JCE 3460
Transportation Engineering

Introduction
Tonight’s Agenda

- Student and Instructor Expectations
- Course Overview
- What is Transportation Engineering?
- Relax, you won’t be tested on anything covered TONIGHT!
Who is this guy?

- Licensed Professional Engineer: CO, IL, KY, MN, MO, NC, WI, NV
- Certified Professional Traffic Operations Engineer
- Certified Professional Transportation Planner
- Education
  - B.S. Environmental Engineering; USMA at West Point, 1993
  - M.S. Civil Engineering; University of Wisconsin at Madison, 1997
- Principal/Vice President/COO @ CBB
- Active in Professional Organizations
  - ITE: International Past President (2017)
  - MOVITE: Past President (2009)
  - TEAM: Past President (2005) and current Chapter Administrator
  - TRB: Military Transportation Committee
Experience

- **20 Years of Consulting**
  - Traffic Engineering and Transportation Planning
- **US Army – 1986 to 2003 (Active and Reserve)**
  - US Army Corps of Engineers (Commissioned)
  - Radio Operator (Enlisted)

- **Teaching Experience**
  - Wash U/UMSL Joint Engineering Program since 2003
    - Transportation Engineering JCE3460/CE346
    - Highway & Traffic Engineering JCE4600/CE445
    - Traffic Operations and Analysis
    - Special Topics in Civil Engineering
Teaching Philosophy

- Who you are:
  - Bright and intelligent students
  - You have an interest in transportation

- My job:
  - My job is not to lecture you, but to help you learn
  - I want to enrich your education experience

- Instructor Approach
  - This is all about YOU
  - My main asset is experience focused through an “academic” lens
  - Communication is key – let me know if you are unhappy

- Teaching Methods
  - I tend to ask for a lot of student interaction, please let me know if this makes you uncomfortable
You are paying for this class, help me make it a success for YOU!

- Who are you? (Name / major)
- What is your transportation background?
- What are your future plans (for now, anyway)?
- What you want to get out of this class?
- What you expect from me?
- What are your classroom pet peeves?
  - Best classroom experience
  - Something that make you crazy
Past Comments

What would you tell to other students:
- Writing intensive class about the history of transportation in America and the current issues and practices of transportation engineering today.
- There is a lot of outside research and writing that is not covered in class.
- The textbook is not used in all exams.
- The TA is just the grader.

Suggestions
- Spread out the workload throughout the semester. Many points fall within the last few weeks.
- Give students more guidance or exposure to answers for more of the take home midterms. Let students know that this is more of a writing class. Cover more materials in the midterms in class.
- Teach more from lectures. Do not assign papers to have the class research and learn about transportation.
- Provide a list of useful websites that pertain to the area of interest in the midterm questions.
- Provide a less broad description of the final project would help students not waste as much time with irrelevant and insignificant research.
- Inform students at the beginning of the course that they will be graded by the standard of the best answers given by the class--the scale is set by class.

What they liked:
- “Open floor” feel of this class. Great discussions with interactive group.
- Speakers at the end of the semester – their messages will stick with me throughout my career.
What are we doing here?

- Fundamental treatment of the planning, engineering, design, and procedural aspects of multimodal transportation are covered. Intermodal freight and urban transportation planning processes and overview of environmental, energy, and economic issues are discussed.
Transportation Courses

- JCE 3460 – Transportation Engineering
- JCE 4600 – Highway and Traffic Engineering
Classroom Schedule

- Anticipated Schedule
  - 7:00 PM – 7:50 PM Block 1
  - 7:50 PM – 8:00 PM Break 1
  - 8:00 PM – 8:50 PM Block 2
  - 8:50 PM – 9:00 PM Break 2
  - 9:00 PM – 10:00 PM Block 3

- PLEASE REMIND ME OF THE BREAKS!
Course Format

- Encouraged
  - Ask questions and participate in discussions on lecture material
  - Let me know when I make an error
  - Find and discuss transportation related current events
  - Remind me when it is break time
  - Be patient and constructive, this course is a work in progress

- Good, healthy, heated debates are the best way to explore complex material
Course Text

- Purchase from ITE
- www.ite.org
- Student/member discounts apply
  - http://www.ite.org/students/index.asp
Communication

- Email – sleight@wustl.edu
- Phone
  - Work – 314-449-8241
  - Cell – 314-922-3099
- Please no calls after 9PM
- Office hours will be set up by request
- Course Website - [http://classes.engineering.wustl.edu/jce4600/](http://classes.engineering.wustl.edu/jce4600/)

- Please send me your email!
- Send me a grade sheet “code” (NOT SSN or Student ID).
Grading

- **Grading**
  - 10% Class Participation
  - 30% Course Project
    - 10% Report
    - 10% Instructor Presentation Grade
    - 10% Peer Presentation Grade
  - 60% Midterm Exams
    - 20% Each

- **Late Assignment** Default is “F”
  - If you have emergency, talk with me as soon as you can and we’ll work something out
Writing 101

- Answer the **whole question**.
  - Read and break down the question.

