Atlanta Mobility

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Who am I?

• Born in The Netherlands
• MS in Mechanical Engineering from the University of Twente (1987)
• Worked at the Maritime Research Institute of The Netherlands – MARIN (1987-1988)
• Ph.D. in Operations Research from University of Houston (1992)
• Faculty in the School of Mechanical Engineering since 1992
• Research interest: Sustainable Design and Manufacturing

Prof. Bert Bras
Mechanical Engineering
How much longer?!?!
What we are trying to do

• Identify (technical) options for improved urban mobility in Atlanta area
  – Ranging from “traditional” to “innovative”

• Assess impact in terms of financial, environmental and social benefits/costs
  – Use existing and new assessment models

• Create an engineering design type framework
  – Managing requirements and desired functions with appropriate solutions

• Pursue pilot implementations around Georgia Tech
  – Lead and verify by example

• Create a research thrust area around “sustainable mobility”
  – Including industrial goods movement
• Founded as **Terminus** in 1837 at the end of the Georgia railroad line
• **Population** (2007)
  - City 486,411
  - Urban 3,499,840
  - Metro 5,138,233 (9th Largest)
• **Elevation:** 738-1,050 ft (225-320 m)
Why Atlanta?

In 1907, Peachtree Street, the main street of Atlanta, was busy with streetcars and automobiles.

Centennial Park with Olympic Rings and fountains. CNN Studio, World of Coca-Cola, Georgia Aquarium all surround this park.

A map showing roads and Indian trails circa 1815, with late 19th century Fulton County and City of Atlanta outlines overlaid.

The Midtown and Downtown areas of Atlanta have experienced tremendous growth and revitalization since the 1996 Olympics.

Between 2000 and 2006, the Atlanta metropolitan area grew by 20.5%, making it the fastest growing metropolitan area in the US.

Forecasted population growth between 2005 and 2030: about 56%

Source: Atlanta Regional Commission
Transportation Challenges

• **Money:**
  – Atlanta's commutes are costliest in U.S. A family with two commuters here can expect to pay more than $4,500 at the gas pump.
  – Congestion costs each commuter $1,100-$1,600/year

• **Time:**
  – 60 hours/year wasted in traffic delays

• **Commuting Distance:**
  – Atlantans commute 100,000,000 miles/day = 200 RT to the moon per day!

• **Accidents:**
  – Total vehicle crashes in the Atlanta region increased almost 12%, from 173,000 crashes in 2000 to 194,000 in 2004.

• **Commerce:**
  – Atlanta region ranks fourth in the nation in warehouse inventory, a major contributor to the truck traffic on the region’s transportation system.

• **Health:**
  – Atlanta Named 2007 “Asthma Capital” by Asthma and Allergy Foundation of America: Atlanta is the worst U.S. city to live in for asthma sufferers. Atlanta earns its "worst" score from the city's high asthma death rate, high pollen levels, and severe air pollution.
Existing Transit Service and Propensity
“Public” Transportation Challenges

Ridership is low, but rising

<table>
<thead>
<tr>
<th>Access Mode</th>
<th>MARTA Bus</th>
<th>MARTA Rail</th>
<th>CCT</th>
<th>Gwinnett/Clayton</th>
<th>Total</th>
</tr>
</thead>
<tbody>
<tr>
<td>Walked</td>
<td>92,588</td>
<td>33,173</td>
<td>4,838</td>
<td>112</td>
<td>130,711</td>
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<tr>
<td></td>
<td>67%</td>
<td>41%</td>
<td>55%</td>
<td>33%</td>
<td>57%</td>
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<tr>
<td>Bicycle</td>
<td>728</td>
<td>600</td>
<td>66</td>
<td>2</td>
<td>1,396</td>
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<tr>
<td></td>
<td>1%</td>
<td>1%</td>
<td>1%</td>
<td>1%</td>
<td>1%</td>
</tr>
<tr>
<td>Rode with someone who parked</td>
<td>2,046</td>
<td>2,494</td>
<td>79</td>
<td>6</td>
<td>4,625</td>
</tr>
<tr>
<td></td>
<td>1%</td>
<td>3%</td>
<td>1%</td>
<td>1%</td>
<td>2%</td>
</tr>
<tr>
<td>Shuttle/Vanpool</td>
<td>1,215</td>
<td>1,201</td>
<td>54</td>
<td>2</td>
<td>2,472</td>
</tr>
<tr>
<td></td>
<td>1%</td>
<td>1%</td>
<td>1%</td>
<td>1%</td>
<td>1%</td>
</tr>
<tr>
<td>Taxi</td>
<td>1,185</td>
<td>1,205</td>
<td>282</td>
<td>3</td>
<td>2,675</td>
</tr>
<tr>
<td></td>
<td>1%</td>
<td>1%</td>
<td>3%</td>
<td>1%</td>
<td>1%</td>
</tr>
<tr>
<td>Drove a car and parked</td>
<td>2,357</td>
<td>25,219</td>
<td>577</td>
<td>109</td>
<td>28,262</td>
</tr>
<tr>
<td></td>
<td>2%</td>
<td>31%</td>
<td>7%</td>
<td>32%</td>
<td>12%</td>
</tr>
<tr>
<td>Transferred from bus</td>
<td>12,875</td>
<td>7,138</td>
<td>903</td>
<td>26</td>
<td>20,942</td>
</tr>
<tr>
<td></td>
<td>9%</td>
<td>9%</td>
<td>10%</td>
<td>8%</td>
<td>5%</td>
</tr>
<tr>
<td>Was dropped off by someone</td>
<td>6,281</td>
<td>7,420</td>
<td>994</td>
<td>27</td>
<td>14,722</td>
</tr>
<tr>
<td></td>
<td>5%</td>
<td>9%</td>
<td>11%</td>
<td>8%</td>
<td>6%</td>
</tr>
<tr>
<td>Transferred from MARTA rail</td>
<td>18,621</td>
<td>2,454</td>
<td>1,009</td>
<td>53</td>
<td>22,137</td>
</tr>
<tr>
<td></td>
<td>14%</td>
<td>3%</td>
<td>11%</td>
<td>16%</td>
<td>10%</td>
</tr>
<tr>
<td>Total</td>
<td>137,896</td>
<td>80,904</td>
<td>8,802</td>
<td>340</td>
<td>227,942</td>
</tr>
</tbody>
</table>

