Reading Guide - Chapter 1
"Systems Engineering Life Cycles: Life Cycles for Research, Development, Test, and Evaluation; Acquisition; and Planning and Marketing" - by F. G. Patterson, Jr. - pages 59-111
[in Handbook of Systems Engineering and Management, A. P. Sage and W. B. Rouse, eds.]

There is a brief synopis of this chapter on pages 33-34.

What should be gained from reading and studying this chapter?

(1) You should be able to identify and concisely describe the three major phases of a system life cycle based on Sage's enterprise model.
(2) You should be able to convey an understanding of DDD and RAS, their relationship to one another, and their usefulness for defining generic system process models.
(3) You should be able to describe and critique a life cycle model for RDT&E.
(4) You should be able to describe and critique a life cycle model for Acquisition.
(5) You should be able to generalize a life cycle model for Acquisition and apply it to Production.
(6) You should be able to define and describe the application of Ould's V model.
(7) You should be able to describe and critique a life cycle model for Planning and Marketing.
(8) You should be able to identify, describe, and critique three software engineering acqusition life cycle models: Royce's waterfall, Boehm's waterfall, and Boehm's spiral.
(9) You should be able to identify and discuss deficiencies in the life cycle approach to systems engineering.
(10) You should be able to identify and describe at least one trend in systems engineering life cycle modeling.
(11) You should be able to define CMM and discuss its appropriateness for generic systems.

General comments: The author is with the Office of Training and Development at NASA Headquarters. He completed his PhD at George Mason University, in the Department of Systems Engineering and Operations Research in the School of Information Technology and Engineering, where A. P. Sage is a Professor. The chapter explores several types of, and frameworks for, systems engineering life cycle models. It is lengthy and can be difficult to follow, primarily due to life cycle models which have phases, which in turn have their own life cycles and phases, which in turn also have their own life cycles and phases. Section 1.4 is particularly long and challenging. The life cycles and models in the chapter are addressed primarily in the context of the U.S. federal government, with little attention given to the private or commercial sector.

Section 1.1 - Introduction - The primary thrust of this section is to relate life cycles to Stogdill's organizational structure model. Note the equivalence of life cycles to process models in the very first sentence. Also note reference to Sage's enterprise model as the basis for the three major types of life cycles (process models) addressed by this chapter (i.e., RDT&E, Acquisition or

Production, Planning and Marketing). Buried back on page 86 in Section 1.6 is a sentence regarding models that may be helpful to keep in mind while reading this entire chapter. The sentence reads "The purpose of any model is to provide a framework that is better understood than the reality that it models, and whose outcomes are sufficiently close to reality to counter the easy, obvious, and devastating objection: 'Does this reflect the way things really are?'"

Section 1.2 - Classification of Organizational Purpose - Pay particular attention to the introduction of Sage's nomenclature and classification scheme for generic systems engineering life cycle representation; i.e., Definition, Development, Deployment (DDD) versus Recognize, Analyze, Synthesize (RAS). This representation (depicted in Figure 1.3 on page 66) is repeatedly invoked throughout the remainder of the chapter. The descriptive questions relevant to each of the three major life cycle types that are provided in Figure 1.4 on page 67 may be particularly helpful.

Section 1.3 - RDT&E Life Cycles - The relevance of research and development (R&D) as a risk mitigation tool is aptly described in the table provided as Figure 1.5 (page 68). Note that although RDT&E is defined as one of the three phases in the complete life cycle of a system, RDT&E is also identified as having its own five-phase life cycle, and that these five phases have been additionally mapped into the DDD framework. The discussion on the relationship between RDT&E and marketing is interesting. (Note that what the author calls a "chameleon" is called a "question mark" by some other authors.)

Section 1.4 - System Acquisition or Production Life Cycles - It is important to be aware that most of the material in this section addresses acquistion, and that it is primarily reflective of U.S. government acquistion frameworks. It might have been helpful to the reader had this lengthy section been divided into specific subsections. One way in which the reader can create his/her own "subsections" is as follows:

1.4.1 - Start with the beginning of Section 1.4 on page 72, and continue through the sentence "The basic shape of the acquisition life cycle follows the basic definition-development-deployment shape that is the basis of many action models" in the first paragraph on page 73. This "subsection" briefly discusses a variety of life cycle models that have been used to describe the Acquisition or Production phase of the complete life cycle for a system. I would also have included Figure 1.13 on page 82, together with the short paragraph that follows it, in this "subsection." It is useful to know that the remainder of Section 1.4 follows the definition-development-deployment format cited in the sentence quoted above.

1.4.2 - Start with the sentence "During the definition phase, we create and generally prefer to distinguish between its two basic products: requirements and specifications," and continue through the end of the paragraph at the very top of page 77 (the last sentence ends with "create marketing plans, tools, and schedules."). This "subsection" addresses the Definition phase of an Acquisition or Production life cycle.

