Collaborative Sciences Center for ROAD SAFETY

Safe Systems Summit

Redefining Transportation Safety

Systems 101: Systems Thinking

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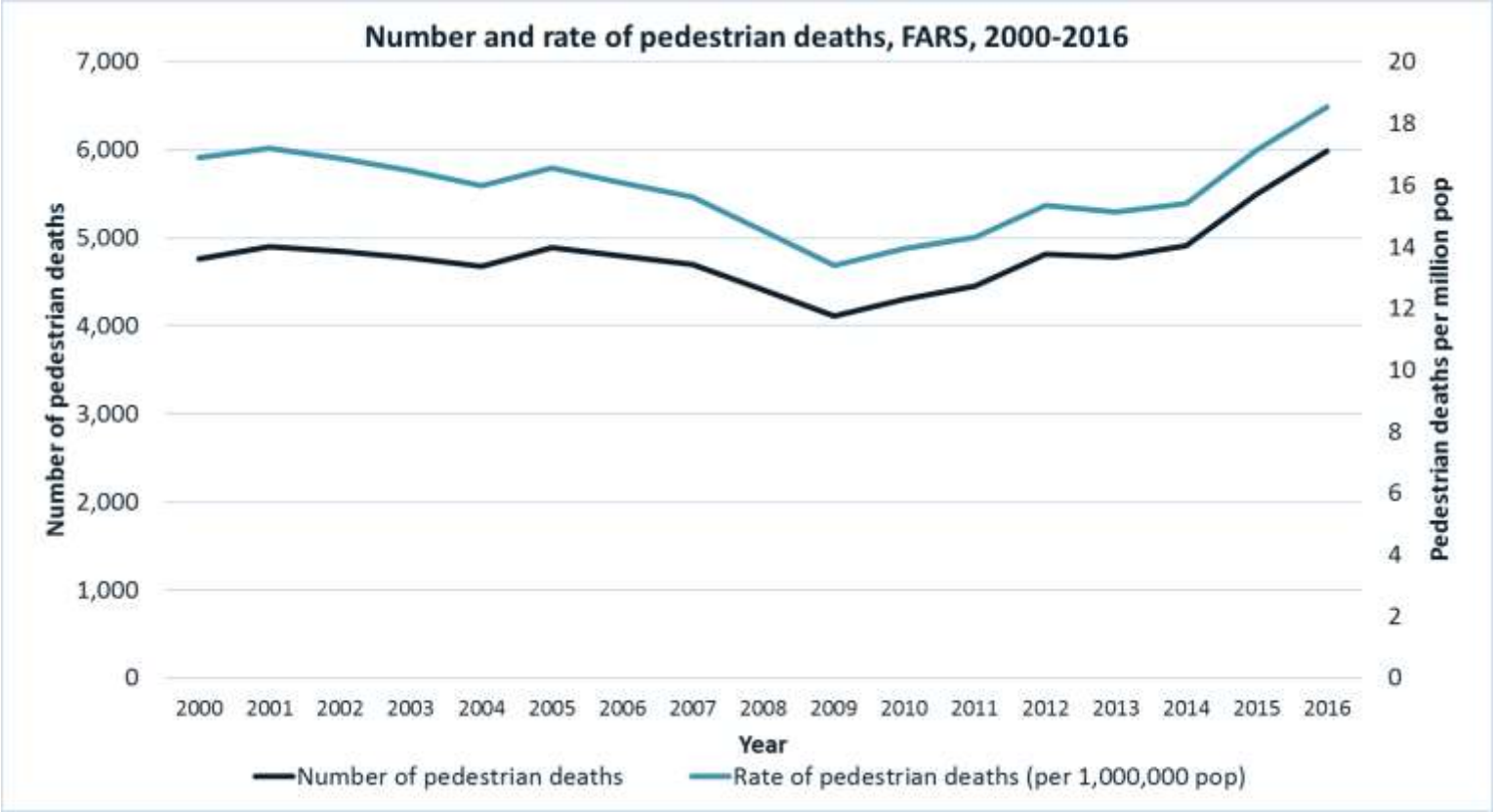
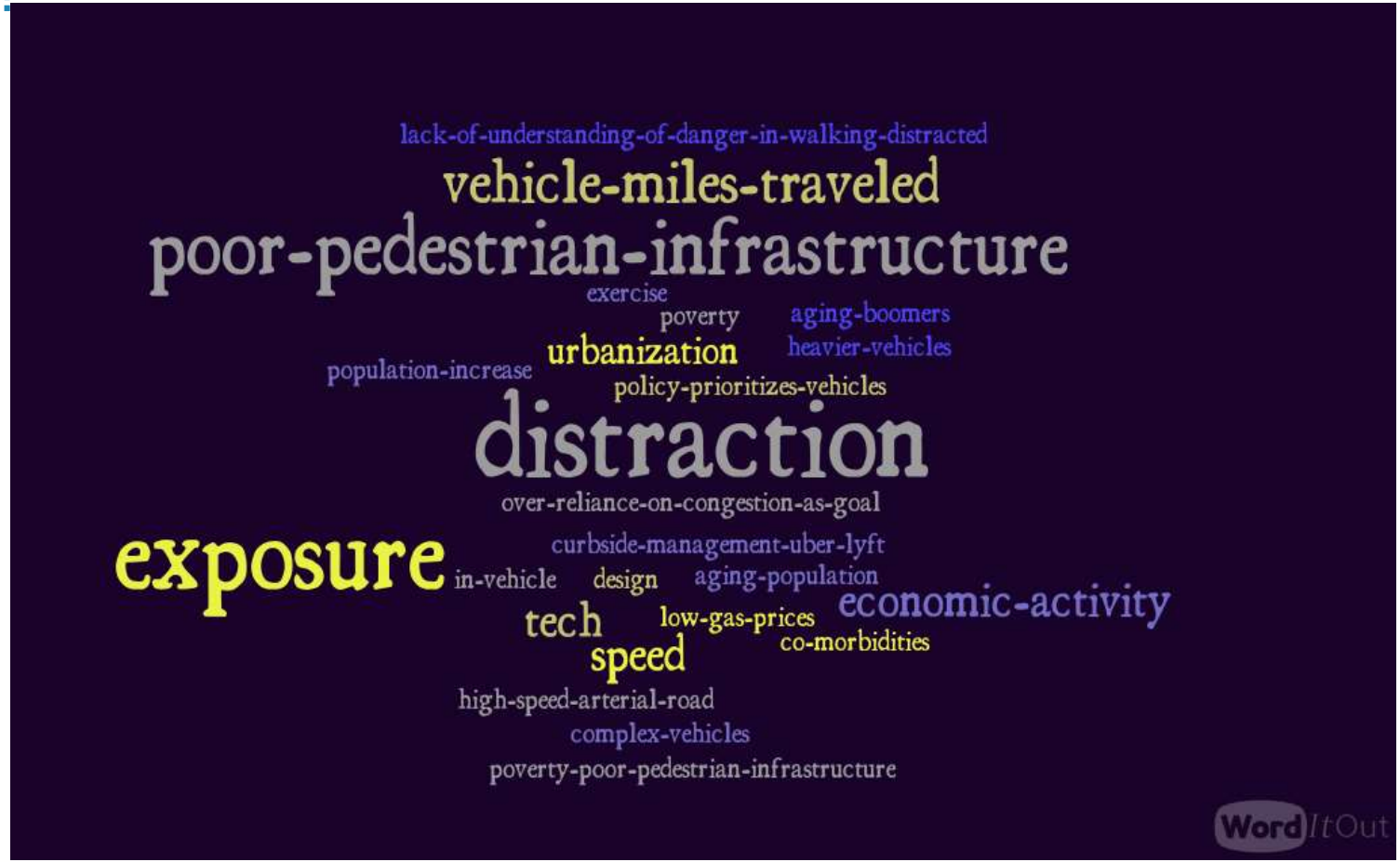
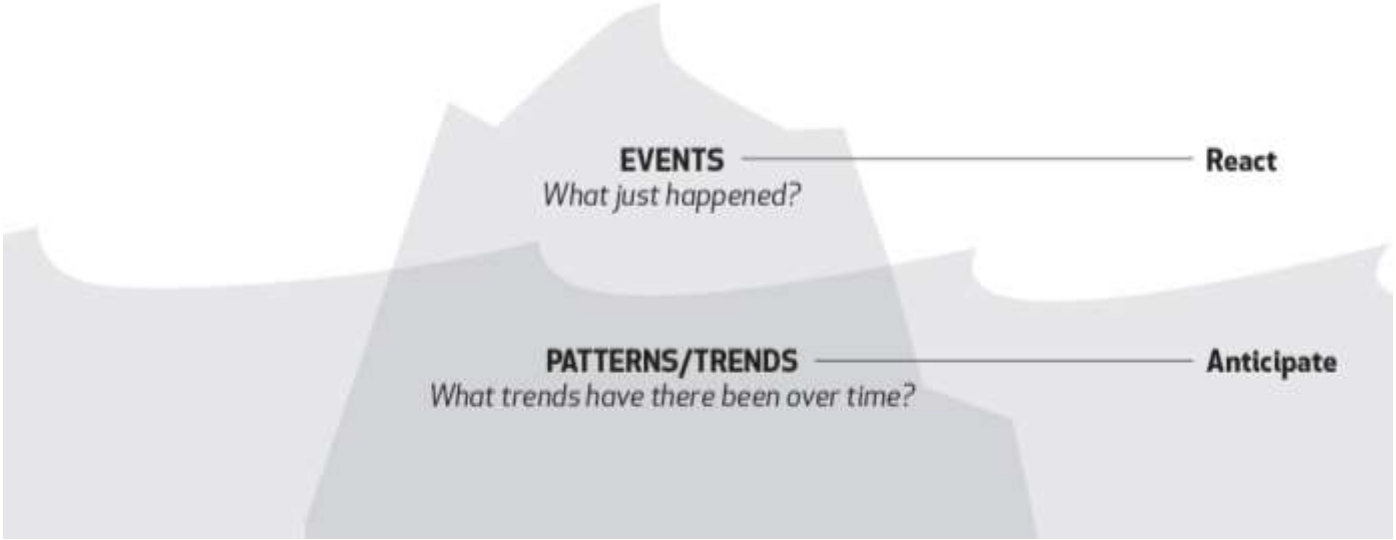
The problem


