R&S Consulting

Rural ITS Conference
Big Sky, Montana
August 15

Reducing the Risks of Truck Rollover Crashes Due to High Winds

R&S Consulting
-- Joe McCarthy
-- Larry Redd, P.E.
-- Gary Schneider

Agenda

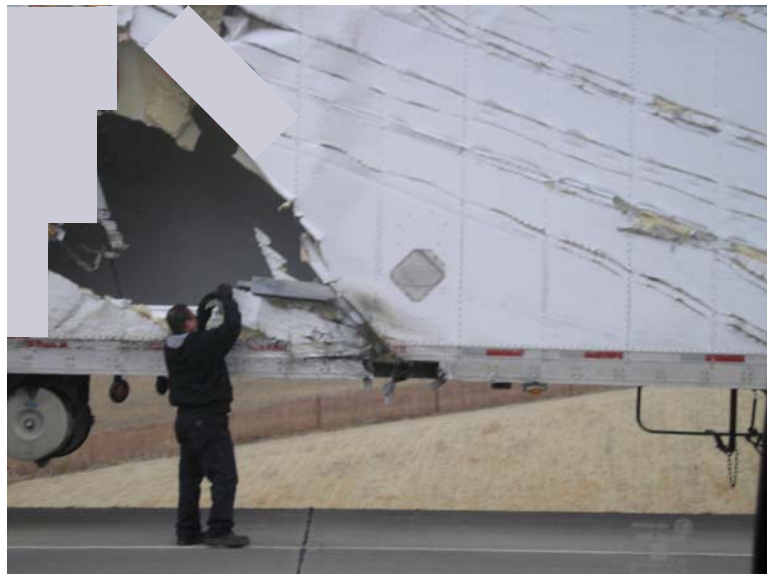
- Background on high winds in Wyoming
- Building on work already done
- Our project
  - Overview & Objectives
  - Challenges and complexity
  - Scenario development
  - Solution options, and evaluation
- Conclusions thus far

Problem – Some Compelling Numbers

- One day (early in December, 2005)
  - 10 semi-tractor trailer rigs blown over between Wellington, CO and Cheyenne, WY (I-25)
- Bordeaux segment of I-25 (3 winter seasons)
  - 48 wind-related crashes (21 injuries)
  - 37 roll-over accidents with high winds
- From 1996 to 2005
  - Several hundred wind-caused crashes in Wyoming; Many of them blow-over

The Problem – in Images

Truck Blow-over crashes do occur frequently in Wyoming…



…causing damage, injury, delays, and economic losses.

The Problem – in Images

Delays may include extended road closures…

The Problem – in Images

Even when the danger is evident, accidents continue to happen…

The Consequences

- Material damage
  - To vehicles, their contents, and the roadway
- Personal losses
  - Injuries and Deaths
- Traffic Delays
  - Slowdowns, lane and road closures, spoilage, etc.
- Significant economic impacts
  - Property Damage
  - Injury (18K$ per) and Death (3 M$ per)
  - Delays (I-80; 1M$/hour of closure)
- Not to mention…
  - Increased risks, negative publicity

Acknowledgements

- Joel Meena
  - Wyoming Department of Transportation
  - I-25 Bordeaux Crash Analysis, etc.
- Rhonda Young, Joel Liesman, David Lucke, Shane Schieck
  - *Wyoming Freight Movement and Wind Vulnerability*
  - University of Wyoming
- Manjunathan Kuma, Christopher Strong
  - *Comparative Evaluation of Automated Wind Warning Systems*
  - Western Transportation Institute
- Lynette Goodwin
  - Best Practices for Road Weather Management
  - Miratek Systems, Inc.
- Kevin Cooper
  - Kevin Cooper Aerodynamics
- Saiidi, M. and E. Maragalas
  - *Identification of Trigger Wind Velocities to Cause Vehicle Instability.*
  - Nevada DOT
- And others…
  - Our literature search continues

Building on the foundation of previous work

Leveraging existing work

- Models of wind-related accidents; critical speed to blow over, slide, etc.
- Study methodologies and results
- Definition and measures of “effectiveness”
- Assessments of deployed solutions
- Best Practices & Lessons Learned

Our WYDOT Study

- Consider enhanced solutions
  - Consider emerging technologies, models
  - Consider People & Processes AND Technology
  - Approaching the ideal
- Simplify to feasible solution
  - Starting point
  - “Future proof”
- Apply to other scenarios

Wind-caused accident modes

- Blow-over
  - Vehicle is physically pushed over
  - The focus of the project
- Push-over
  - Vehicle pushed into obstacle or off road
  - Could be associated with under- or over- steering due to gusts
- Slide-over
  - Sliding, associated with slick pavement
- Blown apart
  - E.g. pickup shell blown off, loss of cargo
- Bad Vibrations
  - Yaw / resonance

