A RISK MANAGEMENT CONCEPT COMBINING THE DISCIPLINES OF SYSTEM SAFETY, RANGE SAFETY, AND EXPLOSIVES SAFETY

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Abstract

This paper defines the risk management approaches used in the three recognized safety engineering disciplines, articulates each, and compares their strengths and weaknesses. It examines improvements developed in the last decade and the synergism between the three disciplines. Finally, it addresses a risk management approach that embraces all three disciplines.

Introduction

There exists a substantial variety of risk management concepts and approaches which have been published and are in use today. They each have merit and a history of successful use. While there are similarities, there are also notable differences. This paper first examines the similarities and differences, and then distills the common elements into a generic approach for use in making risk acceptance decisions.

The generic approach is used as standard to evaluate the approaches used by the similar disciplines of range safety, system safety, and explosives safety. Each of these disciplines is called upon to have a systematic process and to reach risk acceptance decisions. In the context of this paper, system safety makes decisions to accept system risk, range safety makes decisions to accept the go/no go risk of launches, and explosives safety accepts the risks associated with establishing a location (site) for explosives.

Existing Risk Management Concepts

In Figure 1, five published risk management approaches are compared. The color coding is an attempt to highlight similarities.

They include the Army and Air Force Operational Risk Management (ORM) Processes (Ref. 1 and 3), the NASA Continuous Risk Management Process (Ref. 2), the President's

Commission on Risk Management Process (Ref. 4), and the Generic Risk Management Process for System Safety (Ref. **Error! Reference source not found.**).

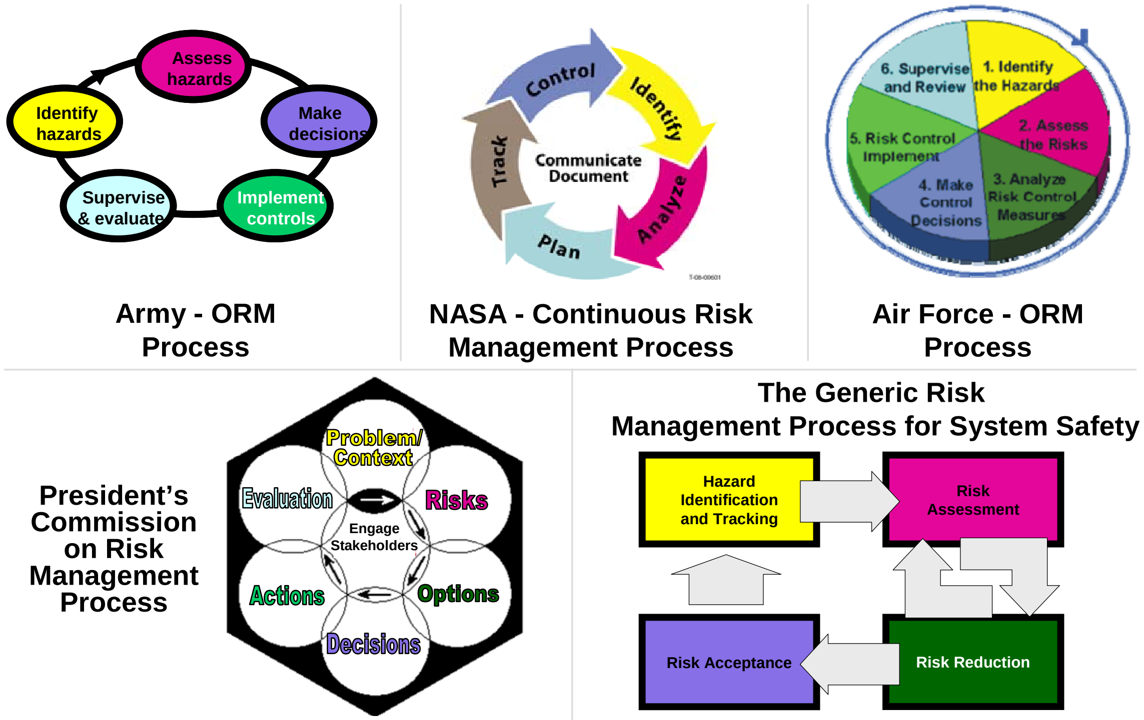

Figure 1. Risk Management Approaches

Discrete Risk Acceptance

This paper focuses on those processes which include discrete risk acceptance decisions to proceed. This focus helps distinguish the risk acceptance function from similar processes in operational situations where operational risk management is a philosophy without a formal risk acceptance decision.

