Quantifying the Necessity of Risk Mitigation Strategies

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Risk Assessment Overview

- **Current Method:**
  - A project's risk management plan involves identifying risks, the analysis of the cost/schedule impact of these risks, formulations of risk mitigation strategies, and tracking.
- **Issue:**
  - The assessments tend to suffer from subjectivity using current risk analysis methodologies.
- **Hypothesis:**
  - Using a time phased approach, the risk process can be redefined to yield a less subjective and more quantifiable, easily traceable, risk process thereby reducing uncertainty, oversight, and costs.

Time Phased Data

- **Requirements:**
  1) A data source with high importance on schedule and impact to overall risk mitigation strategies
  2) A large set of data over a sufficient time period
  3) A common end goal to normalize progress over time

- **Hypothesis: NCAA Men's Basketball AP Rankings**
  1) Tracking of AP rankings by week to show effects of unexpected risks (losses) and results of risk mitigation strategies
  2) Data tracked on a weekly basis for the last 30 years
  3) All teams studied ended as National Champions
     - Tracked teams that successfully followed proper risk mitigation strategies to complete the pre-season goal (plan) of being the best team.

Dataset

		Season AP Ranking (weeks until Champion)																				
Year	School	20	19	18	17	16	15	14	13	12	11	10	9	8	7	6	5	4	3	2	1	Champ
2013	Louisville		2	2	2	5	5	6	5	4	4	3	1	5	12	11	12	10	10	8	2	1
2012	Kentucky		2	2	2	1	1	3	3	3	2	2	2	1	1	1	1	1	1	1	1	1
2011	Connecticut		26	26	26	7	6	4	4	4	8	10	8	5	6	10	13	14	16	21	9	1
2010	Duke		9	9	7	6	8	7	7	7	5	8	7	8	11	8	6	5	4	4	3	1
2009	North Carolina		1	1	1	1	1	1	1	1	3	5	5	5	3	3	3	4	2	1	2	1
2008	Kansas	4	4	4	4	3	3	3	3	3	3	3	2	2	4	3	4	6	5	5	4	1
2007	Florida		1	1	1	4	7	5	5	3	3	2	1	1	1	1	1	3	5	6	3	1
2006	Florida		26	26	14	11	10	7	5	5	5	2	2	5	8	7	10	12	17	16	11	1
2005	North Carolina		4	4	11	9	8	5	4	4	3	3	6	3	2	2	4	2	2	2	2	1
2004	Connecticut			1	1	3	2	1	1	1	1	1	4	6	5	5	8	8	7	9	7	1
2003	Syracuse		26	26	26	26	26	26	26	26	26	25	26	24	19	17	15	15	12	11	13	1
2002	Maryland			2	6	5	3	3	2	8	8	4	3	3	3	3	3	2	2	2	4	1
2001	Duke		2	2	2	1	1	1	1	3	3	2	2	2	2	3	3	4	2	3	1	1
2000	Michigan State		3	2	3	8	4	5	5	8	11	11	10	9	8	6	6	5	7	5	2	1
1999	Connecticut			2	2	2	1	1	1	1	1	1	1	1	1	1	2	2	4	3	3	1
1998	Kentucky			8	9	8	7	4	4	4	6	6	6	7	7	8	7	8	7	7	5	1
1997	Arizona			19	19	11	15	8	6	9	9	7	6	11	10	14	11	13	15	12	15	1
1996	Kentucky			1	1	1	5	5	4	2	2	2	2	2	2	2	2	2	1	1	2	1
1995	UCLA			6	6	5	2	2	2	2	2	6	4	4	7	6	6	2	1	1	1	1
1994	Arkansas			3	3	2	1	1	1	1	1	4	3	5	6	3	1	1	1	1	2	1
1993	North Carolina			7	8	7	5	5	5	5	6	5	3	3	6	6	3	3	1	1	4	1
1992	Duke			1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1
1991	Duke				6	8	5	10	9	8	8	14	12	9	7	6	5	7	8	6	6	1
1990	UNLV				1	6	5	14	13	12	10	7	9	5	12	9	7	4	2	3	2	1
1989	Michigan			3	3	2	2	2	2	2	7	6	6	10	11	10	13	13	10	8	10	1
1988	Kansas			7	16	18	17	18	17	18	16	16	26	26	26	26	26	26	26	26	26	1
1987	Indiana					3	3	2	8	8	6	4	4	3	4	2	2	2	3	4	3	1
1986	Louisville				9	9	16	15	16	15	18	17	18	13	18	16	19	16	13	11	7	1
1985	Villanova				26	26	26	26	26	26	26	16	18	14	18	19	16	26	26	26	26	1
1984	Georgetown				4	3	3	5	5	5	4	4	6	4	4	3	2	2	4	2	2	1
	Average	4.0	8.8	6.9	7.6	6.7	6.6	6.5	6.4	6.6	6.9	6.6	6.8	6.6	7.5	7.1	7.1	7.3	7.2	6.9	6.0	1.0

