

Safe Systems Summit

Redefining Transportation Safety



Navigating complex transportation systems


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Session Objectives

- Provide examples of tools that can be used to better understand complexity underlying road traffic injury problems.
- Demonstrate the importance of integrating researchers, practitioners, and other key stakeholders in applying a systems approach to road safety issues.
- Highlight unique insights derived from quantitative complex systems modeling approaches and potential for integration into practice.



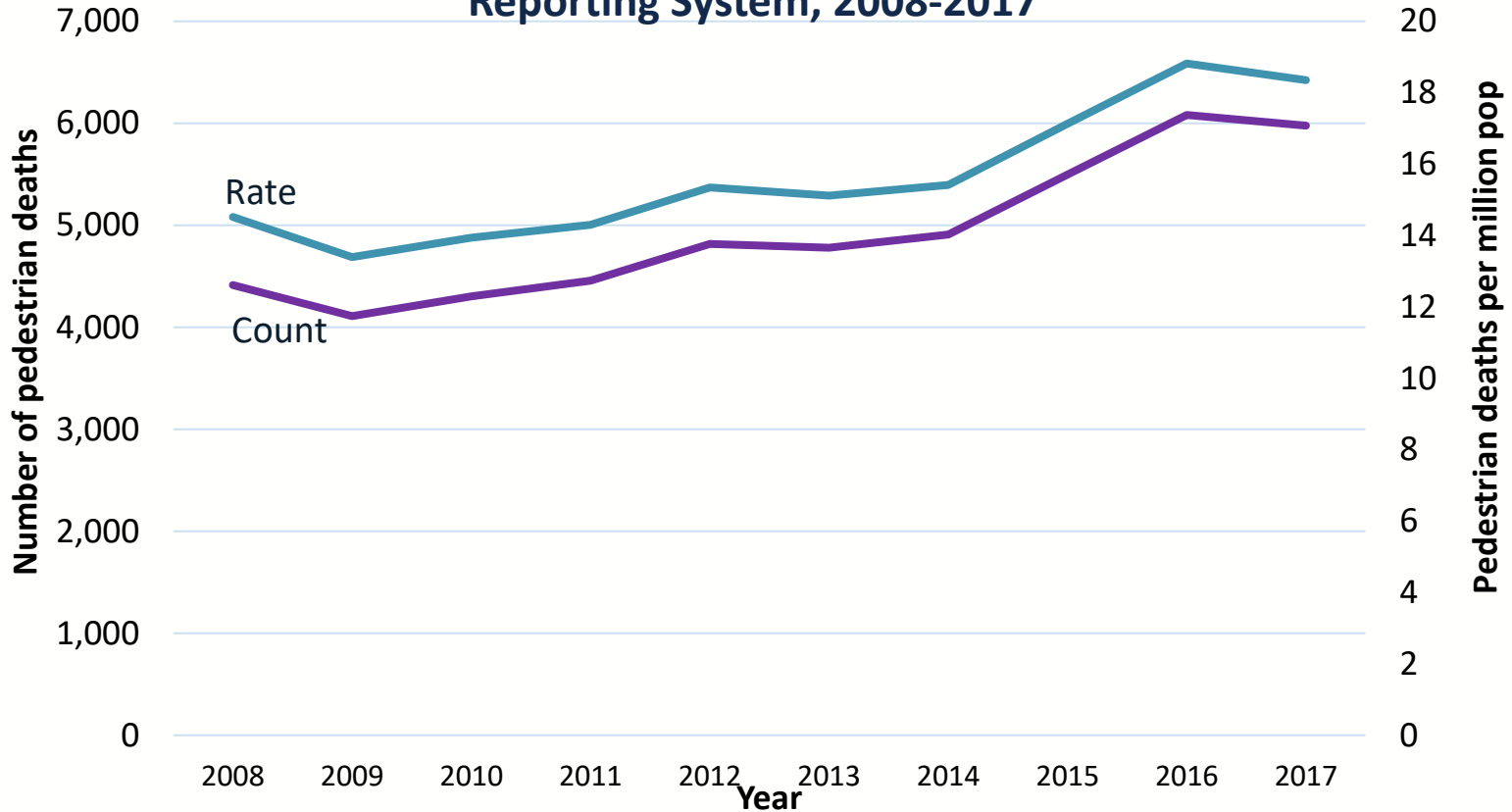
A systems approach to
examining the rise in
pedestrian fatalities

Enhancing multi-modal
mobility in the central
Florida region with a
complex systems
approach

Acknowledgements

- **Research Team:** Laura Sandt, Jill Kuhlberg, Stephen Heiny, Wes Kumfer, Kristen Hassmiller Lich, Steve Marshall
- **Research Support:** UNC IPRC is partly supported by an Injury Control Research Center award (R49/CE002479) from the National Center for Injury Prevention and Control, Centers for Disease Control and Prevention. This work was also supported by the Collaborative Sciences Center for Road Safety (www.roadsafety.unc.edu), a United States Department of Transportation National University Transportation Center (award # 69A3551747113).

Number and rate of pedestrian deaths, US Fatality Analysis Reporting System, 2008-2017



Walking while drunk fuels surge in US pedestrian deaths

Updated Aug 6; Posted Aug 6



Distracted walking could be a contributor to the nearly 6,000 pedestrian deaths in 2017

UT Police are warning students that texting and walking can be dangerous.

Author: Brandon Bates

Published: 9:51 PM EDT August 27, 2018

Updated: 8:18 AM EDT August 28, 2018

The rise in SUVs is linked to a surge in pedestrian deaths

By Jill Pottinger • May 6, 2018



Where Pedestrian Deaths Are Up, Is Marijuana to Blame?



Marijuana buds being stripped from stalks in Denver. Data from Colorado and other states that have legalized recreational marijuana "is a marker for concern," the author of a study by the Governors Highway Safety Association said. [Photo: David Brown for The New York Times](#)

By Neal E. Boukette

Feb. 28, 2018

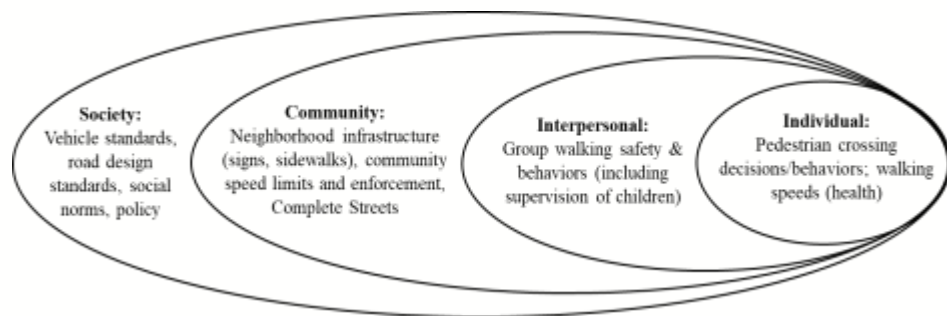
The New York Times

A Complex System

- Numerous health and transportation problems involve a wide range of factors- enormous detail complexity
- Many of our frameworks help with conceptualization of those factors
- Apply a level of “systems thinking”: cross-discipline, cross-sector, collaborative approaches, multi-pronged interventions, broaden perspective

