



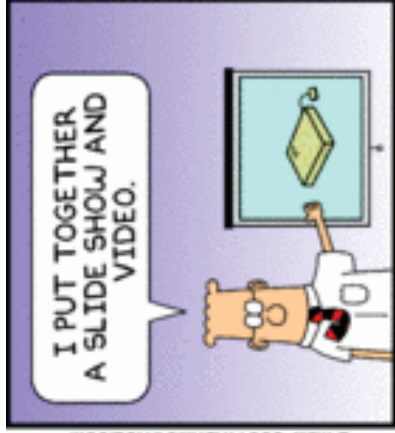
Risk Matrices

Not just pretty colors!

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A GENERAL DYNAMICS COMPANY

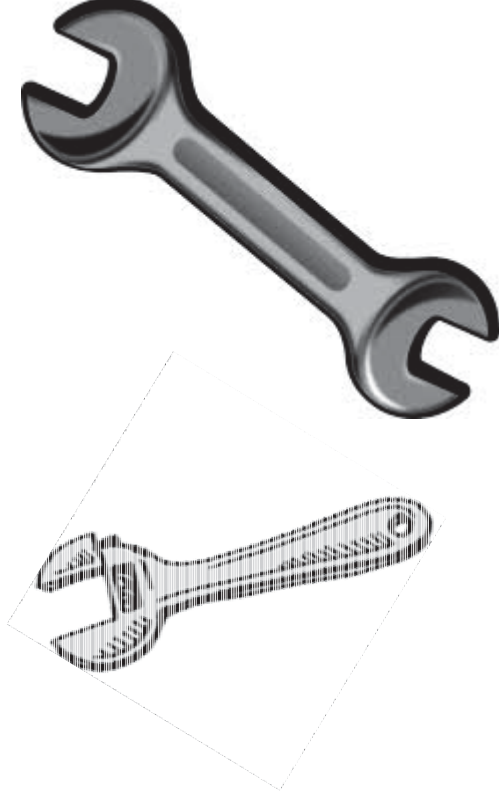
Introduction

- Ben Luther, Flight Test Safety Manager, Gulfstream
- Rules of engagement



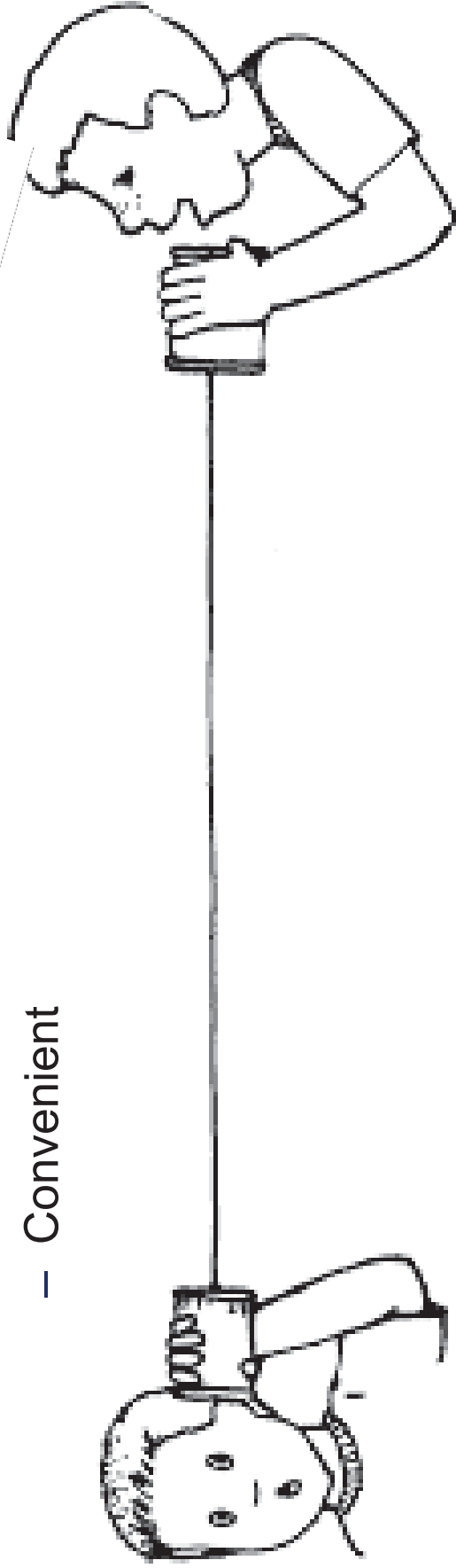
Objective

- **Appreciation**
 - Risk Matrix as a tool
 - Complexity
- **Tools**
 - Better risk assessments
 - Mitigate not administrate



Positives

- Communication
 - Normative
 - Easily documented
- Simple
 - Conceptually (!!)
 - Convenient

