



**CENTER FOR
TRANSPORTATION
RESEARCH**



0-6803-01-P4

TEXAS TECHNOLOGY TASK FORCE WHITE PAPERS, VOLUMES 1–5:

*How the Age of Technology Is Transforming Transportation
Agencies*

Authors:

Kristie Chin

Andrea Gold

Dr. C. Michael Walton

TxDOT Project 0-6803-01: Texas Technology Task Force (TTTF)

AUGUST 2015; PUBLISHED NOVEMBER 2015

Performing Organization:

Center for Transportation Research
The University of Texas at Austin
1616 Guadalupe, Suite 4.202
Austin, Texas 78701

Sponsoring Organization:

Texas Department of Transportation
Research and Technology Implementation Office
P.O. Box 5080
Austin, Texas 78763-5080

Performed in cooperation with the Texas Department of Transportation and the Federal Highway Administration.

Table of Contents

Volume 1: Understanding the Customer of the Future

Volume 2: Revolutionizing the Global Logistics Industry

Volume 3: Identifying Opportunities and Challenges of UAVs

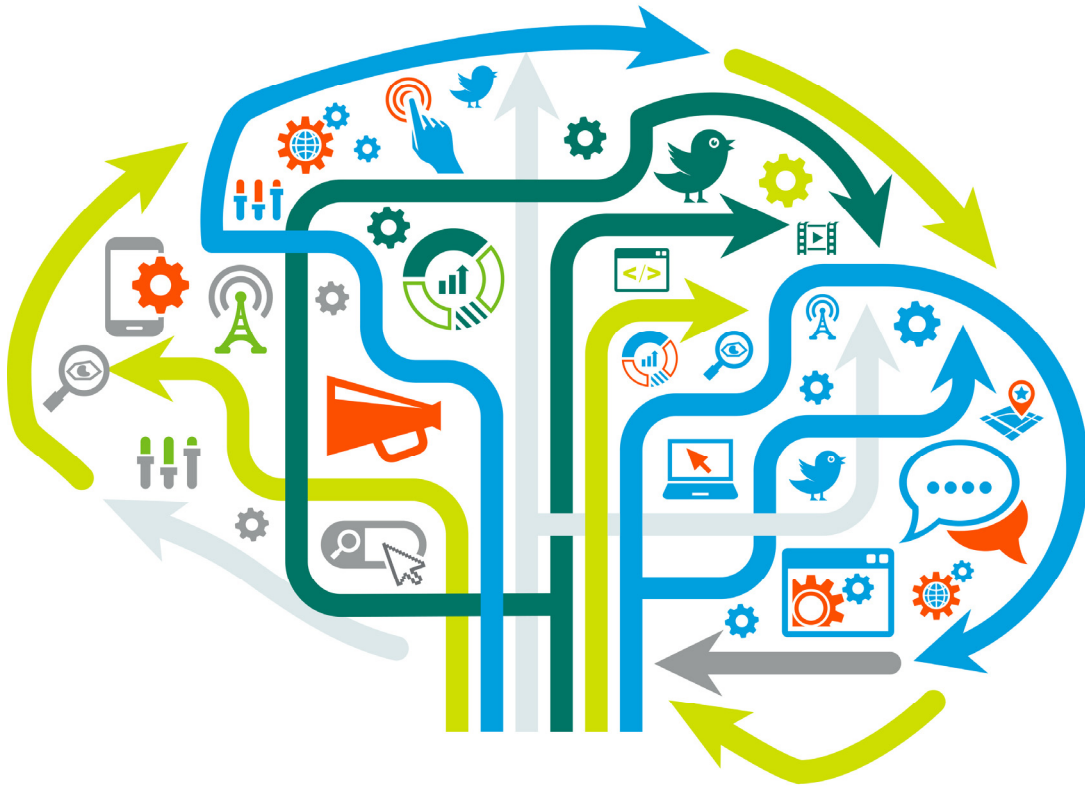
Volume 4: Managing Customer Relationships Using Big Data

Volume 5: Formulating a Communications Strategy

Understanding the Customer of the Future

White Paper

How the Age of Technology is Transforming Transportation Agencies



How can transportation agencies leverage technology to enhance the customer experience and remain relevant in the wake of major demographic, cultural, and business changes?

By viewing transportation as an interconnected experience, Texas can develop customer service strategies that ensure every touchpoint in the customer journey leads to a seamless transition to the next stage. Using data to study the customer profile, transportation agencies can better understand their customers' needs and develop personal communication strategies that will resonate with each individual.

Through customized incentives, transportation agencies can encourage customers to modify their route, time of day, and mode choices to benefit the transportation system as a whole. By developing a customer-centric mentality and prioritizing the customer relationship, transportation agencies can gain a deeper understanding of their stakeholders' interests.

Understanding the Customer of the Future

White Paper

How the Age of Technology is Transforming Transportation Agencies

KEY STRATEGIES



Study the Customer Profile

Changing demographics and cultural trends are impacting the customer base. Using the latest technology, transportation agencies can leverage relevant data to provide customers with a personal and valuable experience.



Discover the Customer Experience

When transportation agencies understand the five factors that are shaping the customer experience, they can utilize technology to strengthen customer engagement and build their brand.



Respond to Consumer Behavior

E-commerce, the shared economy, and evolving travel patterns have major implications for the transportation system. Transportation agencies will need to be prepared to respond to emerging consumer behaviors and incorporate new strategies into their planning efforts.



Exceed Customer Expectations

The transportation agency that goes above and beyond empowers the customer to become a brand advocate. By providing quality traveler information, roadway maintenance, and roadside assistance services, transportation agencies increase customer satisfaction.



Deliver Quality Customer Service

Proactively communicating important information to customers improves relationships and reduces potential dissatisfaction. By monitoring all communication channels, transportation agencies can respond swiftly and effectively, creating a consistent level of quality customer service.

Understanding the Customer of the Future

White Paper

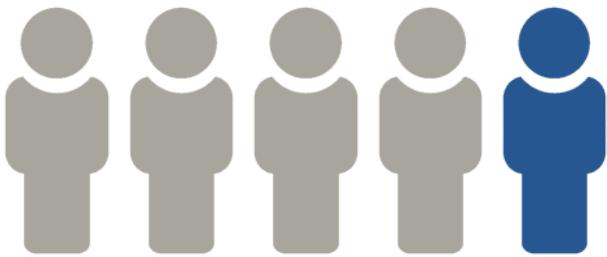
How the Age of Technology is Transforming Transportation Agencies

STATE OF RESEARCH & PRACTICE

Study the Customer Profile

Population Growth. The U.S. population is projected to increase by 80 million between 2014 and 2050, with a growth of 13.5 million occurring in Texas alone [2]. Much of the population growth in Texas is expected to come from the large urban counties of Harris, Dallas, Tarrant, Bexar, and Travis, but the fastest growth will occur in the suburban rings surrounding these counties [3]. With such rapid growth, congestion is worsening and infrastructure maintenance demands are increasing. In 1999, computer manufacturer Dell acknowledged that Central Texas traffic contributed to its decision to expand in Tennessee rather than at its Round Rock headquarters north of Austin. Transportation and urban planners will need to prepare for the state's future to ensure that Texas continues to attract rather than repel opportunities.

Age. By 2050, one in five Texans is projected to be 65 and over [2].



More people will require quality public transit connections to medical and other services. Transportation agencies will also need to be aware of cultural shifts, such as reduced vehicle ownership, taking place in the millennial generation. It will be critical for transportation agencies to consider universal design principles to provide a positive customer experience for all ages.

Diversity. A strong transportation system depends on a vibrant, diverse workforce that reflects the state as a whole. In Texas the Hispanic population will likely surpass the Anglo population by 2020, and comprise the majority by 2042 [3]. The Texas Department of Public Safety currently provides driver knowledge tests in English and Spanish. Supporting customer needs through outreach, signage, and information in multiple languages will continue to be crucial to public education efforts.

Since 2010, women with driver's licenses outnumber men [4]. Changing gender demographics will impact the scale and nature of vehicle demand, energy consumption, and road safety. Women are more likely than men to purchase safer and more fuel-efficient cars; drive less; and have a lower fatality rate per mile [4].

Urbanization and Land Use. By 2050, emerging megaregions could absorb 75 percent of the U.S. population; rural populations are expected to continue declining [3]. Retailers, including Walmart, are accelerating small store growth as a real estate strategy to connect with urban customers. Citizens, supported by movements such as New Urbanism, are increasing pedestrian and bicycle activities. Transportation and urban planners will need to consider linking transportation and land use through mixed-use development, value capture models, and multi-modal transportation strategies.

Cultural Trends. Strategy Analytics, a research and consulting firm, forecasts that by 2020 the average person will be connected to 4.3 devices [5]. Transportation agencies will need to consider how to communicate with customers through PCs, tablets, wearables, smartphones, televisions, radio, and vehicle infotainment systems. Using the latest technology, State DOTs can leverage relevant data to provide customers with a personal and valuable experience.

Understanding the Customer of the Future

White Paper

How the Age of Technology is Transforming Transportation Agencies

Discover the Customer Experience

Safety. Roadway safety touches the lives of every person. In 2014, Texas experienced 3,534 motor vehicle traffic fatalities [6]. There was a 4% increase in the number of people killed in Texas crashes involving distracted driving. Transportation agencies need to incorporate safety concerns related to emerging technologies, such as distractions from vehicle infotainment systems and no-fly-zone restrictions for unmanned aerial vehicles, into traditional safety campaigns.

When disaster strikes, the public should be able to trust transportation agencies to work together to respond in a timely and effective manner. Emergency management plans require seamless coordination, swift communication, and good organization. When Hurricane Rita swept the Texas coast in 2005, as many as 2.5 million people were jammed on evacuation routes. Emerging technologies have a role to play in supporting emergency response efforts and protecting the public from safety threats.

Efficiency. The old adage “time is money” applies to every transportation customer. The American commuter spends on average 38 hours a year stuck in traffic, with commuters in the Houston area experiencing 52 hours of delay [7]. The IH-35 segment from US 290 N to SH 71 in Travis County takes 2.54 times as long to travel during rush hour as it does during off-peak period, costing auto commuters \$196 million [7]. By incentivizing customers to alter their time of day, route, and mode choices, transportation agencies can optimize the transportation network as a whole, restoring customers’ personal and family time.

Reliability. Customers are unwilling to risk the perceived or actual reliability of driving. If buses arrive late or if traveler information is inaccurate, customers become discouraged. In a passenger perception survey, riders in San Francisco said they had reduced their use of public transportation specifically because of its unreliability, switching to other modes and adding stress to an already congested highway system [8]. By providing real-time information, transportation agencies can enable the customer to make informed decisions and adjust travel expectations accordingly.

Quality. Highway potholes, crowded buses, and lack of sidewalk infrastructure all negatively impact the customer’s transportation experience. In 2012 the American Society of Civil Engineers assigned a grade of “D” to Texas roads, attributing the poor performance to declining maintenance and funding. Customers are often unaware of specific agency responsibilities, and may lay blame on the wrong public agencies [9]. Thus, transportation agencies will need to work together to provide a complete and positive customer experience.

Convenience and Choice. Emerging technologies offer conveniences and choices to the customer. Electronic toll collection systems provide a nonstop way for drivers to pay tolls through prepaid, charge, or invoice options. Toll roads in Orange County, California, save drivers over \$182 million a year as a result of reduced traffic congestion during the daily peak periods [10]. Another innovative system is the Green Lane Concept proposed by Southwest Research Institute and Automated Port Solutions. If a commercial driver meets the qualifications of “trusted truck, trusted trip, and trusted trucker,” the driver may proceed directly to the port without waiting in the queue [11]. Providing customers with added convenience saves them time and money and alleviates congestion during peak hours.

Emerging technologies add value to the customer experience.

Understanding the Customer of the Future

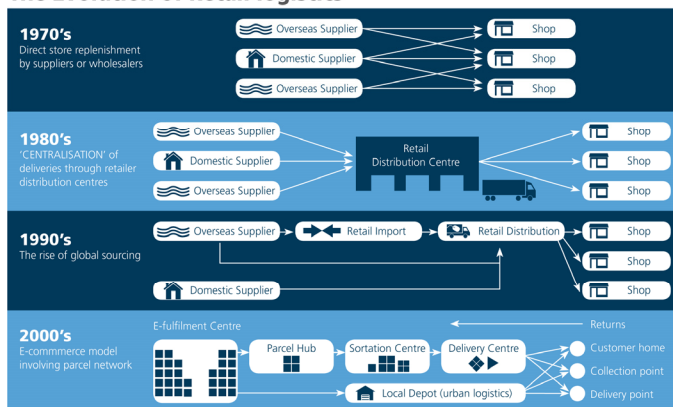
White Paper

How the Age of Technology is Transforming Transportation Agencies

Respond to Consumer Behavior

Increased Demand for E-Commerce. Consumer habits are changing and retailers recognize e-commerce as an established business. Online shopping is driving up demand for small package home delivery, which could soon substitute for many household shopping trips. Many retailers are providing ship-from-store offers to better connect demand with inventory. Ann Taylor has converted over 300 of their stores into distribution nodes, increasing sales and gross margins by not having to mark down slow-selling items in one store that might sell at full price in another [12]. Other retailers are promoting ship-to-store offers in order to increase foot traffic and reduce greenhouse gas emissions. In 2013 Target reduced loads and miles by shipping more efficiently to CityTarget stores (which are typically smaller than traditional Target stores, customized to appeal to urban dwellers) and continuing to upgrade its transportation management systems [12]. Transportation agencies can anticipate commercial growth by remaining aware of evolving retail logistic strategies.

The Evolution of Retail logistics*



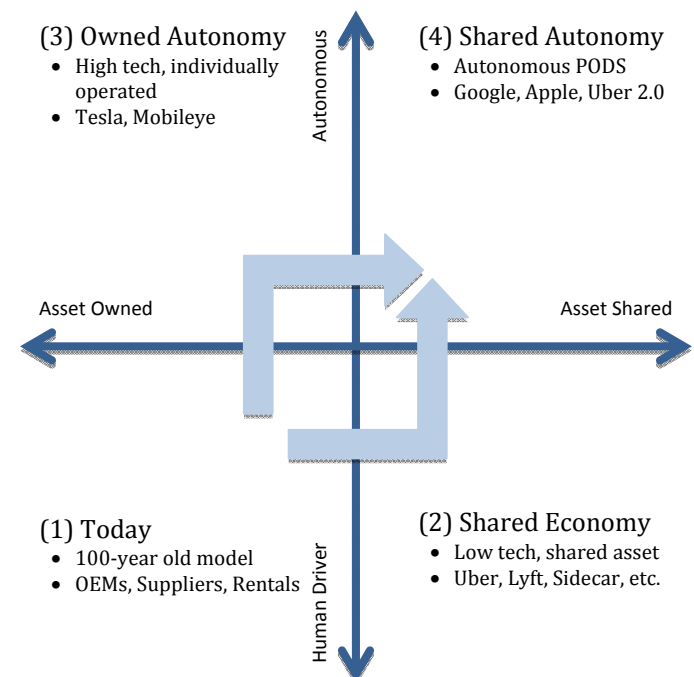
Based on non food distribution in developed markets

Source: [22]

Shared Economy. The sharing of goods and services is disrupting traditional business models. Its rapid growth is rooted in three factors:

- Ability to leverage space capacity and expand systems without large investment
- Exponential effect of collaborative experimentation and learning
- Ubiquitous nature of distributed capacity

A typical car lies unused for approximately 23 hours a day. Transportation network companies, such as Uber and Lyft, are taking advantage of overcapacity to satisfy a demand for mobility. From 2007 to 2011, vehicle ownership for people aged 18 to 34 fell almost 30% [2]. As a result, car manufacturers and vehicle rental companies have introduced their own carsharing services, including Daimler's Car2Go, BMW's DriveNow, and Avis's ZipCar. Businesses are also creating low-speed, shared vehicle fleets for employee use on campus and in neighborhood communities.



Understanding the Customer of the Future

White Paper

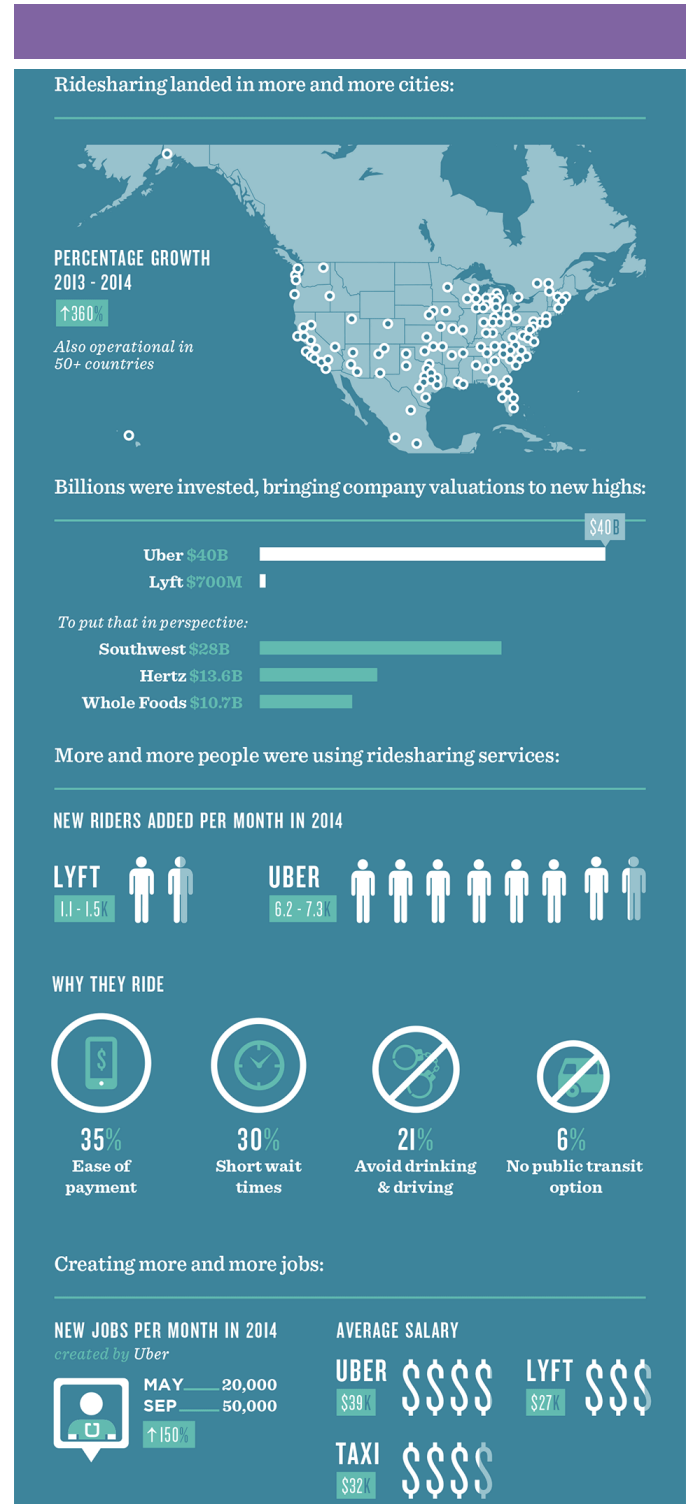
How the Age of Technology is Transforming Transportation Agencies

Travel Patterns. Customers are creatures of habit who can often become fixed in their traditional travel patterns, driving the same route to work at the same time every morning. With the introduction of new technologies and services, however, customers have begun telecommuting as well as shifting route, mode, or time of day.

