PART III

METHODS, TOOLS, AND TECHNOLOGIES

From the point of view of the human systems integration (HSI) practitioner, this part is the heart of the *Handbook.* Collectively the following seven chapters provide the state of the art for those methods, tools, and technologies needed by practitioners to effectively participate in the systems acquisition culture (Part I) and processes (Part II). All of the HSI domains have at least one chapter devoted to the methods, tools, and technologies specific to their domain, but the contributors have made special efforts to indicate areas where there is overlap among their disciplines and point out those methods, tools, and technologies that are designed to integrate several domains. Most of the chapters in this part provide amplifying information that is directly related to principle 7 (HSI technology).

Chapter 11, by Archer, Headley, and Allender presents the state of the art for manpower, personnel, and training (MPT) integration methods and tools. It begins with a description of MPT factors important in analysis and assessment issues, covers examples of tools developed by the U.S. military services, the United Kingdom, and Canada to support MPT trade-off processes, illustrates examples of nonmilitary MPT tools usage, and ends with the key challenges facing future developers of MPT integration technology. This chapter is the most comprehensive chapter in the *Handbook* for illustrating the technical results of military and commercial investment in HSI technology for the past decade.

In Chapter 12, Hettinger describes training as one of the most critically important disciplines involved in the safe and effective operation of complex human–machine systems. He recognizes, however, that the training domain is perhaps the least developed HSI domain conceptually, methodologically, and culturally. Although training, when utilized to prepare individuals to function within the context of existing systems, is well established, it has been largely unsuccessful at achieving the benefits that should be expected from an HSI approach to systems acquisition. The objective of training from an HSI perspective is not simply to instill knowledge, skills, and abilities (KSAs) into personnel adequate to satisfactorily operate and maintain developed systems. Training should also (a) influence systems requirements, design, development, test, and evaluation throughout all stages of the system acquisition process and (b) incorporate knowledge from other technical domains when conceiving training requirements and strategies. Because of the relative immaturity of the training domain at influencing the systems

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acquisition process, the primary objective of Hettinger is to provide a state-of-the-art review on training from an HSI perspective. He does this by providing a new training model as a framework for integrating training within the systems acquisition process; discussing the key training issues and challenges currently facing the training domain; and summarizing some of the more pressing research and applications questions needing answers to help steer training into a more effective HSI domain.

With Chapter 13, Lockett and Powers present a much needed overview of the broad area of human factors engineering (HFE) methods and tools. Although there is extensive information on methods and tools throughout the human factors literature, it is difficult for the beginning HFE practitioner working as part of an HSI team to employ HFE methods and tools effectively. Lockett and Powers organize their chapter so that it begins with a brief discussion of the purpose and scope of human factors engineering, followed with a description of HFE basic methods accompanied with useful information on how to find, select, and employ HFE technologies and tools. They describe the major classes of tools and methods available to address HFE issues as a part of HSI. Examples of tools and methods covered range from guidelines, standards, user juries, and mockups to task network modeling, human figure modeling, and work domain analysis. Near the end, they provide a section on common pitfalls to avoid in HFE that has proved especially useful for HFE program managers. Selected references are provided to guide the reader through the vast field of HFE.

Chapter 14, by Swallom, Lindberg, and Smith-Jackson, provides an introduction to the system safety (SS) domain for HSI. System safety includes system safety engineering and management and involves both the organizational practice of a systems approach and the design of the work environment to be consistent with a systems approach. System safety engineering deals with the tools of the trade, the principles and methodology of analyzing the hazards of system components, subsystems, and interfaces. System safety management deals with how system safety decisions are made based on the system safety engineering analysis. Swallom, Lindberg, and Smith-Jackson designed their chapter to provide information useful not only to SS practitioners but also to be helpful to those disciplines having interfaces with SS in conducting system development efforts. Their chapter includes key safety definitions and references, basic risk assessment models, a comprehensive list with selected examples of system safety methods and techniques, and an outline of the system safety process. The specific methods and techniques described include various hazard analyses, event and fault tree analyses, failure mode and effects analysis, and cause–consequence analysis. The chapter provides sufficient detail of the SS process steps (identify, assess, mitigate, verify, accept, and track SS requirements) so that the chapter can act as a general guideline for system safety applications in the systems acquisition process.

In Chapter 15, Roberts presents the state of the art on health hazards (HH) categories applicable to military and commercial environments. He describes each HH category in considerable detail, including the hazard definition, its health consequences, typical hazard sources, typical subject matter experts, and current tools and techniques used to assess and control the hazard. The HH categories are: acoustic energy, biological substances, chemical substances, oxygen deficiency (ventilation and high altitude), radiation (nonionizing and ionizing) energy, shock (nonelectrical), temperature extremes (hot and cold), trauma, and vibration. Roberts also provides an extensive reference list for detailed sources on each HH category.

Perhaps the most unique domain for HSI is personnel survivability. Unlike the other six domains, it is not considered a formal discipline having a career field such as human factors, safety, health, personnel, and training. There are no institutions that grant degrees in personnel survivability. It is, however, an extremely important HSI domain. Personnel survivability is the HSI domain that addresses those system acquisition concerns of how to help personnel survive during combat and other hostile events. With Chapter 16, Zigler and Weiss introduce the reader to the personnel survivability domain by describing the systems survivability concept along with personnel survivability methodology available for use by survivability analysts. Zigler and Weiss discuss the systems acquisition issues involved in trying to increase the likelihood that equipment and people operating as a system can survive hostilities and illustrate these issues with numerous examples drawn from actual events. Their chapter defines the six components that make up personnel survivability and discusses each of the components in the context of a survivability analyses process. Survivability analysis tools such as the MANPRINT soldier survivability (SSv) "parameter assessment list" and the interactive survivability considerations chart are described to illustrate how the HSI analyst proceeds through the survivability analysis process.

Rouse and Boff acknowledge in Chapter 17 that assessing and trading off economic and noneconomic factors in HSI can be very difficult. The combination of such uncertainties as both tangible and intangible benefits, multiple stakeholders, and inherent unpredictability make cost–benefit analyses for HSI a considerable challenge. Rouse and Boff address this challenge by first reviewing alternative frameworks for cost–benefit analysis and then proposing an overall methodology for situations with these characteristics. Use of the methodology is illustrated by its application in three investment problems that involve technologies for aiding, training, and ensuring the health and safety of personnel in military systems. This chapter is one that perhaps could have fit into one or more of the other parts as well as Part III. It was placed here, however, because of its methodological approach and to expose HSI methods, tools, and technology developers to the subtleties and complexities of making a convincing cost–benefits argument for program managers and acquisition decision makers.