Transport in the Digital Age

An Industry View Michael L. Sena August 2015

Why am I here

Thank you for inviting me here to share my knowledge of the digital age of transport with you.

I went to Princeton University to study architecture, and I stayed there for seven years doing just that. After a year at the Greater London Council, I continued my work life as an architect and urban planner in Boston. I even passed the professional architecture license examination and practiced for five years. Then, I decided to take an offer from a Swedish company to do something completely different. That decision in 1977 changed the course of my personal and professional life. It led me here to you today.

I have been asked to speak here because before the start of the <u>digital age</u> of transport in 1995 I spent the previous twenty years learning how to build and use the tools that would make that digital age possible. I have spent the twenty years since the arrival of the digital age of transport helping the transport sector to cope with its effects while continuing to learn about new technologies and business processes.



Amazon did not cause the problem; it exploited it.

Why should you be listening to this talk

- I believe you are here because your organizations sent you here to return with good ideas about how to improve your effectiveness, profitability, sustainability—to make sure your organization survives. Not all of them will survive the changes that are occurring. The example of Borders Book Store is a case in point. It owed its existence to changes in transport, and its demise was caused by the arrival of the Digital Age of transport.
- Borders did not cause the demise of local book stores. People moving to the suburbs away
 from cities, and the rise of the shopping mall, provided the opportunity for the super bookstore
 to come into existence in 1971. The same is true for food stores, clothing stores and most of
 the businesses that had once thrived in the centers of cities. Bigger stores server a larger
 number of people, but at the cost of greater distance from where people are to where they
 have to go. Buenos Aires has about a third of the number of inhabitants as London, but it has
 a density that is almost three times higher. London has sprawled; Buenos Aires has not.
- Amazon did not cause the problem of people and books being too far apart from one another, but they capitalized on it and brought them closer together starting in 1995.
- Once Amazon and its the on-line bookstore brought book shoppers closer to what they wanted to buy, and DHL and FedEx united the books with their purchasers as quickly as the next day, the demise of the shopping mall bookstore was inevitable. Borders closed in 2011.



Why you should be listening to this talk

- The Digital Age of Transport arrived in 1995, and it is finally having profound impacts on both why and how people and goods move from one place to another.
- I will explain these impacts from the industry perspective, from the viewpoint of companies developing and delivering the products and services that transport the people and the goods. I will offer suggestions on what you need to do to prepare for a very different transport future than the one we are living with today.
- I promise you will leave this talk today with at least one good, new idea that you will be able to include in your report back to your organization.

The (green) elephant in the room

The Environment

- The environment is the elephant in the room whenever the topic of transport is raised, especially road transport. Anything we do should first and foremost consider the short-, medium- and long-term environmental effects. The green elephant wants us to walk, like she does, everywhere we go. She grudgingly accepts bicycles and trains, but not cars or trucks.
- I believe that industrialization has made a mess of our planet, and continues to do so today. But I also believe that humankind has evolved from being unaware of its responsibilities to being conscious of the damage we have done, and are ready to do something about it. I grew up within a hundred meters of a river that was completely polluted by coal mine waste, raw sewage, industrial waste and the blood and carcasses of hundreds of butchers lining its banks. Nothing lived in that river, and if anyone was unlucky enough to fall in and survived, they were taken to the hospital for a full battery of shots for all manner of diseases. In 1970, the wife of the former governor of the state, whose family founded the city and gave it its name, decided it was time to do something about the river. Today, children swim in its waters and trout of prodigious sizes are caught in the middle of the city.
- I do not believe we are going to walk or cycle to everywhere we will have to go in the future. Not
 everyone has healthy legs or is blessed with endless time like the green elephant. I do not believe that
 private mobility is evil. Less is not more when it comes to how we need to move ourselves and the things
 we need to live. I also believe that whatever we do, we must minimize transport's negative effects on the
 environment, but we must also consider the effects on our ourselves and our society. So I acknowledge
 that the green elephant is in the room and am prepared to take questions from her at any time.

Transport milestones
We built roads
We built vehicles
We built containers
We continue to dream

Transport Milestones

- In 1984, my Swedish wife and I built a Swedish-manufactured house in the US, in the outskirts of Boston. All of the interior furnishings, from floors to cupboards to counters to sofas, were bought from IKEA in Sweden. There were no IKEA stores in the US back then. The house and the furnishings arrived from Sweden in three containers. I had never given shipping containers a thought before that.
- The shipping container was invented and patented in 1956 by a man named Malcolm McLean. McLean was a trucker who wanted to find a better and faster way of loading cargo from trucks to ships to warehouses. He bought a tanker company which he renamed Sea-Land Shipping. With containers, the cost of loading freight was reduced by more than 90%. The cost of loose cargo was reduced from \$5.86 per ton to \$0.16. Japan, Korea and China owe their economic existence to this invention.
- This probably had as large an effect on transport as the invention of the motorized vehicle did at the end of the 19th century. Without needing to be repacked, goods could be transported across seas and continents and moved from ship to rail to truck and delivered to distribution points or to the eventual buyer of the goods. It changed everything. In 2000, McLean was awarded "Man of the Century" by the International Maritime Hall of Fame. Fifteen years later, the era of the shipping container is nearing its end, as we shall see.