Unranked
21 to 25
16 to 20
11 to 15
6 to 10
1 to 5

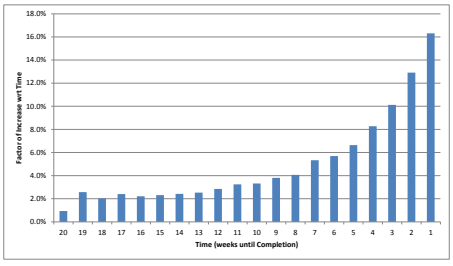
Analysis

- Measuring Avg room for improvement divided by weeks remaining

Weeks to Completion	20	19	18	17	16	15	14	13	12	11
Average	0.14	0.39	0.31	0.37	0.34	0.35	0.37	0.39	0.43	0.49
Normalized	0.9%	2.6%	2.0%	2.4%	2.2%	2.3%	2.4%	2.5%	2.8%	3.2%

Weeks to Completion	10	9	8	7	6	5	4	3	2	1
Average	0.51	0.58	0.62	0.81	0.87	1.01	1.26	1.54	1.97	2.48
Normalized	3.3%	3.8%	4.1%	5.3%	5.7%	6.6%	8.3%	10.1%	12.9%	16.3%

- The dataset shows high variability throughout the season but higher impacts with less time until completion



Analysis Conclusions

- Data proves the intuitive belief that changes closer to the completion of a program have larger impacts
- Quantifies the impact based on a 30 year sample to be used in practical cost estimating methodologies
- Does not account for imminent risk issues in the near term that can be catastrophic

Current Risk Mitigation Cost Estimating Example

- **Program Risks: Current top (10) risk items**
- **Cost Impact if Occurs: Cost if any given example happens**
- **Likelihood of Occurrence: Percent from 0 to 100 for odds of a risk happening (based on MTTF, SME, etc.)**
- **Risk Mitigation Budget: (Cost Impact) x (Likelihood of Occurrence) Represents the most likely cost impact of identified risks to occur.**
- **Rank: Current relative position of most costly risks to program**

	Top Program Risks	Cost Impact if Occurs	Likelihood of Occurance	Risk Mitigation Budget	Rank
1	Example A	$ 6,800,000	9.0%	$ 612,000	10
2	Example B	$ 12,000,000	21.0%	$ 2,520,000	7
3	Example C	$ 31,200,000	50.0%	$ 15,600,000	1
4	Example D	$ 16,300,000	50.0%	$ 8,150,000	4
5	Example E	$ 33,900,000	27.0%	$ 9,153,000	3
6	Example F	$ 10,700,000	69.0%	$ 7,383,000	5
7	Example G	$ 20,600,000	11.0%	$ 2,266,000	8
8	Example H	$ 14,200,000	89.0%	$ 12,638,000	2
9	Example I	$ 33,300,000	13.0%	$ 4,329,000	6
10	Example J	$ 14,300,000	15.0%	$ 2,145,000	9
	Total	$ 193,300,000		$ 64,796,000	

