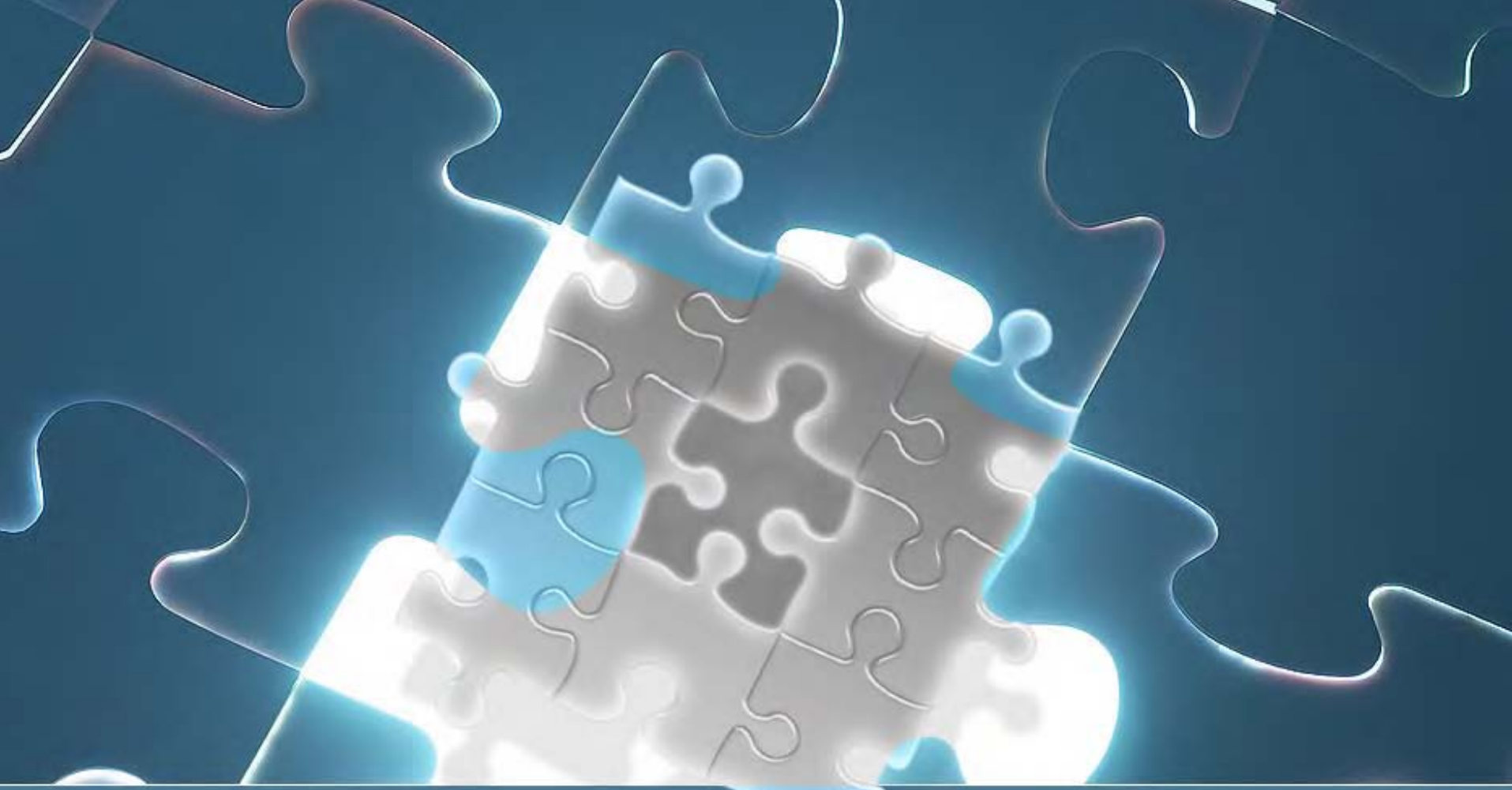


The Dark Side of Road Safety:

Dealing with uncertainty and risk in VE

John B. L. Robinson

delphi MRC

A life without adventure is likely to be unsatisfying. But a life in which adventure is allowed to take whatever course it will is likely to be....short

Bertrand Russell

What we'll talk about

- Road safety analysis in VE
- The dark side: Uncertainty
- A proxy approach
- Benefits & stakeholder perceptions
- Concluding thoughts

Road safety analysis in VE

Road safety analysis in VE

- Limitations:
  - Road safety & human factors only
  - Explicit evaluation
    - Some quantitative
    - Some qualitative
  - Uncertainty is usually relatively undefined:
    - Pessimistic, most likely, optimistic

The Dark Side... Uncertainty

Uncertainty breeds risk ...

