Emerging Technologies

INTRODUCTION

Think about your drive home from work, school, or errands. But notice something is different: there are cars on the road but no traffic congestion, the air is clean, there are no crashes, and you aren't worried about getting a speeding ticket.[1] If you ride your bike home you'll see it, too—vehicles aren't whizzing past close enough to clip you and, when you get tired of pedaling, you rest your feet and coast home. If you take public transportation, the ride is a productive extension of your day as you finish a report and catch up on email.

Sounds great, right? Well, these are just a few examples of how transportation technologies could enhance our quality of life in the future. Transportation innovations aim to improve the efficiency, safety, and comfort of each travel mode addressed in *Communities in Motion 2040 2.0* (CIM 2040 2.0): automobile, bicycle, pedestrian, freight, and public transportation.

CIM 2040 2.0 looks to the horizon year of 2040 to anticipate transportation needs. The crystal ball is inherently murky looking ahead 20+ years, so let's first look *back* 20. The year was 1998, *Titanic* became the first film to gross over $1 billion, Will Smith was "Getting' Jiggy wit It," and *Seinfeld* aired its final episode. The new technology of the era included MP3 players, cell phones, and everyone's favorite pet, the Tamagotchi.

Just as we could not have anticipated all of today's technological advances in 1998, no one knows for sure what the next decades will bring. However, it is still important to consider the changes coming to transportation and evaluate who they will impact and how we should adjust. Idaho stakeholders are partnering to innovate and implement many technologies sooner rather than later.[2]

CAVEATS

The impact of any futuristic innovation is difficult to predict; while some innovations will come to fruition, others will not. For every Wikipedia there is an America Online. Also, while many of these technologies will change the way we travel, there is the potential to overhype the product and expect it to do too much (Figure 1).

Also, there isn't always a straight line from idea to implementation. There is a messy labyrinth of economic, political, legal, demographic, and market considerations. The rise of one technology may suppress another, or it may create a symbiotic relationship that increases the adoption of both technologies. For example, the internet made online streaming possible and undermined television watching, thus both advancing and disrupting the entertainment industry.

The purpose of this document is not to identify every possible transportation technology or speculate on exactly how or when technology will impact our lives. Instead, it will address key issues to consider about future transportation technologies and highlight some of the potential technological changes that may impact the transportation realm.

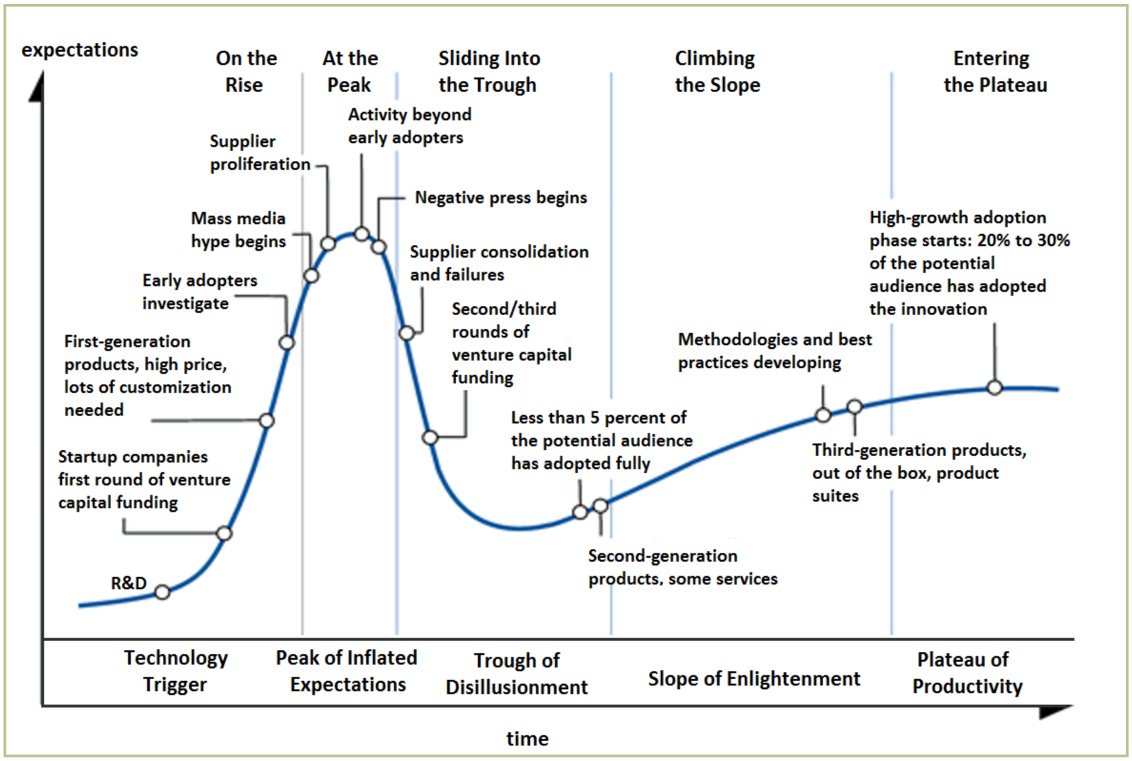

Figure 1. Hype cycle for technology. *Source*: Wikipedia Commons, **based on the Gartner Hype Cycle.**

WHAT IS IT? TECHNOLOGY TYPES

The technologies explored in this section are grouped as near-term, medium-term, and long-term innovations, and alphabetized within those groups.

Near-Team Innovations

This section covers innovations that are currently being used and/or are expected to be widely used in the next few years.

Alternative Fuels

Alternative fuels are derived from cleaner energy sources than traditional fuels, and include electricity (including electricity from solar energy), hydrogen, natural gas, and propane. These can make driving a vehicle cheaper, more convenient, and more environmentally friendly, and can reduce dependence on foreign oil.

The use of alternative fuels is expected to grow over the next decade; however, gasoline and diesel are expected to continue to provide the majority of transportation energy.[3] In many instances, using alternative fuels requires the vehicle to incorporate additional technologies, which can increase production costs.[4] Government subsidies for clean energy can shift market demands but can be politically divisive.

Bike Share Programs

Bike sharing has become a popular tool for short point-to-point trips. Users pick up a bicycle at a permanent or portable self-serve bike station and return it to any other bike station located within the system's service area.[5] Boise GreenBike has been a program of Valley Regional Transit (VRT) since 2015. As of 2016, it was providing over 26,000 trips to over 7,500 active members per year, with bikes at 15 stations.[6]

Most bike-share programs, in Boise and in other regions, primarily serve downtown areas where destinations are close together and bikes can be used for localized trips or for recreation and tourism (see *Travel and Tourism*[7]). However, coupling bike share with electric bikes (see below) would allow riders to cover more ground and, thus, extend the geographic footprint of bike-share services beyond the downtown core.

