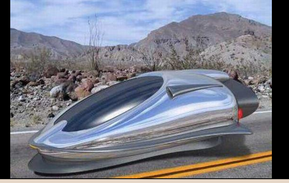
An Examination of the Interaction between Two Prospective Transport Technologies:

Questioning the Importance of High Speed Rail in a Driverless Vehicle Society

Ryan J. Westrom



Clifford Winston *(The Wall Street Journal, July 18, 2012)*

"Instead of focusing on an enormously expensive high-speed rail system, government should promote modern highway design for cars of the future."

in an article entitled: *Paving the Way for Driverless Cars*

Scenario Planning

The future is uncertain.

We must consider multiple scenarios as we envision what the world could become.

What do we envision for the future?

- Two new alternative transportation technologies in high speed rail (HSR) and driverless cars
  - These innovations may result in a transportation paradigm shift
- Continued urbanization and population growth
  - 82.4% of Americans live in urban areas (80.7% Canadians)
  - 75% of the world's population by 2050

Assuming driverless cars become reality, will intercity travel still require HSR?

- How will these technologies interact?

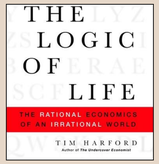
Are cities vital?

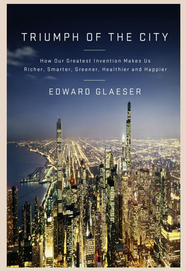
Urbanization is ongoing. Will this continue, and will cities remain of vital importance?

Tim Harford *(The Logic of Life):*
"…vibrant cities [are] the ultimate source of innovation and progress, fundamental to civilization."
"Given how environmentally friendly cities are, how fundamental they are to innovation and economic growth, and how likely they are to play an increasingly important role in future…Cities are likely to enter a new golden age."

Ed Glaeser *(Triumph of the City):*
"Ideas move from person to person within dense urban spaces, and this exchange occasionally creates miracles of human creativity."
"Cities…are the nodes that connect our increasingly globalized world. Urban areas…have always played this role, but as the world becomes ever more tightly knit, cities are becoming even more important."

Tim Keller *(Why Cities Matter):*
"Cities are culture forming wombs. You are thrown together with people who are like you, but also with people who are not like you. This leads to massive creativity… [And] this creative tension always births new culture."





The Driverless System

We must ask, what would a driverless car system look like?

Four Factors in Evaluating a Complex System:

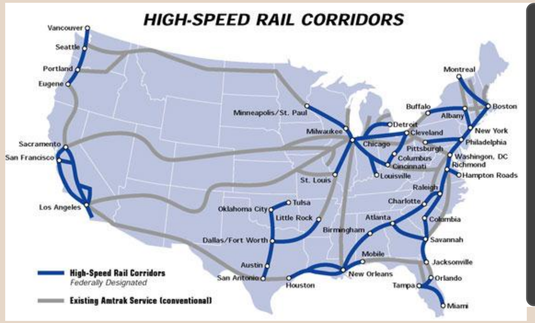
- Scale and Scope
  - Is it scalable? How many vehicles would there need to be?
- Function
  - What effects on congestion would it truly have? What safety gains are there?
- Structure
  - What speed could they travel?
- Timeframe
  - How far away is this system?

Thomas Frey *(Senior Futurist at DaVinci Institute)*
"Keep in mind that the first wave of driverless vehicles will be luxury vehicles that allow you to kick back, listen to music, have a cup of coffee, stop wherever you need to along the way, stay productive with connections to the Internet, make phone calls, and even watch a movie or two."

- Peter Stone, a computer scientist at the University of Texas at Austin, estimates delays at intersections can be reduced by more than half.
- Maximum speed on highways could be increased to a vehicle and roadway's safety limits, with headways reduced to a safe comfortable synchronized stopping distance.

Safety Considerations

- U.S. Annual Automobile Crashes
  - 32,367 (2011)
  - Significant Crash Reduction is expected
- Would cataclysmic event possibilities remain?
- Driverless Cars Versus High Speed Rail?
- Pedestrian and Bicyclist interactions



Consider the Northeast Corridor

NEC = Boston to Washington, D.C.

- 444 miles (road distance)

What does this mean for intercity travel times?

- Current best rail time (Amtrak Acela, 68 average mph): 6h 32m
- Current driving time: 7h 20m
- Flying time: 1h 40m (including transit to/from, security, and waiting time: 3h 20m – 4h 40m)
- HSR travel time (max 220 mph): 3h 8m
- Driverless average trip time (20% congestion reduction/ speed increase): 5h 52m

Origin to Destination is important

- Assume the average commute to/from a city center HSR station is 20 minutes within the center city and 1 hour to/from the suburbs
- Assume the average commute to/from the driverless vehicle highway system is 20 minutes from the average center city origin and 10 minutes within the suburbs

City Origin to City Destination

- HSR: 3h 48m; Driverless car: 6h 32m

Suburban Origin to Suburban Destination

- HSR: 5h 8m; Driverless car: 6h 12m

Implications?