Based on the American Community Survey data, telecommuting has increased 80% from 2005 to 2012, with government workers constituting the highest proportion of the total 3.2 million teleworkers [13]. Federal employees in Washington who worked from home during four official snow days saved the government an estimated \$32 million [13]. As this movement grows, transportation agencies may encourage teleworking as part of the solution to peak period congestion.

Incentives are an effective means to encourage drivers to use alternative routes and times of day. Transportation corridor agencies in Orange County, California, offered \$30 in free tolls to be credited to new accounts and the following month offered a promotion where motorists could try its toll roads free for an entire week [10]. The campaigns increased ridership and contributed to additional downloads of The Toll Roads app, now used to interface with over 360,000 customers.

Ride-sharing and car-sharing have increased exponentially within the last decade. Ride-sharing companies such as Uber, Lyft, Sidecar, eRideShare, and Ridester create business exchanges between drivers and passengers. Car-sharing services such as FlightCar, GetAround, and RelayRides act as brokers between people offering their cars for rent and those seeking rentals. Transportation agencies may consider partnerships with new services to provide auto-centric customer bases with an alternative to driving alone.



Source: [23]

Understanding the Customer of the Future

White Paper

How the Age of Technology is Transforming Transportation Agencies

Exceeding Customer Expectations

Personalization. Customers are increasingly expecting a unique experience tailored to their needs and wants. Personalization is the foundation of the dynamic customer experience. For example, Pandora generates personalized music streams, Flipboard individualizes consumption of the news, and Amazon has customized online shopping. The innovative transportation agency will personalize the travel experience, providing highly contextualized information and adjusting its offerings to strengthen customer engagement.

Speed. This is the era of “NOW.” Customers expect services to be available 24x7 and want answers to their queries delivered on-demand. RideScout is a mobile app that shows the customer real-time information about transportation options that are available right now. Users can see transit, bus, bike, taxi, car share, rideshare, parking, and walking direction in a single view. By transforming data into valuable information, transportation agencies can provide customers with the appropriate tools to make informed decisions.

Accuracy. Inconsistent, wrong, or outdated information is unacceptable to customers. Centralizing and standardizing information ensures that answers are delivered quickly and accurately. Also, communicating at the scale of highest interest to the customer (for example, providing information about a personal route to work) allows the message to resonate. Applying a local and precise approach demonstrates a transportation agency is vested in its customers interests.

The transportation agency that goes beyond customer satisfaction empowers the customer to become a brand advocate.

Delivering Quality Customer Service

Service-Oriented Enterprise. The successful transportation agencies provide services reflecting the needs of their customers. The average person travels 36 miles per day, spending about one hour in a vehicle, according to the 2009 National Household Travel Survey [14]. Managing how that time is spent determines if the customer has a positive or negative experience. By providing quality traveler information, roadway maintenance, and roadside assistance services, transportation agencies increase customer satisfaction.

Listening to the customer offers new insights, perspectives, and strategies.

Proactive. Customer care cannot afford to wait for problems to arise. Proactively communicating important information to customers improves relationships and reduces potential dissatisfaction. For example, notifying travelers of scheduled construction or lane closures allows customers to identify alternative routes. Anticipating customer concerns reduces support calls and empowers the customer to become a brand advocate.

Responsive. Customers need to be valued. By listening to concerns regarding brand, products, and services, a transportation agency can learn new insights, gain perspective, and adapt its strategies accordingly. For example, knowing the status of service requests reassures the customer that his or her requests are being fulfilled. Pizza Tracker is Domino's online tool that allows customers to follow the progress of their order from the time it is placed through delivery. The tool offers transparency, reduces calls regarding order status, solicits feedback, and improves customer loyalty. By monitoring all communication channels, transportation agencies are able to quickly resolve problems and improve customer relationships.

Understanding the Customer of the Future

White Paper

How the Age of Technology is Transforming Transportation Agencies

PUBLIC POLICIES & PROGRAMS

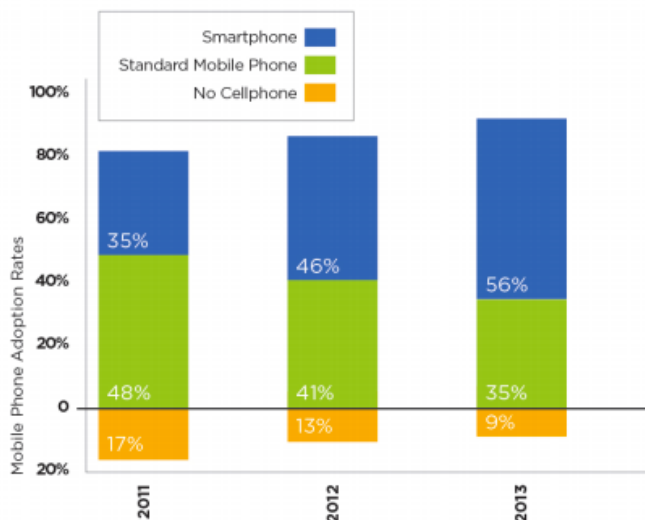
National Efforts

Beyond Traffic: Trends and Choices 2045. The U.S. Department of Transportation (USDOT) published a framework for the future of the nation's transportation system [15]. The document underscores critical decision points facing the country, by means of data-driven analysis, research, expert opinions, and public engagement. The report focuses on the following five areas:

- How will we move?
- How will we move things?
- How will we move better?
- How will we adapt?
- How will we align decisions and dollars?

In the area of emerging technologies, *Beyond Traffic* highlights connected and autonomous vehicles, 3D printing, robotics, unmanned aircraft systems, positive train control, real-time mobile access, NextGen air traffic control, and Big Data as having transformative impacts upon the customer's transportation experience.

Cellphone Adoption Rates in the U.S. (2011 – 2013)



Millennials – Shaped by Technology

There are **73 million millennials** aged 18 to 34. They are the first to have access to the internet during their formative years and will be an important engine of our future economy [15].

Income Inequality

10% of the population takes home one-third of the U.S. national income. Transportation is the second largest expense for U.S. households, accounting for nearly **20% of total household expenses** and 12 to 15% of total household income [15].

Older Americans – Redefining Longevity

About **one-third** of people over 65 have a disability that limits mobility. Their access to critical services will be more important than ever [15].

Freight – Transportation and the Economy

54 million tons of freight move across the U.S. every day. By 2040, U.S. freight volume will grow to **29 billion tons**, an increase of 45%. The value of freight is projected to grow to \$39 trillion, an increase of 125% [15].

Safety – Driven by Vehicle Automation

The Insurance Institute for Highway Safety has estimated that if all vehicles had forward collision and lane departure warning, blind spot assist, and adaptive headlights, about **one in three** fatal crashes and **one in five** injury crashes could be prevented [15].

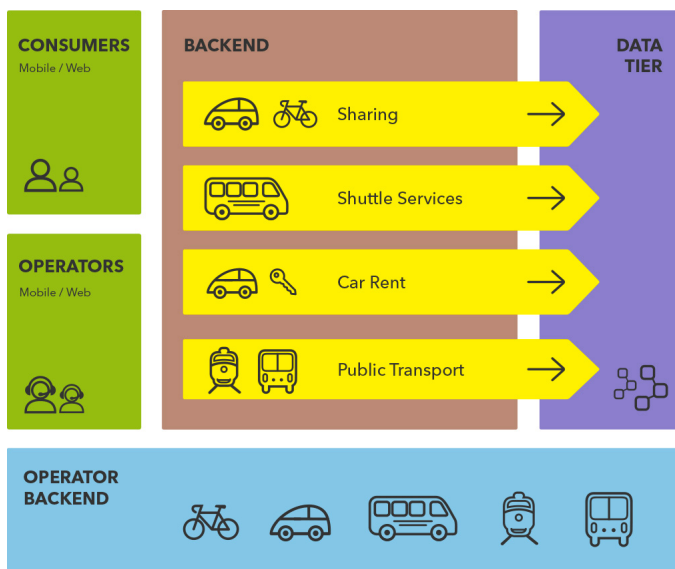
Understanding the Customer of the Future

White Paper

How the Age of Technology is Transforming Transportation Agencies

Mobility as a Service. What if transportation services were bundled together similar to mobile phone price-plan packages? Gaining momentum in Europe, Mobility as a Service (MaaS) is a mobility distribution model in which a customer's major transportation needs are met over one interface and are offered by a service provider [16]. User benefits include developed, personalized, and smart mobility services reflecting the customers' diverse needs; seamless, well-functioning transportation services; and easy access to mobility.

New technologies enable users to take a more dynamic, proactive role as a developer and data producer in the transportation system. MaaS may be used to develop transportation as an experience—everyone's personal 60 minutes each day. For transportation agencies, advanced data deployment improves the effectiveness of the whole system, effectively allocates resources, and improves traffic incident management.



Mobility as a Service (MaaS) Architecture:
Creating the personal transportation experience.

Activity-Based Models and MAP-21. Traditional travel demand modeling uses a trip-based approach. However, this approach does not realistically represent customer behavior and has difficulty assessing policies such as telecommuting, congestion pricing, and flexible work hours. On the other hand, the activity-based approach adopts a holistic framework that recognizes the complex interactions in activity and travel behavior, using interconnected time periods as the unit of analysis [17]. For example, an individual makes interrelated mode and time-of-day decisions based upon the activities for the whole day: dropping the children off at school, going to work, eating lunch downtown, returning to work, and running errands before arriving home.

Activity-based modeling also supports dynamic traffic assignment (DTA), which is capable of modeling more complex traffic patterns at a range of scales from the corridor level to the regional. The combination of activity-based approaches and DTA supports metropolitan planning organizations (MPOs) and other stakeholders in tracking performance measures outlined in the Moving Ahead for Progress in the 21st Century (MAP-21) Act, including safety, freight movement and economic vitality, and environmental sustainability [18]. By understanding evolving customer behavior, travel demand modelers can better represent choices made by individual travelers and improve forecasts used for planning efforts.

“The reality about transportation is that it is future-oriented. If we are planning for what we have, we are behind the curve.”

- Anthony Foxx, USDOT

Understanding the Customer of the Future

White Paper

How the Age of Technology is Transforming Transportation Agencies

City and Regional Initiatives

Open Fare Payment System. Current programs to upgrade and modernize the fare collection infrastructure are underway in numerous urban areas [19]. Open fare payment systems are an architecture designed to incorporate multiple operators, multiple modes, and a central clearinghouse. New transit payment systems offer interoperability, data integrity, cash replacement, convenience, and customer service. Imagine a system where a customer could use a single rechargeable account to access bus, rail, toll roads, parking, and other transportation services in every city throughout the state.

Contactless Smart Card Fare Systems		
City	Cards (x000)	Transportation Access
Atlanta, GA Breeze Card	1,400	Bus, Metro Rail, Parking
Boston, MA CharlieCard	4,000	Bus, Metro Rail, Light Rail, Parking, Ferry
Chicago, IL Chicago Card	780	Bus, Metro Rail
Houston, TX Q Card	350	Bus, Light Rail
Los Angeles, CA TAP Card	500	Bus, Metro Rail, Light Rail
Miami, FL EASY Card	1024	Bus, Metro Rail, Commuter Rail, Parking
NY/NJ SmartLink Card	350	Metro Rail
Salt Lake City, UT EFC Card	150	Bus, Light Rail, Commuter Rail
San Francisco, CA Clipper Card	800	Bus, Metro Rail, Light Rail, Commuter Rail, Parking
Seattle, WA ORCA Card	800	Bus, Light Rail, Commuter Rail
Washington, DC SmarTrip Card	1,800	Bus, Light Rail, Commuter Rail

Highway Emergency Response Operator (HERO) Program. The Central Texas Regional Mobility Authority (CTRMA) in partnership with TxDOT offer a free roadside assistance service that provides aid to stranded motorists, minimizes traffic delays, and improves highway safety along IH 35 and US 183. Services include providing traffic control, clearing damaged and disabled vehicles from roadway lanes and shoulders, removing debris, changing flat tires, and adding gasoline. Operators responded to over 10,000 roadway incidents in 2013, guaranteeing quality customer service [20].

Metropia. Metropia is an intelligent traffic management system that incentivizes communities to work together to ease city roadway congestion. Beginning September 2014, CTRMA partnered with Metropia to beta test a pilot program in Austin [21]. Users download an app that rewards commuters each time they use a suggested route or time of day. Points may be redeemed for prizes like gift cards to Amazon, Starbucks, and local restaurants.

CUSTOMER SERVICE SUCCESS STORY

"I was in Austin helping my daughter while her husband was away for military training. When I got a flat tire on I-35 it was upsetting because I was in an unfamiliar place driving my daughter's car. I was having trouble getting through to AAA when Clarence D. drove up and offered to change my tire. What a blessing he was to me. Thank you HERO Patrol!"

- Satisfied Customer

Understanding the Customer of the Future

White Paper

How the Age of Technology is Transforming Transportation Agencies

CUSTOMER SERVICE CHALLENGES

Cultural Barriers

Change. Customer trends and advances in technology can change rapidly. It is important for transportation agencies to tap into industry and academic expertise in order to remain well informed of behavioral and technological shifts. Conferences, forums, and journals are other examples of resources that leadership can leverage in order to ensure strategic plans remain relevant.

Privacy. Although transportation agencies may want to better understand their customers, many citizens are still wary of “Big Brother” and are apprehensive about providing personal information. Transparency regarding what data is collected, for what purpose, and with whom it is shared is important to maintaining public trust.

Technical Considerations

Finding the Right Technology. Emerging technologies offer valuable customer insights. The challenge lies in finding the right technology to improve the right parts of the customer experience. For example, with Big Data, it is important to understand the purpose for which the technology would be applied. Technology is not intended to replace traditional customer service, but rather serve as a tool to enable new and strengthen existing customer service strategies.

Systemizing a Customer Feedback Process. Customer feedback is an essential component required in order to benchmark and improve the customer experience. Without feedback, it is very difficult to evaluate what strategies are successful and which ones should be improved. Popular customer feedback loops include customer satisfaction surveys, quarterly business reviews, and comment boxes on the website.

“Quality in a service or product is not what you put into it. It is what the client or customer gets out of it.”

- Peter Drucker

Organizational Obstacles

Creating a Customer-First Culture. Transportation agencies are not exempt from the old adage “the customer is always right.” Adjusting priorities and becoming a service-oriented enterprise requires amending rewards and incentives based on the new preferred outcomes. The transition can also be catalyzed through the formation of the values the transportation agency embodies. Through effective communication, leadership can direct employees as to how they should engage, interact, and communicate with customers.

Delivering a Consistent Customer Experience. Research by Rawson, Duncan, and Jones found that customers do not care about singular touch points across the customer journey. Instead, they care about their cumulative experiences across multiple touch points and channels over time. This means customers no longer rate the service based on individual interactions; instead, they look at the experience the agency delivers as a whole.

Customer Segmentation Is Critical. When preparing educational, marketing, or communication materials, it is important to know the needs of the stakeholder. For example, a state legislator, MPO director, and member of the public are likely to be concerned about different aspects of the transportation system. Listening to the customers’ needs is essential in determining which types of information should be conveyed to which stakeholder.

Understanding the Customer of the Future

White Paper

How the Age of Technology is Transforming Transportation Agencies

STRATEGIC APPLICATIONS FOR TEXAS

Develop a Seamless Customer Experience

By viewing transportation as an interconnected experience, Texas can develop customer service strategies that ensure every touchpoint in the customer journey results in a seamless transition to the next stage. Open fare payment systems are one way to create a data-rich environment that can be mined for customer insights regarding route, mode, and time-of-day information. Real-time traveler information is another service that can be used to manage customer expectations. By developing a customer-centric mentality and prioritizing the customer relationship, transportation agencies can gain a deeper understanding of their stakeholders' interests. Sharing the information and collaborating between transportation agencies can accelerate Texas towards achieving the vision of a truly interoperable transportation system

Customize and Localize Information

Knowing what information is most important to which stakeholder and why is the foundation to any good communications strategy. Performance metrics and their respective visualization tools will vary according to the user. By crafting a personal and relevant message for each customer segment, transportation agencies can ensure their message resonates.

