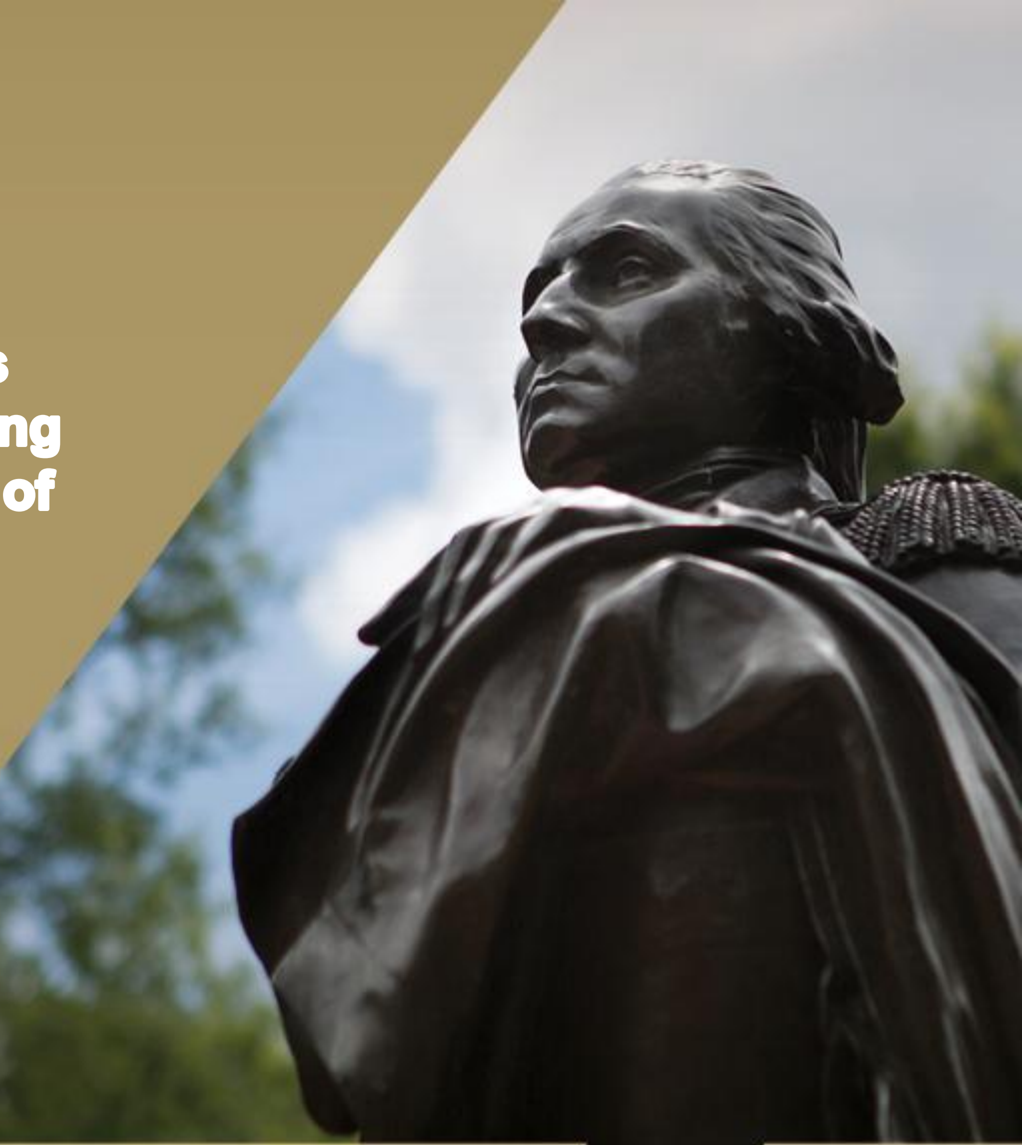
THE GEORGE WASHINGTON UNIVERSITY
WASHINGTON, DC

Cumulative Effect of Departures from Specifications (DFS) [during the Operating & Support Phase of the Life Cycle] Utilizing a Risk Management Framework



NDIA 19th Annual Systems Engineering Conference

October 26, 2016

Raymond D. O’Toole, Jr.

