Pavement Preservation for the Anthropocene

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US car-centric transportation system is EXPENSIVE and RESOURCE INTENSIVE

- Road Infrastructure Cost - $100+ billion per year
- Car Ownership and Operational Costs
  - $9k per year
  - Totals $1+ trillion per year
- Oil
  - 90% of U.S. oil consumption
  - $300-$500 billion year
- Climate Change -1/3 of U.S. GHGs
- Air Pollution - One half of urban air pollution

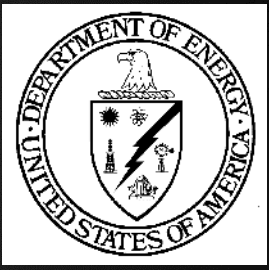
SOURCE: Daniel Sperling, UC Davis; Keynote Address, TRB's International Transportation for Sustainability Conference, May 2015

Impacts of Pollution

- Human Health
- Human Welfare
  - Visibility
  - Well being
- Ecosystem Impacts
- Climate Change
- Development
  - Investment
  - Livability
  - Tourism

Strategies include…

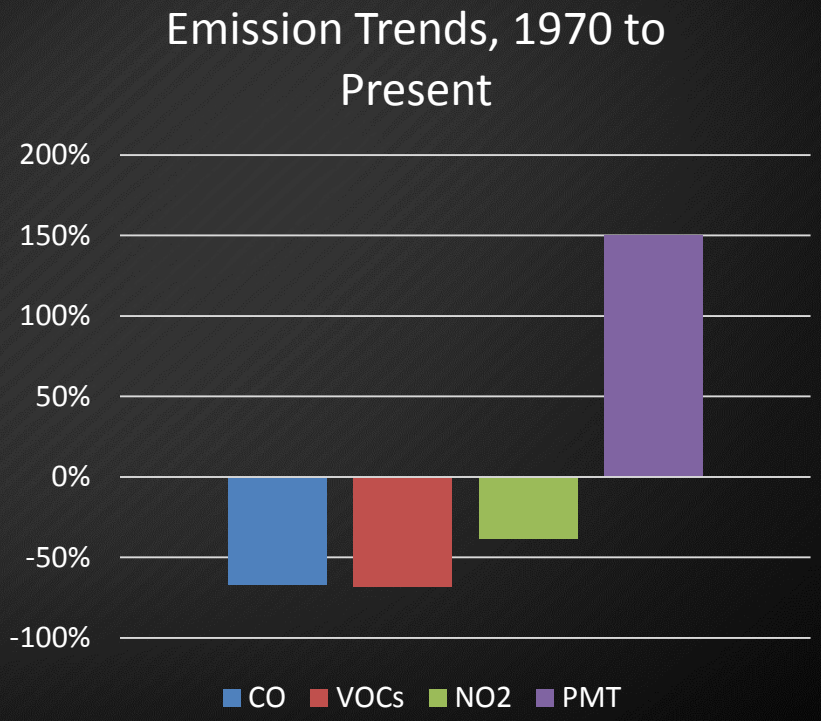
- Collaboration with:
  - HUD & EPA on GHG reduction through land use solutions
  - DOE on electricity/alternative fuel infrastructure for transportation
  - FAA on low-emission airport technology and infrastructure improvement



Successes

Present transportation sector emissions compared to 1970:

- 67% decrease in CO
- 68% decrease in VOCs
- 38% decrease in NO_2
- *Despite* a 150% increase in passenger miles traveled



Challenges Remain

- Transportation consumes 29% of US energy, almost all from petroleum, and emits 29% of US GHGs

