

A SYSTEMS ENGINEERING PARTIALLY ANNOTATED BIBLIOGRAPHY AND RESOURCES LIST

*Prepared by the Naval Surface Warfare Center Dahlgren Division's Systems
Engineering Focus Team -- June 1997*

Introduction and Acknowledgments

In support of NSWCCD's Systems Engineering Focus Team goals, the accompanying bibliography and resources list have been compiled. It is hoped that the information provided contributes to the promotion of sound systems engineering practices through the familiarization with the experiences of other practitioners.

This bibliography is a compilation of bibliographies found in System Engineering sites in the World Wide Web and reference lists provided by SEFT members. In particular the following contributors are acknowledged: George J. Chambers (INCOSE member), Edwin Dean (NASA), Carolyn Kotlas (Institute for Academic Technology), M. Johnna Shamp (consultant in TQM/OD), and David E. McConnell (NSWCDD).

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PARTIALLY ANNOTATED SYSTEMS ENGINEERING BIBLIOGRAPHY, RESOURCES LIST AND RELATED INFORMATION

General Information

What is Systems Engineering?

MIL-STD-499B

“Systems engineering is an interdisciplinary approach to evolve and verify an integrated and optimally balanced set of product designs that satisfy user needs and provide information for management decision making.”

MIL-STD-499A Systems Engineering

“...the application of scientific and engineering efforts to

- transform an operational need into a description of system performance parameters and a system configuration through the use of an iterative process of definition, synthesis, analysis, design, test, and evaluation;
- integrate related technical parameters and ensure compatibility of all physical, functional, and program interfaces in a manner that optimizes the total system definition and design;
- integrate reliability, maintainability, safety, survivability, human engineering, and other such factors into the total engineering effort to meet cost, schedule, supportability, and technical performance objectives.”

DSMC Systems Engineering Management Guide, January 1990, pg 1-2. “...is the management function which controls the total system development effort for the purpose of achieving an optimum balance of all system elements. It is a process which transform an operational need into a description of system parameters and integrates those parameters to optimize the overall system effectiveness.”

IBM Federal Systems Company definition used as the basis for decision, internal SE practices and education: “The iterative controlled process in which users needs are understood and evolved, through incremental development of requirements specifications and system design, to an operational system.”

Joe DeFoe and Jim McAuley; November 1991: “The processing of building real things to solve real problems within technological, environmental, economic, legal, ethical, cultural, and institutional constraints.”

Computer Aided Systems Engineering, Howard Eisner, Prentice Hall, 1988, pg 17. “...an iterative process of top-down synthesis, development, and operation of a real-world system that satisfies, in a near-optimal manner, the full range of requirements for the system.”

Field Manual: System Engineering, FM 770-78 Headquarters, Department of the Army, April 1979, pg 1-2. Summary definition in the introduction of the manual. “The transforming of an operational need into a description of system performance parameters and a system configuration.”

“Fundamental of Systems Engineering at NASA,” *INCOSE/ASEM Proceedings*, October 1991, Robert G. Chamberlain and Robert Shishko, Ph.D., pg 23. “...is a robust approach to the design and creation of systems to accomplish desired ends.”

P.M’Pherson, “Systems engineering: A proposed definition,” *IEE Proce.*, Vol. 133, pp. 330-331, Sep. 1986: “...is a hybrid methodology that combines policy analysis, design and management. It aims to ensure that a complex man-made system, selected from the range of options on offer, is the most likely to satisfy the owner’s objectives in the context of long-term future operational or market environments.”

Related General Information

The System Engineer's Job

Braid described the systems engineer's job as “understand[ing] in some detail what needs to be done, to know what it is feasible to do, and to know when to do it.”

In 1965, Hino stated that: “It is essential that the [system] engineer, like the general medical practitioner, has an adequate and comprehensive professional background and can readily understand and apply the techniques that are presented. He simply needs guidance to the solution of a particular type of problem.”

Sage amplified Hino's assumption when he observed that, "the systems engineer must, above all, be capable of facilitation and communication of knowledge between the diverse group of professionals involved in the wide scope of [system engineering]."

Military Standard 499B: An Overview

This section presents a brief overview of Appendix A of MIL-STD-499B which will assist systems engineers in evaluating the materials contained in this bibliography. According to 499B, the system engineering process is a

"... logical sequence of activities and decisions transforming an operational need into a description of system performance parameters and a preferred system configuration."

This process consists of nine phases:

- 1.mission requirements analysis,
- 2.functional analysis,
- 3.allocation,
- 4.synthesis,
- 5.logistic engineering, including
 - logistics support analysis,
 - maintenance engineering analysis,
 - repair level analysis, and
 - logistic support modeling,
- 6.life cycle cost analysis,
- 7.optimization, including
 - trade-off studies,
 - system/cost effectiveness analysis, and
 - effectiveness analysis modeling,
- 8.production engineering analysis, and
- 9.generation of specifications.

