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Special Report

NEXT STOP, INNOVATION: WHAT'S AHEAD FOR URBAN MOBILITY?



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Transportation in the 21st century is entering a robust phase that mirrors the early years of the automobile, when gasoline, steam and electric technology vied for market share. Although electric cars led for a while, the internal-combustion engine reached dominance by 1920, with profound effects on American city-based public transportation — which atrophied as car ownership grew.

Today, urban transit is making a comeback, as is the electric car. Congested highways still face emission concerns, but consumers now often have the choice of light and heavy rail. Car sharing, which began as a European phenomenon, has prospered in U.S. urban centers, along with bicycle sharing, vanpooling and other options.

Government plays a major role in shaping efficient urban transportation systems. So far, regulations have proven an effective driver in the early development of new technology. But for ultimate success, environmentally friendly options also must satisfy consumers’ needs and meet economic goals. This special report, produced in coordination with Wharton’s Initiative for Global Environmental Leadership (IGEL), explores how cities are expanding their options for cleaner transportation, and how new technologies, innovations and incentives are revitalizing the sector.

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American cities were designed for the private automobile, but they are evolving to accommodate other — and more efficient — forms of transportation, aided by advances in technology and progressive legislation. Cities are adopting congestion-pricing schemes, hosting car- and bicycle-sharing networks, linking neighborhoods with light rail and investigating regional corridors for high-speed trains.

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Environmental regulation and funding are helping to revitalize urban transportation networks. Federal rules require a doubling of auto fleet fuel economy by 2025, and on the state and city levels, incentives are encouraging the replacement of polluting diesel trucks with electric versions. But consistency remains a problem regarding funding and incentives, which often are renewed only for short periods.

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Hybrid and electric cars together are still less than 4% of the American auto market, but they are increasingly viable as alternatives to internal combustion models. Their short-range limitations and low-emissions status make them eminently suitable for urban settings, especially for car sharing and truck fleets. They also are the likely choice for the self-driving city cars of tomorrow.



Transportation Alternatives and Evolving Infrastructure

America's love affair with the automobile has continued unabated for more than a century, and private cars and trucks are likely to remain the dominant form of transportation in the U.S. for a long time to come. But despite that reality, transportation is evolving in important ways, as alternatives such as car sharing, bike sharing, Internet-enabled carpooling programs, vanpooling and public transportation continue to build constituencies and gain governmental support on all levels. And as this evolution moves forward, a new model of urban mobility is emerging in cities across the country.

"American cities were designed for the automobile," says Vukan Vuchic, a professor of transportation engineering at the University of Pennsylvania and author of a trilogy of books on transit policy. "We're making great improvements in alternative transportation, but it's not easy. Some cities — San Francisco, Portland [Oregon], Sacramento — are way ahead of others."

The federal government is providing some of the fuel for this evolution. Although it's not well known, the 157-page "fiscal cliff" deal worked out in Congress as 2012 drew to a close includes an extension of pre-tax benefits for transit commuters that could save individual consumers \$550 annually. More than 2.7 million families are eligible for the tax break, which was achieved with a minimum of political dissension.

But not all such legislation has an easy time of it. New York is by far the least car-dependent city in America, with prohibitive private automobile costs trumped by a robust public transportation system that debuted in 1904 and that now serves nearly five million passengers a day. But New York's streets are still heavily congested with cars — a million a day enter Manhattan.

That's why, on Earth Day 2007, Mayor Mike Bloomberg proposed a congestion-pricing scheme, modeled on London and other European cities, which would have charged commuters \$8 for entering Manhattan's central business district. According to the Campaign for New York's Future, the plan would have cut vehicle traffic by 6%, and put 78,000 new people on transit. But Mayor Bloomberg was unable to muster enough support to enact the program. The experience stands as an example of how hard it is to significantly alter America's long-term love affair with the automobile — even in cities where cars are the underdog.

Car Sharing Around the World

Still, despite the obstacles, huge progress is being made on a number of fronts, including car sharing. Car sharing, which invites people to join organizations that provide access to short-term automobile use, began in Europe as a non-profit venture. The first car-sharing cooperative, known as Sefarge, was launched in Switzerland circa 1948. It gained immediate popularity, because cars were both scarce and expensive in post-war Europe.

But the movement really gained momentum in the 1970s as environmental awareness (and gas prices in some quarters) increased. The growth encompassed much of Europe, including Switzerland, Sweden, France, the Netherlands and Great Britain. Early European studies indicated that between 15% and 31% of members sold a vehicle after they began car sharing, but larger numbers (23% to 26%) simply postponed such a purchase. Those numbers haven't changed much since then — car sharers tend to keep their own cars, but use them less. Europeans, who pay more for both cars and gasoline, have always had stronger incentives to adopt car sharing.

In the U.S., on the other hand, the need for car sharing wasn't immediately recognized. But interest has certainly grown over time. Today, the Edmunds.com website describes non-profit co-op car sharing in the U.S. as "a combination of condo time-sharing, traditional car renting, a loaner library or tool rental yard.... Rather than owning a car and paying all the insurance, maintenance and fuel costs, why not pay for the vehicle only when you're behind the wheel? This saves time, resources, aggravation and, perhaps most importantly, money."

Despite those obvious benefits, however, a 1969 academic study, entitled "Restructuring the Form of Car Ownership," concluded that what were then known as "community garages" were doomed to failure beyond Europe. "Where it simply will not do is in the United States," Leslie Fishman and Stuart Wabe wrote in the article, which was published in *Transportation Research*. "American cities have, with almost no exception, become motor cities — adapted to the owner-driver form of transport.... The American city can no longer be adapted to a community garage scheme. Their path is irreversible, and they have gone beyond the point of no return."

It didn't happen overnight, but that assessment proved to be wrong. Some U.S. cities, including San Francisco, Boston, Seattle and Portland, Ore., have embraced car sharing wholeheartedly.

The Short-Term Auto Rental (STAR) program was a demonstration program that existed in San Francisco from 1983 to 1985. Carshare Portland was launched by David Brook in 1998 with just one car and some neighbor-members. Zipcar (in Boston) and Flexcar (in Seattle) were both formed in 2000, and agreed to merge in 2007. By 2012, some 800,000 people belonged to American car-sharing services, according to the Transportation Sustainability Research Center at the University of California, Berkeley. That is a 44% increase from 2011.