Sunday

- High 10°C
- Low 4°C

A mix of sun and cloud

Thursday night

- Low 9°C
- POP 60%

Chance of drizzle

Saturday

- High 10°C
- POP 60%

Chance of showers

Tonight

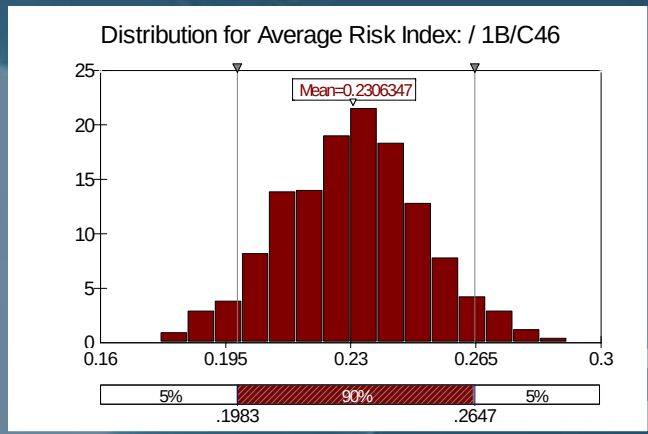
Cloudy. 60 percent chance of drizzle overnight. Fog patches developing overnight. Wind north 20 km/h becoming light this evening. Low 9.

Two terms you should know ...

- Deterministic:
  - *The answer is a single number*

Alternative >>> / Collision Vector	Risk Evaluation: Risk Indices				
	1A	1B	2A	2B	3
Driver workload	0.15	0.30	0.15	0.30	0.39
Information placement	0.06	0.12	0.10	0.14	0.14
Interchange/Ramp spacing	0.25	0.42	0.36	0.33	0.36
Atypical features	0.06	0.15	0.03	0.13	0.20
Confinement	0.20	0.30	0.18	0.27	0.36
Roadside	0.24	0.35	0.24	0.35	0.45
Geometry/Alignment/Consistency	0.12	0.10	0.15	0.13	0.18
Roadway cross section	0.08	0.08	0.08	0.08	0.15
Speed	0.11	0.16	0.11	0.16	0.25
Sight distance available	0.10	0.20	0.12	0.23	0.30
Vulnerable road users	0.18	0.07	0.21	0.18	0.14
Average risk index:	0.14	0.20	0.16	0.21	0.27

- Probabilistic:
  - *The answer is a probability distribution*



Another example

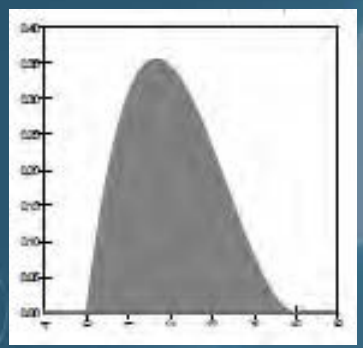
- Countermeasure or VE suggestion effects:

Collision frequency after = SPF x CMF

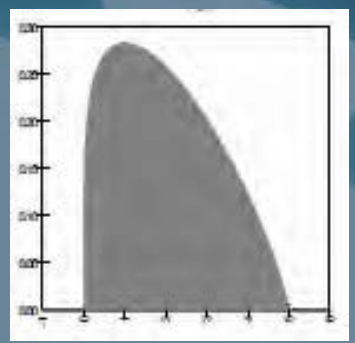
SPF: safety performance function

CMF : collision modification factor

SPF **CMF**



X



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Quantifying risk ...

- Requires:
  - Specific data on variability of inputs
    - Distribution & standard error
  - Knowledge & skill:
    - Monte Carlo techniques most common
  - Policies:
    - What risk levels are we prepared to accept?
      - Eg. AASHTO flexible pavement design ...
    - What risk management measures?