	Host	Agent/ vehicle	Environment (physical & social)
Pre-event	Use of reflective clothing to increase pedestrian visibility	Pedestrian detection technologies in cars	Traffic calming infrastructure; separation of pedestrian and vehicle traffic; enforcement of traffic safety laws
Event (crash)	Physical conditioning (overall health, frailty)	Sideguards on large trucks	Enforcement of speeding laws to reduce severity of injury even if crash occurs
Post-event	Adherence to injury rehabilitation	Automatic post-crash EMS notification to facilitate rapid response times	Community design allowing for quick EMS response; policies ensuring affordable access to necessary rehabilitation services for all persons

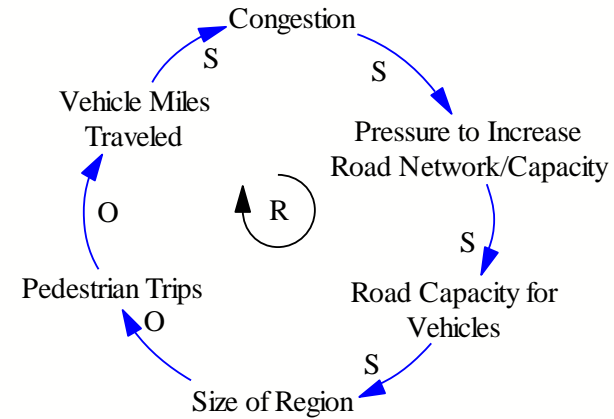
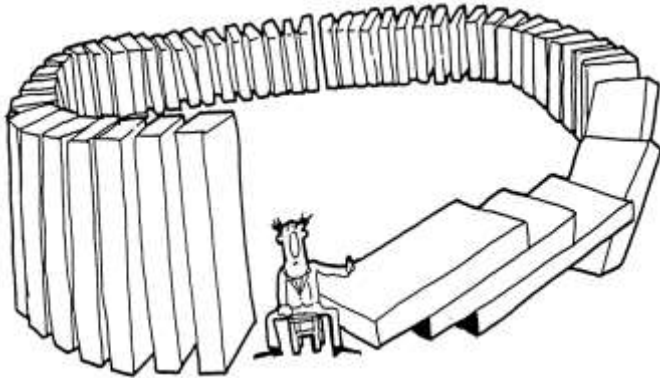
Haddon matrix



Social ecological model

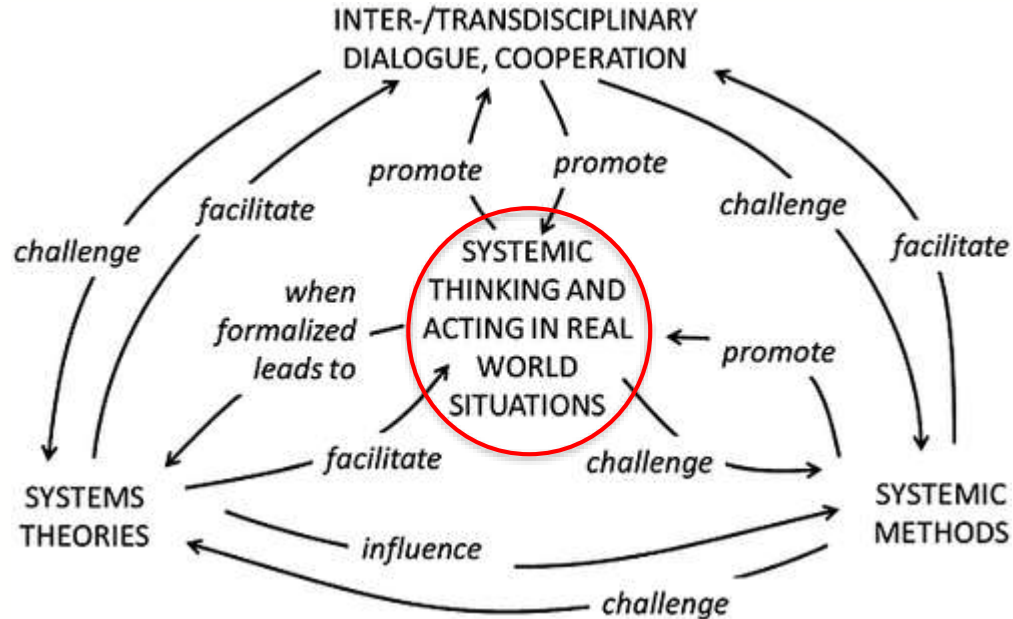
A Dynamically Complex System

- Dynamic interactions among these factors
- Attributes like: nonlinearities (i.e., threshold effects), time delays, adaptiveness, feedback loops
- Complex systems science approaches



“The world is made of Circles. And we think in straight Lines.” — Peter Senge

Systems Science Approach



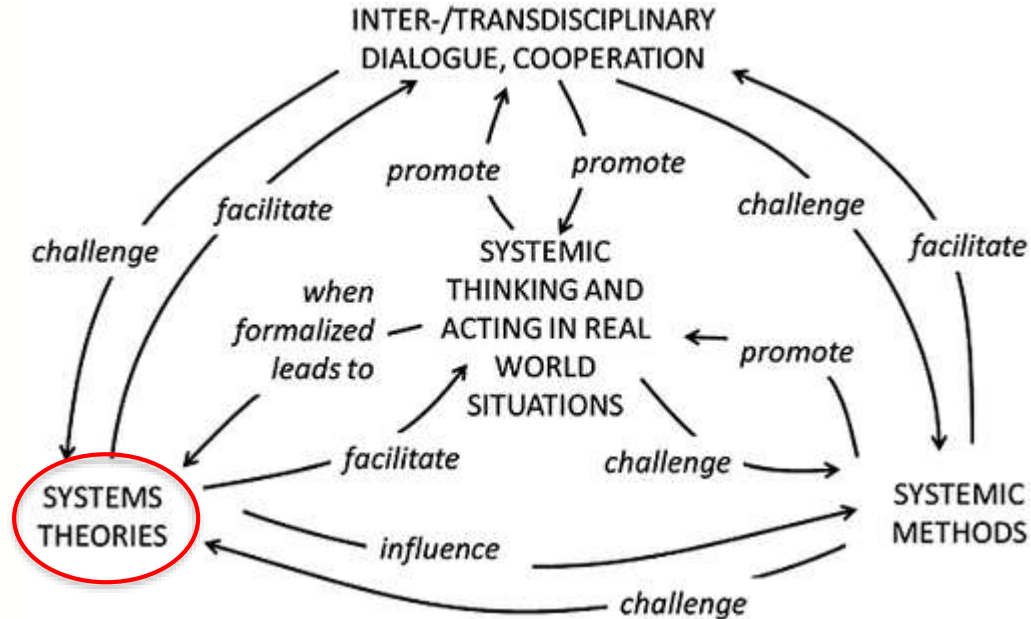
Source: Hieronymi A. Understanding Systems Science: A Visual and Integrative Approach. Systems Research & Behavioral Science 2013; 30(5): 580-595.

