



# **Opportunities: Carefully Evaluate Before Implementing**

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# Edmund Conrow Background

- **Have worked for U. S. Government, prime contractors, FFRDCs, National Labs, support contractors, commercial companies (including non-aerospace) since 1977**
- **Risk manager or mentor to risk managers 50+ times on actual programs/proposals**
- **Have written/re-written/performed/evaluated/edited scores of Risk Management Plans, hundreds of risk analyses, and hundreds of risk handling/mitigation plans**
- **Have provided risk management training to U. S. Government, prime contractors, support contractors, and professional societies since mid-1980s**
- **INCOSE Fellow (practitioner and researcher: risk management, and cost/performance/schedule trades), member INCOSE Fellow Selection Committee, INCOSE ESEP certification**
- **AIAA Life Associate Fellow, IEEE Life Senior Member, ASPRS Emeritus Member**
- **IMC Certified Management Consultant, PMI PMP, PMI risk leadership positions, etc.**
- **185+ professional presentations, papers, webinars, books, and book chapters since 1978 (risk management and related topics)**
  - **Winner, DAU/DSMC David D. Acker Award for "Skill in Communication"**
  - **Author of highly regarded risk management book (AIAA, 2<sup>nd</sup> Edition)**
  - **Author/co-author/contributor of numerous DoD, DAU/DSMC, Air Force, industry, and professional society risk management policies and documents**
- **B.S.N.E. and M.S. nuclear engineering, Ph.D. general (systems) engineering, M. Phil. and Ph.D. policy analysis (economics)**

# Agenda

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- **Dictionary Definitions and Inequality Relationships**
- **5x5 Risk and Opportunity Matrices and Their Limitations**
- **Is Risk Management Always “Negative” Focused?**
- **When Might Opportunity Management Be Beneficial?**
- **Opportunity Management Admonitions**
- **A Few Opportunity Management Examples**
- **Wrap-up**

# Dictionary Definitions—Risk

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- **Risk**
  - No specific examples/reference to acquisition or procurement
  - Descriptors such as: danger, harm, loss, threat, unpleasant, unwelcome
  - No implicit or explicit reference to positive outcomes
- **Sources**
  - *Oxford English Dictionary*, Oxford University Press, Second Edition, 1992
  - *Oxford on-line dictionary*, Oxford University Press, accessed 11 April 2016

# Dictionary Definitions—Opportunity

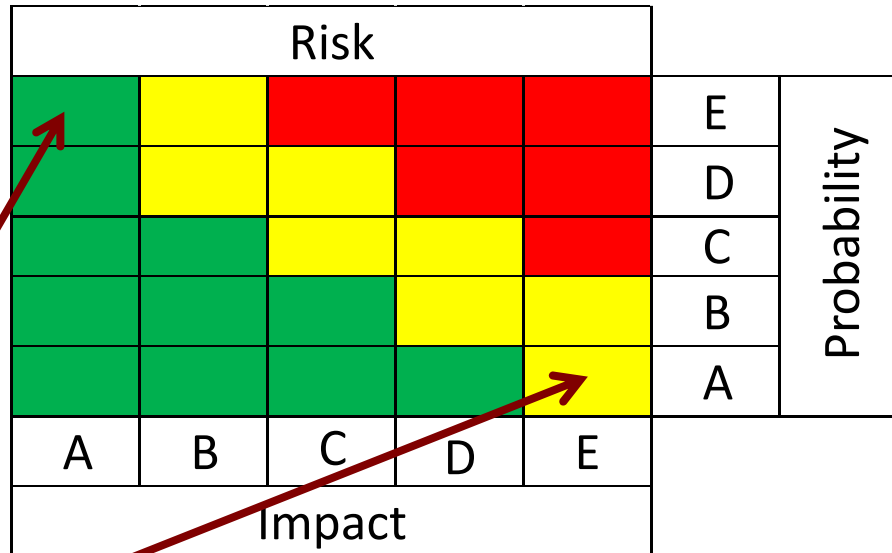


- **Opportunity**
  - No specific examples/reference to acquisition or procurement
  - Descriptors such as: to do something, promotion, chance for success (counterbalanced by a “situation that presents itself”)
  - No implicit or explicit reference to “positive risk”
- **Sources**
  - *Oxford English Dictionary*, Oxford University Press, Second Edition, 1992
  - *Oxford on-line dictionary*, Oxford University Press, accessed 11 April 2016

