



Risk v. Reward

Risk-Based Decision Making

*Decisions, Decisions
Your Risk is not My Risk
We Don't Know What We Don't Know*


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Colin S. 'Chip' Howat
HowatRisk.com



- Design Professor, University of Kansas, 29 years
 - 19 Student AIChE Design Awards
- Safety Professor, University of Kansas, 27 years
 - Developed Syllabus 1984, evolved as PSM evolved
 - 6 Student AIChE Process Safety Awards
- Principal Associate & Director – C. S. Howat & Associates
- Consultant PHA/PSM Services
 - Food Processing (Explosive Dust Handling)
 - Agricultural Chemicals (Pesticides, Herbicides)
 - Gas-to-Liquids (Landfill Gas)
- Consultant Expert Witness Services
- Design, Performance Analysis & Risk Experience in Food, Petrochemicals, Refining, Pharmaceuticals, Polymers - 43 years
- Presenter Global Congress on Process Safety
- Chair Process Plant Safety Symposium
- Author 175+ Papers, Presentations, Workshops, Books
- Process Design and Process Safety Workshops – Teaching Faculty Process Safety
- P.E. Missouri
- AIChE (Fellow of AIChE; Former Fellows Council)
- Center for Chemical Process Safety Member Company
- May Kay O'Conner Process Safety Center Board, Technical Advisory Committee
- Director Education, Professional Bicycle Mechanics Association
- Former Director, USAC Mechanics Clinic, World Championship USA Mechanic

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Risk-Based Decision Making 'RBDM'

- What are the potential problems that could occur?
- How likely are the potential problems to occur?
- How severe might the potential problems be?
- Is the risk of the potential problems tolerable?
- What should be done to lessen the risk?

**A Cautionary Tale
This is a Tough Row to Hoe!**

$$\text{Risk} = (\text{Likelihood} * \text{Severity})$$

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Take Homes

Decisions, Decisions



Your Risk is Not My Risk



We Don't Know What We Don't Know



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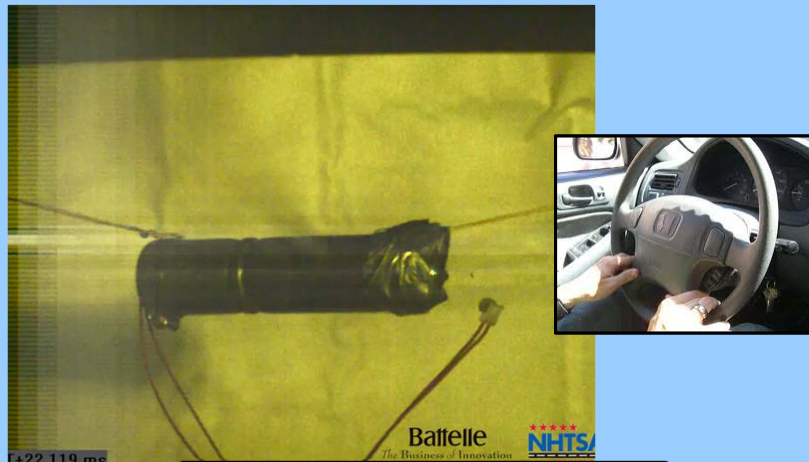
Decisions, Decisions
We All Practice RBDM



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Decisions, Decisions
We All Practice RBDM



1422.119 ms

Ammonium Nitrate, Takata Airbag Test



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We All Practice RBDM



Propane, Blue Rhino Propane Station, Tavares, Florida

Decisions, Decisions
We All Practice RBDM
No Risk, No Reward

$$\text{Risk} = (\text{Likelihood} * \text{Severity})$$

Decisions, Decisions
We All Practice RBDM
No Risk, No Reward

$$\text{Perceived Risk} = (\text{Likelihood} * \text{Severity}) / \text{Comfort}$$



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CDC Personal Activity Statistics 1999-2015



4,170 Bicyclists Killed
Where is the Outrage?