Systems Science Approach



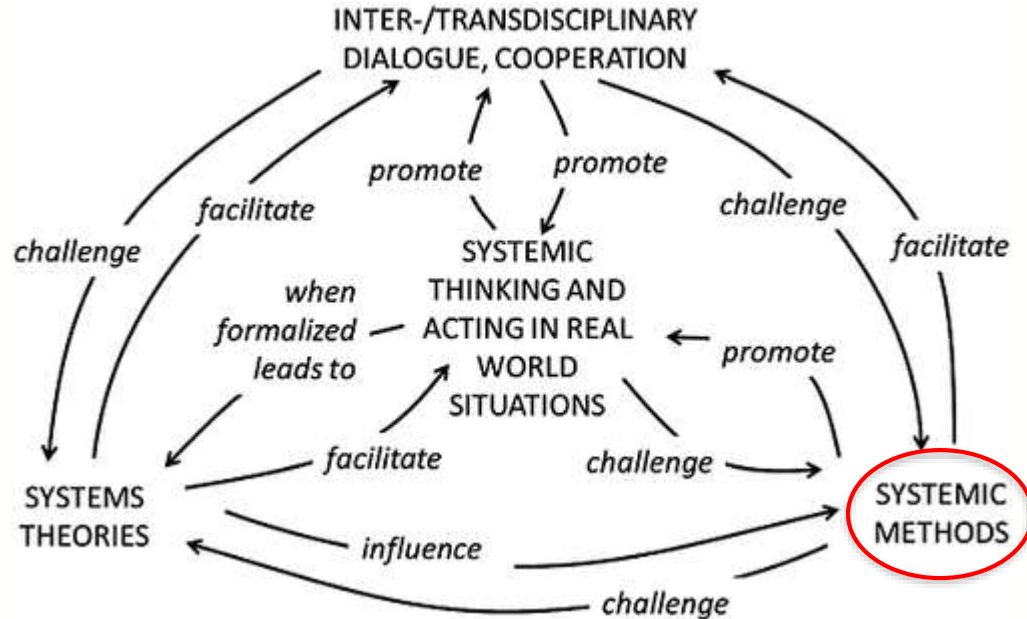
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Systems Science Approach



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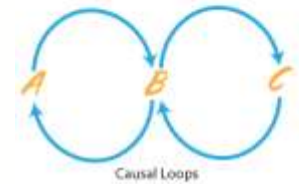
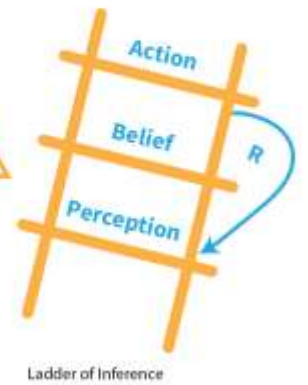
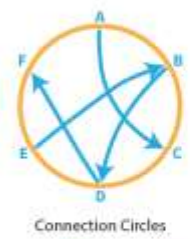
Systems Science Approach



Source: Hieronymi A. Understanding Systems Science: A Visual and Integrative Approach. Systems Research & Behavioral Science 2013; 30(5): 580-595.

Adding to Our Toolbox

- Group model building
- Qualitative
 - Behavior over time graphs
 - Causal loop diagramming
 - Interrelationship diagram
 - System support mapping
 - Network maps
- Quantitative
 - System dynamics simulation (stock and flow simulation)
 - Agent-based models & microsimulation
 - Social network analysis



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Source: <http://www.clexchange.org/curriculum/complexsystems/populationdynamics/>

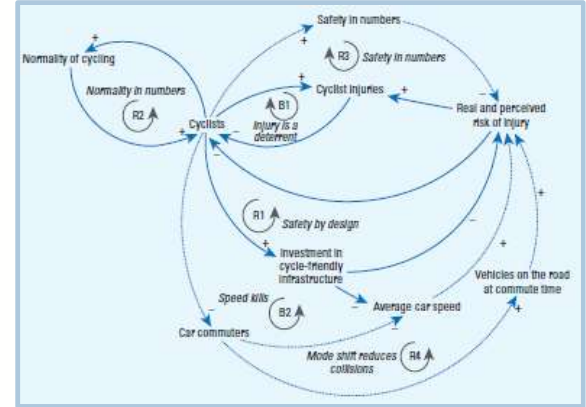
Project Goals

- Illuminate core assumptions and uncertainties related to increase in pedestrian deaths
- Enrich our hypotheses. Develop specific, dynamic, and testable hypotheses
- Understand future data collection and research needs



Approach

- Group model building workshops, working with a diverse group of experts
- Developed system maps (causal loop diagrams)
- Analyzed & synthesized maps, using a grounded theory approach

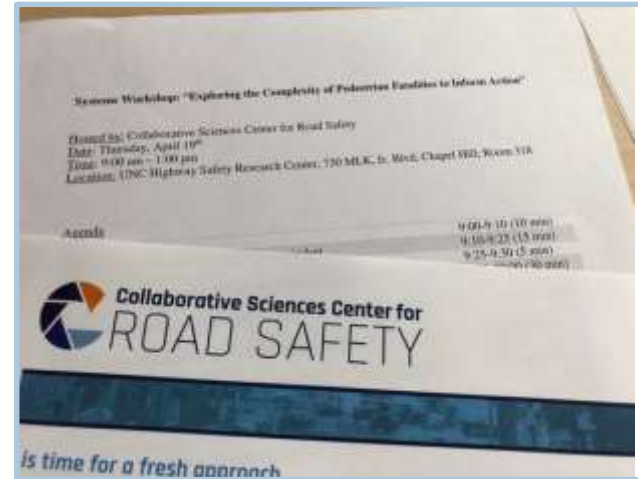


Source: Macmillan et al. The Societal Costs and Benefits of Commuter Cycling: Simulating the Effects of Specific Policies Using System Dynamics Modeling. *Environ Health Perspect.* 2014; 122:335–344.

Systems Workshops

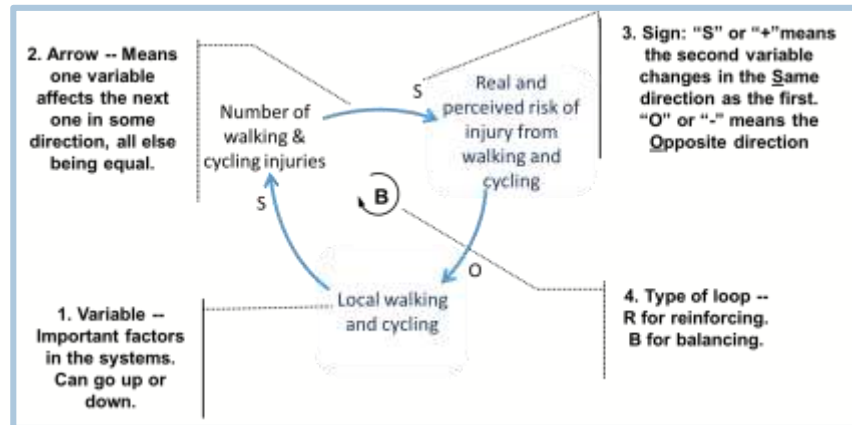
3 workshops conducted to date; attendees have represented:

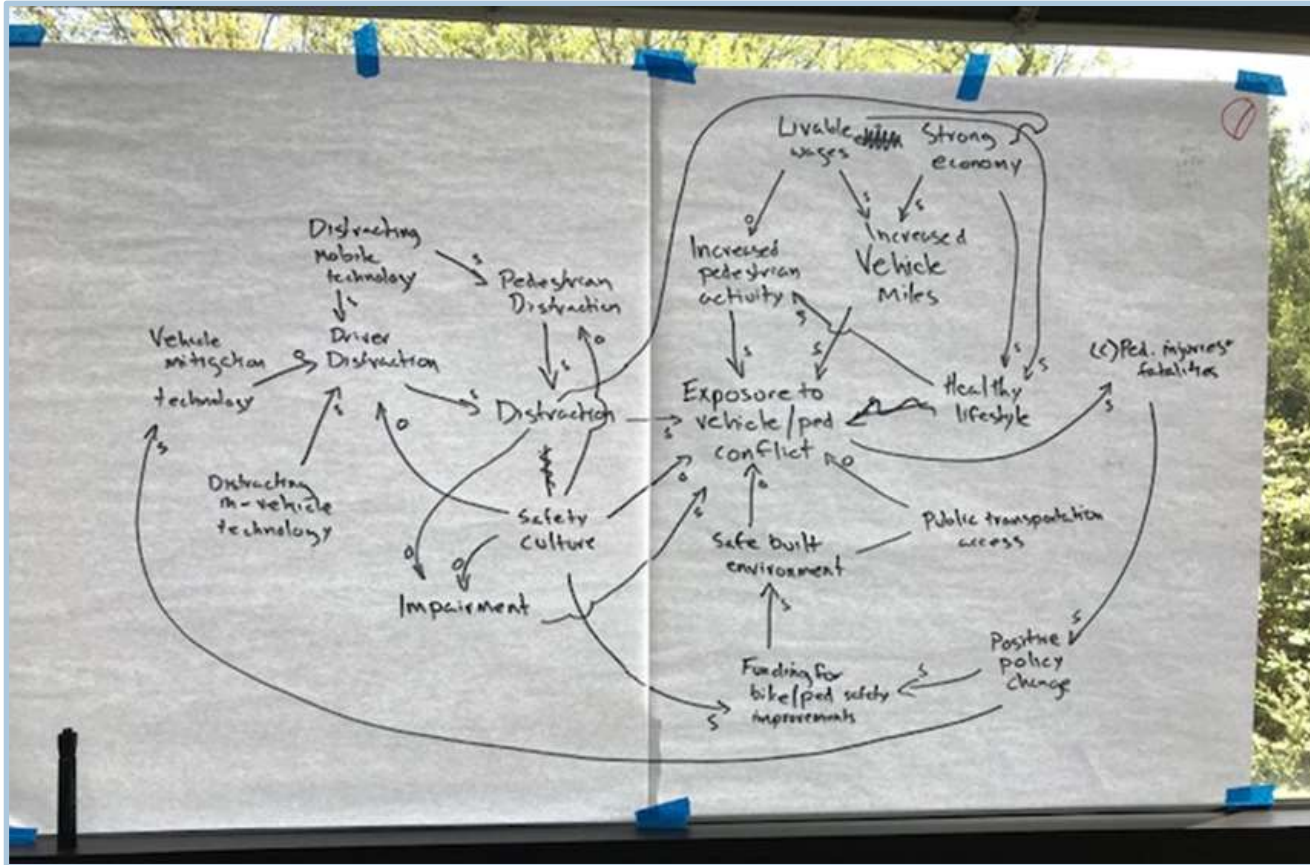
- Law/ injury claims
- Transit (local and state)
- Local and state planners and pedestrian/bicycle coordinators
- State DOT safety engineers
- State Department of Health and Human Services
- Law enforcement
- Fire department
- Journalism
- Medicine/Trauma
- Researchers (epidemiology, planning, robotics, engineering, child development, economics)
- Automakers
- Local elected officials (town council member)
- Advocacy (injury prevention, AARP, coalition to end homelessness)

