Using the Advancement Degree of Difficulty (AD^2) as an input to Risk Management

James W. Bilbro
JB Consulting International
Huntsville, AL

Multi-dimensional Assessment of Technology Maturity
Technology Maturity Conference
Founders Inn & Spa, Virginia Beach, VA
September 8-12, 2008

Report Documentation Page

Form Approved
OMB No. 0704-0188

1. REPORT DATE	2. REPORT TYPE	3. DATES COVERED
SEP 2008		**00-00-2008 to 00-00-2008**

4. TITLE AND SUBTITLE	5a. CONTRACT NUMBER
Using the Advancement Degree of Difficulty (AD2) as an input to Risk Management	5b. GRANT NUMBER
	5c. PROGRAM ELEMENT NUMBER
6. AUTHOR(S)	5d. PROJECT NUMBER
	5e. TASK NUMBER
	5f. WORK UNIT NUMBER
7. PERFORMING ORGANIZATION NAME(S) AND ADDRESS(ES) **JB Consulting International,4071 Panorama Dr. SE,Huntsville,AL,35801**	8. PERFORMING ORGANIZATION REPORT NUMBER
9. SPONSORING/MONITORING AGENCY NAME(S) AND ADDRESS(ES)	10. SPONSOR/MONITOR'S ACRONYM(S)
	11. SPONSOR/MONITOR'S REPORT NUMBER(S)

12. DISTRIBUTION/AVAILABILITY STATEMENT
Approved for public release; distribution unlimited

13. SUPPLEMENTARY NOTES
See also ADM002183. Presented at the Technology Maturity Conference held in Virginia Beach, Virginia on 9-12 September 2008. U.S. Government or Federal Rights License.

14. ABSTRACT

15. SUBJECT TERMS

16. SECURITY CLASSIFICATION OF:			17. LIMITATION OF ABSTRACT	18. NUMBER OF PAGES	19a. NAME OF RESPONSIBLE PERSON
a. REPORT **unclassified**	b. ABSTRACT **unclassified**	c. THIS PAGE **unclassified**	**Same as Report (SAR)**	**15**	

Using AD² as an Input to Risk Management

JB International

Advancement Degree of Difficulty (AD2) is a method of systematically dealing with aspects beyond TRL.

It is a "predictive" description of what is required to move a system, subsystem or component from one TRL to another.

It provides information in the form of:

- Liklihood of occurrence of an adverse event. } **Risk**
- Cost to ensure that such an event does not occur. } **Impact**
- The time required to implement the necessary action. } **Impact**

Using AD² as an Input to Risk Management

JB International

- AD² consists of a set of questions in 5 specific areas:
  - Design and Analysis
  - Manufacturing
  - Software Development
  - Test
  - Operations
- The questions are asked about each element in the product WBS structure from the top level system down to the individual component.
- The questions are not directed toward the element itself, rather toward the issue of:
  - Do you have the resources – people, skills, tools, facilities, etc. to design, manufacture, test and operate it?

Using AD^2 as an Input to Risk Management

JB International

The levels of risk associated with AD^2 are described in terms of the experience base of the developers.