1.4.3 - Start with the sentence "The second phase of the system acquisition life cycle is the development phase" at the beginning of the new paragraph near the top of page 77, and continue until you reach the new paragraph in the middle of page 80 that begins with the sentence "The third part of the systems engineering life cycle is deployment." This "subsection" addresses the Development phase of an Acquisition or Production life cycle.

1.4.4 - Start with the new paragraph in the middle of page 80 that begins with the sentence "The third part of the systems engineering life cycle is deployment," and continue through to the bottom of the same page.

It may be helpful to some readers to review Figure 1.12 on page 81 before reading Section 1.4, and to use the Figure as a guide while reading "subsections" 1.4.2, 1.4.3 and 1.4.4. The comments that follow refer to the "subsections" as defined above.

1.4.1 - Definition Phase of Acquisition or Production Life Cycles - The author is grappling with the definition of a generic and consistent framework of life cycles for the Definition phase, which is frequently referred to as a Requirements phase. He first presents a requirements life cycle (summarized in Figure 1.9 on page 74), and then, in the last paragraph on page 75, groups its life cycle phases into the definition-development-deployment structure. As previously observed, it is not difficult for the reader to become bogged down in the cycles within phases, which are in turn cycles within phases, etc., and so the "subsection" must be read very carefully. The various links of the Definition phase of an Acquisition life cycle, to other life cycles, which starts near the top of page 76, must also be read carefully to ensure that the reader understands which life cycle and/or phase is being referred to.

1.4.2 - Development Phase of Acquisition or Production Life Cycles - Once again, the author is grappling with the definition of a generic life cycle framework, given multiple proposed frameworks. Ould's V process model for software engineering is emphasized and discussed in some detail. The discussion of verification and validation on page 78, although developed specific to software engineering, can be useful in understanding at least one of the interpretations of the difference between verification and validation.

1.4.3 - Deployment Phase of Acquisition or Production Life Cycles - This is very brief, and does not explore in depth the life cycles associated with this particular phase.

1.5 - The Planning and Marketing Life Cycle - Briefly describes, in list format, models published by Kast and Rosenzweig, and Briner and Hastings, then describes, again in list format, a potential definition-development-deployment life cycle model for the Planning and Marketing Phase of an Acquisition or Production life cycle. Relationships between Planning and Marketing, and the other two major phases (RDT&E; Acquisition and Production), are also briefly considered. It is useful to recall that marketing was also discussed in Section 1.3.

1.6 - Software Acquisition Life Cycles - Note particularly the author's position that software

engineering is a part of systems engineering. The primary thrust of the section is to address three models: Royce's waterfall model, Boehm's waterfall model, and Boehm's spiral model. The discussion of the spiral model segues into consideration of models of incremental development and evolutionary development. Readers engaged in software engineering will find a wealth of references to relevant standards in this section.

1.7 - Trends in Systems Engineering Life Cycles - Section opens by addressing systems engineering deficiencies arising from life cycle approaches. 1.7.1, Process Improvement, takes a look at alternatives: (a) ISO-9000 is briefly addressed, (b) the majority of the subsection considers the Capability Maturity Model defined for software, (c) a NASA methodology is briefly addressed, and (d) a description of performance-based contracting is provided. 1.7.2, Concurrent Engineering, provides good definition and description of concurrent engineering. Note the claim ascribed to Grady that "concurrent engineering is merely a return to what systems engineering should be." 1.7.3, Software Engineering for Reuse, defines both types, describes a common life cycle, and discusses the relationship between software reengineering and business process reengineering. 1.7.4, Knowledge-Based Software Engineering, describes the impact of CASE (computer-aided software engineering) tools on software engineering, and projects the potential impact of knowledge-based tools on software engineering (e.g., "Ultimately, the specification-to-design-to-code process will be replaced by domain-specific aids that will generate code directly from specifications.").

1.8 - Conclusions - Most of this section is a brief summary of the chapter. Worthy of particular note is Table 1.1, page 106, pertaining to systems engineering failures. The author concludes in part that systems engineering life cycles should be tools, not simply substitutes for a systems approach.

Reading Guide - Chapter 2
"Systems Engineering Management: The Multidisciplinary Discipline" - by A. J. Shenhar - pages 113-136
[in Handbook of Systems Engineering and Management, A. P. Sage and W. B. Rouse, eds.]

There is a brief synopis of this chapter on pages 34-35.

What should be gained from reading and studying this chapter?

(1) You should be able to identify and describe key differences between systems engineering and systems engineering management.
(2) You should be able to identify the systems engineering management responsibilities for which you are the most, and the least, qualified at this stage of your career.
(3) You should be able to describe the relationships between system scope and technological uncertainty in the context of systems engineering management.
(4) You should be able to describe and critique the author's perception of systems engineering management skills, tools, and disciplines, as well as the educational strategy for achieving same.

General comments: The author is a Professor at the Stevens Institute of Technology in New Jersey who specializes in project management. Formally educated as an electrical engineer, he was with Rafael, a high-technology defense organization in Israel, for more than 20 years, where he served as Executive VP (Human Resources) and also President of the Electronic Systems Division. The paper is well written and relatively straightforward to read. The content is extremely useful to the aspiring or practicing systems engineer or systems engineering manager.