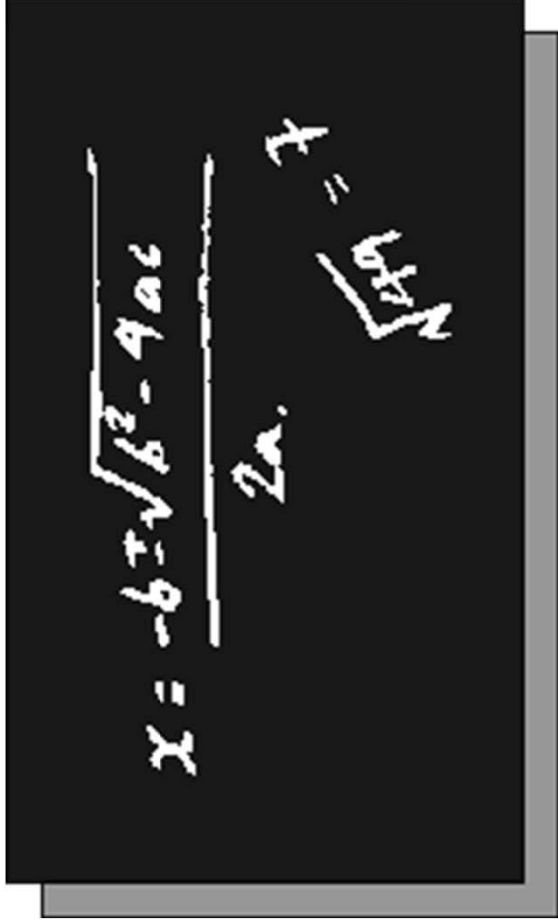


Issues

- Exposure



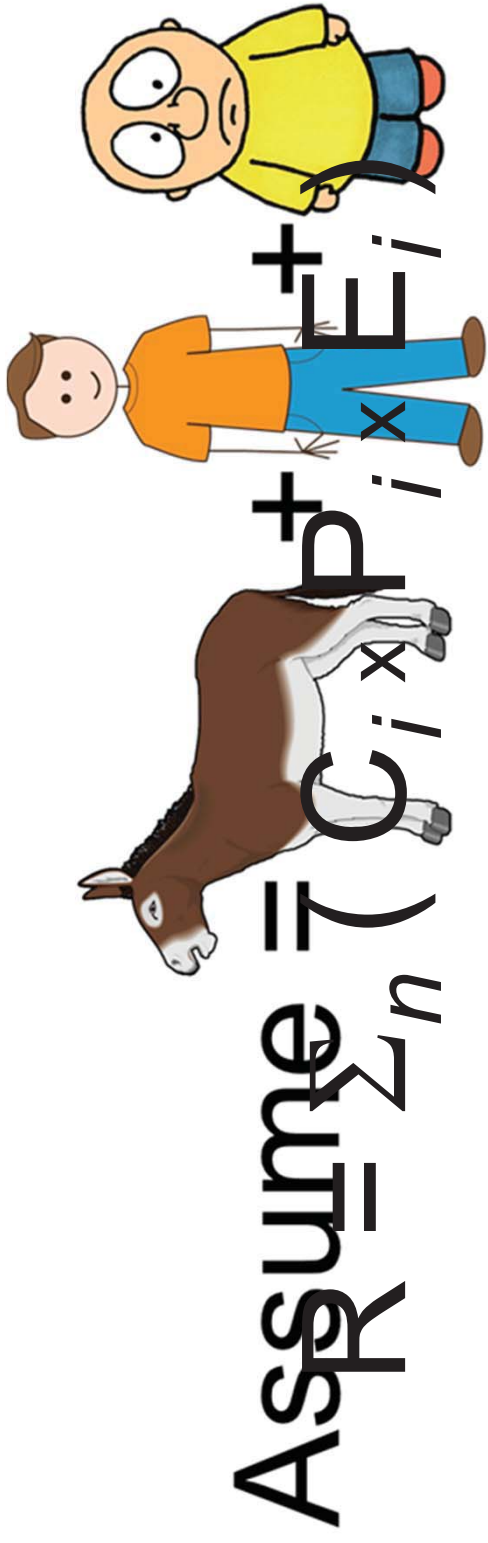
... the Math


$$x = \frac{-b \pm \sqrt{b^2 - 4ac}}{2a}$$
$$\sqrt{49} = 7$$



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... the Math



Assumptions to simplify:

$$R = C \times P$$

Risk Formula

$$\text{Risk} = \sum_n (C_i \times P_i \times E_i)$$

C_i : consequence

P_i : probability

E_i : exposure

& . Q_i : perception


- But ... assumptions
 - Exposure is constant
 - P is tiny for all but one
- True for flight test ??