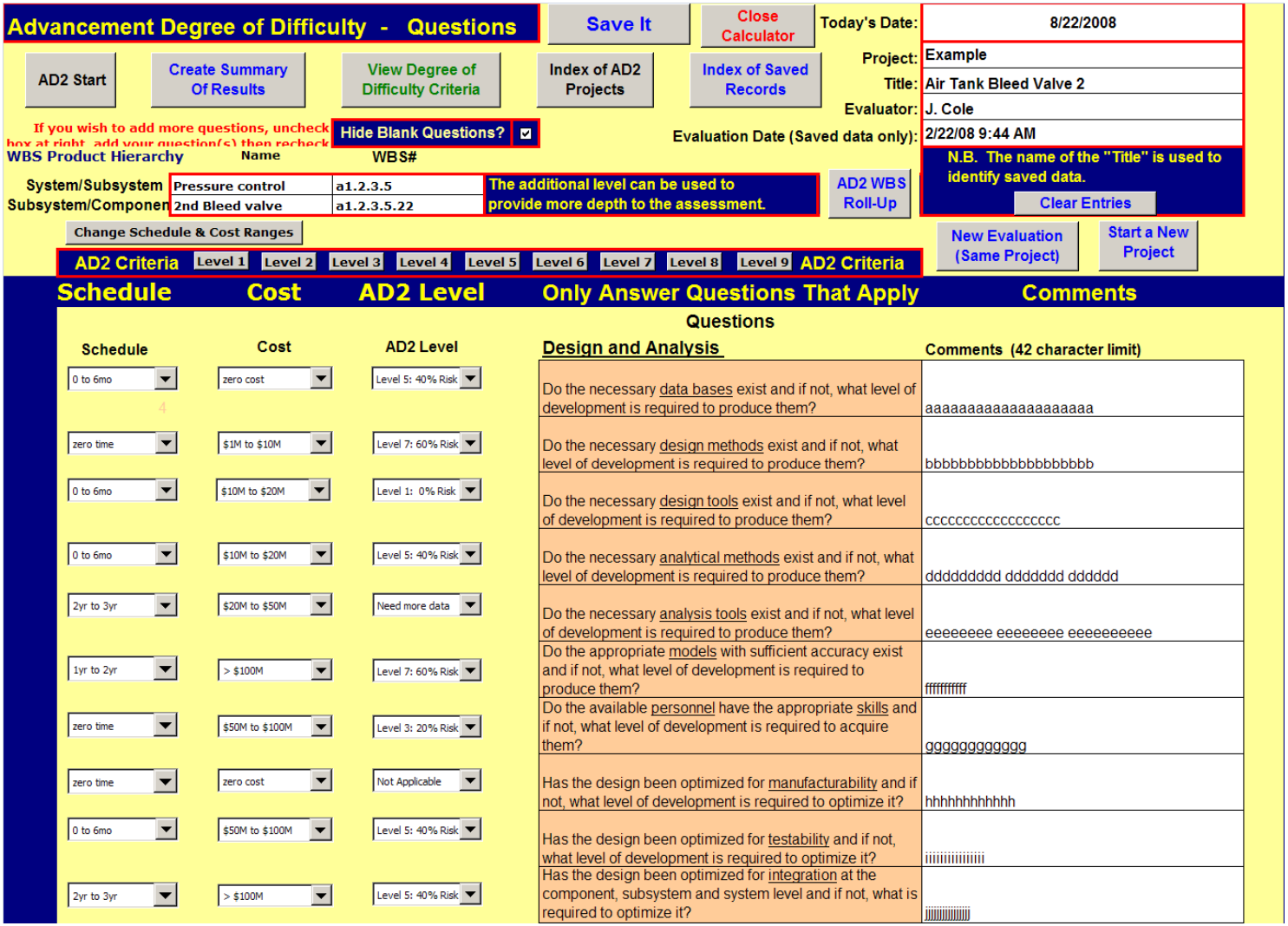
i.e., have they done this before?

Using AD² as an Input to Risk Management

JB International

AD² LEVEL		RISK
9	Requires new development outside of any existing experience base. No viable approaches exist that can be pursued with any degree of confidence. Basic research in key areas needed before feasible approaches can be defined.	90%
8	Requires new development where similarity to existing experience base can be defined only in the broadest sense. Multiple development routes must be pursued.	80%
7	Requires new development but similarity to existing experience is sufficient to warrant comparison in only a subset of critical areas. Multiple development routes must be pursued.	70%
6	Requires new development but similarity to existing experience is sufficient to warrant comparison on only a subset of critical areas. Dual development approaches should be pursued in order to achieve a moderate degree of confidence for success. (desired performance can be achieved in subsequent block upgrades with high degree of confidence.	50%
5	Requires new development but similarity to existing experience is sufficient to warrant comparison in all critical areas. Dual development approaches should be pursued to provide a high degree of confidence for success.	40%
4	Requires new development but similarity to existing experience is sufficient to warrant comparison across the board. A single development approach can be taken with a high degree of confidence for success.	30%
3	Requires new development well within the experience base. A single development approach is adequate.	20%
2	Exists but requires major modifications. A single development approach is adequate.	10%
1	Exists with no or only minor modifications being required. A single development approach is adequate.	0%

Using AD² as an Input to Risk Management



Advancement Degree of Difficulty - Questions

Save It | Close Calculator | Today's Date: 8/22/2008

AD2 Start | Create Summary Of Results | View Degree of Difficulty Criteria | Index of AD2 Projects | Index of Saved Records

Project: Example
Title: Air Tank Bleed Valve 2
Evaluator: J. Cole
Evaluation Date (Saved data only): 2/22/08 9:44 AM

If you wish to add more questions, uncheck box at right, add your question(s) then recheck | Hide Blank Questions? ☑

N.B. The name of the "Title" is used to identify saved data.