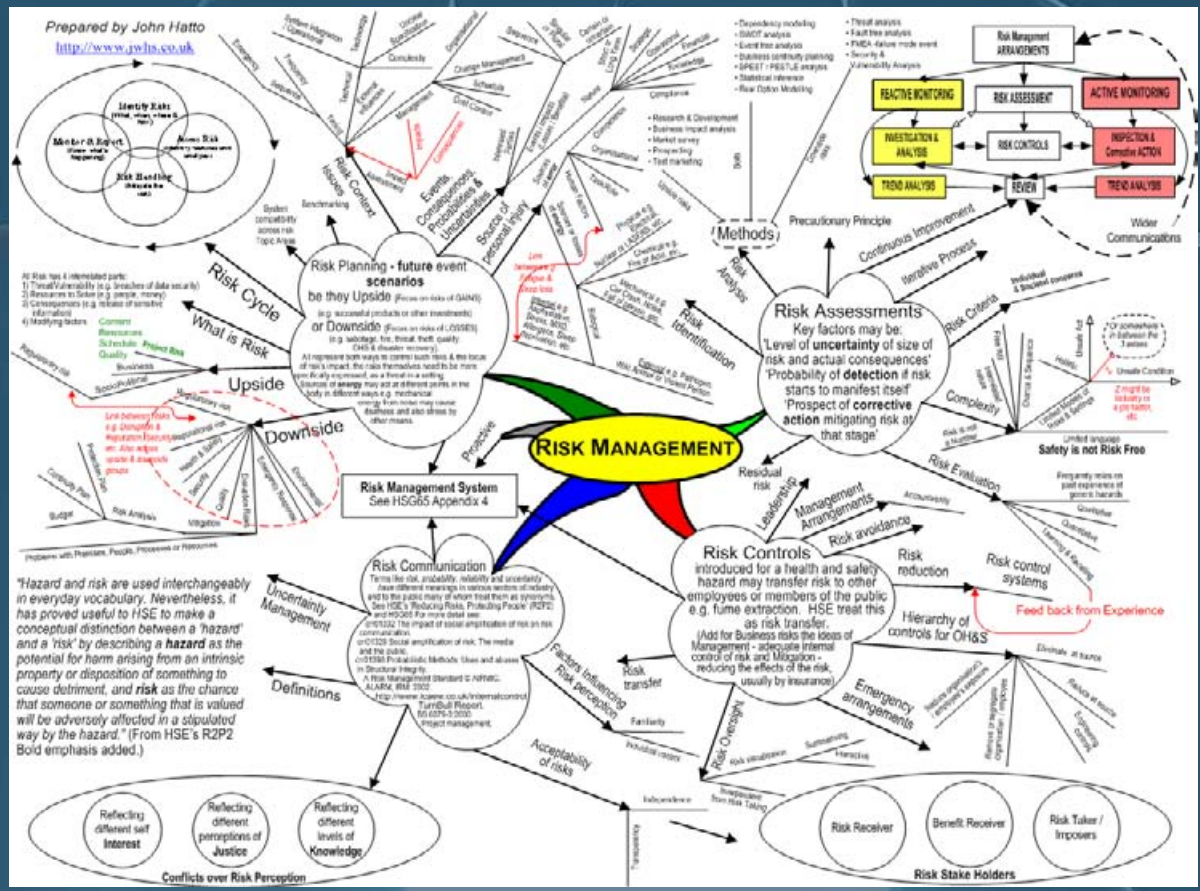
Risk

- Old Oxford Dictionary:
  - To expose to the chance of injury or loss
- So – there is:
  - A potential loss
  - A ***chance*** of loss (a sure loss is not a risk)
  - Decision maker can affect the magnitude or chance of loss