SOCIAL TRANSPORT

After telecommuting from home in the morning, you need to get across town for an afternoon meeting with a dient.

3 It's raining when your meeting wraps up, so you opt to share a ride to the gym after work.

You pull up your real-time rideshare app and see that a driver headed in the same direction is just a few blocks away.

> When you get out of the locker room you ha an alert from your personal travel assistant th indicates there's been an accident a half mile from your apartment and traffic's at a stand still. You opt to burn off some additional calories and walk home rather than wait for traffic to dear.

COMMUTE PLANNER

2 A quick comparison of the time cost carbon footprint, health-benefit analysis a good and the travel ons, you see that there are shower are chnology changed ht's office and opt everything irab a bikeshare iss town. Transport is a means, not an end When you get home, This is only the you log the day's trips and see that ^{2,750} beginning you are close to the top of the employee trip reduction IINTS NEEDED FOR leaderboard at ext avard 2010 work—lust 300 points away from that mountain bike you've had. vour eve on.

Illustration from Digital-Age Transportation: The Future of Urban Mobility; Delloitte University Press (2012)

Transport in the Digital Age

 Humans walked or ran, then we rode other animals to get where we needed to go. But it was the wheel, a new technology invented around 5000 years ago, that began to make the difference. We have been building on that invention ever since.



Today, with a small device in our hands, a smartphone, we can move effortlessly around the world on land, sea and air, pay for all our needs, seeing where we are the whole time and measuring our every step, including how much additional pressure we are putting on Mother Earth.

But most of our movement is with purpose. Transport is a means, not an end. The definition of 'Transport' is to carry ourselves or goods from one place to another. Transport connects As to Bs and Cs. Unless you are out for a Sunday drive going nowhere in particular, it is the As, Bs and Cs that are the reasons for moving. The main reason for transport problems is that the As, Bs and Cs are in the wrong places at the wrong times.

• This is only the beginning. The car, truck, bus paradigms are a bit more than one hundred years old. The train is slightly older; airplanes are a couple of decades younger than cars, and containers have been with us for five centuries. All are in for a change. <u>Social transport is multi-modal</u>, using whatever means are available from whomever is within listening range of our <u>digital tomtom drums</u>.



- Technological Big Bang in 1995
- Bits replaced atoms
- Computers reached the vehicle
- The smart phone era began

Technology Changed Everything

- There are years we remember. Some of them are personal, like the year we were born, while others are part of the collective memory of a nation, like 1776 for the United States or 1861 for Italy. Others are global, like the stock market crash in 1929.
- Most people don't think of a date when they think of all the technology we have in and around transport in general and vehicles in particular. It's here now; who cares when it arrived? It matters if you believe that everything will always be the way things are today, especially if you have never experienced life before everything changed, if you were born, say, in 1990 or later.
- There is a memorable date for transport, and it is 1995. That is when all the forces aligned to cause a Technological Big Bang, an explosion with enormous impact.
- Events were set in motion that continue.
- We began to move data rather than paper to convey information.
- Digital processes began to replace physical ones, including in our motorized vehicles.
- Smart Phone era began

Microcomputing,

Wireless Technologies

Internet



GNSS

Technological Big Bang in 1995 **GPS** set free **Internet** opened Roads made digital Phones made wireless Computers miniaturized

Technological Big Bang: Why 1995?

- GPS was made public Full Operational Capacity (FOC) of the Global Positioning System was achieved in July of 1995 with the placement and activation of the last of the 24 satellites. First public use was in 1983, but not until '95 was it truly usable for positioning.
- Internet was opened to public The final restrictions on carrying commercial traffic ended on April 30, 1995 when the National Science Foundation ended its sponsorship of the NSFNET (National Science Foundation Network) Backbone Service and the service ended
- BMW had the first navigation system in 1994, but the first digital navigable maps were not available in 1995
- First GSM phone Nokia 1011 was the first mass-produced GSM phone.
- Last but not least, the DVD-ROM was commercialized in 1995, allowing the on-board storage of large amounts of map data for the navigation systems.



Bits replaced atoms: the Negroponte Switch Wired and wireless must trade places Cheaper to ship bits than atoms More dependable to drive by wire than with mechanical linkages

Negroponte Switch

- Nicholas Negroponte was head of the MIT Media Lab from its founding in 1985 until 2006, simultaneously influencing and then working with the changes that the personalization of computers was bringing about.
- He captured the essence of these changes in his 1995 book, *Being Digital*
- His book discusses similarities and differences between products made of atoms and products made of bits.
- Why are telephones connected by wires and TVs by air waves, he asked. Telephones need to be mobile and TVs are stationary—at least they were back then. He suggested that a switch was in order, and wireless phones and cable TV were the result.
- In essence, one can very cheaply and quickly make a copy of a product made of bits, and ship it across the country or around the world both quickly and at very low cost.
- Driving by wire is more dependable than driving with mechanical linkages.
- Industries changed; products evaporated: encyclopediae, dictionaries, product manuals, records and CDs, paper maps, travel agencies disappeared or changed completely.
- It was only the beginning of the beginning.