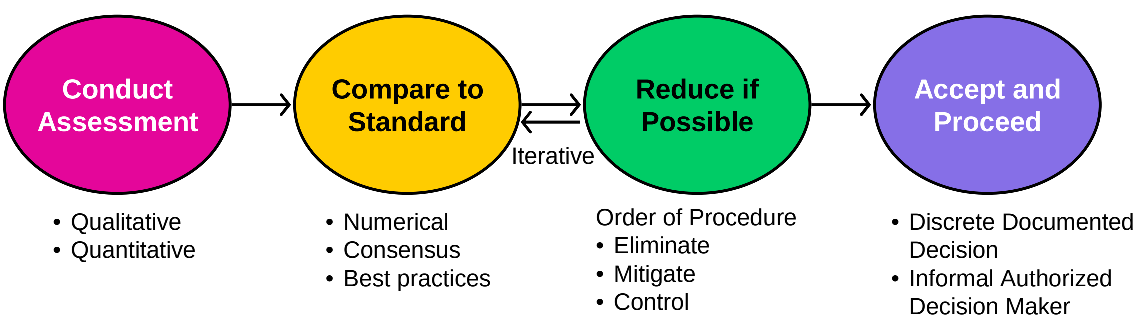

Figure 2. Minimal Risk Management Process

Figure 2 illustrates a minimal risk management process which can lead to repeatable and consistent results.

The System Safety Process

In Figure 3, a commonly used system safety process is described. This process is a direct application of the generic Identify, Assess, Reduce, Accept (IARA) process. This process has been described and adopted in several of the recent publications and endorsed by the G-48 (Ref. **Error! Reference source not found.**).