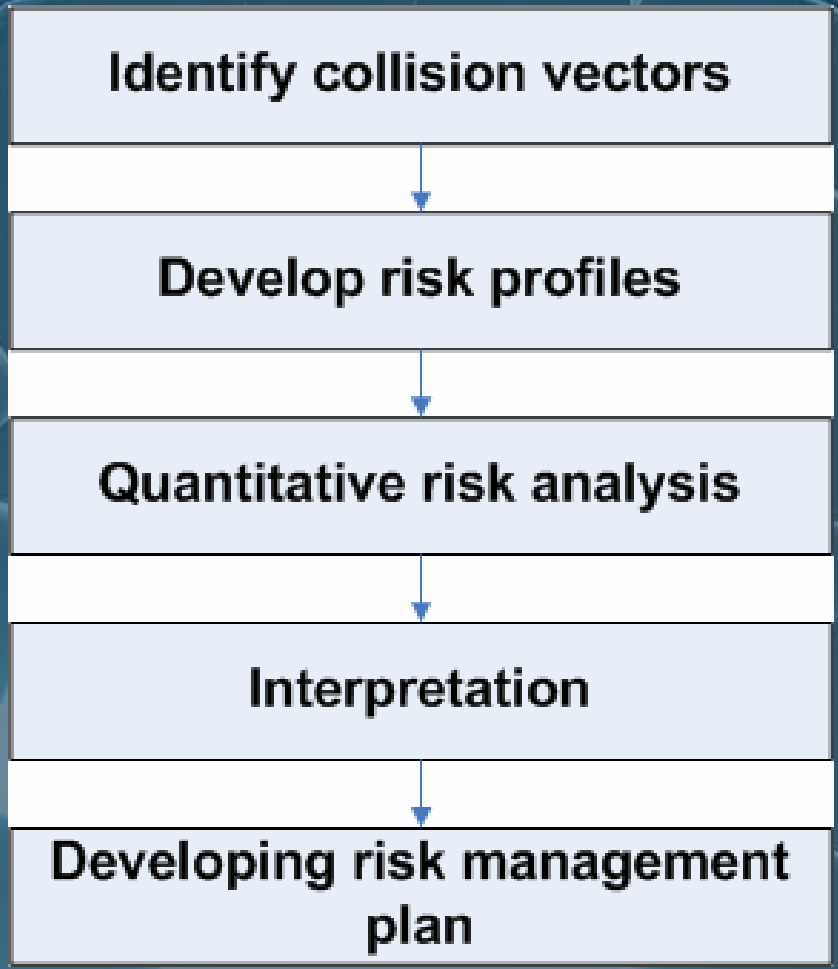
Risk issues

- Risk involves 2 key issues:
  - The frequency of the loss (how often)
  - The consequences of the loss (how large)
- The perception of the loss:
  - Also important – effects on stakeholders
- Mitigating measures
  - May create new risks

A Proxy Approach



Overview


Identify collision vectors
Develop risk profiles
Quantitative risk analysis
Interpretation
Developing risk management plan

The foundation

- Identification of risk feature
- Assessment of potential “impact”:
  - 0 to 1 scale reflecting collision severity
- Assessment of “likelihood” of occurrence
  - 0 to 1 scale reflecting relative likelihood

- Development of a quantitative index:

Risk Index = Impact x Likelihood

Some comments on Risk Index

- Scaling is “probability-like” (0 to 1)
  - Not real probabilities
- Can be subjective or statistically based
- Relative differences are key
  - Lower values are “more safe”
  - Higher values are “less safe”

Identifying Risk Features: Collision vectors

Collision vectors

- A design or operational feature
- Other element
- Associated with risk of collisions

- Examples:
  - Horizontal curve
  - Aggressive roadside
  - Insufficient gap search & manoeuvre distance

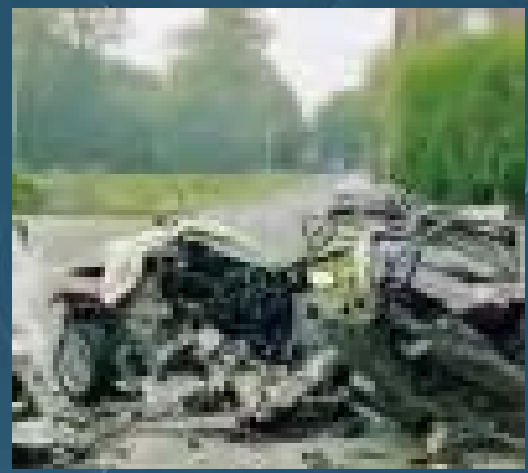
A case study sample ...

- Driver workload
- Information placement
- Ramp spacing
- Atypical features
- Confinement
- Roadside
- Geometry/alignment
- Cross section
- Speed
- Sight distance
- VRU treatments

Collision vector risk profiles

- The ranges/distributions used for:
  - Impact
  - Likelihood

For each collision vector



- Based on toolset developed over multiple projects & from research literature

Risk Profiles Used

Probabilistic Risk Analysis of Alternatives			
	Impact		
Alternative >>> / Risk element	Min	Max	Most Likely
Driver workload			
Information placement			
Interchange/Ramp spacing			
Atypical features			
Confinement			
Roadside			
Geometry/Alignment/Consistency			
Roadway cross section			
Speed			
Sight distance deficiency			
Vulnerable road users			
	Impact		
Alternative >>> / Risk element	Min	Max	Most Likely
Driver workload			
Information placement			
Interchange/Ramp spacing			
Atypical features			
Confinement			
Roadside			
Geometry/Alignment/Consistency			
Roadway cross section			
Speed			
Sight distance deficiency			
Vulnerable road users			

Deterministic outputs

Alternative >>> / Risk element	A	B	C	D	E
Driver workload	0.15	0.30	0.15	0.30	0.39
Information placement	0.06	0.12	0.10	0.14	0.14
Interchange/Ramp spacing	0.25	0.42	0.36	0.33	0.36
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Speed	0.11	0.16	0.11	0.16	0.25
Sight distance available	0.10	0.20	0.12	0.23	0.30
Vulnerable road users	0.18	0.07	0.21	0.18	0.14
Average risk index:	0.14	0.20	0.16	0.21	0.27
Performance Scale Score:	6	8.00	7.00	9.00	10.00