Public Sector as an Enabler

Transportation agencies have the power to leverage technology as a platform for change. Through customized incentives, transportation agencies can encourage customers to modify their route, time-of-day, and mode choices to benefit the transportation system as a whole. Connecting people with information and opportunities enables economic growth, increased mobility, and improved service delivery.

Understanding the Customer of the Future

White Paper

How the Age of Technology is Transforming Transportation Agencies

REFERENCES

1. Title Page Art. Source:
<http://mms.businesswire.com/media/20141027005023/en/437952/5/WDS-Virtual-Agent.jpg>
2. U.S. Census Bureau. "2014 National Projections."
<https://www.census.gov/population/projections/data/national/2014.html>
3. Office of the State Demographer. "Texas Population Projections 2010 to 2050."
http://osd.state.tx.us/Publications/2014-11_ProjectionBrief.pdf
4. Sivak, Michael. "More Women Drivers than Men on U.S. Roads Now."
<http://www.usatoday.com/story/money/cars/2012/11/12/women-drivers-men-licenses-roads/1700185/>
5. Strategy Analytics. "33 Billion Internet Devices by 2020: Four Connected Devices for Every Person in World."
<https://www4.strategyanalytics.com/default.aspx?mod=pressreleaseviewer&a0=5609>
6. Texas Department of Transportation. "Texas Motor Vehicle Traffic Crash Highlights, 2014."
<http://www.txdot.gov/government/enforcement/annual-summary.html>
7. Texas Transportation Institute. "2015 Urban Mobility Scorecard."
<http://d2dtl5nnlpr0r.cloudfront.net/tti.tamu.edu/documents/mobility-scorecard-2015-wappx.pdf>
8. Carrel, Halvorsen, Walker. "Passengers' Perception of and Behavioral Adaptation to Unreliability in Public Transportation, 2013."
<http://trrjournalonline.trb.org/doi/10.3141/2351-17>
9. American Society of Civil Engineers. "2013 Report Card for America's Infrastructure."
<http://www.infrastructurereportcard.org/>
10. The Toll Roads. "Bye-Bye Cash...Hello Convenience."
<https://www.thetollroads.com/newsroom/pressreleases/archive/201401/pr-20140114-bye-bye-cashhello-convenience.php>
11. Southwest Research Institute and Automated Port Solutions. "Green Lane Concept."
12. Fortna. "Ship-from-Store Distribution: Reducing the Impact of an Imperfect Forecast."
<http://www.fortna.com/whitepapers/ship-from-store-distribution-reduces-impact-of-imperfect-forecast-FINAL-EN.pdf>
13. American Community Survey. "Home-Based Workers in the United States: 2010."
<https://www.census.gov/prod/2012pubs/p70-132.pdf>
14. National Household Travel Survey. "Summary of Travel Trends."
<http://nhts.ornl.gov/2009/pub/stt.pdf>
15. USDOT. "Beyond Traffic: Trends and Choices 2045."
https://www.transportation.gov/sites/dot.gov/files/docs/Draft_Beyond_Traffic_Framework.pdf
16. ITS in Europe. "Mobility as a Service."
http://www.itsineurope.com/its10/media/press_clippings/ITS%20Supp_et214.pdf
17. Bhat, Chandra R.; Koppelman, Frank S. "Activity-Based Modeling of Travel Demand."
<http://www.caee.utexas.edu/prof/bhat/ABSTRACTS/TSHANDBK.pdf>
18. USDOT Federal Highway Administration. "MAP-21: Moving Ahead for Progress in the 21st Century."
<https://www.fhwa.dot.gov/map21/factsheets/pm.cfm>
19. Smart Card Alliance. "Transit and Contactless Open Payments: An Emerging Approach for Fare Collection."
http://www.smartcardalliance.org/resources/pdf/Open_Payments_WP_110811.pdf
20. Central Texas Regional Mobility Authority. "HERO Emergency Patrol Service."
http://www.mobilityauthority.com/information/files/HERO_Fact_Sheet_0113.pdf
21. Central Texas Regional Mobility Authority. "Metropia Traffic Management Mobile App to Beta Test in Austin."
http://www.mobilityauthority.com/monkeewrench/files/resources/PR_Metropia_Austin_Launch_092614.pdf
22. Figure: The Evolution of Retail Logistics. Source:
<http://uploads.link51.com/1202/E-commerce%20White%20Paper%20Image%202%20-The%20Evolution%20of%20Retail%20Logistics.jpg>
23. Figure: 2014 the Year of Ridesharing. Sources: 1. Salary.com/Taxi-Driver-Salary.html|glassdoor.com/Salary/Lyft-Salaries-E700614.htm|blogs.wsj.com/digits/2014/06/06/uber-ceo-travis-kalanic-were-doubling-revenue-every-six-months/trendkite.com|side.cr|uber.com|lyft.com|google.com/trends/|http://techcrunch.com/2014/12/04/uber-confirms-new-1-2b-funding-round-loos-to-asia-for-expansion/|wired.com/2014/09/ubers-revenue-12-times-bigger-lyfts-new-study-says/|mashable.com/2014/09/08/uber-ceo-techcrunch-disrupt/|cnbc.com/id/102004686

Revolutionizing the Global Logistics Industry

White Paper

How the Age of Technology is Transforming Transportation Agencies



How can transportation agencies prepare for ‘the new normal’ in supply chain management and enhance their own competitiveness in the logistics market?

With strong state growth, the connectivity of the interstate highway network, and proximity to the Mexico border, Texas could leverage state resources and conditions to appeal to logistics providers. By developing a synergistic environment that supports emerging technologies, such as 3D printing, the Internet of Things, drones, and RFID, Texas has the potential to become a leading candidate for logistics providers to perform new technology trials.

Initial planning activities should focus on providing improved intermodal connections, expanding shipping choices, conducting intermodal studies to aid local and regional economic development efforts, and facilitating the cooperative operations between mode-specific agencies. States and regions that plan for and support an increase in freight movement will enhance their own competitiveness in international and domestic markets.

Revolutionizing the Global Logistics Industry

White Paper

How the Age of Technology is Transforming Transportation Agencies

KEY STRATEGIES



Understand the Full Suite of Technologies

The future of freight and urban logistics hinges upon technology development and adoption. Understanding the suite of emerging technologies is critical for integrating them into logistics services and supply chain management.



Develop an Interface between Modes

Planning for the interface between modes will provide for the optimum use of all of the State's transportation modes for freight movement. When modes interface well, paths for goods movement increase as congestion and delay decrease.



Identify Future Markets and Influences

Growth in freight shipment has a strong connection with population growth and overall economic health and is also influenced by many other factors. Understanding trends in these areas will provide indications to transportation agencies on the amount and types of freight movement that need to be accommodated.

Revolutionizing the Global Logistics Industry

White Paper

How the Age of Technology is Transforming Transportation Agencies

STATE OF RESEARCH & PRACTICE

Understand the Full Suite of Technologies

Additive Manufacturing (3D) Printing. The idea of 3D printing or additive manufacturing (AM) as it is also known is not a new idea; however, it is only in recent years that it has become a reality. AM makes it possible for manufacturers, businesses, and individuals to print exact working replicas of parts and products using plastics, metals, resins, ceramics, paper, and wax. Already, a number of personal 3D printers can be purchased on customer sites such as Amazon for as little as \$360.

In larger-scale business applications there are a number of AM technologies, each with their own strengths and weakness, that better serve manufacturing of the end product. The table below provides a snapshot of several AM technologies along with key attributes of the technology.

By understanding the range of technical capabilities, transportation agencies can develop a synergistic environment for emerging technologies.

Increasingly manufacturer and technology companies are becoming more involved in 3D printing and are making parts for automotive, aerospace, defense, and medical industries [2]. A list of leading AM/3D printing companies and 2014 revenues are listed below [3].

- Stratasys Direct Manufacturing \$750 million (NASDAQ: SYSS)
- 3D Systems: \$650m (NYSE:DDD)
- Materialise: \$81m (NASDAQ:MTLS)
- ExOne: \$43.9m (NASDAQ:XONE)
- Arcam: \$39m (Stockholm Stock Exchange, STO:ARCM)
- SLM Solutions: \$36m (XETRA: AM3D)
- Alphaform \$30m (ETR:ATF)
- voxeljet: \$17m-18m (NYSE:VJET)

AM could have a lasting impact on freight and logistics for a number of reasons, but primary reasons include onsite production or the ability to print products anywhere, particularly the customer's business location, and the idea that printing on location is faster than shipping from remote supplier and traditional manufacturers. Replacement or unique parts that traditionally require expensive offsite new manufacturing can be scanned and printed same day.

Summary of Printing Technologies

Process	General material used	Material deposited or on bed?	Material fused by what process?	Popular Process/Brand	Select Companies with Process
Material Extrusion	Thermoplastic	Deposited	Nozzle	FDM	SSYS; DDD
Material Jetting	Photopolymer/Wax			PolyJet/ProJet	SSYS; DDD
Vat Photopolymerization	Photopolymer	Bed	Laser	SLA	DDD; EnvisionTEC
Binder Jetting	Powders		Bonder	3DP	DDD; XONE; VJET
Powder Bed Fusion			Laser/EBM	SLS/DMS	DDD; ARCM; EOS
Directed Energy Dep.				DM	Trumpf, Optomec
Sheet Lamination	Paper	Deposited	Bonder	LOM/UAM	Mcor Technologies

Source: Pacific Crest Securities estimates

Revolutionizing the Global Logistics Industry

White Paper

How the Age of Technology is Transforming Transportation Agencies

Internet of Things (IoT). A number of factors are driving the rise of the IoT, including the widespread availability of broadband Internet, Wi-Fi capable devices (especially smartphones) and sensors, and the overall decrease in the cost of connecting. In short, IoT allows devices to communicate with one another using communication infrastructure, absent human intervention. Devices include everything from smartphones, household appliances, wearable devices, and components of machines such as vehicle engines, and much more. Ultimately the IoT will become a massive network of connected things with connections between people-people, people-things, and things-things. The application of IoT to future freight and logistics is expected to increase speed, decrease waste, and reduce costs.

Example IoT applications possible through connected sensors and devices for urban freight and logistics include the following [4].

- Waste management—detection of trash container levels provides information for the optimization for waste management routes.
- Traffic congestion—monitoring of vehicles, cyclists, and pedestrians to optimize delivery vehicle routing.
- Shipment quality—monitor container vibrations, hits, and openings to indicate potential quality issues.
- Item location—query of individual items in large areas like warehouses or harbors.
- Storage incompatibility detection—monitor and warn of emissions from containers storing inflammable goods near others containing explosive material.
- Fleet tracking—monitor routes followed for delicate goods like medical drugs, jewels, or dangerous merchandises.

IOT Challenges

Security – Keeping data secure is a big issue when considering millions or billions of devices being connected together. Transportation agencies and original equipment manufacturers should consider strategies for keeping information secure.

Privacy – The IoT also opens up companies and customers to more security threats, which also threatens their privacy. Agencies will need to find ways to monitor their databases, limit access, properly encrypt data, or use other strategies to ensure privacy of data.

Data Management – With massive, connected networks, the amount of data that devices will produce will be enormous. Agencies will need to figure out how to store, query, analyze, and use the immense amounts of data that will be generated.

Revolutionizing the Global Logistics Industry

White Paper

How the Age of Technology is Transforming Transportation Agencies

Drones. Consumer purchasing and delivery is changing largely in part due to online shopping—customers are increasingly interested in click-and-buy shopping on mobile devices. Soon, the way that goods reach the consumer’s door could change with on-demand, last-mile delivery options. Same-hour bicycle delivery and vehicle delivery (like Uber) are becoming options, but the truly transformational technology that may be a reality in the future is delivery drones. Large, reputable companies like Amazon and Google have already made known their plans for delivery drones in the U.S. with programs called Amazon Prime Air and Project Wing. Delivery companies FedEx and UPS have also indicated research activities in the area of drones [5]. International delivery giant DHL is already testing drone based delivery in Europe [6].

In all of these schemes, small unmanned aerial vehicles (UAVs), or drones, weighing less than 55 pounds would be used at a maximum flight level of 400 ft above ground. The few operational details released by Amazon include plans for 30-minute-or-less delivery, a 10-mile flying radius from launch point, and 30-minute battery life [7]. Each UAV could carry a package of up to five pounds, which applies to about 80 or 90 percent of all items Amazon sells [8].

Current regulation issued by the U.S Department of Transportation’s Federal Aviation Administration (FAA) does not allow for testing of commercial delivery schemes like Amazon’s proposal. Restrictions regarding drone operations (such as the mandate for full line of sight, prohibition of flying over people, etc.) make it impossible to test delivery drones in urban areas. Until urban delivery trials are allowed on a small scale, U.S. transportation agencies should watch Amazon Prime Air approvals and trials in others countries for lessons learned.

Robotics and Automation. Although these two ideas are closely related, their applications differ in the context of freight and logistics. One application of automation is the autonomous, or partially autonomous, freight truck. Such vehicles would allow for computer takeover of driving tasks in large semi trucks. Daimler has already announced the trial of such a concept and said that the company will begin testing on public roadways in Nevada [9]. Automated trucks offer safety and operational benefits because autonomous systems can react faster than human drivers and adjust driving according to real-time vehicle information. This capability not only increases safety on the road, but also increases operational efficiencies by enabling truck platooning. Similar trials in Sweden have resulted in millions of gallons in fuel savings from autonomous systems that optimize driving under continually monitored driving conditions.

At ports, automation or robotics may be used for loading and unloading, automated container transport, and automated container storage using autonomous guide vehicles, autonomous stacking cranes, or ship-to-shore cranes [10]. Benefits of these could include reduced costs and increased productivity. Empirical evidence from global ports using automation shows improvements like increased productivity and efficiencies. For example, Hong Kong, Singapore, and Taiwan, which have highly automated ports, are able to undertake 46 crane moves per hour, making them 13 percent more efficient than Middle Eastern ports and 43 percent more efficient than North American ports in unloading cargo [11].

Automated truck platooning offers safety and operational benefits. Trials in many states are already underway.

Revolutionizing the Global Logistics Industry

How the Age of Technology is Transforming Transportation Agencies

White Paper

Radio Frequency Identification (RFID). RFID is an automated identification and data collection technology that is found in items such as access cards and toll tags. It allows an object to be tracked by identifying it with a transponder or tag. Periodically, the tag transmits its unique ID number through radio frequency or an RFID reader requests that the tag to broadcast its data. The reader receives tag data and sends it to middleware that filters, aggregates, and formats the data for business applications. RFID comes in a various forms, although the most common are passive (no battery) and active (with battery) forms [12]. RFID technology can be used in the freight and logistics for the following applications.

RFID Applications

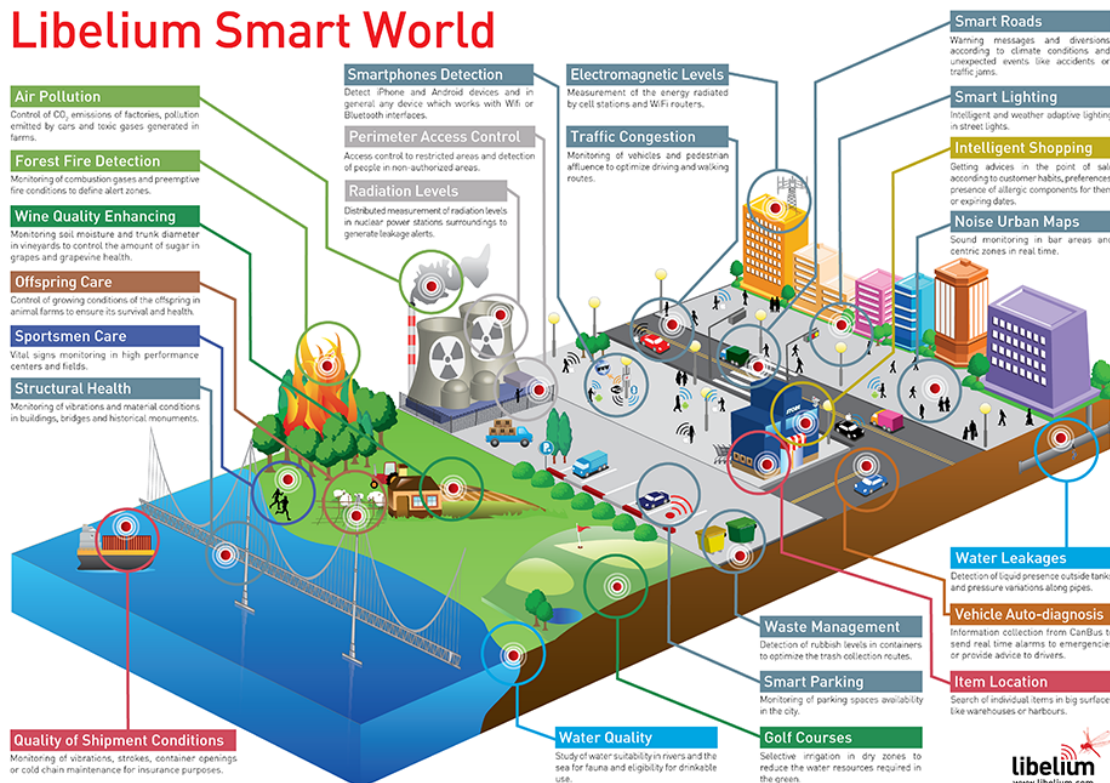
Network Asset Visibility – RFID can be used to track containers and trucks across many supply chain modes.

Operational Control – RFID can allow monitoring of automated processes within terminal or ports.

Safety – This technology can help to ensure safety of personnel and equipment through nearly continuous monitoring within a terminal or port.

Security – RFID can aid in control and securing assets in the inventory.