Number and rate of pedestrian deaths, FARS, 2000-2016
Number of pedestrian deaths
Pedestrian deaths per million pop
7,000
6,000
5,000
4,000
3,000
2,000
1,000
0
20
18
16
14
12
10
8
6
4
2
0
2000 2001 2002 2003 2004 2005 2006 2007 2008 2009 2010 2011 2012 2013 2014 2015 2016
Year
Number of pedestrian deaths
Rate of pedestrian deaths (per 1,000,000 pop)

Why?


lack-of-understanding-of-danger-in-walking-distracted
vehicle-miles-traveled
poor-pedestrian-infrastructure
exercise
poverty
aging-boomers
urbanization
heavier-vehicles
population-increase
policy-prioritizes-vehicles
distraction
over-reliance-on-congestion-as-goal
curbside-management-uber-lyft
exposure
in-vehicle
design
aging-population
economic-activity
tech
low-gas-prices
co-morbidities
speed
high-speed-arterial-road
complex-vehicles
poverty-poor-pedestrian-infrastructure
WordItOut

A core tenet of systems science: The Iceberg

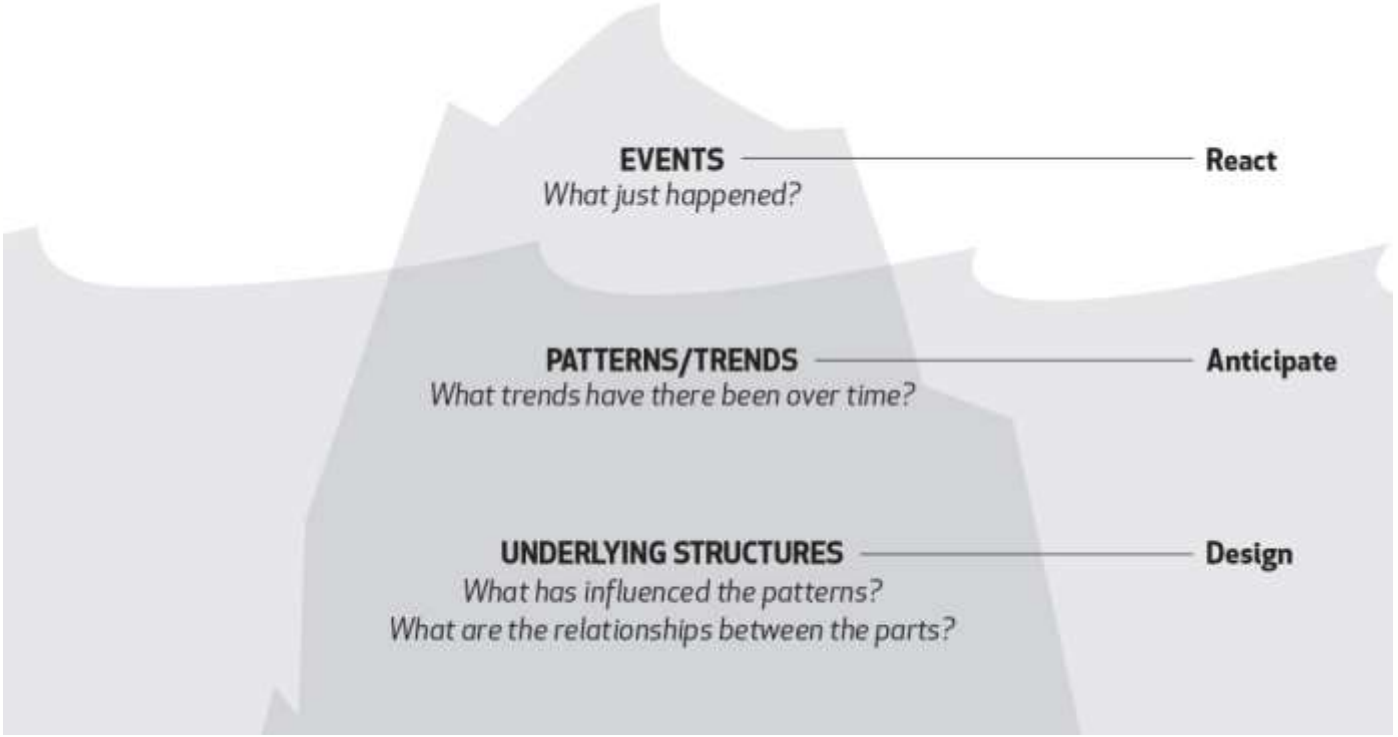


Source: https://www.nwei.org/iceberg/

We need to get further under the water… and understand the “system”

But what do I mean by “system?”