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Decision Theory

J. M. Bocker and M. C. Bryson. "Decision analysis in project management: An overview," IEEE Trans. Eng. Manag., vol. EM-32, pp. 3-9 Feb. 1985 provides an overview of decision analysis and discussions of various fields which encompass decision theory or with which it interacts. A list of 96 additional references is also provided.

R. A. Howard, "The foundations of decision analysis," IEEE Trans. Syst. Sci. Cybern., vol. SSC-4, pp. 211-219, Sept. 1968 provides system engineers with additional theoretical background that can be added to the tutorial data presented by North below.

D. W. North, "A tutorial introduction to decision theory," IEEE Trans. Syst. Sci. Cybern., vol. SSC-4, pp. 200-210, Sept. 1968, since system engineers must make many decisions during the design process, provides a firm foundation for understanding how good decision can be made.

Design

W. G. Beazley, "Terminal products of design," Proc. Int. Conf. Cybernetics and Society, 1979, pp. 834-839 defines the terminal products of design as being problem statements. These problem statements can terminate in one of three mutually exclusive states: successful, impossible, or infeasible. These states and their implications on design are described.

R. Bernard, "Overlooking the obvious," IEEE Spectrum, vol. 18, pp. 85-89, Oct. 1981 argues that even if manufacturers have methods for filtering potential failure mechanisms, whether obvious or obscure, in the design and testing stages of products, some errors get overlooked. The author cites several examples and provides recommendations for avoiding similar errors (see also entry G-12 [Missing?]).

S. Blandford and R. P. Hope, "Systematic methods for the problem solving process with particular reference to design," Proc. Inst. Elec. Eng., vol. 132, pt. A, pp. 199-212, July 1985. presents a model for describing the relationship of the various stages of human activity within the process of solving a system problem.

Chow, W. W. Cost Reduction in Product Design. New York: Van Nostrand Reinhold Co., 1978.

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M. E. Connelly, "System design," in Handbook of Automation, Computation and Control. S. Ramo, E. M. Grabbie, and D. E. Woolridge (eds.), Section III. New York: John Wiley, 1961.

A. J. Feduccia "System design for reliability and maintainability," Air Force J. Logistics, pp. 25-29, Spring 1984 identifies decisions that are made, knowingly or not and willingly or not, that impact the lifetime reliability, maintainability, and logistics readiness of systems; determines the possible effects of such decisions on systems; and introduces some technological advances in reliability and maintainability engineering which the decision maker can use to make an informed choice.

J. S. Gansler and G. W. Sutherland, "A design to cost overview," Defense Manag. pp. 2-7, Sept. 1974 provides a succinct introduction to the concept of designing to cost.

A. Giddings, "Compromise is bad design," Naval Engineers Journal, November, 77-78. 1986.

W. Hammer, "Designing a safe system," Machine Design, pp. 92-97, Sept. 3, 1970 describes a methodology for performing hazard analysis during system design and offers various accident prevention methods.

H. Katzan, Jr., *Systems Design and Documentation*. New York: Van Nostrand Reinhold, 1976 introduces a technique for describing a system in terms of its inputs, constituent processes, and Outputs. It also provides a basic background essential to the understanding of structured design techniques.

C. J. Koomen, "The entropy of design: A study on the meaning of creativity," *IEEE Trans. Syst., Man, Cybern.*, vol. SMC-15, pp. 16-30, Jan./Feb. 1985 intends "to improve the methods and techniques for the design of complex systems by formalizing the basic mechanisms and incorporating the acquired knowledge into these mechanisms."

D. J. Leech, *Management of Engineering Design*. New York: Wiley, 1972 describes principles of good engineering design, as measured in terms of economic viability and technical innovation, appreciation of which is essential to the successful design of systems. This basic text is highly recommended for those beginning their careers as systems engineers.

E. Lurcott, "F2D2 (functional flow diagrams and descriptions), a system management tool," *Defense Syst. Manag. Rev.*, vol. 1, pp. 19-28, Autumn 1977 describes a system engineering management tool useful for coordinating the interplay between system engineers and engineering specialists. The tool also simplifies the attainment of a balanced system design in which each major design is based upon the proper coordination of system variables, including facilities, equipment, computer programs, personnel, training, testing, and intrasystem interfaces.

Maddox, M., and D. Allen, "What have you done to my interface?" *Ergonomics in Design*, January 1993, pp. 12-19.