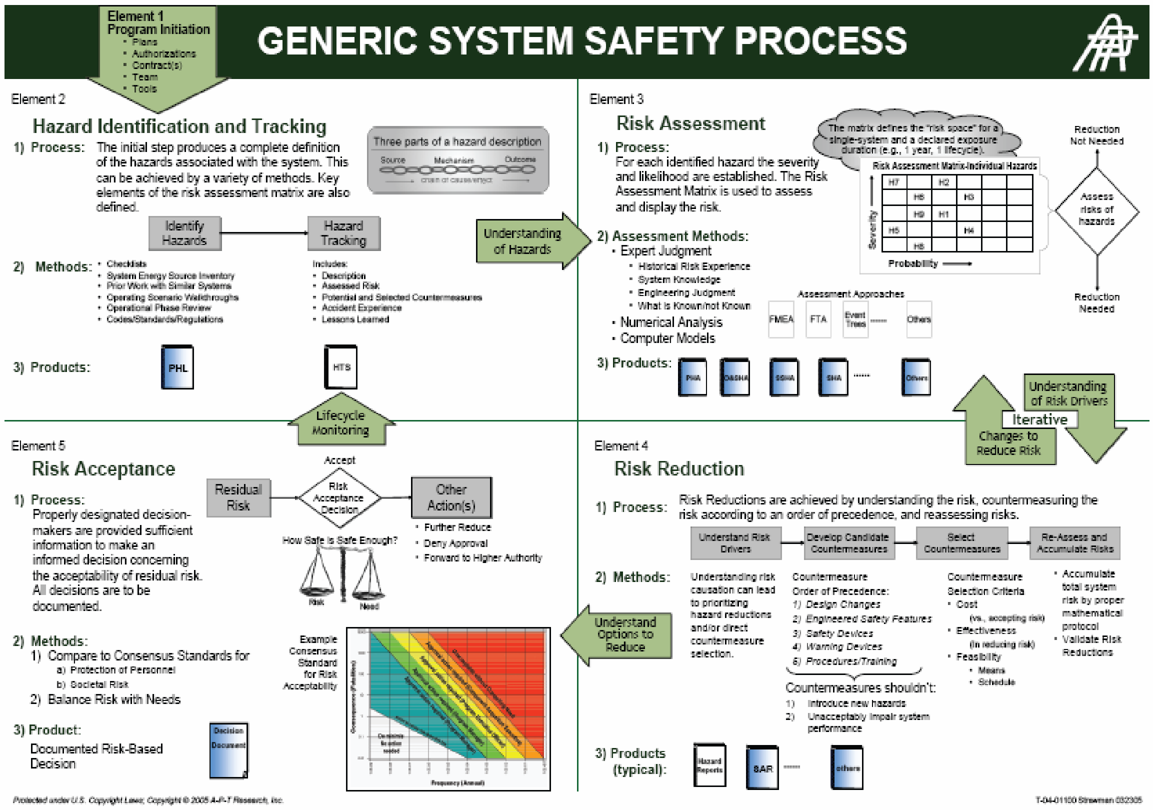

Figure 3. Generic System Safety Process

This process has multiple features. In **Error! Reference source not found.**, some of the main features are compared to the four essential elements. This comparison shows that all four elements are addressed, some more thoroughly than others. The weakest of the four is a recognized or widely used method of comparing to a known standard. A part of the problem is that risk analyses in system safety are often communicated on very subjective RAC matrices and are not typically compared to a standard. This is an area where the discipline can be improved.

Feature	Conduct Assessment	Compare to Standard	Reduce if Possible	Accept and Proceed
Identify hazard	Orderly process			
Multiple assessment methods	Comprehensive			
Risk Summing	New practice			
RAC Tailoring		▪ Value judgment ▪ Widely variable		
Order of Precedence			▪ Iterative ▪ Value added	
Formal acceptance				Well documented
Overall				

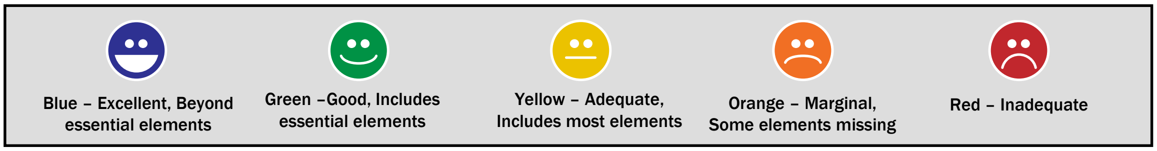

Figure 4. Generic System Safety Process Comparison

Range Safety

The most current range safety processes are defined in RCC 321-07 (Ref. 5). These processes, while not mandatory, are more or less followed at U.S. National Ranges.

The practice described in RCC 321 tailors the IARA concept into a specific sequence of activities as shown in Figure 5.

In comparing the RCC process to the minimum essential elements, we find that each theoretical element meets full compliance. Figure 6 highlights the features of the RCC process and correlates the major functions to each element. It should be no surprise that range safety, which uses a very formal process to make go/no go risk acceptance decisions before launch would also embed each of the essential risk management elements into that process.