- **Note: Worse Case scenario (all risks occur) and likely risk budget values**

Problems with Current Method

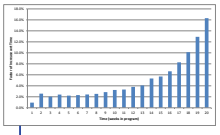
- **Often based on subjective inputs (i.e. Subject Matter Experts)**

	Top Program Risks	Cost Impact if Occurs	Likelihood of Occurance	Risk Mitigation Budget	Rank
1	Example A	$ 6,800,000	9.0%	$ 612,000	10
2	Example B	$ 12,000,000	21.0%	$ 2,520,000	7
3	Example C	$ 31,200,000	50.0%	$ 15,600,000	1
4	Example D	$ 16,300,000	50.0%	$ 8,150,000	4
5	Example E	$ 33,900,000	27.0%	$ 9,153,000	3
6	Example F	$ 10,700,000	69.0%	$ 7,383,000	5
7	Example G	$ 20,600,000	11.0%	$ 2,266,000	8
8	Example H	$ 14,200,000	89.0%	$ 12,638,000	2
9	Example I	$ 33,300,000	13.0%	$ 4,329,000	6
10	Example J	$ 14,300,000	15.0%	$ 2,145,000	9
	Total	$ 193,300,000		$ 64,796,000	

- **Risk Assessment (cost and likelihood of occurrence) are not revaluated as the project approaches completion**
- **Neglects growing impact of risks for schedule milestones**

Time Phased Risk Mitigation Cost Estimating Example (At Time x)

- Schedule Impact Factor taken from previous NCAA data analysis graph



	Top Program Risks	Cost Impact if Occurs	Likelihood of Occurance	Weeks to Delivery	Schedule Impact Factor	Risk Mitigation Budget	Rank
1	Example A	$ 6,800,000	9.0%	8	4.1%	$ 636,858	10
2	Example B	$ 12,000,000	21.0%	6	5.7%	$ 2,663,421	7
3	Example C	$ 31,200,000	50.0%	7	5.3%	$ 16,432,355	1
4	Example D	$ 16,300,000	50.0%	2	12.9%	$ 9,202,565	4
5	Example E	$ 33,900,000	27.0%	3	10.1%	$ 10,079,648	3
6	Example F	$ 10,700,000	69.0%	9	3.8%	$ 7,664,204	5
7	Example G	$ 20,600,000	11.0%	10	3.3%	$ 2,341,305	8
8	Example H	$ 14,200,000	89.0%	4	8.3%	$ 13,683,706	2
9	Example I	$ 33,300,000	13.0%	9	3.8%	$ 4,493,883	6
10	Example J	$ 14,300,000	15.0%	10	3.3%	$ 2,216,284	9
	Total	$ 193,300,000				$ 69,414,228	

- Note: No change to Worse Case scenario but likely risk budget increased by ~$5M incorporating time until delivery (schedule) factor

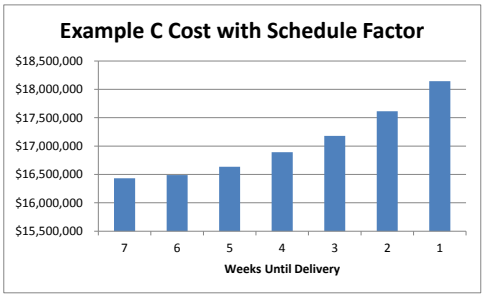
Time Phased Risk Mitigation Cost Estimating Example (At Time x + 1)