Computers reach the vehicle

- Broadcast traffic
 - Telematics
- Connected Driving

Automatic emergency cal





Computers Reach the Vehicle

- RDS/TMC (Traffic Message Channel) was the first solution to broadcasting traffic information that could be connected to a physical location on a map, and that map could be a digital one on a screen in a vehicle. Volvo was first to show TMC traffic messages on a navigation screen, and that was in 1995.
- OnStar telematics was announced by General Motors in 1995 and introduced in the United States the following year. It arrived in Germany two years later.
- The term telematics was originally said to be a combination of telecommunications and informatics, the latter word referring to "the making of information". Literally, telematics as derived from the Greek root tele, meaning "far off" or "distant", and the Latin root matic, meaning "to make happen", means "to make something happen at a distance".
- The car could call for help even if the driver couldn't. GSM/SMS (Short Message Service) allowed messages to be sent from the vehicle and received by servers that could pinpoint the position of a vehicle.
- Connected Car era began.



Connected Driving

- In twenty short years, simple mechanical devices, like my 1994 Volvo 945, which substituted horsepower for horses, have been transformed into powerful information processing devices capable of much more than simple transport.
- Car manufacturers began equipping their vehicles with embedded SIM-cards, while others used the customer's phone to connect to services.
- But many other things have changed that affect why we move ourselves and our goods, which in turn have affected how we move them. One of these changes is the smart phone.



iPad Presented in April 2010



First iPod sold November 2001



The smart phone era began
Apple rises like a Phoenix
iOS and Android crush competition

First iPhone sold June 29, 2007

Smart phone era began

- Ten years after the start of the Digital Age of Transport, the Smart Phone era was about to begin. Before the smartphone, there was strong consensus in the transport industry in favour of embedding telematics control units with built-in SIM-cards. After smartphones showed what could be done with a powerful hand-held computer, opinions split, and remain so.
- It now seems that we have unlimited possibilities for communicating to and from vehicles. An example of just how quickly things can change is the impact that the iPhone has had.
- Steve Jobs introduced the iPhone, in his own words, "...<u>as a wide-screen iPod with touch screen controls and a full-function smart phone with Internet connectivity</u>." The first iPhones were delivered to consumers in June 2007. In eight years, this invention changed almost everything in society, including transport. The iPad followed. Jobs presented it in January 2010. Whatever hadn't changed by then changed afterwards.
- Mobile apps for Google Android and iPhones help us do things we never thought would be
 possible for normal <u>people—meaning not super wealthy—like</u> having people pick up and drop
 off our laundry, walk our pets, pick us up and drop us off at our door.
- But it is still the same As and Bs and Cs we are moving between, and this is where the biggest changes will be coming. The reasons why we transport ourselves and our goods have not changed, but where those As, Bs and Cs are, and what is happening at those places, is changing dramatically.



Transport is a means not an end

- We move because we must
 - Live, work, shop
- Congestion is a symptom, not the sickness

Sunday Drive

Transport is a means not an end

- This workshop is about transport in the digital age from an industry perspective. I have said that technology changed everything. Now what?
- Will companies engaged in the transport industry have to do things differently in the future, or will they simply carry on as they have in the past? What should national and local governments do to improve mobility? Should they just keep promoting buses and trams and trains and keep on with their campaigns against driving private cars and moving goods with trucks?
- I believe we need to think more about <u>the 'Why?'</u> of transport rather than <u>the 'What?'.</u> I believe we have focused too much on the design of cars and their features, rather than on why people use them. We have focused too much on trying to get people to take buses and trains rather than understanding why they prefer—and will continue to do so—private mobility.
- I do not say cars. <u>I say private mobility</u>. Cars happen to be the best option on the market today, but they may not be the best alternative in the future.
- As Uber has shown, people are prepared to pay someone for a ride, not because the car is operated by an authorized taxi business and has a government-issued hackney medallion. They pay because it solves a particular set of problems they have with driving their own car, taking an authorized taxi or taking public transport. They see it as <u>more convenient, more</u> <u>dependable</u>, less troublesome, less costly, more secure.

Transport is a means not an end

- <u>My goal is not to own a car</u>. I just want to be able to go wherever and whenever I want in the privacy of my own space without having to ask anyone else for permission to do so. The fact that I choose to buy a BMW or Audi—or in my case, a Toyota—rather than a Fiat or an Opel is what the car business is all about, but it is not the fundamental reason for preferring to drive a car rather than ride a bus. The problem is that my goal of riding when and how I want is in direct conflict with other people's goals and with societal goals.
- <u>It is my thesis that the divergent goals are converging</u>. Call it a realignment of the stars that for a period of a hundred years were not in synch. We have reached the limit of sprawl. The universe may continue to expand forever, but we cannot do the same on earth. The <u>opposite of the cosmological Big Bang is the Big Crunch</u>, and that is what is happening on earth. People and jobs are moving back to our cities from being out in the exurbs and, most of all, out of our countries.
- As a result, the car in its present form has had its day because it is not designed for personal urban transport. It takes too much care and feeding. More importantly, it is not designed for boys and girls who grew up being chauffeured and who are <u>not</u> going to take their drivers' licenses. They are not going to own cars; they are not going to share cars. They are going to be driven in cars, just like they have always been.