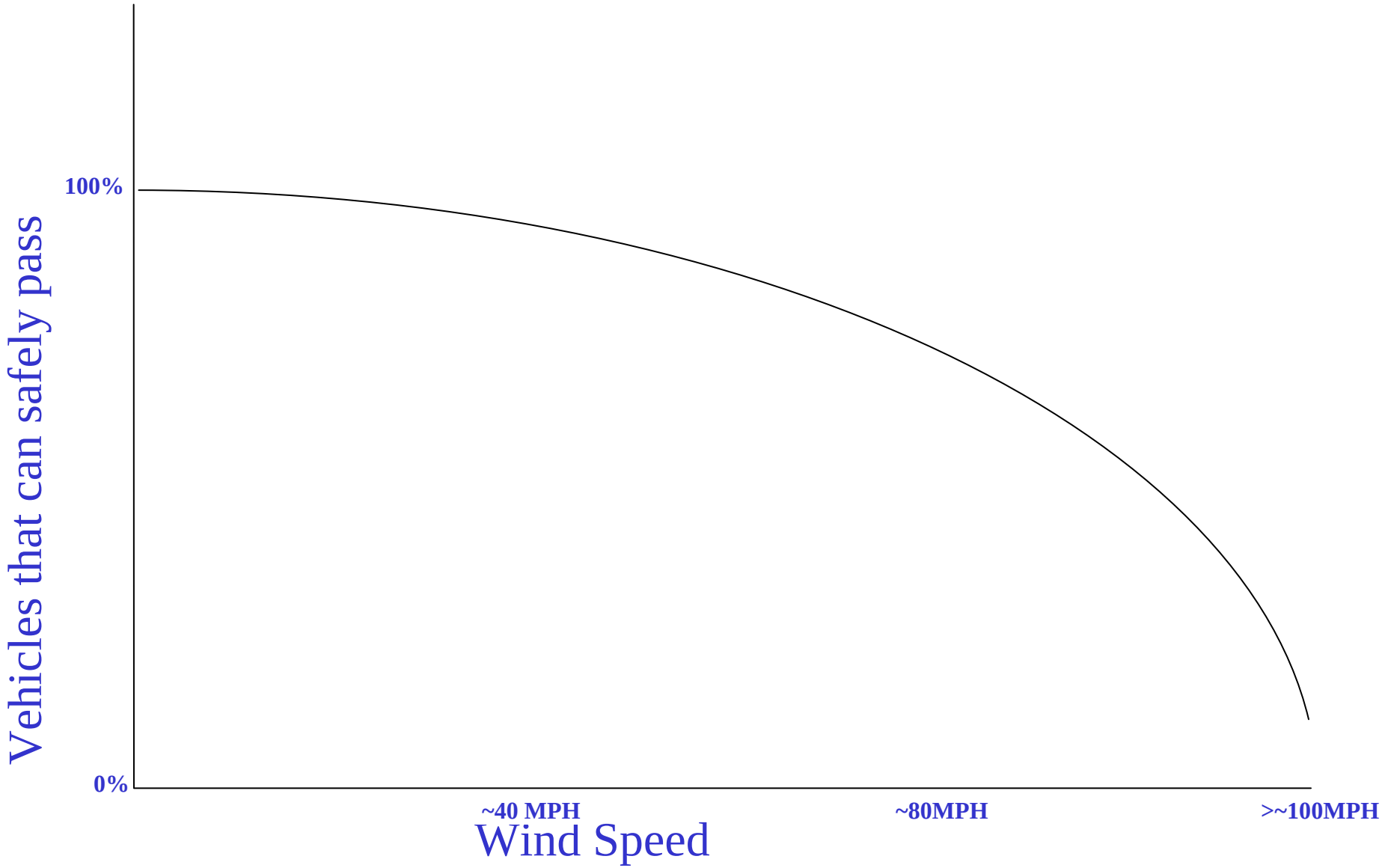
Challenges to High Wind warnings

- High winds are often concentrated in specific *danger areas*
- Decision points can be far from danger areas
  - Things can change in the mean time
- Wind events duration is variable
- Many parameters at play regarding risk to vehicles
- Human factors
  - Drivers tend to gradually forget warnings
  - Different perceptions of risk
  - Pressure to go on (JIT, etc.)

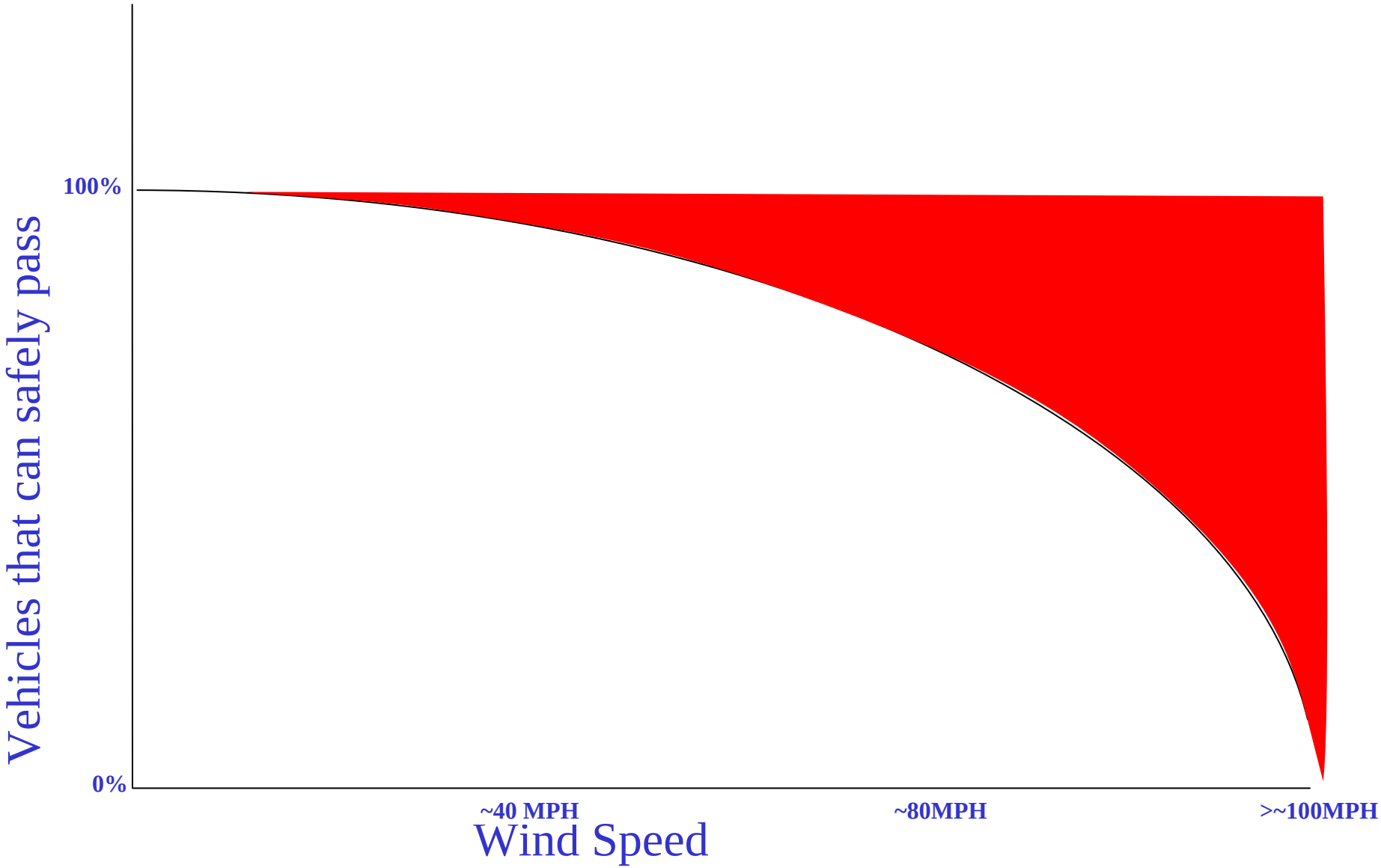
A bit about Wyoming

- Very high winds are frequent, especially in winter
  - 4 main trouble spots
  - Often compounded with blowing snow, ice/snow
- High percentage of large truck traffic
  - ~ 50% and growing
- Limited number of driver options
  - Not many alternate routes
  - Not many cities or rest areas near “danger zones”
- Current *High Winds* warning lacks teeth
  - Limited enforcement applicability; still many crashes
  - Would need statutory changes for additional enforcement