$$\text{Risk} = C \times P$$

Exposure

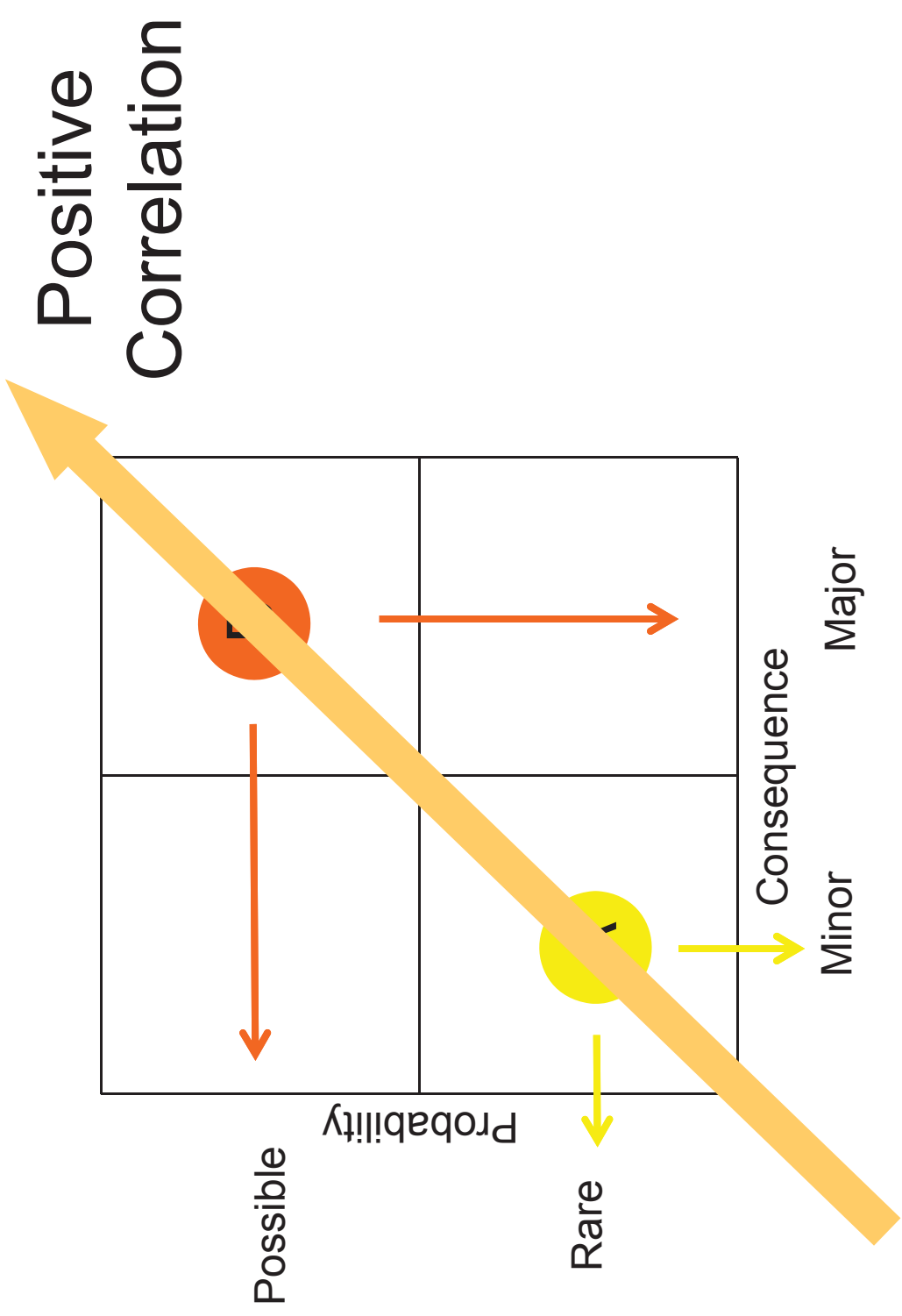


Issues