J. Malouin, and M. Landry, "The mirage of universal methods in systems design," *J. Appl. Syst. Anal.*, vol. 10, pp. 47-62, 1983 argues that many published design methodologies have limited applicability to situations other than those that such methodologies were originally intended to solve. The authors believe that a choice of a design methodology can be made rationally and systematically. They present a framework intended to help in the judicious and enlightened choice of a design method.

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D. D. Meredith, K. W. Wong, R. W. Woodhead, and R. H. Wortman. *Design and Planning of Engineering Systems*, 2nd ed. Englewood Cliffs, NJ: Prentice-Hall, 1985 is one of the newest texts to present the major principles and methods employed in system planning and design.

P. K. M'Pherson, "A framework for systems engineering design," *Radio Electron. Eng.*, vol. 51, pp. 59-93, Feb. 1981 views the system engineering design process from a slightly different perspective than most American writers. This difference in prospective, M'Pherson's easy writing style, and breadth of coverage make this a "must read" paper.

G. Nadler, "Systems methodology and design," in *Proc IEEE Int. Conf. Systems, Man, and Cybernetics*, 1984, pp. 427-437 (also in *IEEE Trans. Syst., Man, Cybern.*, vol. SMC-15, pp. 685-697, Nov/Dec 1985) first reviews the problems faced by today's economy and relates them to engineering problem solving and design. He then compares traditional and modern ways of handling design problems. This is followed by a review of different traditional sciences as a possible basis for a unified system methodology and design and the implications of such sciences for system design.

G. Nadler, "An investigation of design methodology," *Management Sci.*, vol. 13, pp. B642-B655, June 1967 compares the purpose and methodologies of research and of designing. He argues that, while their purposes are different, the methodologies then in use were the same. This paper provides the background required to appreciate the other papers in this section.

D. A. Norman. *The Design of Everyday Things*. New York: Doubleday, 1988.

J. G. Peterson, G. Nadler, and M. Chignell, "Perspectives on design: Problems, processes, and purposes," in Proceedings of the 1987 IEEE International Conference on Systems Man and Cybernetics. New York: IEEE, 980-984, 1987.

V. Riley, "FAIT: A systematic methodology for identifying system design issues and tradeoffs," in Proceedings, IEEE, 1036-1038, 1989.

W. B. Rouse and K. R. Boff. System Design: Behavioral Perspectives on Designers, Tools, and Organizations. New York: North-Holland, 1987.

A. M. Ruskin, J. B. Carraway, and M. J. Singer, "Developing one-of-a-kind systems systematically," in Proceedings, 1989 IEEE 2nd International Conference, 28-38, 1989.

M. G. Ryschkewitsch., The NASA Mission Design Process: An Engineering Guide to the Conceptual Design, Mission Analysis, and Definition Phases. NASA Engineering Management Council, December 22, 1992.

A. P. Sage, "A methodology for system design," in IEEE Systems/Man/Cybernetics Conf. Proc., 1980, pp. 272-277 presents a normative model of the design process. The model presented consists of a five-phase iterative methodology. Sage claims that the approach is sufficiently robust so that it can be adapted to a variety of system design situations.

_____ (Author missing). System Design for Human Interaction. New York: IEEE Press, 1987.

K. K. Schwarz, "The many facets of engineering design, Proc. Inst. Elec. Eng., Part A, vol. 130, pp. 196-201, June 1983 describes how the combination of many different disciplines contribute to the production of engineering "goods." He presents some of the difficulties with and differences between conceptual and physical designs.

T. B. Sheridan, "Designing complex technology: Understanding it as of, by, and for people," Technological Forecasting and Social Change, 36, 89-97, 1989.

L. Smith, "Hierarchical design structures simplify system development," EDN, vol. 28, pp. 165-167, Sept. 15, 1983 relates the structured, hierarchical design techniques of software engineering to the design and management of complex electronic systems.

B. C. Steward, "Design process analysis modeling--An approach for improving the system design process," in Proc. 1978 IEEE Int. Conf. Cybernetics and Society, 1978, pp. 3-7 presents a discussion of some problems impacting the development of large-scale data-intensive systems. Procedures for resolving these problems are presented. Steward's efforts will aid systems engineers to "fill-in-the-holes" in more comprehensive texts such as those by DeMarco or by Katzan.

D. V. Steward, "The design structure system: A method managing the design of complex systems," IEEE Tram. Eng. Manag., vol. EM-28, pp. 71-74, Aug. 1981 discusses a "matrix" methodology for ordering the tasks of system design. According to Steward, the matrix can assist in organizing the design of a system, developing an effective engineering plan, showing where estimates are required, and analyzing the flow of information that occurs during the design work.

L. J. Van Poolen, "A philosophical perspective of technological design, " Inter. J. Engineering Education, 319-329,

W. Visser, "More or less following a plan during design: Opportunistic deviations in specification," Inter. J. Man-Machine Studies, vol. 33, 247-278, 1990.