Cause of Death	Percentage
MV Traffic	28.3
Suicide	23.1
Poisoning	18.1
Fall	14.6
Total	2,021,388

https://webappa.cdc.gov/cgi-bin/broker.exe?_service=v6prod&_server=aspu-wisq-1.cdc.gov&_port=5099&_sessionId=IS18RSR1P52&_program=wisqars.dd_details10.sas&_service=&type=U&prfmt=STAN DARD&age1=.&age2=.&agegp=AllAges&deaths=2016510&_debug=0&icdfmt=lcd1ageðnicity=0&ranking=10&deathie=Death - 7/13/17 1135
<https://webappa.cdc.gov/cgi-bin/broker.exe - 7/13/17 1136>



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Cause of Death	Odds
Heart Disease and Cancer	1 in 7
Chronic Lower Respiratory Disease	1 in 28
Intentional Self-harm	1 in 95
Unintentional Poisoning by and Exposure to Noxious Mat'ls	1 in 96
Motor Vehicle Crash (1/9008 yearly odds)	1 in 114
Fall	1 in 127
Assault by Firearm	1 in 370
Car Occupant	1 in 645
Pedestrian Incident	1 in 647
Motorcycle Rider Incident	1 in 985
Unintentional Drowning and Submersion	1 in 1,188
Exposure to Fire, Flames or Smoke	1 in 1,498
Choking from Inhalation and Ingestion of Food	1 in 3,461
Cyclist Incident	1 in 4,486
Firearms Discharge	1 in 6,905
Air and Space Transport Incidents	1 in 9,821
Exposure to Electric Current, Radiation, Temperature and Pressure	1 in 15,212
Exposure to Excessive Natural Heat	1 in 16,584
Contact with Sharp Objects	1 in 38,174
Contact with Heat and Hot Substances	1 in 56,992
Contact with Hornets, Wasps and Bees	1 in 63,225
Cataclysmic Storm	1 in 66,335
Being Bitten or Struck by a Dog	1 in 112,400
Lightning Strike	1 in 161,856

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Decisions, Decisions All Practice RBDM

Action Threshold Color Coding and Definitions					
Color Code	Threshold Action				
	Corrections are required immediately				
	Corrections are required at next opportunity				
	Corrections may be necessary and should be evaluated				
	Corrections are not required				

Risk Evaluation Table		Severity				
Frequency (per year)	Frequency	1	2	3	4	5
	Very High					
	High					
	Medium					
	Low					
	Very Low					
	Minimal					
	None					

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$$\text{Perceived Risk} = (\text{Likelihood} * \text{Severity}) / \text{Comfort}$$

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Your Risk is Not My Risk Darwin Award Candidates



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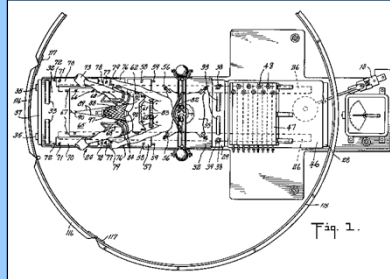


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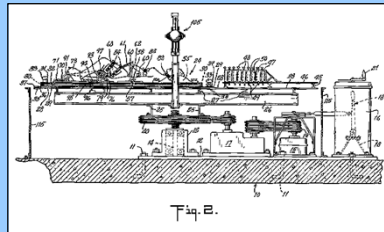
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APPARATUS FOR FACILITATING THE BIRTH OF A CHILD BY CENTRIGUGAL FORCE

GEORGE B. BLONSKY and CHAROLETTE E.
BLONSKY
Patented November 9, 1965



rpm	rps	ft/sec ²	g's
0.0	0.0	0	0
31.2	0.52	32	1
41.1	0.76	64	2
53.9	0.92	96	3
62.4	1.04	128	4
69.7	1.16	160	5
76.3	1.27	192	6
82.3	1.37	224	7



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REGFORM



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CDC Violent Death Statistics 1999-2015

Cause of Death	Deaths
Suicide Firearm	31,227
Homicide Firearm	19,227
Suicide Suffocation	9,859
Suicide Poisoning	46,899
Homicide Cut/Sharp	907,604
Homicide Unintentional	
Suicide Hanging	
Suicide Drowning	
Suicide Other	
Heart Disease	
Stroke	
Diabetes	
Alcohol	
Chronic Disease	
Accidents	
Motor Vehicles	

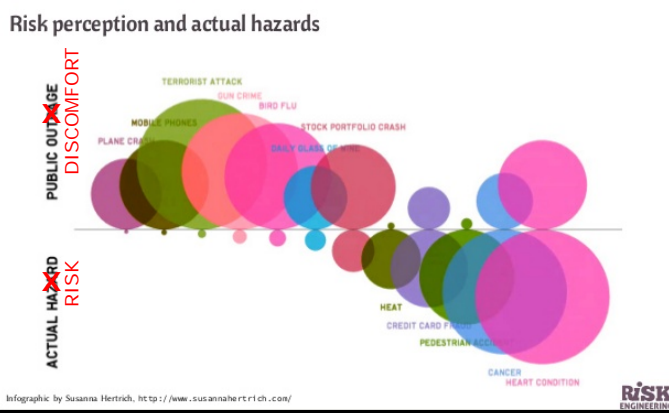
512,401 By Firearm
2nd to
Motor Vehicles