Dissertation Topic

[Department of Engineering Management and Systems Engineering - School of Engineering and Applied Science]

Doctoral Research Advisors:

Dr. Michael Grenn & Dr. Blake Roberts

Research Topic

- My research will answer the following question: When will the cumulative effects of Departures from Specifications result in an increase to the already defined Likelihood or Consequence or both using the Risk Management Framework?

- My hypothesis is that when the analysis of impact from multiple (i.e. cumulative effects) Departures from Specifications is completed, the Likelihood and/or Consequence to the system will be increased resulting in a higher level of overall risk being identified.

Departure from Specifications

- Deviation/Waiver
- Major Departure from Specification is one that affects:
  - performance;
  - durability;
  - reliability or maintainability;
  - interchangeability; effective use or operation;
  - weight or appearance (where a factor);
  - health or safety;
  - system design parameters such as schematics, flow, pressures, or temperatures; or
  - compartment arrangements or assigned function.
- Minor Departure from Specification. Not a major DFS.

Departure from Specifications

GENERAL SPECIFICATIONS

FOR

Machinery for Vessels

OF THE

United States Navy

COVERING WORK UNDER COGNIZANCE OF
U.S. BUREAU OF STEAM ENGINEERING

WASHINGTON
GOVERNMENT PRINTING OFFICE
1920

53. DEPARTURES FROM SPECIFICATIONS.

(*a*) In cases where, in the development of design, contractors deem it advisable to make departures from the specifications, they will make application through the inspector of machinery, stating the nature and object of the change, accompanied by a full statement of the reasons therefor and advantages to be obtained. Departures from the specifications of minor import not involving a material change in design or a change of cost will be acted upon by the bureau, and such matters will be treated as developments rather than as changes. The inspector will in all such cases make a definite recommendation for approval or disapproval.

(*b*) Where the matter involves change of cost, or is a material change or alteration, it will be treated as a change and handled as directed under paragraphs 55, 56, and 57 herein.

59. RECORD OF CHANGES.

(*a*) There will be kept in the office of the inspector of machinery for each ship under inspection a special record of all proposed changes, showing by whom originated, when received by the inspector, when forwarded to the contractors, when forwarded to the bureau with estimate, when action of bureau or department is received, including a record of amount of increased or decreased cost and weight in each case.

65. ESTIMATED CHANGE IN WEIGHT AND CENTER OF GRAVITY, FORM 135.

(*a*) In all cases of changes in machinery and electric plant involving change in weight and center of gravity, the estimated change in weight and center of gravity must be reported to the bureau on Form 135 in triplicate. This report will not be forwarded until after the change in question has been approved by the bureau and referred to the Board on Changes.