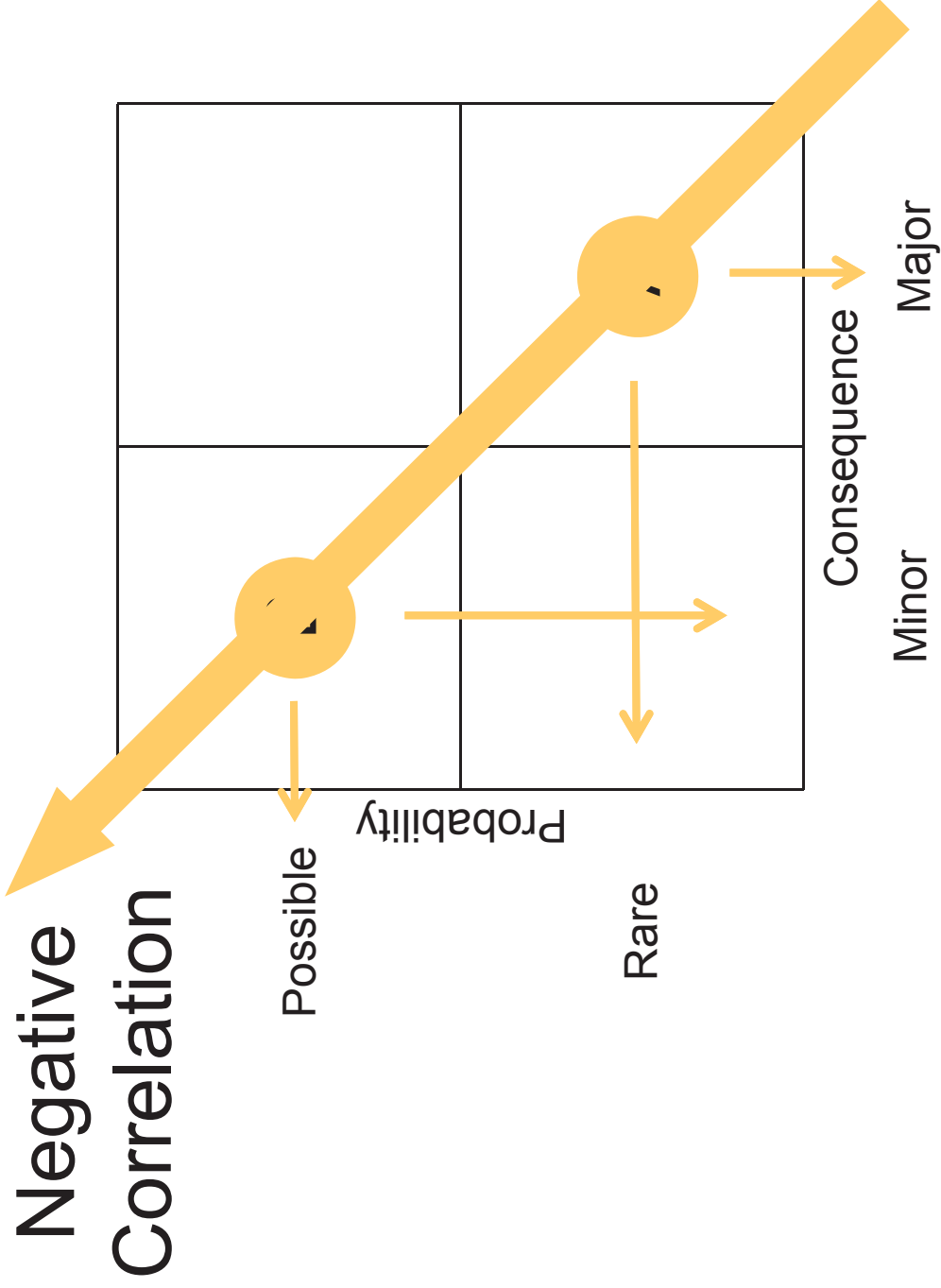
- Exposure 
- Ambiguity
 - Negative correlation



