

RISK AND SAFETY - PERSPECTIVES FROM THE AEROSPACE INDUSTRY



Michael Kelly

Overview

- Background
- Commercial Aviation Perspectives
- Aircraft Maintenance Perspectives
- Flight Test Perspectives
- Space Launch Perspectives
- Common Threads

Background

Education:

- MBA, UCLA Anderson School of Management
- MS, BS Aerospace Engineering Purdue University

Work History

- Design Engineer 1997
- Aerospace Engineer 1998 – 1999
- Aircraft Maintenance Officer 2002 – 2005
- Flight Test Engineer 2005 – 2009
- Systems Engineer 2010 – 2012
- Program Manager 2012

Designing Maintenance Trainers



This or...

...This

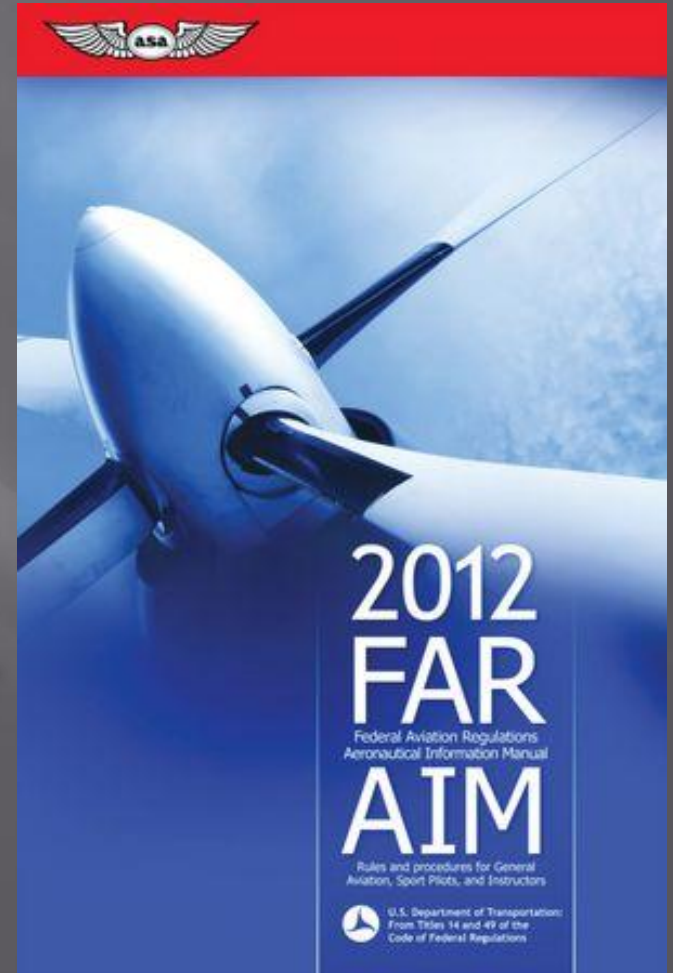
How and on what
do you want people
to learn?



Certification of Commercial Aircraft



- Regulations – FAA, EASA
- Software



Managing Maintenance Activities

- Role of the maintenance officer
- Unique military culture
- Approach to maintenance activities
 - Guidance
 - Training
 - Discipline
- Operational Risk Management

Military Culture

- Training
- Attention to Detail
- Discipline
- Deployment



Maintenance Guidance Documents

BY ORDER OF THE
SECRETARY OF THE AIR FORCE



AIR FORCE INSTRUCTION 90-901
1 APRIL 2000

Command Policy
OPERATIONAL RISK MANAGEMENT

COMPLIANCE WITH THIS PUBLICATION IS MANDATORY

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OPR: HQ AFSC/SEPO (Mr John D. Phillips) Certified by: HQ USAF/SEP (Col Robert W. Scott)
Supersedes AFI 91-213, 1 September 1997. Pages: 7
Distribution: F

This instruction implements AFDPO 90-901, Operational Risk Management. It establishes the requirement to integrate and sustain operational risk management (ORM) throughout the Air Force. It assigns responsibilities for program elements and contains program management information. HQ Air Force staffs, major commands (MAJCOMs), direct reporting units (DRUs) and field operating agencies (FOAs) are responsible for establishing and sustaining their respective programs according to the program elements described in this instruction. It applies to all Air Force personnel and functional areas, including the Air Force Reserve and Air National Guard. Do not supplement this instruction without prior review by the Air Force Chief of Safety (AF/SE). **Records Disposition.** Maintain and dispose of records created as a result of processes prescribed in this publication in accordance with AFMAN 37-139, Records Disposition Schedule.