Systems Engineering Life Cycle

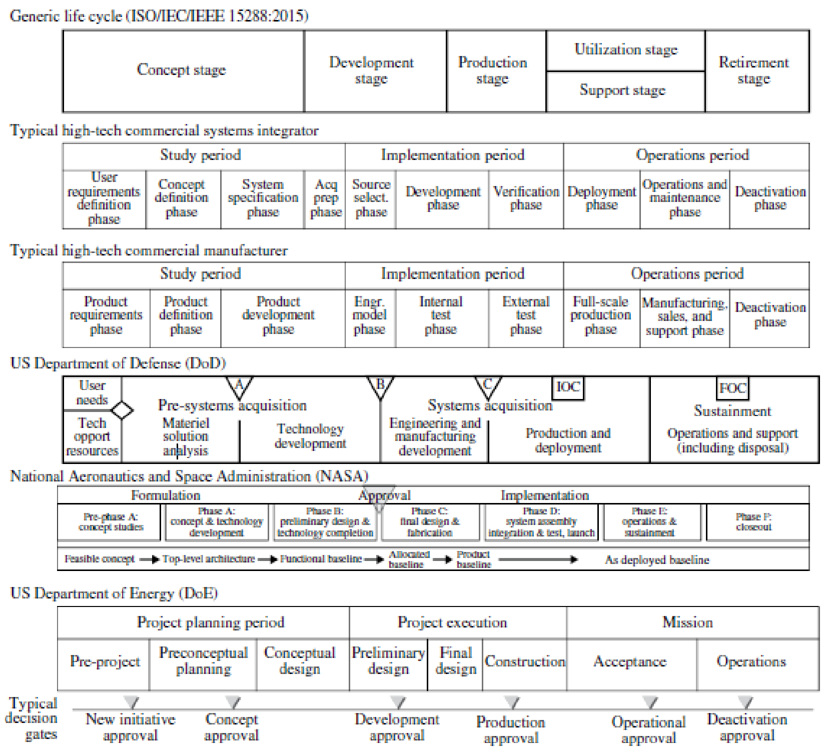
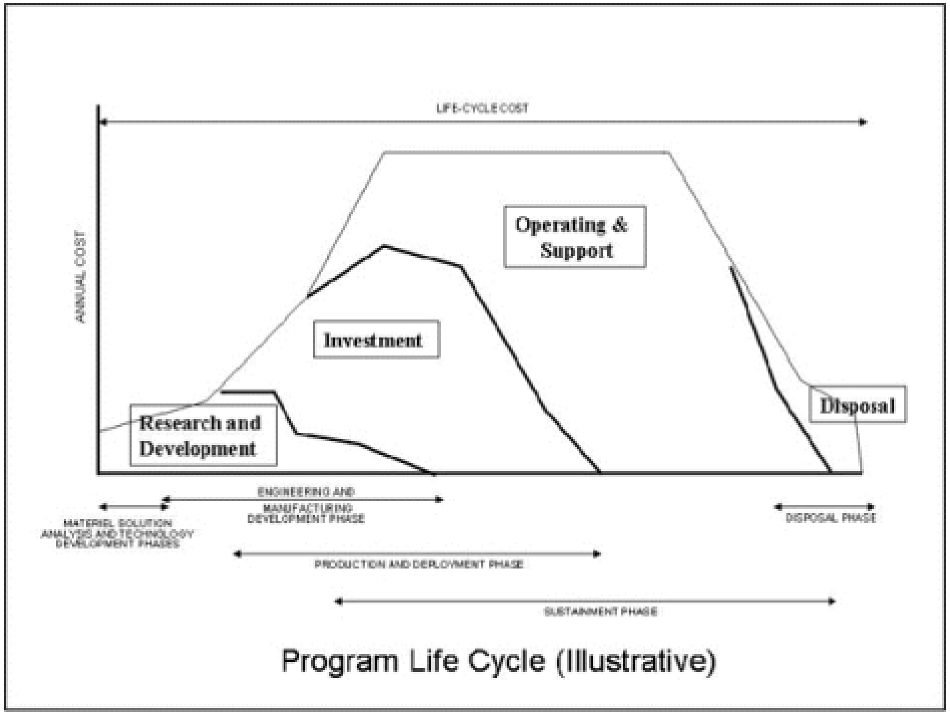


FIGURE 3.3 Comparisons of life cycle models. Derived from Forsberg et al. (2005), Figure 7.2. Reprinted with permission from Kevin Forsberg. All other rights reserved.

From the INCOSE Systems Engineering Handbook Version 3.2.2 and 4



From the Defense Acquisition Guide Book Figure 3.1.2.F1. Illustrative Program Life Cycle

Systems engineering is concerned with the overall process of defining, developing, operating, maintaining, and ultimately replacing quality systems.