- **Give complete answers.**
  - Include beginning, middle, and end.

- **Do research. Cite sources.**
  - Give credit to others for their work
  - Show that you did the research
  - Help those who follow

- **Thoughts on original thought.**
  - Do your research on the material requested. Then, put it in your words.
  - Copy/paste is just being lazy.

- **Be precise.**
  - Facts are facts. Opinions are opinions. Be clear about what you present as facts and what you present as opinions.

- **Be concise.**
  - Don’t rabbit trail.
  - Stick to the point.
Why are you taking JCE 3460 and what are your expectations for the course?

- The paragraph below states why I decided to take JCE 3460 and my expectations for the course. One reason that I decided to take JCE 3460 is because passing this course is a requirement to obtain a Civil Engineering degree from the UMSL/Wash U Joint Undergraduate Engineering Program and I am a student in this program (www.umsl.edu/divisions/engineering/Civil%20Engineering/index.html). Moreover, I have been told by others who have previously taken the course that it is an informative and interesting way to learn about transportation engineering (interviews with Josh Q. Traffic and Amy P. Transportation). I am interested in learning about this subject matter. My expectations are that by participating in this course I will learn the “fundamental treatment of the planning, engineering, design, and procedural aspects of multimodal transportation”, “intermodal freight and urban transportation planning processes”, and an “overview of environmental, energy, and economic issues” (Course Spring 2014 Syllabus). Thus, I am taking JCE 3460 because it is a step toward earning a Civil Engineering degree and I expect that it will be a good way for me to learn about transportation engineering.

What isn’t included:

- This is the “best course” in the program. (Fact or opinion?)
- Discussion about the Thermo class that you took last semester
Policy on Academic Integrity

- Students are expected to conform to high standards of conduct. Please ask me if you have any questions during the course of the semester.
  - [http://www.wustl.edu/policies/undergraduate-academic-integrity.html](http://www.wustl.edu/policies/undergraduate-academic-integrity.html)
  - [http://engineering.wustl.edu/ess/academic-integrity.aspx](http://engineering.wustl.edu/ess/academic-integrity.aspx)

- Although the course project will be completed in groups, JCE 3460 is a course based upon **individual achievement**. It is acceptable to go to your classmates for help on homework problems but each student is responsible to complete their own work.

- Video: [http://studentconduct.wustl.edu/academic-integrity/](http://studentconduct.wustl.edu/academic-integrity/)
Policy on Academic Integrity

- Violations include, but are not limited to:
  - **Plagiarism**: Taking someone else's ideas, words, or other types of work product and presenting them as one’s own.
  - **Cheating**
  - **Copying/collaborating on assignments without permission**
  - **Fabrication/falsification of data**
  - Submitting the same work to multiple courses without permission
  - **Requesting an academic benefit based on false information**
    - Extension of time, a better grade, or a recommendation
  - **Making changes to material submitted for a re-grade**
  - Willfully damaging the efforts or work of other students
  - **Stealing, defacing, or damaging academic facilities or materials**
  - **Collaborating with other students in academic misconduct**
  - Submitting academic work under someone else’s name
  - [http://www.wustl.edu/policies/undergraduate-academic-integrity.html](http://www.wustl.edu/policies/undergraduate-academic-integrity.html)
Keys to success

- Attend lectures/take notes
- Practice Student Academic Integrity
- Participate
- Don't leave the course project until the end
Class Project

- Define a local transportation opportunity or need
- Who is responsible?
- What solution would be required to address the opportunity or need?
- What challenges, barrier, and constraints stand in the way of your solution?
- Deliverable: 10-20 page proposal to the responsible agency
  - Define opportunity or need
  - Demonstrate why addressing the opportunity/need should be a priority for the responsible agency
  - Illustrate your conceptual design to address this opportunity or need. Why is yours the best solution?
  - Discuss the challenges, barriers, and constraints to the implementation of your solution and how these can be overcome.
- 20 Minute presentation during final class period
- Work in groups of 2 to 3
- **Bring 3 topic ideas to the next class**
BREAK
JCE 3460

So you want to be a Traffic Engineer?
What is Transportation Engineering?

- Transport
  - to carry from one place to another

- Engineering
  - the application of scientific principles to practical ends as the design, construction, and application of efficient and economical structures, equipment, and systems.
Ice Breaker
Back to Basics: What People Think we do

What we REALLY do: Mobility

- 2nd Largest Inland Port
- 2nd & 3rd Largest Rail Hubs
- Major Interstate Hub
Estimated Vehicle Miles Traveled on All Roads

- Trillions
- Recessions
- Miles Traveled: 12 Month Moving Average


- Nov 2007
- Nov 2011 trough at 48 months after peak, 3.65% off high

39 months below previous peak -3.2% at trough

A Close Look Since 2007

Trillions

What’s Changed?