- Same risk picture one time period (i.e. week, month) later

	Top Program Risks	Cost Impact if Occurs	Likelihood of Occurance	Weeks to Delivery	Schedule Impact Factor	Risk Mitigation Budget	Rank
1	Example A	$ 6,800,000	9.0%	7	5.3%	$ 644,654	10
2	Example B	$ 12,000,000	21.0%	5	6.6%	$ 2,687,325	7
3	Example C	$ 31,200,000	50.0%	6	5.7%	$ 16,487,845	1
4	Example D	$ 16,300,000	50.0%	1	16.3%	$ 9,479,087	4
5	Example E	$ 33,900,000	27.0%	2	12.9%	$ 10,335,102	3
6	Example F	$ 10,700,000	69.0%	8	4.1%	$ 7,682,879	5
7	Example G	$ 20,600,000	11.0%	9	3.8%	$ 2,352,307	8
8	Example H	$ 14,200,000	89.0%	3	10.1%	$ 13,917,468	2
9	Example I	$ 33,300,000	13.0%	8	4.1%	$ 4,504,833	6
10	Example J	$ 14,300,000	15.0%	9	3.8%	$ 2,226,699	9
	Total	$ 193,300,000				$ 70,318,199	

- Note: Risk budget increases further as time to delivery shortens (~$1M for one time period later)

Tracking a Single Risk Over Time



Top Program Risks	Cost Impact if Occurs	Likelihood of Occurance	Weeks to Delivery	Schedule Impact Factor	Risk Mitigation Budget
Example C	$ 31,200,000	50.0%	7	5.3%	$ 16,432,355
Example C	$ 31,200,000	50.0%	6	5.7%	$ 16,487,845
Example C	$ 31,200,000	50.0%	5	6.6%	$ 16,635,820
Example C	$ 31,200,000	50.0%	4	8.3%	$ 16,890,791
Example C	$ 31,200,000	50.0%	3	10.1%	$ 17,179,340
Example C	$ 31,200,000	50.0%	2	12.9%	$ 17,614,726
Example C	$ 31,200,000	50.0%	1	16.3%	$ 18,144,018

Key Improvements to Risk Mitigation using Schedule Impacts

- **Gives the ability to track the cost of each risk with respect to time.**
  - Can be combined with lean manufacturing schedule assessments to find optimal times to mitigate each risk to keep overall cost impact to the program minimal
- **Alleviates issues stemming from lack of revaluation of program risks.**
- **Can assess multiple risks with varying completion dates at the same time.**

Theory Evolution and Application

Initial Assumptions

- **Each month has it's own unique risks. All risks for Month (time period) 1 are discrete costs for that month and are not the same as those found in Month 2. Any months with the same values are coincidental and for example purposes only.**
  - The same principle applies to individual risks for each time period. Risk 1 in Month 1 is not the same as Risk 1 in Month 2.
- **Each risk within a month has a worst case cost and a most likely cost that account for the probability of a risk occurring in that time period.**
- **The analysis emphasizes key time periods in a program to examine and address risks. As such results should be though of from the Point of View of a Program Manager and what time periods will require the most examination.**

Step 1: Time Phasing the Standard Risk Model

Step 1

- Divide program into equal time durations. Multiply cost risks and probabilities like you would in a standard risk cube, sum the totals into time frames of expected occurrence.

Program Start	Risk	Solution	Cost	Probability of Occurance	Risk Cube Value
Month One Risks	Risk 1	Solution 1	$ 200,000	50%	$ 100,000
	Risk 2	Solution 2	$ 1,500,000	10%	$ 150,000
	Risk 3	Solution 3	$ 100,000	5%	$ 5,000
	Risk 4	Solution 4	$ 50,000	70%	$ 35,000
	Risk 5	Solution 5	$ 150,000	80%	$ 120,000
	Risk 6	Solution 6	$ 200,000	20%	$ 40,000
			$ 2,200,000		**$ 450,000**
Month Eight Risks	Risk 1	Solution 1	$ 200,000	50%	$ 100,000
	Risk 2	Solution 2	$ 1,500,000	10%	$ 150,000
	Risk 3	Solution 3	$ 100,000	5%	$ 5,000
	Risk 4	Solution 4	$ 50,000	70%	$ 35,000
	Risk 5	Solution 5	$ 1,500,000	80%	$ 1,200,000
	Risk 6	Solution 6	$ 200,000	20%	$ 40,000
			$ 3,550,000		**$ 1,530,000**