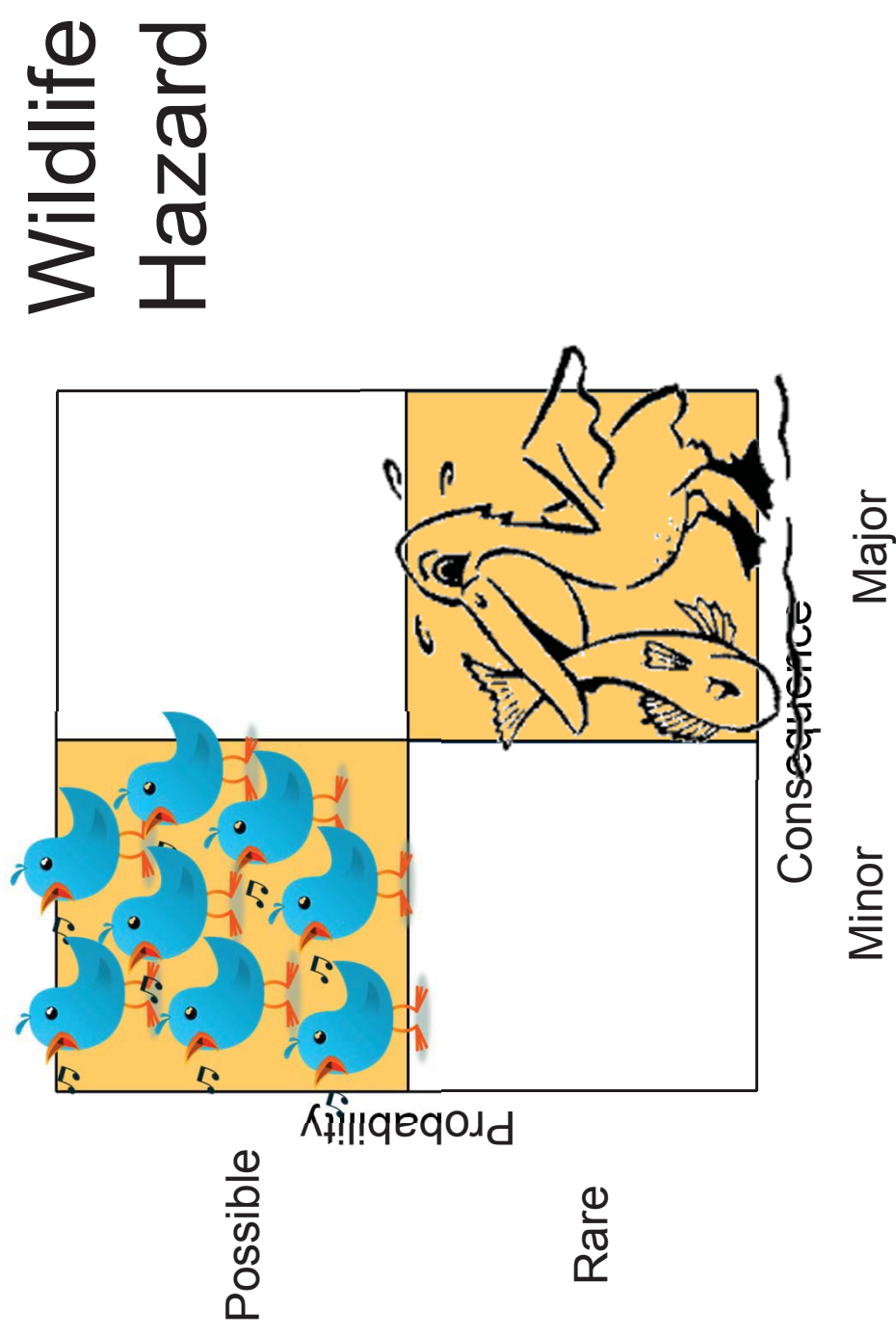
Negative Correlation




Negative Correlation



Negative Correlation

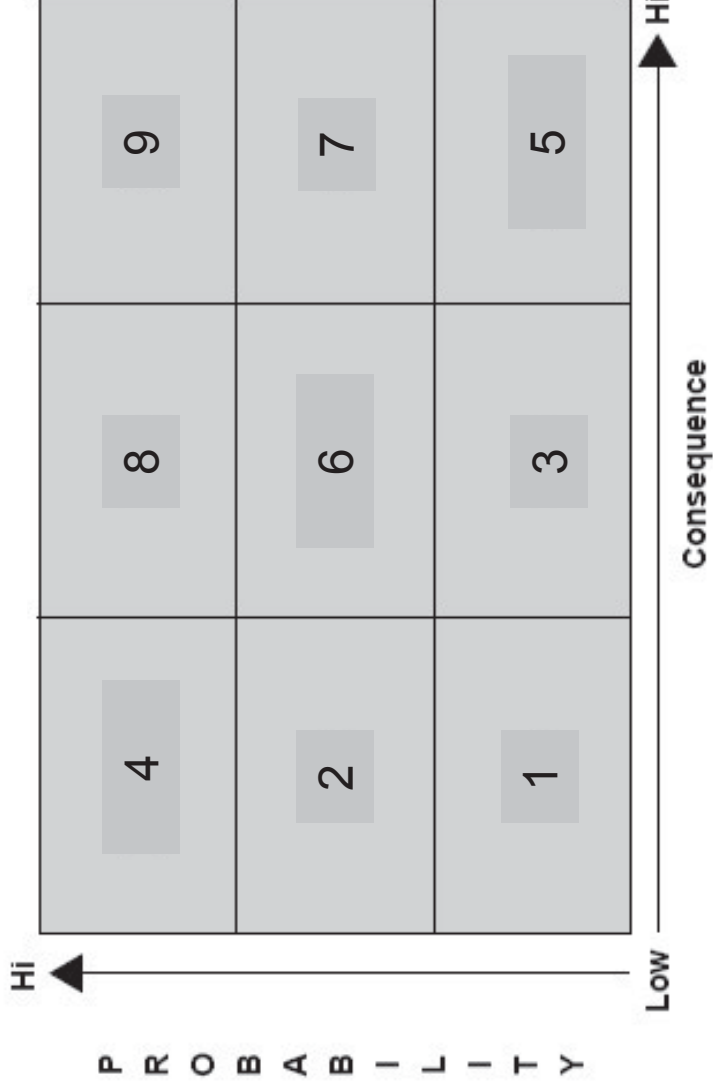


Issues

- Exposure 
- Ambiguity 
 - Negative correlation
- Colors
 - Continuity and consistency
 - Iso-risk lines and scales (linear or logarithmic)
 - False resolution