Clear Entries

WBS Product Hierarchy	Name	WBS#
System/Subsystem	Pressure control	a1.2.3.5
Subsystem/Componen	2nd Bleed valve	a1.2.3.5.22

The additional level can be used to provide more depth to the assessment.

AD2 WBS Roll-Up

Change Schedule & Cost Ranges

New Evaluation (Same Project) | Start a New Project

AD2 Criteria | Level 1 | Level 2 | Level 3 | Level 4 | Level 5 | Level 6 | Level 7 | Level 8 | Level 9 | AD2 Criteria

Schedule	Cost	AD2 Level	Only Answer Questions That Apply — Questions	Comments (42 character limit)
0 to 6mo	zero cost	Level 5: 40% Risk	Do the necessary data bases exist and if not, what level of development is required to produce them?	aaaaaaaaaaaaaaaaaaa
zero time	$1M to $10M	Level 7: 60% Risk	Do the necessary design methods exist and if not, what level of development is required to produce them?	bbbbbbbbbbbbbbbbbbb
0 to 6mo	$10M to $20M	Level 1: 0% Risk	Do the necessary design tools exist and if not, what level of development is required to produce them?	ccccccccccccccccc
0 to 6mo	$10M to $20M	Level 5: 40% Risk	Do the necessary analytical methods exist and if not, what level of development is required to produce them?	ddddddddd ddddddd dddddd
2yr to 3yr	$20M to $50M	Need more data	Do the necessary analysis tools exist and if not, what level of development is required to produce them?	eeeeeeee eeeeeeee eeeeeeeeee
1yr to 2yr	> $100M	Level 7: 60% Risk	Do the appropriate models with sufficient accuracy exist and if not, what level of development is required to produce them?	fffffffffff
zero time	$50M to $100M	Level 3: 20% Risk	Do the available personnel have the appropriate skills and if not, what level of development is required to acquire them?	ggggggggggg
zero time	zero cost	Not Applicable	Has the design been optimized for manufacturability and if not, what level of development is required to optimize it?	hhhhhhhhhhh
0 to 6mo	$50M to $100M	Level 5: 40% Risk	Has the design been optimized for testability and if not, what level of development is required to optimize it?	iiiiiiiiiiiiii
2yr to 3yr	> $100M	Level 5: 40% Risk	Has the design been optimized for integration at the component, subsystem and system level and if not, what is required to optimize it?	jjjjjjjjjjjjj

Using AD² as an Input to Risk Management

Return To AD2 Start

AD2 Roll-up of Subsystem Drivers

Re-Calculate WBS Roll-up

8/22/08 4:28 PM

AD2 Current Evaluation | Index of Saved Records | Index of AD2 Projects

Sensitivity: Level 7: 60% Risk

Project: Example

Record	WBS Sub Sys	Comp	Name	Problem Areas	Schedule	Cost	Tech Dev Needed
5		1.1.0					
5		1.1.0	Inducer				
3		1.2.0	Impeller				
4	1.3.0	1.3.1	Pump Housing				
4		1.3.1	Volute				
6		1.3.2	Diffuser				
7		1.4.0	Turbine Blades				
8		1.5.0	Turbine Nozzles				
11	1.6.0	1.6.1	Turbine Housing				
11		1.6.1	Manifolds				
9		1.6.2	Guide Vanes				
10		1.7.0	Dynamic Seals				
12		1.8.0	Bearings/Rotor				
13		1.10.0	Axial Thrust Balance				
14		1.10.2	Axial Thrust Balance2				
2	a1.2.3.5	a1.2.3.5.21	Pressure control				
2		a1.2.3.5.21	Bleed valve				
				D&A - Necessary data bases	zero time	zero cost	Level 7: 60% Risk
				D&A - Appropriate skills	zero time	$50M to $100M	Level 7: 60% Risk
				D&A -	zero time	zero cost	Level 8: 80% Risk
				Mfg - Necessary metrology	zero time	$20M to $50M	Level 7: 60% Risk
				Mfg - Appropriate skills	0 to 6mo	> $100M	Level 7: 60% Risk
				Mfg -	6mo to 1yr	$1M to $10M	Level 7: 60% Risk
				SW Dev -	1yr to 2yr	$20M to $50M	Level 7: 60% Risk
				T&V - Test facilities	6mo to 1yr	$1M to $10M	Level 7: 60% Risk
1		a1.2.3.5.22	2nd Bleed valve				
				D&A - Necessary design methods	zero time	$1M to $10M	Level 7: 60% Risk
				D&A - Necessary analysis tools	2yr to 3yr	$20M to $50M	Need more data
				D&A - Models with sufficient accuracy	1yr to 2yr	> $100M	Level 7: 60% Risk
				D&A - Optimized for manufacturability	zero time	zero cost	Not Applicable
				D&A -	zero time	zero cost	Level 7: 60% Risk
				D&A -	2yr to 3yr	$50M to $100M	Level 9: 100% Risk
				Mfg - Necessary materials	1yr to 2yr	$10M to $20M	Need more data
				Mfg - Necessary mfg. tooling	6mo to 1yr	$20M to $50M	Not Applicable
				Mfg - Necessary metrology	zero time	$20M to $50M	Level 7: 60% Risk
				Mfg - Necessary mfg. software	0 to 6mo	0 to $1M	Level 7: 60% Risk
				Mfg - Brassboards	zero time	zero cost	Not Applicable
				Mfg - Qualification models	0 to 6mo	$50M to $100M	Not Applicable
				Mfg -	2yr to 3yr	0 to $1M	Need more data
				Mfg -	6mo to 1yr	$1M to $10M	Level 9: 100% Risk
				SW Dev -	0 to 6mo	$20M to $50M	Level 8: 80% Risk
				SW Dev -	zero time	$20M to $50M	Level 9: 100% Risk
				SW Dev -	zero time	$50M to $100M	Not Applicable
				SW Dev -	1yr to 2yr	$20M to $50M	Need more data