Section A—ORM Process Description

1. Definition, Purpose, and Scope. Operational risk management is a decision-making process to systematically evaluate possible courses of action, identify risks and benefits, and determine the best course of action for any given situation. ORM enables commanders, functional managers, supervisors, and individuals to maximize operational capabilities while limiting all dimensions of risk by applying a simple, systematic process appropriate for all personnel and functions both on- and off-duty. Appropriate use of ORM increases both an organization's and individual's ability to accomplish their mission, whether it is flying an airplane in combat, loading a truck with supplies, planning a joint service exercise, establishing a computer network, or driving home at the end of the day. Application of the ORM process ensures more consistent results, while ORM techniques and tools add rigor to the traditional approach to mission accomplishment, thereby directly strengthening the Air Force's warfighting posture.

2. Goals:

- 2.1. Enhance mission effectiveness at all levels, while preserving assets and safeguarding health and welfare.

Technical Manuals

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TECHNICAL MANUAL

AEROSPACE EQUIPMENT MAINTENANCE INSPECTION, DOCUMENTATION, POLICIES, AND PROCEDURES

(ATOS)

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Published under authority of the Secretary of the Air Force

1 SEPTEMBER 2010

Air Force Instructions

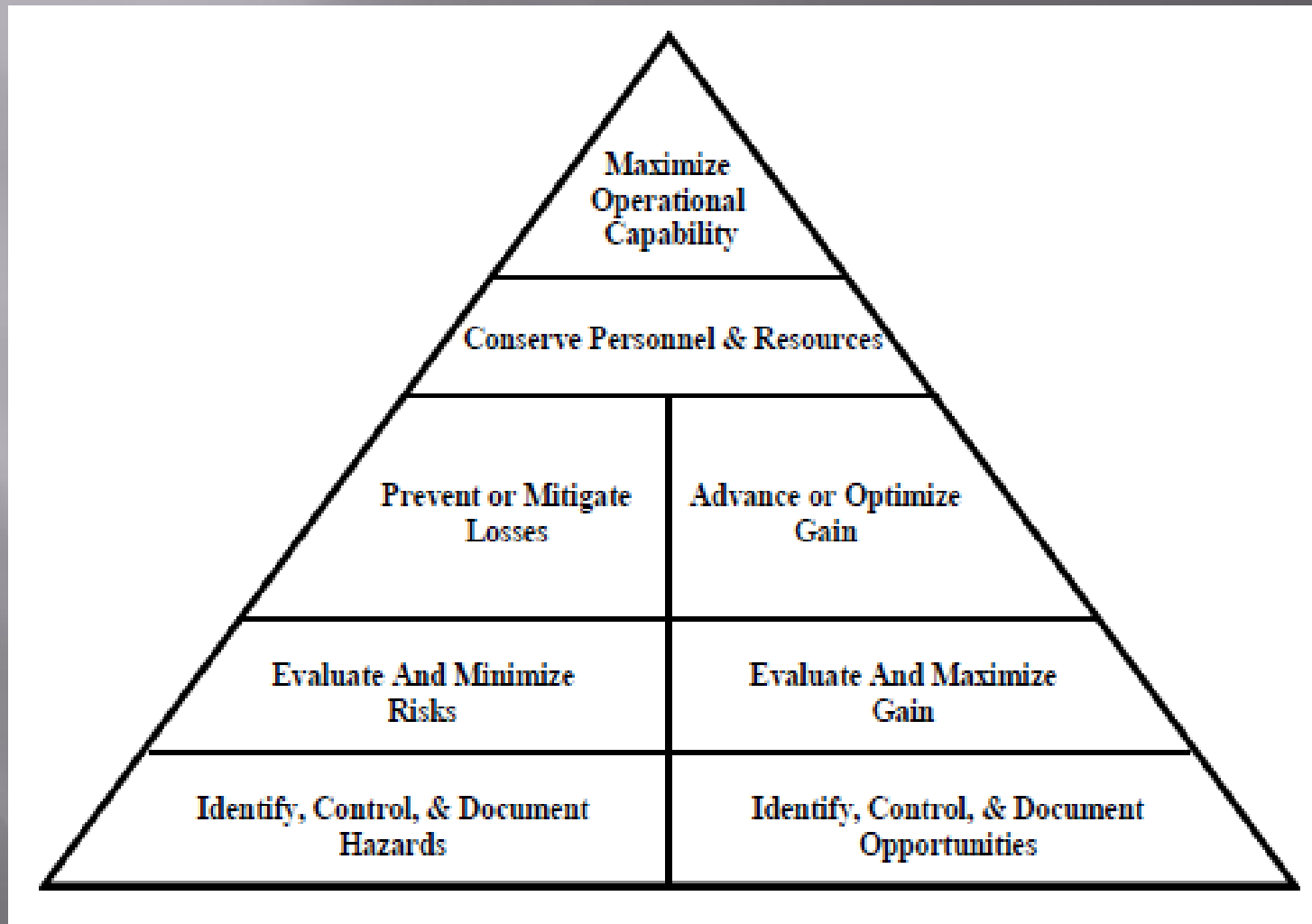
Training



Discipline



The Risk Management Goals



The 5M's of ORM

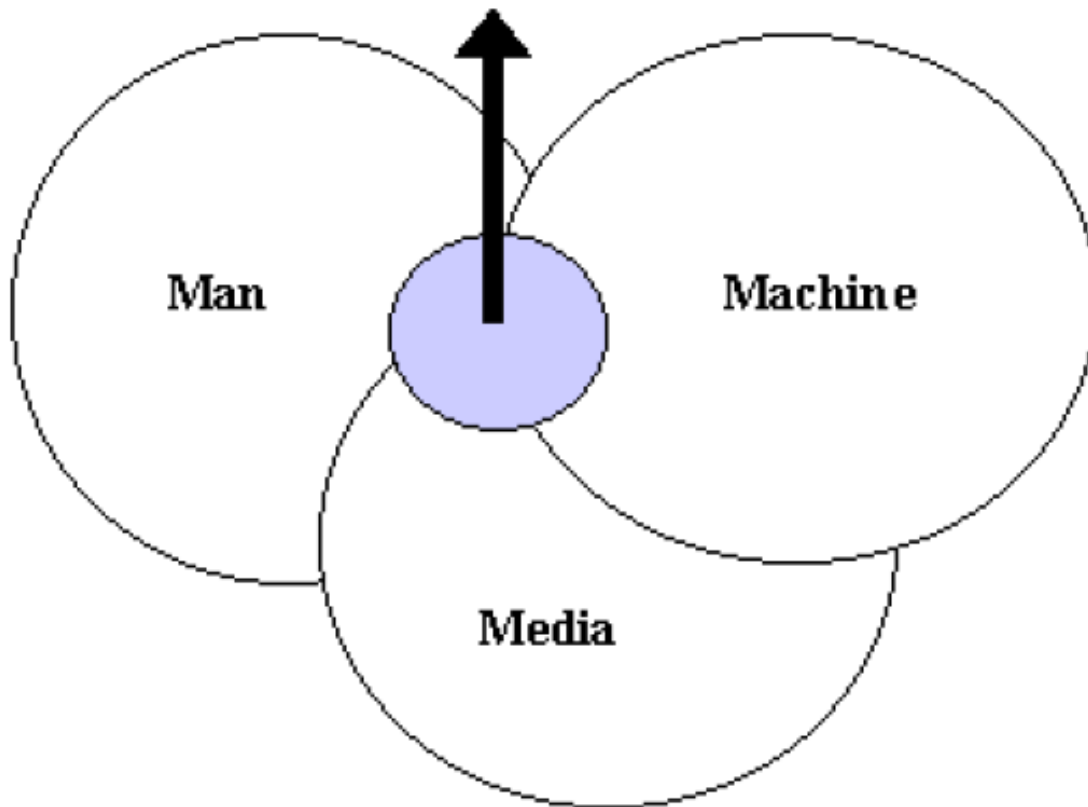
Management

Mission

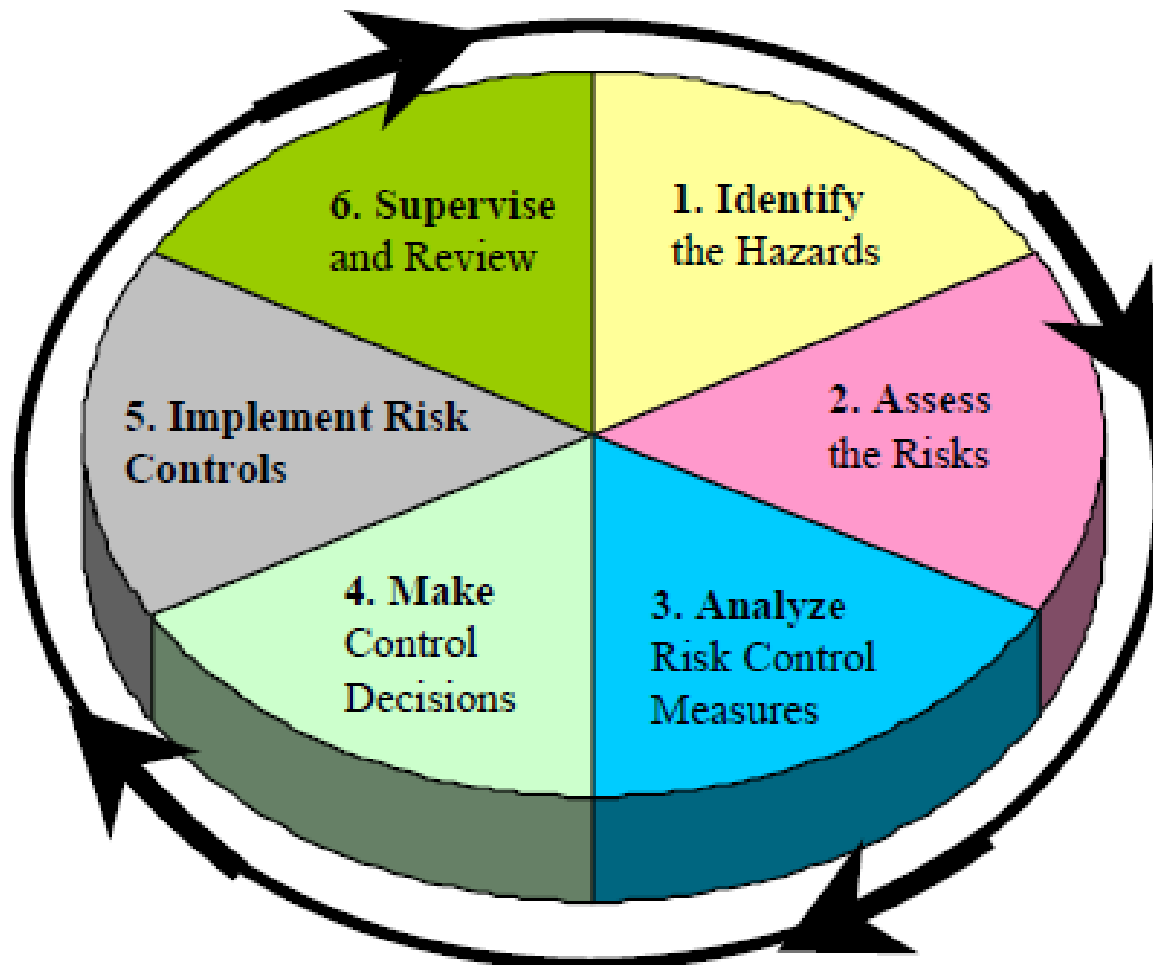
Man

Machine

Media



The Six Steps of ORM



Step One - Identify

ACTIONS FOR STEP 1—IDENTIFY THE HAZARDS

ACTION1:
MISSION/TASK ANALYSIS

ACTION2
LIST HAZARDS

ACTION3
LIST CAUSES



Step Two - Assess

ACTIONS FOR STEP 2—ASSESS THE RISK

**ACTION 1:
ASSESS HAZARD
EXPOSURE**

**ACTION 2:
ASSESS HAZARD
SEVERITY**

**ACTION 3:
ASSESS
PROBABILITY**

**ACTION 4:
COMPLETE RISK
ASSESSMENT**

Risk = Probability * Consequence

			Probability				
			Frequency	Likely	Catastrophic	Slides	Unlikely
			A	B	C	D	E
SEVERITY	Catastrophic	I	Extremely				
	Critical	II	High	High			
	Moderate	III		Medium			
	Negligible	IV					Low
			Risk Levels				

Step Three - Analyze

ACTIONS FOR STEP 3—ANALYZE CONTROL MEASURES