http://www.incose.org/educationcareers/careersinsystemseng.aspx

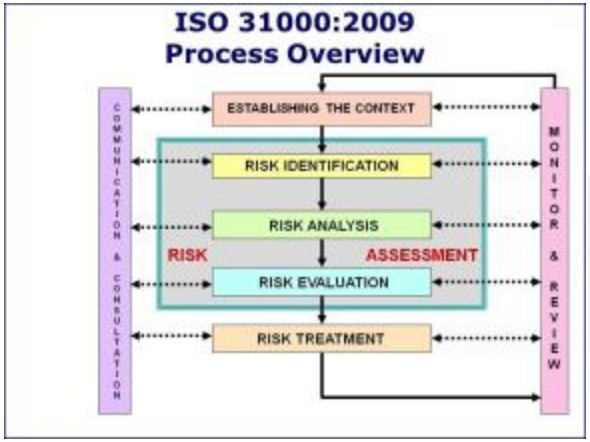
THE GEORGE WASHINGTON UNIVERSITY

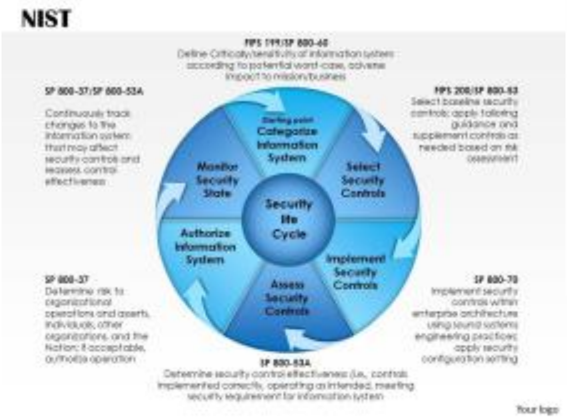
WASHINGTON, DC

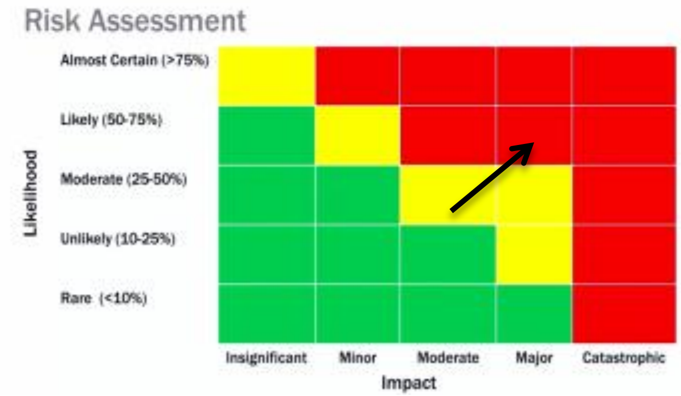
Risk

- Simple Definition (Merriam-Webster's Dictionary):
  - The possibility that something bad or unpleasant (such as an injury or a loss) will happen
  - Someone or something that may cause something bad or unpleasant to happen
  - A person or thing that someone judges to be a good or bad choice for insurance, a loan, etc.
- Risk Analysis:
  - Support decision analysis
  - Enables us to take quantities (certain & uncertain) into account and determine to what extent specific events or scenarios can be expected to occur in the future
  - Provides a basis for comparing alternative concepts, actions or system configurations under uncertainty
- International Organization for Standardization (ISO) 3100:2009 offers no guidance on aggregation, although it says you could consider more than one risk at a time.