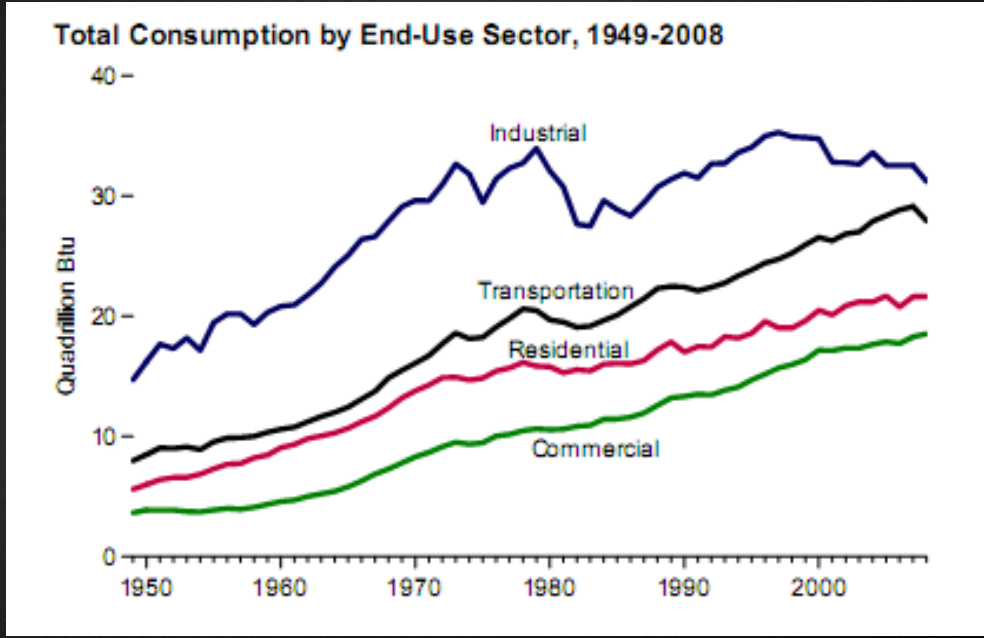


Image Source: US DOE

Reality Check?

Need new approaches, institutions, and thinking

- HOV lanes failed
- Demand management policies, on whole, have failed
- Conventional transit performs poorly
  - 60% of metro transport budgets for <10% of trips
  - Similar GHG/PMT to cars

SOURCE: Daniel Sperling, UC Davis; Keynote Address, TRB's International Transportation for Sustainability Conference (May 2015)

Sustainability Trends

Sustainability is inevitable.

What Are Sustainability Goals in Maintenance?

- Reduce waste
- Minimize energy use
- Preserve soils and native plants & animals
- Reduce persistent bio-accumulative toxins
- Manage water and related facilities in the ROW
- Fiscal sustainability – cover the needs with the available resources.
- Institutionalize sustainability as an agency value

Sustainability Metrics

Will these get us where we need to go?

- Annual tons of solid waste produced
- Annual recycling rate
- Annual electricity, natural gas, gasoline, and diesel fuel consumption
- Annual renewable energy consumption
- Annual water consumption
- Agency fleet fuel efficiency
- Agency fleet annual vehicle miles traveled
- % of procured items that are sustainably produced, contain recycled materials, produced locally, etc.

“Cradle to Cradle” Thinking

- Being less bad is not good enough.
- Rethink how we plan, construct, and operate the transportation infrastructure to replenish and restore the earth rather than destroy it.
- A “good” transportation plan or design not only minimizes cost and maximizes safety but also improves the environment and social well being.

Being less bad is not good enough

Eco-efficiency - the traditional goal of reducing negative impacts

Eco-effectiveness - a new paradigm of increasing positive impacts

Younger Generations Demand Action:

- There are more Millennials than the Baby Boomers
- They are largely motivated by things other than money.
- They have growing concerns about the impacts of unsustainable behavior.

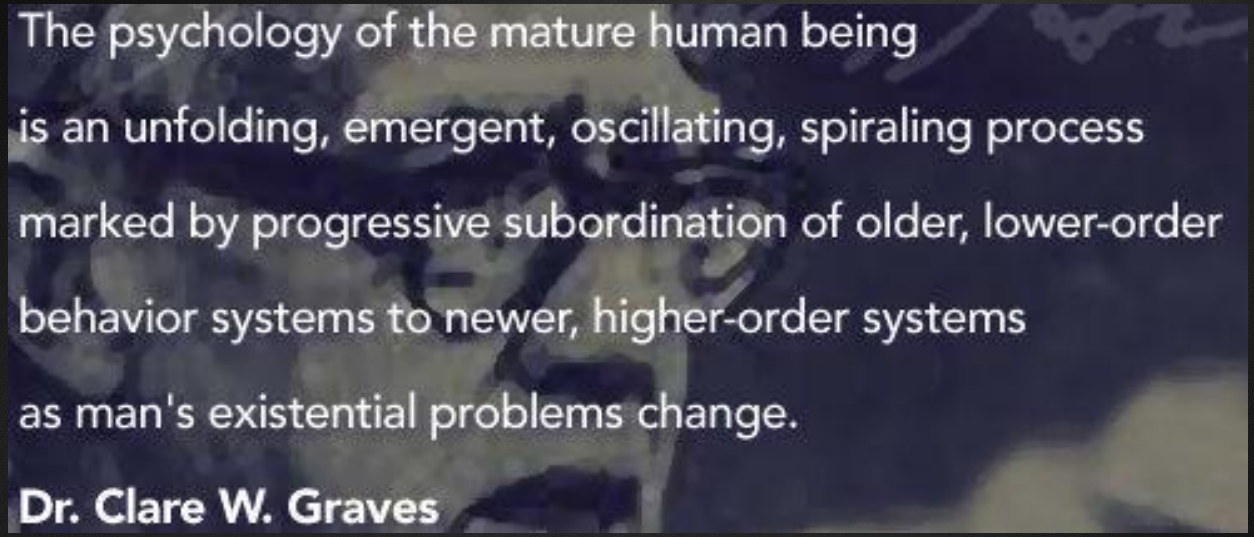
Change Trickles Up, Not Down:

- Politicians are much better followers than leaders.
- The real action on sustainability is happening in companies and communities around the world.
- Mayors from over 135 major cities signed an accord to report and reduce their emissions.
- California implemented the nation's largest cap-and-trade plan.
- National and international markets, commitments, and investments are only a matter of time.

Eco-effective Transportation System
How do we get there?

- Culture of Sustainability to transform values, behaviors and practices
- The precedence : Culture of Safety
- Dispel concerns about costs
- Intergenerational effort
- Transform transportation to work in sync with people and nature

Evolution of Human Consciousness



Clare Graves (1970) "Levels of Existence: An Open System Theory of Values." *Journal of Humanistic Psychology.* Vol. 10 No.2., pp. 131-155

Administrative Challenges

- Clare Graves' questions:
- Assume we can measure sustainability, how do we institutionalize it?
- How do we change beliefs, norms and behaviors?

- Focus on administrative actors

Practical Setting

- U.S. Department of Transportation (DOT) Strategic Plan, FY 2014–18 identifies five strategic goals for America's transportation system:
  - Safety
  - State of Good Repair
  - Economic Competitiveness
  - Livable Communities
  - Environmental Sustainability

- First three are classic transportation functions, widely accepted and measured
- Last three, not so much… Challenges of non-mission based measures

Ambiguity and Subjectivity of Performance Data

- Examine same programs but disagree on data
- Agree on data but disagree on meaning
- Agree on meaning, but not on next action steps/resources

- Subjectivity - select and interpret performance information consistent with institutional values and purposes
- Ambiguity – ability to contest performance data leads to inability to find solutions when there are competing beliefs

Challenges for Highway Maintenance

- How will a culture of sustainability change the decision-making process for highway maintenance?
- How will a culture of sustainability benefit public health?
- How can we move from down-cycling to up-cycling of infrastructure assets?
- How do we use ecosystem services to address environmental impacts of the transportation system?
- How does highway maintenance affect the eco-effectiveness of energy efficient and connected vehicles?

"America's transportation system is a fossil in 2045."

US DOT asking the BIG questions…

- How will we move?
- How will we move things?
- How will be move better?
- How will we adapt?
- How will we align decisions and dollars?

How will we align decisions and dollars?

Weak Sustainability : “Triple Bottom Line” (TBL) allows for the exchange of ecosystem, human health or social systems, for benefits of mobility and economic growth.

Strong Sustainability : Uses Environmental Economics which does not allow the preservation of the environment to be supplanted by increased stores of social or economic capital.