Architecture Heuristics

F. P. Brooks, "Architectural philosophy," in Planning a Computer System. W. Bucholz (ed.), New York: McGraw-Hill, 5-16, 1962.

D. N. Chorafas. Systems Architecture & Systems Design. New York: McGraw-Hill, 1989.

F. Ferguson. Architecture, Cities and the Systems Approach. New York: Braziller, 1975.

R. Groner, M. Groner, and W. F. Bischof. Methods of Heuristics. Hillsdale, NJ: Lawrence Erlbaum Associates, 1983.

E. Rehtin. Systems Architecting: Creating and Building Complex Systems. New York: Prentice-Hall, 1991.

D. G. Reinersten. "Use product architecture to slash design time," Electronic Design, December 3, 1992, pp. 59-62.

Effectiveness (Cost/System)

B. S. Blanchard, "Cost effectiveness, system effectiveness, integrated logistic support, and maintainability," IEEE Tram. Rel., vol. R-16, pp. 117-126, Dec. 1967 presents a comprehensive discussion of cost effectiveness, system effectiveness, integrated logistic support (ILS), and maintainability. This basic background will assist system engineers in carrying out system engineering, Phase 5.

J. S. Byrnes and R. A. Angell, "The dependency model: A tool for calculating system effectiveness," IEEE Tram. Rel., vol. R-34, pp. 17-23, Apr. 1985 presents a mathematically unsophisticated but useful and practical tool for measuring the effectiveness (reliability, availability, maintainability, efficiency, etc.) of a complex system.

R. A. Erickson. Measures of Effectiveness in Systems Analysis and Human Factors. China Lake, CA: Naval Weapons Center, Sept. 1986.

D. S. Fields, "Cost/effectiveness analysis: Its tasks and their relationships," Operations Res., vol. 14, pp. 515-527, May 1966 discusses the nature of the major tasks involved in cost/effectiveness analysis and how they are interrelated.

D. H. Heaton, "System/cost effectiveness analysis in the system engineering process," Defense Ind. Bull., pp. 34-37, July 1969 specifically relates system/cost effectiveness analysis to the system engineering process.

S. Laut, "Subsystem optimization effectiveness improvement by the option trade-off Analysis process," IEEE Tram. Syst. Sci. Cybern., vol. SSC-4, pp. 133-137, July 1968 provides explanations of effectiveness attributes and tradeoff analysis which contain basic information essential for understanding system engineering, Phase 7.

R. W. Pike. Optimization for Engineering Systems. New York: Van Nostrand Reinhold, 1986.

K. N. Sargent, "Insight into SEEing: A discussion of the philosophy underlying systems effectiveness engineering," IEEE Tram. Aerosp. Electron. Syst., vol. AES-2, pp. 506-510, Sept. 1966 provides some historical insights into systems effectiveness engineering. He compares and contrasts several extant models and introduces the equation $E = ADC$, where E is the quantitative measure of the achievement of requirements, A is availability, D is dependability, and C is capability.

D. C. S. Shearn, "Approaches to achieving cost effectiveness," Proc. Inst. Elec. Eng., Part A, vol. 129, pp. 269-273, June 1982 explains the various ways in which the term "cost effectiveness" is used. These explanations can form a firm foundation for the study of cost effectiveness in systems engineering and also

provide a benchmark for comparing other writings.

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F. A. Tillman, C. L. Hwang, and W. Kuo, "System effectiveness models; An annotated bibliography," *IEEE Trans. Rel.*, pp. 295-304, Oct. 1980 provides a source of in-depth information for studying the concept of system effectiveness.

Evaluation (Cost/Performance)

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R. F. Erlandson, "System evaluation methodologies: Combined multidimensional scaling and ordering techniques," *IEEE Trans. Syst., Man, Cybern.*, vol. SMC-8, pp. 421-432, June 1978 describes a methodology for evaluating alternative systems for future use. The multidimensional scaling technique introduced was used to determine the interrelationships between system attributes. These attributes are 1) system structure (from stable to dynamic), 2) system functions or service (service done on a system versus service performed by the system), 3) human-system interactions (human-system versus system-system interaction), and 4) system control. An understanding of the concepts described will aid system engineers in performing the functional allocation task (system engineering, Phase 2).

D. H. Hamburger, "Accurately estimate your project's cost," *EDN*, pp. 217-221, Sept. 2, 1981 provides useful guides for setting up a project cost estimating system.

J. D. Hessman and V. C. Thomas, "A time of great testing," *Sea Power*, pp. 30-37, Mar. 1985 explains that the design and development of engineered systems is not complete until after successful operational testing. This interview with the commander of the Navy's Operational Test and Evaluation Force provides insight into the current state-of-the-art of operational testing.