Old Trends
- Urban sprawl
- Development patterns
- Two earner households
- More vehicles/drivers
- Global economy
- Kid activities

New Trends
- Internet
- Modal Shifts
- Technology
- Sharing Economy
Estimated Vehicle Miles Traveled on All Roads

Latest down 3.16% from peak 11.8 years later

55 months total, 21 months to 5.0% trough

Jan 1971

Jun 2005

Population adjusted using the BEA Mid-month population estimates [FRED POPTHM]
Peak-Period Congestion on High-Volume Truck Portion: 2011

Notes: High-volume truck portions of the National Highway System carry more than 8,500 trucks per day, including freight-hauling long-distance trucks, freight hauling local trucks, and other trucks with six or more tires. Highly congested segments are stop-and-go conditions with volume/service flow ratios greater than 0.95. Congested segments have reduced traffic speeds with volume/service flow ratios between 0.75 and 0.95. The volume/service flow ratio is estimated using the procedures outlined in the HPMS Field Manual, Appendix N.

First-ever #AmazonPrimeAir customer delivery is in the books. 13 min—click to delivery. Check out the video: amzn.to/primeair
What we do: Safety

<table>
<thead>
<tr>
<th>Rank</th>
<th>Infants Under 1</th>
<th>Toddlers 1-3</th>
<th>Young Children 4-7</th>
<th>Children 8-15</th>
<th>Youth 16-20</th>
<th>Young Adults 21-24</th>
<th>Other Adults 25-34</th>
<th>Other Adults 35-44</th>
<th>Other Adults 45-64</th>
<th>Elderly 65+</th>
<th>All Ages</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>Perinatal Period 12,999</td>
<td>Congenital Anomalies 406</td>
<td>Malignant Neoplasms 374</td>
<td>MV Traffic Crashes 851</td>
<td>MV Traffic Crashes 3,947</td>
<td>MV Traffic Crashes 3,278</td>
<td>Accidental Poisoning 6,209</td>
<td>Malignant Neoplasms 12,519</td>
<td>Malignant Neoplasms 157,445</td>
<td>Heart Disease 479,152</td>
<td>Heart Disease 599,413</td>
</tr>
<tr>
<td>2</td>
<td>Congenital Anomalies 5,319</td>
<td>Accidental Drowning 405</td>
<td>MV Traffic Crashes 338</td>
<td>Malignant Neoplasms 716</td>
<td>Homicide 2,386</td>
<td>Homicide 2,347</td>
<td>MV Traffic Crashes 5,651</td>
<td>Heart Disease 11,081</td>
<td>Heart Disease 104,188</td>
<td>Malignant Neoplasms 391,038</td>
<td>Malignant Neoplasms 567,628</td>
</tr>
<tr>
<td>3</td>
<td>Heart Disease 386</td>
<td>Homicide 336</td>
<td>Congenital Anomalies 184</td>
<td>Suicide 468</td>
<td>Suicide 1,948</td>
<td>Suicide 2,219</td>
<td>Suicide 5,320</td>
<td>Accidental Poisoning 7,388</td>
<td>Chronic Lwr. Resp. Dis. 18,824</td>
<td>Chronic Lwr. Resp. Dis. 117,099</td>
<td>Chronic Lwr. Resp. Dis. 137,353</td>
</tr>
<tr>
<td>4</td>
<td>Homicide 317</td>
<td>MV Traffic Crashes 268</td>
<td>Accidental Drowning 139</td>
<td>Homicide 362</td>
<td>Accidental Poisoning 1,025</td>
<td>Accidental Poisoning 1,984</td>
<td>Homicide 4,222</td>
<td>Suicide 6,677</td>
<td>Chronic Liver Disease 17,531</td>
<td>Stroke 109,239</td>
<td>Stroke 128,842</td>
</tr>
<tr>
<td>5</td>
<td>Influenza/Pneumonia 234</td>
<td>Malignant Neoplasms 262</td>
<td>Exposure to Smoke/Fire 115</td>
<td>Congenital Anomalies 273</td>
<td>Malignant Neoplasms 714</td>
<td>Malignant Neoplasms 816</td>
<td>Malignant Neoplasms 3,859</td>
<td>MV Traffic Crashes 4,856</td>
<td>Diabetes 17,086</td>
<td>Alzheimer’s 78,168</td>
<td>Alzheimer’s 79,003</td>
</tr>
</tbody>
</table>

| Septicemia | Heart | Homicide | Heart | Heart | Heart | Heart | Homicide | Stroke | Diabetes | Diabetes |
Annual traffic accident cost are about $2000 per typical American family
2013 Fatality Rates by Age and Sex
2013 Injury Rates by Age and Sex
Primary Contributing Cause in the St. Louis, Missouri Region