Value opportunities

Design Alternative	Value Improvement Opportunities (Risk Index >0.30)	Relevant Risk Index
A	None	NA
C	Interchange ramp spacing	0.36
B	Driver workload Interchange ramp spacing Confinement Roadside	0.32 0.42 0.30 0.35
D	Driver workload Interchange ramp spacing Roadside	0.30 0.33 0.35
E	Driver workload Interchange ramp spacing Confinement Roadside Sight distance available	0.39 0.36 0.36 0.45 0.30

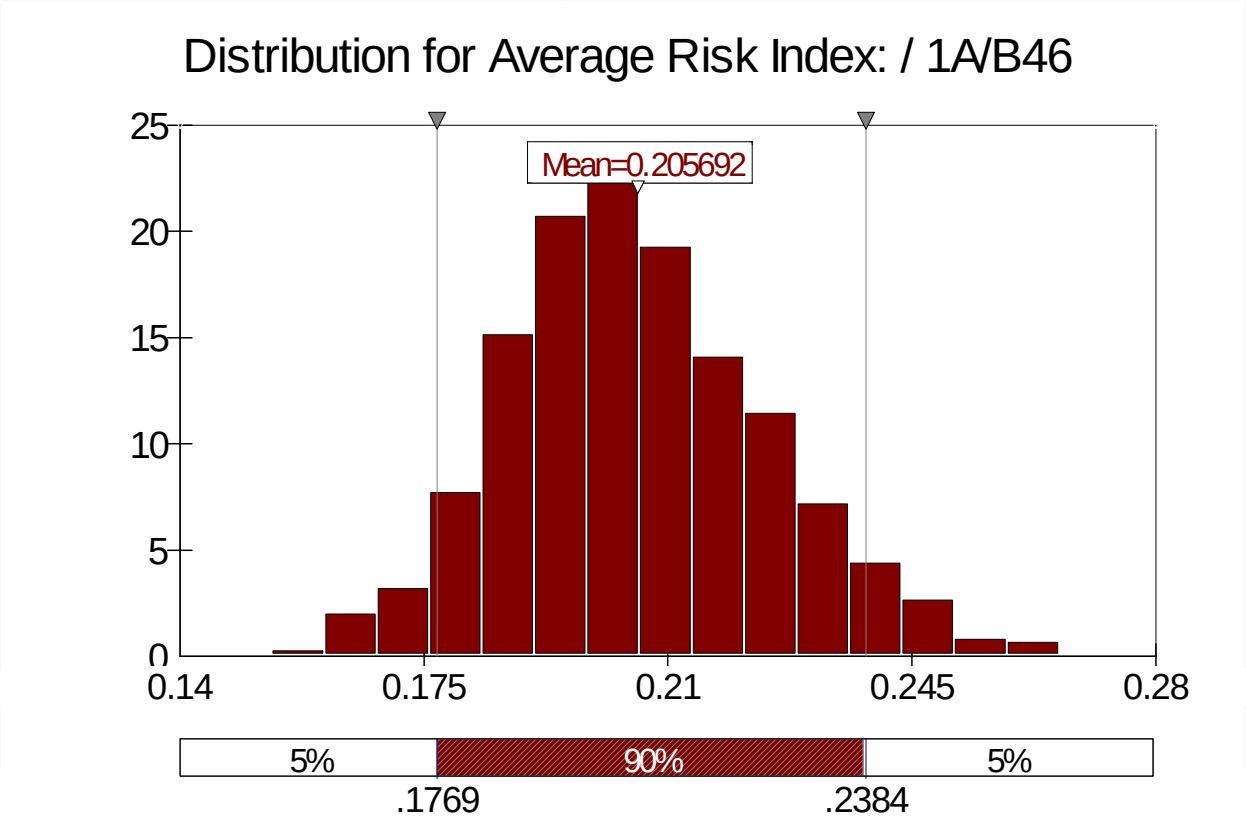
Focus of value opportunities

- Derived from detailed collision vector commentary

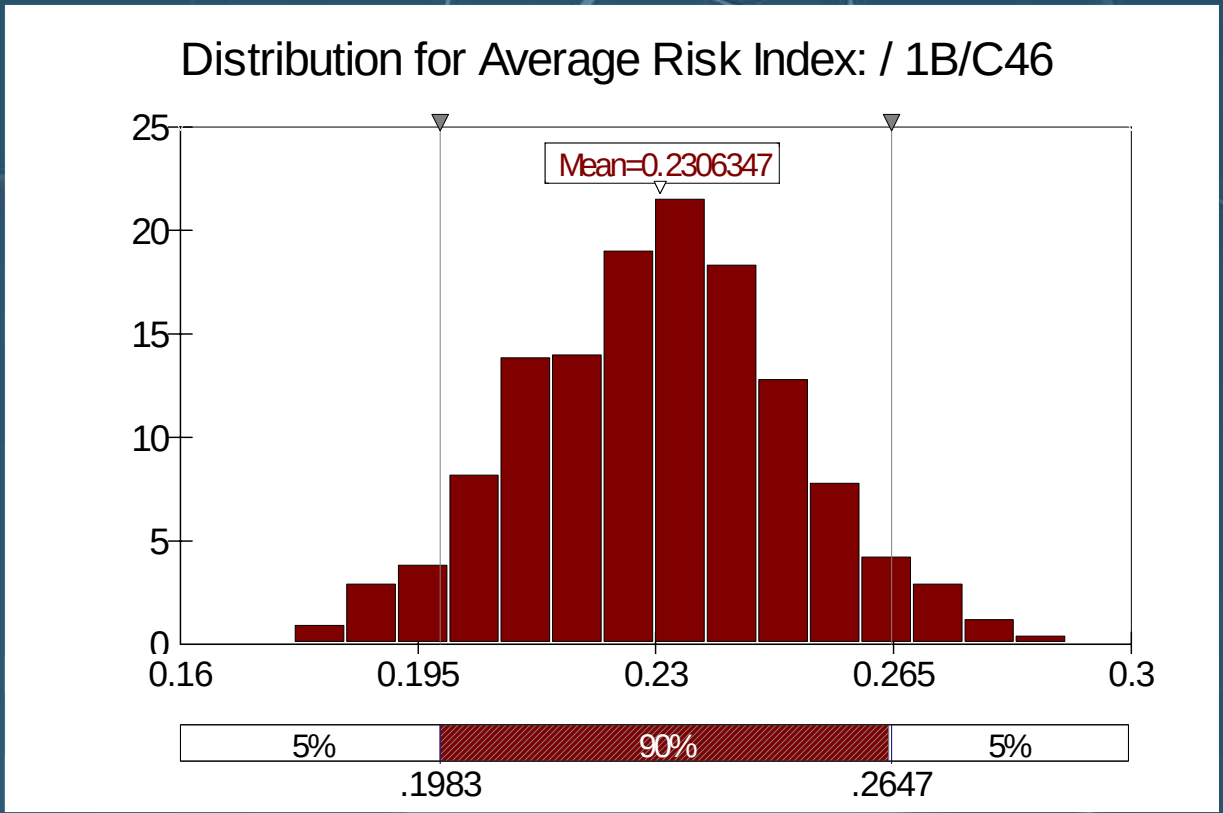
Probabilistic model

- Uses:
  - Collision vector format
  - Min/Max ranges from deterministic model
  - Most likely values from deterministic model
  - Suitable statistical distribution(s)
- Monte Carlo simulation used

