: more older people living alone and larger families due to more immigration.
- Economic Growth:
  - No Free Lunch two percent GDP growth and 1.2 percent personal income growth per year.
  - Fueled and Freewheeling 2.5 percent GDP growth and two percent income growth annually.
- Goods Movement (ties with GDP growth):
  - No Free Lunch 0.9 percent annual growth.
  - Fueled and Freewheeling 1.1 percent annual growth.
- Domestic oil production increases from 8 million barrels per day in 2010 to 15 million by 2030 thanks to unconventional sources. Tight oil production in Texas to the Pacific Northwest adds three million barrels, and Oil Sands make up the bulk of the remaining increase. Shale gas does not grow due to environmental opposition. Growing world demand is easily able to absorb this additional oil production.
- Telecommuting:
  - No Free Lunch 40 percent of workers.
  - Fueled and Freewheeling 15 percent of workers.

GREATER PHILADELPHIA FUTURE FORCES: TECHNICAL REPORT

Publication Number: 16007

Date Published: March 2016

Geographic Area Covered: Nine-county DVRPC region consisting of Burlington, Camden, Gloucester, and Mercer counties in New Jersey; and Bucks, Chester, Delaware, Montgomery, and Philadelphia counties in Pennsylvania.

Key Words: Future Forces, Futures Group, Background Forces, What-If Scenarios, Enduring Urbanism, Free Agent Economy, Severe Climate, Transportation on Demand, U.S. Energy Boom, Universal Actions, Contingent Actions, Autonomous Vehicles, Ride Sourcing, Micro Transit, Leading Indicators, Decision Making, Goods Movement, Transportation Infrastructure, On-Demand Outsourcing, On-Demand Economy, Sharing Economy, Freelancers, Gig Economy, Automation, Robotics, Energy, Greenhouse Gas Emissions, Climate Change, Technology, Mobile Communications, Real-Time Information.

Abstract: This effort builds scenarios off a set of Future Forces of change in Greater Philadelphia. Future Forces may accelerate or reverse current trends, or create new ones that significantly impact demographics, development patterns, use of the regional transportation system, the economy, and/or the environment. These Future Forces were identified collaboratively by the Greater Philadelphia Futures Group consisting of regional stakeholder experts:

- ☐ Enduring Urbanism – People and jobs moving to walkable centers is the start of a long-term trend.
- ☐ The Free Agent Economy – Increased outsourcing and automation means individuals must create their own economic opportunities.
- ☐ Severe Climate – Continued rise in atmospheric carbon levels lead to significant disruptions from climate change.
- ☐ Transportation on Demand – Smartphones, apps, and real-time information help people get around using a variety of new and existing transportation modes.
- ☐ The U.S. Energy Boom – An abundance of domestically produced oil and natural gas keeps the cost of energy low.

The Future Forces were analyzed and modeled as what-if scenarios out to the year 2045. This highlights how the region may change over the next 30 years, with potential shifts in transportation demand, and identifies specific opportunities that may arise and challenges the region is likely to face. Lastly, the report identifies actions needed to better position the region to respond to these Future Forces. Contingent actions and skills are specific to each force, and leading indicators can be used to determine if it is occurring in the region. Universal actions are beneficial regardless of which forces arise. A shorter, more graphic report (Greater Philadelphia Future Forces, DVRPC Publication Number 16007A) was developed to accompany this technical version.

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