Libelium Smart World



Revolutionizing the Global Logistics Industry

White Paper

How the Age of Technology is Transforming Transportation Agencies

Develop an Interface between Modes

Intermodal. Goods shipment requires more than one mode. It requires a combination of ships, trains, trucks, ports, rails, and roads, and demands a support structure for intermodal operations so that the economy of the U.S. continues to thrive. Since goods movement takes place in an interconnected, complex system, the impact of increased freight on one mode impacts other modes. For example, more efficient water ports may be capable of handling bigger ships with larger loads and at a quicker turnaround time, too. But if those goods cannot be efficiently moved to trucks and rail, then waterways will become congested and backed up rendering larger ships ineffective.

Intermodal efficiency is critical and to be planned for at high levels with coordination among agencies that traditionally have interest in a single mode (e.g., aerospace, rail, surface transportation, etc.). Public and private sectors stakeholders alike have an interest in identifying the most efficient combination of modes for shipments across the supply chain since revenue is tied to efficiency. Where there are inefficiencies at modal interfaces, solutions must be made to relief congestion and delays. The Port of Savannah, for example, has built two freight rail lines located in terminals for long-distance or heavy cargo, and has also built a direct three-mile roadway link to Interstate 95 at a cost of \$73 million in order to save 11 minutes to and from the port [13].

DIRECT ROAD MOVEMENT TO PORT



INTERMODAL/EXPORT



INTERMODAL



INTERMODAL/DOMESTIC



Revolutionizing the Global Logistics Industry

White Paper

How the Age of Technology is Transforming Transportation Agencies

Identify Future Markets and Influences

Consumer Purchases. The demand for goods movement will ultimately be driven by customer purchases. To that end, the Census Bureau has estimated that the U.S. population will increase 20% by 2040, which translates to roughly one additional person every 12 seconds who needs and wants consumer goods [14]. Further, the Boeing Company previously released worldwide projections for the global air freight market, which is expected to double in the next 20 years. This is supported by the notion that there will be a continuing, strong need to transport air goods to North America from Asia. To meet demand, Boeing predicts that carriers will buy nearly 840 new freight planes over the next two decades at an estimated value of \$240 billion with an annual global rate of air freight growth of 4.7 percent [14].

Freight and logistics companies and transportation agencies should also be aware of a number of other market factors that will impact their operations and bottom line, such as fuel prices, alternative energy advances, demand for personal travel that impacts road network performance, labor and personnel availability and training, and more.

The global air freight market is expected to double by the year 2035.

American Trucking Association Projections for the U.S.

Overall freight tonnage will grow 23.5% from 2013 to 2025 and freight revenues will increase by 72%.

Growth in overall freight volume is pegged at 2.8% per year from 2014 to 2019, and then it tapers off to 1.0% during the next six years through 2025.

Trucking's share of freight tonnage will increase from 69.1% in 2013 to 71.4% in 2025

Rail intermodal tonnage will grow 5.5% annually through 2019 and 5.1% a year through 2025—yet the rail market share will shrink from 14.5% of all tonnage in 2013 to 13.8% in 2025.

Revolutionizing the Global Logistics Industry

White Paper

How the Age of Technology is Transforming Transportation Agencies

OPPORTUNITIES FOR TEXAS

Leverage Natural State Resources

Texas could leverage state resources and conditions that are appealing to logistics providers. Strong state growth, the interstate highway network, proximity to the Mexico border, and other factors make Texas a prime candidate for logistics providers to perform new technology trials.

Facilitating Intermodal Planning

Initial planning activities should focus on providing improved intermodal connections, expanding shipping choices, conducting intermodal studies to aid local and regional economic development efforts, and facilitating the cooperative operations between mode-specific agencies. States and regions that plan for and support increase in freight movement will enhance their own competitiveness in international and domestic markets.

Revolutionizing the Global Logistics Industry

White Paper

How the Age of Technology is Transforming Transportation Agencies

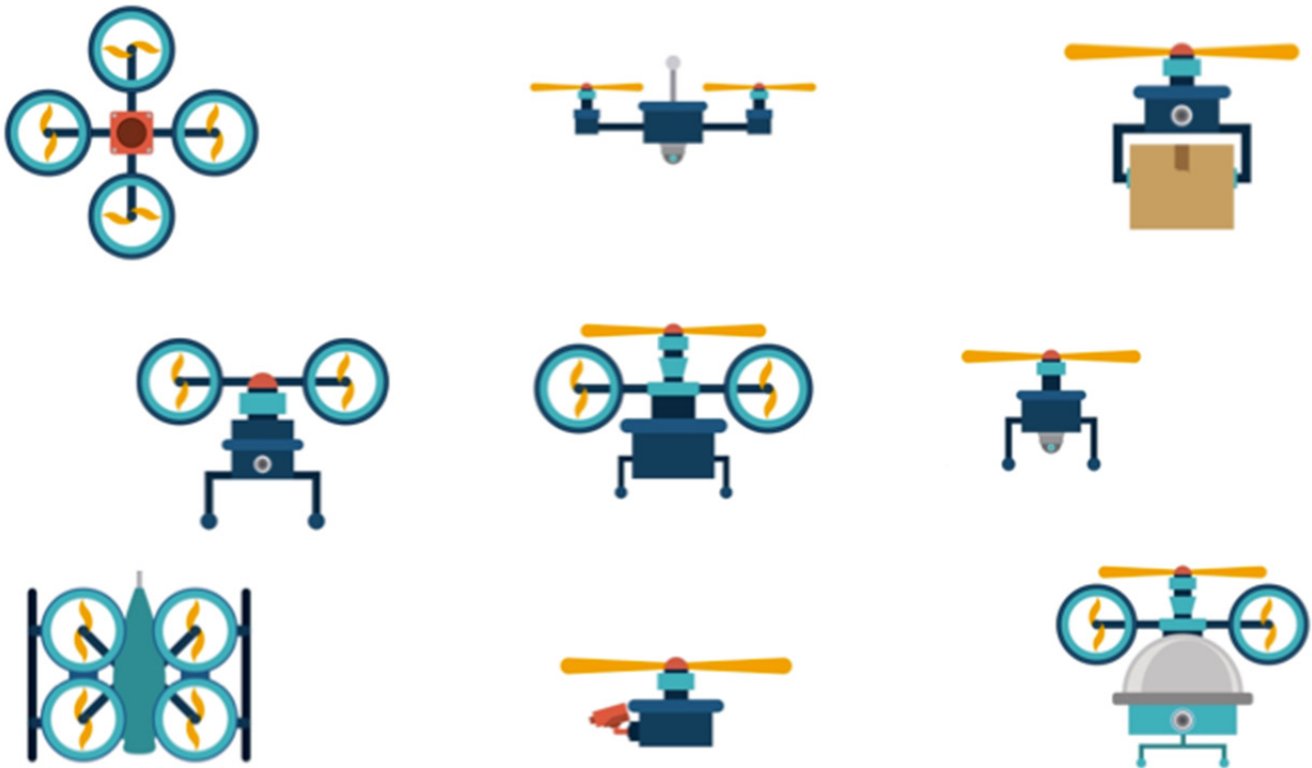
REFERENCES

1. Title Page Art. Source:
http://cdn2.hubspot.net/hub/312296/file-498999919-png/Web_Page_Images/Logistics.png?t=1403634386000
2. Forbes. "What Can 3D Printing Do? Here Are 6 Creative Examples."
<http://www.forbes.com/sites/amitchowdhry/2013/10/08/what-can-3d-printing-do-here-are-6-creative-examples/2/>
3. 3D Printing Industry. "The Top 10 3D Printing Stocks for 2015"
<http://3dprintingindustry.com/2015/03/19/fiscal-2014-revenue-results-3d-printings-top-10-guns/>
4. Libelium. "50 Sensor Applications for a Smarter World."
http://www.libelium.com/top_50_iot_sensor_applications_ranking
5. The Financialist. "Drones: Deliverymen of the Future."
<http://www.thefinancialist.com/drones-deliverymen-of-the-future/>
6. DHL. "DHL parcelcopter launches initial operations for research purposes."
http://www.dhl.com/en/press/releases/releases_2014/group/dhl_parcelcopter_launches_initial_operations_for_research_purposes.html
7. CNN. "Amazon's drone delivery: How would it work?"
<http://www.cnn.com/2013/12/02/tech/innovation/amazon-drones-questions/>
8. Popular Science. "Amazon's Gur Kimchi On The Future Of Delivery Drones."
<http://www.popsoci.com/amazons-gur-kimchi-talks-future-delivery-drones>
9. Fortune. "In trucking, a little automation saves a lot of money."
<http://fortune.com/2015/05/19/trucking-automation/>
10. Terex. "Fully-Automated Container Terminals."
<http://www.terex.com/port-solutions/en/solutions/solutions-for-terminals/fully-automated-container-terminals/index.htm>
11. Navis. "Automated Future for Ports."
<http://navis.com/news/in-news/automated-future-ports>
12. Pema. "RFID in Ports and Terminals."
<http://www.eskema.eu>
13. Citylab. "A Complete Guide to the Future of U.S. Freight Movement."
<http://www.citylab.com/work/2014/10/a-complete-guide-to-the-future-of-us-freight-movement/381012/>
14. Air Freight. "Boeing projections show healthy future for air cargo market."
<http://www.airfreight.com/blog/boeing-projections-show-healthy-future-air-cargo-market>

Identifying Opportunities and Challenges of UAVs

White Paper

How the Age of Technology is Transforming Transportation Agencies



How are drones changing the way transportation agencies do business and does Texas have the potential to become a leader in this space?

Potential commercial and civilian uses of small unmanned aerial vehicles (UAVs), also known as drones, offer many beneficial applications in the areas of emergency response, structure inspections and safety, traffic monitoring and investigating, delivery and logistics, and more. Transportation agencies at all levels can get creative with proposed drone applications, which will offer safety, cost savings, and operational efficiency gains. In order for these benefits to be realized,

transportation agencies should be proactive in planning by staying informed of FAA rules and regulations, understanding technological and operational barriers, and planning to mitigate citizen concerns through strategic initiatives. Transportation agencies can also support UAV integration by taking steps to provide the necessary support infrastructure, personnel, and programs.

Identifying Opportunities and Challenges of UAVs

White Paper

How the Age of Technology is Transforming Transportation Agencies

KEY STRATEGIES



Develop an Ecosystem to Support UAV Integration

The introduction of UAVs to support transportation operations across all modes requires consideration and provision of a full, supportive ecosystem for safely managing them in our airspace.



Monitor FAA Rulemaking and Regulations

The FAA is expected to issue updates to rules governing commercial and civil uses of drones in late 2016 or early 2017. Transportation agencies should watch for these updates and take advantage of other key initiatives for UAV integration supported by the FAA.



Identify Commercial and Civil Applications

Already a number of commercial uses of UAVs have been proposed by companies across the U.S. Transportation agencies can monitor these proposals in order to plan for their operations, learn from those trials, or partner with the private sector for their own trials.



Discover and Mitigate Operational Obstacles and Barriers

Many barriers and obstacles exist, which will slow the introduction of UAVs for commercial and civil uses. Transportation agencies should anticipate these barriers and have a mitigation plan in place to increase the safe integration of UAVs.

Identifying Opportunities and Challenges of UAVs

White Paper

How the Age of Technology is Transforming Transportation Agencies

STATE OF RESEARCH AND PRACTICE

Develop Ecosystem to Support UAV Integration

Unmanned Aircraft (UA). The Federal Aviation Administration (FAA) states that a UA, also known as a drone, is one component of the larger system that is necessary to operate such an aircraft. The UA is a flying aircraft that is piloted through a ground control system, or autonomously through on-device computers and also using information transmission devices. The larger UA system (UAS) is made up of components such as control stations, data networks and transmission devices, navigation equipment, etc. UAVs offer a number of commercial and civil uses that could enhance surface transportation, provide economic benefits, and promote U.S. competitiveness.

Small UAVs. Small UAVs are defined as those that weigh less than 55 lb (25 kg) and fly at an altitude of under 400 ft (122 m) above ground level. This class of UAVs is typically powered by rechargeable batteries or small internal combustion engines (ICEs) and flown either manually via a remote controller or autonomously using an automated program in the UAV. Federal rules governing the use of drones vary depending upon the use class—recreational, commercial, or government. While there are a large number of drone applications, most can be described as delivery operations; utility operations; or surveillance, photography, or imagery operations.

Small UAVs come in a variety of shapes, sizes, and styles—each with unique benefits and applications.

General UAV Characteristics. Small UAVs come in a variety of shapes, sizes, and styles. With each style and body variation comes unique benefits and drawbacks that make the aircraft more or less appropriate for a particular application. Ultimately a UAV pilot (also called the operator) is required to match a best-fit vehicle with an application based on understanding key attributes. Currently there are two broad categories of UAVs—fixed wing and rotary wing. Each of these two categories can be further broken down into subclasses, with their own unique characteristics and advantages and disadvantages. The following section describes two broad UAV styles and corresponding characteristics. A discussion of other technological components follows.

Fixed Wing Small UAVs. This type of UAV has a rigid (fixed) wing with a predetermined airfoil that makes flight possible by causing lift of the vehicle using forward airspeed. Lift requires forward thrust generated by propeller and electric or internal combustion engine. Fixed wing UAVs can be broken into subclasses; for example, a fixed wing UAV can be high wing, mid wing, low wing, and flying wing. The aircraft is controlled by wing surfaces with control components (i.e., elevator, ailerons, and rudder). These components permit the vehicle to rotate around three axes that are perpendicular to one another and joined at the vehicle's center of gravity. Each component controls movement for each axis—for example, the elevator controls the pitch (lateral axis), ailerons control the roll (longitudinal axis), and the rudder controls the yaw (vertical axis) [1].

Identifying Opportunities and Challenges of UAVs

White Paper

How the Age of Technology is Transforming Transportation Agencies

Rotary Wing. Rotary wing small UAVs have two to three rotor blades that rotate around a fixed, center mast—the rotor. These UAVs come in a number of setups, such as helicopters with one rotor, tripticopters with three masts, quadcopters with four rotors, hexacopters with six rotors, etc. Like fixed wings, rotary wing UAVs can be broken into subclasses that offer their own unique advantages and disadvantages for a flight mission. Rotor blades work exactly the same way as a fixed wing; however, constant aircraft forward movement is not needed to produce airflow over the blades. Instead, the blades themselves are in constant movement, which produces the required airflow over their airfoil to generate lift.

Fixed Wing versus Rotary Wing. Overall the fixed wing UAV is a simpler structure compared to a rotary wing UAV. Due to its simplicity, maintenance and repair is typically less expensive and complicated, resulting in more fly time at a lower cost. In addition, fixed wings offer more efficient aerodynamics with the advantage of longer flight times at higher speeds, making them a competitive option for applications such as surveying and mapping where larger areas per flight can be realized. Fixed wing UAVs also offer natural gliding (no power) capabilities (a feature rotary wings lack), meaning that they are able to carry greater payloads for longer distances on less power.

The disadvantages of fixed wings are the need for a runway or launcher for takeoff and landing. They also require air moving over their wings to generate lift and must stay in a constant forward motion, meaning they do not have stationary capabilities. Thus, fixed wing UAVs are not practical for stationary applications such as inspection work, where hovering is necessary.



Identifying Opportunities and Challenges of UAVs

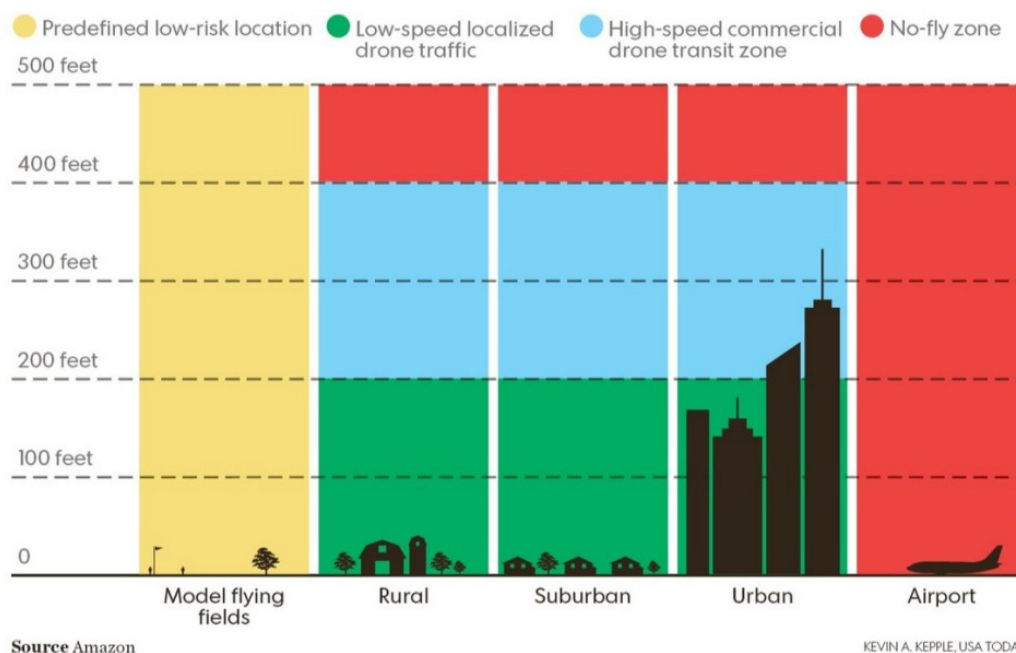
White Paper

How the Age of Technology is Transforming Transportation Agencies

Energy and Propulsion System. Small UAVs typically have one of two engine technologies—internal combustion or electric. ICE and electric engines present distinctly different advantages (and disadvantages) for flight missions. ICEs provide for longer endurance flights that may be good for mapping and surveying, and electric engines provide for quiet operations, which may be ideal for missions in and around populated areas.