Transport is a means not an end

- We move because we must--the days of the Saturday evening cruises and Sunday afternoon drives are merely a fond memory for those of us lucky enough to have experienced them.
- How we move is dependent on where we live, work and shop, the three fundamental basics of life.
- The main problem with movement, congestion, is the result of these places being in the wrong location, and it is at its worst in those places where a large number of people want to live, work and shop, places like London and Tokyo and San Francisco. As anyone who has been to downtown Detroit knows, congestion is not its biggest problem. Businesses do not exist in a vacuum. The transport industry is no exception. The more vehicles that are sold, the greater are the chances that the transport pie will grow. The opposite is also true. Vehicle sales are the result of how well or how poorly societies are functioning. Vehicle sales in the US and Europe collapsed in 2009 and China sailed by both regions.
- In one way or another, all businesses, including and especially transport, are completely reliant on four macro factors:
 - 1. Where and how we live?
 - 2. What **work** we do and where will we do it?
 - 3. How and where will we **purchase** our physical goods?
 - 4. How will **we** and our goods get from where we are to where we want to be?
- Answers to these questions will help us to improve our short- and long-term profitability or the very existence of our businesses.



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Where we are
Sprawl
Global production
Shopping malls
Independent mobility

Where we are

- So where are we? I believe we are familiar with the progression of events that has led our societies to where we are today, to sprawl, global production, big box stores in the suburbs and exurbs and independent mobility
- In 1790, there were approximately 4 million people living in the United States, and farmers comprised 90% of the labour force. In North America and Western Europe, industrialization created a mass movement from the rural countryside to the cities in the 18th and 19th centuries. By 1990, there were 261 million people in the US and farmers were 2.6% of the labor force. Today there are 320 million people in the US and less than 1% are farmers.
- In the second half of the 20th century, wars, crime, cars, new ways of communicating and many other factors combined to move people from cities to suburbs. A suburb, for statistical purposes, is any place in a metropolitan area outside the central city. By 1951, more people in the United States lived in suburbs rather than in central cities or rural areas.
- Let's look at where people are living today and where it is most probable they will be living in the coming decades.

1950 2013 2050 forecast 2.5 7.2 Total World Population 9.6 The ten most populous countries, billions of people 3 3 3 Ω 1 China China India 1 2 India India China 3 **United States United States** Nigeria Russia* **United States** Indonesia 4 Indonesia 5 Brazil Japan Pakistan 6 Indonesia Pakistan Nigeria 7 Germany Brazil Bangladesh 8 Brazil Bangladesh Britain Russia Ethiopia 9 10 Italy Japan Philippines Source: United Nations *Then part of the Soviet Union USSR Population 1991: 283 million Asia North America Europe Latin America Africa US Population 1991: 253 million

World Population Growth: The Ten Most Populous Countries



Mega Cities are growing in both numbers and size



Things are changing

- In the 2nd century A.D. the population of London was 60,000. When the Western Roman Empire fell in the beginning of the 5th century, the Romans began to leave Britania and the Angles and Saxons arrived. By the end of the 5th century, London was practically abandoned. It turned out that the Germans didn't like to live in cities, and had none in the vast areas that had not been conquered by the Romans.
- The city of Rome had 1 million residents in 100 A.D. By 500 A.D. it had 1/10th that number
- In 1970, there were two mega cities, Tokyo and the conurbation around New York City. By 1990 there were 10, and by 2011, 23. By 2025, it is predicted that there will be 37 mega cities housing 8% of the world's population.
- More and more people in what we have called the *emerging markets* are moving from the countryside to the city. Baby boomers in what we have called the *developed countries* are giving up their suburban estates and Weber grills for urban condos and dinners delivered to the door.
- Today, more than half the world's population lives in urban areas, and by 2050 the UN estimates that will be more like 67 percent. In developed countries, that percentage will be higher.





Where we will live Ever-larger cities Smaller and worn out cities will become smaller We will live closer to our work We will be chauffered wherever we want to go

Where we will live in the digital age of transport

- All signs point to knowledge workers working closer to where they live, but <u>do not</u> <u>believe those who say that everyone will live in city centers.</u> Living in the mega city of Shanghai can mean having a few hours' drive to the Bund.
- Groupware, virtual private networks, conference calling, videoconferencing, and Voice over IP (VOIP) are making it possible for people to stay where they are and still communicate with co-workers. It can be efficient and useful for companies since it allows workers to communicate over long distances, saving significant amounts of travel time and cost.
- As broadband Internet connections become more commonplace, more and more workers have adequate bandwidth at home to use these tools to link their home to their corporate intranet and internal phone networks.
- All signs point to knowledge workers working closer to where they live. All signs point to where they live will be in a condo somewhere in the twenty-five super cities with more than 10 million residents rather than in an isolated hilltop cabin in the Apennines.