Bike-share programs have typically catered to higher-income groups and those who are comfortable riding in mixed traffic.[8] To convert the "interested but concerned" user into a bike-share participant, safer infrastructure paths and bicycle lanes are needed. Most bike-share programs require a credit card, which can create a barrier for low-income populations. Providing payment structures that better enable low-income groups to participate, such as cash options, can help overcome this barrier. In addition, providing links to other forms of public transportation could increase the viability of bike share as a part of the larger transportation system and provide more options for lower-income groups.[9]

Big Data

Not only is technology expected to bring new and exciting types of vehicles to the transportation system, one of the earliest benefits of technology is in transportation planning. Planning future roads and services hinges on understanding travel patterns, such as when and where people travel, so planners can predict future needs. Big data refers to the large volumes of information from a variety of sources that can be used to track growth, predict traffic patterns, and otherwise monitor and forecast travel needs.

COMPASS uses data from the National Performance Management Research Data Set (NPMRDS) to evaluate travel behavior. NPMRDS data are collected from "passive" information sources generated by pings on mobile phones. The ping shows where a vehicle is on the roadway system; subsequent pings are used to determine the distance and speed traveled. The result is a huge database that has the potential to produce travel data at a fraction of the cost of traditional methods. While this approach can greatly reduce costs of surveys and primary data research, it is not perfect. Many people are concerned about the potential for abuse of private data; others choose not to participate in providing data.

NPMRDS data have been used to assess typical commute patterns as well as non-reoccurring congestion, such as that caused by major events or weather. For example, travel speeds along Interstate 84 during the January 2017 "Snowpocalypse" can be assessed using NPMRDS data. On January 4, 2017, between 7 am and 7:15 am, there was a 35-mph speed loss compared to average commute speeds. On January 10, 2017, the evening commute slowed to less than 10 mph and the peak "rush" hour lasted several hours longer than normal due to the effects of snowy roads. Having this information is critical for understanding the impact of events such as snowstorms on the transportation network and developing responses to improve travel (Figure 2).

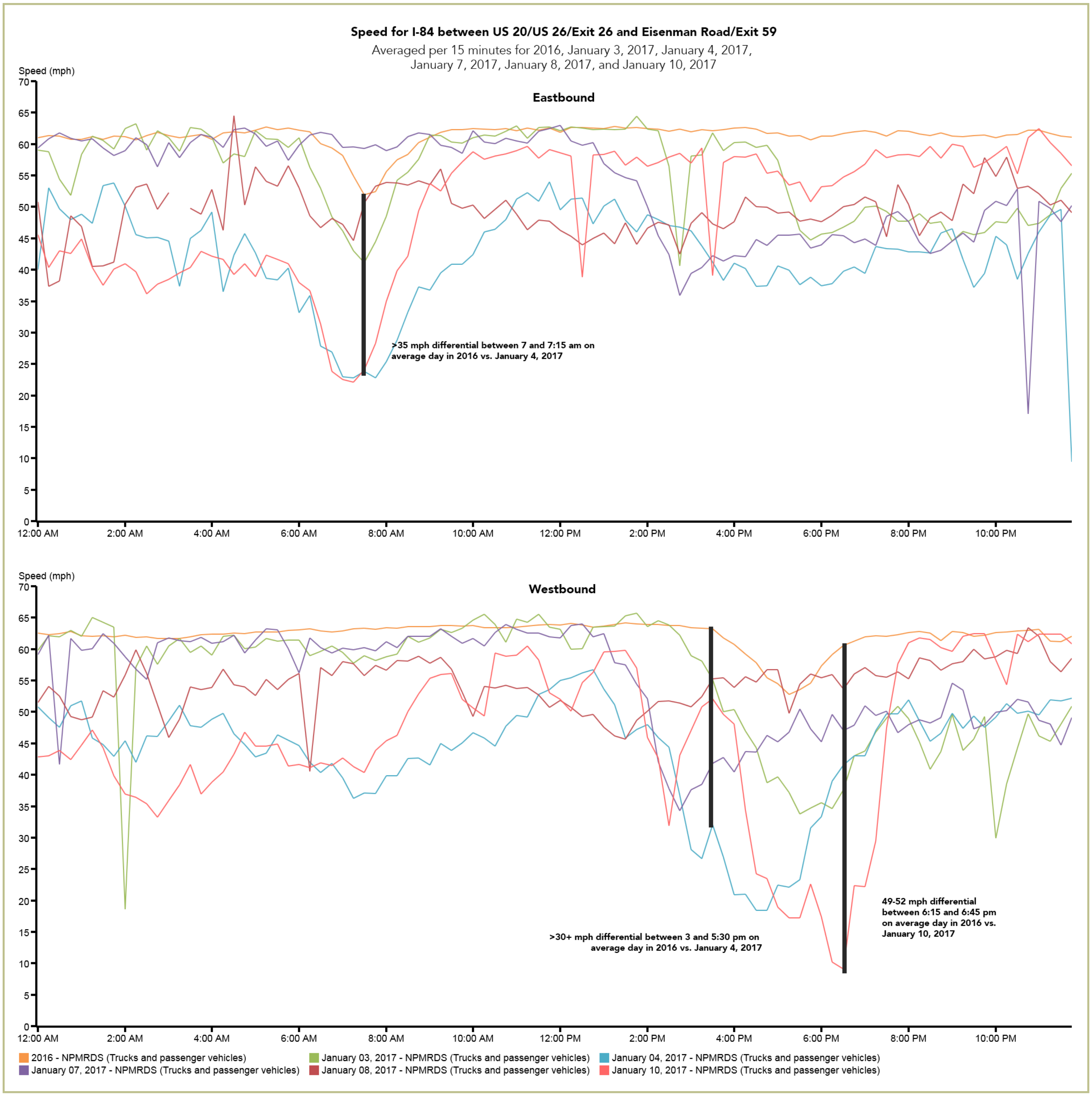

Figure 2. Use of big data in understanding impact of January 2017 weather

Electric Bicycles

Ride a bike without pedaling? Sign me up! Electric bikes (e-bikes) have electric motors that can provide assistance to the rider, helping them climb hills easier or go farther with less effort.

E-bikes can increase the distances bicycle commuters or recreational riders are able to travel for work and play. E-bikes could also fill a need for those who are less mobile, such as the elderly or youth, allowing them to reach destinations that would normally be outside the biking range. While these bikes are more expensive, the prices will fall as the technology is adopted more widely.