Contributing Factors in 1,777 Fatal Crashes
East-West Gateway Region 1997-2002

<table>
<thead>
<tr>
<th>Cause</th>
<th>Percentage</th>
</tr>
</thead>
<tbody>
<tr>
<td>Inattention</td>
<td>35%</td>
</tr>
<tr>
<td>Drinking</td>
<td>30%</td>
</tr>
<tr>
<td>Speeding</td>
<td>15%</td>
</tr>
<tr>
<td>Too fast for Conditions</td>
<td>10%</td>
</tr>
<tr>
<td>Failure to Yield</td>
<td>5%</td>
</tr>
</tbody>
</table>

DEATHS FROM MOTOR VEHICLE CRASHES
Per 100,000 population, 2002

1. Austin: 18.3
2. Nashville: 19.2
3. Phoenix: 17.4
4. Memphis: 16.6
5. San Antonio: 15.1
6. Oklahoma City: 14.6
7. Houston: 14.5
8. Kansas City: 14.3
9. St. Louis: 14.2
10. Louisville: 13.8
11. Atlanta: 13.5
12. Charlotte: 12.6
13. Dallas: 12.5
14. Columbus: 11.5
Average: 11.2

United States Census Bureau, 2000
Are we making Improvements?

Fatalities and Fatality Rate per 100M VMT by Year

FARS 1975–2010 (Final) 2011 Annual Report File (ARF); Vehicle Miles Traveled (VMT); Federal Highway Administration.
Motorcycles

Motorcycle Rider Fatality and Injury Rates per 100 Million Vehicle Miles Traveled, 1975-2004

Fatality Rate per 100 Million Vehicle Miles Traveled

Injury Rate per 100 Million Vehicle Miles Traveled

What we REALLY do: Sustainability

- Active Transportation (e.g., Bike Share)
- Land Use/ Place Making (e.g., Density, Parking Requirements, and Set-backs)
- Reduce VMT
- Electrification (e.g., Busses, Charging Stations, Parking Codes)
- Maintenance and Operations
- Revenue
Transportation Impacts

- “Measurable” Impacts
  - Safety
  - Delay and Congestion
  - Transportation Costs

- “Soft” Impacts
  - Sense of Community
    - New Urbanism, Urban Sprawl, Transit Oriented Design
  - Public Health
    - Obesity in our Vehicle Dependent Culture
  - Economic Development
System with Choices

Missouri’s Four Transportation Goals

- **Maintenance**: Take care of the transportation system and services we enjoy today
- **Safety**: Keep all travelers safe, no matter the mode of transportation
- **Economic Development**: Invest in projects that spur economic growth and create jobs
- **Connections and Choices**: Give Missourians better transportation choices (more viable urban and rural transit, friendlier bike and pedestrian accommodations, improvements in rail, ports and airport operations)
Congestion costs to the U.S. economy total about $90 Billion Annually, This is about the same economic impact as 9/11 had on NYC.

the average household spent $6000 — one fifth of its total expenditures — on transportation in 1995.

What we REALLY do: Access to Opportunity

- Enhanced Public Transport
- Mobility on Demand and the Sharing Economy
- Services (e.g., Wifi, Mobile Learning, Metro Market)
What we REALLY do: Access to Opportunity
Local Decisions Make a Difference

Lambert Airport

Kansas City Airport

Eads Bridge
Regional Steps Forward: St. Louis

- **Public Transportation**
  - Metrolink (1993)
  - Cross County Metrolink Line Opens (2006)
  - St. Louis Multi-modal Center (2008)
  - St. Louis County Prop A for Metro (2010)
  - St. Louis Rapid Transit Connector-BRT-Study (2013)
  - St. Louis Streetcar Feasibility Study (2013)
  - Delmar Loop Trolley (Anticipated 2015)

- **Bicycles and Pedestrians**
  - Great Rivers Greenway Trail District (2000)
  - East West Gateway Great Streets Program (2006)
  - City of St. Louis Complete Streets Ordinance (2010)
  - Bike STL On-Street Bicycle Facility Plan (2011)
  - St. Louis County Complete Streets Ordinance (2014)
  - Regional Bike Share Study (2014)
  - Northside Southside Metrolink Study (2017)

- **What is the next Game Changer?**
The Surface Transportation System

- Driver
- Vehicle
- Other Vehicles
- Roadway
  - Road Surface, Roadway Width, Curvature, Sight Lines
- Traffic Control
  - Signs, Traffic Lights, Traffic Cops
- Obstructions and other Factors
  - Animals, Weather
Integrated Approach