Issues:
- How to get to transportation
- Convenience
- Time
- Safety
Changing Times and Opportunities

- The Beltline
- The Golden Mile on Peachtree
- Light Rail connections with Athens, Macon, etc.
- MARTA expansions
- Armour Yard project
- …
Citizen Groups are becoming active…

But what makes the most sense?
Stakeholder Meetings Needed

• Government
  – Governor’s Congestion Mitigation Taskforce
  – City of Atlanta – Mayor’s Office

• NGOs
  – Atlanta Regional Commission
  – Livable Communities Coalition
  – Clean Air Campaign
  – Midtown Alliance
  – Central Atlanta Progress

• Chamber of Commerce

• Educational Institutions
  – Georgia Tech/Georgia State/Emory
    • GT Stinger & Trolley shuttle route - NextBus
    • Emory-CDC Cliff shuttle route

• Employers
  – Coca-Cola
  – Home Depot
  – Delta

• Main Atlanta transit organizations
  – MARTA – serves Fulton and Dekalb counties through bus/rail system
  – C-tran - serves Clayton County, linking to MARTA rail service at the airport station
  – Gwinnett County Transit - Express buses on 6 routes that use HOV lanes on I-85 with
drop off and pick up at MARTA Five Points and Arts Center Stations
  – Xpress - Serves 12 metro-Atlanta counties
  – The buc - Free shuttle service to employees, visitors and residents of the Buckhead
  area
  – CCT, Cobb Community Transit - Bus system that serves Cobb County, linking to
MARTA at Arts Center Station, the Dunwoody Station and the Holmes Station
  – Railroads (Norfolk Southern, CSX, etc)
Shifting Gears: What can Nature teach us?

- Nature has been sustainable for a long time.

- What can we learn from past & present biological systems?
  - Including extinct systems…

- Can we derive design guidelines from Nature that will result in inherently sustainable mobility systems?
Areas for Bio-Inspiration (1)

- **Network Scaling Properties in Biological Systems**
  - Physical properties of the vascular (fluid transport) system of plants and animals have well known relationships to organism size (Murray’s Law)

- **Signaling and Self-Organization in Biological Systems**
  - Biological systems are self organizing, and emphasize distributed decision making based on local control and information feedback.
  - Signaling processes lead to feedback loops that cause changes in organism behavior (e.g., ant column formations), which frequently lead to environmental modulation of signaling that further reinforces particular behavioral patterns (e.g., trail formation).

\[ R_k^3 = \eta R_{k+1}^3 \]
Areas for Bio-Inspiration (2)

• **Structural Food Web Analyses (May, Pimm, Odum)**
  - Mobility options (cars, buses, etc) can be thought of as consumers that require fuel and/or passengers as “food”
  - Extensive biological and ecological literature exists on food webs, species, and their interactions
  - Limitations in feeding periods caused by environmental fluctuations lead organisms to depend upon intermittent, intense feedings. Organisms specialize on certain resources because they must take advantage of these fluctuations. This suggests a rational structure contingent on the stability of resources (fuels).