But if it has a motor, is it still a bicycle? That's the conundrum the Idaho legislature has faced; it has yet to come up with a clear answer.[10] Locally, the City of Boise passed a law that allows e-bikes to operate on sidewalks and crosswalks, bike lanes, streets and the Boise River Greenbelt within city limits.[11]

Electric Vehicles

Electric vehicles (EVs) use electricity to power the engine's motor. Plug-in electric vehicles have a completely electric motor and a battery pack, while plug-in *hybrid* electric vehicles use both a traditional internal combustion engine as well as an electric one.

EVs have many benefits, including:

- Economics: Electricity as a fuel is significantly cheaper than gasoline or diesel, and EVs do not require maintenance of the exhaust systems. This equates to approximately four cents per mile to operate the vehicle—a significant savings over gas-powered vehicles.[12]
- Air quality: EVs are zero-emission vehicles, which improves air quality.

Despite the benefits of EVs, several market barriers currently prevent broader implementation. EVs hold a small share of the market and are a relatively new vehicle type, so there is not a large used-car market, creating financial barriers for those who cannot or choose not to buy a new car. Also, the range of electric vehicles remains fairly small, making them suitable for daily commuting but not necessarily for long trips, especially for an isolated area such as the Treasure Valley. Idaho Power has developed an *Alternative Fuels Corridor Plan* to address gaps in the EV charging network (Figure 3).

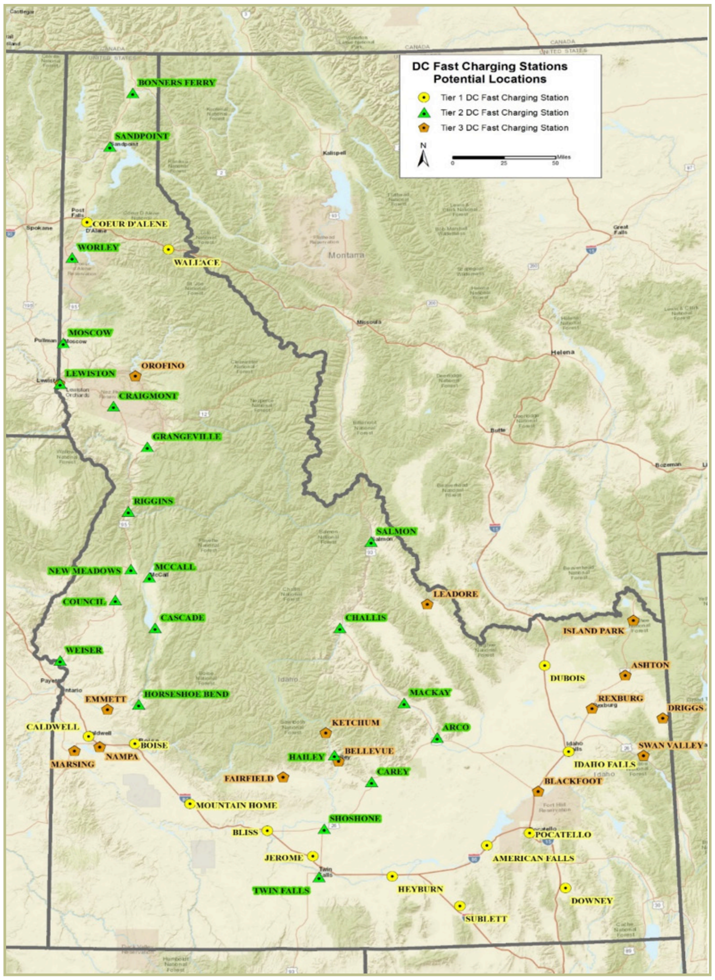

Figure 3. Potential locations for EV fast-charging stations

Currently, EVs encompass approximately 1% of all vehicle sales, split evenly between plug-in electric vehicles and plug-in hybrids.[13] By 2040, it is anticipated that half of new vehicles may be EVs.[14]

Non-Pneumatic (Airless) Tires

Typical pneumatic tires, which are filled with air, are subject to flats. A flat tire can be an inconvenience or even dangerous. Airless tires, on the other hand, use solid materials that are impervious to flats.

Initial tests of airless tires are promising, but higher costs might slow general deployment.[15] General use of airless tires could make automobile and freight travel safer and bicycle travel more convenient.

Shared Mobility

Shared mobility, in all its various forms, describes the strategy of using vehicles on an as-needed basis. This is made possible by enhanced communication services, including cell phones and real-time data. There are many different models for shared mobility, based on who owns the vehicle, how fees are applied, and the technology used for connecting vehicles, drivers, and riders. A few approaches include:

- Bike sharing: Discussed above.
- Car sharing: A service that provides members with access to an automobile for intervals on an as-needed basis. Vehicles can either be owned by an individual who rents out the use to other clients, owned and shared by individuals, or owned by a company or organization that rents to those with memberships.
- Microtransit: Private multipassenger transportation services on a smaller, more flexible scale than buses. They use dynamically generated routes and may expect passengers to make their way to and from common pick-up or drop-off points.
- Ride sharing or Transportation Network Company (TNC): Use of online networks to connect passengers with independent drivers who use their personal, noncommercial vehicles. Examples include Uber and Lyft.

The advantages of using vehicles as a service rather than traditional ownership models are plenty, some of which we may not even know yet. Shared mobility may help individuals, such as youth, elderly, low-income, and those with limited abilities or limited English skills, who may not have the ability or desire to own or drive their own vehicle. Shared mobility is increasing in popularity, becoming a legitimate alternative to owning a vehicle in many urban areas (Figure 4).[16] Shared mobility has the potential to impact land uses, housing, and economic development, as less parking is needed—and downtowns, commercial centers, large office campuses, and even residential areas could be repurposed to take advantage of reduced parking needs.[17] For example, at the Boise Towne Square Mall, roughly half of the shopping center's 120 acres is consumed by parking. As transportation shifts to shared mobility services, fewer shoppers will need