# Risk, Issue, Opportunity Inequalities

- **Risk and issue inequality representations exist, but no consensus representations exist for opportunity**
  - **Risk**
    - **$0 < \text{Probability} < 1$ , **Consequence  $< 0$** , time-frame: future**
  - **Issue**
    - **Probability = 1, Consequence  $< 0$** , time-frame: past, present, future
      - **Note: a future time-frame may be an issue, while a past or present time-frame may be a problem**
  - **Opportunity**
    - **$0 < \text{Probability}$  but upper bound is unclear ( $< 1, \leq 1, = 1$ )**
    - **Consequence  $< 0$ , relative (e.g., less negative), or  $> 0$**
    - **Time-frame: unclear**

# “Typical” 5x5 Risk Matrix



What does this represent?

# “Typical” 5x5 Opportunity Matrix

		Opportunity				
Probability	E					
	D					
	C					
	B					
	A					
		E	D	C	B	A
		Impact (“Benefit”)				

What does this represent?



# “Typical” 5x5 Risk and Opportunity “Butterfly Matrix”

		Opportunity					Risk						
Probability	E											Probability	E
	D												D
	C												C
	B												B
	A												A
		E	D	C	B	A	A	B	C	D	E		
		Impact					Impact						

# Characteristics of This “Butterfly Matrix”

- **Asymmetric boundaries exist for Probability = E, Impact = A vs. Probability = A, Impact = E for risk and opportunity**
  - **The risk portion is not “neutral” vs. the diagonal of the matrix**
  - **The opportunity portion is not “neutral” vs. the diagonal of the matrix**
- **Also represents the risk and opportunity portions as mirror images of each other**
  - **Why is this wrong?**

# Reasons This Butterfly Matrix Is Wrong (1)

- **“Prospect Theory: An Analysis of Decision under Risk,” Daniel Kahneman, Amos Tversky, *Econometrica*, Vol. 47, No. 2. (March, 1979), pg. 279.**
  - ...“we have proposed that the value function is:
    - (i) defined on deviations from the reference point;
    - (ii) generally concave for gains and commonly convex for losses;
    - (iii) steeper for losses than for gains”
      - Implies losses have a positive first and second derivative vs. value
      - Implies gains have a positive first derivative and negative second derivative vs. value
  - See Figure 3 of the Kahneman and Tversky (1979) paper
    - May require Econometrica written permission to reproduce
- **Given the value function criteria, a mirror image “butterfly matrix” is incorrect**

## Reasons This Butterfly Matrix Is Wrong (2)

- **“Advances in Prospect Theory: Cumulative Representation of Uncertainty,” Amos Tversky, Daniel Kahneman; *Journal of Risk and Uncertainty*, Vol. 5, Issue 4, (October, 1992), pg. 297-323.**
  - **“Uses cumulative rather than separable decision weights”**
  - **...“allows different weighting functions for gains/losses”**
  - **Results...“confirm a distinctive fourfold pattern of risk attitudes: risk aversion for gains and risk seeking for losses of high probability; risk seeking for gains and risk aversion for losses of low probability.”**
    - **Again, a mirror image “butterfly matrix” is incorrect**
- **Prospect Theory contributed to Dr. Kahneman’s 2002 Nobel Prize in Economics (Dr. Tversky died in 1996)**

## Is Risk Management "Negative" Focused? (1)

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- **Development item: complex dichroic beamsplitter (optical component) needed for a space sensor**
  - **Sensor was judged to have moderate technical risk and high/very high schedule risk at the start of development**
    - **4 to 5 year development schedule compressed into 1 year!**
- **Program lead optical engineer visited the vendor developing the beamsplitter**
  - **Optical lead was concerned that the vendor had questionable design and manufacturing practices, and potentially inadequate contamination control**
  - **The result would likely be an unacceptable component, leading to program termination**

## Is Risk Management "Negative" Focused? (2)

- Before returning to Los Angeles, the optical lead contacted a local vendor he had previously worked with
  - Vendor claimed they could develop and deliver the beamsplitter in six weeks, and for \$15K
  - Program manager immediately approved the second source development and the risk manager concurred
- Outcomes
  - Original vendor never produced one acceptable part
    - This would have led to program termination
  - Second vendor delivered a suitable part, which met all specs, on-time/on-budget
    - This likely “saved the program”
  - *This approach (thinking and action) demonstrates excellent risk management and project management and is clearly not negative focused*