Controllers and Onboard Technology. A controller is needed in order to take flight. Controllers come in many forms, including gamepad-like devices and smartphone and tablet apps. The controller allows a pilot to launch, navigate, and land the UAV, typically through 2.4 gigahertz radio waves [2]. UAVs have a variety of onboard technologies as well. For example, GPS chips for relaying location and navigation, gyroscopes for determining the reference system for the navigation, altimeters for monitoring altitude useful for hovering, etc.

Small UAS Ecosystem. According to the Institute of Electrical and Electronics Engineers (IEEE), UAS will present greater communication needs compared to current manned aircraft partly due to issues like communication bandwidth—or the rate at which data can be sent over a communication link. Many small UAS applications necessitate fast response times in locations where permanent supporting communication infrastructures do not exist [3]. Current approaches that use long-range or satellite communications require equipment that is too large and expensive for small aircraft, whereas smaller radios limit the small UAS operational envelope in terms of range, altitude, and payload. Much research and planning is needed to understand the full ecosystem of hardware and software needed to safely integrate more UAVs into the airspace. In addition, the FAA will need to work with the FCC regarding the communications frequencies used by UAVs, and with the government and Congress on privacy issues to support the ecosystem.



Identifying Opportunities and Challenges of UAVs

White Paper

How the Age of Technology is Transforming Transportation Agencies

Monitor FAA Rulemaking and Regulations

Federal Aviation Administration (FAA). The FAA under the U.S. Department of Transportation oversees operations of any aircraft in the national airspace and requires that aircraft are certificated and registered, are operated by a licensed pilot, and have operational approval.

Current Rules. General and current rules for small UAVs are described below and vary depending on use. Uses are divided into three categories: recreational, business, and public.

- UAV flights must be below 400 feet and remain clear of surrounding obstacles
- UAVs shall remain within visual line of sight at all times
- UAVs must stay well clear of manned aircraft operations
- UAVs cannot fly within 5 miles of an airport without contacting the airport and control tower beforehand
- UAVs cannot fly near people or stadiums
- UAVs cannot fly an aircraft that weighs more than 55 lbs
- Operators cannot be careless or reckless with the UAV

The FAA does allow the flight of small UAS for commercial or business purposes on a case-by-case basis. Operators are prohibited from flying for commercial purposes without the express permission of the FAA. There are two ways to obtain such permission. Operators can apply for an exemption (see description of Section 333 to follow) from the FAA to operate commercially or obtain an FAA airworthiness certificate and operate pursuant to FAA rules. In either case the operator needs an FAA Certificate of Waiver or Authorization (COA).

Finally, public entities, including publically funded universities, law enforcement, fire departments, and other government agencies, can apply for a COA from the FAA for the use of small UAS in public aircraft operations. For both commercial and public uses, the FAA will thoroughly evaluate each COA application and determine the safety of proposed use. COAs will be used for a specific period of time (typically two years) and include special provisions unique to each proposal, such as a defined block of airspace or the time of day the UAS can be used.

Proposed Rules. Earlier in 2015 the FAA provided notice of rulemaking for small UAVs, known as “Small UAS Notice of Proposed Rulemaking,” which was followed by a required 60-day public comment period ending on April 24, 2015. Comments were solicited for the FAA’s proposed framework of regulations for the routine use of small UAVs in the national airspace. Next, the FAA will review the public comments and make any necessary changes to proposed rules. The FAA has not announced an expected completion date for the changes. The proposed rules apply to non-recreational operations and non-model aircraft and further addresses operational hours, visual-line-of-sight requirements, height restrictions, operator certification, optional use of a visual observer, and aircraft registration and marking. Until a final rule is issued, no part of the rule will be in effect and current regulations will continue to apply. Until the new rules are issued, commercial operators must request and receive a Section 333 grant of exemption.

Identifying Opportunities and Challenges of UAVs

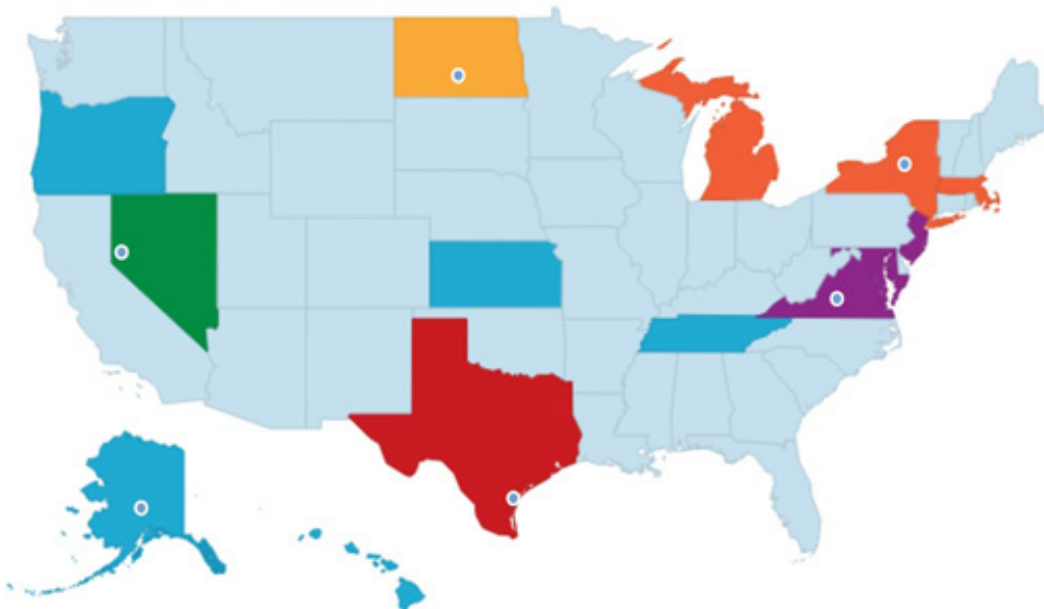
White Paper

How the Age of Technology is Transforming Transportation Agencies

Highlights of the “Small UAS Notice of Proposed Rulemaking” include provisions for operator certification and responsibilities such as passing an initial aeronautical knowledge test and provisions for aircraft requirements (aircraft markings, registration, inspection, etc.). In addition to rule making, the FAA is currently engaging in a number of key initiatives designed to research and plan for the integration of UAVs into the national airspace. An overview of such initiatives is provided below.

Test Sites. The FAA has chosen six UAS sites across the country for research and testing. Each of the six sites is in partnership with a university and has been chosen for its geography, climate, proximity to ground infrastructure, research needs, airspace use, safety, aviation experience, and risk. These sites combined represent cross-country geographic and climatic diversity in order to help the FAA meet its UAS research needs. The sites are congressionally mandated and will complete critical research that will inform the certification and operational requirements needed to safely integrate UAS into the national airspace in coming years.

Summary of FAA UAS Test Sites		
Location	Approval Date	Research Area
University of Alaska (includes test ranges in Hawaii, Oregon, Kansas, and Tennessee)	May 5, 2014	Wildlife surveys: demonstrating how UAS can accurately locate, identify, and count large wild animals UAS safety: collect safety-related operational data needed for UAS integration
State of Nevada	June 9, 2014	Airport safety: verifying UAS can operate safely at the airports Standards and operations: UAS standards and operations as well as operator standards and certification requirements
New York's Griffiss International Airport (includes test range locations in Massachusetts and Michigan)	August 7, 2014	Safety: integration of unmanned aircraft into the national airspace Agriculture: detection of insects, weeds, diseases, crop characteristics, crop biomass and background soil characteristics farm fields
North Dakota Department of Commerce	February 11, 2015	Precision Agriculture: UAS check of soil quality and the status of
Texas A&M University – Corpus Christi	June 20, 2014	Multiple areas: safety of operations and data gathering in authorized airspace, UAS airworthiness standards, command and control link technologies, human-factors issue for UAS control-station layout, and detect-and-avoid technologies
Virginia Polytechnic Institute and State University (Virginia Tech) (includes test ranges in New Jersey and Maryland)	August 13, 2014	Agriculture: spray equipment testing, Standards and Operations: development of aeronautical procedures for integration of UAS flights in a towered airspace and developing training and operational procedures for aeronautical surveys of agriculture



Identifying Opportunities and Challenges of UAVs

White Paper

How the Age of Technology is Transforming Transportation Agencies

Center of Excellence. The FAA chose Mississippi State University, through a competitive process, to house the UAS Center of Excellence (COE). The COE will focus on education, research, and training necessary for the successful and safe integration of UAS into the national airspace. Research focus areas include detect and avoid technology; low-altitude operations safety; control and communications; spectrum management; human factors; compatibility with air traffic control operations; and training and certification of UAS pilots and other crewmembers, in addition to other areas [4]. While these are initial focus areas, the research program is expected to change and evolve as the program grows, with activities commencing in September 2015 and evolving to a fully operational and robust research agenda by January 2016.

The COE operates in partnership with 15 of the nation's leading UAS and aviation universities, which are listed below.

- Drexel University
- Embry Riddle Aeronautical University
- Kansas State University
- Kansas University
- Mississippi State University
- Montana State University
- New Mexico State University
- North Carolina State University
- Ohio State University
- Oregon State University
- University of Alabama, Huntsville
- University of Alaska, Fairbanks
- University of Kansas
- University of North Dakota
- Wichita State University

Section 333 (Commercial & Business Applications).

“Section 333” refers to the provisions of Section 333 of the FAA Modernization and Reform Act of 2012 titled “Special Rules for Certain Unmanned Aircraft Systems.” This section will ultimately allow for commercial or business operations in low-risk, controlled environments. Currently, UAVs that are flown for purposes other than recreation or hobby (commercial or business) are required to obtain FAA authorization via Section 333 and a grant of exemption, until new rules are issued by the FAA.

The following items are needed for commercial or business operations, including the Section 333 grant of exemption:

- Section 333 grant of exemption,
- Certificate of Waiver or Authorization (COA),
- Aircraft registered with the FAA, and
- Pilot with an FAA airman certificate

More information on Section 333 exemptions can be found online on the FAA Section 333 webpage [5]. In addition, granted exemptions can be found online on the Authorizations Granted Via Section 333 Exemptions page, which gives details on the petitioners and proposed UAV uses [6]. At the time of this paper, over 1200 petitions had been granted.

Focus Area Pathfinders. The FAA supports an initiative designed to work in partnership with UAV industry partners to consider next steps in UAV operations and integration not included in the draft small UAS rule it published in February. To date, three industry partners have asked the FAA to partner for work in specific focus areas. Each partnership and focus area is described below and more information can be found on the FAA’s Focus Areas Pathfinder webpage [7].

Identifying Opportunities and Challenges of UAVs

White Paper

How the Age of Technology is Transforming Transportation Agencies

FOCUS AREA PATHFINDERS

Partner: CNN

Work: Visual line-of-sight operations in urban areas considering how UAS might safely gather news in populated areas

Partner: PrecisionHawk

Work: Exploration of crop monitoring in precision agriculture operations beyond visual line of sight in rural areas

Partner: BNSF Railroad

Work: Exploration of command-and-control challenges beyond visual line of sight in rural areas to inspect rail system infrastructure using UAS

UAS in the Arctic. The FAA Modernization and Reform Act of 2012 Section 332 also charged the FAA with the task of developing a plan to designate permanent areas in the Arctic where small UAVs could carry out research and commercial operations. An Arctic Implementation Plan for such activities is available on the FAA's Key Initiatives webpage [8].

UAS Roadmap. The previously mentioned FAA Modernization and Reform Act of 2012, Public Law 112-95, mandated the creation and publication of a five-year roadmap for UAS research and integration. It gives a broad timeline for tasks and considerations needed to enable UAS integration, such as research, regulations, policies, procedures, guidance, and training plan development. Revision is completed annually in partnership with other relevant national agencies. The first and latest version of the UAS plan can be found on the FAA's UAS Roadmap website [9].

Identify Commercial and Civil Applications

Delivery Applications. Amazon has gone public with its plans for a customer delivery scheme that is said to deliver packages in under 30 minutes. Amazon has not officially released details of the intended delivery UAV, but early images suggest a rotary wing octocopter. Amazon CEO Jeff Bezos has stated that the octocopter would have a 10-mile radius limit from launch point due to battery limitations, which means that customers in urban areas may be better delivery candidates. Payload limit would not exceed 5 pounds—86% of all amazon deliveries [10].

DHL is already using its 'parcelcopter' for initial operations for research purposes in Europe and is completing regular flights to the North Sea island of Juist. Operational flights are completed with DHL's university and industry partners at the same time every day and are used to deliver emergency medications and urgently needed goods. This is the only UAV operation in Europe where UAVs are authorized to fly outside the operator field of vision [11].

Disaster Aid and Emergency Response. Google's UAV scheme, called Project Wing, envisions using drones for disaster relief, i.e., delivery of emergency supplies to areas in need [12, 13]. Google's concept aircraft has four electrical propellers; a wingspan of nearly five feet; weighs just less than 19 pounds (22 pounds with payload) and can take off and land without a runway. The UAV is controlled through computer programs with operator-override capabilities when necessary [14].

The FAA expects that 7,500 small UAVs will be operating in the U.S. by 2018. The market for UAVs could exceed \$1 billion by 2020.

Identifying Opportunities and Challenges of UAVs

White Paper

How the Age of Technology is Transforming Transportation Agencies

Utility. Although this is not a small UAV application, Facebook is using larger drones to beam internet signals in remote places. With a wingspan of a Boeing 737, this UAV will be launched into the sky using a large balloon that will carry it into the stratosphere. It will hover at altitudes between 60,000 and 90,000 feet where it will not interfere with commercial airline flights and will remain above inclement weather. The UAV will be fitted with solar panels and an electric motor, which jointly will allow it to remain in the sky for 3 months uninterrupted [15].

The Revell Texter Helicopter is a rotary UAV that allows users to upload via USB a basic text message or image to be displayed in LED lighting [16]. Such a drone could be used for emergency messaging in remote or inaccessible areas.

Surveillance, Photography, Imagery. A number of applications exist for the use of UAVs with imaging, photography, and video equipment. A short list of applications and uses for illustrative purposes is provided below [17].

- Shell Oil Company uses UAVs to monitor and inspect oil and gas facilities that are unsafe or difficult for in-person inspectors to access.
- Engineers at the Polytechnic University of Catalonia in Barcelona have developed a drone that could be used to catch rhino poachers in national parks in Africa by making use of thermal vision technology.
- Network Rail's ORBIS project in the UK will use drones to get better images of the rail's transport networks.
- BBC and Al Jazeera have begun using drones for aerial filming.
- Budget airline EasyJet uses drones for safety inspections on its aircrafts.

Discover and Mitigate Operational Obstacles and Barriers to UAV Integration

Theft and Civilian Take-Down. There are already many cases where civilians have shot down drones due to privacy concerns. Concern exists regarding the opportunity for theft of surveillance and camera equipment or customer goods.

Privacy. UAV deployment before proper regulation and policing causes great concern for privacy. Drones equipped with facial recognition software, infrared technology, and microphones capable of monitoring personal conversations could cause unprecedented invasions of privacy rights. Interconnected drones could enable tracking of vehicles, and finally, micro drones could go largely unnoticed while peering into the windows of unauthorized places.

Managing Traffic in National Airspace. With the unprecedented number of drones that could join the national airspace if commercial operations are allowed, there is concern about crowding and airspace management.

Safety. There is concern about UAVs flying over urban areas because a drone could potentially fall from flight onto people or moving traffic. In addition, children or pets could become injured by the rotary blades when trying to retrieve packages from rotary UAVs.

Weather Restrictions. Drones fly well in reliable weather but not able to withstand unreliable or inclement weather. Precipitation would obscure sensors, and more research is needed in this area.

Identifying Opportunities and Challenges of UAVs

White Paper

How the Age of Technology is Transforming Transportation Agencies

OPPORTUNITIES FOR TEXAS

Identify Beneficial Uses of UAVs

UAVs for Civil Uses. A starting place for planning for the introduction of UAVs for civil uses should include an investigation into how they could be used to improve civil operations, followed by developing a list of applications of interest. Civil uses would likely take advantage of UAV cameras and sensors, as in the following examples of potential uses.

Traffic Monitoring. Small UAVs could be used to collect data on and manage peak period traffic.

Emergency and Disaster Response. UAVs could be launched to monitor dangerous conditions presented by events such as wildfires, flooding, or hurricanes. Real-time traffic conditions for evacuations during these events could also be provided by UAVs.

Law Enforcement. Border patrol and criminal activity investigation, especially in remote areas, could benefit from UAV surveillance.

Utility. Hovering UAVs with cameras could perform remote inspection and sensing of civil infrastructure like transmission lines, pipelines, bridges, etc.

Partner with UAV Test Sites for Safe Trials

The UAS test sites supported by the FAA have the expertise to safely and properly conduct UAV trials, and Texas has one of these six sites in Corpus Christi. Partnering with one of these sites for UAV trials would provide public agencies and industry partners alike with the technical expertise and regulatory knowledge needed for successful operations within the FAA allowable rules.