Internationally, there are 1.7 million car sharers in 27 countries, a statistic that includes peer-to-peer services, which allow rentals of individually owned vehicles. France is a center of car sharing in Europe, with some 430,000 subscribers. The services in Europe are run by private associations, but 24% are managed by regional and inter-town councils.

Car Sharing: Convenience and Savings

What motivates drivers to car share? The practice is often discussed in terms of its environmental

benefits, but, as a group, car sharers appear to be more interested in saving money than they are in saving the planet.

A study by Fleura Bardhi and Giana Eckhardt, "Access-Based Consumption: The Case for Car Sharing" (*The Journal of Consumer Research*, December 2012), looks at why Zipcar drivers, many of them already vehicle owners, choose to sign up for sharing services. "The type of consumption we uncover is not motivated by altruistic concerns," they write. Car sharing, they say, is a "unique form" that "can be underlined by economic exchange and reciprocity." In fact, Edmunds.com reports that one Boston Zipcar user estimated she saved \$3,000 during her first six months of usage.

Moreover, as Bardhi and Eckhardt have pointed out, people use car sharing because they perceive it to be in their financial and personal interest to do so. According to Lee Broughton, head of corporate sustainability for Enterprise Holdings (which owns the Alamo, National and Enterprise car rental brands), that decision is easiest to make in crowded urban environments, where owning a car is cost-prohibitive, congestion charges may apply and parking is a hassle.

In addition, people who do not drive cars presumably will walk, bike or take public transit more often. However, Broughton says it's difficult to prove how many cars are taken off the road by car sharing and local car rental, though certainly total vehicle miles traveled is dramatically reduced. "Disruptive technologies take off because they create convenience," he notes. "That's what happened with traditional car rental initially when it moved from the airports to the neighborhoods, and it's what's happening with car sharing now — it's a cheaper, easier way to have occasional access to a vehicle."

Other major American rental companies have recognized that car sharing fits well into their business models. Hertz, for example, launched its Connect by Hertz service in 2008, with 22 locations in New York, Paris and London. Rebranded Hertz on Demand 24/7 in 2011, it now has more than 150,000 members and 700 vehicles in more than 500 locations.

To grow the car-sharing retail segment even further, some car rental companies have acquired city-based nonprofits. Enterprise bought PhillyCarShare (then facing \$2.7 million in back taxes) in 2011, after establishing its own coast-to-coast brand (now called

Enterprise CarShare). It added the Boston- and New York-based Mint Cars on Demand in 2012. And in early 2013, Avis-Budget jumped into the car-sharing segment for the first time by purchasing Zipcar.

According to John Paul MacDuffie, a Wharton management professor and co-director of the International Motor Vehicle Program (IMVP), “It’s not surprising that the smaller car-sharing start-up companies have attracted the attention of the larger rental entities and, possibly, their investment. The rental sector has been following car sharing intensely as it has grown.” In essence, think of car sharing as short-hop rentals that maximize the convenience for the driver/member — a smart concept, though not all that different from the well-established local car rental business in the U.S.

Car-sharing members (including government and business fleets, as well as individuals) lower their transportation budgets by considerable sums, and enjoy an average reduction of 44% in their vehicle miles traveled. For example, the city of Loveland, Colo., replaced 40 owned vehicles with 15 shared ones through Enterprise, and projects savings of \$300,000 annually. City fleet manager Steve Kobler says that sharing vehicles enables the city “to reduce our overhead, maintenance and insurance expenses while providing safe, reliable and fuel efficient transportation for city employees.” Car sharing also reduces the city’s paperwork: The system automatically charges the user’s account for its use, with no need for time-consuming forms.

Public Transportation Crawls Along

In contrast to the rapid growth of car sharing in the U.S., public transportation is evolving more slowly. The United States has more than 6,000 mass transit agencies operating buses, light and heavy rail, demand-response para-transit, and more — employing more than 350,000 people. In 2010, Americans took 10.2 billion transit trips and rode 54 billion miles. Transit usage is at its highest level in 50 years.

It sounds impressive, but the American commitment to public transit pales in comparison to Europe, where every major city is already linked by rail and where intra-urban lines reach most neighborhoods. The rest of the world is catching up fast. In 2008, China devoted \$12.50 of every \$1,000 of GDP to rail and transit; the U.S. spent just \$1.50, and remains the most car-dependent country in the world.

As noted in a joint 2010 study by Northeastern

University and the Worldwatch Institute, titled “Global Competitiveness in the Rail and Transit Industry,” in the 1930s and 1940s, “U.S. inter-city passenger trains were the envy of much of the world.” But between 1956 and 1969, nearly 60,000 miles of track had been taken out of passenger service, and ridership fell by almost two-thirds between 1946 and 1963. Less than one in five of the inter-city trains that ran in 1954 were still operating in 1971, the year Amtrak was created.

But that was the low point, and things are looking up for transit. Amtrak still struggles for funding, and fights the impression among some in Congress that rail systems should pay for themselves (see companion story). But the system set a ridership record in fiscal 2012, carrying more than 31 million passengers — a 3.5% increase over 2011. Amtrak would like to emulate the high-speed trains common in Europe, Japan and China, and in early 2013 began exploring acquisition of rail sets capable of 220 mph. Electrifying routes now served mostly by diesel locomotives is a priority.

In 2009, the Obama administration’s stimulus package included \$17.7 billion for all forms of public transportation. Congested cities are interested in trains again, and there are now at least 30 light rail systems operational in the U.S. and another 10 under construction. But the U.S. still accounts for only 5% of the world’s transit rail cars (Europe has 35% and Japan 11%). Buses, not trains, carry the largest percentage of public transportation riders (38.9% in 2010).

Since 2004, transit growth has outpaced the increase in population, and highway travel, too. Since 1995, ridership has grown by nearly three billion trips annually, reports the American Public Transportation Association. This is noteworthy progress, which could be greatly enhanced with high-speed rail corridors linking the major population centers in the U.S. Today, only the Boston-to-Washington Acela offers a semblance of that service, though track issues and other obstacles often mean it’s barely faster than regular Amtrak service.

MacDuffie notes that visitors to Japan often come back as converts to the value of high-speed rail, which could compete with airline travel in many parts of the U.S. “I think we should start with a truly fast East Coast rail corridor that could be a beachhead to show Americans what it’s like,” he says. “The East Coast has the population density to make it work.”