L. Wilkerson, and A. Paul, "Every system should have one: A collection of properties which can be used as a criterion for evaluating the quality of a system," *Inform. Process. Manag.*, vol.21, pp. 45-49, 1985 provides a comprehensive summary of what properties a system should possess. A means is provided to identify systems and measure them against a checklist.

Functional Allocation

M. V. Hemenway, "Functional analysis of weapon systems," *Logistics Spectrum*, vol. 23, no. 2, 19-23, Summer 1989.

E. Lurcott, "F2D2 (functional flow diagrams and descriptions), a system management tool," *Defense Syst. Manag. Rev.*, vol. 1, pp. 19-28, Autumn 1977 See entry D-Lurcott.

H. E. Price, "The allocation of functions in systems," *Human Factors*, vol. 27, pp. 33-45, Feb. 1985 presents the best readily available information to aid system engineers in performing system engineering, Phase 3.

E. J. Wittry; *Functional Analysis: Simplify Before Automating*. New York: Van Nostrand Reinhold, 1991.

General Readings

M. Alford, "Structuring the dialog between system and software engineers," in Proc. 15th Southeastern Symp. System Theory, 1983, pp. 348-351 presents an approach for performing the iterative process of system design in terms of a structured dialog between systems and component engineers.

T. H. Athey, *Systematic Systems Approach: An Integrated Method for Solving Systems Problems*. Englewood Cliffs, NJ: Prentice-Hall, 1982 presents an integrated methodology for solving complex systems problems. This methodology is based on the "universal aspects of systems" and will aid system engineers in developing their problem-solving abilities.

N. R. Augustine, *Augustine's Laws*. New York: Amer. Inst. Aeronaut. Astronaut., 1983 sets forth "laws" which are "dedicated to the proposition that, with a better understanding of the history of past programs, one need only selectively repeat history in the future." In addition to providing valuable insight into problems encountered in previous system development efforts, this book is highly entertaining.

J. A. Baird, "How can systems engineers do systems engineering?" *IEEE Tram. Aerosp. Electron. Syst.*, pp. 405-407, Mar. 1971 asks three questions: "What is expected of systems engineers?" "What is not expected of systems engineers?" and "What jobs can systems engineers do and what can't they do?" One of the first steps in the system engineering process is to define the boundaries of the proposed system. Baird attempts to do this for systems engineers.

J. S. Baumgartner, *Systems Management*. Washington, DC: Bureau of National Affairs, 1979 is a collection of writings providing insight into the broad spectrum of systems management. An appreciation for the problems facing system engineering managers will help system engineers in their day-to-day design activities.

W. R. Beam. *Command, Control and Communications Systems Engineering*. New York: McGraw-Hill, 1989.

J. A. Bent, *Applied Cost and Schedule Control*. New York: Marcel Dekker, 1982 has a practical approach that will assist system engineers with limited background in cost and schedule control techniques to develop the required understanding of these essential concerns.

B. S. Blanchard and W. J. Fabrycky; *Systems Engineering and Analysis*. Englewood Cliffs, NJ: Prentice-Hall, 1981.

F. P. Brooks, Jr. *The Mythical Man Month*. New York: Addison-Wesley, 1982.

G. J. Chambers, "What is a systems engineer?" *IEEE Tram. Syst., Man, Cybern.*, vol. SMC-15, pp. 517-521, July/Aug. 1985 presents an explanation of the functions typically performed by systems engineers in the military-industrial environment of the 1980's. The knowledge, skills, and abilities required are examined and means for acquiring these are described.

P. Checkland. *Systems Thinking, Systems Practice*. New York: John Wiley & Sons, 1981.

C. W. Churchman. *The Design of Inquiring Systems*. New York: Basic Books, 1971.

K. B. De Greene, "Large technology-based systems and the need for paradigm shift," *Technological Forecasting and Social Change*, vol. 39, 349-362, 1991.

F. E. Emery (ed.). *Systems Thinking* (vols. 1 & 2). New York: Penquin Books, 1981.

M. Gupta, "Preparation of a technical bibliography," *IEEE Trans Prof. Commun.*, vol. PC-16, pp. 7-10, Mar. 1973.

Hall, M. N. (1993). "Reducing Long term System Cost by Expanding the Role of the Systems Engineer," Proceedings of the 1993 International Symposium on Technology and Society, IEEE, 23-23 October, Washington DC, pp. 151-155.

R. W. House, "A morphology of technical innovation as a process," in Proc. Int. Conf. Cybernetics and Society, 1979 presents a comprehensive review of the elements of the technological innovation process. This morphology can help system engineers to diagnose or prevent problems in the technological innovation process.