Where and how we will work

- Manufacturing is characterized by tangible output, outputs that a customer consumes over time, like a vacuum cleaner. Service is characterized by intangible outputs, outputs that customers consume immediately, like a hamburger.
- Fifty years ago, twelve of the fifteen largest US companies were involved in the production of tangible output. Four of them were in the transport business. Today only three of the top fifteen US companies are goods producers, and only one of them from 1960 is among the top 15. There is one transport-related company and that is UPS.
- In the past fifty years, the industrialized West has lost its manufacturing base, mostly to Asia. Manufacturing in these regions has been replaced by a combination of services and higher unemployment. Service operations are different from manufacturing operations in terms of tangible versus intangible output, customer consumption, use of labour and equipment, customer contact, customer participation in conversion processes.
- In services, the most expensive resource is people, while in manufacturing the most expensive resource is machinery and the facilities to house the machinery. Services are off-shored in order to reduce the hourly costs of labour. Manufacturing is off-shored in order to substitute inexpensive manual labour for expensive manual labour and expensive automation. Keep in mind that automation is not principally for replacing expensive labour but to improve responsiveness to changing conditions and demands, of which labour availability and costs are two.
 - As off-shore costs for manual labour rise, as has been the case, the advantages of off-shoring both services and manufacturing disappear. The result is re-shoring, and that is what is happening. Services and manufacturing are returning to Europe and North America.



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Where we will work
Work at home or in local clusters
Virtual meetings
Local production

Where and how we will work in the digital age of transport

- Service work will increasingly be done from home by solo workers or by small teams in distributed work clusters. These work clusters will be located in cities close to public transportation and at park-and-ride facilities at the edges of cities to make them accessible to the greatest number of individuals.
- Manufacturing will be re-shored and be performed in micro factories which are highly automated and widely distributed so they are close to their destination markets—the cities, where most people will live.
- Increased development of personal manufacturing tools operated by 'makers' will intensify and reduce the distance between producers and consumers.
- Result:
 - The goods that people use in their work will be delivered to many smaller places in smaller quantities.
 - Instead of long commutes to office complexes in the exurbs, we will have short trips to meeting places or no trips at all.
 - If you think of the workplace also as a schoolplace, the same will be the case.
- These changes are not occurring because of laws or regulations, but because technology is allowing people to make different choices than those that were possible when sprawl occurred. One of those technologies is Cloud Computing.



Where we will shop From our phone Delivered to our home/apartment (or car or bicycle) Return of local shops—and urbanization of some big box stores

Where we will shop in the digital age of transport

- Some predict the demise of all forms of physical stores in favour of home delivery for all of our everyday needs, from latte for the coffee and the evening's dinner to clothes, shoes, medicines, the week's laundry and dry cleaning. <u>It is the out-or-town shopping centers</u> <u>that will disappear.</u>
- So, instead of trucks delivering to shopping centers and big box stores, they will deliver to distribution points and then from these points to our doors or to community drop points.
- We are going to shop closer to home and goods will once again be delivered to our door, just like they were before almost everyone had a car, or to our car. The bigger change will be how those products actually get to the door, and here's where technology comes into the picture again.
- <u>The local store is making a comeback</u>. The first 10 Walmart Express test stores opened last year, and more test stores will open later this year. One-tenth the size of the typical Walmart discount store, these Express stores are a combination of food, pharmacy, and convenience stores -- targeting customers more inclined to visit a smaller bargain store like Dollar General, Family Dollar, or Dollar Tree.
- I predict that IKEA will open small shops in cities and adapt their business model and tactics to the new realities: people no longer are willing to work for lower prices.



How the goods will get to the door.

 Across the United States, Amazon is erecting massive distribution centers in the nation's exurbs to shorten the distance between online shoppers and the goods they want. They are now committing to a program that will get those goods to consumers in hours rather than days.

"We're excited to share Prime Air — something the team has been working on in our next generation R&D lab. The goal of this new delivery system is to get packages into customers' hands in 30 minutes or less using unmanned aerial vehicles. Putting Prime Air into commercial use will take some number of years as we advance the technology and wait for the necessary FAA rules and regulations." Jeff Bezos, Amazon CEO

 While the legislative wheels move to allow Amazon's and other delivery firm's robotic aircraft to fly, Amazon is trying out an old retail trick with a new twist. Reminiscent of the ice cream truck and the itinerant peddler, Amazon's Treasure Truck began rolling through the streets of Seattle, the company's headquarters, on July 1st of this year.

Local Learning Centers (The Library)



Home Schooling

Distributed Offices and Manufacturing





Local Viewing/Pick-up and Return Centers

Personal Rapid Transit Where we are going
Concentration
Local production
Home delivery
Chauffered mobility

Where we are going

- From sprawl to concentration;
- From producing goods globally to sell locally, we will move to producing goods close to where we use them;
- We will eventually stop driving our cars and vans to shopping centers and loading them up for a week or a month because we will buy what we need and it will be delivered to our door where there will be special lock boxes and refrigerators, or we will have pickup points that will proliferate, or goods will be delivered to to our car;
- We will no longer have to drive ourselves when we can be driven like the rich and famous—and all the children born after 1980—we will be chauffeured, mostly by cars that drive themselves.
- All this will fundamentally change the transport industry, not just the car and truck business, but all forms of transport.
- Some day, perhaps, although not in the next six years, the entire concept of moving people and goods may well be quite different from today and we will wonder why we wasted so much time and so many resources getting ourselves and our things from one place to another. The reason we waste so much time today is congestion.