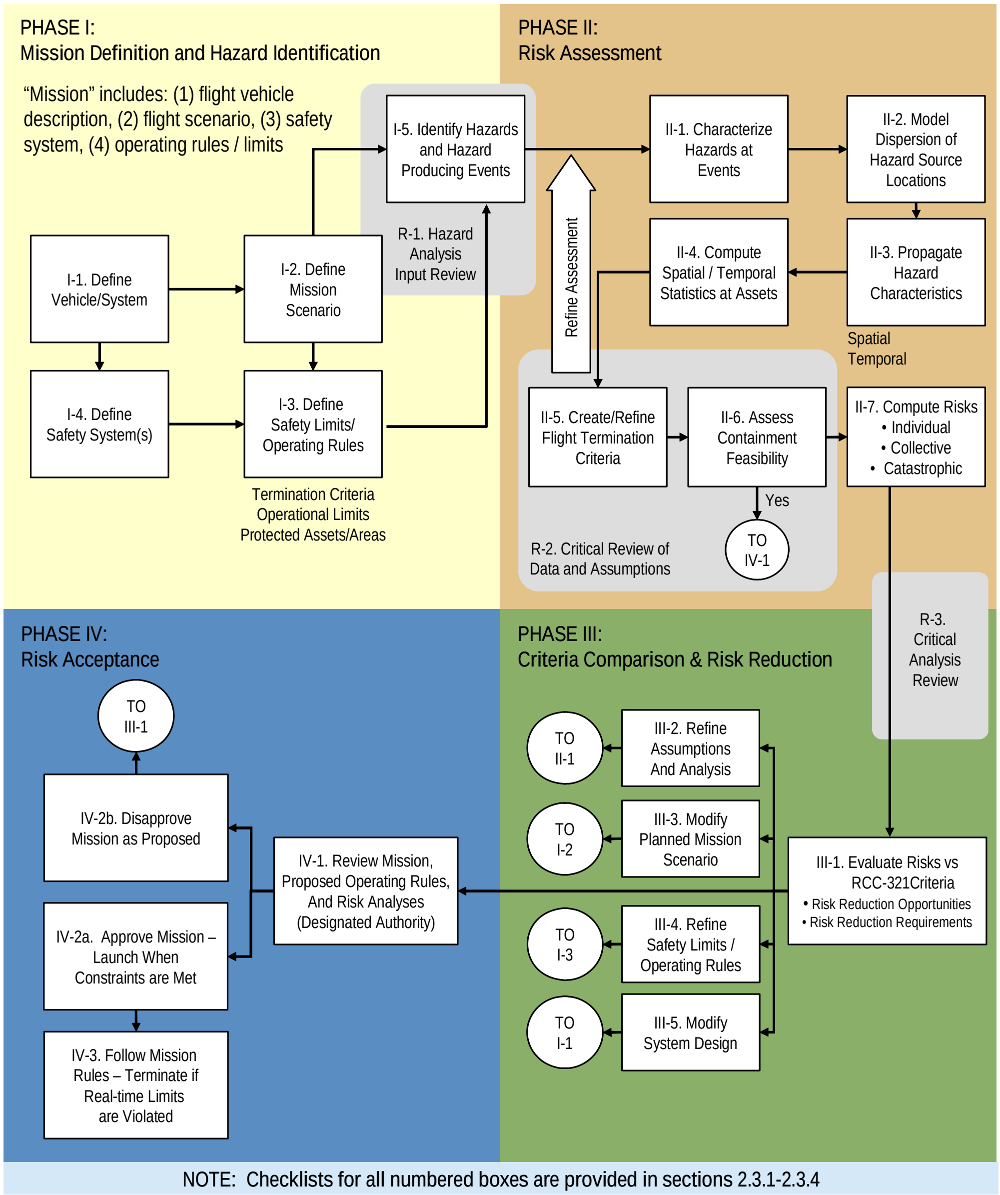

Figure 5. Range Safety Process

Feature	Conduct Assessment	Compare to Standard	Reduce if Possible	Accept and Proceed
Phase I: Mission Definition	Early in mission cycle			
Phase II: Risk Assessment	Comprehensive			
Phase III: Criteria Comparison and Risk Reduction		Quantitative standard	Iterative	
Phase IV: Risk Acceptance				Formal process
Overall				

Figure 6. Range Safety Assessment

Explosives Safety

Two concepts are used to manage risks for explosives. For the most of the last century, quantity-distance has been used. This concept applies the basic principles that larger quantities of explosives require greater separation distances and applies a cookie-cutter concept to determine acceptability. Lookup tables define acceptability. The military uses DoD 6055.9-STD and civilians use the American Table of Distances (Ref. 7 and 8).

In the last decade, the risk-based approach has grown in popularity. Formal analysis processes have been documented in DDESB Technical Paper #14 (Ref. 9) and are now in use by a growing number of military and civilian organizations.

A comparison of these two processes to the minimum elements is shown in Figure 7.

Feature	Conduct Assessment	Compare to Standard	Reduce if Possible	Accept and Proceed
QD Evaluation	Cookie-cutter	Unambiguous		Leads to waivers
QD Tables		Voluminous		
Review Process			Often too late	Multiple levels
Risk-Based Method	Comprehensive	Quantitative criteria	Under-utilized	
Overall				