Section 2.1 - Introduction - Provides good background and statement of purpose for the paper.

Section 2.2 - Defining Systems Engineering Management - The author grapples admirably with the fluidity of multiple systems engineering definitions and the proposal for a systems engineering management definition.

Section 2.3 - Activities and Roles of the Systems Engineering Manager - Provides succinct descriptions of systems engineering activities, and the roles that a systems engineering manager might play for differing systems; portions could serve as the basis for position descriptions.

Section 2.4 - Toward a Comprehensive Framework for the Implementation of Systems Engineering Management: The Two-Dimensional Taxonomy - Provides a useful structure for classifying, by scope and technology, a range of technical endeavors. There appears to be a strong conceptual relationship to contemporary innovation studies and theory not referenced here.

Section 2.5 - Different Systems Engineering Management Roles for Various Project Types - Comes very close to yielding a complete set of coherent guidelines for systems engineering managers to use in defining their responsibilities and identifying the types of expertise required. It would be most interesting to relate Shenhar's structure, which emphasizes projects, to industry-based structures proposed by Parker, Twiss and other researchers of innovation and entrepreneurship/intrapreneurship.

Section 2.6 - The Skills, Tools and Disciplines Involved in Systems Engineering Management - Overly brief; cluster selections open to debate, since, for example, it could be argued that clusters 2 and 3 are in reality one cluster addressing technical discipline domain.

Section 2.7 - Developing Educational and Training Programs in Systems Engineering Management - An interesting proposal; perhaps overly ambitious as to graduate program content.

Section 2.8 - Conclusion - First paragraph seems particularly pertinent.

Reading Guide - Chapter 4
"Discovering System Requirements" - by A. T. Bahill and F. F. Dean - pages 175-219
[in Handbook of Systems Engineering and Management, A. P. Sage and W. B. Rouse, eds.]

There is a brief synopis of this chapter on page 35.

What should be gained from reading and studying this chapter?

(1) You should know what a requirement is.
(2) You should be able to identify and describe the basic characterizations of a requirement.
(3) Using the information in the chapter as a reference, you should be able to write a reasonably good requirement, and you should be able to assess the quality of a requirement wirtten by someone else.
(4) You should have a reasonably good understanding of the level of difficulty of identifying and writing good requirements.
(5) You should know and be able to describe the basic stages in the requirements development process.
(6) You should have a reasonable level of comprehension of some of the tools that can be useful in developing system requirements.

General comments: Take into consideration that the chapter emphasizes software systems to the detriment of a balanced presentation more inclusive of hardware systems and human systems. The chapter could benefit from improved organization and less redundnacy. Some of the details incorporated in the main text might have been more aptly omitted or placed in appendices. The chapter is based on a report prepared for the New Mexico Weapons Systems Engineering Center at Sandia National Laboratories in 1996, indicating the context in and perspective from which the chapter material has been selected and written. Bahill, whose educational background is in electrical engineering, is a Professor in the Department of Systems and Industrial Engineering at the University of Tucson in Arizona. Dean, educated in mathematics at the Illinois Institute of Technology, is with Systems Engineering and Project Management at Sandia National Laboratories in Albuquerque, New Mexico.

Section 4.1 - Introduction - Sets the context.

Section 4.2 - Stating the Problem - The essential information can be gained early in each subsection of the section. Examples are useful for further comprehension.

Section 4.3 - What are Requirements? - Excellent information and illustrations.

Section 4.4 - Characterizations - It is important to understand the meanings and implications of

types, sources, modalities (operational needs), and input-output trajectories in characterizing requirements. In 4.4.2, note multiple and overlapping possibilities for sources of requirements, including lack of consensus among expert practitioners as to how requirements should be identified/categorized; listing of sources primarily useful for scanning for use as a reference and the equivalent of a check list when developing requirements. Note the overemphasis on software/programming systems when modalities are discussed in 4.4.3; the three factors to consider in expressing requirements are very good. The segment on input-output trajectories (4.4.4) also overemphasizes details pertinent to software/programming products.

Section 4.5 - Tools for Gathering Requirements - Provides a list and refers to Appendix 4B, which has excellent content (although it might be better organized and more succinct).

Section 4.6 - The Requirements Development Process - The section is somewhat overwritten and becomes repetitive in some places of material elsewhere in the chapter. The importance of this section lies in understanding the stages/phases of the requirements development process and the meanings of same. Figures 4.5 and 4.7 are quite useful. Note the discussion in 4.6.1.6 regarding conflicting operational definitions of "validate" and "verify."

Section 4.7 - Characteristics of a Good Requirement - Provides the equivalent of a 20-item check list of particular use as a reference in assessing the quality of requirements as they are being developed. Note the military/political bias in some of the discussions.

