#### **Solar-Powered Automated Transportation Networks**

the future of sustainable urban transportation

Burford Furman Eric Hagstrom Eric Rosenfeld

San José State University

2016-11-17

Ron Swenson

Shannon McDonald Southern Illinois University

U.S. Department of Transportation Office of the Assistant Secretary for Research and Technology

#### T3e Webinar November 17, 2016



#### **Presenter information - Burford Furman**

#### **Burford (Buff) Furman, PhD, PE** Professor, Mechanical Engineering MTI Research Associate San Jose State University

- Research interests
  - Automated transit
  - Automation and control
  - Sensors and measurements
- Recent publications

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• Automated Transit Networks (ATN): A Review of the State of the Industry and Prospects for the Future, Mineta Transportation Institute,

CA-MTI-14-1227, September 2014. <u>http://transweb.sjsu.edu/project/1227.html</u>





#### **Overview of the webinar**

- What is ATN? (Buff)
- Why ATN? (Ron)
- What are solar ATN's unique advantages? (Buff)
- How can ATN integrate into urban environments? (Shannon)
- What are the challenges facing implementation? (Buff)
- How can universities and students make a difference in ATN development and implementation? (Eric H. & Eric R.)
- What action might you take to make solar ATN a reality? (ALL)
- Q&A

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### What is ATN?



#### The solar-powered automated transit network is the next 'big thing' in sustainable urban transportation



Source: Jpods.com



#### ATN vehicles function more like automated taxis rather than buses, trains, light rail, or other transit vehicles

#### Non-stop origin-to-destination



Source: http://tinyurl.com/jgwdknx



## ATNs use offline stations, so vehicles only stop and start at origins and destinations



**Buff Furman** 

Source: http://www.prtconsulting.com/



#### ATN vehicles are relatively small (4-6 people)



http://81.47.175.201/livingrail/images/prt2.JPG



#### ATN service is on-demand, rather than on fixed schedules



http://tinyurl.com/h2yyme2



#### ATN vehicles are fully automated (no driver)



Buff Furman



http://www.ultraglobalprt.com/

## ATN vehicles are captive to a guideway that is reserved for their exclusive use



http://www.beamways.com/



#### ATN guideways can be relatively slim, are usually elevated, but can also be at or near ground level or underground



http://tinyurl.com/zatoqwg



## ATN vehicles are able to use all guideways and stations on a fully connected network, for example in San Jose



#### **Buff Furman**





**Buff Furman** 

photo courtesy of Trans.21





https://c1.staticflickr.com/1/507/18700664619\_96ff4383c7\_b.jpg



#### Masdar City (c. 2010)

**Buff Furman** 



http://www.greenprophet.com/wp-content/uploads/2011/05/masdar-city-pod-car.jpg

#### Heathrow Terminal 5 (c. 2011)



http://www.ultraglobalprt.com/wp-content/gallery/heathrow/pods-006.jpg



# Suncheon Bay (c. 2014)

**Buff Furman** 

http://tinyurl.com/jsajxa5



#### **Presenter information - Ron Swenson**

#### **Ron Swenson**

International Institute of Sustainable Transportation

- Research interests
  - Solar-Powered Transportation
  - Bioclimatic Design
- Recent publications



- The Solarevolution: Much More with Way Less, Right Now—The Disruptive Shift to Renewables, Energies, August 2016
- Mitigating Climate Change with Solar-Powered Transit, Podcar City 10, Antwerp, September 2016
- More at www.swenson.com/ron/library







## Why ATN?







## Congestion







# Congestion is overwhelming our cities and widening isn't working



#### Ron Swenson





#### This is the same "freeway" with electric vehicles



#### Ron Swenson





#### This is the same "freeway" with automated cars



#### Ron Swenson





# ATN reduces congestion and achieves the same throughput as ordinary rail



## **Climate Change**







# Climate change is real—it's getting late for incremental solutions to do any good



# Solar ATN eliminates fossil fuel use and cuts pollution to zero







# As shown in Paris, there is political will to replace fossil fuels with renewable energy ... to eliminate CO2 emissions



#### Projected Energy Supply & Demand, California

\* 2015-2030 WWS % estimated based on 2010-2014 WWS market penetration and projected renewable energy supply (80% WWS by 2030).