Step 2: Risk Percentage by Time Interval

Step 2

- Find % of Risk Budget by Time Interval (Months)

Month of Program	Value of Impact	Budget	% of Risk Budget
1	$ 2,200,000	$ 450,000	5.1%
2	$ 2,200,000	$ 450,000	5.1%
3	$ 2,200,000	$ 450,000	5.1%
4	$ 2,200,000	$ 450,000	5.1%
5	$ 2,200,000	$ 450,000	5.1%
6	$ 2,200,000	$ 450,000	5.1%
7	$ 2,200,000	$ 450,000	5.1%
8	$ 3,550,000	$ 1,530,000	17.2%
9	$ 3,550,000	$ 1,530,000	17.2%
10	$ 2,200,000	$ 450,000	5.1%
11	$ 2,200,000	$ 450,000	5.1%
12	$ 2,200,000	$ 450,000	5.1%
13	$ 2,200,000	$ 450,000	5.1%
14	$ 2,200,000	$ 450,000	5.1%
15	$ 2,200,000	$ 450,000	5.1%
Total	**$ 24,700,000**	**$ 8,910,000**	

Step 3: Calculate Percent of Attention

- **Key Terms:**
  - Time value of risk mitigation strategy: the relationship for current risk to overall time elapsed for the program. Represents the measure of current risk to program maturity.
  - Risk mitigation prioritization snapshot: the relationship to completion of a program. Represents the importance for a PM to address the nearest term risks first

Step 3

- **Dived the % of risk by both total durations remaining and number of durations remaining until the risk is expected to occur (when you need your $ avail). In this case, Months. Find the percent of total for each.**
- **This will provide you with the prioritization variable or "% of Program Managers Attention Needed".**

% of Risk Budget	Month of Program	Months Remaining in program	Time Value of Risk Mitigation Strategy	%of Attn	Risk Mitigation Prioritization Snapshot	%of Attn
5.1%	1	15	0.003	1.68%	0.051	25.74%
5.1%	2	14	0.004	1.80%	0.025	12.87%
5.1%	3	13	0.004	1.94%	0.017	8.58%
5.1%	4	12	0.004	2.10%	0.013	6.44%
5.1%	5	11	0.005	2.30%	0.010	5.15%
5.1%	6	10	0.005	2.52%	0.008	4.29%
5.1%	7	9	0.006	2.81%	0.007	3.68%
17.2%	8	8	0.021	10.73%	0.021	10.94%
17.2%	9	7	0.025	12.26%	0.019	9.72%
5.1%	10	6	0.008	4.21%	0.005	2.57%
5.1%	11	5	0.010	5.05%	0.005	2.34%
5.1%	12	4	0.013	6.31%	0.004	2.15%
5.1%	13	3	0.017	8.42%	0.004	1.98%
5.1%	14	2	0.025	12.62%	0.004	1.84%
5.1%	15	1	0.051	25.25%	0.003	1.72%
			0.20	1.00	0.20	1.00

Step 4: Calculate "Big Picture Prioritization"

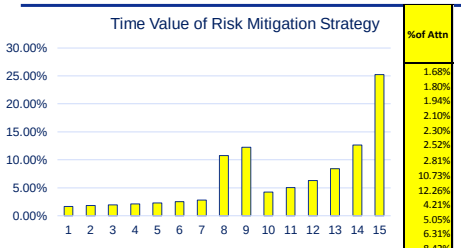
Step 4

- **Multiply together and find the percent of total of each (seen here in green)**

Represents what months require the most attention from a PM based on overall cost and the time of risks occurring ↓