Section 4.8 - Related Items - Good reference material for learning some of the differences in vocabulary use in systems engineering. Provides a good tool for future use.

Section 4.9 - A Heuristic Example of Requirements - The template provided at the beginning of the section is very useful. The example could be a helpful future reference when writing requirements.

Appendix 4A - Behavior Scenarios of ATM Transations - Thorough and detailed example potentially useful for future reference.

Appendix 4B - A Comparison of Some Systems Engineering Tools that Aid in Developing and Understanding System Requirements - Refer to comments under Section 4.7.

Reading Guide - Chapter 5
"Configuration Management" - by P. Brouse - pages 221-233
[in Handbook of Systems Engineering and Management, A. P. Sage and W. B. Rouse, eds.]

There is a brief synopis of this chapter on page 36.

What should be gained from reading and studying this chapter?

(1) You should know what a configuration is.
(2) You should be able to define configuration management and its primary purpose.
(3) You should know and be able to briefly describe basic phases of configuration management.
(4) You should know and have a basic understanding of key configuration management activities.
(5) You should be able to generalize the key configuration management phases and activities to non-software configurations.

General comments: The author is a faculty member at George Mason University, where she also earned her Ph.D. Her educational background is primarily in software engineering and information technology. Her focus in the chapter is almost exclusively on software configuration management. The extensive use of acronyms is likely to create comprehension difficulties for readers having little familiarity with military and ISO standards and acronyms. The chapter is not particularly well written. The Appendix, References, and Bibiligraphy are rich resources, particularly for readers involved with software.

Section 5.1 - Introduction - Provides reasonably good definitions of configuration management, particularly with respect to software.

Section 5.2 - Configuration Management Procedures - The phases that are identified, and the basic meaning of each, are worth noting. Readers involved with software should find some of the details useful in their work.

Section 5.3 - Configuration Management Responsibilities - Table 6.5.1 provides a reasonably good summary of responsibilities.

Section 5.4 - Configuration Management Activities - Read from the perspective of identifying and knowing the five basic activities, and being able to describe and discuss the essence of each. The engineering change proposals forms provided on pages 228 and 229 should be instructive for readers who are not familiar with engineering change proposal processes.

Section 5.5 - Conclusion - Very brief.

Appendix - Applicable Standards - Identifies and briefly describes six documents for standards pertinent to configuration management.

Reading Guide - Chapter 6
"Cost Management" - by B. S. Blanchard - pages 235-268
[in Handbook of Systems Engineering and Management, A. P. Sage and W. B. Rouse, eds.]

There is a brief synopis of this chapter on pages 36-37.

What should be gained from reading and studying this chapter?

(1) You should be able to define, and describe the benefits of, life-cycle costing.
(2) You should know and understand the basic steps in life-cycle cost analysis.
(3) You should have the ability to convey a basic understanding of functional economic analysis.
(4) You should be able to describe a work breakdown structure and how it is used.
(5) You should be able to define, and describe the advantages of, activity-based costing.
(6) You should have the ability to convey a basic understanding of cost and effectiveness analysis.

General comments: The author is a well-known expert in engineering economic analysis and cost management, as well as other domains associated with systems engineering. He is Professor Emeritus of Engineering at Virginia Polytechnic Institute and State University, where he chaired the systems engineering graduate program for almost 20 years. The chapter might have been presented more effectively had some of the material, such as the example of a cost and effectiveness analysis, been placed in an appendix in a case study format. Cost management is an extremely important topic area for project and program managers. The chapter content is relatively well balanced.

Section 6.1 - Introduction - Provides good overview of, and rationale for, chapter content.

Section 6.2 - Life-Cycle Costing - Starts with a good synopsis of life-cycle costing. Figure 6.2 yields succinct summary of the need for life-cycle costing. A key point in 6.2.2 is the application of life-cycle costing to both new and existing systems; Figures 6.3 and 6.4, together with the list of steps on page 241, aptly summarize essential content.

Section 6.3 - Functional Economic Analysis - Read the section from the perspective of extracting the identity and meaning of the four basic activities. For some readers, Figures 6.6 and 6.7 may be more confusing than they are helpful.

Section 6.4 - Work Breakdown Structure - Work breakdown structures are used extensively, and basic knowledge about them is essential. The narrative is a bit dense for an initial discussion of work breakdown structures; readers may find Figures 6.10 and 6.11 to be more instructive than much of the narrative.

Section 6.5 - Activity-Based Costing - In the context of accounting history, activity-based costing is a very new concept. The rationale for activity-based costing is well stated in the initial paragraph of the section. Understanding the basic concepts of activity-based costing allows you to more effectively interpret the distortions in traditional accounting (especially cost accounting) values and reports. Read the section for general understanding. Figures 6.12 and 6.14 are worthy of careful study.

Section 6.6 - Cost and Effectiveness Analysis - Read and understand pages 254 and 255. The balance of the section addresses an example and can be scanned. The example provides a useful guide for anyone who needs to conduct or interpret a cost and effectiveness study.