ACTION 1:
IDENTIFY CONTROL OPTIONS



ACTION 2:
DETERMINE CONTROL EFFECTS



ACTION 3:
PRIORITIZE RISK CONTROL MEASURES

Step Four - Decide

ACTIONS FOR STEP 4—MAKE CONTROL DECISION

ACTION 1:
SELECT RISK CONTROLS



ACTION 2:
MAKE RISK DECISION

Step Five - Implement

ACTIONS FOR STEP 5—IMPLEMENT RISK CONTROLS

ACTION 1:
MAKE IMPLEMENTATION CLEAR

ACTION 2:
ESTABLISH ACCOUNTABILITY

ACTION 3:
PROVIDE SUPPORT

User Involvement

User Ownership: Operators are empowered to develop the risk control
Co-Ownership: Operators share leadership of the risk control development team
Team Member: Operators are active members of the team that developed the risk control
Input: Operators are allowed to comment and have input **before** the risk control is developed
Coordination: Operators are allowed to coordinate on an already developed idea
Comment and Feedback: Operators are given the opportunity to express ideas
Robot: Operators are ordered to apply the risk control

STRONGER



WEAKER

Command Involvement

Sustained consistent behavior
On-going personal participation
Accountability actions and follow up
Follow up inquiries by phone & during visits
Verbal support in staff meetings
Sign directives