# Opportunity Management Can Potentially Be Beneficial (1)

- **Opportunities can be considered in all program phases**
  - **Carefully examine every case regardless of program phase**
  - **Program definition and sustainment phases may offer the best openings and potential results for examining opportunities**
- **“Program definition stage—when alternative technical solutions are actively being examined**
  - **At this point in a program, innovative thinking and approaches are required to be explored, and program assumptions and constraints challenged**
  - **OM has the potential to be an effective remedy for the scourge of overly optimistic program cost and schedule estimates that currently rely on achieving technological breakthroughs on demand in order for them to be met.”**
- **Source: Edmund Conrow, Robert Charette, “*Opportunity Management: Be Careful What You Ask For,*” Defense AT&L: March-April 2008, pg. 19.**

## Opportunity Management Can Potentially Be Beneficial (2)



- **Program sustainment phase with systems engineering, “when opportunities for investments in new system or platform capabilities often present themselves.”**
- **Source: Edmund Conrow, Robert Charette, “*Opportunity Management: Be Careful What You Ask For*,” Defense AT&L: March-April 2008, pg. 19.**



# Introduction to Opportunity Management Admonitions

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- **Six sets of published admonitions associated with opportunity management are now presented**
  - **Other similar admonitions exist**
  - **These admonitions should be viewed as cautions**
  - **Warnings of this type are rarely stated or recognized**

# Opportunity Management Admonitions (1)

- **“Opportunities should be evaluated for both advantages and disadvantages. This is important because potential benefits associated with an opportunity may be overstated and corresponding risks may be understated. In addition, all candidate opportunities should be thoroughly screened for potential risks before they are approved, and handling plans should be developed and implemented as appropriate.” (DoD)**
- **“Of course, opportunities usually carry risks, and each opportunity will have its own set of risks that must be intelligently judged and properly managed to achieve the full value.” (INCOSE/Forsberg)**
- *“Department of Defense (DoD) Risk, Issue, and Opportunity Management Guide for Defense Acquisition Programs,” 29 June 2015, pg. 49.*
- **“INCOSE Systems Engineering Handbook,” INCOSE (2015), Fourth Edition: Hoboken, NJ: John Wiley & Sons, Inc., pp. 121-122, which cites: Kevin Forsberg, Hal Mooz, and Howard Cotterman (2005). *Visualizing Project Management*, Third Edition: Hoboken, NJ: John Wiley & Sons, Inc., pg. 224.**

# Opportunity Management Admonitions (2)

- **...“In practice, however, a positive opportunity exposure will not match a negative risk exposure in utility space, since the positive utility magnitude of improving an expected outcome is considerably less than the negative utility magnitude of failing to meet an expected outcome (Canada 1971, Kahneman-Tversky 1979). Further, since many opportunity management initiatives have failed to anticipate serious side effects, all candidate opportunities should be thoroughly evaluated for potential risks to prevent unintended consequences from occurring. In addition, while opportunities may provide potential benefits for the system or project, each opportunity pursued may have associated risks that detract from the expected benefit. This may reduce the ability to achieve the anticipated effects of the opportunity, in addition to any limitations associated with not pursuing an opportunity.”**
- **Barry Boehm, Edmund Conrow. “Risk Management.” in BKCASE Editorial Board. 2016. *The Guide to the Systems Engineering Body of Knowledge (SEBoK)*, v. 1.6. R.D. Adcock (EIC). Hoboken, NJ: The Trustees of the Stevens Institute of Technology. Accessed 17 May 2016. [www.sebokwiki.org](http://www.sebokwiki.org). BKCASE is managed and maintained by the Stevens Institute of Technology Systems Engineering Research Center, the International Council on Systems Engineering, and the Institute of Electrical and Electronics Engineers Computer Society. This material is used under a Creative Commons Attribution-NonCommercial ShareAlike 3.0 Unported License from The Trustees of the Stevens Institute of Technology.**
- **This article subsection cites: John Canada, *Intermediate Economic Analysis for Management and Engineering*. Upper Saddle River, New Jersey: Prentice Hall, 1971, pp 245-249; and Kahneman and Tversky, 1979.**