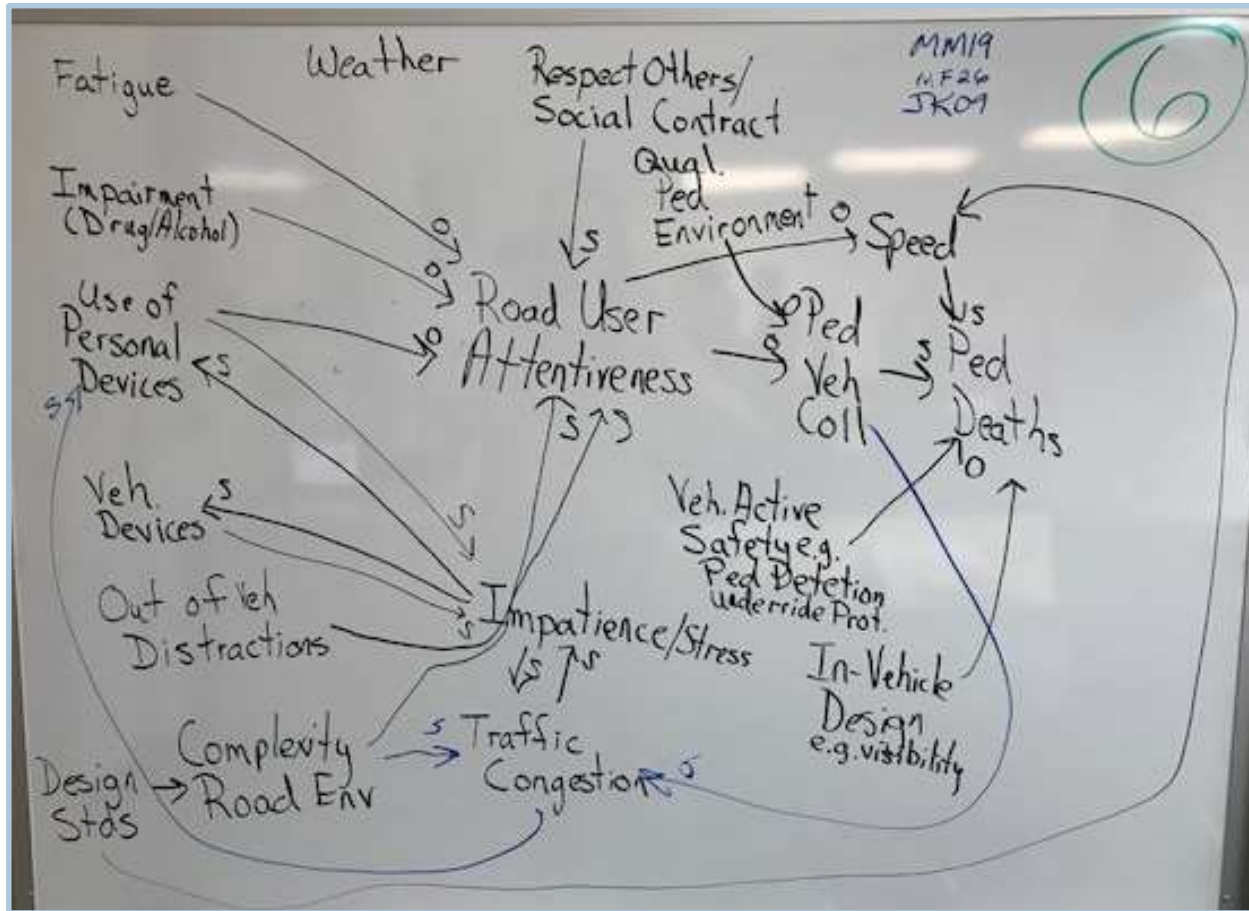


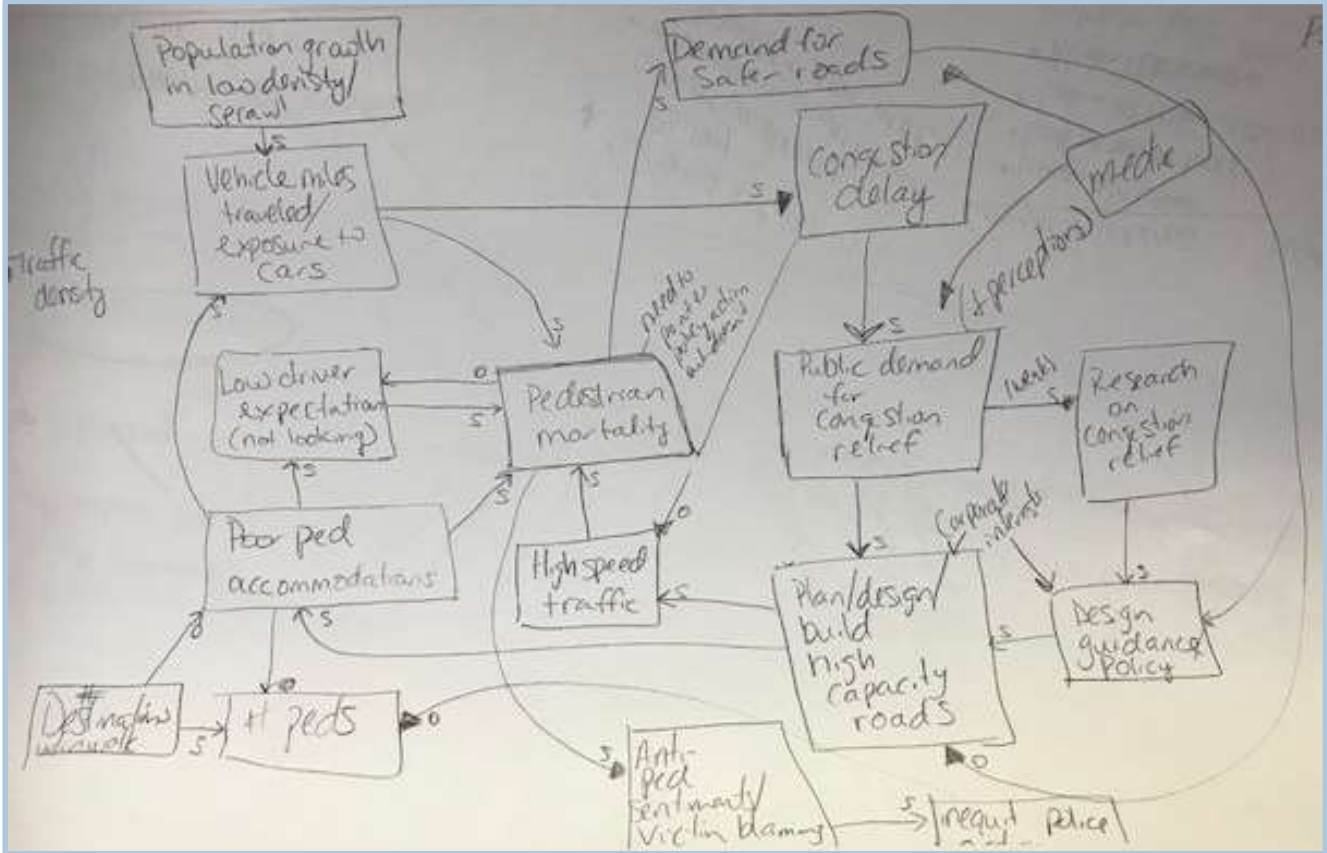
Workshop Agenda

- Pre-workshop reflections
- Intro to systems thinking/ causal loop diagramming
- Individual diagramming
- Small group diagramming
- Share insights
- Post-workshop reflections









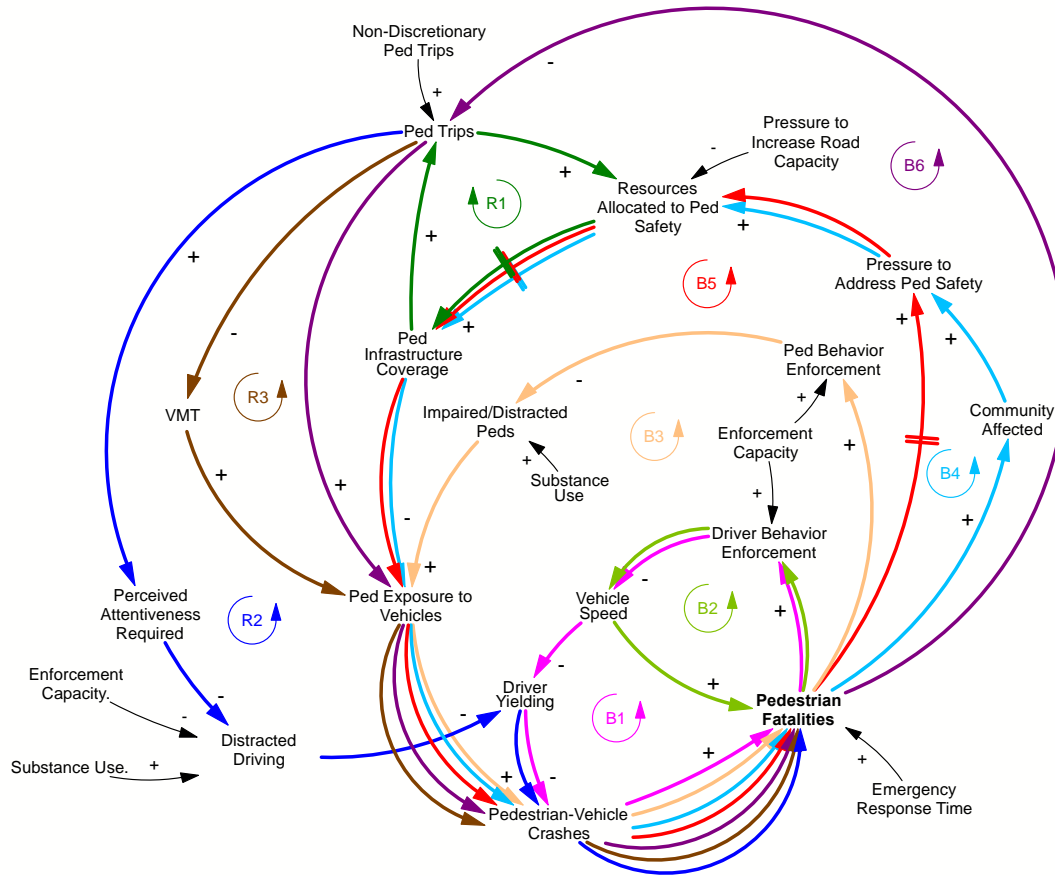
Workshop Insights

- Perspectives on the nature of the issue and potential solutions changed after the workshop
- Acknowledged & recognized the limitations of existing data in telling the full story and in identifying solutions
- Appreciated the complexity of the issues more and the chance to think more deeply about the issues; the mapping approach was a thought-provoking way to generate and inspire research ideas
- Some participants (from non-transportation fields) reported better seeing how their work relates to pedestrian safety
- New collaboration opportunities emerged

