ENVIRONMENTALLY SOUND AND SUSTAINABLE FERRY DESIGN

SNAME Philadelphia, February 18, 2015
“Environmentally sound” aims to achieve the lowest impact on the environment for a certain system.

“Sustainable” aims to achieve a solution that can continue forever without depleting Earth’s resources.

Engineers could call both concepts “system efficiency with regard to energy and Earth’s resources.”
How efficient are ferries?

- Water transport is very efficient
- High speed water transport is less efficient
- How efficient can we make water transport?
- Would it be sustainable?
- Ferries only make sense if there is water
- But don’t bridges and tunnels carry passengers more efficiently?
- Micro or Macro efficiency and sustainability
1 m/s = 3.6 km/hr, which equals about 2 miles per hour
ZERO IMPACT FERRY (OLD)
ZERO IMPACT FERRY (OLD BUT CURRENT)
LOW(ER) IMPACT FERRY

Source: http://www.siferry.com/
HIGH(ER) IMPACT FERRY

Source: Mark Harrison for The Seattle Times
LOWER HIGH(ER) IMPACT FERRY
To make system efficiency gains, the use of ferries needs to beat other methods of transportation.

Ferries do not need to beat every part of a transportation system.

Ferries need to beat overall transportation system efficiencies.

Let’s assume ferries are people transporters.

People travel to only three places: home, work and recreation.
## Top US Cities for Public Transportation

<table>
<thead>
<tr>
<th>No.</th>
<th>Transit Score</th>
<th>City</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>81.2</td>
<td>New York City</td>
</tr>
<tr>
<td>2</td>
<td>80.5</td>
<td>San Francisco</td>
</tr>
<tr>
<td>3</td>
<td>74.8</td>
<td>Boston</td>
</tr>
<tr>
<td>4</td>
<td>70.4</td>
<td>Washington, D.C.</td>
</tr>
<tr>
<td>5</td>
<td>67</td>
<td>Philadelphia</td>
</tr>
<tr>
<td>6</td>
<td>65.3</td>
<td>Chicago</td>
</tr>
<tr>
<td>7</td>
<td>57.3</td>
<td>Seattle</td>
</tr>
<tr>
<td>8</td>
<td>56.9</td>
<td>Baltimore</td>
</tr>
<tr>
<td>9</td>
<td>49.9</td>
<td>Los Angeles</td>
</tr>
<tr>
<td>10</td>
<td>49.6</td>
<td>Portland</td>
</tr>
</tbody>
</table>

**Source:** Walk Score

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**2014 Transit Score® Rankings**

- **Top Midwest Cities**
  - 1. Chicago
  - 2. Minneapolis
  - 3. Milwaukee

- **Top Northeast Cities**
  - 1. New York
  - 2. Boston
  - 3. Philadelphia

- **Top Western Cities**
  - 1. San Francisco
  - 2. Seattle
  - 3. Oakland

- **Top Southern Cities**
  - 1. Washington DC
  - 2. Miami
  - 3. Atlanta

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## Transportation in US Cities

<table>
<thead>
<tr>
<th>No.</th>
<th>Transit Score</th>
<th>City</th>
<th>Commute Time (min by County)</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>81.2</td>
<td>New York City</td>
<td>39.5</td>
</tr>
<tr>
<td>2</td>
<td>80.5</td>
<td>San Francisco</td>
<td>30.5</td>
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<tr>
<td>3</td>
<td>74.8</td>
<td>Boston</td>
<td>29.0</td>
</tr>
<tr>
<td>4</td>
<td>70.4</td>
<td>Washington, D.C.</td>
<td>29.7</td>
</tr>
<tr>
<td>5</td>
<td>67</td>
<td>Philadelphia</td>
<td>31.8</td>
</tr>
<tr>
<td>6</td>
<td>65.3</td>
<td>Chicago</td>
<td>30.3</td>
</tr>
<tr>
<td>7</td>
<td>57.3</td>
<td>Seattle</td>
<td>27.0</td>
</tr>
<tr>
<td>8</td>
<td>56.9</td>
<td>Baltimore</td>
<td>28.8</td>
</tr>
<tr>
<td>9</td>
<td>49.9</td>
<td>Los Angeles</td>
<td>29.3</td>
</tr>
<tr>
<td>10</td>
<td>49.6</td>
<td>Portland</td>
<td>25.3</td>
</tr>
</tbody>
</table>