Section 6.7 - System Evaluation and Cost Control - Read carefully from the perspective of a manager.

Section 6.8 - Summary - Worthy of reading.

Reading Guide - Chapter 8
"Reliability, Maintainability, and Availability" - by M. Pecht - pages 303-326
[in Handbook of Systems Engineering and Management, A. P. Sage and W. B. Rouse, eds.]

There is a brief synopis of this chapter on pages 37-38.

What should be gained from reading and studying this chapter?

(1) You should be able to define reliability, maintainability, and availability (RMA), and identify their differences.
(2) You should be able to describe some benefits of RMA.
(3) You should be able to describe qualification and quality conformance, and identify their differences.
(4) You should be able to define and describe the nature of some basic system reliability models.
(5) You should have the ability to convey a general understanding of failure modes and effects analysis (FMEA).
(6) You should be able to differentiate between readiness and availability.

General comments: The author is a mechanical engineering professor at the University of Maryland who specializes primarily in the assessment of electronic products and systems. The chapter is written almost exclusively from the perspective of hardware, although there are analogous issues with software. There is some uneveness in the chapter; for example, analytic models are included for determining system reliability, but not for predicting failures over system operating life. Overall, this is a good chapter.

Section 8.1 - Introduction and Motivation - Provides good rationale for the importance of RMA.

Section 8.2 - Evolution of RMA Engineering - Good historical background; provides context for RMA.

Section 8.3 - Allocation - Some readers may have difficulties deciphering this small section. The essence is that RMA goals (and relevant metrics) are specified during the concept phase for subsystems, based on allocations of the RMA system goal. Historical data provide the basis for defining subsystem goals. [Note that the aggregation of estimated RMA performance of subsystems can yield an estimated RMA performance of the system.]

Section 8.4 - Design for Reliability - Provides nicely organized descriptive list of major RMA tasks to be addressed as part of the systems engineering and management process.

Section 8.5 - System Architecture - [note: the second paragraph of 12.2 on page 430 provides

concise architecture definitions.] Chapter has good exposition on protective system architectures (e.g., redundant systems).

Section 8.6 - Stress Analysis and Management - Emphasizes physical stresses on physical entities and systems. Readers will have differing levels of comprehension depending on their knowledge of physics and/or engineering sciences.

Section 8.7 - Qualification - Good exposition; good description of what qualification is.

Section 8.8 - Reliability Testing - Emphasizes physical components and systems. Readers will have differing levels of comprehension depending on their knowledge of physics and/or engineering sciences.

Section 8.9 - Quality Conformance - Good discussion of conformance issues and approaches for physical systems.

Section 8.10 - Reliability Assessment - Good discussion of considerations relevant to identifying and mitigating potential failure mechanisms before they occur; focus is on physical components and systems; example physics-of-failure process for electronics is provided in Figure 8.1 and is helpful.

Section 8.11 - System Reliability Assessment and Modeling - Primary emphasis of section is on traditional mathematical models. These models have been applied to hardware, software, and bioware. Readers will have differing levels of comprehension depending on their knowledge of these mathematical models. Readers should focus on comprehension of 8.11.6 and the first paragraph of each of subsections 8.11.1, 8.11.2, 8.11.4, and 8.11.5. Scan the remainder of the section.

Section 8.12 - Fault Trees - Short section is difficult to understand if reader has no familiarity with fault trees. Before reading the section, it may be beneficial to examine the fault trees illustrated in Figure 3.16 on page 166, and Figure 19.1 on page 693.

Section 8.13 - Failure Modes and Effects Analysis (FMEA) - A good exposition on the FMEA process.

Section 8.14 - Design for Maintainability - The field of maintainability is in its infancy in comparison to reliability; some basic principles and admonitions with respect to hardware are presented in the section; software analogues exist but are not discussed; there are some analytic approaches to maintainability that are not addressed here.

Section 8.15 - Data Collection, Classification, and Reporting - First two paragraphs address concerns regarding data collection and reporting; failure classifications for physical entities are summarized; there is no discussion of the analytic approaches to modeling the failures for

comprehensive system evaluations.

Section 8.16 - Warranties and Life-Cycle Costs - Skim this short section; the content is minimal, and the topics are worthy of more attention.

Section 8.17 - Operational Readiness and Availability - Read. Not addressed here are analytic approaches for modeling readiness and availability and for assessing the consequences of same.

Reading Guide - Chapter 9
"Concurrent Engineering" - by A. Kusiak and N. Larson - pages 327-370
[in Handbook of Systems Engineering and Management, A. P. Sage and W. B. Rouse, eds.]

There is a brief synopis of this chapter on page 38.

What should be gained from reading and studying this chapter?

(1) You should be able to define concurrent engineering.
(2) You should have the ability to briefly summarize some contemporary analytical approaches to concurrent engineering.