STRONGER



WEAKER

Step Six – Supervise/Review

ACTIONS FOR STEP 6—SUPERVISE AND REVIEW

**ACTION 1:
SUPERVISE**



**ACTION 2:
REVIEW**



**ACTION 3:
FEEDBACK**



In Practice



In Practice



In Practice



Conducting Flight Test

Environment

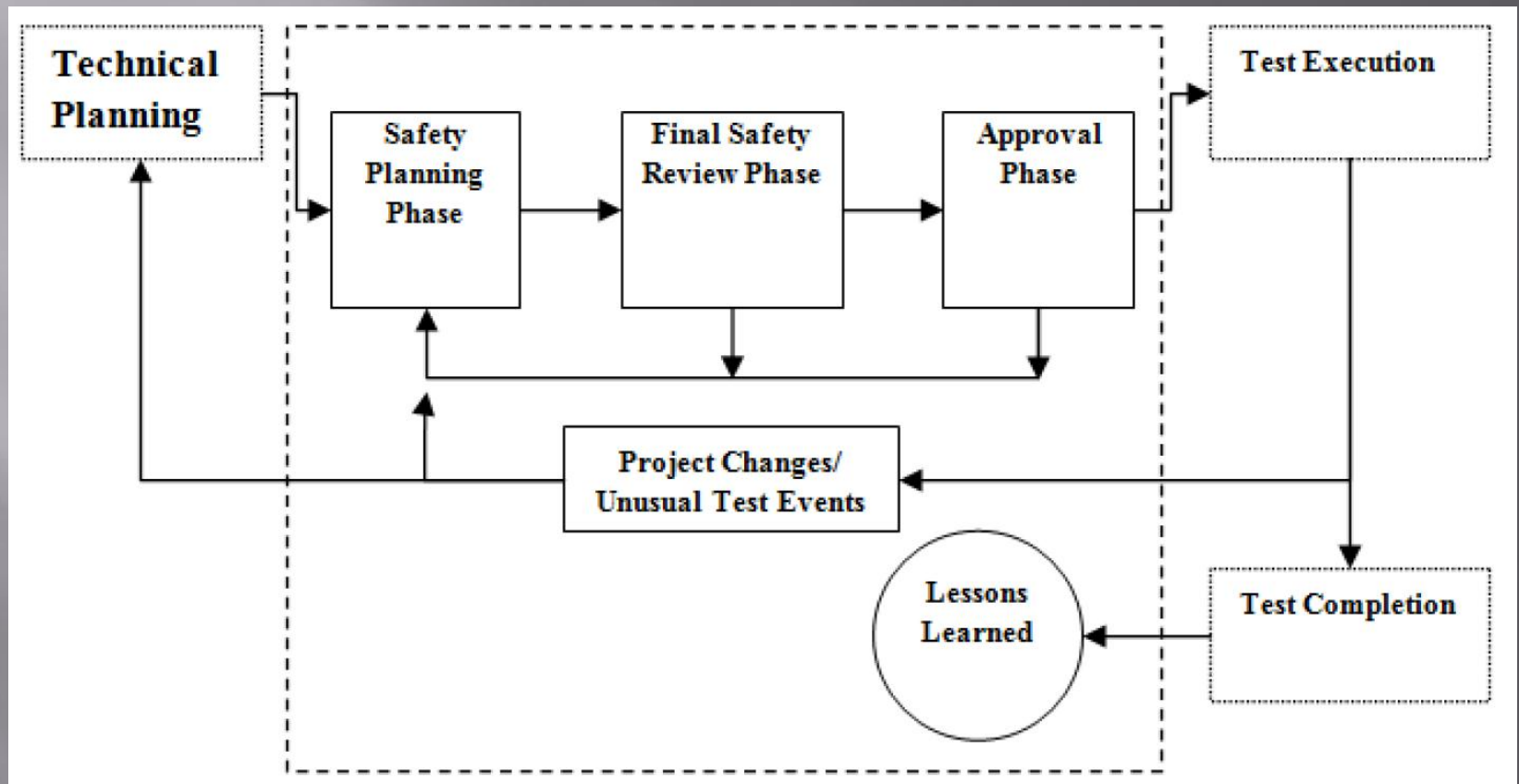
- New/untested equipment and software
- Different mission

Response

- Different training
- Management processes



Conducting Flight Test



Conducting Flight Test

		Mishap Severity Category			
		Catestrophic – I Death, System/Facility Loss, Severe Environmental Damage (e.g. Class A Mishap)	Critical – II Severe Injury, Occupational Illness, or Major System/Facility/ Environmental Damage (e.g. Class B Mishap)	Marginal – III Minor Injury, Occupational Illness, or Minor System/Facility/ Environmental Damage (e.g. Class C Mishap)	Negligible – IV Less than Minor Injury, Occupational Illness, or System/ Facility/Environmental Damage (e.g. Class E Mishap)
Probability of Mishap Occurring During the Test	Very Likely (A) Highly expected to occur – Many significant concerns even after mitigation applied	1	3	7	13
	Likely (B) Expected to occur – Significant concerns remain after mitigation applied	2	5	9	16
	Less Likely (C) Not expected but possible – Some concern exists even with mitigation applied	4	6	11	18
	Unlikely (D) Unexpected – Minor concerns after mitigation applied	8	10	14	19
	Very Unlikely (E) Highly unexpected – Little or no concern after mitigation applied	12	15	17	20