## **Energy Independence**







#### The future of oil in the U.S.A. was looking good a year ago

#### U.S. Field Production of Crude Oil



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eia Source: U.S. Energy Information Administration



## Yet when you take a good hard look at the data, you now can see that oil production is down







## Yet when you take a good hard look at the data, you now can see that oil production is down







#### It takes drilling rigs to fill the pipeline



#### **Renewable capacity is growing rapidly worldwide**



Solar PV Total Global Capacity, 2004–2013





## Solar PV on the guideway allows the system to collect the energy needed within the 'footprint' of the system



#### Ron Swenson




### **Livable Cities**







#### **Car cities are almost unlivable**



### Ron Swenson





#### In the past, cities streets were lively places



#### Ron Swenson





#### **Podcar networks can restore city streets for people**



### Ron Swenson





### Safety







#### **Can at-grade transit possibly be a solution?**



### Ron Swenson





# For 100 years the automobile has dominated city streets, with dire consequences



### What are solar ATN's unique advantages over other forms of transit?







# Transportation machinery is physically separated from everything else (especially people!)



### Buff Furman



# ATNs use a tiny fraction of the land required for cars, buses, and trains — without needing new rights-of-way



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### **Buff Furman**

# ATNs can be located on or near existing rights-of-way and can be 100% solar powered



### Buff Furman



#### **Presenter information - Shannon McDonald, AIA**

### Shannon Sanders McDonald, AIA Assistant Professor at the School of Architecture at Southern Illinois University, Carbondale, IL

Research interests

Automated transit and its impact on sustainable architecture and urban design



#### Recent publications

"Road Vehicle Automation 2" edited by Sven Beiker and Gereon Meyer paper titled: Envisioning Automated Vehicles Within the Built Environment: 2020, 2035, and 2050 is available online at <u>http://www.springer.com/gp/book/9783319190778</u>

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### How can ATN integrate into existing and new urban environments?



# Small compact design allows for multiple opportunities to integrate into the existing urban fabric.



4th year SIU Architecture Student Philip Jordon, 2015



# Small compact design allows for multiple opportunities to integrate into the existing urban fabric even with watertaxi.