Ridesharing and Telecommuting

As sharing cars gains momentum in more U.S. cities, sharing the ride also is gaining new popularity as a more sustainable alternative to solitary commuting. The first U.S. ridesharing was the informal network of “jitneys” (usually Model T Fords) that, for five cents, gave streetcar riders an alternative way of getting to work during the First World War. Much later, the Arab Oil Embargo of 1973-1974 led to a revival of interest in ridesharing that eventually led President Jimmy Carter to create a federal task force in 1979, even as some cities created their own agencies to facilitate shared rides.

Americans created car- and vanpools in great numbers during the 1970s and 1980s, when they constituted 20% of all work trips. But with cheaper gas, participation dropped off. Just 12.6% of commutes were pooled by 2000.

Vanpool use is on the rise again, and companies and institutions offer incentives for their workers who use them. Some large corporations create their own pools, but the two biggest commercial players are VPSI Inc. and Enterprise Rideshare. VPSI estimates that a commuter who travels 30 miles a day would save more than \$4,000 a year by using a vanpool. Users may also be eligible for auto insurance discounts (if they designate their cars as “recreation only”) and could qualify for a tax break if employed by a firm that offers a pre-tax payroll deduction for mass transit.

Meanwhile, advances in communications technology are making it possible for more and more employees to go to work — without leaving home. The Internet and teleconferencing, combined with the smartphone and other advanced devices, are providing another way to bring remote employees into the office — and make telecommuting more desirable for both workers and companies. The implications for relieving the burden on our crowded highways are clear. According to the Department of Transportation, “Even a modest decrease of traffic due to telecommuting could reduce congestion significantly, thereby magnifying savings in time and fuel use, and reduction in emission of pollutants.”

More than three million Americans (2.5% of the U.S. workforce) relied on regular telecommuting in 2011, nearly double the number in 2005. And 20 to 30 million Americans work at home at least one day a week. The federal government has made the biggest telecommuting gains, with 424% growth between

2005 and 2011. “We believe our employees can work anytime, anywhere,” Danette Campbell, senior telework advisor at the U.S. Patent and Trademark Office, told *The Washington Post*.

According to the Reason Foundation, on the days they telecommute, workers reduce their daily trips by as much as 50% and cut their vehicle miles traveled between 50% and 75%. In some cities — San Diego, Dallas, Phoenix, Raleigh-Durham, Nashville — telecommuters outnumber regular transit commuters.

Bike Sharing Answers an Urban Call

In the shifting urban mobility equation, another rising alternative to the car is the bicycle. And, as with car sharing, the trend began in Europe. The first “white bikes” were offered in Amsterdam in 1965, with the so-called Witte Fietsen program. The plan set the pattern for the shared bike schemes of today: The public could borrow the white bikes, ride them to their destinations, and leave them for the next user. But according to the *Journal of Public Transportation* (2009): “Things did not go as planned, as bikes were thrown into the canals or appropriated for private use. The program collapsed within days.”

That experience set back this urban transportation experiment, to the extent that it was not until 1995 that Bycklen — a larger and more mature model that featured sturdier bikes and a coin deposit system — was started in Copenhagen, Denmark. A year later, students at Portsmouth University in England were using magnetic cards to access shared bikes. Soon, bike sharing could be accessed through mobile phones or home computers.

The programs grew quickly. Velo’v launched in Lyon, France, with 1,500 bikes, and Paris followed two years later with Vélib’, which started with 7,000 bikes and quickly grew to more than 23,000 in the city and surrounding suburbs. By 2009, there were 120 programs worldwide, including Washington, D.C.’s Capital Bikeshare, which has 175 stations in the region and 1,670 bikes.

Details vary from program to program, but generally cyclists buy a subscription, ranging from a day pass (at \$5 to \$10) to an annual membership (\$60 to \$75). To access bikes, they swipe a smart card, use a key or punch in a code. Often, the first 30 minutes of use is free. Bikes can be returned to any city station, so it’s obviously more convenient if there are many strategically placed locations.

In 2010 alone, third-generation bike-sharing operations began in Denver, Minneapolis, Chicago and Washington, D.C. These were followed by programs in Miami, Boulder, Colo., Madison, Wis., and Portland, Ore. A major rollout also is planned for New York City, but it was delayed by software problems and by the flooding of equipment during Hurricane Sandy.

Proof of the programs' effectiveness is not hard to find. Vélib' reduced traffic in Paris by 5% in its first year. In Denver, 43% of B-Cycle users say they have replaced car trips with bike rides. Montreal's Bixi system has created 400 new jobs. And bike sharing induces people to try riding: 96% of Velo'v users in Lyon said they had not previously ridden bikes in the city. In the first year, Lyon reported a 44% increase in bike use.

"Bike sharing sets in motion a welcome urban lifestyle pattern," says Deborah Gordon, a senior associate at the Carnegie Endowment for World Peace's Energy and Climate Program. "If you own a car, it doesn't make financial sense to never use it. Bike sharing gives Americans options, and it's a first step to reducing our dependency on the automobile. The programs have been very successful because of the flexibility they give people."

Two Billion Cars?

The above are all major currents that are coming together to advance the state of urban mobility. But it's fair to ask: How much impact is all this having? Gordon is co-author (with Daniel Sperling) of the book *Two Billion Cars*. She says that particular milestone in the world car population has been postponed somewhat by the international recession,

but it still might be reached sometime in the late 2020s. Alternatives, including public transit and sharing programs, also affect growth in the number of cars, though their effect is probably more modest than that of recessions, oil shortages and gasoline price hikes.

Private cars and trucks will remain the dominant form of transportation for decades to come, and nowhere more than in the U.S., where the Census Bureau reports that more than 76% of Americans who drive to work do so alone. In 2010, 4.9% used public transportation and only 2.8% walked to work.

Americans have shown that they will also use other modes of transit when it makes sense, including public transportation (if it's available; there's no option in many parts of the U.S.) and both bike and car sharing. From 2001 to 2011 in North America, more than 10,000 vehicles entered car-sharing programs, and more than 500,000 people became members. Clearly, if alternatives are convenient and affordable, people will choose to use them, easing congestion and reducing impact on the environment.