General comments: Kusiak is a Professor and the Director of the Intelligent Systems Laboratory at University of Iowa. Larson is Lean Transformation Manager at Rockwell Collins in Cedar Rapids, Iowa, and earned his Ph.D. under Kusiak. Most of the research summarized in the chapter was conducted by Ph.D. students working under Kusiak. A majority of the chapter cannot be understood by readers who are not conversant with the set of analytic methods frequently grouped under the rubric of operations research, and with process modeling computer languages. Regardless, selective reading and review yields insight into some of the analytic approaches that are influencing and institutionalizing concurrent engineering environments.

Section 9.1 - Introduction - Provides insight into the motivation for concurrent engineering.

Section 9.2 - Concurrent Engineering and the Product Life Cycle - Provides excellent background on concurrent engineering; Table 9.1 is well worth noting.

Section 9.3 - Building a Concurrent Engineering Environment: A Systems Engineering Perspective - This lengthy section is primarily devoted to descriptions of analytic research models of concurrent engineering components and some results from their application. The section is divided into subsections to address research on the people, processes, mechanisms and information components as part of concurrent engineering. With the exception of the content in the list provided below, the rest of the section can be scanned. Some of the models and methods described will be of interest to, and accessible to, some readers depending on their background. Read at least pages 330-331; paragraphs 1-3 of 9.3.1.2; paragraph in middle of page for 9.3.2; paragraphs 1-4 of 9.3.2.1; paragraph 1 of 9.3.2.2; paragraphs 1-3 of 9.3.3; paragraph 1 of 9.3.3.1; paragraph 1 of 9.3.4; all of 9.3.4.1; paragraphs 1-7 of 9.3.4.2.

Section 9.4 - Managing a Concurrent Engineering Environment: Tools and Techniques - Like Section 9.3, this section consists primarily of research reports. With the exception of the content listed below, the remainder of the section can be scanned. Read paragraph 1 of 9.4 and 9.4.1;

paragraphs 1-2 of 9.4.2.

Section 9.5 - Implementation - Reasonable, but relatively sparse, overview of implementation concerns.

Section 9.6 - Conclusion - More a summary rather than a conclusion; worth reading.

Reading Guide - Chapter 13
"Systems Design" - by K. P. White, Jr. - pages 455-481
[in Handbook of Systems Engineering and Management, A. P. Sage and W. B. Rouse, eds.]

There is a brief synopis of this chapter on pages 40-41.

What should be gained from reading and studying this chapter?

(1) You should be able to define systems design and to describe an iterative design process.
(2) You should be able to describe some common difficulties encountered in the design process, and some approaches to ameliorating them.
(3) You should be able to identify and briefly describe a design tool.
(4) You should be able to describe at least one design theory.
(5) You should have the ability to convey a basic understanding of concurrent engineering, DFM, and DFX, as well as their relationships to one another and to systems design.
(6) You should be able to describe some common difficulties encountered in implementing concurrent engineering, DFM, and DFX concepts.
(7) You should be able to describe the applicability of concurrent engineering, DFM, and DFX concepts to your technical professional domain.

General comments: The author is a Professor of Systems and Information Engineering at the University of Virginia. His background is primarily in areas associated with operations research, and he has a considerable interest in design for manufacturing (DFM). The chapter is unusual in its emphasis on the role of DFM in systems design. It will be advantageous to readers to interpret DFM concepts in the context of their own technical professional domain.

Section 13.1 - Introduction: What is Systems Design? - Briefly addresses definitions of design.

Section 13.2 - Steps in the Design Process - Generally good discussion of the technical design process. The subsection titles follow the design process shown in Figure 13.1 on page 456. Subsections 13.2.1 and 13.2.2 are relatively strong; Subsection 13.2.4 is overly sparse. Read the entire section carefully.

Section 13.3 - Design Tools - Uneven presentation, with emphasis on CAD/CAE/CAM/CIM. and having only references to other chapters to address the multitude of other design tools. The section is relatively weak in content.

Section 13.4 - A Brief History of Recent Design Theory - The reader should benefit from reading this section both after reading Section 13.1, and then again after reading Section 13.3. Read the entire section carefully; it provides important contexts for understanding the challenges and

elusiveness of achieving good technical design.

Section 13.5 - Design and Concurrent Engineering - [Note: DFM is an acronym for "Design for Manufacturing."] The presentation in this section is somewhat uneven, and so it must be read carefully. It is very important to note that DFM is a philosophy, that it has not been fully realized, and that it extends far beyond manufacturing and engineering per se. Readers from the computer science technical domain should take particular note of the central significance of information systems in the potential realization of DFM/concurrent engineering.

Reading Guide - Chapter 14
"Systems Integration" - by J. D. Palmer - pages 483-518
[in Handbook of Systems Engineering and Management, A. P. Sage and W. B. Rouse, eds.]

There is a brief synopis of this chapter on page 41.

What should be gained from reading and studying this chapter?