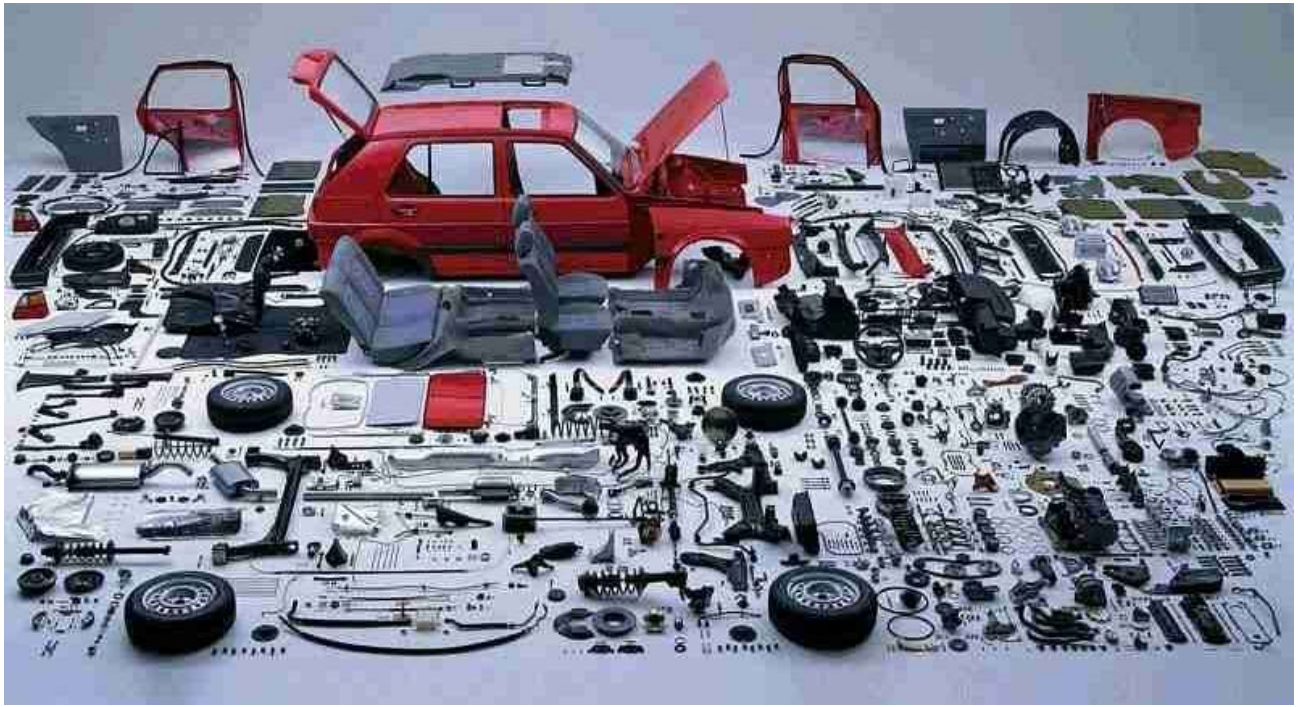
A core tenet of systems science: The Iceberg



Source: https://www.nwei.org/iceberg/

Detail complexity

- Lots of parts



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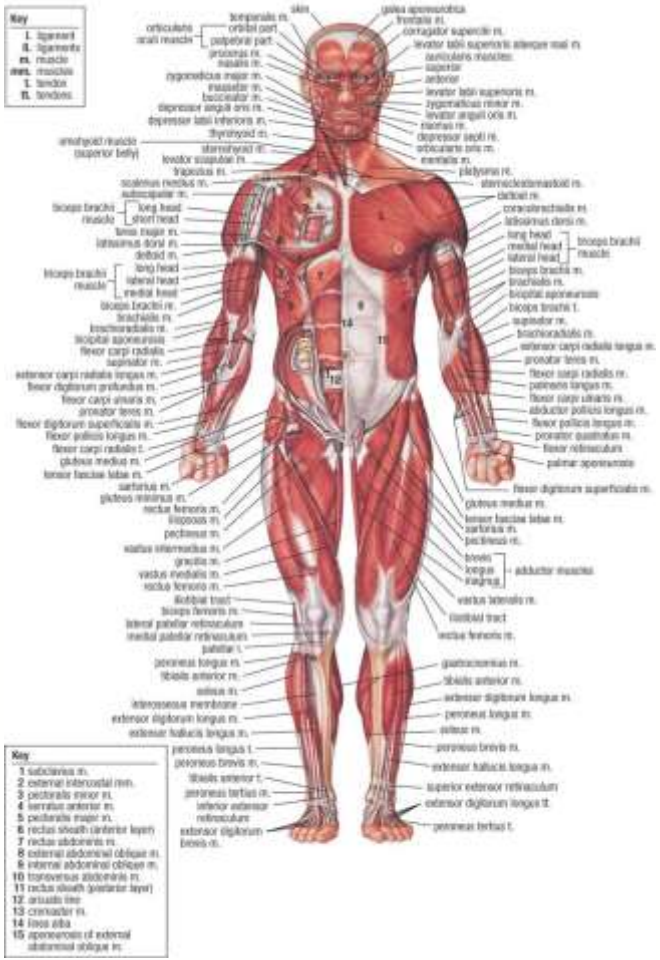
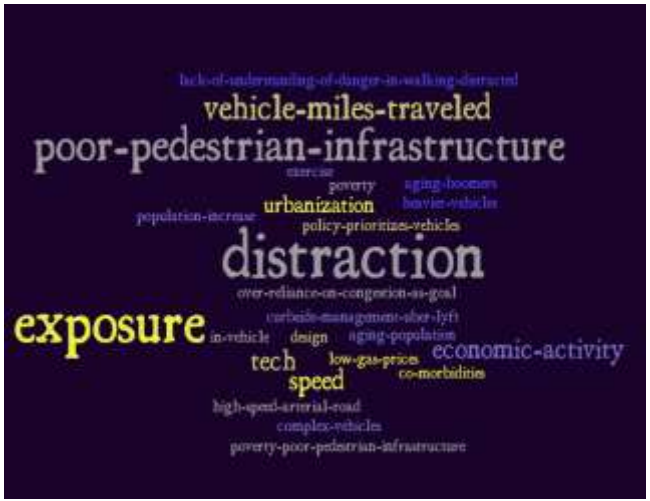
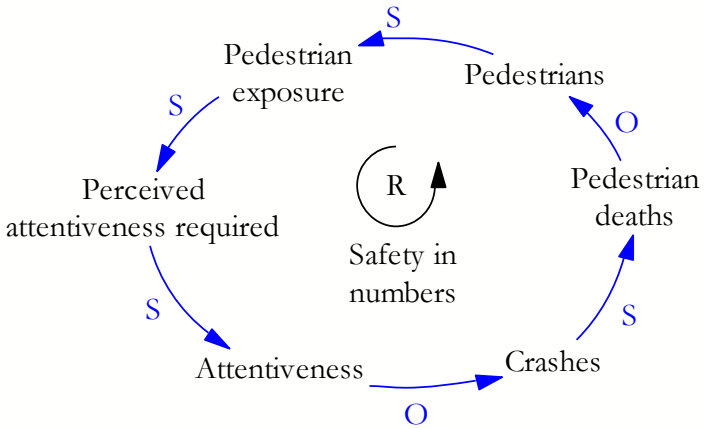