Identifying Opportunities and Challenges of UAVs

White Paper

How the Age of Technology is Transforming Transportation Agencies

REFERENCES

1. Title Page Art. Source: <http://impulse.net/impulse/wp-content/uploads/2014/07/HiRes1.jpg>
2. Engadget. "What you need to know about drones." <http://www.engadget.com/2014/06/13/commercial-drone-explainer/>
3. Time Magazine. "This Is How Drones Work." <http://time.com/3769831/this-is-how-drones-work/>
4. IEEE. "Airborne Communication Networks for Small Unmanned Aircraft Systems." http://ieeexplore.ieee.org/ieee_pilot/articles/96jproc12/jproc-EFrew-2006127/article.html
5. FAA. "Center of Excellence." https://www.faa.gov/uas/legislative_programs/coe/
6. FAA. "Section 333." https://www.faa.gov/uas/legislative_programs/section_333/
7. FAA. "Authorizations Granted Via Section 333 Exemptions" https://www.faa.gov/uas/legislative_programs/section_333/333_authorizations/
8. FAA. "Focus Area Pathfinders." https://www.faa.gov/uas/legislative_programs/pathfinders/
9. FAA. "Key Initiatives." https://www.faa.gov/uas/legislative_programs/
10. FAA. "UAS Roadmap." https://www.faa.gov/uas/legislative_programs/uas_roadmap/
11. CNN. "Amazon's drone delivery: How would it work?" <http://www.cnn.com/2013/12/02/tech/innovation/amazon-drones-questions/>
12. DHL. "DHL parcelcopter launches initial operations for research purposes." http://www.dhl.com/en/press/releases/releases_2014/group/dhl_parcelcopter_launches_initial_operations_for_research_purposes.html
13. Tech Times. "TAG Google, NASA, Drone, FAA, Federal Aviation Administration, Google X, Project Wing Google Quietly Teamed Up With NASA To Test Project Wing Drone Program." <http://www.techtimes.com/articles/76392/20150813/google-quietly-teamed-up-nasa-test-project-wing-drone-program.htm>
14. BBC. "Google tests drone deliveries in Project Wing trials." <http://www.bbc.com/news/technology-28964260>
15. The Verge. "Google's Project Wing is a secret, drone-based delivery system." <http://www.theverge.com/2014/8/28/6080369/googles-project-wing-is-a-secret-drone-based-delivery-system>
16. Fortune. "Behind the scenes with Facebook's new solar-powered Internet drone and laser technology." <http://fortune.com/2015/07/30/facebooks-solar-power-drone-internet-earth/>
17. Daily Mail. "Deliver your message from above: the 'texting helicopter' that can display pictures and words from the sky." <http://www.dailymail.co.uk/sciencetech/article-2544810/Deliver-message-drone-texting-helicopter-display-messages-sky.html>
18. TechWorld. "Nine uses of drones in UK business." <http://www.techworld.com/picture-gallery/personal-tech/6-best-uses-of-drones-in-business-3605145/#6>

Managing Customer Relationships Using Big Data

White Paper

How the Age of Technology is Transforming Transportation Agencies



How can transportation agencies develop a data-rich environment that generates valuable information for all of its stakeholders?

Texas has the potential to develop a truly interconnected transportation system by utilizing data as a platform for engaging with its customers. Empowering the customer with a voice and listening to his or her concerns are small steps that can have large impacts on the transportation network. Big Data can also be transformed into an effective decision-support tool. The key is to match

the right tool to the right problem in order to effectively communicate to the decision-maker in a timely manner the best course of action. By making a commitment to data-driven decision-making, transportation agencies can take advantage of improved efficiencies, effective resource management, and cost savings across the state.

Managing Customer Relationships Using Big Data

White Paper

How the Age of Technology is Transforming Transportation Agencies

KEY STRATEGIES



Capture Data

By viewing data as a core asset, transportation agencies move beyond reactive and silo-based approaches to proactive and integrated management strategies. Collecting real-time data and relaying information to the customer can inform travel decisions that generate immediate value.



Integrate Silos of Information

Shifting from a single source to a multi-source, multi-modal approach creates a comprehensive, data-rich environment from which state, regional, and local agencies can draw valuable information about their customers.



Analyze for Insight

Matching the right tool to the right problem enables the transportation agency to effectively communicate to the decision-maker the best course of action for the customer. Improvements may be achieved in efficiency, resource management, and cost savings.



Measure Performance

Developing a system of key performance indicators (KPIs) monitors the health of the enterprise and evaluates whether a transportation agency is achieving the goals it defined. Benchmarks and milestones are useful tools for establishing a concrete direction for the agency.



Leverage Data to Create Value

Knowing the customer helps the agency to better serve the customer and the public as a whole. Equipped with information, transportation agencies have the potential to offer incentives encouraging customers to shift to an alternative route, time of day, or mode.

Managing Customer Relationships Using Big Data

White Paper

How the Age of Technology is Transforming Transportation Agencies

STATE OF RESEARCH & PRACTICE

Capture Data

What is Big Data? Big Data is a relative term describing a situation where the volume, velocity, and variety of data exceed an agency's storage or computational capacity for accurate and timely decision-making [2].

Data Types. There are generally two types of data: structured and unstructured. Structured data, such as traffic counts and customer records, refer to information with a high degree of organization, are readily searchable, and may be easily stored in database management systems. On the other hand, unstructured data, such as text and multimedia content, require different architecture, technologies, and analytics. Since up to 85 percent of an agency's data can be unstructured, it is important to find ways to incorporate the unstructured data into quantitative analysis and decision-making.

Data Sources. A successful Big Data strategy must take into account data generated from both traditional and nontraditional sources [2].

- Traditional Enterprise Data – includes customer information, transactional ERP (enterprise resource planning) data, and web store transactions
- Machine-Generated/Sensor Data – includes smart meters, manufacturing sensors, and traffic counts
- Social Data – includes customer feedback streams, micro-blogging sites like Twitter, and social media platforms like Facebook

Understanding existing data sources is the first step in identifying gaps between known and unknown information.

Internet of Things. The Internet of Things (IoT) is an enabler of Big Data and falls under the second data source category of machine-generated/sensor data. Imagine a world in which a transportation agency is collecting traffic information from connected vehicles, bridge stress and strain information from embedded sensors, and commercial vehicle size and weight information through roadside infrastructure. Combined with traditional data collected through pavement testing and new photographic information supplied through social media, transportation agencies now have the ability to optimize maintenance schedules and improve response times to customer requests.

The Real-Time Factor. "Real-time" data is defined based on two considerations: frequency and latency. The first is the data capture interval or how often data is collected. The second is the time lag between when data is collected and when it can be shared with users [3]. Collecting real-time data, such as weather and travel times, and relaying route information to the customer can inform travel decisions, generating immediate value.

Ownership, Storage, & Maintenance. With the increasing use of technology for data acquisition, developing policies for ethical data management is crucial. Grasping the full implications of a Big Data policy requires answering these questions: Who owns the data—public sector, private sector, or the individual? How often should data be collected and how long should data be stored? Who is best equipped to maintain the data and does the agency have sufficient in-house expertise? The answers to these questions will vary depending upon the data and its purpose. By viewing data as a core asset, transportation agencies can move beyond reactive and silo-based approaches to proactive and integrated management strategies.

Managing Customer Relationships Using Big Data

White Paper

How the Age of Technology is Transforming Transportation Agencies

Integrating Silos of Information

Single-Source to Multi-Source, Multi-Modal. Most data environments are single-source: they capture one type of transportation data, such as vehicle crashes, roadway inventory, or travel times. These data sets, however, are rarely integrated with other pertinent information and consequently provide an incomplete view of field conditions. With Big Data analytics, it is now possible to understand the relationships between traffic delays and their correlation to traffic counts, crash history, and weather conditions [4].

Data integration may also be improved across modes. In order to enhance the freight network, it is imperative to incorporate travel information throughout the supply chain. The Freight Advanced Traveler Information System (FRATIS) is one such concept that includes shipment schedules, port queue lengths, highway route restrictions, container disposition, and intermodal connection updates [5]. Another example is a Port Community System, which is an electronic platform connecting multiple systems operated by a variety of organizations that make up a seaport, airport, and inland port community [6].

Center of Excellence. Transportation agencies are embracing a holistic, enterprise view that treats data as a core asset. In addition to the usual array of internal data—such as demographics, campaign responses, sales, revenues, and other customer data—Chico’s now integrates information about customer online behavior, the competitive landscape, and the local trade area into its customer data warehouse [2]. By applying the same principles, a state DOT could better understand a consumer’s willingness to carpool, public transit needs, and attitudes towards toll roads, roadway maintenance standards, and tolerance of traffic congestion.

Types of Database Architecture. Two main types of databases are currently used in the transportation environment: Relational Database Management Systems (RDBMS) and Not Only Structured Query Language (NoSQL).

RDBMS is the traditional architecture that places data within well-defined tables, fields, and records. Most RDBMS support Structured Query Language (SQL) and are simple to understand, allow multiple users, and minimize redundancy. Its primary disadvantages, however, are inadequate performance and limited scalability at high volumes and variety of data.

NoSQL was created to overcome the shortcomings of RDBMS for the storage of Big Data. NoSQL systems are designed to capture all data, structured and unstructured, without categorizing and parsing it upon entry. The dynamic data structures are extremely scalable and support high throughput for data processing. On the other hand, the system has limited functionality and the complexity of NoSQL requires additional knowledge and skills [7].

Transportation agencies are embracing a holistic, enterprise view that treats data as a core asset.

Teamwork and Collaboration. Data are usually collected by a number of different agencies and are not necessarily compatible. Federal, state, regional, and local agencies need to work together towards a common goal to improve the overall efficiency of the transportation system. Gathering stakeholder input is critical to developing an effective Big Data strategic plan. Through meaningful collaboration, transportation agencies can break down data silos to build a unified view, deliver quality services, and ultimately improve the customer experience.

Managing Customer Relationships Using Big Data

White Paper

How the Age of Technology is Transforming Transportation Agencies

Analyze for Insight

Data Relevance. Data relevance is the intersection of data content and user interest. It is based upon enterprise context and determines which data should be included in analytical processes. Data alone are abstract pieces of information; in other words, data may be considered a “what.” The transportation agency provides a “why,” a motivation or problem statement requiring a solution. By marrying the “what” with the “why,” transportation agencies can develop a Big Data strategy that arms data with a purpose.

Types of Analytics. Analytics are designed to economically extract value from Big Data and may be categorized in five general classes:

Descriptive – Summarizes what happened by digesting Big Data into smaller, more useful nuggets of information.

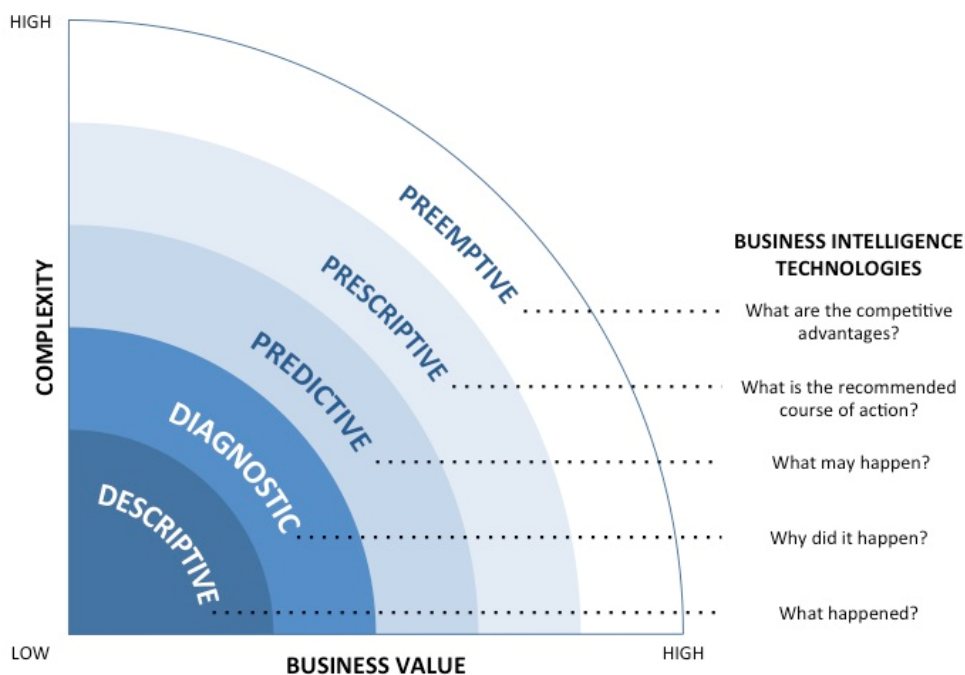
Diagnostic – Identifies the primary and secondary causes for why something happened.

Predictive – Models potential future events using data mining, statistical methods, and machine learning techniques.

Prescriptive – Recommends a course of action based on outcome probabilities using actionable data and a feedback procedure.

Preemptive – Reveals the competitive advantages for a tactical course of action throughout a business ecosystem.

Decision-Support Tools. Executives need to make different types of decisions based upon an understanding of the past (hindsight), present (insight), and future (foresight) of the enterprise. Examples include queries, reports, online analytical processing (OLAP), dashboards, scorecards, and other visualization tools [3]. The key is to match the right tool to the right problem in order to effectively communicate to the decision-maker in a timely manner the best course of action.



Managing Customer Relationships Using Big Data

White Paper

How the Age of Technology is Transforming Transportation Agencies

Measure Performance

Key Performance Indicators. A key performance indicator (KPI) is a business metric used to evaluate factors crucial to the success of an organization [8]. KPIs monitor the health of the enterprise and determine whether an agency is achieving its defined goals. The following framework outlines the basic process for developing KPIs:

1. Define the Goal – What is the agency trying to achieve?
2. Establish Performance Measures – How will the agency make progress?
3. Identify the Target – How does the agency define success?
4. Allocate Resources – What does it take to get where the agency wants to go?
5. Monitor and Publish Reports – How successful is the approach and do changes need to be made?

Milestones and Benchmarks. To evaluate whether a program is successful, milestones and benchmarks may be used as targets to provide concrete direction to the agency. *Milestones* are interim achievements that celebrate the progress of a program up to that point; *benchmarks* represent the end result that the agency is striving to achieve.

SAMPLE KPI ELEMENTS

Goal: Improve EMS response time

Performance Measure: Time to reach incident

Target: Eight minutes or less 90% of the time

Resources: Traffic signal preemption

Reports: Dashboard to track performance

Leverage Data to Create Value

Data-Driven Decision-Making. It is not enough to create a Big Data strategy; rather, the agency must commit to data-driven decision-making. To realize organizational gains, Big Data will entail a new culture of management, requiring agencies to educate their leadership, acquire additional talent, and encourage the organization to embrace innovation. In 2012 the MIT Center for Digital Business, in partnership with McKinsey (a management consulting firm), found that companies in the top third of their industry using data-driven decision-making were, on average, 5% more productive, and 6% more profitable than their competitors [9]. Fortunately, many agencies are already data-oriented, and need only exercise the will and leverage the data to create value.

Knowing the customer helps the agency to better serve the customer and the public as a whole.

Customer Relationship Management. Big Data can be used as a Customer Relationship Management tool to coordinate an agency's interaction with current and future customers. By increasing engagement with customers throughout the customer lifecycle, agencies can improve business relationships, strengthen customer loyalty, and boost the positive visibility of the organization.

Incentivize Customer Behavior. Knowing the customer helps the agency to better serve the customer and the public as a whole. Equipped with information, transportation agencies now have the potential to offer incentives encouraging customers to travel during off-peak hours, try other routes, shift to a new mode, or telecommute more frequently. Compounding moderate changes in customer behavior have the potential to create large impacts on the transportation network.

Managing Customer Relationships Using Big Data

White Paper

How the Age of Technology is Transforming Transportation Agencies

PUBLIC POLICIES & PROGRAMS

National Efforts

Research Initiatives. To accelerate the deployment of innovative practices and realize tremendous operational efficiencies, the White House and six Federal departments and agencies announced in March 2012 a “Big Data Research and Development Initiative” with more than \$200 million in new commitments. This initiative promised to greatly improve the tools and techniques needed to access, organize, and glean discoveries from huge volumes of digital data [10].

TechAmerica Foundation’s Big Data Commission published a report in October 2012, offering a comprehensive roadmap for the use of Big Data by the Federal government and a set of policy recommendations and practical steps agencies can take to get started on Big Data initiatives. The report envisions that distributed sensors on handheld devices, vehicles, and roadways can provide real-time traffic information that is analyzed and shared [11].

Researchers at the Royal Institute of Technology of Sweden (KTH) wanted to better manage congestion by gathering a wide array of real-time data that might affect traffic patterns. Data from vehicle GPS devices and radar sensors on roadways were collected, along with data on congestion pricing, weather, and visibility; these datasets were channeled into a unique software analytics tool. The data was then used to intelligently identify current conditions and estimate travel times between points within Stockholm, offer travel alternatives, and improve traffic in the metropolitan area. The result was a decrease in traffic congestion and accidents. KTH is now looking to expand the capability to support routing of emergency service vehicles [12].

United States Department of Transportation.

Since 2010, the USDOT Intelligent Transportation Systems Joint Program Office (ITS JPO) has been engaged in assessing the potential for systematic and dynamic data capture from vehicles, travelers, and the transportation system infrastructure to enhance current operation practices and transform future surface transportation systems management [13]. The Data Capture and Management Program offers a set of guiding principles and identifies key issues for transforming the federal role. The following candidate applications have been identified as part of the Dynamic Mobility Applications (DMA) Program and are intended to make travel safer, smarter, and greener:

- Enable Advanced Traveler Information System (EnableATIS)
- Freight Advanced Traveler Information Systems (FRATIS)
- Integrated Dynamic Transit Operation (IDTO)
- Intelligent Network Flow Optimization (INFLO)
- Multi-Modal Intelligent Traffic Signal Systems (MMITSS)
- Response, Emergency Staging and Communications, Uniform Management, and Evacuation (RESCUME)

Other Success Stories. The federal government has taken a leadership role in applying Big Data analytics to achieve small and large successes. For example, the U.S. Department of Agriculture reduced the rate of food stamp fraud by 60% using data analytics that quickly identify merchants who traffic them illegally. In the field of imagery, NASA has implemented an online records management tool that benefits the public through state-of-the-art image archiving.

Managing Customer Relationships Using Big Data

How the Age of Technology is Transforming Transportation Agencies

White Paper

State Movements

Dashboards. A business intelligence dashboard is a data visualization tool that displays the current status of metrics and KPIs for an enterprise. Dashboards consolidate and arrange the most important information in a single view to effectively communicate with the target audience. Customizing the dashboard to address a stakeholder's specific needs is a strategy for strengthening the agency's engagement with the community.