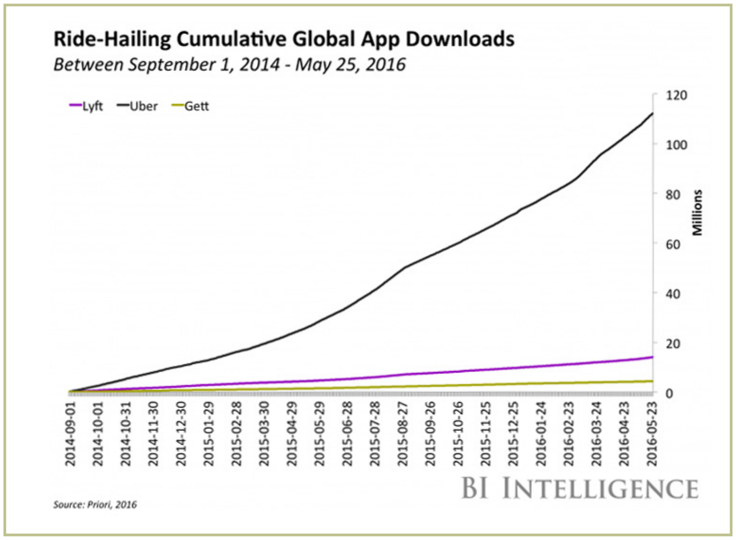

Figure 4. Growth of ride-sharing app downloads. *Source*: Priori, 2016.

parking, reducing the demand for the current number of spots. After converting some parking to loading zones, the extra space could be used to improve economic development: new businesses can emerge, open space and parks can be created to improve the shopping experience, housing could be added to bring consumers closer to retail and restaurant options, and even urban farmland could be introduced to decrease the gap between farm to market or farm to table. Figure 5 illustrates some of the many potential future uses of parking areas at the Boise Towne Square Mall.

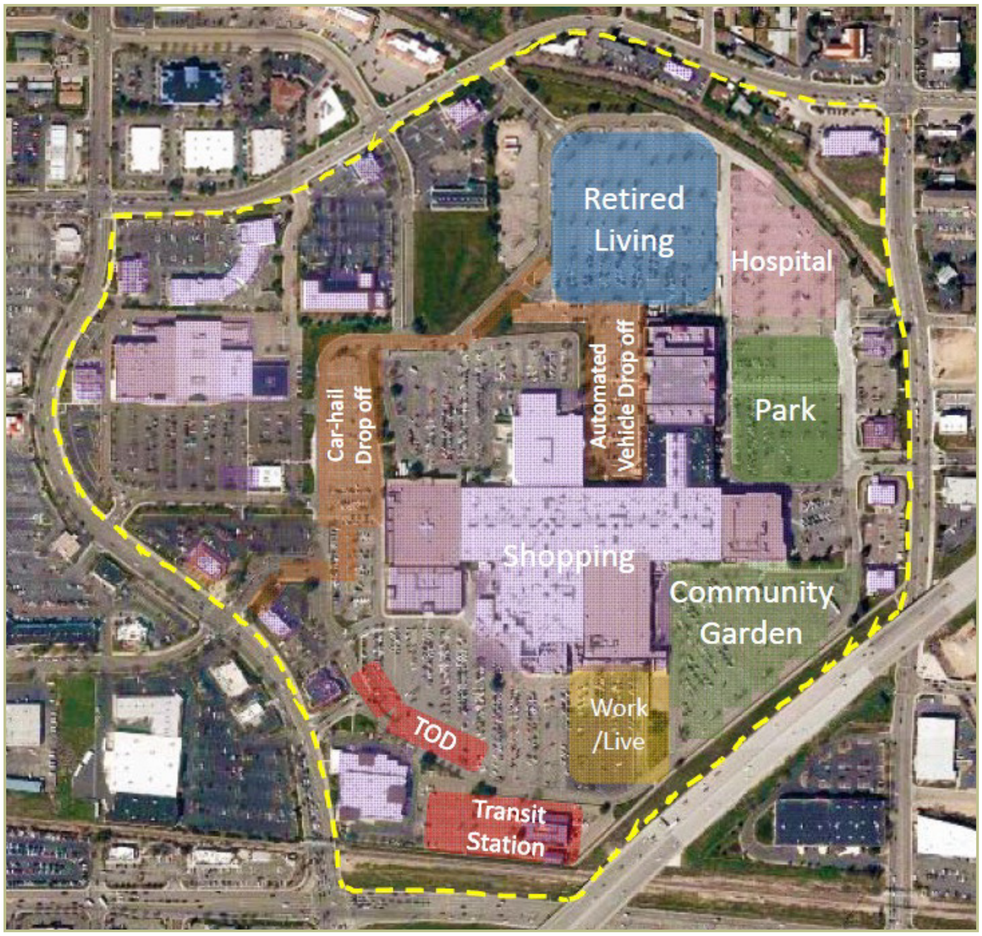

Figure 5. Boise Towne Square Mall redevelopment potential. ***Source*: Idaho Power; Map created by consortium of electric utilities, Office of Energy and Mineral Resources and Treasure Valley Clean Cities Coalition (2017).**

Intelligent Transportation Systems

Intelligent transportation systems (ITS) include wireless communications, computational technologies, sensing technologies, and intelligent transportation applications to improve efficiencies of the road, communicate with drivers to report incidents, and improve safety. Examples of ITS include:

- Electronic toll collection: A detection system that automatically collects tolls without slowing traffic, preventing large queues from building and reducing bottlenecks.
- Ramp meters: Traffic signals on freeway ramps that control the flow of vehicles entering the freeway.
- Traffic signal policing: Computers in high-speed cameras used to detect and photograph traffic violations.
- Traffic signal coordination: Traffic signals that are synchronized across multiple intersections to enhance the operation of one or more directional movements in a system.
- Transit signal priority: Sensors that detect approaching transit vehicles and alter signal timing to give them priority at signalized intersections.
- Traveler information systems: Technologies used to share information with the traveling public regarding trip departures, weather conditions, road conditions, and more.

In 2017, the Ada County Highway District received a $2.25 million Advanced Transportation and Congestion Management Technologies Deployment grant for an ITS project to coordinate signal timing to curb congestion at 82 intersections in Ada County.[18]

Taxation Innovations

Traditionally, transportation projects have been paid for with fuel taxes. However, federal fuel tax rates have remained constant since 1993, while fuel efficiency and construction costs have increased. That means less and less money is coming in to build more expensive infrastructure.

New approaches to taxation of road users are being considered, partly enabled by improved technology. Some states are considering a per-mileage transportation tax rather than a per-gallon fuel tax. This has the potential to keep revenues up despite more efficient vehicles.[19] A per-mile fee has been imposed on freight in Illinois[20] and a mileage-based fee for personal automobiles has been considered in several states.[21] Oregon began implementing a small-scale mileage-based fee program, called OReGO, in 2015.[22]

Oregon also introduced a bicycle tax in 2017 that charges $15 on the sale of each new adult-sized bicycle with a retail price of $200 or more.[23] It is anticipated this law will generate over $1 million annually to help pay for bicycle and pedestrian projects.[24] As this is the first bicycle tax in the nation, it will be interesting to see if it discourages bicycle purchases or whether the resulting enhancements to bicycle infrastructure will encourage more, and safer, bicycle use.