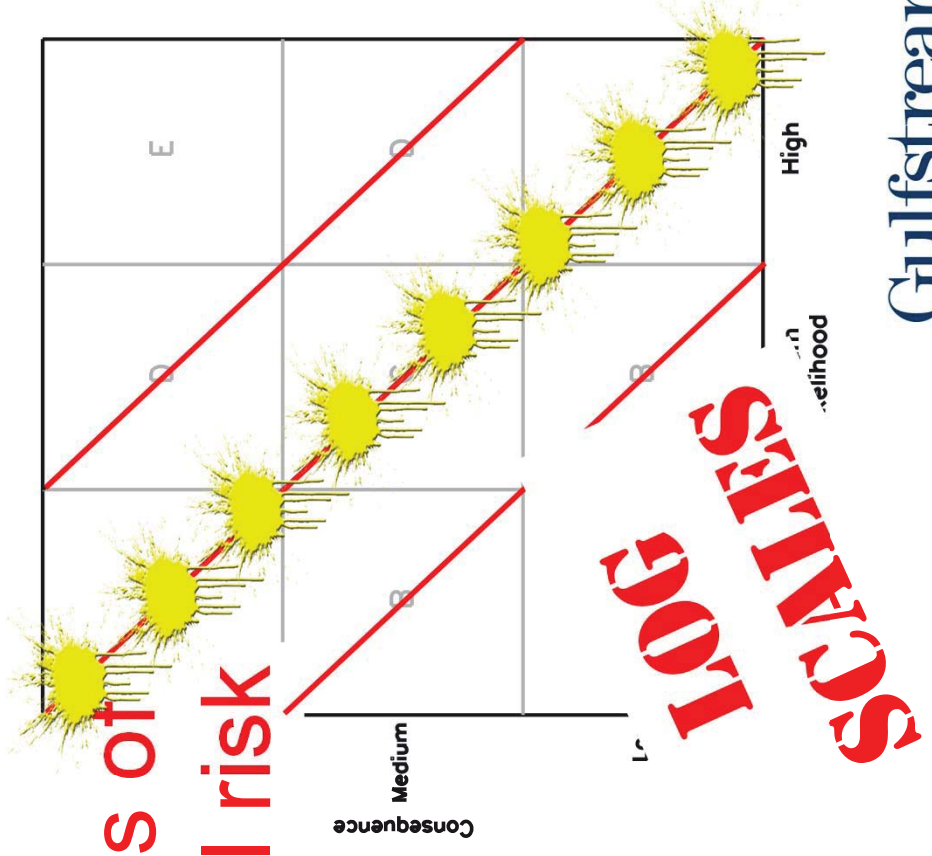
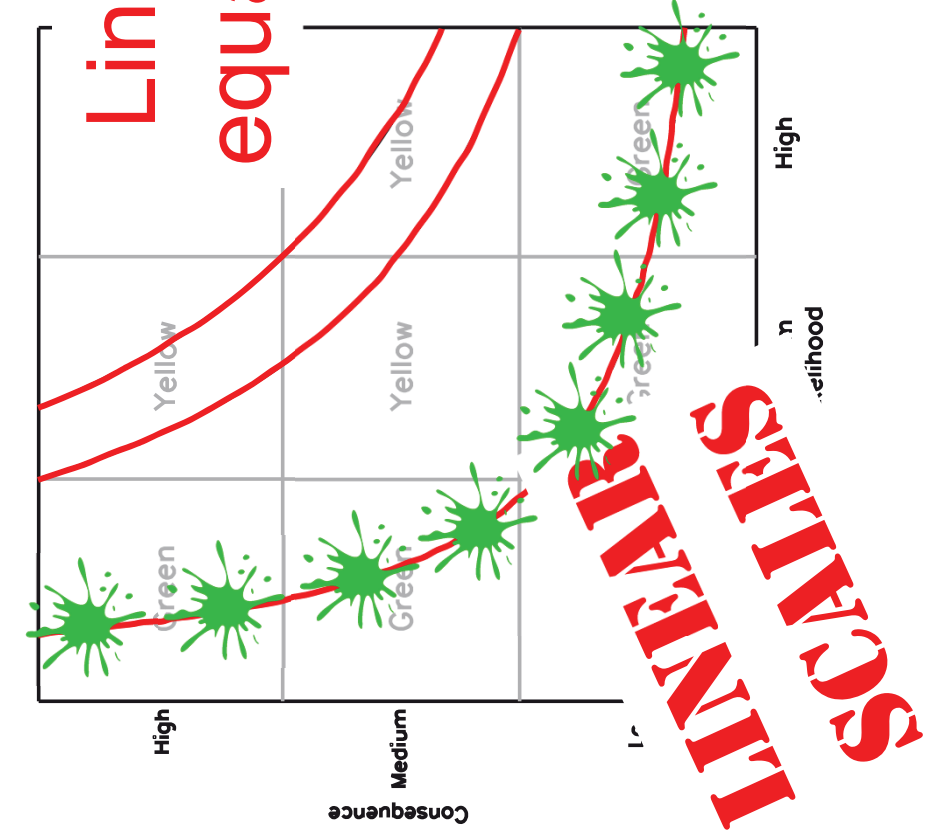