- Note, we're assuming a max 220 mph HSR. Any less will compare less favorably.
- HSR clearly has high value for city-to-city trips. Suburban residents (especially considering transfer penalties) would likely prefer a vehicle. So how important is the city-to-city trip?
- This has clear implications in regard to HSR station siting.

HSR Station Siting Implications

City Center to City Center travel is key.

If the value lies in city center to city center trips, High Speed Rail stations must lie within city centers. This matches the current NEC planning.

Boston
- South Station

New York City
- Penn Station

Philadelphia
- new Market Street station (not 30th Street Station)

Baltimore
- new Charles Center station (not Penn Station)

Washington, D.C.
- Union Station

Space Considerations

Manhattan population:

- 1.6 million people

Manhattan parking spaces:

- Off street: 102,000
- On street: unknown, estimated at 40-55% of the population; say 800,000

Manhattan weekday daytime population:

- 3.67 million people

Chicago:
2000 Census figures from the Chicago Central Area Action Plan:

- 578,000 workers enter the Central Area
- 34,000 workers leave the Central Area
- 50,000 workers both live and work in the Central Area

References

1. Winston, Clifford. *Paving the Way for Driverless Cars,* The Wall Street Journal, July 18, 2012.
2. *Livability in Transportation Guidebook: Planning Approaches that Promote Livability*, U.S. DOT Federal Highway Administration and Federal Transit Administration, 2010.
3. Glaeser, Edward. *Triumph of the City: How Our Greatest Invention Makes Us Richer, Smarter, Greener, Healthier, and Happier,* 2011, The Penguin Press.
4. Harford, Tim. *The Logic of Life: The Rational Economics of an Irrational World*, 2008, Random House.
5. The Driverless Road Ahead: Carmakers are starting to take autonomous vehicles seriously. Other businesses should too. Schumpeter blog. in The Economist, October 20, 2012.
6. Automated Intersection Control: Performance of a Future Innovation Versus Current Traffic Signal Control. David Fajardo, Tsz-Chiu Au, S. Travis Waller, Peter Stone, and David Yang. in Transportation Research Record: Journal of the Transportation Research Board, 2259, pp. 223-232, 2011.
7. Why Driverless Cars Will Increase Tensions in Cities and Suburbs Alike. David Alpert. in The Atlantic Cities, March 5, 2012.
8. What Intersections Would Look Like in a World of Driverless Cars. Emily Badger. in The Atlantic Cities, March 1, 2012.
9. Let the Robot Drive: The Autonomous Car of the Future Is Here. Tom Vanderbilt. in Wired, January 20, 2012.
10. Why Driverless Cars Are Inevitable – and a Good Thing. Dan Neil. in The Wall Street Journal, September 24, 2012.
11. From Horse Power to Horsepower to Processing Power. Eric A. Morris. Freakonomics blog. December 11, 2012.

Presenter Bio:
Ryan J. Westrom
P.E., PTP

Candidate
Master of Science
in Transportation 2014
Massachusetts Institute of Technology

Joseph M. Sussman,
Research Advisor

Eisenhower
Transportation Fellow

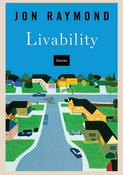
Conclusions

Peter Norvig *(Director of Research at Google)*

"There are these societal problems that are hard because of the way they are, and it's not just that we're not smart enough to solve them."

1. High Speed Rail Retains Promise

HSR clearly has high value for city-to-city trips. And given the growing importance and value of cities, these high efficiency connections will grow more important.

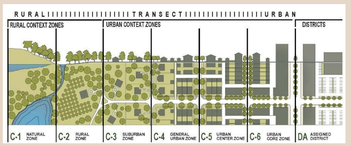


2. Transportation Choices Will Affect Development Form

Ed Glaeser: "Transportation technologies have always determined urban form."

Additionally, the impacts the type of transportation investment will have on our built form and sustainability must be considered.

- HSR may lead to increased urbanism while driverless cars could again incentivize lower density development.
- Greater livability in either scenario is advantageous.



3. Continued High Speed Rail Project Development is Valid

- Despite potential high costs, increased economic return, if cities are as vital as foreseen, is attainable via HSR investment.
- Both systems will likely exist, with markets likely available to both.