Congestion is a symptom It is not public transit or private car; it is both and. Metro Mobility is not a privilege, it's a necessity

Congestion is a sympton

- At the start of my talk I said that congestion is the result of having all the As, Bs and Cs in our journeys in the wrong places at the wrong times. That is a very different formulation from one that states congestion is the result of too many cars and people driving their cars when they should be walking, cycling or taking public transit. I have given several talks on this subject and have offered an alternative system of incentives instead of payments, which is what the signs refer to.
- People <u>choose personal mobility</u>, which includes private cars, taxis, limos, rental cars and shared cars, because, given all the alternatives, it is the best one for them at that particular place and time.
- There are plenty of roads. Even in Shanghai or Moscow or New York City or Los Angeles, which have very highly congested roads during most of the day, you can drive unhindered at certain times of the day or week. In Detroit, you can drive around in the center of the city at anytime without congestion. Why? Because fewer people want to be in Detroit, even though the third largest vehicle manufacturer, GM, has its headquarters there.
- Clearing 20% of the cars from the roads, which appears to be the result of setting up urban tolling, simply makes it easier for people with more money to use the roads, when people with less money are forced to take less convenient alternatives.



Congestion is a symptom It is not public transit or private car; it is both and. Metro Mobility is not a privilege, it's a necessity

Congestion is a sympton

- No city would have accepted congestion charging if it were not for digital techniques making it possible to collect the tolls automatically, without making the congestion worse. So we can say that these toll schemes are one consequence of transport in the digital age. And like the hundreds of toll gates surrounding London in the eighteenth century, I see the enormously expensive tolling stations disappearing from all the cities where they have been erected when we find the right way for paying for mobility.
- Roads in most countries have been paid for with fuel taxes. As fuel usage becomes less, and in some cases disappears, alternative methods to collect money, like tolls, have been necessary. If we could guarantee that we would arrive at a particular time to our destination, a car ride could be charged in the same way as a ride on a bus. If the principal means of personal mobility was chauffeured, a portion of every fare could be paid for the maintenance of the infrastructure.
- There are no limits to the possibilities, only to our imaginations. The existing transport industry is acting in typical fashion for legacy players who are on the verge of being disrupted by companies as diverse as Google, Uber, Virgin and Alibaba.
- Today, the only way to solve the congestion problem is with a recession. In the future, there will be an inverse relationship between congestion and prosperity.



This is only the beginning Mobility is being disrupted New business models are being developed Transport industry is at a crossroads

This is only the beginning

- It is twenty years since the start of the Digital Age of Transport. What we have seen since then is the stuff of science fiction, but in many ways we are still at the beginning of the revolution in transport.
- As I have said, these changes are being brought about by factors outside of the transport sector itself, including changes in lifestyles, working methods, sourcing of goods and methods of computing—not the least being cloud computing.
- Digital techniques, particularly smartphone mobile apps that solve every type of mobility problem from finding and paying for a parking space to ordering a chauffeured car to take you wherever you want to go, are beginning to have major effects on transport businesses, like traditional taxi and bus companies.
- These new businesses are not always playing by the same rules as the existing businesses, which have helped to form the existing laws or have had time to adapt to these laws.
- We are at a crossroads. There are strong forces that want to keep the existing order, while companies like Apple, Google, Amazon, Uber and many others want to do for transport what they did for many other industries that they have disrupted.



Mobility is being disrupted

Global taxi service

U

JBEF

- Ride sharing
- Car sharing
- Chauffeuring

Mobility is being disrupted

- Uber is one of the highest valued companies in the world today, approaching \$50 billion. It is buying companies in the map data processing business, like En Carta. It has just purchased Microsoft's cartographic assets. It is investing in self-driving car research at Carnegie Mellon University, one of the centers of autonomous driving. Uber's stated aim is to make car ownership unnecessary. Recently, the company began testing a new service that would compete directly with UPS, DHL and FedEx.
- The biggest threat to public transport is ride sharing. Public transit runs on its schedules, picks up and drops off at its stops. People would rather run on their own schedules, and be picked up where they are and dropped off where they want to go, which is why private mobility is so popular. Ride sharing is a more customer-friendly way of offering public mobility.
- Why own a car if you can have all of the advantages of <u>personal mobility</u> without all of the disadvantages of car ownership. What makes this possible are platforms that connect people to services. Just like many services have been moved from desktops to the cloud, so are mobility services moving to the same cloud.