Using AD² as an Input to Risk Management

JB International

Relating AD² to Project Uncertainty: from Variation to Chaos*

Variation:

Cost, time and performance levels vary randomly, but in a predictable range.

Foreseen Certainty:

A few known factors will influence the project but in predictable ways.

Unforeseen Uncertainty:

One or more major influence factors cannot be predicted.

Chaos:

Unforeseen events completely dominate the project's target, planning and approach.

*De Meyer, et al

Using AD² as an Input to Risk Management

TRL AD2 Project Status Definition

Project Type	Current TRL	AD2 Risk Level	Project Status
Basic Research	TRL 1 or 2	AD2L 1, 2,3,4	Acceptable
Applied Research	TRL 3 or 4	AD2L 5	
Advanced Research	TRL 5	AD2L 6,7,8,9	
Advanced Tech Demonstrator	TRL 6, 7		
Acquisition Program	TRL 8, or 9		

Reset All

TRL	Adv. Tech Demo	Level	AD2		Risk
Actual system flight proven through successful mission operations	Too well known for Advanced Tech Demonstrator	9	Chaos	Requires new development outside of any existing experience base. No viable approaches exist that can be pursued with any degree of confidence. Basic research in key areas needed before feasible approaches can be defined.	90+%
Actual system completed and flight qualified through test and demonstration	Too well known for Advanced Tech Demonstrator	8	Unknown Unknowns	Requires new development where similarity to existing experience base can be defined only in the broadest sense. Multiple development routes must be pursued.	80%
System/subsystem model or prototype demonstration in a relevant environment	Desirable	7		Requires new development but similarity to existing experience is sufficient to warrant comparison in only a subset of critical areas. Multiple development routes must be pursued.	70%
System/subsystem model or prototype demonstration in a relevant environment	Desirable	6		Requires new development but similarity to existing experience is sufficient to warrant comparison on only a subset of critical areas. Dual development approaches should be pursued in order to achieve a moderate degree of confidence for success. (desired performance can be achieved in subsequent block upgrades with high degree of confidence.	50%
Component or breadboard validation in a relevant environment	Acceptable	5	Known Unknowns	Requires new development but similarity to existing experience is sufficient to warrant comparison in all critical areas. Dual development approaches should be pursued to provide a high degree of confidence for success.	40%
Component or breadboard validation in laboratory	Unacceptable -- Too Risky	4	Well Understood	Requires new development but similarity to existing experience is sufficient to warrant comparison across the board. A single development approach can be taken with a high degree of confidence for success.	30%
Analytical and/ or experimental critical function or characteristic proof-of-concept	Unacceptable -- Too Risky	3		Requires new development well within the experience base. A single development approach is adequate.	20%
Technology concept or application formulated	Unacceptable -- Too Risky	2		Exists but requires major modifications. A single development approach is adequate.	10%
Basic principles observed and reported	Unacceptable -- Too Risky	1		Exists with no or only minor modifications being required. A single development approach is adequate.	0%