Dynamic complexity

Interconnected factors



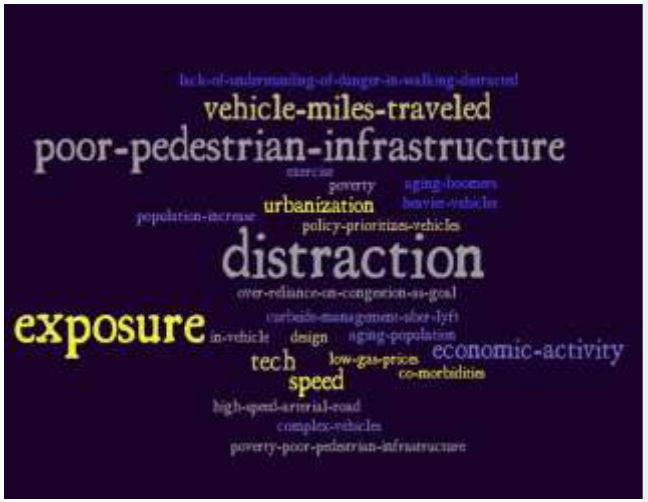
Dynamics & feedback loops



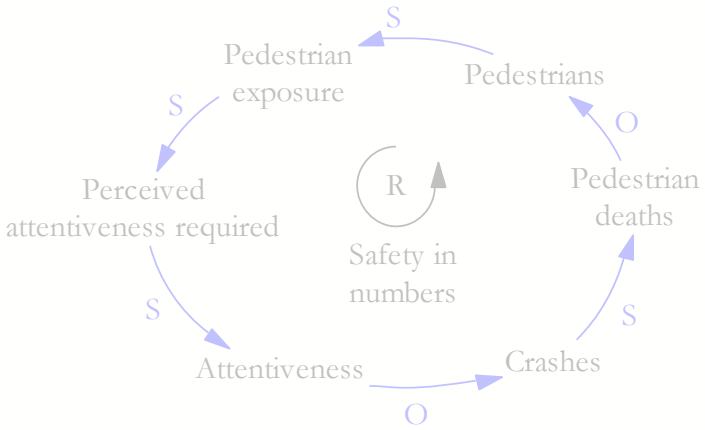
Nonlinear relationships

Dynamic complexity

Interconnected factors



Dynamics & feedback loops



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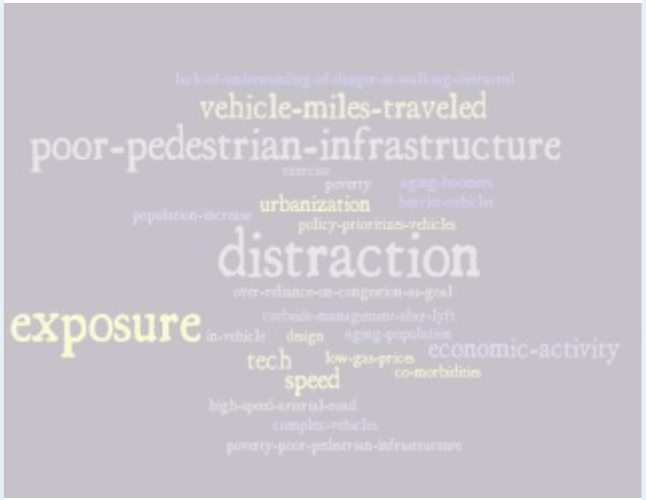

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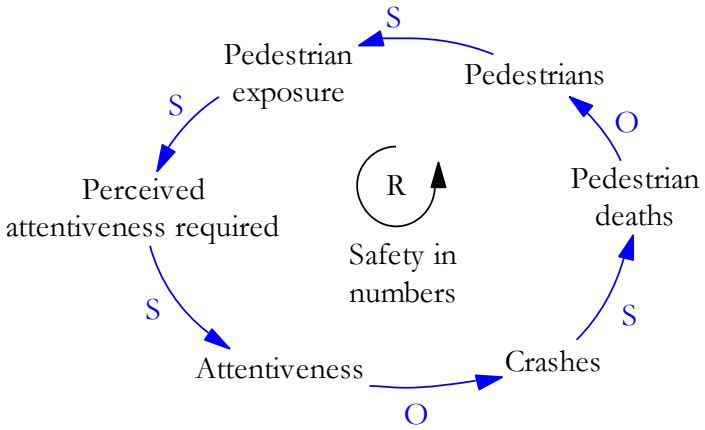

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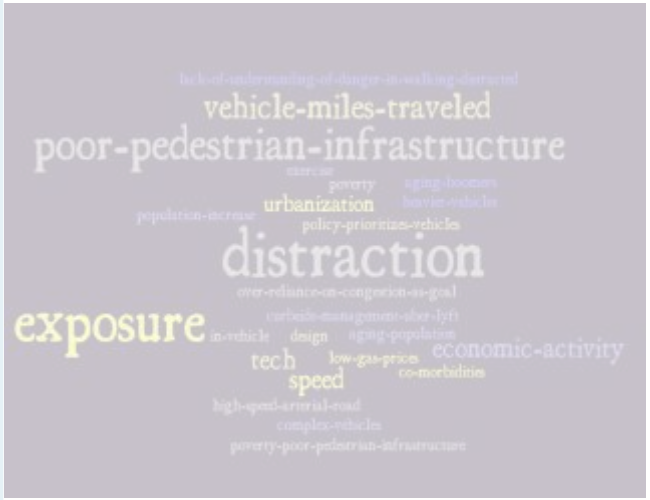

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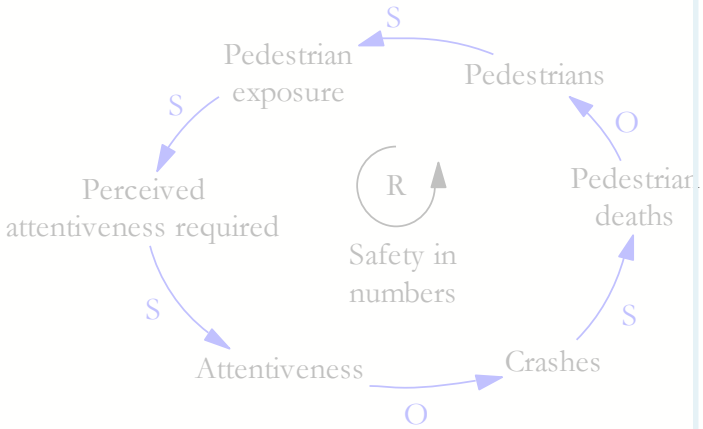