False resolution



Colors

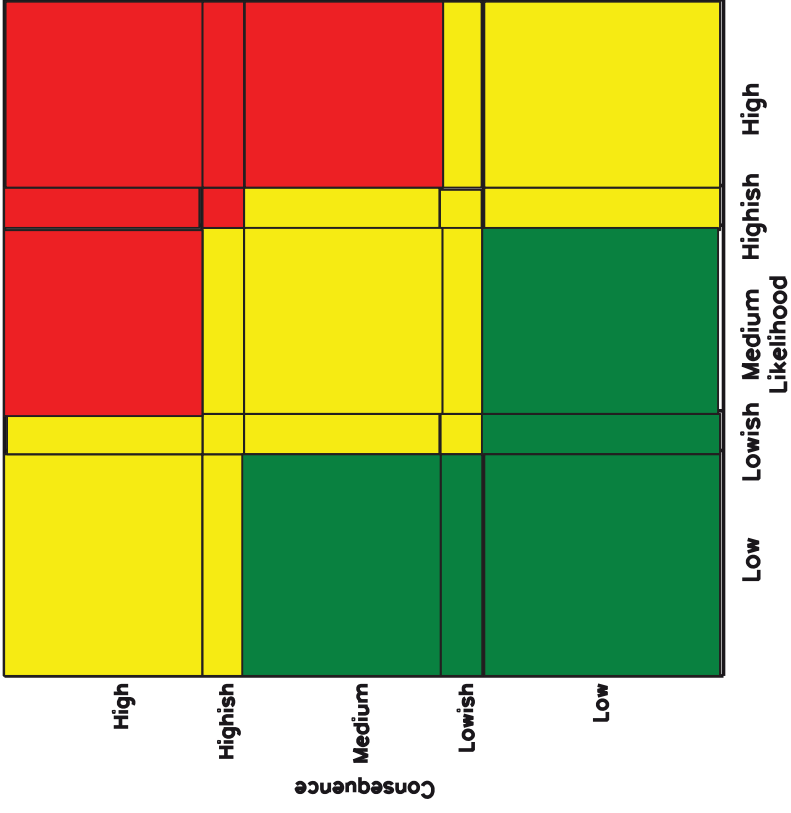
Iso-Risk Lines



Colors

Discontinuous

FIELD



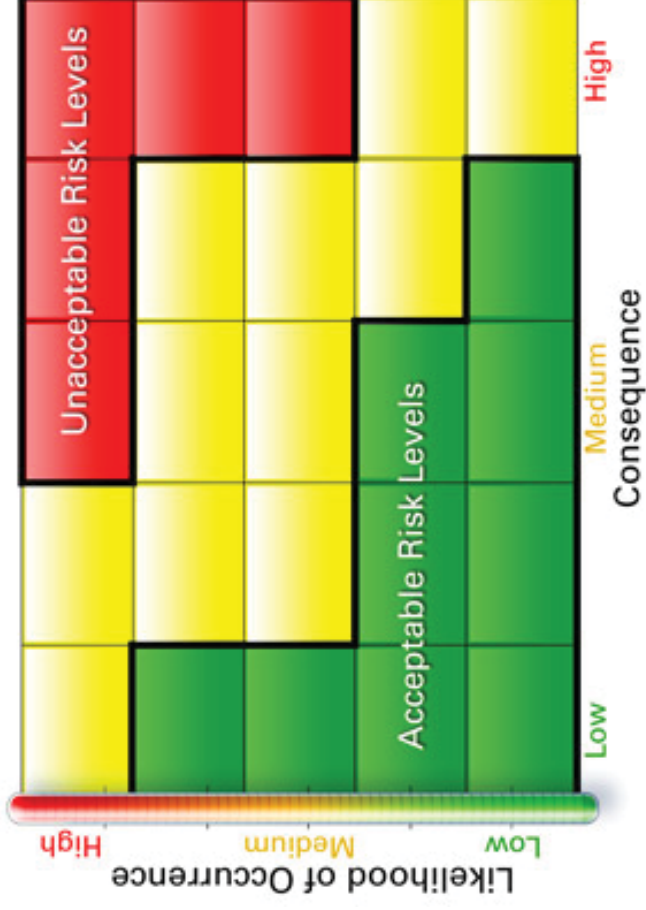
Colors

- Un-justifiable
 - False resolution
 - Discontinuous
- Log scales are OK




		LIKELIHOOD				
		NOT LIKELY	LOW	MODERATE	HIGH	EXPECTED
EXTREME		B14.1, B15.2, B16.2	A22.2, A41.7, A61.1, A101.3, B14.1, B15.2, B16.2, B41.1, B41.2, B41.3, B41.4, A42.2, B92.2	A61.2, A61.6, A81.1, B11.2, B11.3, B12.1, B15.1, B13.2, B18	A81.4, B11.1, B12.2, B15.1, B16.1	A92.6
HIGH	B17	A13, A57, A61.5, A81.6, A101.2, A101.6, B17, B31.4, B31.5, B31.6, B33.4, B33.5, B33.6, B91.2, B91.3	A12.3, A22.1, A41.5, A41.6, A52, A63.3, A81.2, B32.2, B92.3, B93.3	A53.1, A55.1, A55.2, A56, A61.4, A63.4, A92.3, B31.3, B33.3, B91.1		B32.1, B94.2
MODERATE		A92.2, B14.2, E21.1, B85, B92.1, B93.1	A101.4, B93.2		A12.2, A41.1, A41.3, A53.2	A12.1, A14.2, A42.1, A54, A63.2, A92.1, A101.5, A101.7, B21.2, B81.1, B81.3, B81.4, B94.1
LOW		A41.2, A41.4, A92.5, B22.1, B23.1, B31.2, B34.1, B37.1	A21.1, A21.2, A63.5, B31.1, B33.1, B36.1		A71.1, A71.2, A81.5, B33.2	A14.1, A41.8, A61.3, A63.1, A81.3, A92.4, B22.2, B32.2, B34.2, B35.1, B35.2, B36.2, B37.2, B31, B32, B33, B71.1, B71.2, B81.2
NEGIGIBLE						A.11, A91