Source: Walk Score, FlowingData
Methods of Work Commute in Top US Transit Cities

% of County Population

City (Transit Rating 1→10)

Source: FlowingData
Use of Public Transportation in Top US Transit Cities

Source: FlowingData
SO WHERE IS THE WATER FOR FERRIES?

- Surprisingly many water cities
- Maybe bringing in water makes sense
- Today this water is again being populated by ferries
- Today this water is in progressively more expensive sections of the cities
- But is it efficient and sustainable?
OKLAHOMA RIVER (AN EXAMPLE)

- Before 2004 there was just a ditch
- Make it a river
- Olympic rowing
- Drag races
- And ferries
- People love ferries
- From stockyards to stock brokers
CITIES FOR FERRIES

- New York City
- Seattle
- Boston
- Philadelphia
- San Francisco
- Norfolk
- Washington DC
- Pittsburgh?
- Oklahoma City

- Hong Kong
- Shanghai
- Rotterdam
- Amsterdam
- London
- Sydney

All rich, high-density cities?
## TRANSPORTATION IN PA/NY METRO COUNTIES

<table>
<thead>
<tr>
<th>County</th>
<th>State</th>
<th>Commute Time (min)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Bronx</td>
<td>NY</td>
<td>42.4</td>
</tr>
<tr>
<td>Kings</td>
<td>NY</td>
<td>41.1</td>
</tr>
<tr>
<td>New York</td>
<td>NY</td>
<td>30.3</td>
</tr>
<tr>
<td>Queens</td>
<td>NY</td>
<td>41.9</td>
</tr>
<tr>
<td>Richmond</td>
<td>NY</td>
<td>41.7</td>
</tr>
<tr>
<td>Hudson</td>
<td>NJ</td>
<td>34.2</td>
</tr>
<tr>
<td>Monmouth</td>
<td>NJ</td>
<td>33.4</td>
</tr>
<tr>
<td>Philadelphia</td>
<td>PA</td>
<td>31.8</td>
</tr>
</tbody>
</table>

Source: FlowingData
Methods of Work Commute in PA/NY Metro Counties

Source: FlowingData
Use of Public Transportation in PA/NY Metro Counties

Source: FlowingData
SO WHEN DO FERRIES MAKE A DIFFERENCE?
CARS ON FERRIES OR JUST PEOPLE?

- Present issues
  - Cars on ferries avoid terminal parking lots
  - Cars on ferries reduce public transportation requirements and increase flexibility.
  - Cars are very difficult to carry efficiently on ferries
  - Cars are very inefficient

- Is there an efficient solution?
  - Get better cars to fit on ferries efficiently
THE MAXITAXI CONCEPT

- Developed in 2008
- Standardized carpool van
- Web & cellular phone presence
  - GPS technology to dynamically redirect & Uber
- Low or zero emission technologies
- GM Hy-Wire designs
  - Powered by battery or hydrogen fuel cell
  - Rechargeable or refillable
- Automated driving
  - In 2015, we need to include this
  - For parking
- Five-feet-wide
- Small turning radius for improved city-driving, etc.
- Bumpers designed to interlock
- Handicap-friendly
- Can be modified for other purposes
# MAXITAXI PARTICULARS

