Smart Cities and Data Analytics

Michael Hunter
Professor
Georgia Institute of Technology

2/29/2020
Or
What I would like to say to the future transportation leaders

Who conveniently are in this room.
People

human beings · persons · individuals · humans · mankind · humankind · the human race · Homo sapiens · humanity · the human species · mortals · (living) souls · personages · men, women, and children · folk · peeps
SAFETY FIRST!
## 10 Leading Causes of Death by Age Group, United States – 2014

<table>
<thead>
<tr>
<th>Rank</th>
<th>&lt;1</th>
<th>1-4</th>
<th>5-9</th>
<th>10-14</th>
<th>15-24</th>
<th>25-34</th>
<th>35-44</th>
<th>45-54</th>
<th>55-64</th>
<th>65+</th>
<th>Total</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>Congenital Anomalies 5,476</td>
<td>Unintentional Injury 1,236</td>
<td>Unintentional Injury 750</td>
<td>Unintentional Injury 750</td>
<td>Unintentional Injury 17,036</td>
<td>Unintentional Injury 17,357</td>
<td>Unintentional Injury 16,049</td>
<td>Malignant Neoplasms 44,634</td>
<td>Malignant Neoplasms 111,302</td>
<td>Heart Disease 469,722</td>
<td>Heart Disease 614,340</td>
</tr>
<tr>
<td>2</td>
<td>Short Gestation 4,173</td>
<td>Congenital Anomalies 399</td>
<td>Malignant Neoplasms 435</td>
<td>Suicide 425</td>
<td>Suicide 5,079</td>
<td>Suicide 6,569</td>
<td>Malignant Neoplasms 11,267</td>
<td>Heart Disease 34,791</td>
<td>Heart Disease 74,473</td>
<td>Malignant Neoplasms 413,893</td>
<td>Malignant Neoplasms 691,690</td>
</tr>
<tr>
<td>3</td>
<td>Maternal Pregnancy Comp. 1,574</td>
<td>Homocide 364</td>
<td>Congenital Anomalies 192</td>
<td>Malignant Neoplasms 416</td>
<td>Homocide 4,144</td>
<td>Homocide 4,150</td>
<td>Heart Disease 10,386</td>
<td>Unintentional Injury 20,010</td>
<td>Unintentional Injury 10,000</td>
<td>Chronic Lung Disease 24,693</td>
<td>Chronic Lung Disease 147,101</td>
</tr>
<tr>
<td>4</td>
<td>SIDS 1,549</td>
<td>Malignant Neoplasms 221</td>
<td>Homocide 123</td>
<td>Congenital Anomalies 166</td>
<td>Malignant Neoplasms 1,668</td>
<td>Malignant Neoplasms 1,624</td>
<td>Suicide 6,706</td>
<td>Suicide 8,676</td>
<td>Chronic Lung Disease 36,492</td>
<td>Chronic Vascular Disease 113,308</td>
<td>Unintentional Injury 38,068</td>
</tr>
<tr>
<td>5</td>
<td>Unintentional Injury 1,101</td>
<td>Heart Disease 149</td>
<td>Heart Disease 67</td>
<td>Heart Disease 93</td>
<td>Heart Disease 3,341</td>
<td>Heart Disease 2,936</td>
<td>Heart Disease 8,027</td>
<td>Diabetes Mellitus 13,342</td>
<td>Alzheimer’s Disease 92,604</td>
<td>Chronic Vascular Disease 153,103</td>
<td></td>
</tr>
<tr>
<td>6</td>
<td>Placenta Cord Membranes 896</td>
<td>Influenza &amp; Pneumonia 158</td>
<td>Chronic Lung Disease 63</td>
<td>Heart Disease 122</td>
<td>Congenital Anomalies 317</td>
<td>Liver Disease 720</td>
<td>Liver Disease 2,962</td>
<td>Diabetes Mellitus 90,002</td>
<td>Liver Disease 52,792</td>
<td>Diabetes Mellitus 64,181</td>
<td>Alzheimer’s Disease 93,041</td>
</tr>
<tr>
<td>7</td>
<td>Nontuberculous 544</td>
<td>Chronic Lung Disease 53</td>
<td>Influenza &amp; Pneumonia 67</td>
<td>Chronic Lung Disease 71</td>
<td>Influenza &amp; Pneumonia 199</td>
<td>Diabetes Mellitus 709</td>
<td>Diabetes Mellitus 1,890</td>
<td>Chronic Vascular Disease 5,549</td>
<td>Chronic Vascular Disease 11,737</td>
<td>Unintentional Injury 40,295</td>
<td>Diabetes Mellitus 76,489</td>
</tr>
<tr>
<td>8</td>
<td>Respiratory Disease 4,190</td>
<td>Septicemia 53</td>
<td>Cardiac Vascular 45</td>
<td>Cardiac Vascular 45</td>
<td>Cardiac Vascular 45</td>
<td>Cardiac Vascular 45</td>
<td>Cardiac Vascular 45</td>
<td>Cardiac Vascular 45</td>
<td>Cardiac Vascular 45</td>
<td>Cardiac Vascular 45</td>
<td>Cardiac Vascular 45</td>
</tr>
<tr>
<td>9</td>
<td>Cardiovascular Disease 444</td>
<td>Influenza &amp; Pneumonia 36</td>
<td>Cardiac Vascular 41</td>
<td>Chronic Lung Disease 178</td>
<td>Cardiac Vascular 579</td>
<td>Cerebrovascular 1,174</td>
<td>Cerebrovascular 1,745</td>
<td>Cerebrovascular 1,745</td>
<td>Cerebrovascular 1,745</td>
<td>Cerebrovascular 1,745</td>
<td>Cerebrovascular 1,745</td>
</tr>
<tr>
<td>10</td>
<td>Nontuberculous Meningitis 391</td>
<td>Pneumonia 35</td>
<td>Septicemia 33</td>
<td>Influenza &amp; Pneumonia 36</td>
<td>Cardiac Vascular 177</td>
<td>Influenza &amp; Pneumonia 540</td>
<td>Influenza &amp; Pneumonia 1,125</td>
<td>Septicemia 2,014</td>
<td>Influenza &amp; Pneumonia 5,339</td>
<td>Septicemia 29,124</td>
<td>Septicemia 42,173</td>
</tr>
</tbody>
</table>