Another approach is variable pricing, which allows for an increase or decrease in toll rates based on the time of day or real-time congestion. It has been used in a few locations, such as Katy Freeway in Houston, I-15 in San Diego, I-35 in Minneapolis, and the Midpoint Bridge in Florida.[25] Variable pricing has been shown to increase efficiency on the affected corridors, as higher rates during peak hours encourage drivers to shift to other routes or other times of day. However, it has been criticized as pushing congestion to parallel routes and for being unfair to drivers who do not have discretionary income to pay the increased costs or the ability to make that trip at another time.[26]

These innovative solutions, though not without political or legal difficulties in implementation, could generate revenues for lagging infrastructure needs as well as promote different transportation and land-use policies and behaviors.

Medium-Term Innovations

Medium-term innovations are those that are either not available now but that may be mainstream within the next decade, or that are currently minimally available with complete deployment expected years or decades away.

Autonomous and Connected Vehicles

Autonomous vehicles can drive themselves or take on certain aspects of driving in "autopilot" mode using various in-vehicle technologies and sensors. Connected vehicles use one or more communication technologies to communicate with drivers, other vehicles (vehicle-to-vehicle), roadside infrastructure (vehicle-to-infrastructure), or the "cloud."[27] While somewhat different technologies, autonomous and connected vehicles share many similarities and are discussed together here.

Some early autonomous and connected vehicle technologies are already available in the mass market, such as cruise control, self-parking, remote diagnostics, lane change warnings, and automatic notifications of roadwork, crashes, and speeding. Broadly, these fall into four categories:

- Convenience: "Infotainment" displays that provide visual information to the driver, Wi-Fi hotspots, and other features that make the driving experience more enjoyable.
- Navigation: GPS technology that helps the driver navigate more efficiently and without distraction.
- Safety: Features that avoid or mitigate the impacts of crashes, including parking assist systems and lane keeping systems, adaptive cruise control that automatically adjusts the vehicle speed to maintain a safe distance from vehicles ahead, and braking systems that operate automatically in an emergency to avoid a crash.[28]
- Vehicle management: Systems that identify and alert drivers about mechanical issues to help save on operating costs and repairs.

Some of these features are available now while others will be ubiquitous in a few years. All are steps towards fully connected and automated vehicles. One way to view the level of automation is based on the different functions that either the human or vehicle is required to perform. Grouped in four main categories, these include: 1) execution, steering, acceleration, and deceleration; 2) monitoring of driving environment; 3) fallback performance of dynamic driving task; and 4) system capability (Figure 6).[29]

Autonomous vehicles may have the largest impact on future transportation of any of the technologies discussed here; however, it is difficult to speculate what the effects may be. Some potential benefits include:

- Increased safety: According to the National Highway Traffic Safety Administration (NHTSA), 94% of serious crashes are due to dangerous choices or errors people make behind the wheel. Driver-assistance technologies would address these errors and save lives.[30]
- Increased mobility: Some current non-drivers (e.g., the young, elderly, and disabled) could useautonomous or connected vehicles to become mobile, increasing their employment opportunities and options for accessing health and other services.

- More efficient use of space: Full automation could mean that less space will be needed between cars when they are in operation. This could allow for narrower lanes and effectually increase capacity on the roadway. More throughput within the existing road footprint could mean some capacity projects wouldn't be needed, speed limits could be increased, and intersections could be reconfigured to improve efficiencies.
- More efficient use of time: Drivers could potentially multitask as they travel to destinations, meaning the drive to work could be an effective part of the workday.
- Improved air quality: Potential decreases in fuel consumption could result in better air quality.
- Less need for parking: Fleets of autonomous vehicles, coupled with ride-sharing approaches, could reduce car ownership and the space needed to accommodate parked cars. This could lead, for example, to repurposing parking lots for other uses, especially in downtowns.

On the flipside, potential disadvantages abound as well:

- Sprawl: Enabling drivers to multitask during their commutes may encourage longer commutes, as driving time would no longer be considered "wasted time." Autonomous vehicles could incentivize land-use sprawl and consumption of farmland for communities, make healthy commuting options less appealing, and degrade some quality of life aspects.
- Air quality and health: Would adding youth and elderly drivers to the road increase congestion and degrade air quality? Would society increase dependence on vehicles for every trip and reduce the validity of walking and biking as healthy options?

Many barriers exist to an autonomous transportation system, including:

- Infrastructure: A perfectly operating autonomous system would eliminate crashes. However, autonomous vehicles depend on signals from the pavement to "see" lanes and other markings for where to turn, stop, and navigate the system. Whereas deficient striping today is just an inconvenience, it would be downright dangerous with autonomous vehicles on the road. Therefore, it is even more critical for our assets to be well maintained. Moreover, weather conditions could make markings difficult to view, and autonomous buses do not yet recognize human-based signals or actions such as police officers hand-directing intersection traffic.
- Legal: If an autonomous vehicle makes a mistake, who is at fault? Is it the driver, the manufacturer, or the owner of the road who maintains the pavement conditions and markings?
- Regulatory: The largest barrier might be the lack of safety protocols and federal regulations that prohibit the deployment on public roads. The situation is further complicated by phasing in different levels of automation, from those that enable the driver to be assisted by the vehicle to full automation, where the driver does not have an active role.

Depending on the level of automation, autonomous vehicles could fall under near-term (driver assistance) to long-term (complete automation) innovations.

SAE level	Name	Narrative Definition	Execution of Steering and Acceleration/ Deceleration	*Monitoring* of Driving Environment	Fallback Performance of *Dynamic Driving Task*	System Capability *(Driving Modes)*
***Human driver* monitors the driving environment**						
0	No Automation	the full-time performance by the *human driver* of all aspects of the *dynamic driving task*, even when enhanced by warning or intervention systems	Human driver	Human driver	Human driver	n/a
1	Driver Assistance	the *driving mode*-specific execution by a driver assistance system of either steering or acceleration/deceleration using information about the driving environment and with the expectation that the *human driver* perform all remaining aspects of the *dynamic driving task*	Human driver and system	Human driver	Human driver	Some driving modes
2	Partial Automation	the *driving mode*-specific execution by one or more driver assistance systems of both steering and acceleration/ deceleration using information about the driving environment and with the expectation that the *human driver* perform all remaining aspects of the *dynamic driving task*	**System**	Human driver	Human driver	Some driving modes
***Automated driving system* ("system") monitors the driving environment**						
3	Conditional Automation	the *driving mode*-specific performance by an *automated driving system* of all aspects of the dynamic driving task with the expectation that the *human driver* will respond appropriately to a *request to intervene*	System	**System**	Human driver	Some driving modes
4	High Automation	the *driving mode*-specific performance by an automated driving system of all aspects of the *dynamic driving task*, even if a *human driver* does not respond appropriately to a *request to intervene*	System	System	**System**	Some driving modes
5	Full Automation	the full-time performance by an *automated driving system* of all aspects of the *dynamic driving task* under all roadway and environmental conditions that can be managed by a *human driver*	System	System	System	**All driving modes**

Figure 6. Degrees of autonomous vehicles. *Source*: SAE International and J3016.