And although Americans are unlikely to give up their cars, they are increasingly willing to consider alternative power sources for them, including electricity and such biofuels as cellulosic ethanol and biodiesel. And even gasoline need not be a "fossil" fuel. At the Donald Danforth Plant Science Center in St. Louis, James Umen of the Enterprise Rent-A-Car Institute for Renewable Fuels is working to find the perfect algae strain (it's called "bio-prospecting") that could one day be turned into a more renewable form of diesel, jet fuel or gasoline.





Funding Innovation for Cleaner Cities

In 2011, when the Environmental Protection Agency announced that it would require auto manufacturers' fleets of cars and light trucks to average 54.5 mpg by 2025, the move was expected to generate a firestorm of protest from the industry.

But opposition to what's known as Corporate Average Fuel Economy (CAFE) never emerged. Instead, wrote *The New York Times*, "While the American carmakers, as well as their Asian rivals, once argued against even minimal increases in government fuel rules, they are acquiescing without protest to an increase to 54.5 miles per gallon by 2025, from the current 27 miles per gallon." It helped that the public largely supports such legislation. A recent bipartisan poll of 800 registered voters (commissioned by the American Lung Association) showed that 62% favored having the EPA set stricter standards on gasoline and tailpipe emissions from new vehicles.

Still, why did the industry — which has been highly critical of past hikes in CAFE standards — accept this dramatic increase so quietly? Because this time, the CAFE process, driven by an increasing clamor for fuel-efficient cars and action on climate change, involved all the relevant stakeholders. These included: the EPA, the White House and the state of California (which has the unique ability to set its own emission standards), and also the automakers themselves. While 54.5 mpg is not the number the car companies would have picked, the firms embraced it as a single solution offering some degree of certainty.

Gloria Bergquist, a vice president of the Alliance of Automobile Manufacturers, says that what automakers ultimately want is "a single national program for fuel economy and carbon dioxide to avoid a patchwork of regulations." The situation they

most want to avoid, she adds, is having to build one set of cars for most of the country and a second set that adhere to tighter emission standards for California and the states that follow its lead.

Another uniting force is the 54.5 mpg goal itself, which doesn't require automakers to adopt one single technology. It's "technology neutral," unlike California's zero emission mandate. Tougher rules adopted by the state's Air Resources Board in early 2012 will require an additional 1.4 million zero- and near-zero emission cars and trucks by 2025. Half a million of those vehicles have to be either battery electric or fuel-cell, with no tailpipe emissions.

The state rules could have unintended consequences. Some automakers' electric and fuel-cell vehicles, for instance, are called "compliance cars" because they're being built in small programs designed to meet the letter, if not the spirit, of the regulations. If the cars fail because their technology is too far ahead or behind potential buyers' acceptance levels, under-marketed or lacking the public plug-in infrastructure they need, no one's interests would be served. The Air Resources Board argues, on the other hand, that automakers would never commit to electric car programs without California's powerful mandates.

Incentives to Fuel Innovation

California is just one of several states and municipalities that are encouraging fleet operators to switch from polluting diesels to zero-emission battery trucks, and it provides very large rebates of \$40,000 to \$60,000 per truck to achieve that goal. Meanwhile, in six Chicagoland counties, a voucher program offers fleet owners approximately 60% of the cost differential between a diesel truck and its more expensive battery equivalent. New York City and others also offer similar rebates.

These subsidies have encouraged some electric vehicle companies to get into the market, including Cleveland-based Amp Electric Vehicles. In early 2013, Amp announced that it had purchased the Workhorse truck brand from Navistar International, gaining access to an existing step van platform and a factory in Indiana. Amp will produce both fully electric Workhorse vans and hybrids at the factory (as well as conventional versions), and hopes to win major contracts from such companies as FedEx, UPS (already a Workhorse customer) and Frito-Lay — all of which already have substantial alternative power fleets.

Burns says the subsidies could enable a fleet owner to recoup the \$75,000 cost of converting a heavily used medium-duty van in just one to two years. Short-range battery vehicles make sense for deliveries that follow a set route, especially within urban areas. But highway travel is a challenge.

As these and other programs play out in various states and cities, the federal government offers a \$7,500 income tax credit for electric battery vehicles — a step that is proving to be an important factor in early adopter buying decisions. President Obama has proposed increasing the amount to \$10,000 and making it payable at the time of purchase as a rebate, rather than a tax credit. Some legislators would also like to see an increase in the incentives. Michigan Sen. Debbie Stabenow says the \$7,500 credit is “very important,” and calls for new federal subsidies that, like the laws in California and New York, would apply to commercial vehicles, not just passenger cars. “Huge fuel gains are possible with trucks,” she says.

Fickle Funders

The role of federal, state and local governments in assisting the evolution of mobility alternatives — especially in crowded urban areas — is hotly contested. As the issue has become politicized, some incentive programs have become mired in legislative limbo.

“You need long-term funding commitments, sometimes 20 years of sustained effort, to really affect people’s behavior,” says Daniel D. Lee, a professor in the department of electrical and systems engineering at the University of Pennsylvania, and director of the federally funded University Transportation Centers (UTC) — a joint project that addresses urban transit needs in conjunction with Carnegie Mellon University.

“The funding can’t get canceled in the middle — deployment, operations and planning all have to be coordinated,” he adds. Lee notes that funding realities led UTC to concentrate on shorter-term transportation goals that can be achieved with current technology, rather than major infrastructure projects requiring huge budgets and decades of support.

Some transportation programs have endured not only boom-and-bust cycles but also constant threats to their continued existence. National rail carrier Amtrak is a classic example. “Highways have gotten \$50 to \$80 billion per year in federal money,” says Vukan Vuchic, a transit expert and transportation engineering professor at the University of Pennsylvania. “Amtrak receives just \$1 billion to \$2 billion, but the whole noise is that we can’t afford Amtrak subsidies.”

The fact is, the average subsidy for an Amtrak ticket since 2007 is \$5.62, according to the service’s own data. But Amtrak says it now covers 85% of its operating costs with tickets and other revenue, and that its annual grant of \$466 million (in fiscal 2012) is down nearly 50% (with adjustment for inflation) from the \$755 million it received in fiscal 2004. Amtrak’s fiscal 2013 request was down again, to \$450 million, and CEO Joe Boardman was quick to cite the service’s halving of its debt, its record ridership and revenue, better cost controls and improved on-time performance as factors that justify that amount as a prudent federal expenditure.