The high wind safety filter

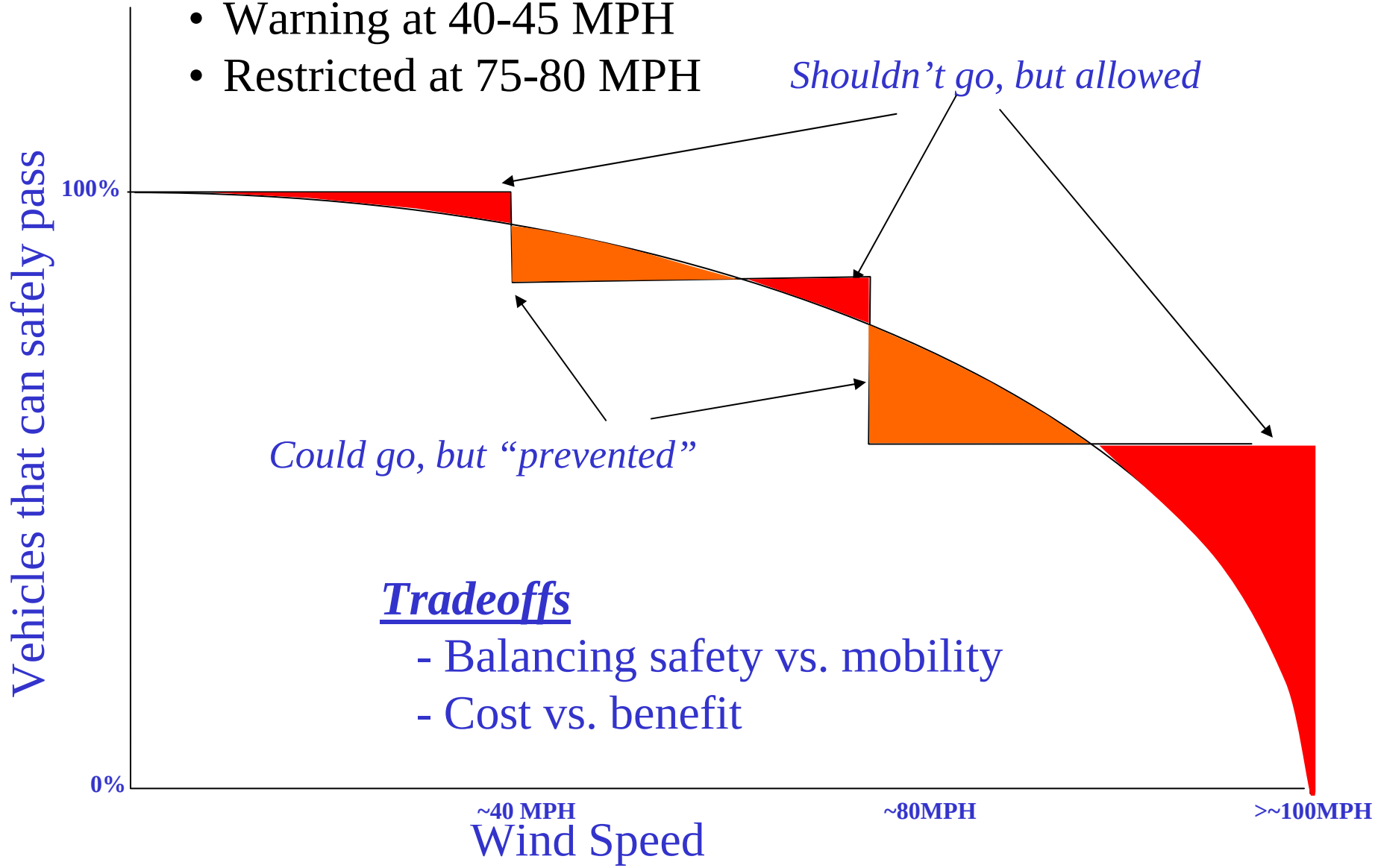


Do nothing Red Zone



An example system

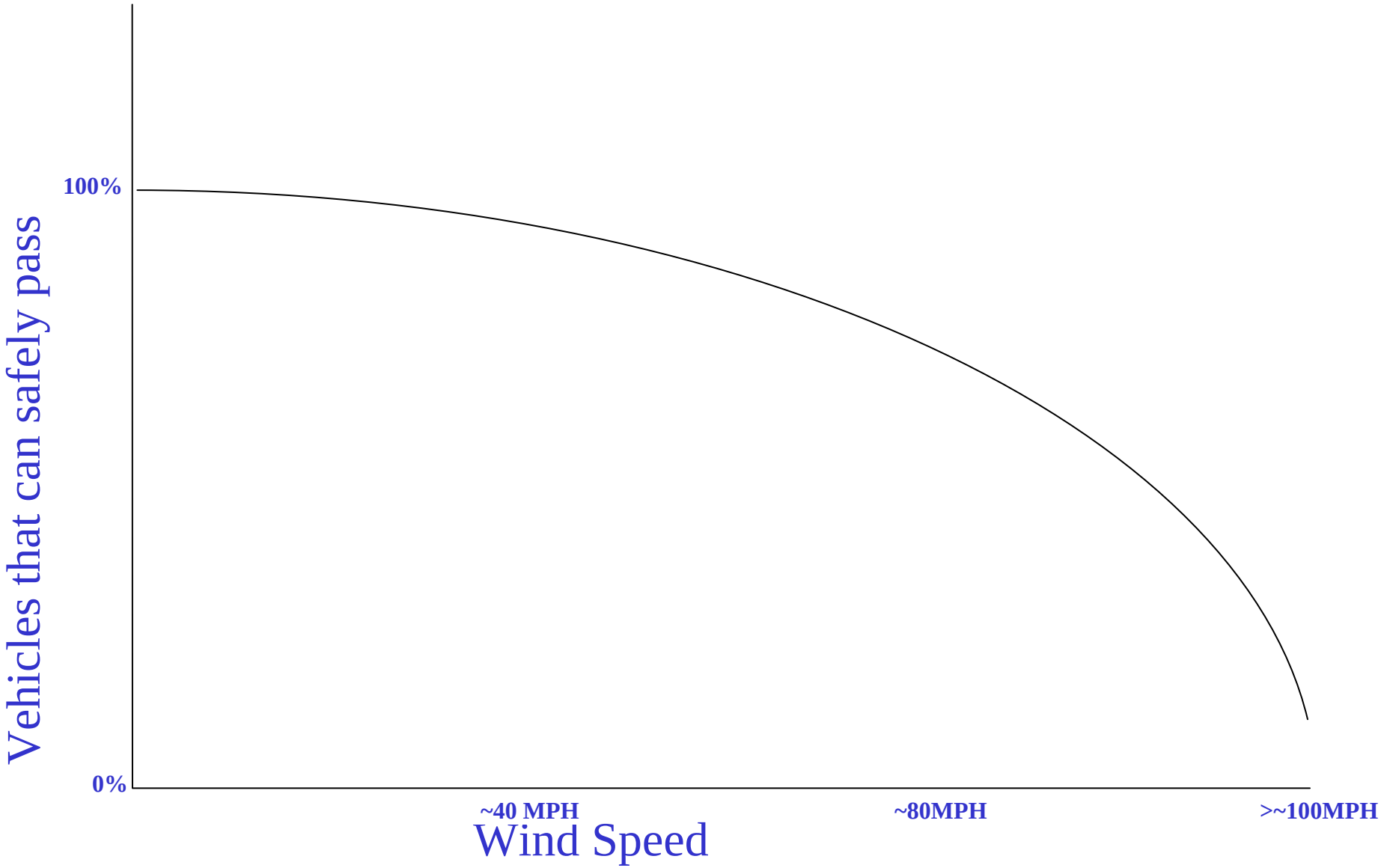
- Warning at 40-45 MPH
- Restricted at 75-80 MPH



Tradeoffs

- Balancing safety vs. mobility