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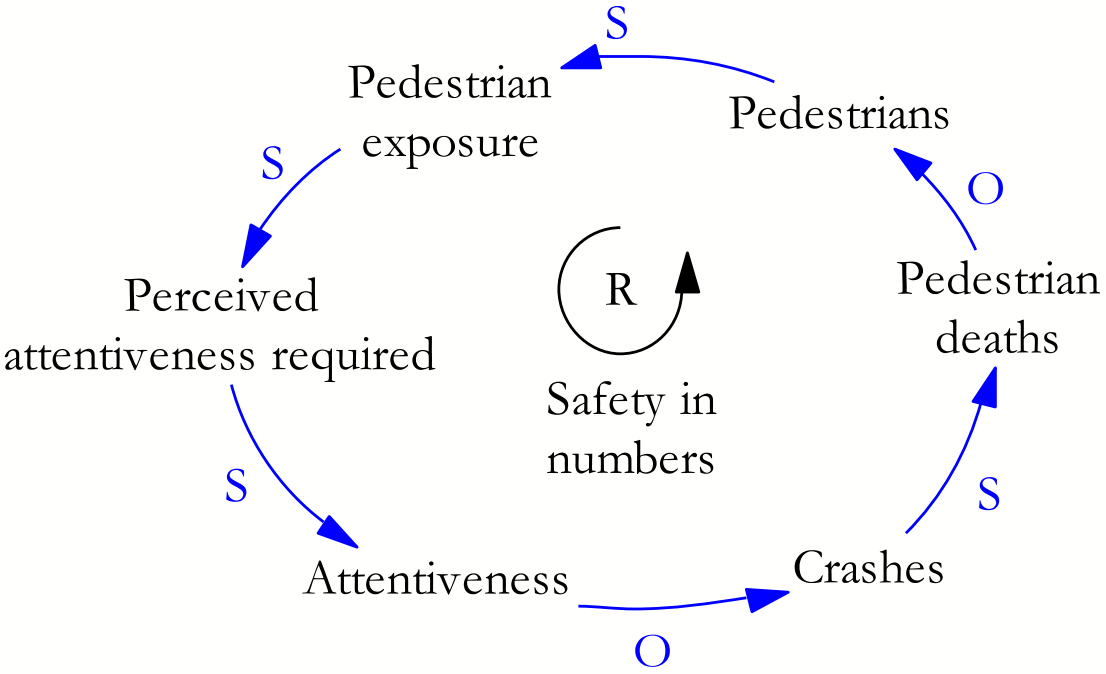
S
Pedestrian exposure
Pedestrians
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O
Perceived attentiveness required
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Safety in numbers
Pedestrian deaths
S
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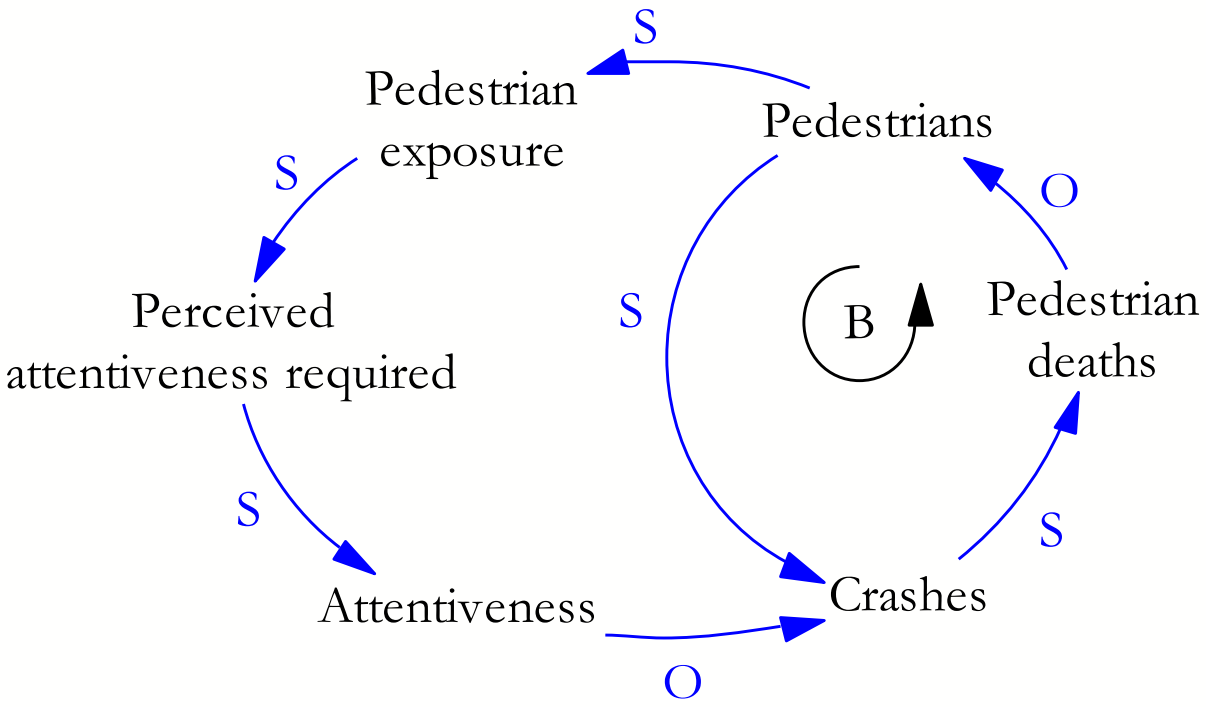
Attentiveness
Crashes
O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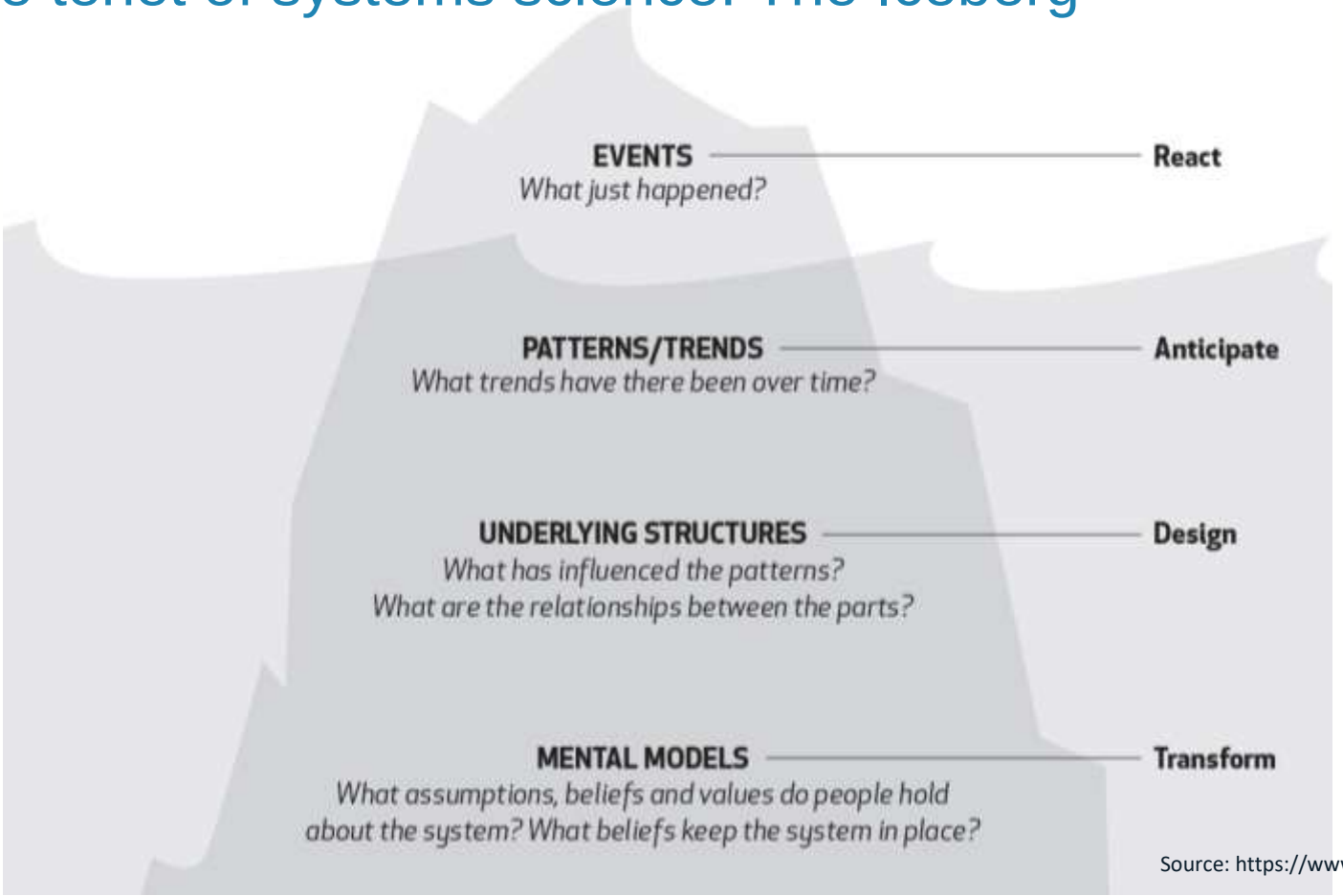
A core tenet of systems science: The Iceberg



Source: https://www.nwei.org/iceberg/

Systems science methods complement our toolbox

- Qualitative
  - Causal loop diagramming
  - Network mapping
  - Process flow diagramming
- Quantitative
  - System dynamics simulation
  - Microsimulation
  - Cost-effectiveness analysis
- Mixed methods
  - Preference elicitation
  - System dynamics

Seeing wholes… zooming in, out, in, out….