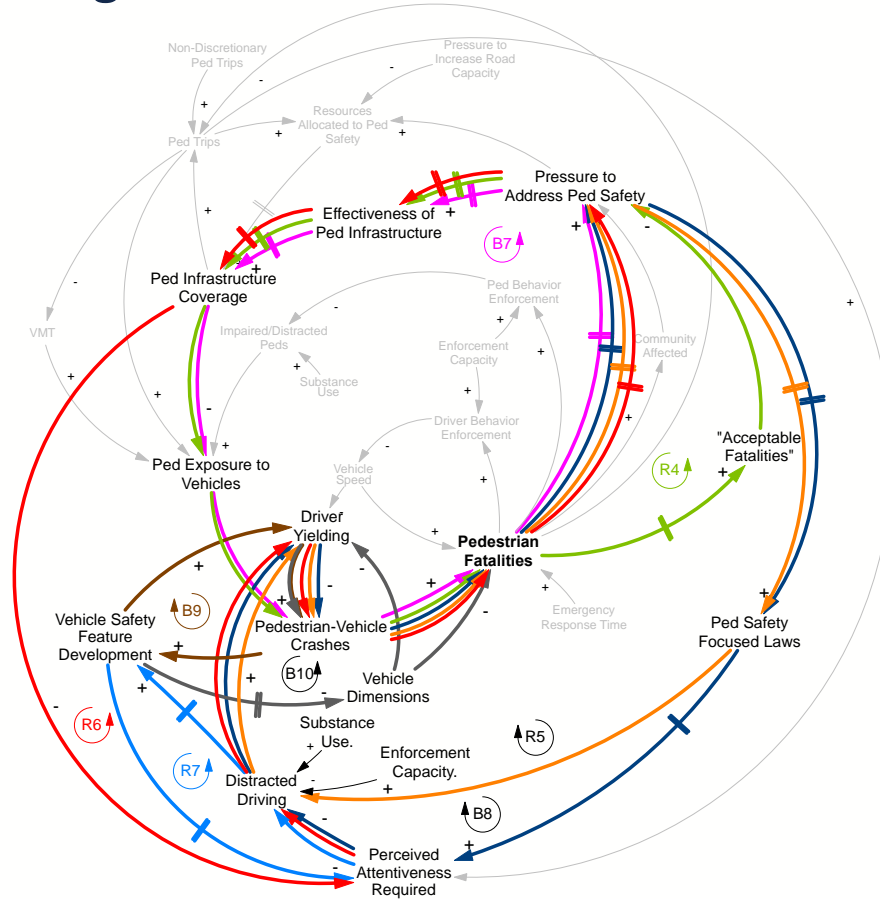


Source: www.pedbikeinfo.org/Dan Gelinne

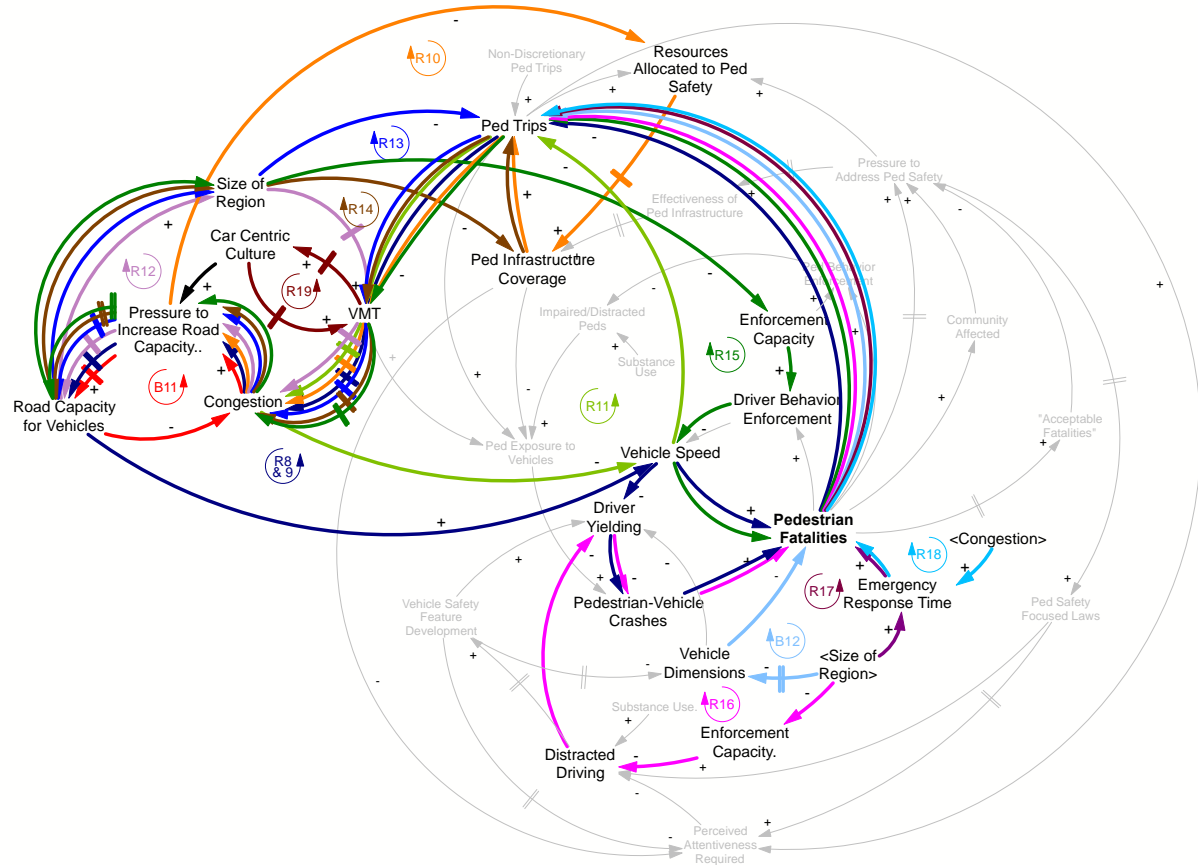
Synthesizing the Data: Community-level System Structure