Autonomous Bus

Self-driving buses generally follow fixed routes using the same technology as connected and autonomous cars. Benefits would include cost savings in public transportation operations and, because of cost savings, additional bus coverage and better frequencies.

Similar barriers to autonomous vehicle implementations exist for buses. The first testing of autonomous buses in the United States began in 2018. A driverless bus is now bringing commuters to a large employment center in the California Bay Area on public roads.[31]

Connected Freight

Truck freight could see innovations similar to autonomous or connected vehicles. Connected freight enables automated speed and following distance.

Dedicated short-range communications technologies can monitor driving conditions and congestion. For example, these technologies can be used at weigh stations to "read" the necessary information as trucks drive by; similarly, radar at intersections can detect trucks and adjust signal timing to allow them to move through the intersection without stopping.

These technologies could dramatically change supply-chain operations. Connected freight can be cleaner, safer, and more efficient. Connected freight could save up to 7% of fuel costs.[32] These types of freight efficiencies could lead to a decrease in the cost of durable goods.

Freight technology applications are likely achieved at Conditional Automation, or Level 3 (see Figure 6, above), where a driver is a necessity and must be ready to take control of the vehicle at all times, even while the vehicle is acting autonomously.

Drones or Unmanned Aerial Vehicles

Harry Potter had his owl, Katniss Everdeen had her silk parachutes, and many retailers envision drones delivering products to our doorsteps. Drone delivery could reduce the amount of truck freight on local roads, thus increasing overall safety and reducing conflicts between freight vehicles and other roadways users, such as bicyclists.

Businesses have conducted trials of drone delivery systems, and drones have the potential to supplement freight deliveries and make the last-mile connection cheaper and quicker.[33] Of course, with drones come airspace conflicts with nearby airports, privacy issues, and barriers related to regulation and enforcement.

Lightweight Materials

One technological innovation could improve safety, personal and community costs, and provide better air quality. Lightweight materials are making vehicles more efficient and are reducing the size and weight of vehicles, while maintaining safety and performance. Replacing cast iron and traditional steel components with lightweight high-strength steel, magnesium alloys, aluminum alloys, carbon fiber, and polymer composites can reduce the weight of a vehicle's body and chassis by up to 50%.[34]

Using lightweight components and high-efficiency engines enabled by advanced materials in one quarter of the US fleet could save more than 5 billion gallons of fuel annually by 2030 and save almost 10% for each vehicle.[35,36] Lighter vehicles would also cause less wear and tear on pavement, thus slowing degradation. Finally, smaller, lighter-weight vehicles could reduce the severity of vehicle/bicycle and vehicle/pedestrian crashes.

However, there may be safety issues with introducing lightweight vehicles onto the public roadway system while the majority of vehicles, including freight trucks, are not lightweight. This problem could persist until lightweight vehicles become ubiquitous.

Personal Rapid Transit

Like the benefits of public transportation with the privacy of a private vehicle? Personal rapid transit (PRT) combines these two systems by moving small groups in automated vehicles on fixed tracks. Passengers benefit from relatively direct routes by only stopping at their destinations and bypassing other stations. Currently, five PRT systems exist in the world: Morgantown, West Virginia; Rotterdam, The Netherlands; Masdar City, Abu Dhabi; Heathrow Airport, England; and Suncheon Bay, South Korea.[37]

PRTs have the potential to revitalize cities in similar ways as light rail or streetcars. Having businesses near stations could increase their marketability and promote redevelopment. Moreover, PRT's small vehicles allow for smaller and less-expensive infrastructure than light rail.

However, political, regulatory, geographic, and technological issues remain. Other technology, such as autonomous vehicles, could make PRTs obsolete. Autonomous vehicles claim many of the same benefits but without the expensive infrastructure and political will necessary to begin a long-term investment in transit. It would be difficult for communities to invest in PRTs if a cheaper solution may be just around the corner.

3D Printing

What if the product you want doesn't get built overseas, then shipped across the ocean, or by train, or by truck, but instead is ready when you want it? 3D printers give manufacturers the potential to streamline operations, improve quality, and lower costs. Similar to how printers enable home office work to be conducted, 3D printers could promote some home-based manufacturing.

The evolution of 3D printing has substantial implications for both domestic and international freight. As more parts and products are manufactured in finished form and manufacturing sites are located closer to the end destination, the need to procure parts from multiple sources around the globe could be significantly reduced and, in turn, decrease the need for global transportation.[38]

Smart Bikes

Improvement in bicycle lights, helmets, navigation systems, and other technology is improving the bicyclist's visibility and overall safety:

- Visibility: Bicycle lights are being developed to be more visible and help auto drivers anticipate a bicyclist's turn movements. Smart bicycle lights can be operated via remote on the handlebars, and can be connected to brake lights to indicate braking.
- Safety: Stanford University has designed a helmet with an airbag that is 600% more shock absorbent than a traditional bicycle helmet.[39]
- Navigation: GPS navigation systems are providing turn-by-turn information to handlebars.

Bicycle technology may reduce the severity of crashes, encourage more bicycle use, and help identify the most-needed improvements. Increased costs may be the biggest barrier to widespread use.

Smart Parking

Tired of spending half of your drive just circling for a parking spot? Up to 10% of city traffic is made of drivers circulating for parking,[40] consumes 17 hours per person per year,[41] and costs $73 billion nationally annually.[42] Smart parking gives real-time information with GPS guidance, notifications, and real-time Wi-Fi payment.[43]

Smart parking has the potential to decrease overall congestion, improve air quality, increase municipal revenue, and better use parking assets. Currently, parking spaces and lots fill up without much awareness of when spaces will become available or where alternative locations may be. Additionally, automated multilevel car parking enables operators of parking garages to more efficiently store and retrieve vehicles. This can reduce the time spent parking, free up land for additional uses, and create economic development in cities. However, higher costs and technical issues of smart parking can frustrate deployment.[44]

Long-Term Innovations

Many technologies being explored right now could be huge interrupters to traditional transportation systems. Of course, we don't know when these will become available and they likely will not be widely used by the general public within the horizon year of CIM 2040 2.0, but they are worth considering and are listed below.