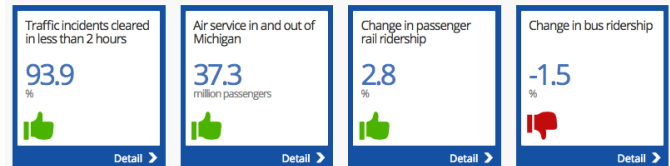
Utah Department of Transportation (UDOT). In March of 2015, UDOT selected Rolta to design and deliver the next-generation Enterprise Data Warehouse for the organization. UDOT will build upon its current dashboard system to communicate information about current interstate travel times, fatalities, construction projects, pavement conditions, and bridge conditions [14].

Virginia Department of Transportation (VDOT). To better connect with the public, VDOT created a performance reporting system for projects and programs. Among typical highway performance metrics, the dashboard includes a unique feature: a citizen survey results section that evaluates how the public views VDOT in terms of roadway maintenance, emergency response, and other categories [15].

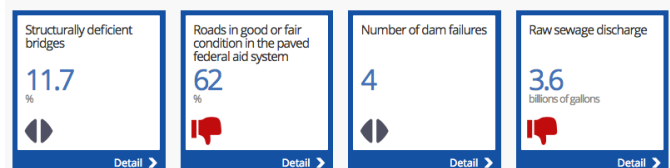
Open Michigan. Michigan's dashboards were implemented by Governor Rick Snyder as part of the Open Michigan initiative to provide a quick assessment of the state's performance in key areas, including economic strength; health and education; value for money government; quality of life; infrastructure; and public safety. The infrastructure dashboard includes metrics describing economic growth, safety, accountability, mobility, and conditions [16].



Mobility



Conditions



Managing Customer Relationships Using Big Data

White Paper

How the Age of Technology is Transforming Transportation Agencies

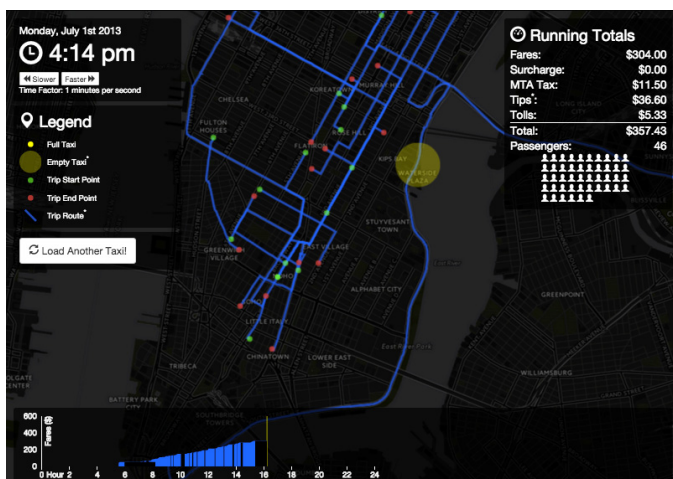
City Initiatives

Open Data Portals. The open data portal is a platform that offers consumers a better way to access and use public information. In an effort to improve transparency, accountability, and interoperability, cities are releasing government-produced, machine-readable data sets through centralized repositories. By engaging with the community, public agencies are enhancing quality of life and the delivery of government services.

The LouieStat Model. Local leadership is acting as a catalyst to jumpstart the open data movement. Led by Mayor Greg Fischer and the chief of the Office of Performance Improvement, Theresa Reo-Wever, Louisville has positioned itself to use data in transformative ways [17]. Fischer signed into law an executive order mandating that data is open by default and launched the LouieStat open data portal in 2012. As a result of the program, drop-off policies were revised and Emergency Management Services delivered 18,000 more patients to the hospital between September and December of 2013 as compared to the same time period in 2012.

Mining Toll Data. Data generated by the E-ZPass toll-paying system is being used to feed other traffic management and analytics applications across New York City [18]. Midtown in Motion is a traffic management program announced by the mayor's office in 2011 that utilizes 100 microwave sensors, 32 video cameras, and E-ZPass readers at 23 intersections to highlight traffic choke points and adjust traffic light timing. The total cost for installation was \$1.6 million, with \$1 million in city funding and \$600,000 in funding from the Federal Highway Administration. NYDOT states the system resulted in a 10% improvement in travel speed and reduced pollution in its first year.

Hackathons. In April 2015, the NYC Taxi and Limo Commission and NYU Rudin Center for Transportation hosted a hackthon. Data scientists, policymakers, and community activists were invited to analyze the 174 million taxi trips from 2013, discover underlying patterns, and collaborate on solutions to local challenges [19]. In particular, several recommendations to address the rush hour taxi problem were proposed, inciting a conversation that resonates in the heart of every New Yorker.



THE POWER OF VISUALIZATION

A new visualization by civic hacker Chris Whong gives users a glimpse into the daily journeys of New York City taxi drivers. The tool traces the route of a random cab as it travels across the boroughs, totaling how many passengers are carried and how much money is earned [19].

Managing Customer Relationships Using Big Data

White Paper

How the Age of Technology is Transforming Transportation Agencies

BIG DATA CHALLENGES

Financial and Political Barriers

Cost. Enabling Big Data requires hardware, software, and skilled resources. Storage costs are significant and proportional to the volume of the Big Data. The real cost, however, is in the operation and overall management or integration of Big Data within an existing ecosystem.

Security, Privacy, and Regulatory Compliance. Preserving data integrity and public trust are essential for building a Big Data foundation. As part of a vehicle-miles-traveled (VMT) user fee pilot program, the Oregon Department of Transportation (ODOT) created multiple options for drivers to share their mileage. Participants could choose to submit their information through a smartphone app, a GPS device, a reporting device without GPS capabilities, or official inspection [20]. By offering the customer a voice in the data sharing process, ODOT was able to collect vital information at the respective comfort level of the customer.

In order to harness the power of Big Data, agencies need to invest the time to define, learn, and capitalize on valuable information.

Technical Considerations

Need for Speed. Improving hardware systems to explore Big Data volumes and gain business insights in near real-time will enable agencies to remain competitive. Some vendors are using increased memory and powerful parallel processing, while others are putting data in memory using a grid computing approach.

Data Quality. Cleaning or scrubbing data requires time to detect and correct a data set's corrupt or inaccurate information that would otherwise cause errors or skew analytics.

Legacy Systems. Transitioning from traditional database management systems can involve complex and timely processes. Data migration, new workflows, and retraining are some considerations that need to be addressed in order to facilitate Big Data adoption.

Organizational Obstacles

Lack of Organizational Support. Championing the importance of data and embracing new technologies, processes, and workflows are critical to overcoming institutional inertia [21].

Vague Mission and Goals. Developing a unity of purpose is important, helping people to identify the right data and determine how best to use it.

Unclear Metrics. Defining concrete and measurable indicators can minimize ambiguity, focusing the agency's energy on the most important metrics.

Required Expertise. Educating, training, and recruiting executives with a deep understanding of Big Data analytics can transform the way the agency perceives and leverages data for valuable information. With the shortage of technically skilled workers, public agencies will need to invest in developing and diversifying their talent base.

Managing Customer Relationships Using Big Data

White Paper

How the Age of Technology is Transforming Transportation Agencies

OPPORTUNITIES FOR TEXAS

Gain Customer Insights

Texas has the potential to gain new insights from data that is already being collected. First, Texas has one of the most sophisticated toll road networks in the country. Can data collected through TxTag, TollTag, and EZ Tag be integrated and shared with local traffic management centers to improve statewide congestion while still ensuring the privacy of its users? Can this information be used to better understand customer travel patterns in order to incentivize behavioral shifts, such as suggesting an alternative route, time of day, or mode choice? Second, TxDOT is already active in social media and collecting information about consumers' interests. Can Facebook, Twitter, and feeds from other platforms be mined in order to improve marketing campaigns and delivery of quality services? Finally, several cities throughout Texas already have open data portals, including Dallas, Houston, Austin, San Antonio, and Denton. Can Texas integrate data from disparate federal, state, and local sources to advance the state economy, education, public safety, energy, and infrastructure?

Embrace Data-Driven Decision-Making

Developing a series of key performance indicators and effectively communicating successes and challenges to stakeholders is a core area in which Big Data can be transformed into information. Dashboards, scorecards, and other visualization tools are effective means for providing executives, policymakers, and the public with valuable information in a format that makes Big Data easy to understand. Equipping decision-makers with timely and accurate information will lead to improved efficiencies, resource management, and cost savings across the state.

Engage with the Community

Empowering the customer with a voice and listening to his or her concerns are small steps that can have large impacts on the transportation network. Beyond traditional methods, civic hackathons are a great forum to invite citizens to collaborate with policymakers, engineers, and software developers and propose solutions to significant challenges. By tapping into the community, transportation agencies can ensure that citizens have a role in shaping the future of their state.

Managing Customer Relationships Using Big Data

White Paper

How the Age of Technology is Transforming Transportation Agencies

REFERENCES

1. Title Page Art. Source: <http://impulse.net/impulse/wp-content/uploads/2014/07/HiRes1.jpg>
2. SAS. "Big Data Meets Big Data Analytics: Three Key Technologies for Extracting Real-Time Business Value from the Big Data that Threatens to Overwhelm Traditional Computing Architectures." http://www.sas.com/content/dam/SAS/en_us/doc/whitepaper1/big-data-meets-big-data-analytics-105777.pdf
3. Oracle. "Big Data for the Enterprise." <http://www.oracle.com/us/products/database/big-data-for-enterprise-519135.pdf>
4. McHugh, Declan. "Prediction and Analysis Using a Big Data and Visualization Approach." http://leeds.gisruk.org/abstracts/GISRU2015_submission_20.pdf
5. Cambridge Systematics. "Freight Advanced Traveler Information System (FRATIS)." http://www.camsys.com/kb_cases_FRATIS.htm
6. European Port Community Systems Association. "How to Develop a Port Community System." http://www.unece.org/fileadmin/DAM/trade/Trade_Facilitation_Forum/BkgrdDocs/HowToDevelopPortCommunitySystem-EPCSAGuide.pdf
7. Planet Cassandra. "NoSQL Databases Defined and Explained." <http://www.planetcassandra.org/what-is-nosql/>
8. SearchCRM. "Key Performance Indicator (KPI) Definition." <http://searchcrm.techtarget.com/definition/key-performance-indicator>
9. McKinsey Center for Business Technology. "Perspectives on Digital Business." http://www.mckinsey.com/~media/mckinsey/dotcom/client_service/bto/pdf/mcibt_compendium_perspectives_on_digital_business.ashx
10. Office of Science and Technology Policy. "Obama Administration Unveils 'Big Data' Initiative: Announces \$200 Million in New R&D Investment." https://www.whitehouse.gov/sites/default/files/microsite/s/ostp/big_data_press_release.pdf
11. TechAmerica Foundation. "Demystifying Big Data: A Practical Guide to Transforming the Business of Government." <https://www-304.ibm.com/industries/publicsector/files/serve?contentid=239170>
12. IBM. "Demystifying Big Data." <https://www-304.ibm.com/industries/publicsector/files/serve?contentid=239170>
13. USDOT Intelligent Transportation Systems Joint Program Office. "Data Capture and Management Program: Transforming the Federal Role." http://www.its.dot.gov/data_capture/datacapture_management_federalrole7.htm
14. Utah Department of Transportation. "Data Portal." <https://maps.udot.utah.gov/ugate/f?p=111:2:0::NO::>
15. Virginia Department of Transportation. "Dashboard 3.0." <http://dashboard.virginiadot.org/>
16. State of Michigan. "Open Michigan." <http://www.michigan.gov/openmichigan>
17. Govloop. "The Govloop Guide: Big Data, Examining the Big Data Frontier, Innovations that Matter." http://img.en25.com/Web/GovDeliveryInc/%7B2d226ca5-be34-4b05-9134-65f7925fd9fb%7D_GovLoop_Innovations_That_Matter_Big_Data_Spring2014.pdf
18. Autoblog. "Far from Tolls: New York gathers location data through E-ZPass." <http://www.autoblog.com/2015/04/22/new-york-e-zpass-tracking/>
19. Data.BetaNYC. "Open Data Unleashed: The NYC Taxi Dataset Hackathon." <http://data.beta.nyc/showcase/open-data-unleashed-the-nyc-taxi-dataset-hackathon>
20. Transportation Investment Advocacy Center. "Oregon." <http://www.transportationinvestment.org/wp-content/uploads/2014/02/Oregon-Case-Study-VMT-2013.pdf>
21. MarketingProfs. "The Five Big Problems of Big Data." <http://www.marketingprofs.com/articles/2013/10243/the-five-big-problems-of-big-data>

Formulating a Communications Strategy

White Paper

How the Age of Technology is Transforming Transportation Agencies

KEY STRATEGIES



Know the Stakeholders

A successful strategic plan requires stakeholder engagement in order to facilitate adoption and implementation. Developing customized communications strategies tailored to specific interests ensures that each stakeholder's contribution is valued.



Build the Agency Brand

Transportation agencies portray themselves through the style represented in their brand, logo, and organization identity. Policies and guidelines on applying brand identity ensure that materials used in all stakeholder communication channels convey a coherent message.



Engage through Multiple Channels

By viewing the transportation experience through the eyes of the customer, transportation agencies can orchestrate the customer experience across all layers so that it is seamless, integrated, and consistent.



Embrace Digital Marketing

Transportation agencies can use digital marketing to strengthen brand awareness, improve engagement, and empower customer advocates. Content marketing in particular can be designed to encourage customers to adjust their travel patterns and behaviors.



Empower Champions of Change

Highlighting current successes and recognizing leaders who are improving the mobility of people, freight, and traveler information for the benefit of all develops a culture of which people feel proud to be a part.

Formulating a Communications Strategy

White Paper

How the Age of Technology is Transforming Transportation Agencies

STATE OF RESEARCH & PRACTICE

Know the Stakeholders

Identify Stakeholders. A successful strategic plan requires stakeholder engagement in order to facilitate adoption and implementation. When identifying stakeholders, it is better to be inclusive rather than exclusive. Below are examples of key stakeholders when considering the advancement and integration of emerging technologies:

- Transportation Officials – USDOT, state DOTs, MPOs/COGs, regional mobility authorities, city engineers
- Policymakers – Federal, state, and local legislators and government officials
- Businesses – Industry leaders, major employers, small business owners, startups, professional societies
- Research Institutions – Universities, private research institutions, public test sites
- Community Organizations – Citizen groups, neighborhoods, and community activists

Each stakeholder may be viewed as an audience. Developing customized communications strategies tailored to specific interests ensures that each stakeholder's contribution is valued. Although this requires additional time, benefits of personalized messages include constructive feedback, emotional connections, effective education, diverse perspectives, proactive problem solving, improved decision making, and engaged stakeholder development.

Developing customized communications strategies tailored to specific interests ensures that each stakeholder's contribution is valued.

Plan Engagement Activities. Effective stakeholder engagement requires advanced planning to ensure the appropriate input to programs and projects is obtained. There are generally three levels of engagement:

- Level 1 – Requires little planning effort; email, word of mouth, newsletters, social media, infographics, promotional items
- Level 2 – Requires some planning effort; press releases, radio, newspaper, television
- Level 3 – Requires detailed planning effort; billboards, charrettes/workshops, websites, mobile applications, major events

Developing the proper meeting format and tools depends on the desired levels of dialogue and interaction amongst participants, as well as the types of outcomes desired.

Strengthen Stakeholder Relationships. Listening is the simplest way to connect with a stakeholder. There are many insights a transportation agency can gain by empowering each stakeholder with a voice. Through interaction and open dialogue, transportation agencies can convey a positive and receptive attitude.

Deliver and Follow Up. It is important to remember that stakeholder engagement does not end at the conclusion of the design phase. Demonstrating that concerns have been genuinely addressed engenders confidence and trust between the stakeholder and the transportation agency. Soliciting feedback is another way to follow up with stakeholders throughout the project process. Learning from positive and negative experiences develops a culture of continuous improvement. Feedback allows a transportation agency to evaluate the overall effectiveness of its efforts and apply that knowledge to future initiatives.

Formulating a Communications Strategy

White Paper

How the Age of Technology is Transforming Transportation Agencies

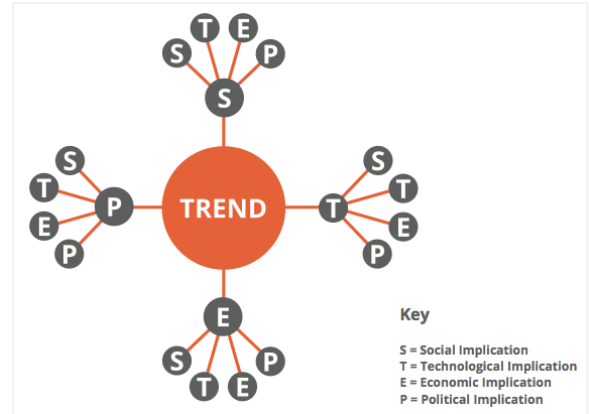
Build the Agency Brand

Brand Recognition. Transportation agencies portray themselves through the style represented in their brand, logo, and organization identity. A brand is more than a logo—it is a promise an organization makes to its customers that must be delivered with every interaction [2]. A consistent use of graphic standards is critical for unity and recognition. Developing policies and guidelines on applying brand identity ensures that materials used in all stakeholder communication channels convey a coherent message.