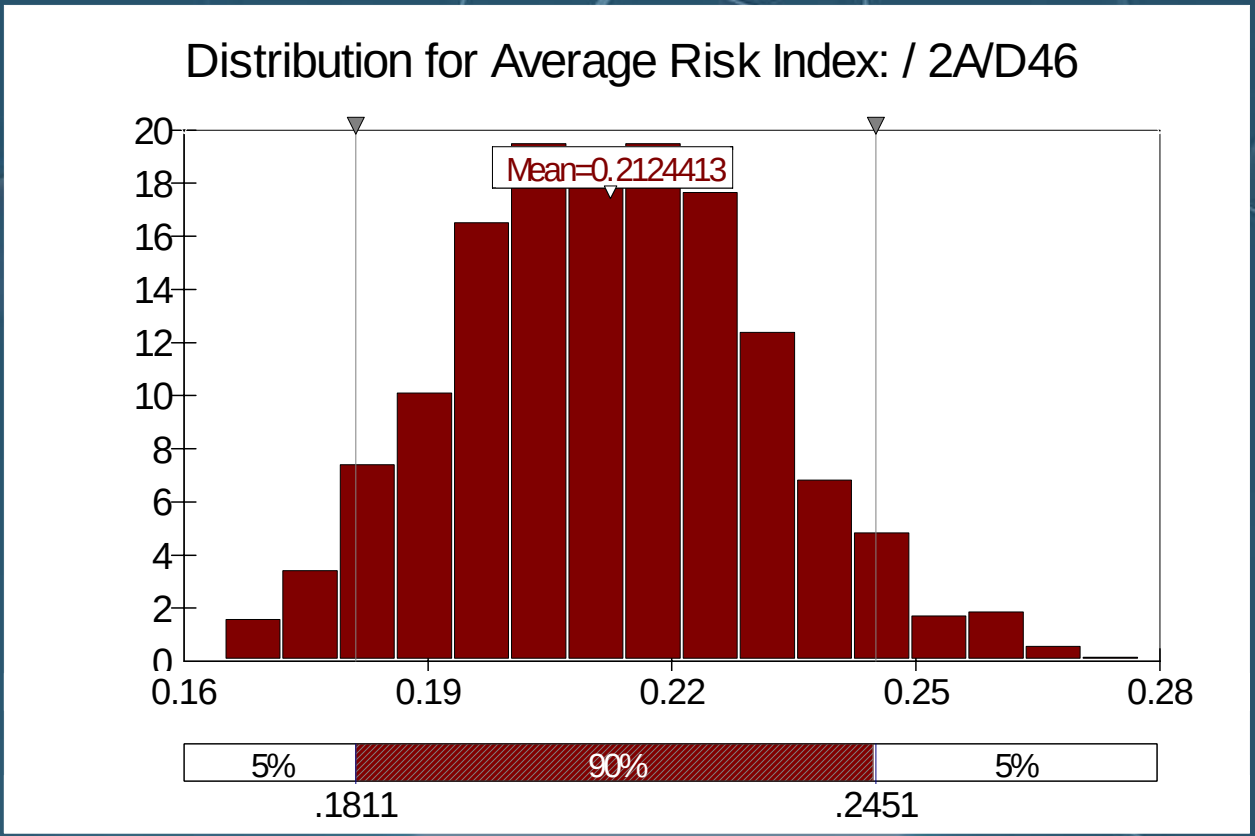
RI distribution: A



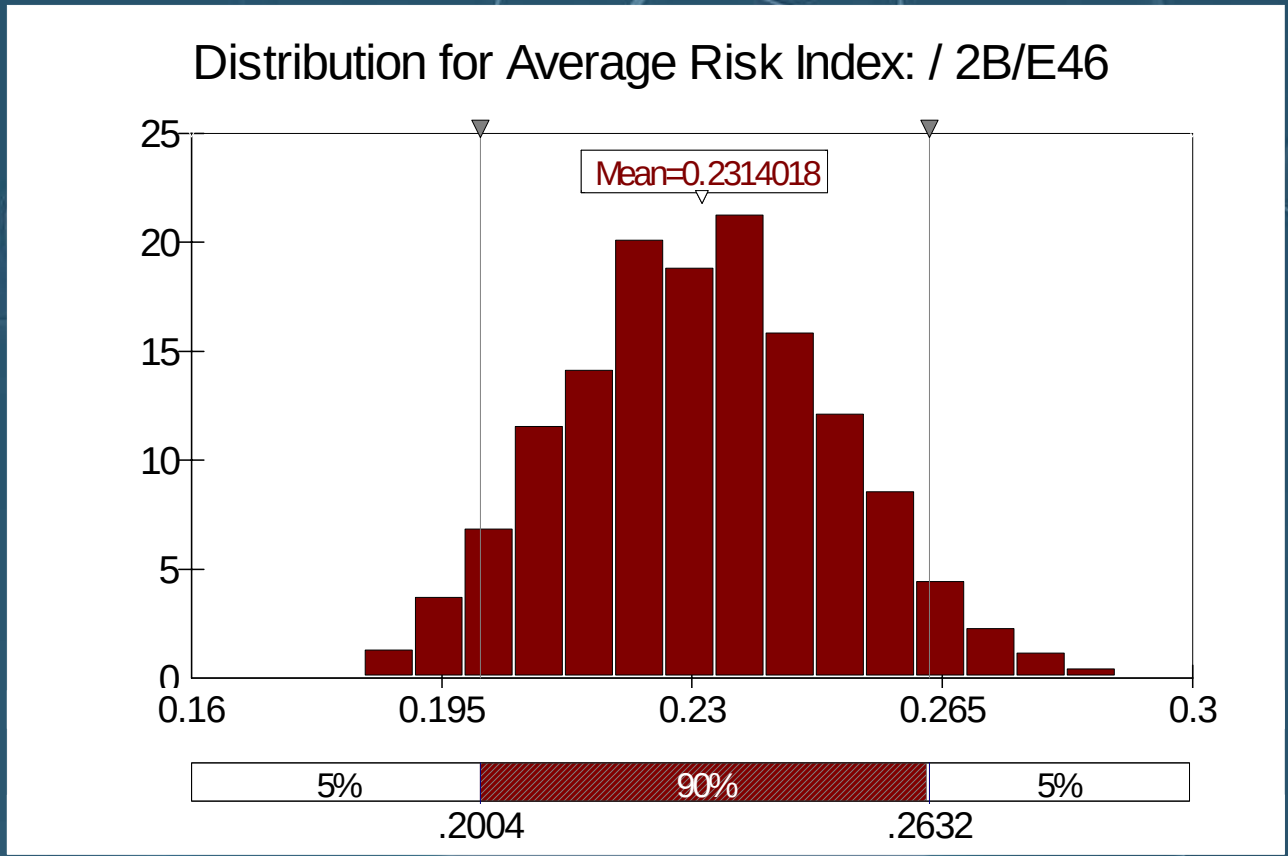
RI distribution: Alt B



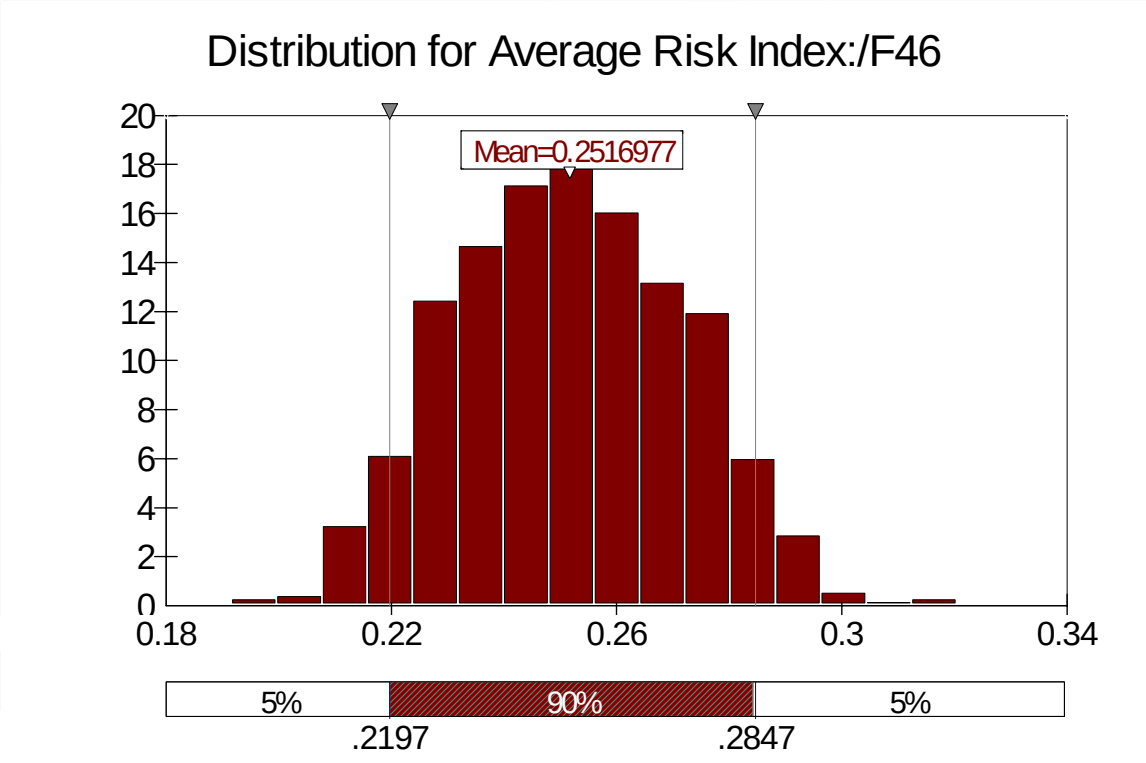
RI distribution: Alt C



RI distribution: Alt D



RI distribution: Alt E



Benefits & Stakeholder Perceptions

Benefits

- Explicit evaluation provides defensibility
- Provides a measure of uncertainty
- Enhances potential for better decisions
- Explains decision-making rationale
- Provides basis for risk management plan

Stakeholder perceptions

- Factors affecting perception:
  - Degree of personal control
  - Potential for catastrophic consequences
  - Whether consequences are “dreaded”
  - Distribution of costs & benefits
  - Degree to which risk is voluntary

Concluding thoughts

Concluding thoughts

- Risk assessment & management: a complex world
- Well established in many areas:
  - Financial, health & safety, insurance etc.
- Opportunities exist in value engineering:
  - A need to recognize uncertainty
  - A need to communicate it effectively

Thanks ...

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PDF of presentation available at

www.delphiMRC.com