<https://webappa.cdc.gov/cgi-bin/broker.exe> - 7/13/17 1259



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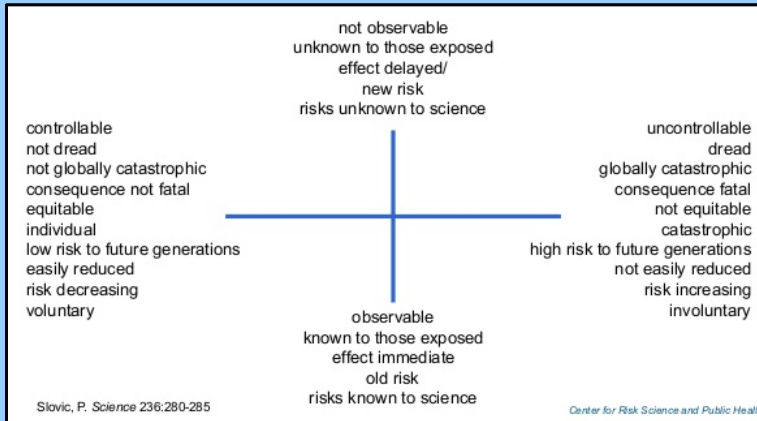


Marsden, E., 2015. Risk Perception. Risk Engineering: 42 slides.
<https://www.slideshare.net/EricMarsden1/risk-perception-48044005> - 7/13/17 1847



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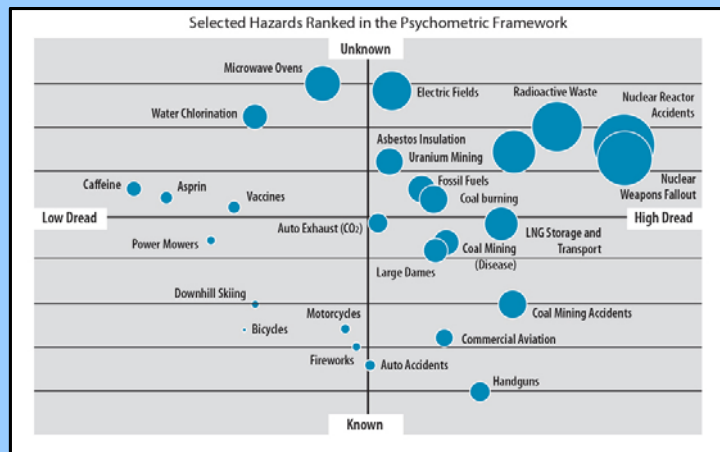
Gray, G. 2014. Risk Perception and Communication. Center for Risk Science and Public Health, Department of Environmental and Occupational Health, Milken Institute School of Public Health. 35 slides.
<https://www.slideshare.net/OECD-GOV/14-georgegrayriskperceptioninamericajune2014-37349886> - 7/13/17 1840

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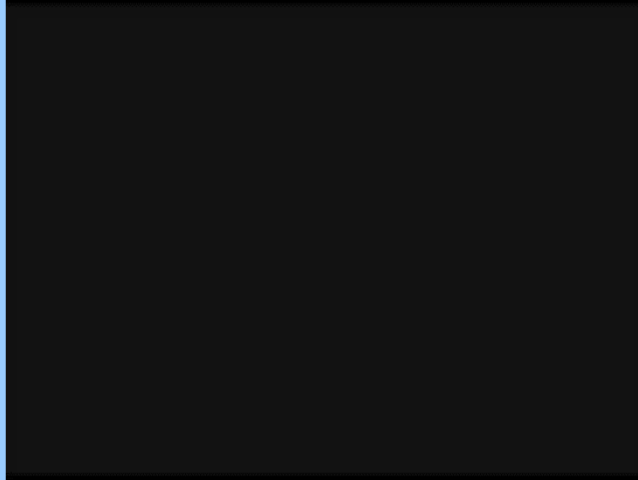
<http://www.on-sitemag.com/features/alligning-risk-perception-and-reality/> - 07/13/17 1828

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**We Don't Know What We Don't Know
When Things Go Wrong**



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We Don't Know What We Don't Know

***This Presents a Real Challenge in Analysis, Communication,
Management, Preparation, Execution and Maintenance.***

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We Don't Know What We Don't Know

It is easy to design an engineering solution; it is extremely difficult to determine all the ways the engineering design, operation and installation can go terribly wrong.