Engineering

Enforcement

Education

THE DIFFERENCE IS YOU
DRIVE SMART

www.MoDOT.org
Roadway Engineering

- Make the Roadway Easier to Drive
- Make Crashes More Survivable
  - Vehicles
  - Forgiving Roadways
    - Clear Zones
    - Breakaway Light Poles
    - Barrier Construction
- Roadway Bottlenecks and Congestion
- Access Management
- Managed Roadways
- Intersection Design
  - Roundabouts
  - Traffic Calming
  - Interchanges
Traffic Operations and Control

- Optimized Traffic
  - Traffic Signal Systems
  - Ramp Metering

- Driver Information
  - CCTV
  - Variable Message Signs

- Positive Guidance

- MUTCD

- Enforcement

- Incident Management
Driver Education and Enforcement

- Motorcycle Helmet Laws
- Driver Education and Testing
  - Graduated Driver’s Education
  - Older Drivers Programs
- Drinking and Driving
  - MADD
  - Coordinated License Suspension Programs
- Speed Enforcement
  - Photo Enforcement
  - Radar/Laser
- Distracted Drivers
  - Cell Phone Laws
Driver Behavior
Automotive Engineering

- Crash Survivability
  - Seatbelts
  - Airbags
  - Safety Glass
  - Crumple Zones

- Crash Avoidability
  - Anti-lock Brakes
  - Traction Control
  - “Heads Up” Displays

- New Technology
  - http://www.snagfilms.com/films/title/the_thinking_car
Transportation Disruptors
Technology. Flying Cars?
The Technology is Here

http://www.youtube.com/watch?v=DFNeflOmmkk#t=183
Self Driving Vehicles

SOCIETY OF AUTOMOTIVE ENGINEERS (SAE) AUTOMATION LEVELS

<table>
<thead>
<tr>
<th>Level</th>
<th>Automation Type</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>0</td>
<td>No Automation</td>
<td>Zero autonomy; the driver performs all driving tasks.</td>
</tr>
<tr>
<td>1</td>
<td>Driver Assistance</td>
<td>Vehicle is controlled by the driver, but some driving assist features may be included in the vehicle design.</td>
</tr>
<tr>
<td>2</td>
<td>Partial Automation</td>
<td>Vehicle has combined automated functions, like acceleration and steering, but the driver must remain engaged with the driving task and monitor the environment at all times.</td>
</tr>
<tr>
<td>3</td>
<td>Conditional Automation</td>
<td>Driver is a necessity, but is not required to monitor the environment. The driver must be ready to take control of the vehicle at all times with notice.</td>
</tr>
<tr>
<td>4</td>
<td>High Automation</td>
<td>The vehicle is capable of performing all driving functions under certain conditions. The driver may have the option to control the vehicle.</td>
</tr>
<tr>
<td>5</td>
<td>Full Automation</td>
<td>The vehicle is capable of performing all driving functions under all conditions. The driver may have the option to control the vehicle.</td>
</tr>
</tbody>
</table>
"We can align what we're seeing to what's stored on the map. That allows us to very accurately—within a few centimeters—position ourselves on the map," said Dmitri Dolgov, the self-driving car team's software lead. "Once we know where we are, all that wonderful information encoded in our maps about the geometry and semantics of the roads becomes available to the car." The Atlantic

http://www.youtube.com/watch?v=TsaES--OTzM
Connected Vehicles

- USDOT initiative
- Major safety benefit
- EMS Traffic Signal Preemption since 1960s
- Connected Vehicle Pilot Deployment Program
  - New York City
  - Tampa
  - Wyoming
- Significant recent discussion on regulatory aspects
Why now?

- Enabling Technology is Ready
- Private Market Driven & Funded
- We have a new concept of “privacy”

“The unprecedented commitment means that this important safety technology will be available to more consumers more quickly than would be possible through the regulatory process.”
Transportation Innovators: Old School

ITE Founders
- W. Graham Cole
- Ernest P. Goodrich
- Maxwell N. Halsey
- Harry H. Hemmings
- Reyburn P. Hoffmann
- John F. Hurley
- Arthur N. Johnson
- Guy Kelcey
- Miller McClintock
- Lewis W. McIntyre
- Donald M. McNeil
- Burton W. Marsh
- Theodore M. Matson
- Irving C. Moller
- Earl J. Reeder
- Joseph G. Regan
- Ladislas Sego
- Hawley S. Simpson
- Peter J. Stupka
How will we move?

Population Increase
2015: 320 million people
2045: 390 million people
In 30 years our population is expected to grow by about 70 million... that's more than the current populations of NY + TX + FL

Older Americans — Redefining Longevity
By 2045, the number of Americans over age 65 will increase by 77%.
About one-third of people over 65 have a disability that limits mobility. Their access to critical services will be more important than ever.