(1) You should be able to define systems integration and describe its purposes.
(2) You should be able to identify the seven-phase systems integration life cycle and describe the activities in each phase.
(3) You should be able to assess your strengths and weaknesses as an aspiring professional on a systems integration team.
(4) You should be able to convey an understanding, in the context of systems integration, of issue identification, issue formulation, and issue resolution.
(5) You should be able to describe the roles and purposes of strategic planning relative to systems integration.
(6) You should be able to describe the purposes of a systems integration audit trail.
(7) You should be able to describe at least three quality assurance concepts as they pertain to systems integration.
(8) You should be able to identify and describe at least two difficulties with systems integration risk management.

General comments: The author is a Professor Emeritus of the School of Information Technology and Engineering at George Mason University. He is the author or coauthor of several books and papers on large scale systems and software systems. The chapter is lengthy, emphasizes software systems integration, and the presentation is uneven. The chapter addresses systems integration from the vantage point of a company engaged in the business of systems integration.

Section 14.1 - Introduction - Concise presentation well worth reading carefully. Note the author's positioning of systems integration as a complex task performed by a company for a client.

Section 14.2 - Systems Integration in Large, Complex Engineered Systems and a Systems Integration Life Cycle - Read carefully. Presents a seven-phase life cycle for systems integration, and then identifies and discusses some of the primary activities within each phase. Note that the waterfall model in Figure 14.1 on page 487 has an error; i.e., "Evaluation" and "Implementation" should be exchanged. Subsection 14.2.3 and Table 14.1, both on page 490, provide valuable insight to software systems life cycle cost components.

Section 14.3 - Systems Integration Management and Technical Skillls and Training Requirements - Although oriented toward software systems, most of the information in this section is readily generalized to other types of complex systems. The value of a relatively broad educational and experiential background for individuals aspiring to systems integration responsibilities is aptly conveyed (see, e.g., Table 14.3 on page 492).

Section 14.4 - Systems Integration Strategy for Success - The tone of this section differs from those that precede it, and the presentation is a bit uneven (e.g., brief references to some figures with little or no explication of same). Section content seems akin to a "do-and-don't" tutorial for companies that are systems integration contractors. The discussion of issues on page 494, and Subsection 14.4.6, are worthy of careful attention.

Section 14.5 - The Audit Trail - The audit trail addressed in this section pertains to the project content and activities, not the more typical financial audit trail. The section should be read carefully, and the need for creating audit trails for technical project work should be taken seriously.

Section 14.6 - Quality Assurance in Systems Integration - Software quality assurance is emphasized. The section is somewhat difficult to follow and might benefit from some reorganization. Pay particular attention to the first paragraph of 14.6, the last two paragraphs of 14.6.1, and Subsections 14.6.2 and 14.6.5.

Section 14.7 - Subcontractor Management for Systems Integration - This section can be scanned; the content presentation is rather general. I did not care for the tone of the section.

Section 14.8 - Subsystem Integration and Delivery - As with Section 14.7, this section can be scanned; the content presentation is rather general. I did not care for the tone of this section.

Section 14.9 - Risk Management - Note the first paragraph of 14.9 and the list of risk management components on page 514. The remainder of the section can be scanned. Although the author is discomfited by qualitative questionnaire approaches, no mechanisms for improving the methodology are proposed.

Reading Guide - Chapter 15
"Systematic Measurements" - by Andrew P. Sage and Anne J. Jensen - pages 519-589
[in Handbook of Systems Engineering and Management, A. P. Sage and W. B. Rouse, eds.]

There is an overly brief synopsis of this chapter on pages 41-42.

What should be gained from reading and studying this chapter?

(1) You should be able to describe at least one major generic purpose for measurement.
(2) You should be able to describe at least two desirable generic attributes of organizational metrics.
(3) You should be able to identify and describe four basic levels of an organization's involvement with measurement.
(4) You should be able to describe at least three relationships between TQM (Total Quality Management) and organizational performance measurement needs.
(5) You should be able to describe the relationship between organizational metrics and organizational strategy.
(6) You should be able to define and describe the GQM (Goal-Question-Metric) approach and its applicability to systematic organizational measurement.
(7) You should be able to identify and describe six historical phases in the development of organizational performance assessment.
(8) You should be able to define the purpose of, and briefly describe the types of metrics used for, the Deming Prize, the Baldrige Award, the ISO 9000 Series, ISO 14000, and GPRA (Government Performance and Results Act).
(9) You should be able to briefly describe the organizational performance measurement approaches proposed by Sink and Tuttle, Kaplan and Norton, and Thor.
(10) You should be able to define FURPS (Functionality-Usability-Reliability-Performance-Supportability) and describe its potential use for establishing and assessing customer satisfaction metrics.
(11) You should be able to describe the use of QFD (Quality Function Deployment) for establishing and assessing customer satisfaction metrics.
(12) You should be able to describe Peters' prescriptions for organizational excellence, and describe at least one potential measure for each prescription.
(13) You should be able to identify and describe the five metric capability maturity levels, and the three process areas, for an SE-CMM (Systems Engineering Capability Maturity Model).
(14) You should be able to identify and rank the most important organizational performance measures as reported by CEOs (Chief Executive Officers).
(15) You should be able to define the purpose and describe the distinguishing characteristics of an EIS (Executive Information System).
(16) You should be able to describe some success and failure factors associated with the development and implementation of an EIS.
(17) You should be able to debate the relative importance of the content of "Systematic Measurements" to the study of systems engineering and management.