Some critics say that Amtrak’s per-ticket subsidy is much higher than \$5.62, and many want to privatize the service. According to Florida Rep. John Mica, chair of the House Transportation and Infrastructure Committee, speaking at a committee meeting, “Despite every ticket being underwritten nearly \$50 by the taxpayers, [Amtrak] is an absolute failure in competing with the cost-effectiveness and level of service provided by the private sector.”

Yet passenger rail has many defenders — such as Congressman Nick Rahall from West Virginia — who points out that the average per-passenger-mile subsidy for Amtrak is less than 44 cents, compared to almost 45 cents for drivers. So is it reasonable to expect Amtrak, or local light rail systems, to pay for themselves? Throughout history they rarely have, but trains pay for themselves in other ways. A 1997 study published in the journal *Transportation Research Record* by Steven Lewis-Workman and Daniel Brod concludes, “[P]roximity to rail transit

stations can be a significant source of benefit to residents within walking distance.”

Municipalities’ Central Role

The experience of the past half-century has indicated that municipalities themselves, with assistance from the federal and state governments, may play the most effective role in advancing the state of the art in urban mobility.

According to the study “Governmental Subsidies for Public Transit” by Daniel Baldwin Hess of SUNY’s University at Buffalo and Peter Lombardi of Rutgers University, “Transit has evolved from a private industry sustained by fare box revenues to a public entity supported by federal and, more recently, state and local governments.... After decades of auto-oriented policies and development patterns that left public transportation neglected and moribund, large public investments in recent decades, combined with increasing highway congestion and a greater recognition of transit’s potential benefits, have managed to brighten prospects for public transit. Cities from the Rust Belt to the SunBelt have planned or constructed new rapid transit systems, and sprawling cities from Atlanta to Los Angeles have begun efforts to encourage transit-oriented development.”

In the 1950s, when the surviving transit systems desperately needed modernization, funding was instead channeled to the new interstate highway system developed by the Eisenhower Administration. In the postwar period, only five cities owned transit systems — Cleveland, Detroit, New York, San Francisco and Seattle. But by the 1970s, the transition to municipal ownership was well under way.

Stimulus came from the Urban Mass Transportation Act (UMTA) of 1964, landmark legislation that applied \$2.23 billion (in 2003 dollars) over three years for building, rebuilding or purchasing transit infrastructure. The next two decades saw much more federal legislation in support of public transportation, such as the National Mass Transportation Assistance Act of 1974. According to the “Governmental Subsidies” report, in 1965 there were only 58 municipally owned transit systems — by 1974 there were 308.

Federal transit funding grew from 6% of total transit spending in 1970 to 41% in 1980, when it totaled \$6 billion. The percentage of funding coming from the

fare box dropped in that period (from 70% in 1970 to 31% in 1980), but a consensus had emerged that transit was a public good and worth supporting. Many cities launched rail projects, with federal funds a major factor.

Funding waned during the 1980s, but rebounded during the 1990s. Perhaps the most important legislation driving all forms of public transit (as well as everything from bike paths to pedestrian walkways) was the Intermodal Surface Transportation Efficiency Act (ISTEA) of 1991 and the related Transportation Equity Act for the 21st century (TEA-21) in 1998.

Washington, D.C.’s public transit experience is an object lesson in how public funding can advance effective urban mobility solutions. In 1974, President Gerald Ford signed an amendment to the 1974 Urban Mass Transportation Act that allowed operating subsidies from the Highway Trust Fund to be applied to a new transit system in the nation’s capital. In 1975, the District of Columbia began to transfer \$2.2 billion in highway funds to build what would become its groundbreaking Metro system. The system opened with Phase One (just 4.2 miles) in 1976, carrying 51,000 people in free service on its first day. The service expanded steadily; the Blue Line, which offers service to what was then called National Airport, opened in 1977.

Washington’s Metro rail system was soon an indispensable part of the region’s transportation system, helping to ease some of the nation’s worst traffic congestion. In July 2008, ridership set a new record of more than 21 million trips taken in a single month.

Cities participate in ways large and small in promoting urban transit. Many cities, in the U.S. and abroad, invest in light rail, bike paths and “traffic-calming” (speed bumps, roundabouts and other efforts to slow down cars and trucks.) The city of Portland, Ore., for instance, installs bike carriers on city buses and will put a free rack in front of a business upon request, provided that the business owner meets minimal requirements. Bicycle lockers are available throughout the downtown area.

The recently completed Southwest Moody Avenue project in Portland is a \$51-million effort that combines new traffic lanes, links to light rail and streetcars, and both bike and pedestrian paths. The city (which maintains an urban growth boundary adopted in 1979), is a leader in “intermodal”

transportation — ensuring that travelers can easily switch from one form of transit to another — and pioneered transit-oriented development.

But Portland's path to a new public transit model hasn't been without its obstacles. Long a heavyweight in urban transit ("We outbox our weight class," TriMet General Manager Neil McFarlane told *Governing* magazine), Portland has become a victim of boom-and-bust funding cycles as it works on further light rail expansion — a \$1.5-billion, seven-mile line slated to be finished in 2015.

If funding for major infrastructure projects is difficult to obtain, smaller initiatives can still thrive. In Philadelphia, federal funding is helping uncover new ways to use low-cost information technology to help unsnarl downtown traffic and encourage transportation alternatives. The University of Pennsylvania's Lee says that UTC, with funding from the U.S. Department of Transportation, is working with the Southeastern Pennsylvania Transportation Authority (SEPTA) on improved techniques for measuring and evaluating the different modes of commuter traffic — private cars, public transit and pedestrians. SEPTA operates the city's trolleys, buses, subways and regional rail.

In a related project, UTC is working with SEPTA's bus lines to make urban transit safer by developing onboard technology that could alert drivers (especially when making turns) to the presence of distracted pedestrians. At a January 2013 symposium on the Penn campus, Camillo J. Taylor, a professor of computer and information science at the University, presented early research on ways to both detect pedestrians in intersections and warn them to pay attention. And John Landis, a professor of city and regional planning at Penn Design, described experiments that measure behavioral change in drivers based on their awareness of traffic

congestion.

"These are questions that governments want to answer," says Lee, "and it's where the engineering side can be useful." Rina Cutler, a deputy mayor for transportation in Philadelphia, added at the January meeting that universities "try to solve problems that public entities aren't ready to tackle."