- Cost vs. benefit

Can we get closer to the ideal?



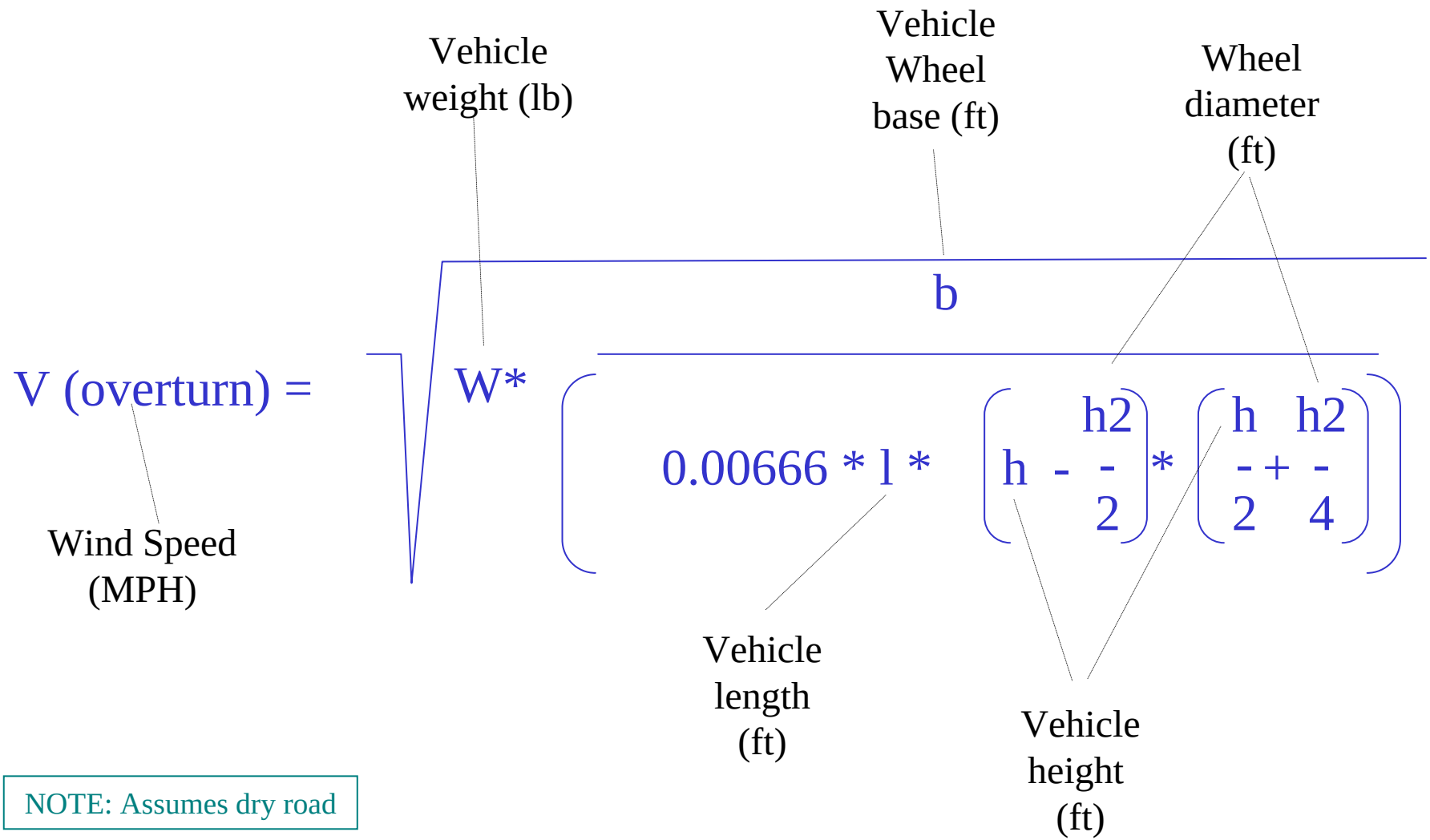
Three basic steps

- Obtain information
  - Device inputs
- Process information
  - Model / algorithm
- Communicate information
  - Outbound channels