TRL Increasing Maturity

AD2 Increasing Risk

Using AD² as an Input to Risk Management

JB International

Relating AD² to a 5X5 Risk Matrix

DOD Likelihood Descriptions

Likelihood

Level	Likelihood	Probability of Occurrence
1	Not Likely	~10%
2	Low Likelihood	~30%
3	Likely	~50%
4	Highly Likely	~70%
5	Near Certainty	~90%

Using AD² as an Input to Risk Management

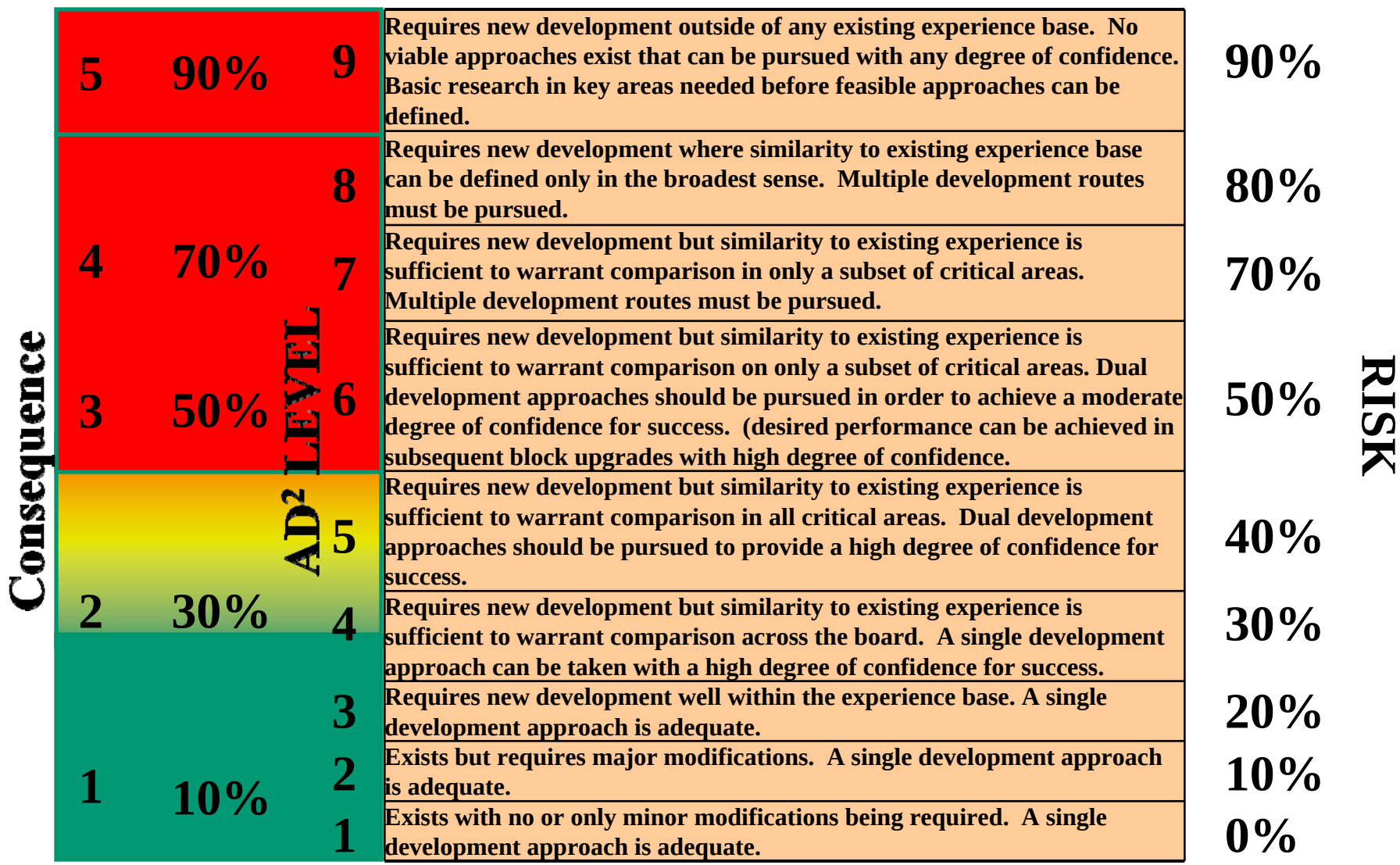
JB International

DOD Consequence Descriptions

Consequence

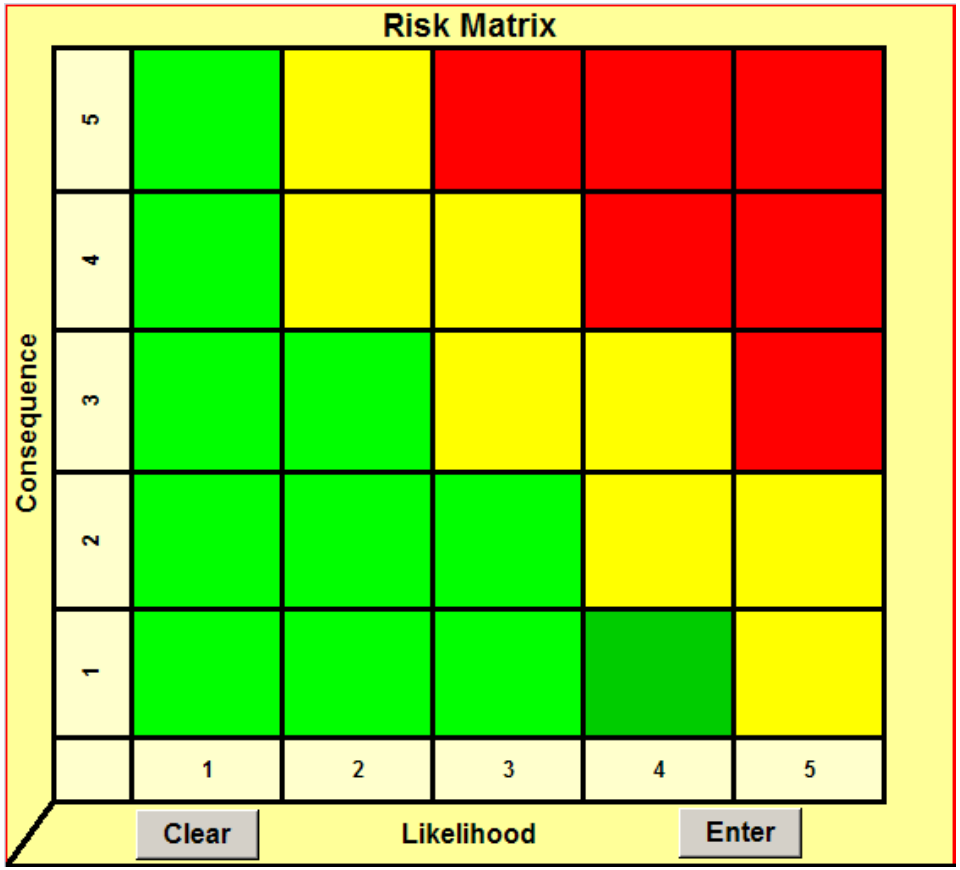
Level	Technical	Schedule	Schedule
1	Minimal or no consequence to technical performance	Minimal or no impact	Minimal or no impact
2	Minor reduction in technical performance or supportability, can be tolerated with little or no impact on the program	Able to meet key dates. **Slip <*month(s)**	Budget increase or unit production cost increases. **<**(1% of Budget)**
3	Moderate reduction in technical performance or supportability with limited impact on program objectives	Minor schedule slip. Able to meet key milestones with no schedule float **Slip <*month(s)** **Sub-system slip<*month(s) plus available float**	Budget increase or unit production cost increases. **<**(5% of Budget)**
4	Significant degradation in technical performance or major shortfall in supportability; may jeopardize program success	Program critical path affected **Slip <*month(s)**	Budget increase or unit production cost increases. **<**(10% of Budget)**
5	Severe degradation in technical performance. Cannot meet KPP or key technical/supportability threshold; will jeopardize program success	Cannot meet key program milestones **Slip <*month(s)**	Budget increase or unit production cost increases. **>**(10% of Budget)**

Using AD² as an Input to Risk Management



Using AD² as an Input to Risk Management

5X5 Risk Matrix



Using AD² as an Input to Risk Management

JB International

Summary

- **The AD2 assessment provides the basis for the development of the Technology Development Plan and for improved accuracy of the development of program/project cost, schedule and risk.**

Using AD² as an Input to Risk Management

Website: www.jbconsultinginternational.com

Bibliography:

- De Meyer, Arnould, Loch, Christoph H., and Pich Michael T., "Managing Project Uncertainty: From Variation to Chaos," MIT Sloan Management Review, pp. 60-67, Winter 2002.
- Risk Management Guide for DOD Acquistion 6th Edition Version 1.0 August 2006.