Need for Long-term Commitment

Curtis Martin, coordinator in northern Los Angeles County for the Department of Energy's Clean Cities program, points out that the federal government has been "subsidizing electric vehicles quite heavily," but that transitions to cleaner forms of transportation take time and need long-term support. Los Angeles County is one of 100 regional coalitions in the federal Clean Cities program, which also engages such businesses as AT&T, PepsiCo, UPS, FedEx, Frito-Lay, General Electric, Enterprise Holdings and others as corporate members.

Martin adds that, after rising fuel prices in 2008, the federal government began promoting alternative fuels, which includes transit buses running on natural gas, propane and even hydrogen. He also points to the cleaner skies over Los Angeles that are largely due to the tireless efforts of a single state agency, California's Air Resources Board, which uses a combination of tough regulations and lucrative financial incentives to make real gains in reducing air pollutants and greenhouse gases.

Penn's Vuchic notes that government funding for transforming gridlocked cities has to compete with the billions needed for basic and often overdue infrastructure maintenance (including deferred highway improvements). "We've made great improvements in transit, but it's not easy," he says. "We're still far behind other parts of the world."





Hybrids and Electric Cars: Tomorrow's Urban Transportation

The American Council for an Energy-Efficient Economy, describing itself as a “catalyst to advance energy efficiency,” recently noted the wide variety and growing number of hybrids, plug-ins, pure battery-electric vehicles and other environmentally friendly vehicles now coming to market. ACEEE lead vehicle analyst Shruti Vaidyanathan says, “There are more hybrid and electric options on the market this year than ever before.... Automakers have revamped their offerings to meet the growing demand for efficient vehicles and new fuel economy standards.”

Similarly, John Paul MacDuffie, Wharton management professor and co-director of the International Motor Vehicle Program (IMVP), calls electric vehicles (EVs) “part of our automotive future.” But such a development is well into the future. He sees a long period of competition ahead between gasoline alternatives, including hybrids, plug-in hybrids and clean diesels, with no clear winner.

Though some pundits have made confident predictions, it's a future that is affected by many wild cards, including the price of gas, legislation and subsidies, improvements and price reductions in battery technology, the availability of public charging stations, and consumer acceptance of a new type of car. That partially explains why electric cars have had a slow start in the marketplace and currently make up around 0.1% of new vehicle sales.

That's not to say that volumes aren't increasing, though not to the levels automakers had once predicted. Some 52,835 battery cars of all types were sold in the U.S. in 2012, though the electrified market jumps to 487,000 (and a 3.3% share) if hybrids and plug-in hybrids are included.

In New York City, Mayor Michael Bloomberg has been a major supporter of hybrid taxis and ordered a fleet of 50 Chevrolet Volts in 2011, putting some of them into service as police cars. In 2010, when Bloomberg opened the first Coulomb EV charging station in a Manhattan parking lot, the city already had 346 electric vehicles in the fleet (including golf carts and other local-use transportation). A city spokesman, Jason Post, said then that 10% of New York's fleet of 6,000 vehicles used some form of alternative fuels. By 2013, the city had 458 plug-in electrics, including 102 Chevrolet Volts, and was planning to add another 50 before the end of the year.

Like Mayor Bloomberg, Enterprise Holdings Chairman and CEO Andrew C. Taylor is gradually incorporating alternative-fueled vehicles into his company's fleet, the largest privately owned fleet in the world.

Taylor has said that Enterprise's rollout of electric and hybrid vehicles needs to be governed by pragmatic and market-driven solutions. “This transition is — and should remain — an evolutionary process,” he said. In 2012, he reaffirmed the company's commitment to test a variety of alternative power options. At the Corporate Eco Forum annual meeting, Taylor said in his keynote address: “There is no single solution, no silver bullet and no individual provider that meets all the mobility challenges facing our world today. It will take time, patience and a lot of trial and error.”

Enterprise offers hybrids and EVs through its rental business, as well as its Enterprise CarShare program — with hybrids gaining more traction in the fleet than battery electrics overall. Ultimately, consumers and the marketplace will have veto power over new technology. An Enterprise effort to

introduce flex-fuel vehicles capable of running on E85 ethanol ultimately failed because of customer apathy, with a shortage of filling stations being one main reason for their lack of interest. Enterprise's experience reinforces the current challenges facing public acceptance of electric vehicles, as well as the need to ensure that the charging infrastructure meets consumers' transportation needs.

Charging Ahead

EVs are closely aligned with an urban mobility strategy because they emit zero emissions and have a relatively short range that is in line with city stop-and-go driving patterns. For example, BMW's i3 electric, due in late 2013, is explicitly marketed as a "megacity" car.

Arthur Wheaton, an auto industry expert and professor at the Cornell University ILR School, says that cities ultimately offer the best opportunity for electric vehicles. "Long-distance suburban commutes are difficult for electric cars," he notes. "They work better for fleets, car-sharing programs, taxis and delivery services. For those uses, I think we'll be seeing a lot more electric drivers."

Meanwhile, with Level III fast-chargers installed at rest stops in Milford, Conn., and Wilmington, Del., in late 2012, Tesla Motors made it possible for the owner of one of its Model S battery cars (with up to 265 miles of range) to drive from Boston to Washington. The East Coast charging corridor, eventually to be solar-powered, complements an existing one between California cities.

Level III charging, operating at 480 volts, can add 150 miles of range in 30 minutes; that's approximately the time it takes to get a bite to eat or take a break at a rest area. Fast charging has the possibility of greatly extending the utility of electric cars, but it also has many implications for urban driving. In an ideal situation, a city commuter would have charging options at both ends of his or her trip. But failing that, 480-volt public chargers could serve as a quick stopover on the way to or from work, providing useful range with just a 10-minute charge.

Fast charging is not yet common, but the Society of Environmental Engineers (SAE) has completed work on a new U.S. standard that combines 240- and 480-volt connections in a single plug. That should speed adoption.

There is growing proof that electric cars can work seamlessly with urban planning efforts to offer a

new era of energy-efficient living in the cities of tomorrow. Panasonic's Eco Ideas House in Tokyo, for example, generates as much electricity as it uses, incorporating solar panels, a fuel cell, a battery for energy storage, a smart control system that uses sensors to track occupants (turning lights on and off accordingly), and an electric car that can both charge from the house and return power to it during blackouts or high-demand periods.