Conducting Flight Test

MISHAP SEVERITY	CATEGORY	CONSEQUENCE OF MISHAP
Catastrophic	I	Death, system loss, or severe environmental damage. System loss or equipment damage exceeding \$2,000,000 (e.g. Aircraft Class A Mishap).
Critical	II	Severe injury, severe occupational illness, or major system/facility/ environmental damage. For personnel, severe injury or illness equates to lengthy hospital stays and/or permanent injury. Major system/facility/ environmental damage equates to equipment or property damage loss exceeding \$500,000 but less than \$2,000,000 (e.g. Aircraft Class B Mishap).
Marginal	III	Minor injury, occupational illness, or minor system/ facility/ environmental damage. For personnel, minor injury or illness requires medical treatment resulting in lost work days but no permanent injury. Minor damage equates to losses exceeding \$50,000 but less than \$500,000 (e.g. Aircraft Class C Mishap).
Negligible	IV	Less than minor injury or system damage. For personnel, the impact of the injury or illness equates to no work days lost. For equipment or facilities, less than minor damage equates to losses less than \$50,000.

PROBABILITY DESCRIPTORS	LEVEL	DESCRIPTION
Very Likely	A	Highly expected to occur - Many significant concerns even after mitigation applied
Likely	B	Expected - Significant concerns remain even after mitigation applied
Less Likely	C	Not expected but possible – Some concern exists even with mitigation applied
Unlikely	D	Unexpected - Minor concerns after mitigation applied
Very Unlikely	E	Highly unexpected – Little or no concern after mitigation applied