G. J. Klir; Architecture of System Problem Solving. New York: Plenum Press, 1985.

H. Ledgard, "Programmers: The amateur vs. the professional," Abacus, vol. 2, pp. 29-35, Summer 1985 provides valuable insights for system engineers who must interact with computer programmers for the first time.

T. Levitt, "Creativity is not enough," Harvard Business Rev., vol. 41, pp. 72-83, May/June 1963 is addressed to business managers but offers valuable advice to system engineers. It stresses the need "to distinguish between the relatively easy process of being creative in the abstract and the infinitely more difficult process of being innovator in the concrete."

B. W. Mar, and R. N. Palmer. "Does civil engineering need system engineering?" J. of Professional Issues in Engineering, vol. 115, no. 1, 45-52, January 1989.

L. L. McLaughlin, "Multiple cooperating for systems engineering," in Proceedings, IEEE 1989 International Conference on Systems Engineering, 191-195, 1989.

Open Systems Group; Systems Behavior (3rd. ed.). New York: Harper & Row, 1981.

J. D. Palmer, "Large scale systems: Systems, man, and cybernetics overview," IEEE Tram. Automat. Contr., vol. AC-28, pp. 653-659, June 1983 is an overview of some of the major areas of activity in the field of large-scale systems and provides an excellent model for the development of a system engineer's learning plan. Forty-four references are provided in six areas: general, input-output-economic models, public system methodologies, imperative structural modeling, transportation systems, and man-machine systems.

H. Petroski, To Engineer is Human: The Role of Failure in Successful Design. New York: St. Martin's Press, 1985 explains how dramatic engineering failure can occur and presents examples of such failures from throughout the history of man-made structures and systems. The Preface states that "to understand what engineering is and what engineers do is to understand how failures can happen and how they can contribute more than successes to advance - technology."

R. M. Pirsig, Zen and the Art of Motorcycle Maintenance. New York: Bantam, 1974 is a quality book about quality. A true appreciation for the values advanced by Pirsig would help system engineers in their efforts to design quality into new systems.

W. R. Rouse; and K. R. Boff. System Design: Behavioral Perspectives on Designers, Tools, and Organizations. New York: North-Holland, 1987.

A. P. Sage, Methodology for Large-Scale Systems. New York: McGraw-Hill, 1977 presents methodologies pertinent to the solution of complex technological and societal systems engineering problems.

H. Simon, The Sciences of the Artificial, 2nd ed. Cambridge, MA: MIT Press, 1981 concerns the thesis that systems (and other phenomena) are "artificial" in that "they are as they are only because of being molded, by goals or purposes, to [their] environment." An understanding of the concepts presented will help system engineers to develop an understanding for the "science of design."

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T. C. Taylor (see entry B-Taylor).

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[Note: To verify currency of standards, visit the Defense Standardization Program Home Page at: <http://www.acq.osd.mil/es/std/stdhome.html>]

Department Of Defense Directives

DoDD 4005.1, DoD Industrial Preparedness

DoDD 4105.62, Selection of Contractual Sources for Major Defense Systems

DoDD 4120.3, Defense Standardization and Specification Program

DoDD 4120.18, Use of Metric System of Measurement

DoDD 4245.3, Design to Cost

DoDD 4245.6, Defense Production Management

DoDD 4245.7, Transition from Development to Production

DoDD 5000.1, Major System Acquisitions

DoDD 5000.3, Test and Evaluation

DoDD 5000.4, OSD Cost Analysis Improvement Group

DoDD 5000.29, Management of Computer Resources in Major Defense Systems

DoDD 5000.39, Acquisition and Management of Integrated Logistic Support for Systems and Equipment

DoDD 5000.40, Reliability and Maintainability

DoDD 5000.43, Acquisition Streamlining

DoDD 5010.19, Configuration Management

DoDD 5010.20, Work Breakdown Structures for Defense Materiel Items

DoDD 5141.2, Director of Operational Test and Evaluation

Department Of Defense Instructions

DoDI 4120.20, Development and Use of Non Government Specifications and Standards

DoDI 5000.2, Major System Acquisition Procedures

DoDI 5000.33, Uniform Budget/Cost Terms and Definitions

DoDI 5000.38, Production Readiness Reviews

DoDI 7000.2, Performance Measurement for Selected Acquisitions

Department Of Defense Guides/Manuals

DoD Guide to Integrated Product and Process Development, Version 1.0, Office of the Under Secretary of Defense (Acquisitions and Technology), February 5, 1996.