Data Sources: National Vital Statistics System, National Center for Health Statistics, CDC. Produced by: National Center for Injury Prevention and Control, CDC using WISQARS™

Georgia Tech | Creating the Next
Who do we design for?

- Reasonable worst case
  - Reads road
  - Acts on feelings, impulse, attitude, frustration
- Not an analytical engineer
- Performs at 90\textsuperscript{th} – 99\textsuperscript{th} percentile
How many times is the basketball passed by players in **WHITE** shirts?
Source: Treat 1979

Figure 3-3. Contributing Factors to Vehicle Crashes
TRAFFIC ENGINEERING

...is the branch of engineering which applies technology, science, and human factors to the planning, design, operations, and management of roads, streets, bikeways, highways, their networks, terminals, and abutting lands...

- ITE Traffic Engineering Handbook
HUMAN FACTORS

…is the scientific discipline concerned with the understanding of interactions among humans and other elements of a system…

- International Ergonomics Association
Human Factors Applications

Transportation System Design & Traffic Guidance

Comprehensive Transportation System Planning

In-Vehicle Assist Technologies and Safety Systems
Technology

autonomous vehicle · connected vehicle · drones · cell phones · apps · video processing · side-fired radar · DSRC · cellular communication · pedestrian detection · 3D printing · hyperloop · internet of things · scooters, flying cars · and on · and on · and on · · ·
Driverless Car
“Nice, but as long as there are readers there will be scrolls.”
Everything Old is New Again
Autonomous Platoons

Join a road train

A safe and energy-efficient way to travel

Drivers who want to join a road train state their destination and are guided by their on-board navigation system. The lead vehicle already joins the rest of the queue and the system takes over control of the car.

The system is built into the cars and does not require any extended infrastructure along the existing road network.

As they approach their destination, drivers take over control of their own vehicles and travel on their own to their destination.

The other vehicles in the queue close the gap and continue together on their journey to the location where the last truck rejoins the rest of its individual vehicles.

The lead vehicle, for instance a bus, is driven by a professional driver. In this system, the lead vehicle takes over all the following vehicles via wireless radio communication.
Capacity: Maximum Sustainable Flow

Speed Flow Density Curve from the Highway Capacity and Quality of Service Manual
“3D printing has the potential to disrupt traditional supply chains and counteract the growth of imports by reducing the need for large-scale manufacturing, transportation, and storage.”

3D Printing

Manufacturers can render precise 3D objects, such as spare parts and cars—on demand.

3D printing will disrupt supply chains as manufacturing becomes decentralized.

The first 3D printed car was created in 2014.
Convergence of Transportation and Manufacturing
Law of Unintended Consequences
Data

signal phasing and timing · volume · emissions · density · location · occupancy · occupancy · basic safety message · time to impact · origin-destination · demand · speed · sample vs screenline · fuel consumption · delay · ridership · headway · illumination · toilet flushes · · ·
Key Attributes

- Volume
- Velocity
- Variety
  - structured, unstructured, video…
- Veracity
  - Accuracy / data quality
- Variability
  - Variations from day to day within the same class
- Visualization
- Value
Little Data

Not all Data is big.

Not all big Data is useful.
Requirements

• Who needs it?

• Who gets in trouble if it is not there?
Emerging Technologies

Adaptive Signal Control - Hardware in the Loop Evaluation

HILS Architecture/Implementation

SCATS PM Southbound Base Travel Time
People  Technology  Data
The intuitive mind is a sacred gift and the rational mind is a faithful servant. We have created a society that honors the servant and has forgotten the gift. –Albert Einstein
Thank you for your time.

Please feel free to contact me at michael.hunter@ce.gatech.edu