Toyota operates a similar eco-house in Toyota City, Japan that also relies on two-way delivery between an electric car and the utility company. The company says that its Verification Project, running to 2014, "will use IT and ITS technologies to efficiently integrate motor vehicles and public transportation for commuting and other travel with the aim of reducing carbon dioxide emissions in the transport sector by 40%."

Car-rental and Car-sharing Challenges

While the urban mobility environment holds the most promise for EV adoption, that same environment also poses challenges, mostly related to charging. The garage-based charger is the norm mostly in the suburbs, while city parking garages haven't yet evolved as a widely available substitute.

Furthermore, the charging infrastructure is growing more slowly than the number of EVs on the road, according to MacDuffie. "To a certain degree, the whole system needs to advance at the same time for there to be more diffusion. Meanwhile, automakers are managing a portfolio of options, and those other technologies will remain in play. But carmakers are showing no sign of backing away from producing electric vehicles."

For instance, a unique twist in the EV evolution involves car sharing. In Mountain View, Calif., Google operates GFleet, which uses car-sharing technology managed through Enterprise CarShare. The corporate electric car-sharing program is the largest in the U.S., with approximately 50 electric cars (including Nissan Leafs and Chevrolet Volts) available to staff. The vehicles have covered more than 220,000 miles. Google supports the program with some 400 EV chargers at its headquarters.

In San Diego, car2go, operated by Daimler North America, put 200 Smart Fortwo Electric Drive vehicles on the road in November 2011. In its first year, the program added 12,500 members who used the vehicles for 200,000 trips. The average car2go trip lasts less than 30 minutes.

According to Ben Holland — manager of the Rocky Mountain Institute’s Project Get Ready (which works with 30 cities on electric car strategies) — the EV sharing program has strengthened public transit in San Diego. Up to 54% of participants reported that they use public transportation more than they did before joining a car-sharing program and 67% have a transit pass. For 35% of members, trips are intermodal—involving both a car2go vehicle and public transit.

In Paris, the municipally owned Autolib’, launched in 2011, has fielded 2,000 battery-powered Bluecars (a joint project of designer Pininfarina and French conglomerate GroupeBolloré.) The program had delivered 100,000 urban rides by the spring of 2012 and has approximately 700 parking spaces strategically located around Paris (which will eventually expand to a total of 1,200), all equipped with charging stations. “The stations are right where the parking meters would be,” says Holland, describing the project as “wildly successful.” Autolib’ has one of the larger urban infrastructure rollouts and the charging density is likely to end range anxiety in France’s capital.

Richard Jones, deputy executive director of the International Energy Agency, says that the service has “transformed Paris into the world’s biggest experiment for vehicle electrification. It shows other cities how easily electric vehicles can avoid both local pollution and the hassle of parking in a densely populated city.”

Still, Lee Broughton, Enterprise Holdings’ head of corporate sustainability, notes that EVs can present some hurdles for both traditional car rental and car sharing. “There is an initial higher purchase price and the resale market has yet to be fully determined,” he says. “Also, people who’ve never driven an EV before typically need some training, and may experience range anxiety about getting to their destination. And customers have to return the vehicle to a space with an electric-car charger.” Enterprise recently launched the Driving Futures Network, with charging stations at certain locations, as well as an expanded electric and hybrid fleet.

Autonomous Cars

Tomorrow’s mobility marketplace could be both electric and autonomous.

In 2007, the University of Pennsylvania, Lehigh University and Lockheed Martin joined forces to create the Ben Franklin Racing Team and entered

the DARPA Urban Challenge. In this program, unmanned vehicles competed in a simulated city to complete a fictitious military supply mission. The team fielded “Little Ben,” a 2006 Toyota Prius hybrid modified for drive-by-wire operation with onboard sensors, laser scanners, computers and other equipment. On the 57-mile course, the autonomous Prius acquitted itself well, finishing in the top six of 100 vehicles entered. It encountered and avoided obstacles and performed in many ways as a human operator would have.

“Autonomous cars are good for urban situations,” notes Daniel D. Lee, a robotics expert in the department of electrical and systems engineering at the University of Pennsylvania and a member of the Ben Franklin team. “But we still don’t have the technology to really understand driver or pedestrian intent. As human drivers, we react differently if we see a grandmother in the street compared to [seeing] someone on a motorcycle. For machines to do that, they have to be taught what an older person is likely to do, and what that motorcycle rider is likely to do.”

Lee adds that the primary issues holding autonomous cars in neutral are not so much technical as legal. If malfunctioning software leads to a catastrophic accident, he notes, liability costs could be enormous and responsibility difficult to assign.

However, a range of developments point to a driver-free future. According to technology trade group IEEE, self-driving cars could be 75% of the traffic stream by 2040. ABI Research predicts that the \$10 billion that automakers spent on “advanced driver assistance systems” could jump to \$130 billion by 2016. And one in five drivers said they want an autonomous car, according to a J.D. Power survey.

General Motors officials say it might have fully autonomous cars on the road by 2020. But the auto maker’s Cadillac division says that a semi-autonomous technology it calls “Super Cruise” could be on the market as early as 2015, offering such features as automated steering, braking and lane centering under certain highway conditions. Many of the technologies that make up Cadillac’s system are already in use on production cars, including adaptive cruise control, brake assist, forward collision alert and pre-crash preparation, lane departure warning and blind spot alerts.

At Volvo, experts estimate that 20% energy savings can be achieved by “platooning” self-driven cars in tight formations impossible for human

operators. Other automakers that are spearheading autonomous research include BMW and Audi, which sent a modified and driver-free TTS Audi model up Pikes Peak.

And Google's fleet of self-driving Toyota Priuses has logged more than one million miles without serious mishap. Three states — Nevada, California and Florida — have legalized autonomous vehicles on public roads. Chris Urmson, director of Google's self-driving car project, says its cars can read red lights, stop for pedestrians and traverse mountain roads. "We're trying to make the car run like a computer and get the benefits from that," he notes. "We think this will happen. When we put people in our self-driving cars, it's amazing how quickly they get it."

Of course, driverless cars don't have to be electric, but there is a lot of synergy with a plug-in infrastructure. For instance, autonomous cars could easily plug themselves in for recharging. Electric cars already use apps to locate available charging stations, and the driver-free version could also make

its own way to that spot and connect to power. Autonomous systems are also likely to reduce "range anxiety" by optimizing driving performance to save on battery power. And they could make decisions to turn off or reduce power to such energy-sapping features as the heater when they're not needed.