Unified Campaign. First, the **statement of purpose** is a simple directive that describes the overarching objective of the communications strategy. Next, it is critical to understand the **current strategy** to know what has been successful or unsuccessful in the past. Applying some of the following **analysis tools** can assist in identifying communication challenges and opportunities [3]:

- **STEP Analysis** – Involves listing the Social (S), Technological (T), Economic (E), and Political (P) factors that may influence the agency's work
- **SWOT Analysis** – Involves listing the Strengths (S), Weaknesses (W), Opportunities (O), and Threats (T) to the agency's work
- **Competitor Analysis** – Identifies main competitors and ranks them according to specified criteria, such as strength of brand, media presence, etc.
- **Stakeholder Map** – Assesses the stakeholders' level of influence with respect to their interest in the agency

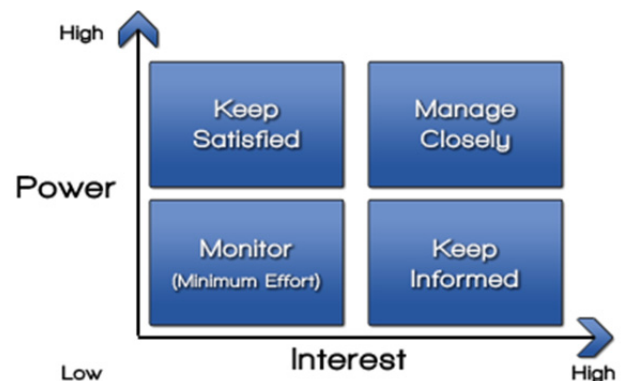
Finally, transportation agencies should prioritize their stakeholders and **craft a relevant message** for each of those audiences.



STEP Analysis



SWOT Analysis



Stakeholder Map

Formulating a Communications Strategy

White Paper

How the Age of Technology is Transforming Transportation Agencies

Engage through Multiple Channels

OmniChannel. By viewing the transportation experience through the eyes of the customer, transportation agencies can orchestrate the customer experience across all layers so that it is seamless, integrated, and consistent [4]. OmniChannel anticipates that customers may start in one channel and move to another as they progress to a resolution. Facilitating the transitions so that they are fluid for the customer develops continuity within the communications strategy.

Website. Developing an online presence through an agency website is critical as the basis for a permanent digital relationship with the customer.

Search. The next digital layer emerged from the development of powerful search engines such as Google. Focusing on the customer's discovery process, transportation agencies can align customers to their desired services and information.

Social Media. Social networks generate another layer of communications and present a new way to connect with customer service. Transportation agencies can take advantage of the opportunities to advertise safety campaigns, promote commerce, and provide service options.

Mobile. Combined with social media, mobile presents an unprecedented opportunity to focus on utility. By providing stakeholders with valuable information in real time, customers can receive traffic alerts or evacuation information and make effective decisions in a timely manner.

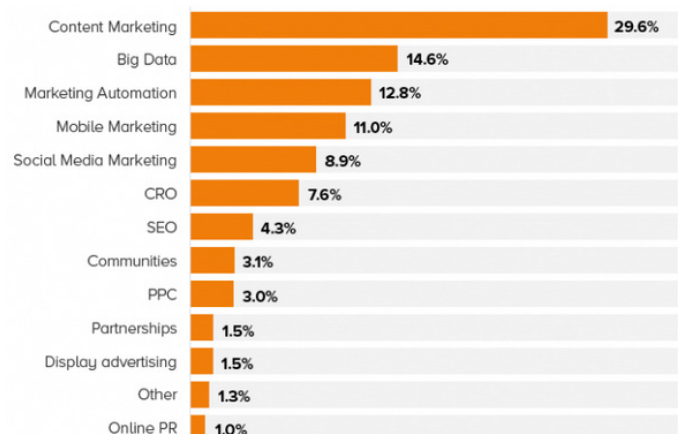
Wearables. Augmented reality, wearable technology, and advanced filters increase the bond between customers and their technology. As individuals become more health conscious, transportation agencies can leverage the trend to promote pedestrian and bicycling initiatives.

Embrace Digital Marketing

Strengthen Content. Content marketing is a strategic marketing approach focused on creating and distributing valuable, relevant, and consistent content to attract and retain a clearly defined audience and, ultimately, to drive positive customer action. B2C Content Marketing found that although social media content is rated the most popular tactic, in-person events are proving the most effective [5]. Transportation agencies can use content marketing to strengthen brand awareness, improve engagement, and empower customer advocates.

RACE Planning. The RACE digital marketing process comprises the following components [6]:

- Reach – Connect with customers to build brand awareness and maximize multiple interactions using different touchpoints
- Act – Encourage website visitors to take the next step by discovering more about the agencies products and services
- Convert – Convince customers to adjust their travel behaviors and alleviate congestion for the whole system
- Engage – Develop a long-term relationship with customers to strengthen stakeholder support and promote open dialogue



Formulating a Communications Strategy

White Paper

How the Age of Technology is Transforming Transportation Agencies

Empower Champions of Change

Celebrate Successes. Highlighting employee, project, departmental, and agency achievements is a positive way to convey success to stakeholders. A good communications strategy will use past success in order to generate momentum to do more in the future. By providing support and encouragement to employees, transportation agencies can develop an organizational culture of which people are proud to represent.

Capture the Micro-Moment. In 2011, Google released an ebook, *Winning in the Zero Moment of Truth*, that helped those in the advertising, search, social, and marketing fields succeed in the early stages of discovery [7]. In 2015, Google followed up by asking, “Right now people all over the world are trying to make the most of every moment—are you there? [8]” Mobile has forever changed the way people live and has forever changed what is expected of brands. The consumer journey has been fractured into hundreds of real-time, intent-driven micro-moments. Transportation agencies should view each one as a critical opportunity for their brand to shape a customer’s decisions and preferences.

Achieve Recognition. In October 2015 the USDOT and the White House Office of Public Engagement will host a Champions of Change event focused on “Beyond Traffic: Innovators in Transportation for the Future” [9]. The public is invited to help recognize leaders who are advancing change that will benefit the nation’s transportation system at the local, regional, and/or national level. The nominees, to be submitted by August 1, 2015, will be considered for their work in improving the mobility of people, the mobility of freight, overarching strategies for enhancing the transportation system for moving things better, and response to a changing environment.

Immediate Action

Smartphones allow us to act on any impulse at any time. We take immediate action whenever we want to learn, find, do, or buy something [10].

Demand for Relevance

When we act on our needs in-the-moment, our expectations are high and our patience is low. This makes the quality, relevance, and usefulness of marketing more important than ever [10].

Loyal to Needs

Our preferences and behaviors are shaped in these micro-moments. Ultimately, the brands that do the best job of addressing our needs in each moment will win [10].

What is a micro-moment?

A micro-moment is a real-time, intent-driven scenario. For example, people who want to find directions to a local restaurant may reference Google Maps or estimate traffic conditions using Waze. People who want to know which bus to take or when it will arrive may access CapMetro’s mobile app. Someone preparing to drive from Laredo through Dallas may follow the @I35Travel Twitter feed for information regarding construction and lane closures. Designing for these new opportunities will prepare transportation agencies to remain relevant in the age of technology.

Formulating a Communications Strategy

White Paper

How the Age of Technology is Transforming Transportation Agencies

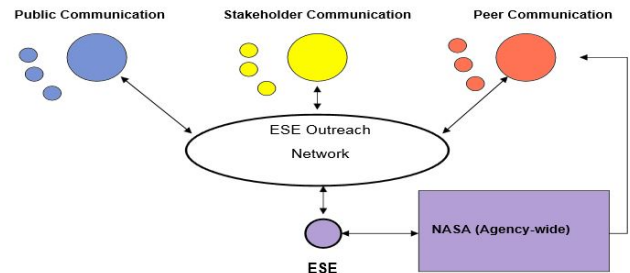
PUBLIC POLICIES & PROGRAMS

National Efforts

Publicly available full communication plans from federal agencies are not abundant, although some do exist. For example, the food and drug administration (FDA) as well as the National Aeronautics and Space Administration (NASA) both publish their complete communication plan [11, 12]. Common content in these plans include identification of agency internal and external stakeholders, lists of communication channels, and primary content to communicate to each stakeholder. The FDA plan also identifies “key trigger events” or events that warrant communication with stakeholders through identified channels. As an example, these include:

- Project/program milestone dates (e.g., initiation, progress, completion)
- External request for agency information or a meeting requiring coordinated and consolidated input from several internal offices or departments
- Agency-wide meetings
- Industry meeting milestones to present updates
- Formation of new teams of divisions
- Updates to standards
- Charter updates

The NASA plan is more oriented toward engaging and communicating with the public rather than focusing on industry stakeholders. It’s a cross-department oriented plan that links communication strategies with furthering agency goals and objectives. Communication-specific goals are laid out for each identified target audience (i.e., public, stakeholder, and peer).



The NASA plan also lists each division or center within the agency and identifies the content each is in charge of communicating to the public. The plan recognizes how important public affairs are to its mission and has a section dedicated to coordination with the NASA Public Affairs Office. Conferences are recognized as a special forum for spreading messages from the agency. The plan has a dedicated section for handling communications at conferences. Finally, there is an inventory of current communication programs, channels, or activities.

In the transportation area, the U.S. Department of Transportation does not have a publicly available communication plan; however, the Federal Highway Administration (FHWA) has its own Policy Communications team that manages the FHWA briefing process for department leadership, including the Secretary, Deputy Secretary, and Administrator. The team has developed and maintains an electronic library containing briefing materials. Maintaining this library ensures accessibility and consistency for data and information. This team is also tasked with oversight of the Office of Public Policy and public outreach effort and ensuring quality control for agency reports to Congress, and assists the Congressional affairs team at need.

Formulating a Communications Strategy

White Paper

How the Age of Technology is Transforming Transportation Agencies

State Strategies

State agencies or other large agencies engaging in public communication and outreach will find that NCHRP Synthesis 413 is a helpful resource [13]. This report synthesizes effective strategies that transportation agencies have used to address challenges and impacts of construction projects in congested urban corridors. An important finding of the study is that stakeholder communication is a critical component of every urban construction project and that the use of the media has become commonplace in these projects. The report provides strategies for stakeholder and public involvement (speaking, branding, targeting stakeholders, etc.) in Chapter 6 and for Media Relations in Chapter 7 (speaking, media relationships, etc.).

Agency-wide communication strategies may be difficult to come by, but successful project-specific strategies used by transportation agencies are readily available. One example is Arizona, which has a communication and outreach strategy for work zone safety and mobility public information [14]. Another example is the Illinois DOT (IDOT) and its use of many social media outlets to provide information on the reconstruction of Willow Road from IL 93 to IL 94—a multimodal improvement project. IDOT created a project-specific web site, a blog, a Facebook page, a Twitter feed, and an Instagram account to share information and project photos [15].

City Initiatives

The Interstate I-405 full closure in Los Angeles is another notable public information and outreach example. This project dealt with the full closure of both directions of a 10-mile stretch of the I-405 Freeway in West Los Angeles on the weekend of July 16–17, 2011 for 53 hours—an event deemed “Carmageddon.” Motorists were warned well in advance of the need to plan ahead, stay home, or avoid the area through English and Spanish public service announcements starring celebrities, coordinated celebrity tweets, news releases and fact sheets, and a count-down clock. It was a joint effort of the Los Angeles Police Department, Los Angeles Fire Department, California Highway Patrol, Los Angeles Department of Transportation, Metro, and Caltrans [16].

Formulating a Communications Strategy

White Paper

How the Age of Technology is Transforming Transportation Agencies

COMMUNICATION CHALLENGES

Financial and Political Barriers

A comprehensive public outreach process can be very time consuming, expensive, and require many organizational resources, but a well-executed process can provide many benefits. These include monetary savings, such as reduced user cost through congestion savings, and customer support for projects. Before undertaking a full public outreach process, agencies are advised to complete a cost-benefit analysis that assesses the full cost of the outreach plan and expected benefits due to improved communications.

Technical Considerations

Before embracing digital media for communication and outreach, agencies should consider the user experience across the many devices that consumers use—especially mobile devices. Once users have a bad experience at a site on their mobile device, their likelihood to return may decrease. In addition, agencies should consider how the audience varies at each digital outlet. For example, Twitter users are only 23% of internet users, which is low when compared to Facebook users, who comprise 71% of all internet users [17].

Organizational Obstacles

Getting a message to the public can be difficult when working with reporters outside the organization. Often reporters seek to find controversy or conflict in stories and events as a method for grabbing audience attention. The desire of transportation agencies is to provide positive, inclusive messages through collaboration with outside channels. Smart collaboration requires developing and using shared key messages about agency activities, and cultivating trusted leaders within the organization to be credible spokespeople. The agency will need to maintain working relationships with reporters to create interesting news angles that do not conflict with agency goals.

Formulating a Communications Strategy

White Paper

How the Age of Technology is Transforming Transportation Agencies

OPPORTUNITIES FOR TEXAS

Statement of Purpose

Texas should formulate a communications strategy focused on emerging technologies to achieve the following three objectives:

- Build awareness and engage with key stakeholders
- Improve the customer experience as a service-oriented enterprise
- Become a leader in interconnected and innovative transportation systems

“On the Move Again” Proposal

What do your morning commute, grocery shopping, and directions to the nearest gas station have in common? These are everyday transportation challenges that can be improved with technology.

Texas Moves People. Texans in the state’s four most populous cities are spending over 40 hours every year sitting in traffic. That’s one full workweek that could be better spent enjoying time with family, having dinner with friends, or reading that book your coworker recommended. Texas transportation agencies are committed to relieving congestion and giving you back your time, but they need your help. Every person, every car makes a difference. So the next time you are preparing to brave the morning commute, instead take advantage of the incentive program and try a different route, take the Express Bus, go in an hour later, or even talk to your employer about working from home once a week. By making these small shifts, you can do your part to improve the transportation system as a whole. In return, transportation agencies will reward you with points at major stores, toll roads, and local restaurants. The greatest benefit though is once again having your time back to do the things that you want. Why sit in traffic if you don’t have to?

Texas Moves Goods. Ever wonder how your groceries get to the local grocery store? Supermarkets rely on several distributors to fill their stores with meat, produce, dairy products, baked goods, and other staples. Regional distributors act as “middle men” to provide consistency and ease, ensuring that the shelves are well-stocked and goods are delivered from the inventory warehouse at the exact level of ripeness desired by you, the customer. Many grocers are also experimenting with urban kiosks and delivery services that make shopping even more accessible.

Underlying the operations of a grocery store is a complex logistics network. When there is a traffic accident, icy road conditions, or a hurricane approaching the Gulf Coast, transportation agencies work with distributors and businesses to maintain a quality level of service and to guarantee just-in-time delivery of your goods. By supporting the freight industry through the use of technology and infrastructure, transportation agencies make it possible for distributors to deliver groceries at your convenience.

Texas Moves Information. Have you found yourself driving around downtown searching endlessly for parking? Or looking for the right bus stop to take you home? Through the open data portal, transportation agencies now have the capability to communicate real-time traveler information and answer your most pressing questions. If you find yourself stuck in traffic, mobile notifications will inform you of better options to get you on the move again.

Texas is on the move again, leading the way in the transportation of people, goods, and information.

Formulating a Communications Strategy

White Paper

How the Age of Technology is Transforming Transportation Agencies

REFERENCES

1. Title Page Art. Source:
<http://www.themarketingbit.com/wp-content/uploads/2014/01/tree-1040x847.jpg>
2. Mississippi Department of Transportation. "Brand Standards and Policies Guide."
<http://sp.mdot.ms.gov/Branding%20Documents/Branding%20Guidelines/MDOT%20Identity%20Booklet.pdf>
3. Knowhow Nonprofit. "Developing a Communications Strategy: Step-by-step guide to producing a communications strategy for your organization."
<http://knowhownonprofit.org/campaigns/communications/effective-communications-1/communications-strategy>
4. Schaefer Marketing Solutions. "10 Things You Need to Know NOW about OmniChannel Marketing."
<http://www.businessesgrow.com/2014/09/02/dont-look-now-web-strategy-become-omni-channel/>
5. Content Marketing Institute. "B2B Content Marketing: 2014 Benchmarks, Budgets, and Trends – North America."
http://contentmarketinginstitute.com/wp-content/uploads/2013/10/B2B_Research_2014_CMI.pdf
6. SmartInsights. "Introducing RACE: A Practical framework to improve your digital marketing."
<http://www.smartinsights.com/digital-marketing-strategy/race-a-practical-framework-to-improve-your-digital-marketing/>
7. Google. "Zero Moment of Truth (ZMOT)."
<https://www.thinkwithgoogle.com/collections/zero-moment-truth.html>
8. Google. "Micro-Moments."
<https://www.thinkwithgoogle.com/micromoments/>
9. Foxx, Anthony. "Seeking Innovators for 2015 Champions of Change in Transportation."
<https://www.whitehouse.gov/blog/2015/07/21/seeking-innovators-2015-champions-change-transportation>
10. Forbes. "Google's Micro-Moment: Why It's a Game Changer for CMOs."
<http://www.forbes.com/sites/onmarketing/2015/04/09/googles-micro-moment-why-its-a-game-changer-for-cmos/>
11. U.S. Food and Drug Administration, Center for Drug Evaluation and Research. "Communications Plan."
<http://www.fda.gov/downloads/Drugs/DevelopmentApprovalProcess/FormsSubmissionRequirements/ElectronicSubmissions/UCM300267.pdf>
12. <http://www.hq.nasa.gov/office/hqlibrary/documents/o57369191.pdf>
13. National Aeronautics and Space Association. "Outreach and Communications Plan."
http://onlinepubs.trb.org/onlinepubs/nchrp/nchrp_syn_413.pdf
14. Arizona Department of Transportation. "Work Zone Safety and Mobility: Public Information and Outreach Strategies." <http://azdot.gov/docs/default-source/about/outreach.pdf?sfvrsn=2>
15. Cook County Department of Transportation and Highways. "Keeping Up on Willow Road."
<http://northfieldwillowroad.blogspot.com/>
16. Federal Highway Administration. "Project-Level Public Information and Outreach Examples."
<http://www.ops.fhwa.dot.gov/wz/publicinfostrategies/projectlevel.htm>
17. Pew Research Center. "Demographics of Key Social Networking Platforms."
<http://www.pewinternet.org/2015/01/09/demographics-of-key-social-networking-platforms-2/>