Tests Done Right and Wrong

<http://www.youtube.com/watch?v=7ZmoVXW-12M>

<http://www.youtube.com/watch?v=NpGwst3VQiM>

http://www.youtube.com/watch?v=VZUwKX3_uE4&feature=plcp

Managing Space Launch Services

Environment

- Different media
- Different mission
- Different machine

Response

- Different approach to risk
- Different management oversight

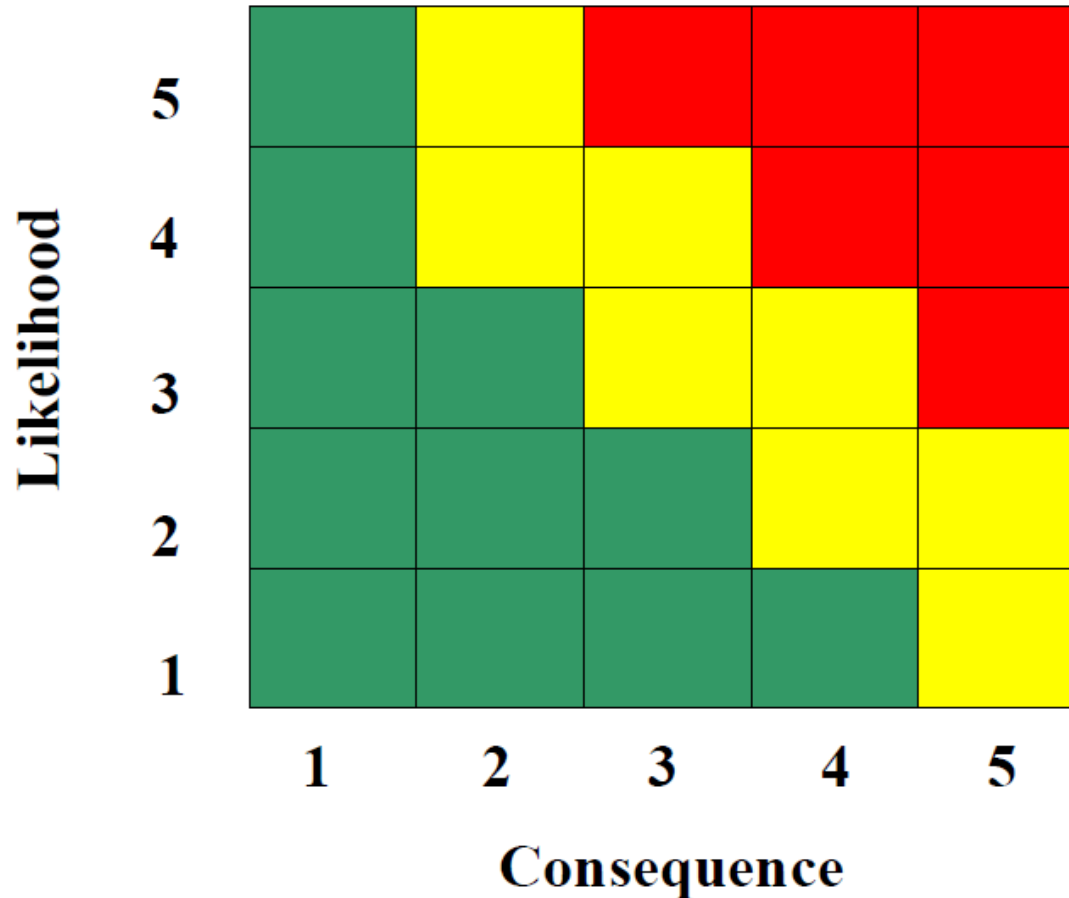


Managing Space Launch Services

Risk Management Process: Key Activities



Managing Space Launch Services



Managing Space Launch Services

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%

Managing Space Launch Services

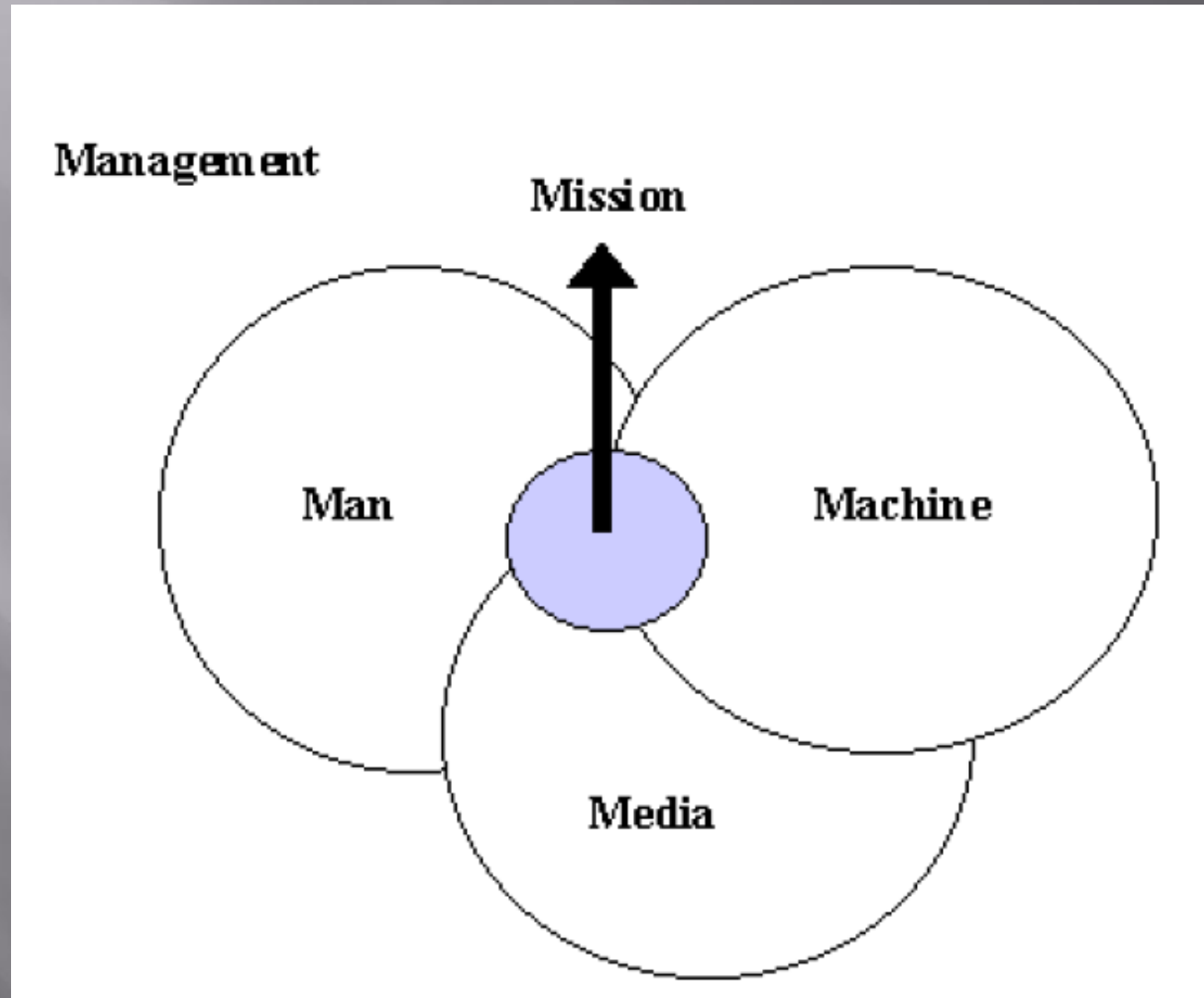
Consequence

Level	Technical Performance	Schedule	Cost
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 program	Able to meet key dates. Slip < <u> </u> month(s)	Budget increase or unit production cost increases. < <u> </u> (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 < <u> </u> month(s) Sub-system slip > <u> </u> month(s) plus available float.	Budget increase or unit production cost increase < <u> </u> (5% of Budget)
4	Significant degradation in technical performance or major shortfall in supportability; may jeopardize program success	Program critical path affected. Slip < <u> </u> months	Budget increase or unit production cost increase < <u> </u> (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 > <u> </u> months	Exceeds APB threshold > <u> </u> (10% of Budget)