Will tomorrow's auto fleet be electric? It's no sure thing. Wharton's MacDuffie thinks a show-stopper could be the inherent limitations of battery chemistry to deliver the power storage necessary for long-range zero-emission travel. "What we really need is a radical breakthrough in cost, performance and weight in batteries, and some observers don't necessarily see that happening," he says.

Indeed, any prediction of an all-electric future should come with caveats and asterisks. But only cars with batteries and hydrogen fuel cells offer zero tailpipe emissions — the Holy Grail pursued by beleaguered cities facing the twin threats of air pollution and climate change.



APPENDIX:

Useful Links:

TRANSPORTATION ALTERNATIVES AND EVOLVING INFRASTRUCTURE

<http://www.portlandoregon.gov/transportation/45195?a=370287>

http://onlinepubs.trb.org/onlinepubs/tcrp/tcrp_rpt_108.pdf

<http://www.smartplanet.com/blog/smart-takes/enterprise-acquires-phillycarshare/18233>

<http://www.nctr.usf.edu/jpt/pdf/JPT12-4DeMaio.pdf>

<http://www.bikesbelong.org/resources/stats-and-research/research/bike-sharing-in-the-united-states/>

http://www.uctc.net/access/39/access39_bikesharing.pdf

http://transportation.stanford.edu/alt_transportation/Vanpool.shtml

<http://ridesharechoices.scripts.mit.edu/home/histstats/>

http://www.apta.com/resources/statistics/Documents/FactBook/APTA_2012_Fact%20Book.pdf

http://siteresources.worldbank.org/INTURBANTRANSPORT/Resources/Thompson-PT-history-USA_08.pdf

<http://www.transitmuseumeducation.org/trc/background>

<http://www.forbes.com/sites/ashleaebeling/2013/01/02/fiscal-cliff-deal-restores-commuter-tax-break-for-2012-and-2013/>

<http://www.carsharing.net/library/UCD-ITS-RR-06-22.pdf>

<http://efficientgov.com/300k-in-fleet-savings-with-car-sharing/>

<http://www.enterprise-carshare.com/about/case-studies/>

<https://mgmt.wharton.upenn.edu/profile/1337/>

<http://www.worldwatch.org/system/files/GlobalCompetitiveness-Rail.pdf>

<http://www.amtrak.com/ccurl/636/294/Amtrak-Sets-New-Ridership-Record-FY2012-ATK-12-092.pdf>

<http://www.bikesbelong.org/resources/stats-and-research/research/bike-sharing-in-the-united-states/>

http://www.carnegieendowment.org/experts/?fa=expert_view&expert_id=558

<http://www.nytimes.com/2012/11/15/nyregion/bike-share-equipment-apparently-damaged-by-flooding.html>

<http://www.detroitnews.com/article/20130117/AUTO04/301170346/1121/AUTO/-Electric-car-not-dead-GM-says>

<http://www.bicycling.com/news/featured-stories/americas-bike-share-programs>

<http://ntl.bts.gov/DOCS/telecommute.html>

<http://reason.org/files/853263d6e320c39bfcdd642d1e16fe.pdf>

<http://www.washingtonpost.com/wp-dyn/content/article/2007/03/22/AR2007032200033.html>

http://www.nytimes.com/2013/01/26/business/car-sharing-services-grow-and-expand-options.html?_r=0

<http://www.drivingfutures.com/legacy/#neighborhood-network>

<https://www.vpsiinc.com/home/submenu.asp?MMID=1&SMID=10&OID=261>

http://www.nj.com/hudson/index.ssf/2013/01/state_legislation_aims_to_prom.html
http://aboutus.enterprise.com/neighborhood_network.html
<http://www.edmunds.com/fuel-economy/car-sharing-part-time-ownership-full-time-savings.html>
http://www.huffingtonpost.com/2013/02/23/yahoo-working-remote_n_2750698.html

FUNDING INNOVATION FOR CLEANER CITIES

<http://wheels.blogs.nytimes.com/2011/07/29/automakers-react-to-54-5-m-p-g/>
<http://dc.streetsblog.org/2012/09/21/reminder-amtrak-subsidies-pale-in-comparison-to-highway-subsidies/>
<http://www.amtrak.com/ccurl/873/667/Amtrak-Covers-85-percent-of-Operating-Costs-ATK-12-081%20.pdf>
<http://www.economist.com/blogs/gulliver/2011/11/road-v-rail>
<http://hartdocs.honolulu.gov/docushare/dsweb/Get/Rendition-93/AR00029779.pdf>
<http://greenvalueblog.wordpress.com/2013/01/21/why-italy-is-the-right-country-for-car-sharing/>
<http://www.portlandoregon.gov/transportation/article/58383>
http://www.ap.buffalo.edu/pdfs/planning/hess/Governmental_Subsidies.pdf
http://www.wmata.com/about_metro/docs/history.pdf
<http://www.fhwa.dot.gov/tea21/factsheets/b-ped.htm>
<http://www.upenn.edu/pennnews/current/2013-01-17/latest-news/penn-drives-transportation-research-forward>
<http://www.cis.upenn.edu/~cjtaylor/>
<http://www.governing.com/topics/transportation-infrastructure/gov-portland-oregon-struggles-to-remain-leader-in-public-transit.html#>

HYBRIDS AND ELECTRIC CARS: TOMORROW'S URBAN TRANSPORTATION

<http://www.nbcnews.com/business/prius-named-greenest-car-ford-f-350-meanest-1B7989955>
<http://www.electricdrive.org/index.php?ht=d/sp/i/20952/pid/20952>
<http://www.pluginCars.com/self-driving-cars-five-reasons-it-works-electrics-125024.html>
http://www.nytimes.com/2013/01/30/business/global/french-automakers-biggest-problem-french-consumers.html?_r=0
<http://www.forbes.com/sites/eco-nomics/2012/09/25/self-driving-cars-will-take-over-by-2040/>
<http://en.akhbarnews.com/100758/environment/toyota-housing-bring-ev%E2%80%99s-power-to-home>
http://blog.rmi.org/blog_2013_01_25_Driving_Miss_Hazy_Driverless_Cars
<http://www.iea.org/newsroomandevents/news/2012/november/name,33604,en.html>
<http://www.reuters.com/article/2012/11/29/idUS187872+29-Nov-2012+PRN20121129>
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