New business models Move first; ask for permission later

- Platforms are key
- Uncovering undervalued assets

New business models

- New mobility businesses are trying to establish a new set of rules by ignoring the old ones. A company in San Francisco called *MonkeyParking* distributed an App that allowed someone who was leaving an on-street parking space to sell it to someone cruising in the vicinity looking for a space.
- The city's attorney reminded the company that street space did not belong to anyone but the city, and no one could take money for selling a space or claim a space as theirs because it was in front of the building or house where they lived, or because they had occupied it.
- "This is stone age thinking," they replied. "We are in the sharing economy now where we can create value out of underutilized resources. Look at people who are renting out their underutilized apartments, or people who are selling the unused seats in their cars."
- The city's attorney replied that people can do whatever they want with what they own, but not with what they don't own. *MonkeyParking* is now in the business of helping driveway owners rent out their underutilized driveways. But another MonkeyParking will pop up somewhere else and push the boundaries of the envelope.
- The problem for the existing transport industry is that its companies and agencies are stuck with old business models, so even if they innovate, they cannot capture the value. Uber innovated with a business model, not with technology.

Crossroads

Transport industry is at a crossroads Will cars, trucks and buses drive themselves Who will build them and how What happens next

Transport industry is at a crossroads

- Why is the transport trade press suddenly filled with articles about self-driving cars? Two
 events started this process which now has achieved a life of its own. The US military,
 through DARPA (Defense Advanced Research Projects Agency) held a couple of
 competitions for self-driving cars with significant money prizes. This got both the car industry
 and academic research started. Second, governments have pushed for ever safer cars, and
 the only way to make further improvements is to eliminate the chief cause of accidents:
 drivers, who account for 95% of traffic accidents
- A study by McKinsey & Company predicts that, in a future where all cars are driverless, we could see a crash rate reduction of up to 90 percent. Lower accident rates would lead to less frequent visits to auto body repair shops, and that would leave a good portion of the 445,000 auto body repairers without a job.
- There are 5.7 million truck drivers globally. According to the US Bureau of Labor Statistics, there were approximately 1.6 million US truck drivers in 2014. They earn a mean income of \$42,000. That's \$67 billion dollars in income about 0.3% of the US GDP. If trucks drive themselves, that's a lot of money saved. It's also a lot of money that won't be spent buying cars and houses and paying taxes.
- There are already fewer jobs building vehicles because of all the automation that is used in factories.

Crossroads

Transport industry is at a crossroads Will cars, trucks and buses drive themselves Who will build them and how What happens next

Transport industry is at a crossroads

- All of this is going to have a major impact on the business of transport, not just on car and truck companies but on all of the companies that repair vehicles and infrastructure and government agencies that build and maintain the infrastructure.
- There are no signs that people are willing to give up personal mobility even if they
 were able to, so they are not going to flock in massive numbers to bus and tram
 stops or start walking or cycling. More, not fewer people will want to be
 chauffeured. More, not fewer people will want the convenience of door-to-door
 travel when it is offered.
- Does all this mean that cars and trucks and all forms of transport will drive themselves?
- Does increased amount of automation in manufacturing mean that the cars and trucks may actually build themselves?
- Yes to both. What happens next in the transport industry has already started.

Highly Automated Driving Map data ADAS Big Data

Highly automated driving

- We started building the first navigable maps thirty-five years ago; we have already started building new maps for the next generation of navigation. Here, a company formerly called Navteq, and TomTom, which bought Navteq's chief competitor, Tele Atlas, are both working on this task. So is Google, that has a few hundred billion more Euro in its treasure chest than do Here and TomTom. Nokia bought Navteq in 2008 and now it has sold it to three German carmakers, Daimler, BMW and Audi, who wanted to make sure they would have the map data they need for the next generation of cars.
- There need to be two kinds of maps, one for seeing what is around the vehicle while it moves at speeds up to 200 km/hr or more, and the other to see over the crests of hills and around corners or in the dark, the so-called 'digital horizon'.
- Vehicles will be even more connected to infrastructure and each other. There are those who criticize the entire V2V and V2I project as unnecessary because self-driving cars do not need anything but their own eyes. This is too narrow a view. More is more, and if the vehicle cannot always see, it may be able to hear or even feel.
- There are many years between where we are and ubiquitous self-driving cars and trucks, and we are already experiencing very highly automated driving.

Highly Automated Driving Map data ADAS Where we are

- Today, when you hear the term Connected Vehicle, you probably think of Big Data. Big data is one of the critical success factors for connected vehicles
- The systems needed to manage the data being received from and sent to millions of vehicles are the same systems being used for big data applications. For some applications, which are used by many connected car drivers around the same time—remote heater start, for example—there can be huge peaks in demand that the systems must manage.
- Many connected vehicle applications will depend on real-time data that must be delivered in a consistent and timely manner. These services need the ability to capture, store, retrieve and process data exchanges of millions of cars in milliseconds. This is new ground for automotive OEMs.
- There are an increasing number of data sources, both on and off the vehicle, such as radar, video, vehicle sensors, roadside sensors, and the data from all of these will need to be processed, mashed together and delivered as information.