=> Reduce crashes…

Source: Saiidi, M. and E. Maragalas

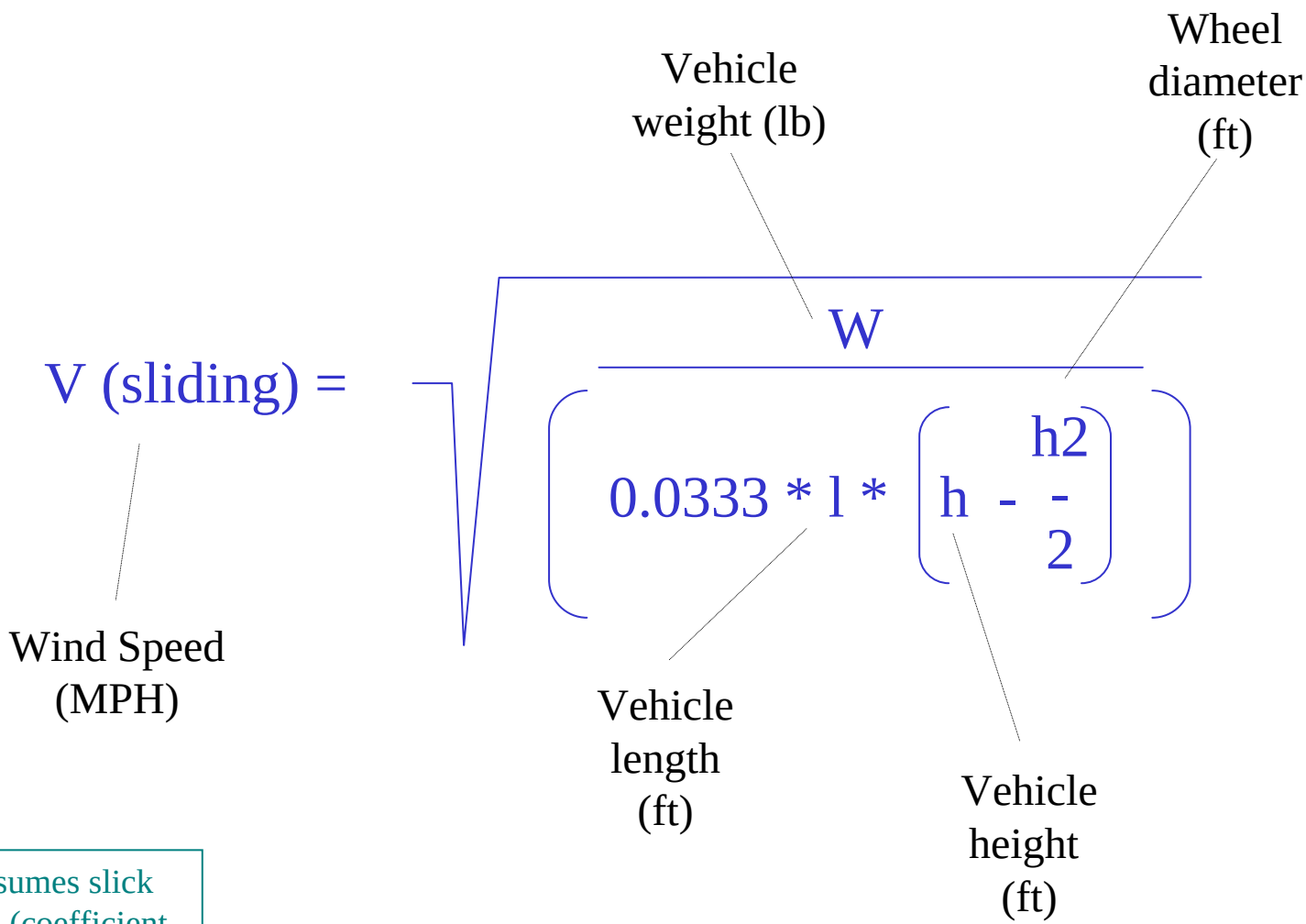
Overturn Equation



NOTE: Assumes dry road

Source: Saiidi, M. and E. Maragalas

Sliding Equation

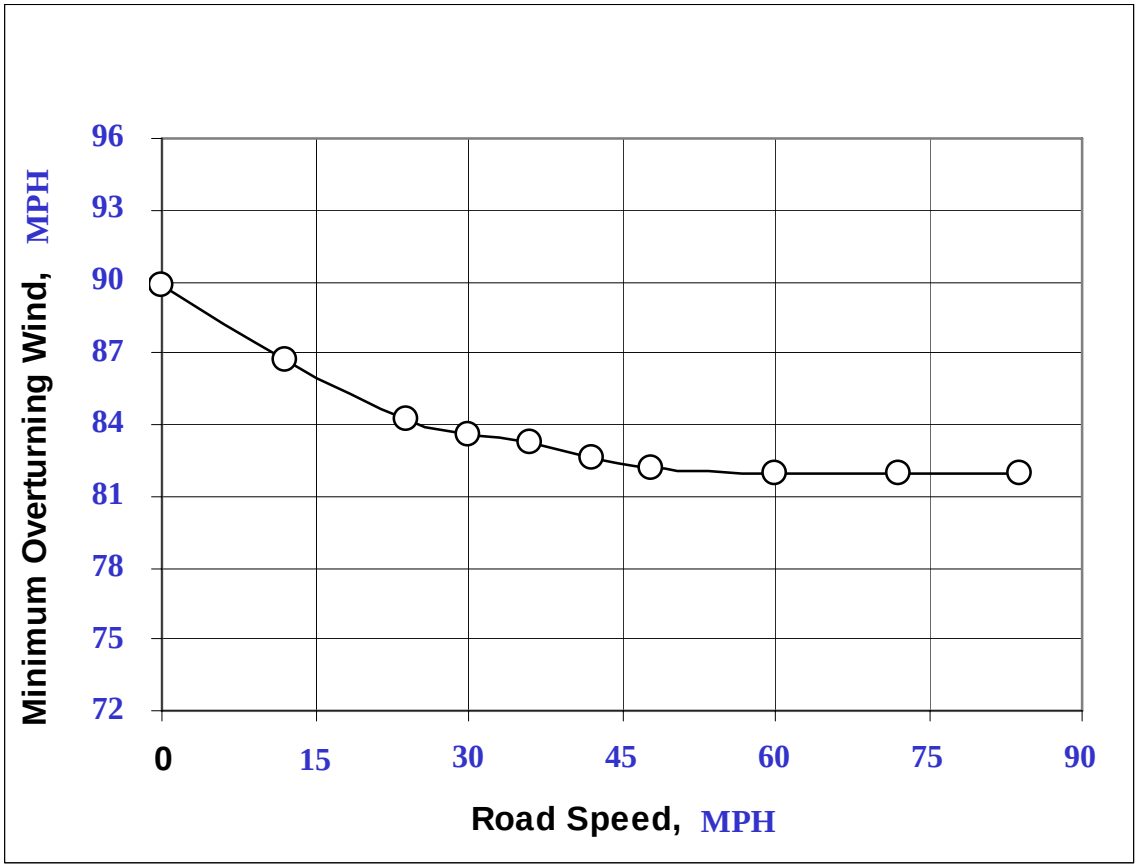


NOTE: Assumes slick road surface (coefficient of friction = 0.1)