Colors

- Much better
 - Justifiable resolution
 - Continuous function
 - Log scale apparent



Issues

- Exposure 
- Ambiguity 
 - Negative correlation
- Colors 
 - Continuity and consistency
 - Iso-risk lines and scales (linear or logarithmic)
 - False resolution



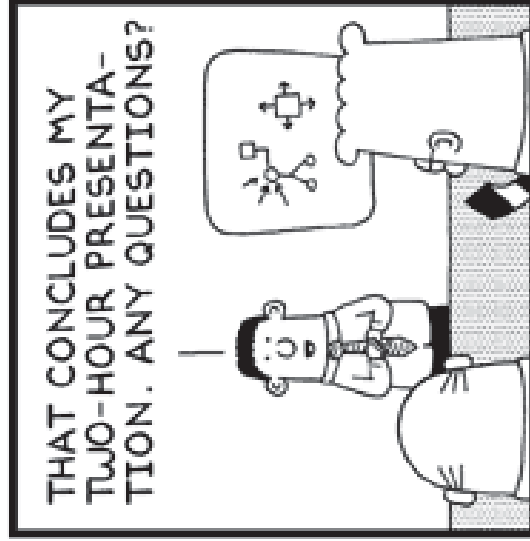
Real Life

- Resource allocation
- Psychological risk attitude
& . *Q_i: perception*
Q_i = 0
or
Q_i = huge

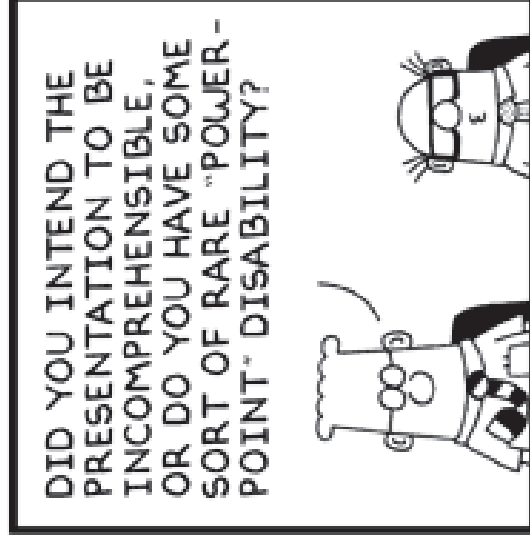
Conclusions

- Analysis tool
- Communication tool
- Underlying science / mathematics
- GIGO
- The matrix is NOT mitigation
 - It is analysis

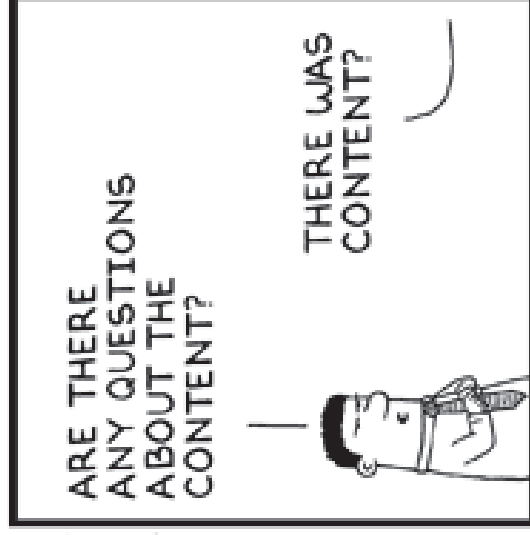
Questions



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References

- Cox L.A., Babayev D. & Huber W. (2005). Some Limitations of Qualitative Risk Rating Systems. *Risk Analysis* 25: 3. doi: 10.1111/j.1539-6924.2005.00615.x
- Cox L.A. (2008). What's Wrong with Risk Matrices. *Risk Analysis* 28: 2. doi: 10.1111/j.1539-6924.2008.01030.x
- International Standard (2009). Risk Management – Principles and Guidelines. ISO 31000:2009(E), first edition.
- Kinney G.F. & Wiruth A.D. (1976). Practical Risk Analysis for Safety Management. Naval Weapons Centre, China Lake, California. NWC TP 5865.
- Levine E.S. (2012). Improving Risk Matrices: The Advantages Of Logarithmically Scaled Axes. *Journal of Risk Research* 15:2. doi: 10.1080/13669877.2011.634514
- Ostrom L.T. & Wilhelmsen C.A. (2012). *Risk Assessment; Tools, Techniques, and Their Applications*. New Jersey, USA: John Wiley & Sons Inc.