 Google Car
 On- and off-road testing
 Regulations

Autonomous vehicles

Autonomous vehicles

- Highly automated driving is already here. We are within a hair's thickness to fully handsoff-the-wheel driving.
- Google has built a car with no steering wheel. An Audi vehicle drove itself and some passengers across the US with no human hands on the wheel. Mercedes-Benz showed its vision of a design for a self-driving car in January of this year at the Consumer Electronics Show, not an auto show.
- Testing tracks are being built all around the world
- Regulations are being changed. US states and European countries are allowing cars to drive themselves in direct contravention to the basis for all driving laws, the 1968 Vienna Convention, which says that a driver must always be in control of <u>his</u> vehicle. There are qualifications to these new regulations, that it is only for research, but this will eventually change.
- One set of regulations that is getting stricter is privacy. There have been debates over "who owns the data"? It is the customer and driver, not the company selling the car. OEMs will be able to use the data after obtaining proper permissions from the owner, but not as a right of having built the vehicle and installed the communications systems.



Autonomous vehicle test tracks

- California Mercedes-Benz
- Borås, Sweden Volvo
- Ann Arbor, Michigan US auto industry
- US, Germany and UK allowing testing on the roads



Who will build the vehicles Electronics companies 3D printed cars Build them ourselves

Who will build the vehicles

- In a recent article in The Economist, the newspaper argued that the automotive companies are best equipped to build cars in the future. Given the current business models of the car companies, I would agree. Tesla, a relative newcomer to the car building business, is trying to become a car company with the same business model and a slightly different technical approach, but it is losing money. The field is littered with the dead bodies of wanna-be car companies, from Spyker to Fisker.
- But if the future of mobility will be based on completely different business models, then the current manufacturers do not necessarily have any advantages. Apple or Virgin can have their cars produced for them just as they have their iPads and airplanes produced, and they can deliver mobility as a service without needing to sell cars in showrooms or have dedicated workshops to maintain them.
- Electronics companies have proven they can deliver products that people want to buy, offer value for money and perform as expected.



Who will build the vehicles Electronics companies 3D printed cars Build them ourselves

Who will build the vehicles

- Manufacturing is changing as well. The sportscar in the image is produced by 3D printing.
 "Divergent Microfactories found a way to make automobiles that holds the promise of radically reducing the resource use and pollution generated by manufacturing," says founder and CEO Kevin Czinger. "It also holds the promise of making large-scale car manufacturing affordable for small teams of innovators. And as their car, named 'Blade' proves, they have done it without sacrificing style or substance.
- Czinger points out that the majority of an automobile's emissions are actually produced during manufacturing, and it gets worse for cars perceived as 'green' alternatives. Manufacturing batteries is a dirty business. A study published by the U.S. Department of Energy's Argonne National Laboratory found that hybrids and EVs come nowhere close to offsetting the amount of greenhouse gases emitted during their production and have much larger carbon footprints than gasoline-powered cars.
- So, what's the solution? Obviously, it's an internal-combustion 700-horsepower supercar that weighs less than 1,400 pounds and can outrun a 2014 Ferrari LaFerrari or 2014 McLaren P1 to 60 mph.
- Or we design our own car, the one that meets out particular needs at a particular point in our own lives, and then we print them ourselves..


PLMN

PSAP

PSAP

Minimum Set of Data

The coming years

- I believe the view from the transport industry is one of common purpose with society as a whole.
 - People should be able to move freely, but with full recognition of the external costs of their movement.
 - There is nothing inherently better or worse with collective or personal mobility; each has its advantages, and it is up to both the users of transport and the providers to ensure that the disadvantages of each are completely minimized.
 - We are entering a new phase of transport in which digital techniques offer the possibility of mobility as a service. The business of transport will not be focused on owning and maintaining and operating individual fleets of vehicles, and it will not be about selling and buying private cars, but will be about offering and using the best means available for getting people and goods from all the places where they are to all the places where they need and want to be.



PLMN

PSAP

PSAP

Minimum Set of Data

The coming years

- The European Union's Regulation that all new cars starting in April2018 shall have an automated eCall device will ensure connectivity, at least in the European Union. It accelerates the introduction of connected vehicles because it is a trigger event that nobody can ignore. All players, OEMs suppliers, telematics service providers, etc. can count on a certain date and volume of customers, which increases the predictability of the business case and thus unleashes budgets for innovation.
- But there are also risks, e.g. if the legislation process is too slow, finally decelerating the introduction of innovations, or if legislation is too restrictive, prohibiting the dissemination of new technologies and innovations. Think about autonomous driving as an example where legislation in the EU is lagging behind the technology and thus is a risk factor for the timely introduction of this innovation.
- Car manufacturers are fitting their cars at an increasing pace with connected devices, so there is no question that all cars will be connected by 2020.
- Trucks will have autonomous driving features before cars, and will be able to use them on motorways by 2020.





Not so far away
Air deliveries
Highly personal rapid transit
Personal air transport

The coming years

- BMW has already changed its mission statement from being a car and motorcycle company to being a mobility provider. It is investing in all types of mobility service businesses through its *BMW i Ventures* with \$100 million in investment funding.
- All companies in the transport industry will attempt to make similar moves. Some will succeed, while others will be by-passed by companies with better solutions to the transport problems, that do a better job of using the technology of the digital age to deliver ourselves and our goods from where they are to where they need to be.

The end of the container era The end of shopping malls The end of work and school campuses in the countryside The end of isolated living

The start of the doorto-door era For people For goods



Transport in the Digital Age

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