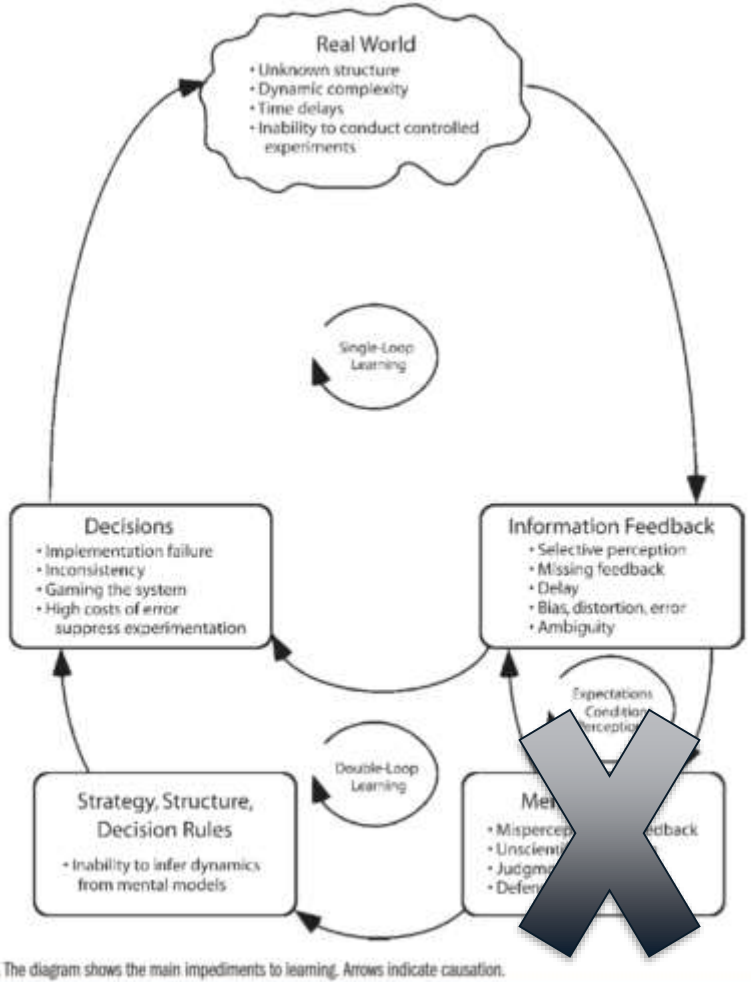
Systems thinking (using system dynamics) is about…

"Systems thinking is a discipline for seeing wholes. It is a framework for seeing interrelationships rather than things, for seeing patterns of change rather than static 'snapshots'...Today systems thinking is needed more than ever because we are becoming overwhelmed by complexity. Perhaps for the first time in history, humankind has the capacity to create far more information than anyone can absorb, to foster far greater interdependency than anyone can manage, and to accelerate change far faster than anyone's ability to keep pace."

Peter Senge,The Fifth Discipline

System dynamics is really all a

- Uncovering mental models
- Collecting better data
- “Double loop learning”

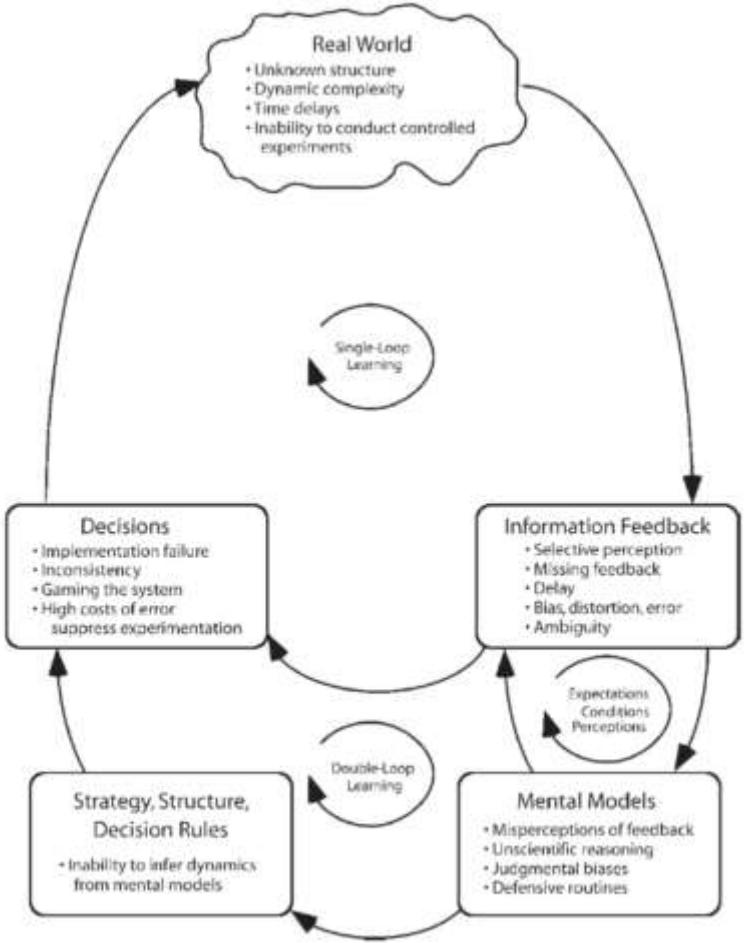


Note. The diagram shows the main impediments to learning. Arrows indicate causation.

FIGURE 2—Learning is a feedback process.

System dynamics is really all a

- Uncovering mental models
- Collecting better data
- “Double loop learning”



Note. The diagram shows the main impediments to learning. Arrows indicate causation.

FIGURE 2—Learning is a feedback process.

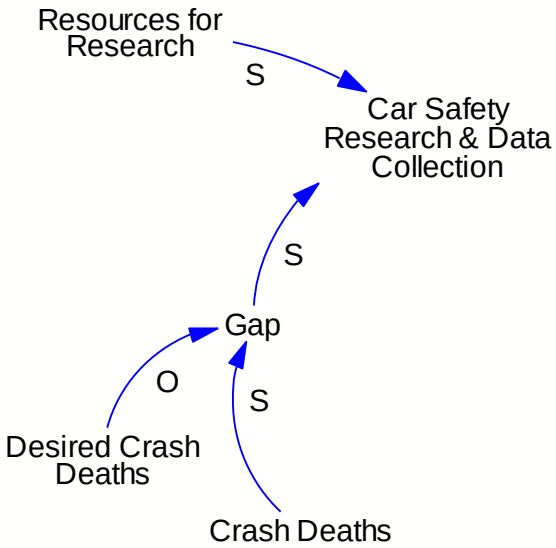
With single loop learning, we…

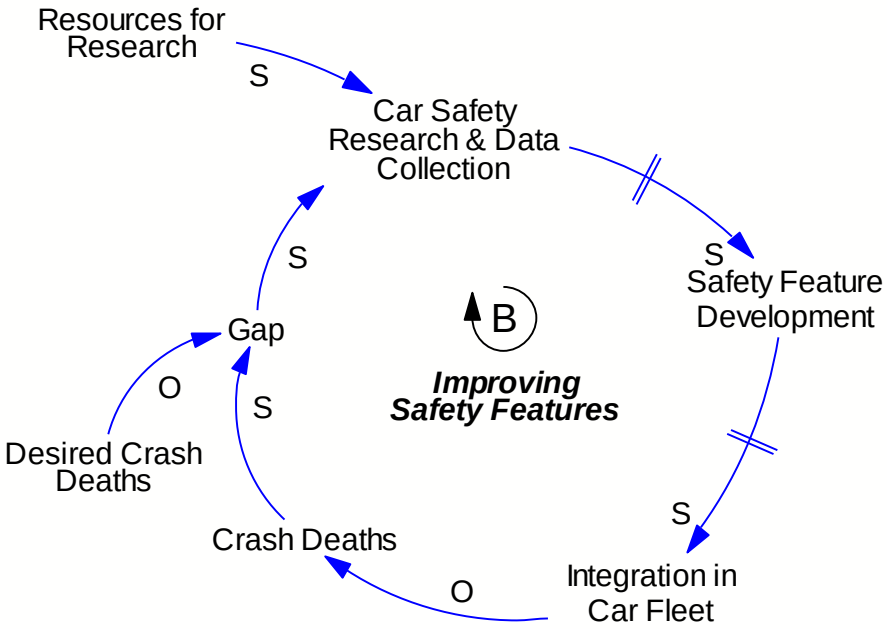
- … keep doing what works, and stop doing what doesn't work
- … don't learn from what works/doesn't
- … often ignore the impact of *current* context

But we need to appreciate that…

- What worked may not keep working
- We need to adapt what we do to the changing context

Systems thinking is a great tool for this!