Flying Cars

"I dreamed I was an angel
and with the angels soared.
But I was simply touring
the heavens in a Ford."
New York Evening Sun, circa 1920s

Flying cars have been prototyped as far back as 1926—when Ford's aircraft division tried to build a "Model T of the air."[45] We've been waiting almost 100 years for that vision to become a reality—and we may be closer than ever before, as several prototypes are nearing production.[46]

While elevating traffic from the roadway to a three-dimensional sphere could reduce surface congestion, there are many problematic issues that would need to be addressed first, such as safety, privacy, congested air space, and cost of ownership.[47]

High-Speed Rail

Since the mid-1960s, the Federal Railroad Administration has explored the development of a high-speed rail transportation network. Over the years, lines have been added to the network map, which reflects routes prioritized for federal investments. Under the Obama administration, a high-speed rail strategic plan was updated with the Passenger Rail Investment and Improvement Act.[48]

A high-speed rail connecting the Treasure Valley with the metro areas along the Pacific Coast and Intermountain West could be a huge boon to tourism and economic development in the region. However, building such a large infrastructure project would be enormously costly and may be undermined by advances in communications technology that facilitate business meetings and reduce other long-distance travel needs. In addition, southwest Idaho is not on the Federal Railroad Administration's "Vision for High-Speed Rail in America" map, so implementation in the Treasure Valley is not anticipated in the foreseeable future (Figure 7).

Maglev Trains

Imagine a new form of public transportation where riders board a rollercoaster-like platform on a journey from Boise to Seattle at speeds of 375 mph. It would take less than 90 minutes to reach your final destination—about the same time it takes to fly!

Maglev is short for "magnetic levitation." The technology uses superconducting magnets to levitate a train car about 10 cm above the track, similar to the technology found in air hockey tables. There are maglev trains in operation internationally (China, Japan, and South Korea) with lines being considered here in the US.[49] The average speed is just over 250 mph, with record speeds of 375 mph.

Maglev trains could move freight and people quickly, safely, on-demand, and directly from origin to destination. Systems would be built on columns or tunneled below ground to avoid wildlife and dangerous

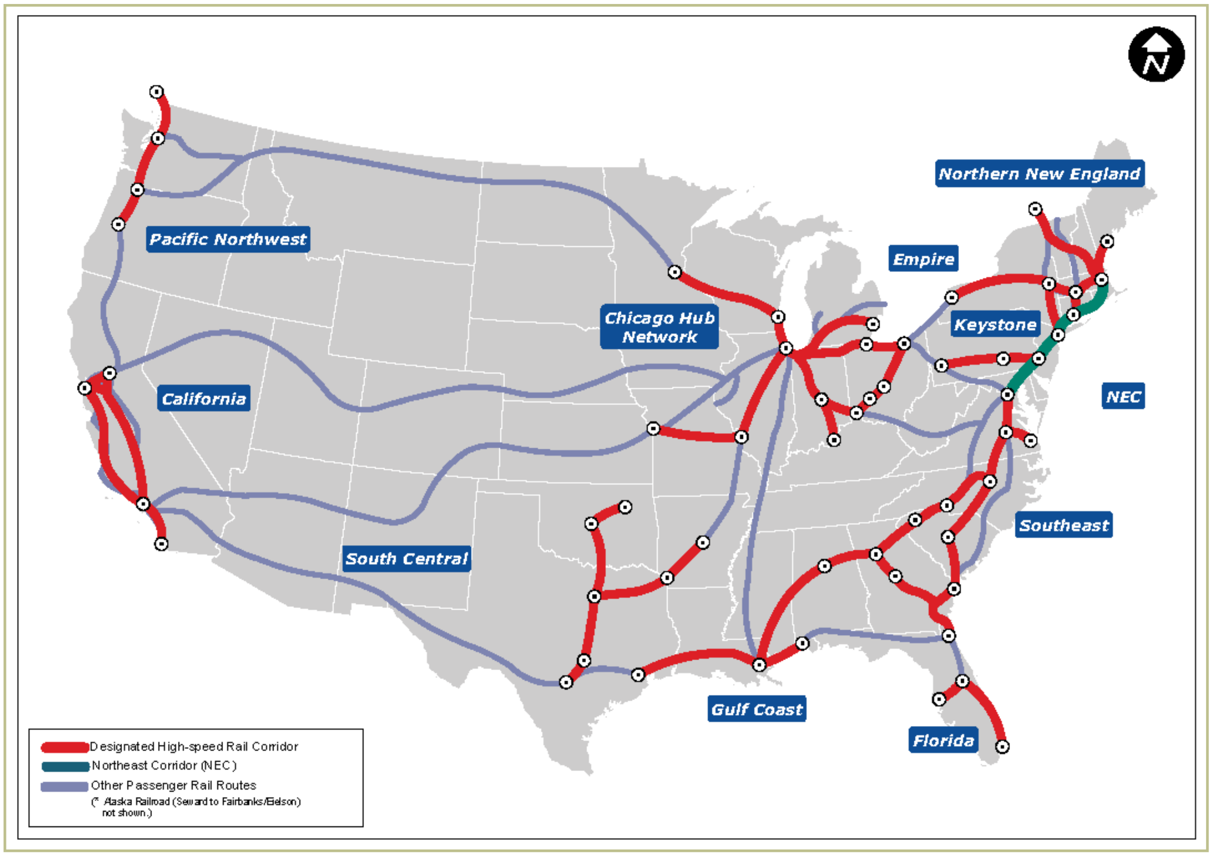

Figure 7. Vision for high-speed rail in America. *Source*: US Department of Transportation Federal Railroad Administration.

grade crossings. The upside to this technology is that, unlike conventional rail, the maglev train almost never touches the track, meaning no friction and, thereby, reduced wear and tear on tracks. Also, maglev is fully autonomous and enclosed, so it eliminates pilot error and weather hazards. It is safe and clean, with no direct carbon emissions.

The major barrier to building a maglev train is the cost and incompatibility with existing rail infrastructure. Construction of the Shanghai Maglev, for example, cost over $1.2 billion for a 20-mile system, or over $60 million per mile.[50] In addition, securing legislative support and right-of-way for travel routes will be major obstacles to implementation.