• **Mutualistic Behavior and Networks (e.g., Bascompte et al)**
  - Individuals of two different species provide resources for one another to derive a benefit, e.g., increased survivorship (e.g., pollination)
  - Major properties are:
    • **Heterogeneity** – most species in a network have few interactions but some have many (a homogenous network would have roughly the same number of interactions per species)
    • **Nesting** – specialized species interact with a small subset which interacts with a more general set which, in turn, interacts with a still more general subset forming a box-in-box pattern of interactions
    • **Weak asymmetric links** – Most species are not strongly dependent; when strong dependences occur, they are one-sided arrangements with one species depending far more on the other than vice versa.
  - Certain mobility options (trains, planes) have a mutualistic association with other options (taxis, buses), but each option competes with others in that class (planes and rail both compete for passengers).
Areas for Bio-Inspiration (3)

• Succession Principles (e.g., Clements, Gleason, Odum)
  – Climax ecosystems and those moving toward climax exhibit different dimensional values than pioneer (early stage) ecosystems. It may be possible to classify different types of fuel and mobility systems as pioneer, transitional or climax based on Odum’s succession trends.
  – An intriguing question is whether biological succession principles could be a scientific basis for policies aimed at promoting and implementing new mobility infrastructures and technologies.

<table>
<thead>
<tr>
<th>#</th>
<th>Area of Study</th>
<th>Succession Trend</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>Energetics</td>
<td>Biomass, inorganic detritus both increase</td>
</tr>
<tr>
<td>2</td>
<td>Energetics</td>
<td>Gross production increase in primary</td>
</tr>
<tr>
<td>3</td>
<td>Energetics</td>
<td>Net production decreases</td>
</tr>
<tr>
<td>4</td>
<td>Energetics</td>
<td>Respiration increases</td>
</tr>
<tr>
<td>5</td>
<td>Energetics</td>
<td>Production to respiration ratio moves toward unity</td>
</tr>
<tr>
<td>6</td>
<td>Energetics</td>
<td>Biomass to production ratio increases</td>
</tr>
<tr>
<td>7</td>
<td>Nutrient Cycling</td>
<td>Element cycles increasingly closed</td>
</tr>
<tr>
<td>8</td>
<td>Nutrient Cycling</td>
<td>Increasing turnover time and storage of essential materials</td>
</tr>
<tr>
<td>9</td>
<td>Nutrient Cycling</td>
<td>Cycling ratio increases</td>
</tr>
<tr>
<td>10</td>
<td>Nutrient Cycling</td>
<td>Nutrient retention and conservation increases</td>
</tr>
<tr>
<td>11</td>
<td>Species and Community Structure</td>
<td>Species composition changes</td>
</tr>
<tr>
<td>12</td>
<td>Species and Community Structure</td>
<td>Diversity-richness increases</td>
</tr>
<tr>
<td>13</td>
<td>Species and Community Structure</td>
<td>Diversity-evenness increases</td>
</tr>
<tr>
<td>14</td>
<td>Species and Community Structure</td>
<td>r-strategists replaced by K-strategists</td>
</tr>
<tr>
<td>15</td>
<td>Species and Community Structure</td>
<td>Life cycles increase in length and complexity</td>
</tr>
<tr>
<td>16</td>
<td>Species and Community Structure</td>
<td>Organism size and offspring size increase</td>
</tr>
<tr>
<td>17</td>
<td>Species and Community Structure</td>
<td>Mutualistic symbiosis increases</td>
</tr>
<tr>
<td>18</td>
<td>Stability</td>
<td>Resistance increases</td>
</tr>
<tr>
<td>19</td>
<td>Stability</td>
<td>Resilience decreases</td>
</tr>
<tr>
<td>20</td>
<td>Overall Strategy</td>
<td>Increase efficiency of energy and nutrient utilization</td>
</tr>
</tbody>
</table>
Of course, all within limits…

Nature also has traffic jams and some species would prefer better mobility too…
In Summary: A Picture of our Research

- **Task Clarification**
- **Concept Design**
  - Emb. Design
  - Detail Design
- **Engineering Design Framework**
- **Mobility Hub Design**
- **Urban Region**
- **Integrated Infrastructures**
- **Mobility Hub Locations & Networks**

**Principles from Biological Systems & Infrastructures**

**Engineering Models & Tools**
- Fuel Options
- Vehicle Options
- IT & Telecommunication Options
- Performance models
- Environmental impact models

**Locality Specific City & Regional Planning Models & Requirements**
- Spatial GIS Data (infrastructure locations, user demographics & behavior patterns, etc.)
- Existing Assets

**Sustainable Positive Socio-Economic Impact**
Jacoby Development Inc. is talking to regional transit officials about expanding MARTA rail service into Hapeville, where Jacoby plans a mixed-use redevelopment at the former Ford plant.

Jacoby -- which has the Ford plant under contract and is close to closing on the 122-acre property, according to a source with direct knowledge of the process -- met with MARTA during the past few weeks.

While Jacoby was already planning to run shuttle buses from the development to nearby Hartsfield-Jackson Atlanta International Airport, and the project does not hinge on new MARTA rail lines, preliminary discussions about taking MARTA into Hapeville could foreshadow a bigger real estate trend.

Developers, taking notice of record-high gas prices, are seeing the stars align for more transit-oriented developments near existing or potential MARTA lines.