DoD Guide LCC-1, Life Cycle Costing

DoD Guide LCC-2, Life Cycle Costing Casebook

DoD Guide LCC-3, Life Cycle Costing for Systems

DoD 4120.3-M, Defense Standardization Manual

DoD 4245.7-M, Transition from Development to Production

DoD 5000.3-M-1, Test and Evaluation Master Plan Guidelines

DoD 5000.3-M-2, The Department of Defense Foreign Weapons Evaluation Program

DoD 5000.3-M-3, Software Test and Evaluation Manual

DoD 5000.3-M-4, Joint Test and Evaluation Procedures Manual

DoD 5000.3-M5, Procedures Manual - Improving Test and Evaluation Effectiveness in Support of the Major Weapon Systems Decision Process

Department Of Defense Standards

DoD-D-1000B, Drawings, Engineering, and Associated Lists

DoD-STD-100C, Engineering Drawing Practices

DoD-STD-480A, Configuration Control - Engineering Changes, Deviations, and Waivers

DoD-STD-963, Data Item Descriptions (DID), Preparation of

DoD-STD-2167, Defense System Software Development

DoD-STD-2168, Software Quality Evaluation

Military Standards

MIL-STD-130F, Identification Marking of U.S. Military Property

MIL-STD-470A, Maintainability Program for Systems and Equipment

MIL-STD-471B, Maintainability Demonstration/Evaluation

MIL-STD-481A, Configuration Control Engineering Changes, Deviations, and Waivers (Short Form)

MIL-STD-482A, Configuration Status Accounting Data Elements and Related Features

MIL-STD-483A, Configuration Management Practices for Systems, Equipment, Munitions, and Computer Programs

MIL-STD-490B, Specification Practices

MIL-STD-499B, Systems Engineering (Draft)

MIL-STD-756B, Reliability Modeling and Prediction

MIL-STD-785B, Reliability Program for Systems and Equipment

MIL-STD-881A, Work Breakdown Structures for Defense Materiel Items

MIL-STD-13881A, Logistic Support Analysis

MIL-STD-13882A, Logistic Support Analysis Record

MIL-STD-1456, Contractor Configuration Management Plans

MIL-STD-1528, Production Management

MIL-STD-1535, Supplier Quality Assurance Program Requirements

MIL-STD-1662A, Ordnance Alteration (ORDALT) Instructions, Preparation of

Military Handbooks

MIL-HDBK-189, Reliability Growth Management

DoD-HDBK-248, Guidance for Application and Tailoring of Requirements for Defense Materiel Acquisitions

MIL-HDBK-259, Life Cycle Cost in Navy Acquisitions

DoD-HDBK-287, Defense System Software Development Handbook

MIL-HDBK-472, Maintainability Prediction

Other Military Documents

MIL-N-7513F, Nomenclature Assignment, Contractor's Method for Obtaining

MIL-Q-9858A, Quality Program Requirements

MIL-S-83490, Specifications, Types and Forms

Army Documents

Department of the Army. System Engineering. Field Manual 770-78. Washington, D.C.: Author, 1979.

Army Force Planning Handbook TTO-ORT-03-776B-V3, "Life Cycle Costing," Joint Tactical Communication

AR 70-10, Test and Evaluation During Development and Acquisition of Material

AR 70-37, Configuration Management

AR 70-64, Design to Cost

AR 71-3, User Testing

AR 702-3, Army Materiel Systems Reliability, Availability, and Maintainability

DAP 11-2, Research and Development Cost Guide for Army Materiel Systems

DAP 11-3, Investment Cost Guide for Army Materiel Systems

DAP 11-4, Operating and Support Cost Guide for Army Materiel Systems

DAP 11-5, Standard for Presentation and Documentation of Life Cycle Cost Estimates

Air Force Documents

AFR 65-3, Configuration Management

AFR 80-14, Test and Evaluation

AFR 800-11, Life Cycle Costing

AFR 800-17

AFR 800-18, Air Force R&M Program

FSC/AFLC Joint Command Working Group on LCC, Life Cycle Cost Procurement Guide

AFSCM 173-4

AFSCN 84-3, Production Management

AFSCP 57-2, Modification Management

AFSCP 800-7, Configuration Management

AFSCR 84-2, Production Readiness Reviews

Department of the Air Force, Software Technology Support Center, *Guidelines for Successful Acquisition and Management of Software Intensive Systems: Weapons Systems, Command and Control Systems, Management Information Systems*; Vols. 1 and 2, September 1994.