Risk Management Frameworks

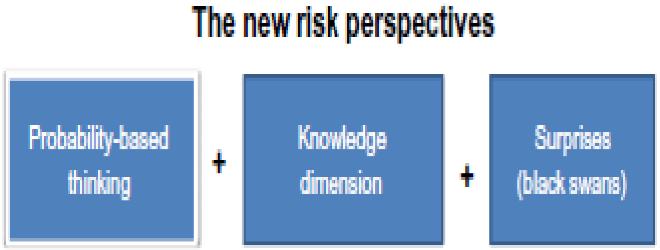






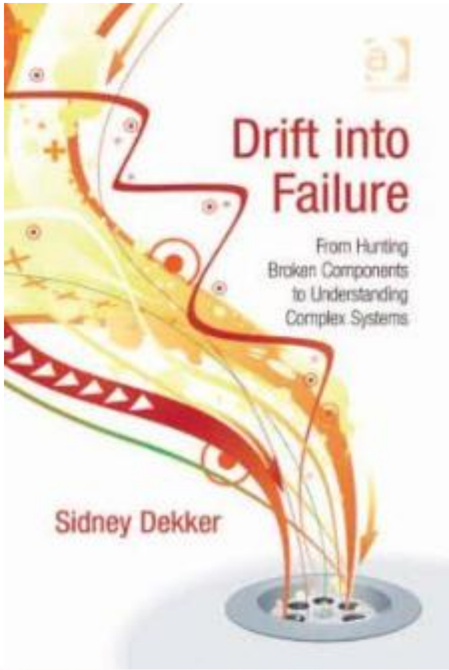
Acceptable Levels of Risks

- Personally
- Socially
- Nationally
- Locally
- Economically



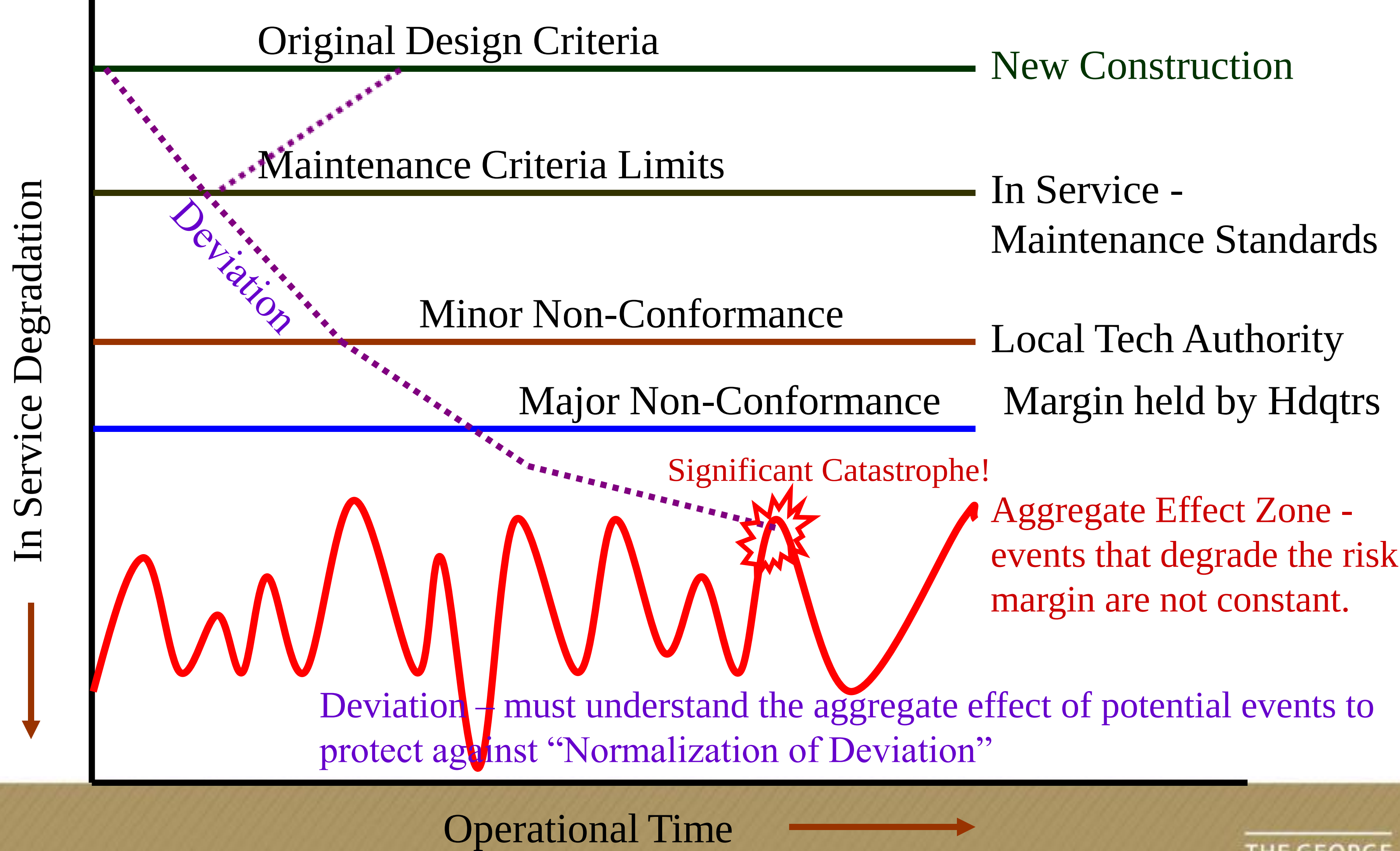
Why is my research important?

Thresher on April 30, 1961 Photograph courtesy U.S. Navy



THE GEORGE WASHINGTON UNIVERSITY
WASHINGTON, DC

Effect of Deviation on Margin of Risk



Literature Background

- **Reviewed over 5600 journal article abstracts/titles on the following terms:**
  - **“Departures from Specifications”**
  - **“Engineering Departures from Specifications”**
  - **“Risk and Standards”**
  - **“Specifications and Standards”, with and without ‘risk’**
  - **“Specifications and Departures”**
  - **“Operations and Maintenance” (GAO only)**
- **Preliminary Results**
  - **Risk is still an inexact science**
  - **Risk based decisions are as much based on experience as the data available**
  - **Risk-informed decision making has been used in various industries**
  - **Economics play an important part as one must weigh the reduction of risk in terms of monetary needs to achieve the reduced risk**

.