Common Threads

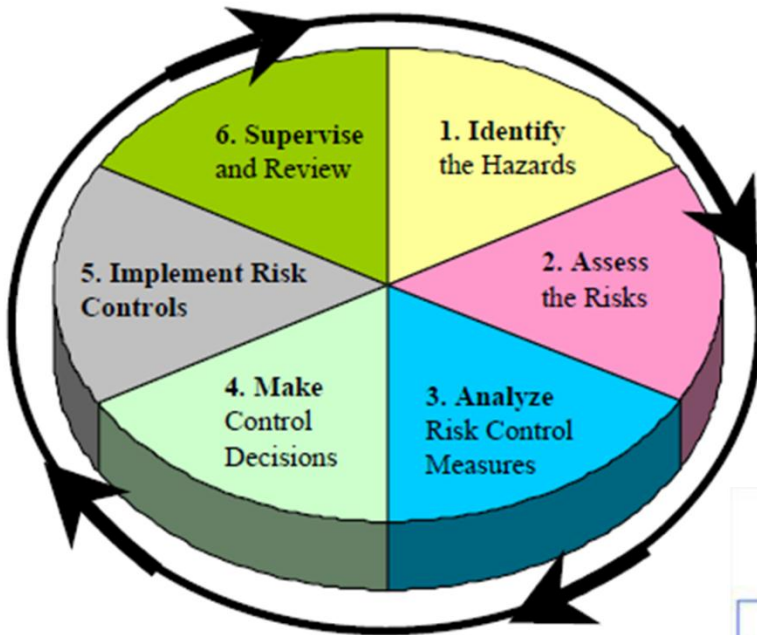


5M's Influence Approach



Iterative Methodology

More detail



More Flexibility

Risk Management Process: Key Activities



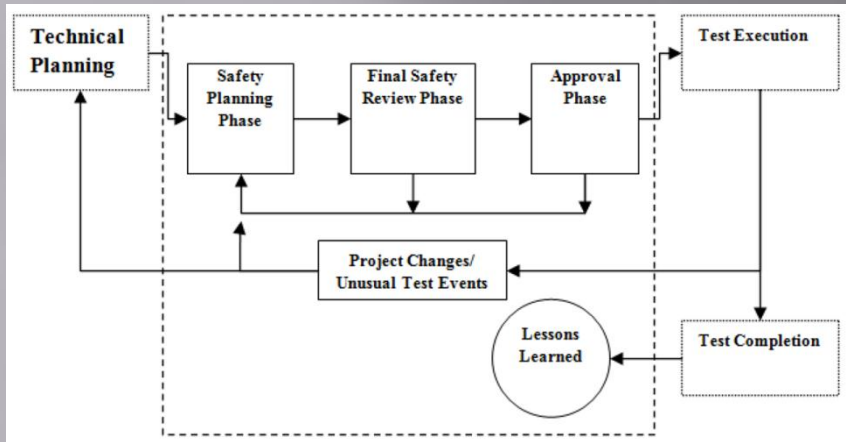
Use of Matrices

			Probability					
			Frequent	Likely	Occasional	Slidow	Unlikely	
			A	B	C	D	E	
S E V E R I T Y	Catastrophic	I	Extremely					
	Critical	II	High	High				
	Moderate	III		Medium				
	Negligible	IV						Low
			Risk Levels					

Likelihood	5					
	4					
	3					
	2					
	1					
		1	2	3	4	5
		Consequence				

		Mishap Severity Category			
		Catastrophic – I Death, System/Facility Loss, Severe Environmental Damage (e.g. Class A Mishap)	Critical – II Severe Injury, Occupational Illness, or Major System/Facility/ Environmental Damage (e.g. Class B Mishap)	Marginal – III Minor Injury, Occupational Illness, or Minor System/Facility/ Environmental Damage (e.g. Class C Mishap)	Negligible – IV Less than Minor Injury, or System/ Facility/Environmental Damage (e.g. Class E Mishap)
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		HIG MEDIUM LO NEGLIGIB			

Management Participation



Formal & process oriented

Formal & people oriented



References

- FAA SYSTEM SAFETY HANDBOOK, CHAPTER 15: OPERATIONAL RISK MANAGEMENT
- AIR FORCE INSTRUCTION 21-101, AIRCRAFT AND EQUIPMENT MAINTENANCE MANAGEMENT
- AIR FORCE INSTRUCTION 90-901, OPERATIONAL RISK MANAGEMENT
- AIR FORCE PAMPHLET 90-902, OPERATIONAL RISK MANAGEMENT (ORM) GUIDELINES AND TOOLS
- AIR FORCE FLIGHT TEST CENTER INSTRUCTION 91-105, AFFTC TEST SAFETY REVIEW PROCESS
- DEFENSE ACQUISITION GUIDEBOOK
- RISK MANAGEMENT GUIDE FOR DEPARTMENT OF DEFENSE ACQUISITION