Time Value of Risk Mitigation Strategy	%of Attn	Risk Mitigation Prioritization Snapshot	%of Attn	Risk Mitigation Prioitization	%of Attn
0.003	1.68%	0.051	25.74%	0.43%	8.92%
0.004	1.80%	0.025	12.87%	0.23%	4.78%
0.004	1.94%	0.017	8.58%	0.17%	3.43%
0.004	2.10%	0.013	6.44%	0.14%	2.79%
0.005	2.30%	0.010	5.15%	0.12%	2.43%
0.005	2.52%	0.008	4.29%	0.11%	2.23%
0.006	2.81%	0.007	3.68%	0.10%	2.12%
0.021	10.73%	0.021	10.94%	1.17%	24.17%
0.025	12.26%	0.019	9.72%	1.19%	24.55%
0.008	4.21%	0.005	2.57%	0.11%	2.23%
0.010	5.05%	0.005	2.34%	0.12%	2.43%
0.013	6.31%	0.004	2.15%	0.14%	2.79%
0.017	8.42%	0.004	1.98%	0.17%	3.43%
0.025	12.62%	0.004	1.84%	0.23%	4.78%
0.051	25.25%	0.003	1.72%	0.43%	8.92%
0.20	1.00	0.20	1.00	4.86%	1.00

Step 5: Plot



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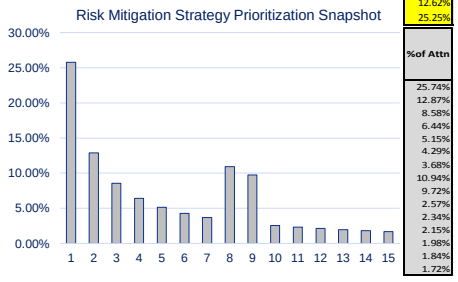

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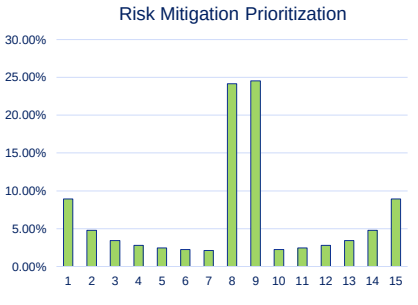

%of Attn
8.92%
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2.12%
24.17%
24.55%
2.23%
2.43%
2.79%
3.43%
4.78%
8.92%

- **Key Points:**
  - Common High risk areas include early program maturity (due to unknown risks), late program (little time to mitigate risks) and large costs risks

Step 6: Milestone Revaluation (30%, 50%, 70%)

Step 6

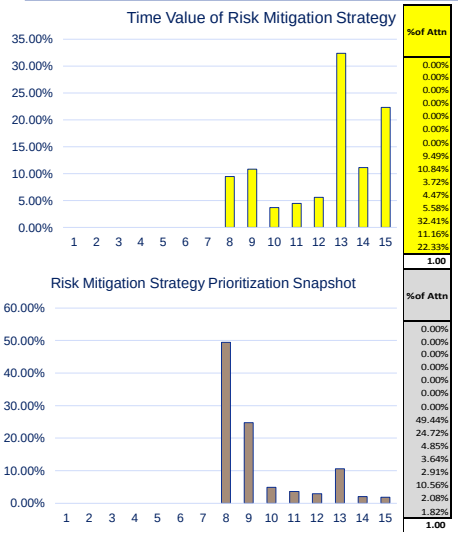
- **Rinse and Repeat as updates are made.**
- **Recommend <u>detailed review</u> at 30%, 50%, and 70% Complete. This accounts for changes in risk as program evolves.**
- **See example in month thirteen.**
  - As the program evolved, Risk 2 in month thirteen grew to 100% probability