Navy Documents

NAVFAC P-422, Economic Analysis Handbook

NAVMATINST 3960.7A, Test and Evaluation of Ship Acquisitions

NAVELXINST 4130.1, Configuration Management

NAVMATINST 5200.11A

NAVSEA 0900-LP-095-2010, TSTP/SP Ship Construction Tests and Trials Manual

NAVSEAINST 4720.3, Fleet Modernization Program (FMP), Plans and Procedures for

ONAS P 4855-X, Engineering Risk Assessment

OPNAVINST 3960.10B, Test and Evaluation

OPNAVINST 4720.2E, Fleet Modernization Program (FMP), Policy for

SECNAV 4200.32, Design to Cost

SECNAVINST 4130, Navy Configuration Management Manual

SECNAVINST 4210.6, Acquisition Policy

Marine Corps Documents

MCO 4130.1A, Configuration Management

MCO 5000.11A, Testing and Evaluation of Systems and Equipment for Marine Corps

Other Government Documents

DARCOM P700-6, NAVMAT P5242, AFLC/AFSCP 800-19, Joint Design to Cost Guide--Life Cycle Cost as a Design Parameter

DEPSECDEF Memorandum of January 11, 1984; Improving Contract Requirements

DEPSECDEF Memorandum of June 3, 1985; Acquisition Streamlining

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DI-CMAN-80008, System/Segment Specification

DI-E-3118, Minutes of Formal Reviews, Inspections and Audits

DI-E-5423, Design Review Data Package

DI-E-30141, Interface Specification

DI-F-30203, Design to Cost/Life Cycle Cost Reports

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Standardizing selected aspects of system development The reader must be aware that the system development effort has a different focus at JPL than at most other organizations. Most other system development organizations are primarily driven by cost and technical performance considerations. JPL is primarily schedule and technical performance driven. The reason for this difference is that the position of the celestial bodies in the sky determines, to a large extent, the success or failure of their programs. D-5000 approaches "system" as a hierarchy of subsystems, sub-subsystems, etc. and applies systems engineering at all seven-phases (their model) of system development. JPL sees the role of systems engineering as being that of delivering to management a fully developed, certified system that meets user requirements. This includes such activities as: defining requirements, developing alternative designs, allocating performance margins and allowances, supporting supersystem development (resolving interface problems), overseeing subsystem engineering, and coordinating system certification.

User Interface Design

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<http://www.acm.org/catalog/catalog.html>

Acquisition Systems Management

<http://www.acq.osd.mil/api/asm/product.html>

An Acronyms and Abbreviations Server
<http://www.ucc.ie/info/net/acronyms/>

American Society of Mechanical Engineers
<http://www.asme.org/index.html>

American Society of Naval Engineers
<http://www.jhuapl.edu/ASNE/>

ANSI Home Page
<http://www.ansi.org/>

Configuration Management Related Links
<http://www.quality.org/html/config.html>

Defense Acquisition Deskbook
<http://www.deskbook.osd.mil/>

Defense Standardization Program Home Page
<http://www.acq.osd.mil/es/std/stdhome.html>

The Electronic Industries Association (EIA)
<http://www.eia.org/>

Engineering of Complex Systems (ECS) Project - NSWC-DL
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Enterprise Process Improvement Collaboration (EPIC)
<http://www.ti.com/indcoll/docs/ic-desc.htm>

George Mason University Systems Engineering Home Page <http://www.site.gmu.edu/~syst/>

Human factors and Ergonomics Links
<http://www.usernomics.com/hf.html>

Human Factors and Ergonomic Society
<http://hfes.org/>

IEEE Home Page
<http://www.ieee.org/>

The International Council on Systems Engineering (INCOSE)
<http://www.inncose.org/index.html>

International Standards Organization (ISO)
<http://www.iso.ch/welcome.html>

ISO Standards Discussion Page
<http://www.exit109.com/~leebee/>

Malcolm Baldrige National Quality Award Home Page
<http://www.quality.nist.gov/>

MO&DSD SYSTEMS ENGINEERING ENVIRONMENT (MSEE)
Tools Capabilities Inventory NASA GSFC Developed Tools
<http://joy.gsfc.nasa.gov/MSEE/toolgsfc.htm>

NASA Marshall Space Flight Center Systems Analysis and Integration Laboratory
<http://elses1.msfc.nasa.gov/>

Project Management Institute
<http://www.pmi.org/>

Project Management System ('Manage and Control large and complex technical systems')
<http://www.airtime.co.uk/users/wysywig/index.htm>

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Requirements Engineering Newsletter
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To download SE-CMM materials
<http://www.csz.com/secat/download.htm>

Software Productivity Center
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SPAWAR / NRD Specs & Standards
<http://diamond.spawar.navy.mil/specs/>

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<http://www.ti.com/indcoll/docs/se-desc.htm>

Systems Engineering Home Page of NASA's Goddard Space Flight Center
<http://rs712b.gsfc.nasa.gov/704/704home.html>

Systems Engineering Dictionary (from George Mason University)
<http://systeng.gmu.edu/insert/dictionary/index.html>

System Engineering Management Plan - Model Text
<http://www.airtime.co.uk/users/wysywig/semph.htm>

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