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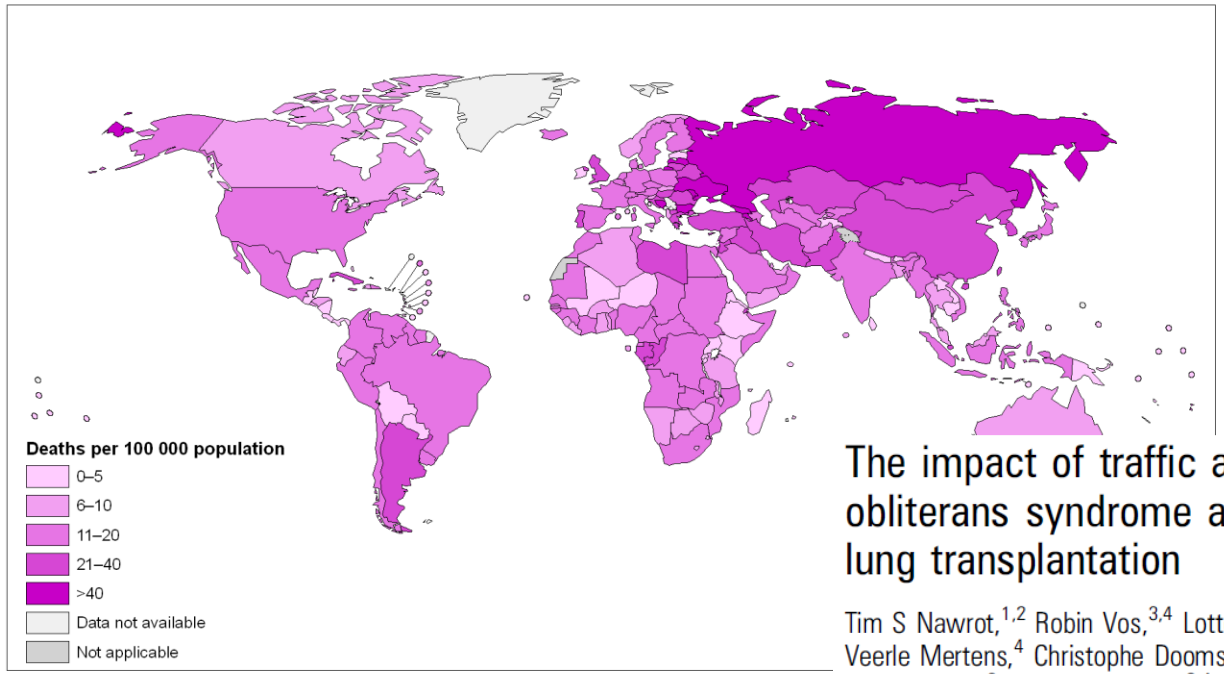
Human Health and Air Pollution

- Short term impacts from high and chronic exposures leading to adverse health impacts are reasonably well understood
  - Occupational exposure to diesel particulate
  - Carbon monoxide poisoning
  - Industrial accidents
  - Environmental tobacco smoke
- Much larger impacts of air pollution that contribute to more prevalent diseases are not yet well recognized as public health risks

Inhalation Exposure and Health Impacts of Air Pollution

- Surprisingly low inhalation exposures can have significant impacts on health
  - More sensitive to inhalation exposures than ingestion and dermal exposures
  - Not only a concern for body burden
- Observed associations with, and impacts of, exposure to atmospheric PM continue to increase
  - Respiratory Disease
  - Cardiovascular Disease
  - Cancer
  - Auto-Immune Disorders
  - Metabolic Syndrome
  - Reproductive Impacts
  - Neurological Development

Example: Lung Transplantation



The impact of traffic air pollution on bronchiolitis obliterans syndrome and mortality after lung transplantation

Tim S Nawrot,[1,2] Robin Vos,[3,4] Lotte Jacobs,[2] Stijn E Verleden,[3,4] Shana Wauters,[4] Veerle Mertens,[4] Christophe Dooms,[3] Peter H Hoet,[2] Dirk E Van Raemdonck,[4,5] Christel Faes,[6] Lieven J Dupont,[3,4] Benoit Nemery,[2] Geert M Verleden,[3,4] Bart M Vanaudenaerde[3,4]

Key Issues

- Large number of studies have been conducted that show adverse health effects associated with distance to roadways
- Over 90 percent of the tailpipe emissions roadways come from 5-10% of the vehicles
  - Critical to remove these emissions
  - If we cannot address high emissions vehicles then we need to move toward electric vehicles
- Need to consider impacts of non-tailpipe emissions
  - Brake Dust, Tire Wear, Road Dust
- Need to make sure that modal shift does not lead to higher exposures to air pollution
  - Buses, subways, etc…

More Challenges for Highway Maintenance

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Summary

- Anthropocene
- Sustainability is inevitable – culture of sustainability will trickle up
- Highway air pollution contributions to more prevalent diseases are not yet well recognized as public health risks
- “Cradle to Cradle” Thinking
- Become Eco-effective not eco-efficient
- Adopt Strong Sustainability practices
- Make decisions using analysis that preserves our stores of environment, social and economic capital.

END

Thank you