Figure 7. Comparison of Processes

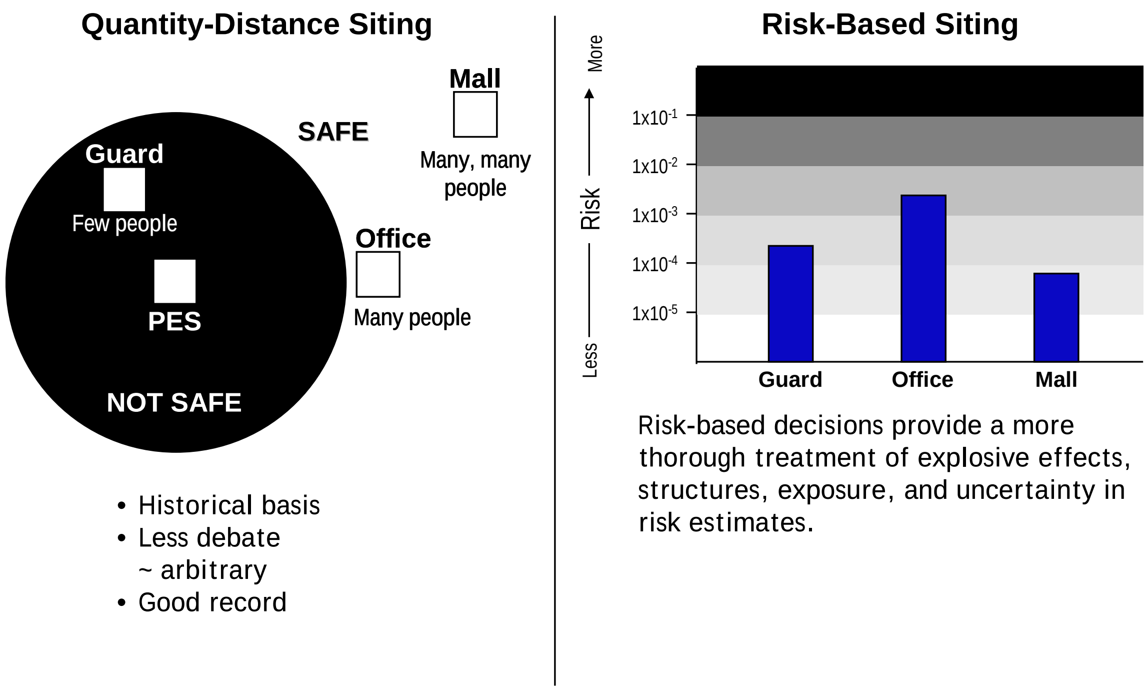

Figure 8. Explosives Safety

While all elements are embedded into the existing process, one stands out with potential to improve. The explosives safety siting approval process operates mostly as a post-design process without real opportunity to implement risk reductions which are a major feature of the system safety process.

In summary, each of the disciplines of system safety, range safety, and explosives safety have excellent features, and can benefit from the others.

The QD process has a long standing and excellent safety record. However, it was adopted into common use well before the current era of risk management. Therefore, several of the key elements of the risk management process are not fully embraced.

The risk-based process shows excellent strength in all elements of risk management, with some potential to improve further in the area with greater emphasis on risk reduction.

References

1. https://crc.army.mil/RiskManagement/default.asp?iChannel=25&nChannel=RiskManagement
2. Dr. Linda H. Rosenberg, et. Al, "Continuous Risk Management at NASA," presented at the Applied Software Measurement / Software Management Conference, February 1999, San Jose, California.
3. Air Force Instruction 90-901, "Operational Risk Management," 1 April 2000.
4. http://www.riskworld.com/nreports/1997/risk-rpt/miscinfo/nr7mi002.htm
5. GEIA-STD-0010, "Standard Best Practices for System Safety Program Development and Execution," June 2008.
6. RCC 321-07, "Common Risk Criteria Standards for National Test Ranges," June 2007.
7. DoD 6055.09-STD, "DoD Ammunition and Explosives Safety Standard," 28 February 2008.
8. Institute of Makers of Explosives, "SLP2, The American Table of Distances," June 1991.
9. DDESB Technical Paper #14, "Approved Methods and Algorithms for DoD Risk-Based Explosives Siting, Revision 3," 2 February 2007.
10. DDESB Technical Paper #19, "User's Reference Manual, Safety Assessment for Explosives Risk, Risk Analysis Software," 2 February 2007.
11. CM-06400, "IMESAFR User's Manual," APT Research, Inc., March 2006.