Source; Kevin Cooper

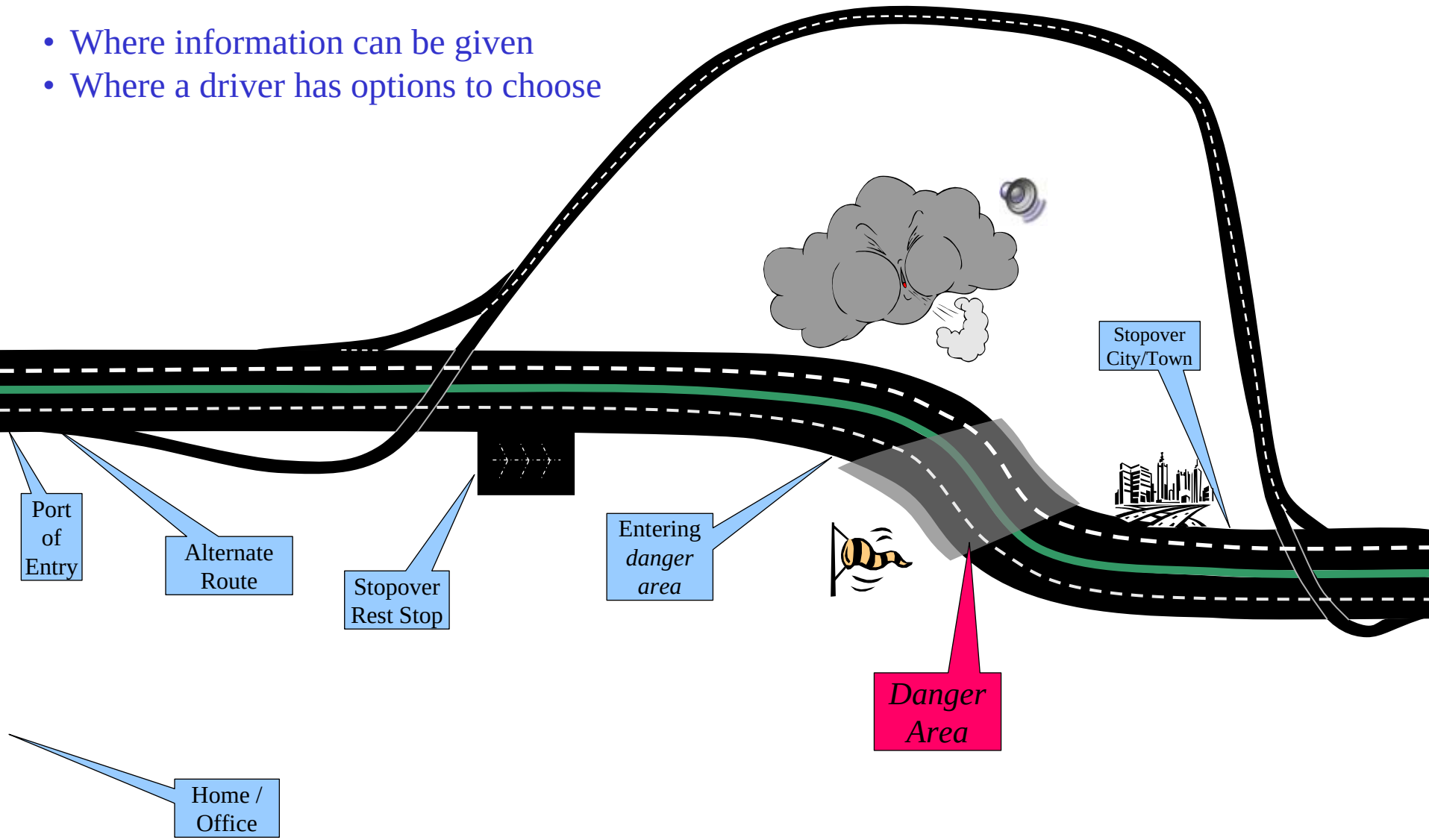
Effect of Vehicle Speed

on Tractor/trailer blow-over

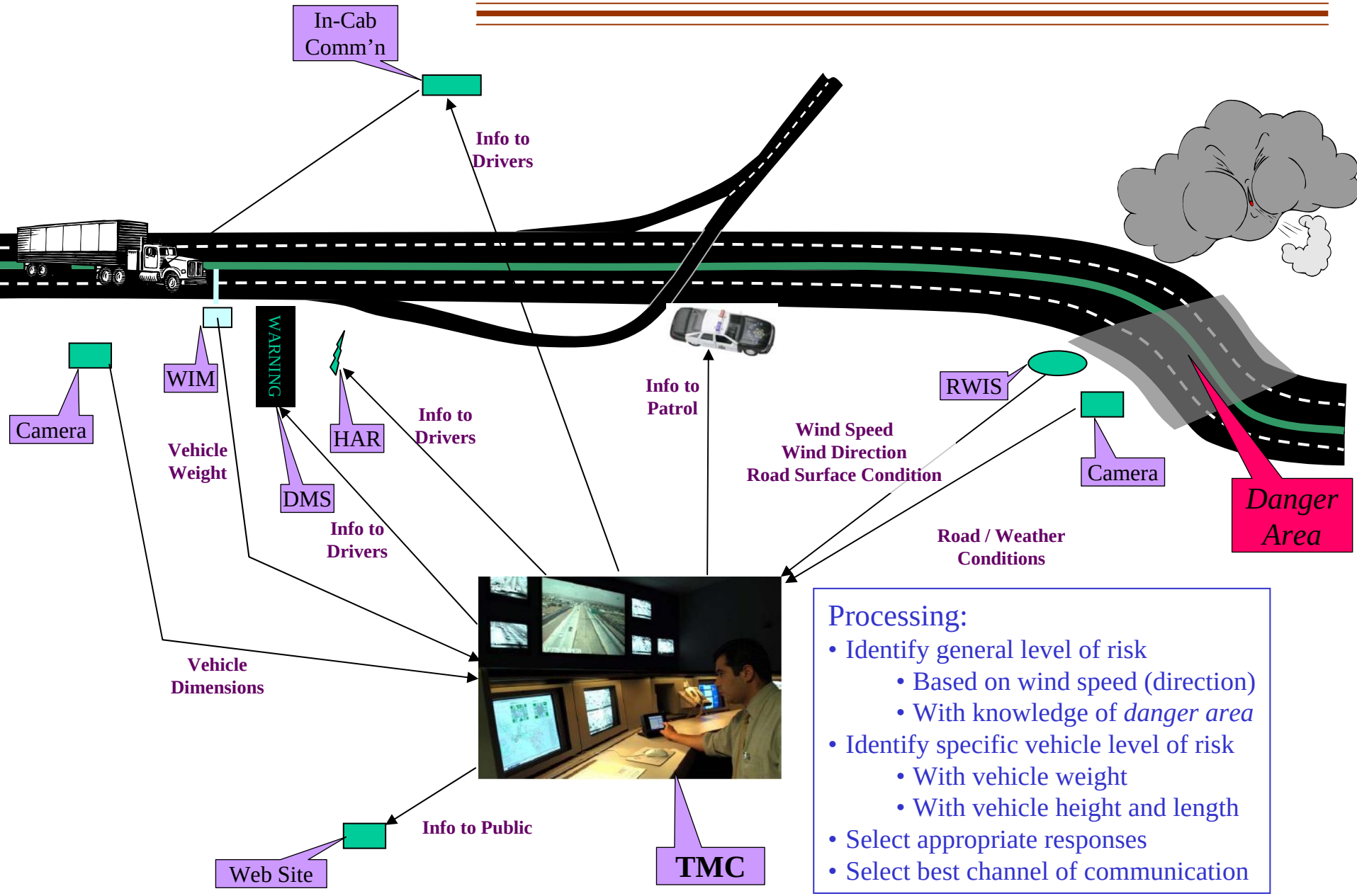


Looking at various Decision Points