General comments: Sage is with the faculty of the Department of Systems Engineering and Operations Research at George Mason University, and is one of the editors of the Handbook of Systems Engineering and Management. Jensen, who studied in the Department, is with the MITRE Corporation, a Federally Contracted Research Center extensively engaged with systems engineering and management. The chapter, much of which is based on a 1995 book authored by Sage, is lengthy and comprehensive, and should be read carefully in its entirety. The material presented is essential to understanding and addressing organizational performance at managerial levels.

Section 15.1 - Introduction - Articulates motivations for making measurements. Makes persuasive arguments for using measurements in organizations.

Section 15.2 - Organizational Needs for Systematic Measurement - Identifies the need for measurement to determine performance levels and to evaluate desired performance improvements. Discusses the difficulties in determining what should be measured, why it should be measured, and how it should be measured, such that it is useful for managers in organizations.

Section 15.3 - Measurement Needs - It can be difficult to differentiate the purpose of this section from that of Section 15.2. One emphasis here is the identification of types and attributes of measurements appropriate to organizational settings. Suggests that published taxonomies of organizational performance measurements, such as ISO 14000, can often be utilized. Relates Total Quality Management (TQM) measurement principles to the broader organizational setting. Proposes a three-dimensional conceptual framework for organizational performance measurements (see page 530, Figure 15.2). This section is likely to require more than one reading in order to grasp it holistically.

Section 15.4 - Organizational Measurements - The thrust of this section interweaves with the preceding two sections and also anticipates concerns about knowledge management. Considers the relationship between organizational strategies and the metrics selected and used. Introduces GQM (Goal-Question-Metric) approach. Provides an historical perspective of organizational performance measurement development.

Section 15.5 - Metrics from Widely Accepted Standards, Awards, and Government Requirements - A nicely rendered section addressing the Deming Prize, the Malcolm Baldrige National Quality Award, the ISO 9000 series of standards, the ISO 14000 standards, and the Government Performance and Results Act (GPRA) requirements. Provides the rationale for, and some insight into the history of, these national (U.S.) and international performance standards. The level of detail included yields an excellent set of reference material for the identification of potential organizational metrics. Although not strongly emphasized in the section, one of the key advantages of using publicly-acknowledged metrics is the potential ability to benchmark performance in relation to other organizations.

Section 15.6 - Selected Measurement Approaches - Provides overview and explanation of three published conceptual approaches to organizational performance measurement: Sink and Tuttle's Organizational Performance Measurement Approach, Kaplan and Norton's Balanced Scorecard Approach, and Thor's Family of Measures Approach. Each of the three approaches provides much-needed guidance to the manager for the development and implementation of an organizational performance measurement system. The first two approaches are also illustrated with helpful figures. The material in the section is quite interesting.

Section 15.7 - Systematic Measurements of Customer Satisfaction - This section is particularly important reading for technical professionals, who are not noted for being attuned to thinking in terms of customer satisfaction. Three approaches are discussed: FURPS (Functionality-Usability-Reliability-Performance-Supportability) attributes assessments, QFD (Quality Function Deployment), and Peters' excellence prescriptions [Peters is Thomas J. Peters who, with Robert H. Waterman, published the best-selling "In Search of Excellence: Lessons from America's Best-Run Companies" in the early 1990s]. The figures included in the section assist in understanding and potentially implementing the approaches. The need to address the internal customer is overlooked in the section's emphasis on the external customer.

Section 15.8 - Systematic Measurements of Effort and Schedule - This is a minimal-content section providing little insight to a topic area of considerable importance in, for example, contract and project management.

Section 15.9 - Systematic Measurements of Defects - Another minimal-content section with multiple references to other sources for the consideration of the topic area.

Section 15.10 - Metrics Process Maturity - Provides an important focal point for understanding that performance measurement systems must evolve over time. Discusses maturity levels and models, relationships with information technology, and benchmarking. Some of the considerations of the Capability Maturity Model (CMM) and the Systems Engineering Capability Maturity Model (SE-CMM) are described, as well as types of positive and negative relationships with information technology. The central message of this section is important and needs to be heeded.

Section 15.11 - Information Technology and Organizational Performance Measurement - Traces the evolution of performance measurement systems in conjunction with information technology. Emphasis on EISs (Executive Information Systems) and their strengths and weaknesses. Consideration of the problems of identifying the information that is needed and how to acquire it.

Section 15.12 - Summary - A relatively brief summary of the primary features of the chapter is followed by the introduction of levels of systematic measurement strategies, the relationship between different types of measurement costs and organization cost and effectiveness, and Schiemann and Lingle's "seven greatest myths of measurement." This section is very worthwhile reading.