Millennials — Shaped by Technology
There are 73 million Millennials aged 18 to 34. They are the first to have access to the internet during their formative years and will be an important engine of our future economy.
Millennials are driving less. By the end of the 2000s, they drove over 20% fewer miles than at the start of the decade.

Income Inequality
10% of the population takes home one-third of our national income. Transportation is the second-largest expense for U.S. households.

Megaregions and Shifts in Population Centers
11 megaregions are linked by transportation, economics, and other factors. They represent over 75% of our population and employment.
In 2014, 365,000 people moved to the South—up 25% from 2013—and moves to the West doubled.

On average, we spend over 40 hours stuck in traffic each year.
The annual financial cost of congestion is $121 billion.
How will we move things?

Transportation and the Economy
By 2045, the U.S. economy is forecast to grow by 115% to $36.7 trillion—and the transportation sector will represent about $1.6 trillion of total Gross Domestic Product.

Global Demand for U.S. Products
Global trade is one of the brightest spots in our economy.

The U.S. energy boom is placing unprecedented demand on our transportation system.

Crude oil production is up 50% since 2008
Rail carried 400,000 carloads of crude oil in 2013

42x the 9,500 carloads of crude oil in 2008

By 2040, U.S. freight volume will grow to 29 billion tons—an increase of 45%.

Major gains in freight movement are predicted by 2040

By 2040, the value of freight will grow to $39 trillion—an increase of 125%.

Freight Movement is Multimodal
Every mode of transportation moves freight, but trucking is the primary mode of freight travel.

<table>
<thead>
<tr>
<th>Mode</th>
<th>2012 (in tons)</th>
<th>2040 (in tons)</th>
<th>Change</th>
</tr>
</thead>
<tbody>
<tr>
<td>Truck</td>
<td>13.2 billion</td>
<td>18.8 billion</td>
<td>+43%</td>
</tr>
<tr>
<td>Rail</td>
<td>2.0 billion</td>
<td>2.8 billion</td>
<td>+37%</td>
</tr>
<tr>
<td>Waterborne</td>
<td>975 million</td>
<td>1.1 billion</td>
<td>+10%</td>
</tr>
<tr>
<td>Air</td>
<td>15 million</td>
<td>53 million</td>
<td>+250%</td>
</tr>
</tbody>
</table>

System Performance and the Cost of Congestion
By 2040, nearly 30,000 miles of our busiest highways will be clogged on a daily basis.

Truck congestion wastes $27 billion in time and fuel annually.
How will we adapt?

Our changing climate is disrupting transportation systems in the U.S. and abroad. 100-year devastating storms used to occur once a century...

... but with the climate changing, they could occur every 3 to 20 years (by 2080).

We’re Heating Up
Average U.S. temperatures are rising.

By 2050, our temperature is predicted to rise 2.5° F

Scientists say we need to avert a 2° F increase in temperature to avoid the most catastrophic impacts of climate change.

Globally, the 10 warmest years have occurred since 1998.

U.S. droughts and western wildfires cost $30+ billion in 2012 alone.

In extreme heat:
- Roads deteriorate faster
- Truck tires are prone to blow out
- Rail track buckles
- Inland waterway traffic is disrupted during droughts

Rising Sea Levels Will Disrupt Transportation

Superstorm Sandy’s surge damaged electrical systems, highways, rail track, runways, and port cargo. The cost to the U.S. economy was an estimated $65 billion.

U.S. Airport Elevations

Sea level is projected to rise up to 4 feet (2100)

Sea level is projected to rise up to 1 foot (2045)

The transportation sector is the second-biggest source of greenhouse gases (GHGs) in the U.S.

Transportation emits 28% of GHGs

New stronger fuel economy standards will double the efficiency of our cars and trucks. Corporate Average Fuel Economy Standards have saved 14 billion tons of CO₂ emissions since 1970.

<table>
<thead>
<tr>
<th>Year</th>
<th>Gas Mileage</th>
</tr>
</thead>
<tbody>
<tr>
<td>1979</td>
<td>19.0 MPG</td>
</tr>
<tr>
<td>2016</td>
<td>34.6 MPG</td>
</tr>
<tr>
<td>2021</td>
<td>41.1 MPG</td>
</tr>
</tbody>
</table>
**How will we align decisions & dollars?**

### Transportation Investment
Improving the condition and performance of the transportation system will cost

- **$120 billion** for highways and bridges between 2015 and 2020. Current annual spending at all levels of government—federal, state and local—is just **$83.1 billion.**
- **$43 billion** for public transportation. Meanwhile, annual capital spending is just **$17.1 billion.**

### To compete in the global economy, the U.S. needs a world-class transportation system. Some of our most critical transportation infrastructure is crumbling.