# Opportunity Management Admonitions (3)



- **“Although there is an upside to pursuing the desired benefits of opportunity management, there are also downsides resulting from changes in the baseline plan and scope of the program, as well as potential unanticipated outcomes and risks. The program should perform an analysis to estimate and justify the potential added cost and/or schedule needed to achieve the intended benefit, or the decreased performance that may result from implementing the opportunity.”**
  
- *“Department of Defense Risk, Issue, and Opportunity Management Guide for Defense Acquisition Programs,” 29 June 2015, pp. 50-51.*

# Opportunity Management Admonitions (4)



- **“The cost, schedule, and performance benefit analysis should justify the handling option selected. Available resources are often a zero-sum situation—applying resources to evaluate and implement opportunities may reduce available risk handling resources, so expenditures must be weighed against program success. In such cases the potential constraints associated with limited resources may still warrant pursuing an opportunity, but this must be balanced against the potential likelihood of achieving the desired benefits, and the degree of value added in meeting existing program requirements.”**
  
- *“Department of Defense Risk, Issue, and Opportunity Management Guide for Defense Acquisition Programs,” 29 June 2015, pg. 51.*

# Opportunity Management Admonitions (5)



- **“Programs should use care to avoid using opportunities as a means of “gold plating” requirements. Even though an opportunity may appear to be a good idea, expenditures need to be justified. Also the government and vendor may see opportunity benefits and associated changes in cost, schedule, and performance differently. For example, a vendor is not likely to propose or facilitate an opportunity that may not benefit itself. When possible, programs should consider ways to create incentives for vendors to recognize and recommend opportunities.”**
  
- ***“Department of Defense Risk, Issue, and Opportunity Management Guide for Defense Acquisition Programs,” 29 June 2015, pg. 51.***

# Opportunity Management Admonitions (6)

- **“If a program desires to analyze the likelihood and benefits of an opportunity in a similar fashion as with analyzing risks, it could choose to establish likelihood and benefits criteria for opportunities. The program should note, however, that risks and opportunities (and their associated 5x5 matrixes) are not the dual or mirror image of each other. Attempting to develop opportunity likelihood and consequence scales and matrix from equivalent risk scales and 5x5 matrix without sound reasoning and data will likely lead to erroneous results. Simple adjustments to risk likelihood and consequence scales and a 5x5 matrix will not yield meaningful opportunity likelihood and benefit scales and matrix. (Figure 6-4 below includes likelihood and benefit scales and a sample 5x5 matrix. This figure is only an illustration and should not be used “as is,” but must be developed using an appropriate, valid value function, and associated decision weights.)”**
- ***“Department of Defense Risk, Issue, and Opportunity Management Guide for Defense Acquisition Programs,” 29 June 2015, pg. 51.***

# Opportunity Management Examples, Introduction (1)

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- **Six opportunity management examples are presented**
  - **All six examples are from complex, “high tech” programs**
    - **Five of the six are from ACAT 1 or equivalent programs**
  - **I was a witness to five of the six examples**
    - **In the third example, the project manager described to me the desired outcomes, unanticipated problems, and actual outcomes**
  - **The names of the items, programs, contractors, and Government organizations are withheld due to security and/or proprietary considerations**



## Opportunity Management Examples, Introduction (2)

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- **The examples are a small sample and do not necessarily represent the population of outcomes**
  - **Some opportunities won't have unanticipated outcomes**
  - **However, carefully evaluate all contrary information and unexpected results**
- **The first example is the equivalent of “winning the lottery,” and with no entrance fee**
- **The second through fifth examples describe unanticipated outcomes (problems) that occurred**
- **The sixth example illustrates problems observed on numerous programs**
- **The six admonitions given on the previous charts are referenced as application (apply) 1 through 6, and are shortfalls associated with the examples**

# Opportunity Management Examples (1)

- **Tell me a good story—*Yes this actually happened!***
  - **A 15 minute telecon took place between a DoD technology development manager (who initiated the call) and a DoD program manager near the end of a fiscal year**
  - **The potential “opportunity” was \$20 million to develop a technology desired by the program manager—it involved “use it or lose it” funds**
  - **At the end of the 15 minute telecon, the technology development manager accepted the program manager’s recommendation for the technology to develop**
- ***Outcome: the \$20 million effort contributed to the early development and use of the desired technology***