SIU Architecture Comprehensive Masters Urban Design Student Team, 2015



#### **ATN networks can change and/or work with existing streets** Major Street (K St)



#### ATN can be integrated into existing campus settings.



Masters SIU Architecture Student Arius Hounwanou, 2015



#### ATN can be integrated into new research campus settings, Drive Lab, Arlanda Airport, Sweden.



SIU Architecture On-Line Comprehensive Masters Urban Design Team, 2014



# ATN can be integrated into new building designs for a campus.



5th year Southern Polytechnic Architecture Student, 2008



# ATN can be integrated into new building designs for a research Drive Lab, Arlanda Airport campus.



SIU Architecture On-Line Comprehensive Masters Jim Muehlbauer, 2016



# ATN can be integrated into new building designs for a research Drive Lab, Arlanda Airport campus.



SIU Architecture On-Line Comprehensive Masters Jim Muehlbauer, 2016



# ATN can be integrated into the landscape/town/University creating a green interconnected ring for the SIU community.



Master SIU Architecture Student, Lucas Shubert Thesis, 2013



# ATN can be integrated with existing buildings and downtowns – Santa Cruiz, CA



Master SIU Architecture Student, Don Olsen, 2015



#### ATN can be integrated into new building design



4th year SIU Architecture Student, Ruba Bdair, 2015



# Small compact design allows for multiple opportunities to integrate multimodal designs.



4th year SIU Architecture Student, Esmeralso Camona, 2015



# ATN can be integrated into new building design and part of a multi-modal connection.



4th year SIU Architecture Student, Ruba Bdair, 2015



# ATN can be integrated into new building design providing interior connection/lobby spaces.



4th SIU On-Line Masters Architecture Student, 2014



# ATN can be integrated as a part of the interior and structure of a new design.



4th year SIU Architecture Student, Aaron Neal, 2015



# On demand access and networked system provides stations within walking distance, no cars needed - Annapolis MD



Study from ATRA Transit Workshop, TRB 2016





#### **Mobility-challenged have accessibility**



SIU On-Line Comprehensive Masters Architecture Urban Design Team, 2014



#### **Topological challenges can be addressed**



SIU On-Line Comprehensive Masters Architecture Urban Design Team, 2014



# Integrated Urban Design for New Mobility can be achieved with podcars



SIU On-Line Comprehensive Masters Architecture Urban Design Team, 2014



#### New mobility ideas can be explored



SIU On-Line Comprehensive Masters Architecture, Adnan Omeragic, 2014



# New Parking Options can be used to store on demand mobility



4th SIU On-Line Comprehensive Masters Architecture, Adnan Omeragic, 2014



#### **Mobility-challenged have accessibility with solar ATN**



SIU Architecture On-Line Comprehensive Masters, Rob S. Andersen, Jr. 2014



#### New internal connections offer greater accessibility



SIU Architecture On-Line Comprehensive Masters, Rob S. Andersen, Jr. 2014


#### New internal connections offer greater accessibility



SIU Architecture On-Line Comprehensive Masters, Rob S. Andersen, Jr. 2014



#### ATN can provide first and last mile connections, Drive Lab, Arlanda Airport



SIU On-Line Comprehensive Masters Architecture Urban Design Team, 2014



#### A new town in the 1970's was designed with ATN networks that created greenspace and sustainabilty





#### A new town in the 1970's was designed with ATN networks that created greenspace and sustainabilty





# What are the challenges facing implementation of ATN?



### A compelling design case is beginning to emerge - think of the rotary telephone, before the...





#### ... iPhone



WAYS Fly in your city



### Cities, planners, and ATN developers face a 'Catch-22' situation



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### Validation must be done to prove the safety and business cases



http://tinyurl.com/pjfjxyc

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#### Validation has been done for other systems in the past



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#### Validation has been done for other systems in the past



http://tinyurl.com/q9qx5g9



#### **Eric Hagstrom**

Lecturer, Mechanical Engineering San Jose State University

- Research Interests
  - Mechanical design
  - Control systems
- Recent Projects





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How can universities and students make a difference in ATN development and implementation?



2012 / 2013









#### 2014 / 2015





2014 / 2015



#### **Eric Hagstrom**



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2015 / 2016





#### 2015 / 2016



#### **Eric Hagstrom**



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#### The Spartan Superway International Research Internship Program allows for interns to continue R&D during the summer.

**Summer 2015** 





#### The Spartan Superway International Research Internship Program allows for interns to continue R&D during the summer.

**Summer 2016** 





#### **The Spartan Superway International Research Internship**

#### Program allows for interns to continue R&D during the summer.

#### Summer 2016





#### **Presenter information - Eric Rosenfeld**

#### **Eric Rosenfeld**

Student, Mechanical Engineering San Jose State University

- Research interests
  - Solar Powered Transportation
  - Sustainable Energy Storage
- Recent publications
  - "Case Study of a Solar Power Installation for an Automated Transit System", Solar 2016, San Francisco







#### The Spartan Superway International Research Internship Program offers diverse ideas and innovative collaboration









### The Spartan Superway utilizes groundbreaking ideas and assistance from professionals around the world





#### In September, I had the opportunity to present my work at Podcar City 10 in Antwerp, Belgium





### The Spartan Superway improves the technical and professional engineering skills of students







#### 80 miles per gallon!



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### What action might you take to make solar ATN a reality?





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#### Spartan Superway Summer Internship Program





## URBAN INTERNATIONAL DESIGN CONTEST

The rapid development of autonomous vehicles for private and public transportation creates a completely new playground for urban development.

The UIDC series of workshops will combine the knowhow and creativity of academics and students, city planners, transportation specialists, and developers to create and propose new urban designs, incorporating the new possibilities that can be achieved with elevated and road-based autonomous vehicles.

#### Best practices for Automated Public Transit



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### **URBAN INTERNATIONAL DESIGN CONTEST**



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#### Develop a solar podcar network in your city















#### There are a number of good references on ATN

- Furman, B., Fabian L., Ellis, S., Muller, P., and Swenson, R. (2014). Automated Transit Networks (ATN): A Review of the State of the Industry and Prospects for the Future, Mineta Transportation Institute, CA-MTI-14-1227. Available at: <u>http://transweb.sjsu.edu/project/1227.html</u> (see especially the Bibliography)
- McDonald, Shannon S. (2013). "Personal Rapid Transit (PRT) System and Its Development." In Transportation Technologies for Sustainability, pp. 831-850. Springer New York.
- Swenson, R. (2016). The Solarevolution: Much More with Way Less, Right Now—The Disruptive Shift to Renewables. Energies, 9(9), 676. <u>http://tinyurl.com/nlp6eld</u>

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• INIST Library: <u>https://www.inist.org/library/</u>

#### And a special thanks to all of our collaborators and sponsors



#### **Questions and Answers**

Buff Furman SJSU Spartan Superway Overview & Mechatronics

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<u>Ron Swenson</u> INIST Solar Energy



Shannon

**McDonald** 

Southern

Illinois Univ

**Architecture** 

Eric Hagstrom SJSU Spartan Superway ME Instructor



Eric Rosenfeld SJSU Spartan Superway ME Student

<u>References</u> <u>www.solarskyways.com/events/T3e</u>

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