Solar Roads

A conversion of the vehicle fleet from internal combustion to electric vehicles will require a greater electrical energy demand. A renewable energy system, such as a roadway solar grid, would offset increases in demand for electricity and provide other benefits, too. If the roadway were a solar grid, energy could be collected and distributed to vehicles within the roadway footprint. Solar roads could also melt ice and snow, improving safety. In addition, technology could be built into solar roads to communicate with drivers regarding things such as crashes, emergencies, or congestion.[51]

A solar road would provide renewable energy, but obviously at a high price. It has been estimated that solar roads would cost about $70 per square foot, about 50 times the cost of asphalt.[52] Solar Roadways, a company in north Idaho, is one of the leaders in this technology and installed a walkable test of the solar paving in a town square in Sandpoint, Idaho.[53]

IMPACTS

If you were around in the early 1900s and you were seeing the first mass production assembly line of cars, would you know the impacts that cars would have on the 20th and 21st centuries? The automobile has directly or indirectly changed almost all aspects of our culture.

We're now in a similar situation, about 100 years later. While we may not know the extent of the impact of these previously discussed technological advances, we know that the next century will not look like the last.

The wave of transportation technologies addressed above may be more transformational than any other era in the history of transportation. Whether the results improve our quality of life and meet the goals in *Communities in Motion* depends a lot on how technologies are developed and how we adapt to changes. Some changes should improve safety and make commuting faster, easier, and healthier, while other changes could result in negative impacts (Table 1).

BARRIERS

There are barriers to most of these technological innovations, including legal, political, infrastructure, market, and societal hurdles that will need to be overcome. It is difficult to anticipate which barriers will be able to be overcome versus which will be insurmountable. A summary barriers can be found in Table 2.

NEXT STEPS

Developing a regional long-range transportation plan means looking into the future. Some predictions will be right and some will be wrong. The key is to move forward with vision and direction, and being willing to adjust as new information becomes available. So, will these technologies actually improve the quality of life in the region or will they be more like the Tamagotchi, cute but totally irrelevant to solving life's problems? COMPASS will be paying attention. The Treasure Valley's next regional long-range transportation plan will be adopted around 2022 and who knows—maybe by then you'll be wearing that 1990s slap bracelet again.

> "I skate to where the puck is going to be, not where it has been."
>
> —Wayne Gretzky

Table 1. Anticipated technology consequences

		Transportation Benefits				Benefits to *Communities in Motion* Planning Elements						
	Technology	Mobility	Congestion	System Reliability	Safety	Community Infrastructure	Economic Development	Farmland	Health	Housing	Land Use	Open Space/ Environment
AUTO	Alternative fuels	≈	≈	≈	≈	≈	≈	≈	●	≈	≈	●
	Autonomous and connected vehicles	●	◘	●	●	◘	◘	○	●	●	●	◘
	Electric vehicles	≈	≈	≈	≈	●	◐	≈	◐	≈	≈	≈
	Flying cars	●	●	●	ϟ	◘	ϟ	ϟ	ϟ	ϟ	ϟ	ϟ
	Lightweight materials	◐	≈	≈	●	●	≈	≈	◐	≈	≈	≈
	Non-pneumatic (airless) tires	≈	≈	≈	●	≈	≈	≈	≈	≈	≈	≈
	Smart parking	≈	◐	◐	≈	◐	≈	≈	◐	≈	◐	◐
	Solar roads	≈	≈	≈	≈	●	≈	≈	≈	≈	≈	●
BIKE/PED	Bicycle safety gear	≈	≈	≈	●	≈	≈	≈	●	≈	≈	≈
	Bike share	◐	◐	≈	≈	◐	◐	≈	◐	≈	◐	◐
	Electric bicycles (E-bikes)	●	◐	◐	◐	◘	◘	◐	●	◐	●	●
	Smart bikes	●	◐	◐	◐	◘	◘	◐	●	◐	●	●
FREIGHT	Connected freight	◐	◐	●	●	●	●	ϟ	◘	ϟ	ϟ	≈
	Delivery drones	◐	◐	●	◐	◐	●	◐	◐	◐	◐	◐
	3D printing	●	◐	◐	◐	◘	●	●	●	●	●	●
PUBLIC TRANSPORTATION	Autonomous bus	◐	◐	◐	◘	◐	ϟ	ϟ	ϟ	ϟ	ϟ	◐
	High-speed rail	◐	◐	◐	◐	◐	●	◐	◐	◐	●	◐
	Maglev trains	◐	◐	◐	◐	◐	●	◐	◐	◐	●	◐
	Personal rapid transit	◐	◐	◐	◐	◐	●	◐	◐	◐	●	◐
	Shared mobility	●	◘	≈	≈	≈	≈	≈	≈	◐	≈	≈
MULTI- OR NONMODAL	Big data	◐	◐	◐	◐	◐	◐	◐	◐	◐	◐	◐
	Intelligent Transportation Systems	●	●	●	◐	◐	≈	≈	◐	≈	≈	◐
	Taxation innovations	◐	◐	≈	≈	●	◘	≈	≈	≈	≈	◐

● Anticipated significant positive impact ◐ Anticipated small positive impact ◘ Anticipated combination of positive and negative impacts ○ Anticipated negative impact
ϟ Unknown impact ≈ No impact

Table 2. Anticipated technology barriers

	Technology	Anticipated Barriers
AUTO	Alternative fuels[54]	Political
	Autonomous and connected vehicles[55, 56]	Infrastructure, Legal, Market
	Electric vehicles	Infrastructure, Market
	Flying cars[57]	Infrastructure, Legal, Market, Political
	Lightweight materials[58]	Legal
	Non-pneumatic (airless) tires	Market
	Smart parking[59]	Infrastructure
	Solar roads[60]	Infrastructure, Legal, Market
BIKE/PED	Bicycle safety gear	Market
	Bike share	Market
	Electric bicycles (E-bikes)[61]	Legal, Market, Political
	Smart bikes[62]	Market
FREIGHT	Connected freight[63]	Infrastructure, Legal
	Delivery drones[64]	Infrastructure, Legal, Political
	3D printing[65]	Market
PUBLIC TRANSPORTATION	Autonomous bus[66]	Infrastructure, Legal, Market
	High-speed rail[67]	Infrastructure, Legal, Market, Political
	Maglev trains[68]	Infrastructure, Market, Political
	Personal rapid transit[69]	Infrastructure, Legal, Market, Political
	Real-time bus information[70]	Infrastructure
	Shared mobility[71]	Legal, Political
MULTI- OR NONMODAL	Intelligent Transportation Systems[72]	Infrastructure
	Big data[73]	Infrastructure, Legal
	Taxation innovations[74]	Infrastructure, Legal, Political

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