Research Approach

- **Various analysis approaches:**
  - **System – deep dive**
  - **Ship – Ship – Model**
  - **Ship Class – Ship Class**
- **Test for Normality of data – various methods are under consideration – ANOVA, Non-parametrics**
- **Hypothesis: Ha: Risk > CumDFSs; Ho: Risk = CumDFSs**
- **Performance Factors under consideration (e.g. safety/number of injuries or breakdowns, time out of service, etc.)**

Potential Data Collection

- Expert Judgment
  - Qualitative - vs. - Quantitative
  - Elicit methodologies – panel discussions, interviews, group settings, etc.
- Data Base
  - eDFS
  - Other data sources
  - Experts from U.S. Navy and non - U.S. Navy – looking for volunteers

References

[1] Aven T. On the new ISO guide on risk management terminology. Reliab Eng Syst Saf 2011;96:719–26. doi:10.1016/j.ress.2010.12.020.

[2] Aven T. Selective critique of risk assessments with recommendations for improving methodology and practise. Reliab Eng Syst Saf 2011;96:509–14. doi:10.1016/j.ress.2010.12.021.

[3] Aven T. The risk concept-historical and recent development trends. Reliab Eng Syst Saf 2012;99:33–44. doi:10.1016/j.ress.2011.11.006.

[4] Aven T. Practical implications of the new risk perspectives. Reliab Eng Syst Saf 2013;115:136–45. doi:10.1016/j.ress.2013.02.020.

[5] Cooke RM, Goossens LLHJ. TU Delft expert judgment data base. Reliab Eng Syst Saf 2008;93:657–74. doi:10.1016/j.ress.2007.03.005.

[6] General specifications for machinery for vessels of the United States Navy covering work under cognizance of Bureau of Steam Engineering. Govt Print Off, 1920.

https://books.google.com/books?id=goJQAAAAYAAJ&pg=PA326&lpg=PA326&dq=departures+from+specifications&source=bl&ots=GUBsxsxbBH&sig=QXe9Qxtz0G4e9MgJrLN52GPPwGE&hl=en&sa=X&sqi=2&ved=0ahUKEwiPxb2f1r7PAhVSET4KHYEfAMUQ6AEIVDAJ#v=onepage&q=departures from specifications&f=false (accessed October 1, 2016).

[7] Goossens LHJ, Cooke RM. Expert judgement – Calibration and combination. n.d.

[8] JFMM Vol 5 (COMUSFLTFORCOMINST 4790.3 REV C CH-3) para 8.2.4 n.d.

[9] Keeney RL, Von Winterfeldt D. On the Uses of Expert Judgment on Complex Technical Problems. IEEE Trans Eng Manag 1989;36:83–6. doi:10.1109/17.18821.

[10] Knight KW. Developing a Risk Management Standard - the Australian experience. Saf Sci 2002;40:69–74. doi:10.1016/j.jallcom.2006.05.115.

[11] Leitch M. ISO 31000:2009 - The new international standard on risk management: Perspective. Risk Anal 2010;30:887–92. doi:10.1111/j.1539-6924.2010.01397.x.

[12] Merrick JRW, Van Dorp JR, Harrald J, Mazzuchi T, SPAHN, John E GRABOWSKI M. A systems approach to managing oil transportation risk in Prince William Sound. Syst Eng 2000;3:128–42. doi:10.1002/1520-6858(200033)3:3<128::AID-SYS2>3.3.CO;2-I.

[13] Moore R. Standards in the 21st Century - The Communication of Risk. Med Device Technol 2002:29.

[14] Murphy PH. Acceptable risk as a basis for regulation. Radiographics 1991;11:889–97. doi:10.1016/S0951-8320(97)00135-X.

[15] NASA. Rep Columbia Accid Investig Board, Vol I n.d. https://www.nasa.gov/columbia/home/CAIB_Vol1.html (accessed October 1, 2016).