<table>
<thead>
<tr>
<th>Specification</th>
<th>Value</th>
<th>Unit</th>
</tr>
</thead>
<tbody>
<tr>
<td>Weight (Empty)</td>
<td>4,000 to 5,000</td>
<td>lbs</td>
</tr>
<tr>
<td>No. of Drivers</td>
<td>1</td>
<td>individual</td>
</tr>
<tr>
<td>No. of Passengers</td>
<td>7</td>
<td>individuals</td>
</tr>
<tr>
<td>Payload</td>
<td>1,500</td>
<td>lbs</td>
</tr>
<tr>
<td>Height</td>
<td>6.2</td>
<td>ft</td>
</tr>
<tr>
<td>Length (Overall)</td>
<td>14</td>
<td>ft</td>
</tr>
<tr>
<td>Length (Stacked)</td>
<td>12</td>
<td>ft</td>
</tr>
<tr>
<td>Width</td>
<td>5</td>
<td>ft</td>
</tr>
<tr>
<td>Turning Radius</td>
<td>28</td>
<td>ft</td>
</tr>
<tr>
<td>Fuel Efficiency</td>
<td>30</td>
<td>mpg</td>
</tr>
<tr>
<td>Top Speed</td>
<td>55</td>
<td>mph</td>
</tr>
<tr>
<td>Maximum Range</td>
<td>50</td>
<td>mi</td>
</tr>
</tbody>
</table>
THE COMBINED FERRY SYSTEM

“Containerization of passenger vehicles”
- Optimize ferries for MAXITAXI transport
- What does the trip look like?

The Commuting Process
- Outlying commuter drives car toward terminal
- En route, driver is directed toward pick-up points
- Automated driving brings car onto ferry & parks
- Interlocking bumpers allow improved loading
- Passengers exit 1st vehicle
- During passage, route optimization occurs; riders are reassigned to 2nd vehicle
- In evening, process is reversed
- Outlying commuters take MAXITAXIS home for night (recharge?)
EFFICIENT LOADING, STORAGE, & DISCHARGE

- Basic assumptions:
  + MAXITAXI loading speed: 10 mph
  + The ferry
    - Single-deck
    - 100-car
    - 800 passengers max
    - 500 passengers typ
  + The trip
    - Short river crossing (1 mi)
    - Max speed: 10 mph
    - Transit time: 10-15 min
Approach 1
- Double-ended ferry
- Single-direction flow
- Loading/Unloading: 3-5 min
- Most efficient of approaches

Approach 2
- Single-ended ferry
- Simultaneous loading & unloading
- Loading/Unloading: 3-5 min
Approach 3
- Single-ended ferry
- Unload cars in reverse
- Load cars into empty lanes
- Loading/Unloading: 10-15 min

Approach 4
- Single-ended ferry
- Cars load in alternating lines
- Car doors open to pathways
- Loading/Unloading: 10-15 min
WHAT DOES THIS LOOK LIKE?

HOME 1

HOME 2

WORK 2

WORK 3

PASSENGERS REASSIGNED

WORK 1
BUT MAXITAXI IS NOT JUST FERRIES

- If you make all cars five-feet-wide, all people transportation becomes more efficient
- Convoying
- Higher highway/bridge capacity
- More efficient parking
- Inherently higher per-car efficiency
- An automated driving moderator
BRIDGE CAPACITY
FIVE-FOOT-WIDE CARS ARE NOTHING NEW
“NOBODY WANTS FIVE-FOOT-WIDE CARS”
SOLAR

COASTTOGA

9.5'x5' (CAR) + 13'x 5' (TRAILER)
THIN FILM SOLAR CELLS

9.5'x6.75' (CAR) + 13'x6.75' (TRAILER)
THIN FILM SOLAR CELLS EACH SIDE

416 SQFT x 13 W/SQFT = 5.4kW
CONCLUSIONS

- Don’t let enthusiasm for boats be the driver, but it doesn’t hurt
- In many cases, ferries sink other concepts
- The real answers exist in the macro analysis
- An inefficient device can result in an efficient system
- Standardize, but standardize as little as possible
- Ferries may be the start-up app
- Ferries may be the killer app
- In our changing world, the flexibility of ferries is the secret sauce to increasing efficiencies and sustainability
- We did all of this before with shipping containers
“CHAOTIC BUT SMART VS ORDERLY BUT DUMB”  
- CHARLES MAROHN

For the full story, go to:

http://www.martinottaway.com/%5Bmenu-trail-parents-path-
raw%5D/maxi-taxi