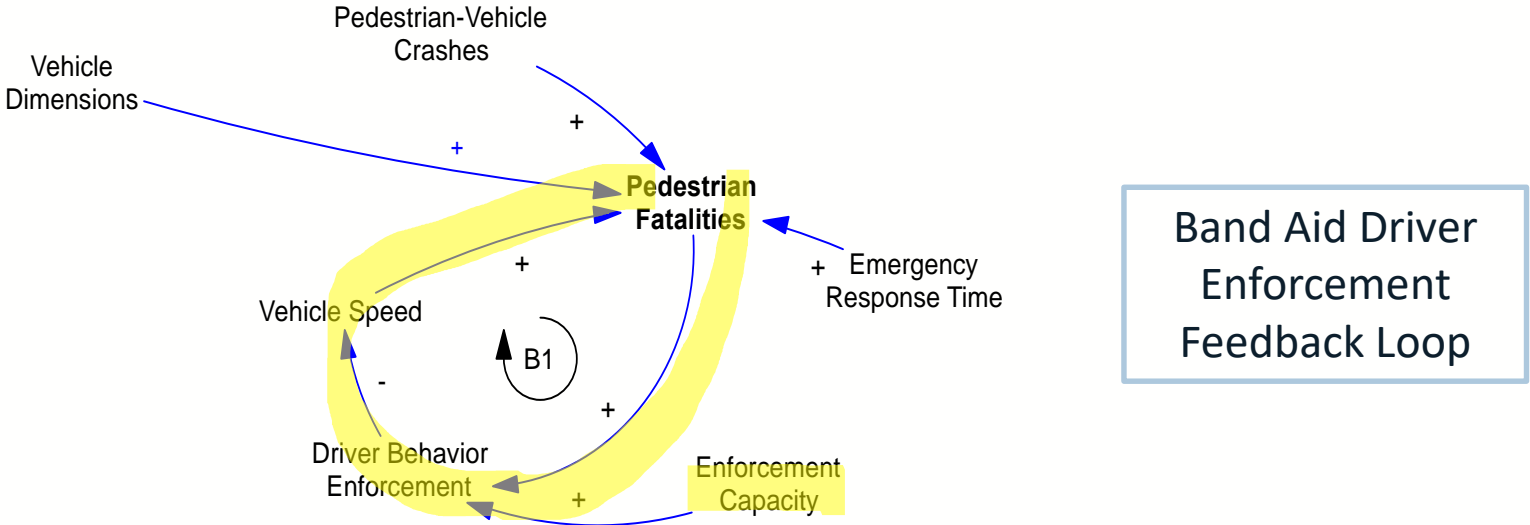
Synthesizing the Data: Factors Outside of a Community



Synthesizing the Data: Factors Related to Regional Growth and Vehicle Miles Traveled

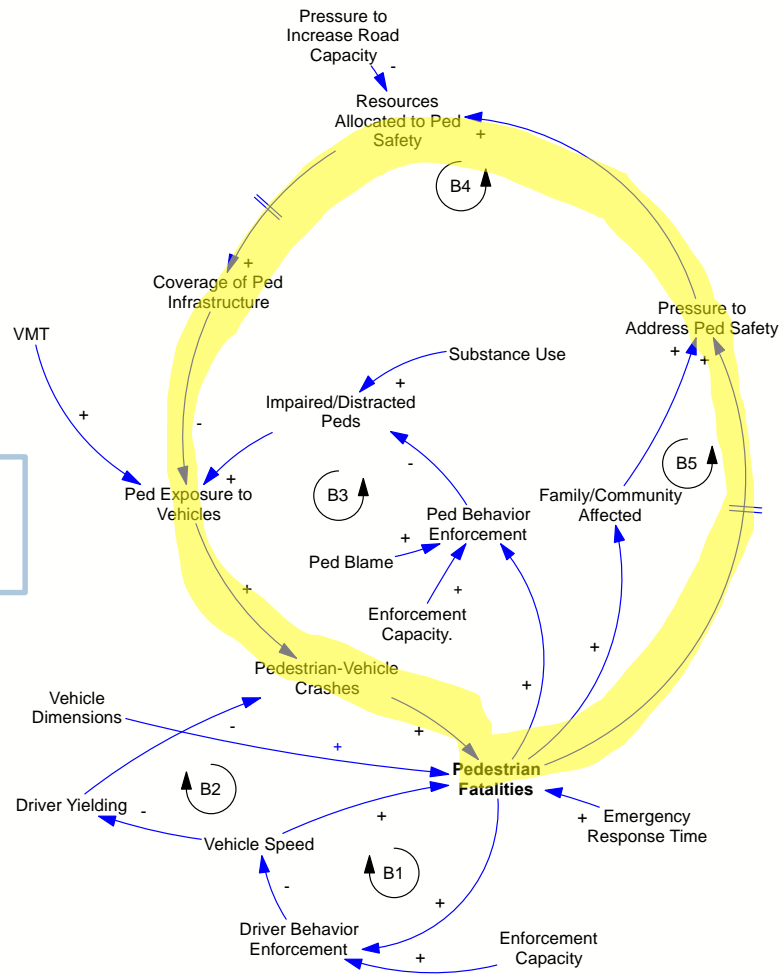


Synthesizing the Data (pieces of the full map)



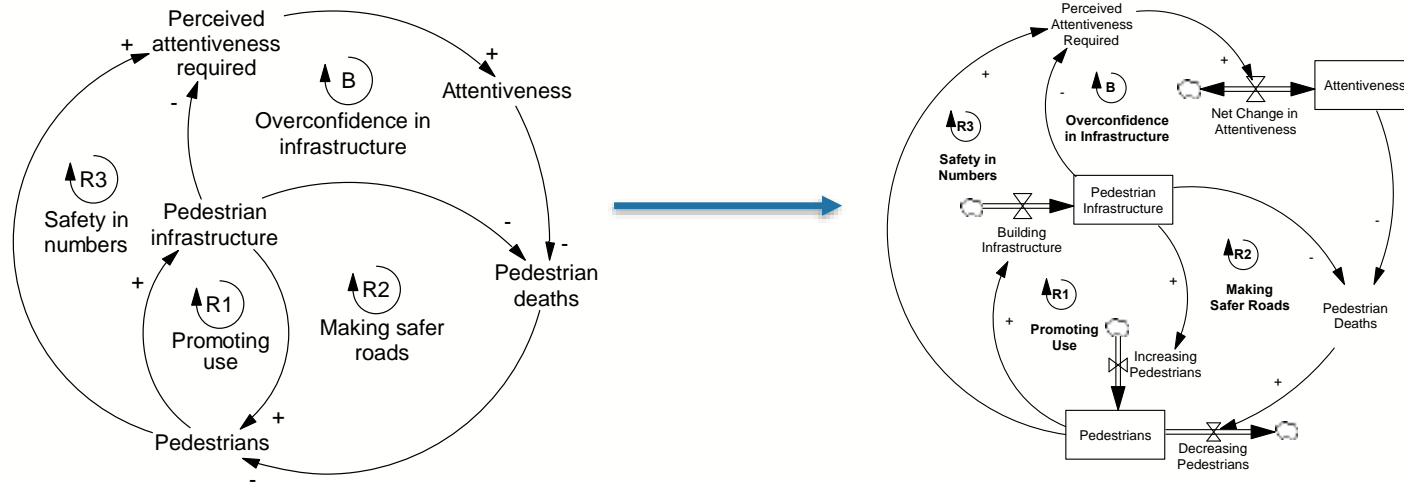
Synthesizing the Data (pieces of the full map)