Resources for Research
S
Car Safety Research & Data Collection
S
Gap
O
S
Desired Crash Deaths
Crash Deaths


Resources for Research
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Car Safety Research & Data Collection
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Safety Feature Development
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Integration in Car Fleet
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Gap
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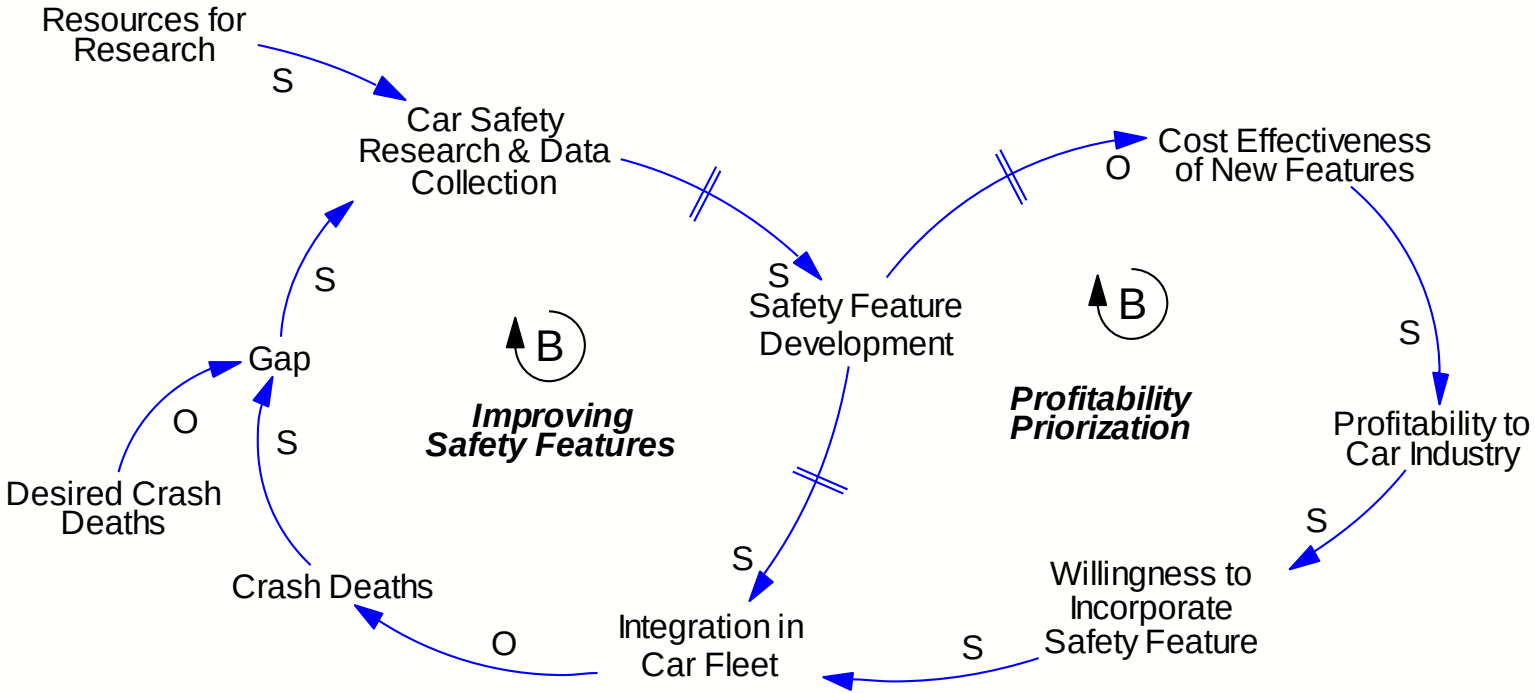
Desired Crash Deaths
B
Improving Safety Features