## Opportunity Management Examples (2)

- An opportunity was selected that was “better” than needed (e.g., gold plating requirements) and would *also support potential use on other programs*
  - Technology/item chosen led to the inability to meet a key systems’ requirement for the intended, primary program
    - Problems related to applications (apply) 1, 2, 3, 4, 5, and 6
- ***Outcome: Opportunity was unacceptable/rejected, program came to a halt, hardware/software development had to be re-done, upper management was removed***
  - *On-time delivery bonus (Govt. to contractor) was irrelevant because the system would be operationally unacceptable*
  - *Ultimately, the Govt. owned the risk because there were no suitable substitutes (the buck stops where?)*

# Opportunity Management Examples (3)

- **Project manager proposed redesigning/updating an electronics box—potential advantage of decreased size and weight (highly desirable for the host program)**
  - **Problems related to applications (apply) 1, 2, and 3**
- ***Outcome: Unanticipated thermal and electro-magnetic interference problems led to considerable box development cost growth and schedule slippage***
  - ***Technical challenges were eventually overcome, updated box was delivered and successfully deployed***
  - ***Project manager, who later became the company division's Avionics Director, used this example as a warning to other engineers regarding unanticipated risks that could have severe, unintended consequences***

## Opportunity Management Examples (4)

- **Added requirements (e.g., gold plating) *for potential use on other programs* led to the inability to achieve electrical design and manufacturing closure**
  - **Problems related to applications (apply) 1, 2, 3, 4, and 5**
- ***Outcome: Contractor program manager and his superior “went ballistic” when they learned of the situation, and excessive requirements (opportunity) was eliminated—this allowed the design to “close” and viable manufacturing to occur***
  - ***Acceptable units were delivered several months later—would not have occurred if the excessive requirements (opportunity) were retained***

# Opportunity Management Examples (5)

- **An opportunity was selected to alleviate a high/medium technical risk but this led to unanticipated failures and considerable, potential system-level degradation**
  - **Problems related to a lack of applications (apply) 3, and implied 5. Here, applications (apply) 1 and 2 were performed, but the disadvantages/potential down-side were not identified despite careful test data evaluation.**
- ***Outcome: After large-scale ground testing, the opportunity was removed from most system elements, and largely replaced by the original item (now reduced to medium/low risk), and lower risk opportunities***
  - ***All systems successfully delivered but at an additional cost of ~ \$50 million to remove the opportunity!***

## Opportunity Management Examples (6)

- **Program contractor and Government Risk Management Plans may tout opportunity management without substantive rationale, suitable analysis methodology, and suitable handling implementation strategies**
  - **Problems related to applications (apply) 1, 2, 3, 4, 5, and 6**
- ***Outcome: “Work in process.” Program personnel often:***
  - ***Incorrectly claim that risk and opportunity management are the dual, mirror, or mirror image of each other***
  - ***Don’t have a suitable analysis methodology. Typically minor adjustments are made to the risk analysis methodology, which can lead to erroneous results.***
  - ***Lack critical thinking to evaluate whether/not an opportunity should be pursued***
  - ***May not find associated risks until later in development***

# Opportunity Management Wrap-Up (1)



- **Carefully examine potential opportunities and pursue those that “make sense” in terms of cost, performance, schedule, and risk**
- **An unlimited budget will not exist**
  - **First deal with (manage) existing high/medium risks because they can kill your program**
  - **Then consider potential opportunities unless they map to the same (high/medium) risks**
- **Ensure you have sufficient resources to pursue the potential opportunity and actively manage all associated risks**



# Opportunity Management Wrap-Up (2)

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- **Opportunity management is NOT a competitive contractor advantage—most have the same shortfalls**
- **Develop a valid opportunity analysis methodology**
  - **Every opportunity analysis methodology I've examined on DoD and other programs was severely flawed**
- **Effective risk management suggests multiple handling strategies (parallel or contingent) for high risks**
  - **If a handling strategy or opportunity fails, then close the deficient strategy and “move on”**

# Opportunity Management Wrap-Up (3)

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- **Eliminate a “hopeful”/biased mind set with regards to potential opportunities. This is all too common and may prevent you from seeing shortfalls and risks.**
- **Carefully evaluate contrary information and unexpected results during opportunity development and integration**
  - ***This information and results may be “signaling” that a potentially unanticipated, adverse outcome exists!***