- Where information can be given
- Where a driver has options to choose



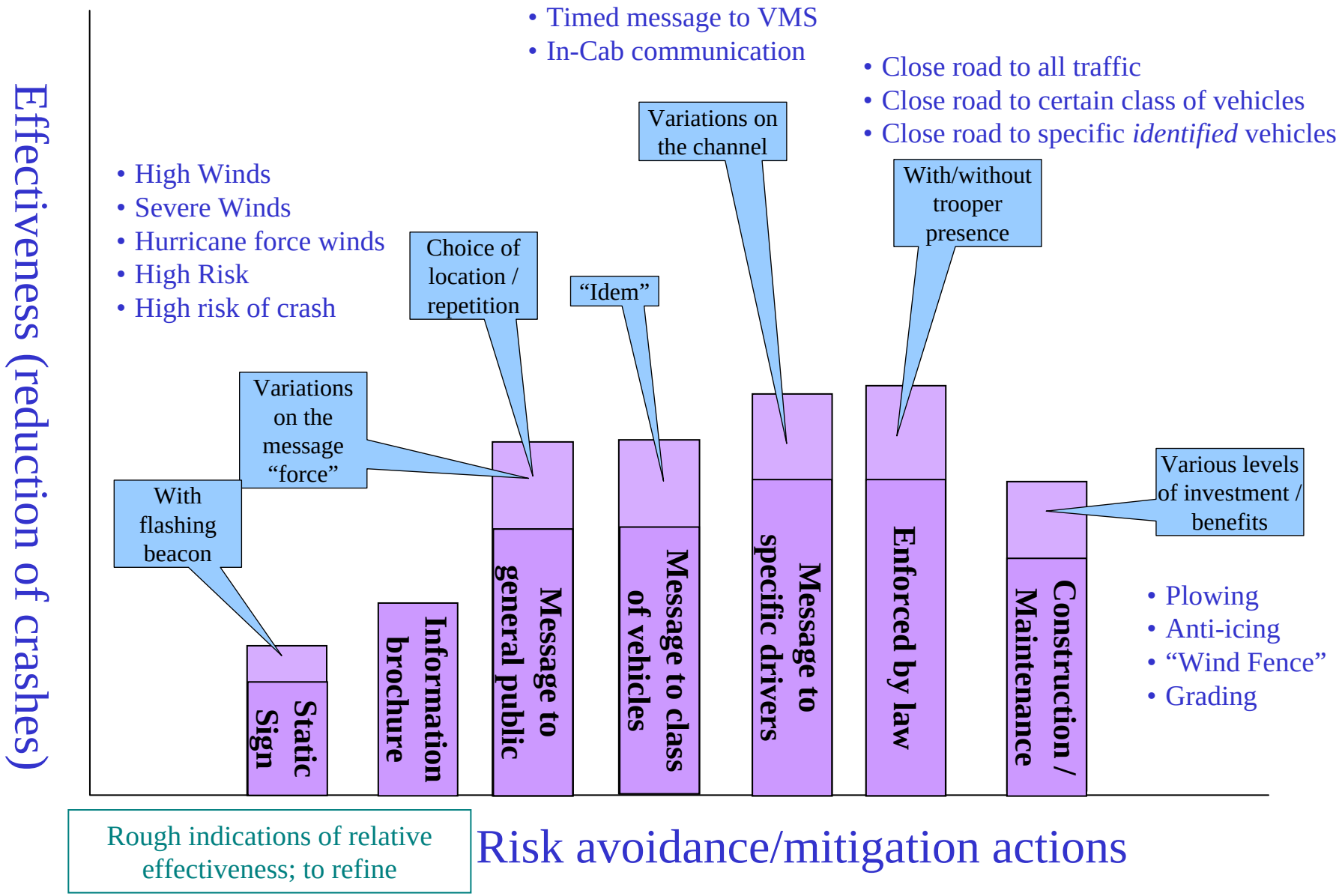
Example "*all-out*" Instrumentation



Processing:

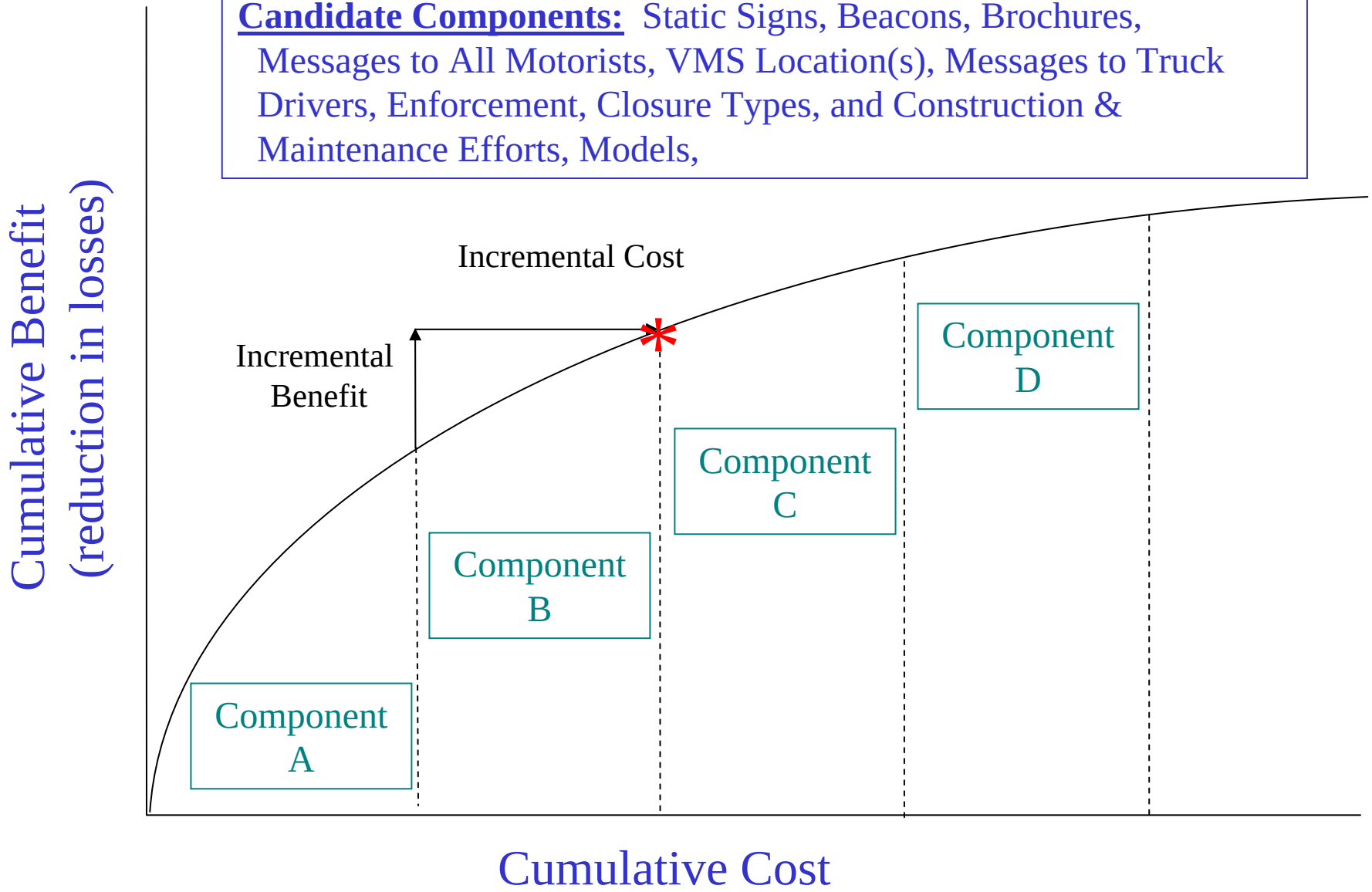
- Identify general level of risk
  - Based on wind speed (direction)
  - With knowledge of *danger area*
- Identify specific vehicle level of risk
  - With vehicle weight
  - With vehicle height and length
- Select appropriate responses
- Select best channel of communication

Solution Components Available



Looking for the *Optimal Solution*

Candidate Components: Static Signs, Beacons, Brochures, Messages to All Motorists, VMS Location(s), Messages to Truck Drivers, Enforcement, Closure Types, and Construction & Maintenance Efforts, Models,



Conclusions so far

- High wind warning systems are effective
  - Quickly become vital
- There will be some “waste”
  - Cost/benefit compromise
  - Err on the side of safety
- Important to “Investigate large / Implement focused”
  - Aggressive on ideas
  - Pragmatic (initial solution)
- Continuous improvement
  - Metrics to drive next steps

Our Next Steps

- Studying Human Factors
  - Talk with blow-over victims
  - Truck Driver survey
- Assess practicality of risk models
- Identify optimum scenarios for Wyoming
  - Generalize; across state, across crash modes
  - Best certainty/simplicity tradeoff
  - Best cost/benefit tradeoff
  - Recommend system solutions
- Follow-On
  - Leverage to other types of conditions
  - Leverage to other geographies / locations
  - Dig in deeper
    - Assess effects of other parameters
    - Assess effects of road surface
    - Incorporate recent crashes into analysis

Thank You!!!

For your attention!

Contact Information:

Joe McCarthy

joem@enablingresults.com

(970) 412-4022