- **65%** of U.S. roads are in **less than good condition.**
- **25%** of U.S. bridges **need significant repair or can’t handle today’s traffic.**
- **50%** of locks and chambers are **more than 50 years old.**

### Overall U.S. Infrastructure Grade

<table>
<thead>
<tr>
<th>Our World Standing</th>
<th>Quality of roads 2008</th>
<th>8th</th>
</tr>
</thead>
<tbody>
<tr>
<td>Quality of roads 2014</td>
<td>16th</td>
<td></td>
</tr>
</tbody>
</table>

### Transportation Spending is in Decline
Our highway and mass transit accounts are trending toward the red. The Federal gas tax is no longer enough to address our transportation needs.

- The Federal gas tax has not increased for over 20 years... 
  - **1993:** 1¢/gal
  - **2015:** 1¢/gal
  - **... and the value of the dollar has declined.**

- Transportation Trust Fund projected annual shortfall
  - Transit: **-$4 billion**
  - Highway: **-$12 billion**

### Oregon Pilots Road User Charges
Oregon is one of many States seeking new revenues to make up for transportation budget shortfalls.

- **1.56¢**

  - **30¢/gal**
    - 1 MILE
    - During a recent pilot program in Oregon, participants paid 1.56 cents per mile driven rather than a state tax of 30 cents per gallon of gasoline.

- Over the next decade higher fuel economy standards will result in more than **$50 billion** in lost gas tax revenues.
How will we move better?

More and more, the transportation sector is relying on data to drive decisions, and on technology to reimagine how we move people and goods.

**Connected Vehicles**
Vehicles that communicate are the latest innovation in a long line of **successful safety advances**.

The motor vehicle fatality rate has dropped by **80%** over the past 50 years.

Connected vehicles and new crash avoidance technology could potentially address **81%** of crashes involving unimpaired drivers.

**Robotics**
Advances in robotics are changing transportation operations and will impact the **future transportation workforce**.

Robots will perform vital transportation functions, such as critical infrastructure inspection.

**NextGen**
GPS and new technologies are leading to a **safer, more efficient** U.S. airspace.

By 2020, **one-second updates** will pinpoint the **aircraft location and speed** of 30,000 commercial flights daily.

**Real-time Travelers**
Mobile access to everything from **traffic data to transit schedules** informs our travel choices.

90% of American adults own a mobile phone.

20% use their phones for **up-to-the-minute** traffic or transit information.

Smartphones are regularly used for **turn-by-turn navigation**.

**Big data** is all around us. Global data generated is projected to grow by **40%** annually.

Data enables innovative transportation options, such as car-sharing, ride-sharing, and **pop-up bus services**, and more **rapid delivery of goods**.
Internet: The New Transportation Mode?

By 2016 10% of all US retail sales are expected to be made via ecommerce
Rise of Smart Cities
MOBILITY AS A SERVICE FRAMEWORK

MOBILITY OPERATOR

MY MOBILITY SERVICES

SERVICE PLATFORM
- TRANSPORTATION
- FLEET
- INFRASTRUCTURE

DATA
Where is all of this really going?????

- Will full automation on cars be required?
- Will we be able to speed?
- How does this impact vehicle ownership models?
- How does this impact AADT?
- Will we need more or less roadway infrastructure in the future?
- Will we still need downtown parking?
- Is this the end of the commercial driving?
- The end of NASCAR?
- How does this impact military transportation
What Could Possible go Wrong?

- https://www.youtube.com/watch?v=5UBdrMTxsvs
- http://www.youtube.com/watch?v=DFNeflOmmkk#t=183
- http://www.youtube.com/watch?v=cdgQpa1pUUE
- http://www.youtube.com/watch?v=TsaES--OTzM
- http://www.youtube.com/watch?v=POcQUTlOvZs
- https://www.youtube.com/watch?v=5UBdrMTxs-vs
BREAK
JCE 3460
Traffic Engineering Roles and Careers
Students Make a Difference!

- Student Leadership Summit
  - 2014-2018, Western District
  - 2016-2018, Midwest/Great Lakes
  - 2018, Florida
  - 2018, Northeast
  - 2019, Australia
What is Transportation Engineering?  
- Technical Side

- **Numbers & Equations** - Evolving Technical Standards
  - (HCM, AASHTO, MUTCD)
  - Based on Ever Growing Body of Research

- **Creativity** - Evolving Engineer’s “Toolbox”
  - (ITS, Traffic Calming, Roundabouts)

- **Computers** - Evolving Analysis Tools
  - Microsimulation (CORSIM, MITSIM, VISSIM)
  - Analytical Analysis (HCS, aaSIDRA, SYNCHRO)
  - Travel Demand Modeling (Tramplan, TransCad)
What is Transportation Engineering?

- People Side

- Public Infrastructure = Public Spotlight
- Communication Skills
  - Project Teams (Environmental Studies, Archeologists, Public Relations, Structural Engineers, Highway Designers)
  - Public Relations
- It’s all about **Solving Problems** in a World FULL of **Conflicting Priorities**
- **No Textbook Solutions!**
Roles of Transportation Engineers (i.e., What Jobs are Out There?)