[16] National Geographic n.d. http://www.nationalgeographic.com/k19/disasters_detail2.html (accessed October 1, 2016).

[17] Nilsen T, Aven T. Models and model uncertainty in the context of risk analysis. Reliab Eng Syst Saf 2003;79:309–17. doi:10.1016/S0951-8320(02)00239-9.

[18] Pluess D, Groso A, Meyer T. Expert Judfgement in Risk Analysis: A Strategy to Overcome Uncertainities. Chem Eng Trans 2013;31:307–12.

[19] Ryan JJCH, Mazzuchi TA, Ryan DJ, Lopez De La Cruz J, Cooke R. Quantifying information security risks using expert judgment elicitation. Comput Oper Res 2012;39:774–84. doi:10.1016/j.cor.2010.11.013.

[20] Skjong R, Wentworth B. Expert Judgement and Risk Perception. Det Nor Verit 2000:1–8.

[21] Van Bossuyt DL, Dong A, Tumer IY, Carvalho L. On measuring engineering risk attitudes. J Mech Des 2013;135:1–13. doi:10.1115/1.4025118.

[22] Vatn J. A discussion of the acceptable risk problem. Reliab Eng Syst Saf 1998;61:11–9. doi:10.1016/S0951-8320(97)00061-6.

Summary

- Results of my research may cause a reanalysis of how risk is characterized for operating systems

- Results of research may recommend a new approach for the Department of the Navy to process Departure from Specifications (DFSs) once the system enters the Operating and Support phase of the system lifecycle

Backup

Biography

Mr. Raymond D. O'Toole, Jr. is a native of Hicksville, New York, located on Long Island. He graduated in 1982 from the State University of New York - Maritime College earning a Bachelor of Engineering in Marine Engineering. He continued his formal education receiving a Master of Engineering Degree in Systems Engineering in 1989 from Virginia Polytechnic Institute and State University (VA TECH) and a Master of Science Degree in National Resource Strategy in 2009 from the Industrial College of the Armed Forces. He is currently pursuing a Ph. D. in Systems Engineering from The George Washington University.

Mr. O'Toole is an employee of the Naval Sea Systems Command as the Deputy Group Director of Aircraft Carrier Design and Systems Engineering. Prior to his current assignment he was the Director of Systems Engineering Division (Submarines and Undersea Systems) where he led a diverse team of engineers who supported all Submarine Program Managers. His other assignments include being a Ship Design Manager/Navy's Technical Authority for both the USS VIRGINIA Class submarine and 54 ships of 14 ship classes with the major ones being all of the Amphibious Ships, Auxiliary Ships, and Command & Control Ships.

Mr. O'Toole has also held other positions within the Department of Defense such as Deputy Program Executive Officer (Maritime and Rotary Wing) at the United States Special Operations Acquisition Command, Staff to the Deputy Assistant Secretary of the Navy for Research, Development & Acquisition (Ship Programs), and Deputy Director of Regional Maintenance for COMPACFLT (N43).

In addition, Mr. O'Toole has over 30 years of experience as a Naval Officer (Active and Reserve) retiring at the rank of CAPTAIN. His significant tours include 5 Commanding Officer tours.

Contact information: rayotoole1@gwmail.gwu.edu
Phone: (443) 624-1233

Departure from Specifications
- vs –
Nonconformance

- Departure from Specifications (DFS):
  - Department of the Navy definition of a DFS:
    - Deviation/Waiver
    - Major Departure from Specification is one that affects (a) performance; (b) durability; (c) reliability or maintainability; (d) interchangeability; (e) effective use or operation; (f) weight or appearance (where a factor); (g) health or safety; (h) system design parameters such as schematics, flow, pressures, or temperatures; or (i) compartment arrangements or assigned function.
    - Minor Departure from Specification. Not a major DFS.
  - Simple Definition for my Research: (1) material system(s) that is/are not restored to design standards and/or (2) software systems that have been degraded by cyber-attacks by instituting a Boundary Layer Defense (system isolation).
- Nonconformance:
  - Simple Definition from Merriam-Webster's Dictionary: Failure to conform
  - ISO 9000 2015: *Nonconformity* is a nonfulfillment or failure to meet a requirement. [A requirement is a need, expectation, or obligation. It can be stated or implied by an organization or interested parties.]