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A Hazard is an inherent physical or chemical characteristic that if released can cause harm.

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*Risk = (Likelihood * Severity) / Culture*

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The Journey: **Initiating Event** that begins the release of the hazard

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The Journey: **Propagating Event** leading to the release of the Hazard

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The Journey: Evaluating the release of the hazard *Severity*

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$$\text{Risk} = (\text{Likelihood} * \text{Severity}) / \text{Culture}$$

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$$\text{Risk} = (\text{Likelihood} * \text{Severity}) / \text{Culture}$$

- | | | |
|------------------------------------|---|----------------------|
| 0. No RBDM Safety Program | ↓ | <i>Making</i> |
| 1. Reactive RBDM Safety Program | ↓ | <i>RBDM</i> |
| 2. Compliance RBDM Safety Program | ↓ | <i>Safety</i> |
| 3. Management RBDM Safety Program | ↓ | <i>A</i> |
| 4. Performance RBDM Safety Program | ↓ | <i>Core</i> |
| 5. Core Value RBDM Safety Program | ↓ | <i>Value!</i> |

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Action Threshold Color Coding and Definitions	
Color Code	Threshold Action
Red	Corrections are required immediately
Orange	Corrections are required at next opportunity
Yellow	Corrections may be necessary and should be evaluated
Light Green	Corrections are not required

Risk Evaluation Table	
Frequency (per year)	Severity
Frequency	

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$$\text{Risk} = (\text{Likelihood} * \text{Severity}) / \text{Culture}$$

Acute v. Chronic

Loss of Primary Containment

Unknown Future Impact

Unknown Chemical and Biological Incompatibility

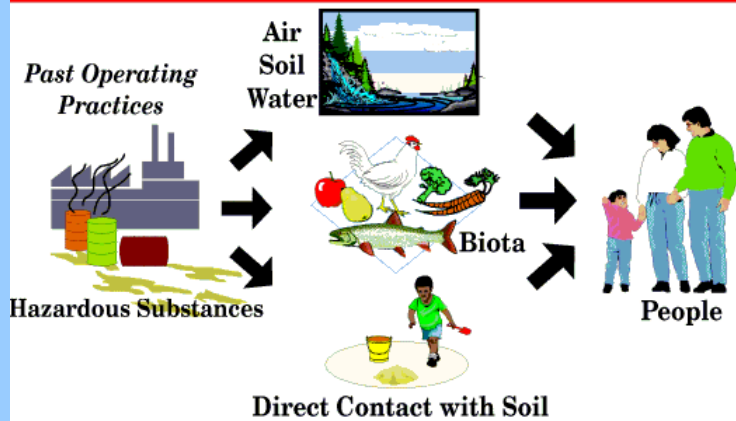
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Exposure Pathways



<http://superfund.oregonstate.edu/all-about-pahs>
11/13/17 1759

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<http://www.investigativepost.org/2016/02/10/landfill-with-love-canal-legacy-still-poses-danger/> 11/13/17 1909



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So, where does this put us in risk-based decisions?



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An Effective, Conceptual Overview

$Risk = (Likelihood \times Severity) / Culture$

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Action Threshold Color Coding and Definitions

Color Code	Threshold Action
Red	Corrections are required immediately
Orange	Corrections are required at next opportunity
Yellow	Corrections may be necessary and should be evaluated
Green	Corrections are not required

Risk Evaluation Table

Frequency (per year)	1	2	3	4	5
High	Yellow	Orange	Red	Red	Red
Medium	Green	Yellow	Orange	Orange	Red
Low	Green	Green	Yellow	Yellow	Orange
Very Low	Green	Green	Green	Green	Yellow
Extremely Low	Green	Green	Green	Green	Green

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We Don't Know What We Don't Know

Prescriptive and Performance (Risk-Based) Decisions can guide us. But, we cannot eliminate or ignore the *uncertainties* and the public *perceptions*. Reasonable and Generally Accepted Good Engineering Practice coupled with Performance Criteria recognizing that we may not know all will reduce risk for all of us.

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