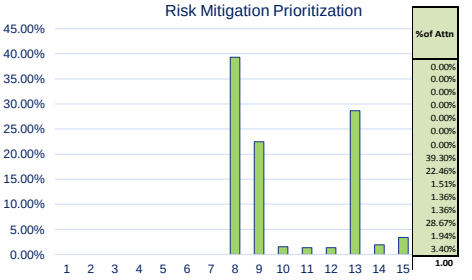
Program is now 50% Complete	Risk	Solution	Cost	Probability of Occurance	Risk Cube Value
Month Nine Risks	Risk 1	Solution 1	$ 200,000	50%	$ 100,000
	Risk 2	Solution 2	$ 1,500,000	10%	$ 150,000
	Risk 3	Solution 3	$ 100,000	5%	$ 5,000
	Risk 4	Solution 4	$ 50,000	70%	$ 35,000
	Risk 5	Solution 5	$ 1,500,000	80%	$ 1,200,000
	Risk 6	Solution 6	$ 200,000	20%	$ 40,000
			$ 3,550,000		**$ 1,530,000**
Month Thirteen Risks	Risk 1	Solution 1	$ 200,000	50%	$ 100,000
	Risk 2	Solution 2	$ 1,500,000	100%	$ 1,500,000
	Risk 3	Solution 3	$ 100,000	5%	$ 5,000
	Risk 4	Solution 4	$ 50,000	70%	$ 35,000
	Risk 5	Solution 5	$ 150,000	80%	$ 120,000
	Risk 6	Solution 6	$ 200,000	100%	$ 200,000
			$ 2,200,000		**$ 1,960,000**

50% Risk Board Prioritization Values

	Week of Program	$ Value of Impact	Budget	% of Risk Budget	Month of Program	Months Remaining in program	Time Value of Risk Mitigation Strategy	%of Attn	Risk Mitigation Prioritization Snapshot	%of Attn	Risk Mitigation Prioitization	%of Attn
	1	$ 2,200,000	$ 450,000	0.0%	0	15	-	0.00%	-	0.00%	0.00%	0.00%
	2	$ 2,200,000	$ 450,000	0.0%	0	14	-	0.00%	-	0.00%	0.00%	0.00%
	3	$ 2,200,000	$ 450,000	0.0%	0	13	-	0.00%	-	0.00%	0.00%	0.00%
	4	$ 2,200,000	$ 450,000	0.0%	0	12	-	0.00%	-	0.00%	0.00%	0.00%
	5	$ 2,200,000	$ 450,000	0.0%	0	11	-	0.00%	-	0.00%	0.00%	0.00%
Complete	6	$ 2,200,000	$ 450,000	0.0%	0	10	-	0.00%	-	0.00%	0.00%	0.00%
	7	$ 2,200,000	$ 450,000	0.0%	0	9	-	0.00%	-	0.00%	0.00%	0.00%
To Go	8	$ 3,550,000	$ 1,530,000	17.2%	1	8	0.021	9.49%	0.172	49.44%	4.69%	39.30%
	9	$ 3,550,000	$ 1,530,000	17.2%	2	7	0.025	10.84%	0.086	24.72%	2.68%	22.46%
	10	$ 2,200,000	$ 450,000	5.1%	3	6	0.008	3.72%	0.017	4.85%	0.18%	1.51%
	11	$ 2,200,000	$ 450,000	5.1%	4	5	0.010	4.47%	0.013	3.64%	0.16%	1.36%
	12	$ 2,200,000	$ 450,000	5.1%	5	4	0.013	5.58%	0.010	2.91%	0.16%	1.36%
	13	$ 2,200,000	$ 1,960,000	22.0%	6	3	0.073	32.41%	0.037	10.56%	3.42%	28.67%
	14	$ 2,200,000	$ 450,000	5.1%	7	2	0.025	11.16%	0.007	2.08%	0.23%	1.94%
	15	$ 2,200,000	$ 450,000	5.1%	8	1	0.051	22.33%	0.006	1.82%	0.41%	3.40%
	Total	**$ 24,700,000**	**$ 10,420,000**				**0.23**	**1.00**	**0.35**	**1.00**	**11.94%**	**1.00**

50% Risk Board Prioritization Plots





Questions?