- Public Sector
  - Federal Government
  - Regional MPO (East-West Gateway)
  - State DOT
  - County Highway Department
  - City Public Works

- Private Sector
  - Consulting Firm
  - Transportation Company

- Academia
Federal Agencies

Policy, Standards, and Oversight

- Bureau of Transportation Statistics (BTS)
- Federal Aviation Administration (FAA)
- Federal Highway Administration (FHWA)
- Federal Motor Carrier Safety Administration (FMCSA)
- Federal Railroad Administration (FRA)
- Federal Transit Administration (FTA)
- Maritime Administration (MARAD)
- National Highway Traffic Safety Administration (NHTSA)
- Office of the Inspector General (OIG)
- Research and Special Programs Administration (RSPA)
- Saint Lawrence Seaway Development Corporation (SLSDC)
- Surface Transportation Board (STB)
- Transportation Administrative Services Center (TASC)
- Transportation Security Administration (TSA)
- United States Coast Guard (USCG)
Regional Metropolitan Planning Organization (MPO)

- **Federal Transportation Funding Prioritization**
  - Decisions Made by a Board of Directors
    - Usually lead by locally elected officials and regional leaders

- **MPO Staff assists Board in Determining Regional Transportation Priorities**
  - Regional Travel Demand Modeling
  - Regional Transportation Investment Studies

- **Regions**
  - St Louis - East-West Gateway Council of Governments
  - Kansas City - Mid-America Regional Council
  - Springfield - Springfield Area Transportation Study Organization
State DOT

- Implements MPO, Federal, and Highway Commission Priorities Through Projects

MoDOT - five major transportation alternatives
  - highways, aviation, waterways, transit and railroads

Highway Department
  - Planning (EIS, Multi-Modal, State Policies and Standards)
  - Design (In house Teams, Lead Consulting Teams)
  - Construction (Bidding/Letting, Inspection)
  - Maintenance (Plowing, Repairs)
  - Operations (Signal Systems, ITS)
Transit Authority

- Transit Planning and Operations
  - Metro
    - MetroLink Light Rail
    - MetroBus
    - Call-A-Ride Paratransit
    - Downtown Airport (Cahokia/Sauget, IL.)
- Kansas City Area Transportation Authority
  - Metro bus
  - AdVantage Vanpool
County Highway Department

- Similar Duties as State DOT
  - Design and Oversee Construction Projects
  - Roadway Maintenance
  - Traffic Signal Operations
- St. Louis County Highway System
  - 3,092 roadway lane miles
  - 200 bridges
City DPW

- **Similar Duties as County Highway Department**
  - Design and Oversee Construction Projects
  - Roadway Maintenance
  - Traffic Signal Operations

- **Address Local Problems**
  - People are driving too fast on my street
  - I want more parking in front of my business
  - There is too much cut-through traffic in my neighborhood
  - I want (don’t want) sidewalks on my street

- **Business Development**
  - Access Control
  - Traffic Impacts
## Private Consulting Firm Support Other Agencies

<table>
<thead>
<tr>
<th></th>
<th>International</th>
<th>Local</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Examples</strong></td>
<td>Jacobs (Sverdrup) Ch2M Hill</td>
<td>CBB EFK Moen</td>
</tr>
<tr>
<td><strong>Culture</strong></td>
<td>Professional Bureaucratic</td>
<td>Informal Family</td>
</tr>
<tr>
<td><strong>Benefits</strong></td>
<td>Wide Geographic Reach (Projects and Transfers) Big Projects</td>
<td>Potential Ownership Involvement at all Levels Bonus Structure</td>
</tr>
<tr>
<td><strong>Clients</strong></td>
<td>Prime Consultants for Big Projects</td>
<td>Subconsultant to Large Firms Public Agencies (Small Projects) Private Developers</td>
</tr>
</tbody>
</table>
Transportation Company

- **Freight**
  - Roadways (Trucking Company)
  - Railroads
  - Air
  - Waterways

- **People**
  - Airlines
  - Charter Busses
  - AMTRACK
Academia

- Basic Research
- Workforce Development
- Program Evaluation
Professional Organizations

- Transportation Research Board (TRB)
  - Highway Capacity Manual
  - Annual Meeting in January in Washington DC
    - 10,000 Attendees, 2700 Speakers, 3 Hotels
- Institute of Transportation Engineers (ITE)
  - Trip Generation Manual
  - MOVITE and TEAM Events
- AASHTO
  - Design Green Book
- American Society of Civil Engineers (ASCE)
  - Transportation and Development Institute
- American Planning Association (APA)
Homework

- Describe 10 features/aspects of GREAT transportation systems (in 1 page or less).