Resources for Research
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Cost Effectiveness of New Features
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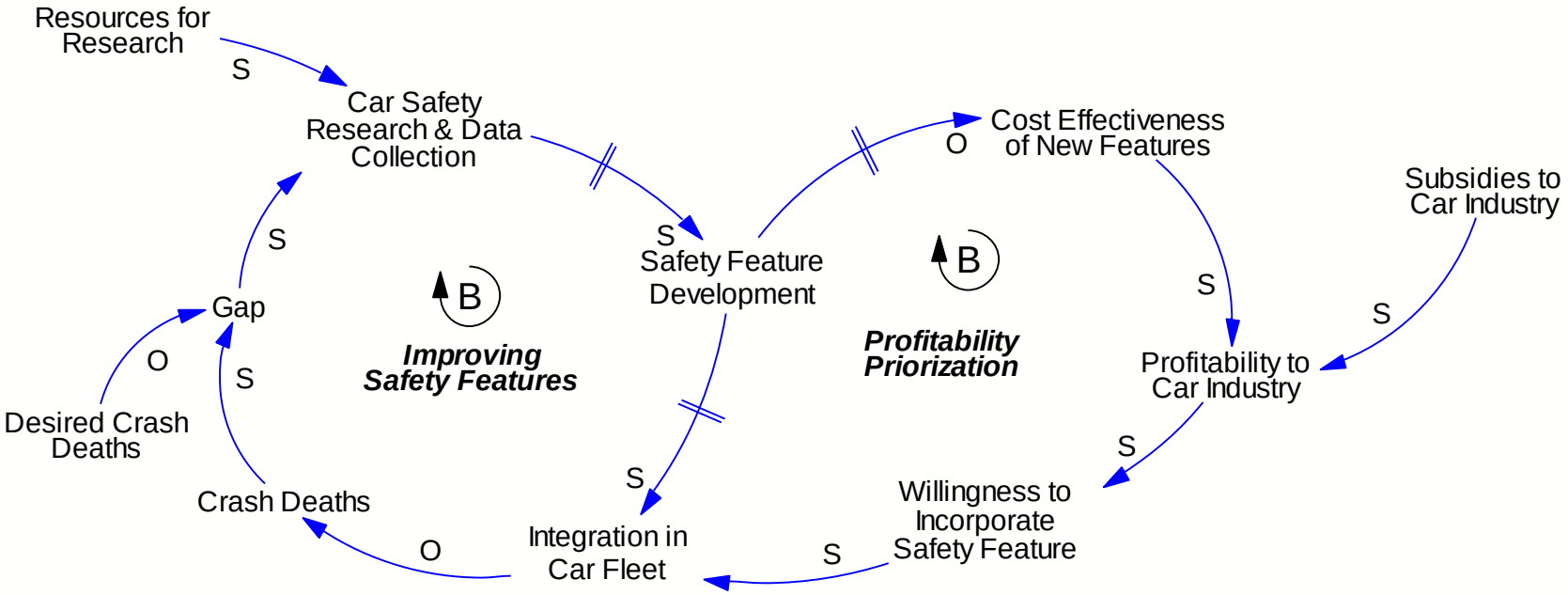
Profitability Priorization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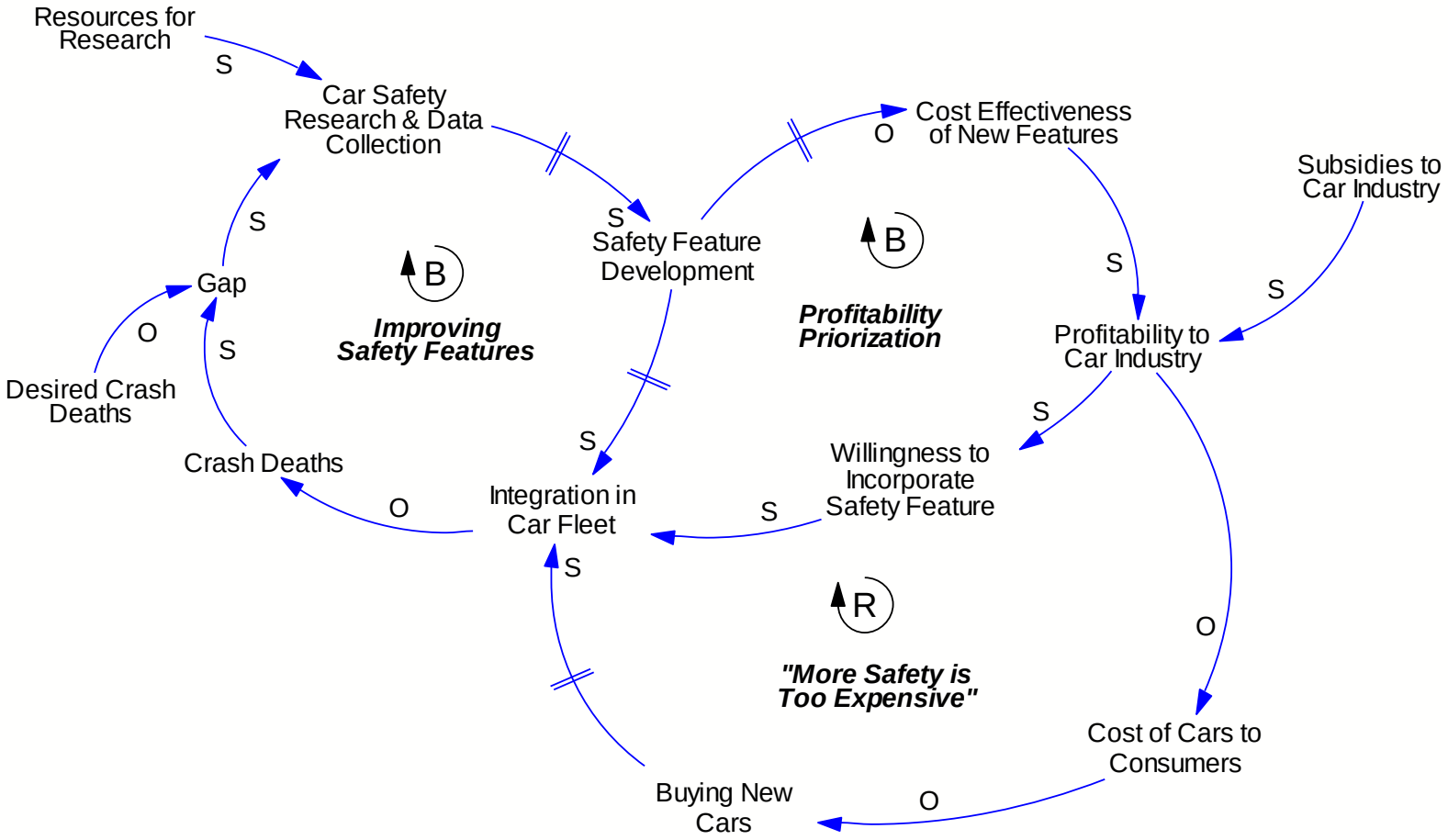
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Buying New Cars
O
Cost of Cars to Consumers
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Crash Deaths
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Gap
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O
Desired Crash Deaths
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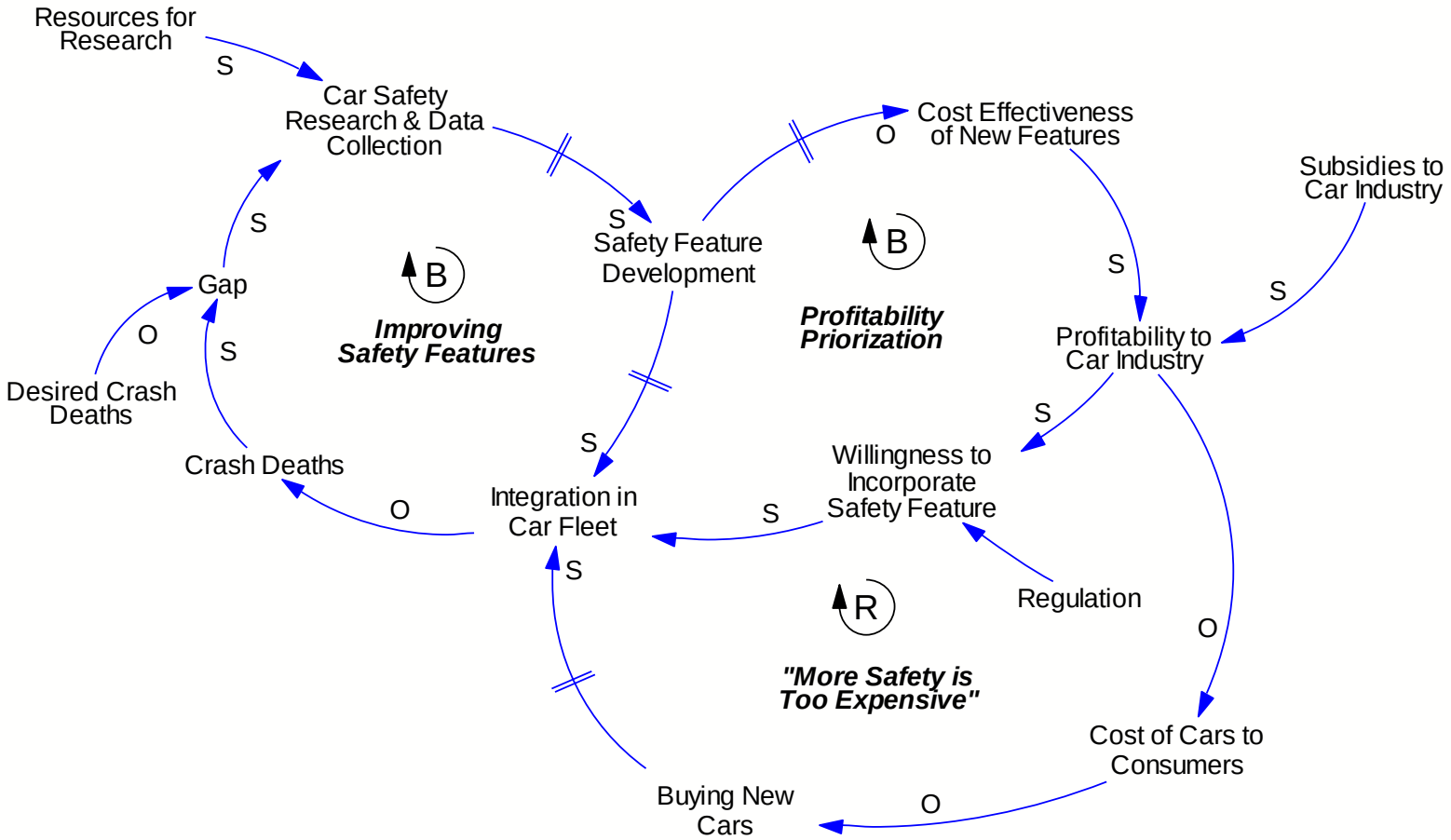
Improving Safety Features
B
Profitability Priorization
R
"More Safety is Too Expensive"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Improving Safety Features
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Profitability Priorization
R
"More Safety is Too Expensive"
Regulation
O
Cost of Cars to Consumers
O
Buying New Cars
S

Additional Resources

- Collaborative Sciences Center for Road Safety
  - www.roadsafety.unc.edu

- Example systems mapping case study:
  - https://thesystemsthinker.com/systems-thinking-at-bmw-clearing-up-germanys-traffic-jam/

- Example systems mapping project:
  - https://www.youtube.com/watch?v=G6oW6iMOpvM&feature=youtu.be

- Systems science readings:
  - https://www.roadsafety.unc.edu/about/safesystems/ (scroll to bottom of page)

Systems science can…

- Help us develop a **shared understanding** of the system
- Framework for **testing dynamic hypotheses** that are identified
- Teach us to **think differently** about how systems behave (that is, in terms dynamics, circular causal feedbacks, accumulations, etc)
- Allow stakeholders to **view the larger system** they are embedded within
- Provide a **framework for integrating** what we know, and determining importance of what we don't know
- Support identification of **high impact leverage points**
- Offer a virtual world in which to **"try out" and compare policies**