Community and Data Driven Advocacy Feedback Loop



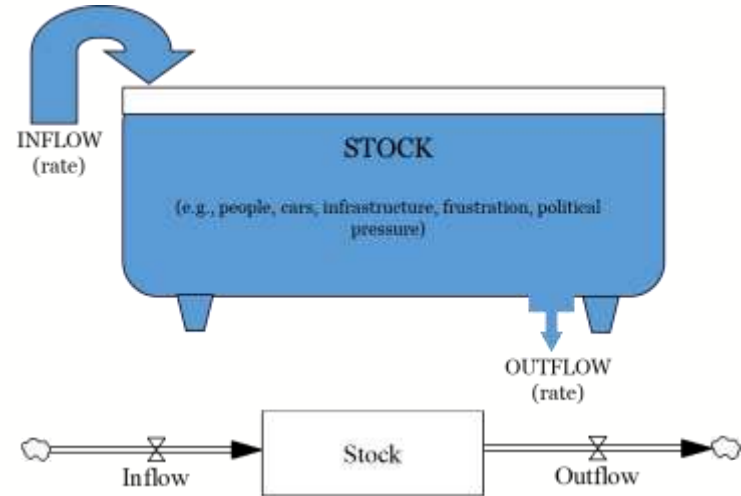
Triangulating and Testing

- Pair hypotheses generated in workshops and qualitative insights with other sources of data.
- Triangulating with specific literature reviews and system dynamics (stock and flow) simulation modeling



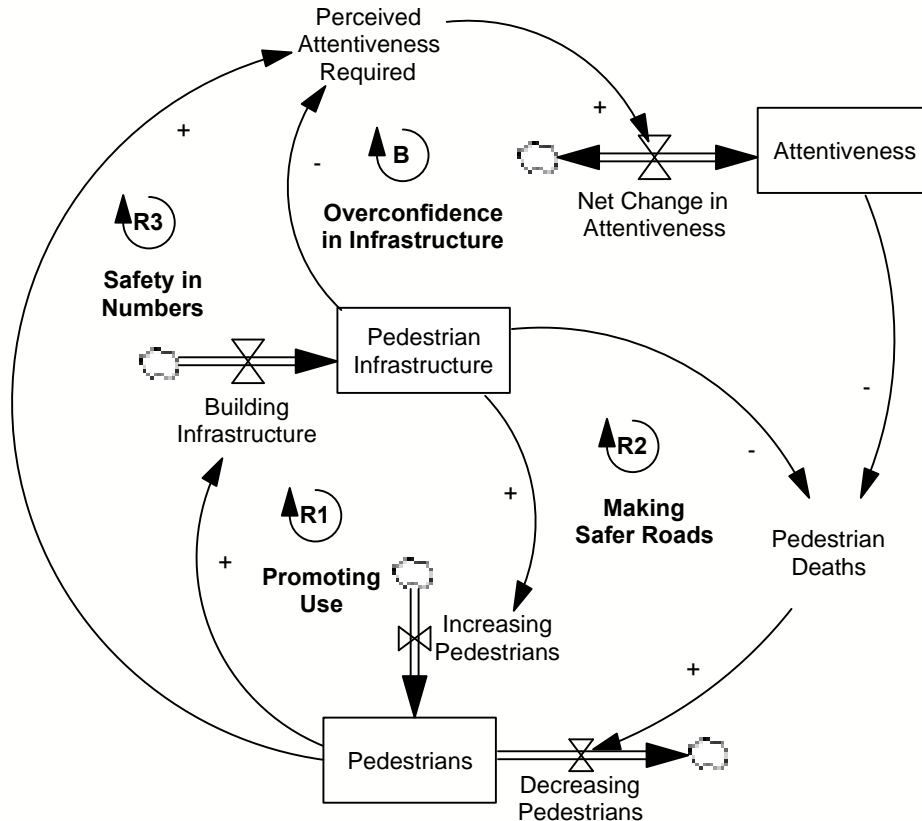
Causal loop diagrams \longrightarrow stock and flow model

- Stocks: where systems hold “stuff”
 - Give a system inertia, can be a source of delays, can be basis for action
- Flows: changes in stocks over time
 - Stocks can only change through their flows
 - Rates (“stuff” per unit time)
- Auxiliary variables: functions of stocks and flows
 - Help define stock and flow equations

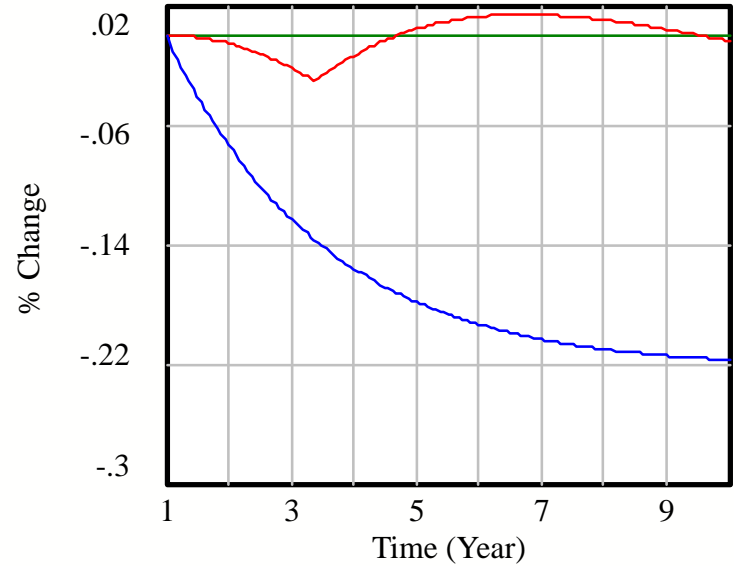


Stock and flow model simulation

- Understanding how stocks and flows interact is not intuitive
 - It's not easy! Simulation can help
- Nonlinearity: the behavior of the whole is more than the sum of the behaviors of individual parts
 - Can not understand “emergent” behavior from the behavior of each individual piece



Percent Change in Ped Deaths

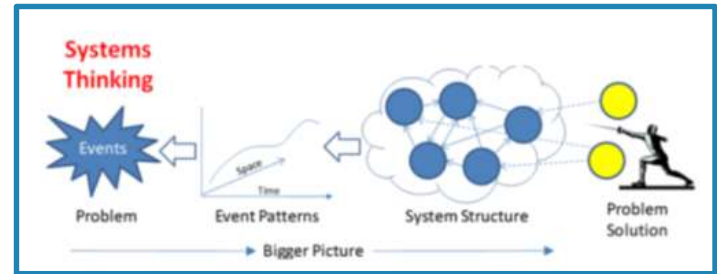


- Low Initial Infrastructure —
- Med Initial Infrastructure —
- High Initial Infrastructure —

Conclusions

A systems approach (group model building and causal loop diagramming) resonated with participants:

- Viewed it as a way to connect the dots on complex issues and to relay different perspectives and rich theories
- Helped think through research directions and hypotheses for the field, as a shared, living diagram for all researchers (not just one research team)
- Fostered discussions about competing goals within our transportation systems, disparities and the role that biases play, processes driving norms and perceptions, and the overall complexity of road safety issues.
- Supported new partnership development
- Also offers a virtual world in which to “try out” and compare policies, examining potential benefits and unintended consequences



Interested in learning more?

Tackling wicked problems using systems mapping lessons
Wednesday, 2:30-4:00

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