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Work in Process: A Body of Knowledge and Curriculum to Advance Systems Engineering (BKCASE™)

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***Abstract*—This paper reviews the progress and content of the Systems Engineering Body of Knowledge (SEBoK) and the Graduate Reference Curriculum for Systems Engineering (GRCSE™) products being developed as part of the Body of Knowledge and Curriculum to Advance Systems Engineering (BKCASE™) project initiated in September 2009. The version 0.25 of each product was released for limited review in fall 2010; version 0.5 of each product will be released for public review in fall 2011; and final version 1.0 of each product are due out in fall 2012. This paper reviews how these products differ from and build upon existing products, and recounts lessons learned after the first 15 months on the project.**

Keywords-systems engineering body of knowledge; systems engineering graduate reference curriculum; systems engineering education; systems engineering workforce development; systems engineering competencies

I. INTRODUCTION

As described in [1], BKCASE is a three-year effort to produce two version 1.0 products: a Systems Engineering Body of Knowledge (SEBoK) and a Graduate Reference Curriculum for System Engineering (GRCSE), in 2012. The BKCASE project is supported by several professional societies including the International Council on Systems Engineering (INCOSE) and the Institute of Electrical and Electronics Engineers (IEEE). BKCASE has additional support by way of sponsored and volunteer authors (about 50) and volunteer reviewers, from government, industry and academia in nine different countries across five continents.

The purpose of BKCASE is to define the "fuzzy boundary" and organize the vast knowledge of the discipline of systems engineering, including its methods, processes, practices, and tools, by way of a comprehensive guide to the SEBoK. In addition, BKCASE is developing a graduate reference curriculum for systems-centric [see 2] programs, documented in GRCSE, that addresses entrance expectations, students' outcomes and objectives, and core knowledge as guidance to both universities and hiring institutions. As such SEBoK is the first broadly based, multisectored, international organization of the systems engineering body of knowledge. This is distinct from other organizations of the body of knowledge developed by particular institutions or authors in the form of guidebooks or textbooks. As such the development of the SEBoK makes a significant contribution to knowledge in SE.

Much of the funding and sponsorship for BKCASE was provided by the U.S. Department of Defense.

II. BACKGROUND

A. Defining the Project

The BKCASE project was started in September 2009 by a core team from the Stevens Institute of Technology, the Naval Postgraduate School, and the U.S. Department of Defense (DoD). This team established guiding principles for BKCASE, including the project charter, vision, objectives, value propositions, project strategy, project characteristics, team and schedule, as described in detail in Appendix A of [3].

B. Communicating the Project

One of the first objectives of BKCASE was to recruit qualified authors and reviewers to develop credible, authoritative products. To recruit these authors and reviewers, the core team members communicated the vision, purpose, and values of the BKCASE project within and beyond the main systems engineering community by distributing flyers, publishing and presenting works describing aspects of the BKCASE project, and sharing information by word of mouth. Project core team members and authors attended conferences around the world where they presented papers, or held panels and sessions to collect ideas for content development or to brief the project's strategy and goals. Appendix A lists the conferences in which the BKCASE team participated in 2010. All project presentations, published conference papers, articles (including [1], [3] and [4]) and panels are available for download from the project website, www.bkcase.org. This

website is frequently updated to provide the latest events, publications, and deliverables. A similar but more widespread BKCASE outreach strategy will continue in 2011.

C. Implementing the Project

Every quarter, the BKCASE author and core team meet to plan the next round of milestones and deliverables and to reach consensus on content and strategy. Each workshop presented its own unique challenges and required a dynamic approach to making progress with a large team of primarily volunteers. One of the distinctive features of the project has been the ability of the core team to maintain consensus among the diverse authors. The periodic workshops were key to achieving this consensus. The approach and results from the first four workshops (a total of 12 are planned) are summarized below.

1) Workshop One

At the initial author workshop in Monterey, CA, in December 2009, 21 authors and team members developed an initial structure for the SEBoK based on the existing INCOSE Handbook and ISO standards [5] and [6], subdivided the work and began to write [7].

2) Workshop Two

At the second workshop in Daytona Beach, FL, in March 2010, the 29 authors and team members expanded the contents of the SEBoK to include applicable knowledge outside of the system life cycle processes space, including systems thinking and concepts. The authors organized the SEBoK around knowledge areas (KAs), topics, and sub-topics and continued writing, now based upon the framework used in [7].

3) Workshop Three

At the third workshop in Chicago, IL in July 2010, 35 authors and team members agreed on the final content areas for [8] as documented in Appendix B. The core team and the authors also agreed on the release criteria and process for the first draft of the SEBoK.

4) Workshop Four

By the fourth workshop in Toulouse, France in October 2010, the first draft of the SEBoK [8] had been released and the 28 authors and team members focused on completing the initial GRCSE development effort. The team finalized release criteria and processes for the first draft of GRCSE. Appendix C lists and describes the final GRCSE content areas.

III. THE SEBOK

One of the most important hallmarks of the maturation of a discipline is an agreement by the professional community regarding what knowledge is included in the discipline and how that knowledge should be captured and organized to facilitate its use by practitioners, researchers, and educators; i.e., a guide to its body of knowledge. Without such a recognized body of knowledge, the discipline has no community-accepted framework to guide practice, education, and certification. The purpose of the SEBoK is to build a guide to the existing BoK for systems engineering while also addressing the gaps in the current available BoK.

A. SEBoK Background and Evolution

The SEBoK builds on earlier work by INCOSE to establish such a body of knowledge (see [9], [10], [11]), on the current INCOSE Handbook [5], and on current standards [6]. The initial approach adopted for the SEBoK allowed us to assign writing to the authors quickly and efficiently to ensure clear direction and progress from the start. The SEBoK extends the earlier works by providing detailed references to the literature — over 800 in the first draft — that provide detail and context. Where there were gaps in the literature, the authors provided essays to cover the material. This outline was amended in workshops to broaden beyond the process focus and to include additional key material on enterprise SE, service SE, systems thinking, case studies, and other important topics. See Appendix B for a listing of the type of knowledge areas and topics addressed in the SEBoK version 0.25.

The SEBoK is being released in three versions. Version 0.25, released in September 2010, is the first draft intended for limited review by a set of about 200 reviewers vetted by the BKCASE team. As an initial draft, the maturity of chapters differed across the document. This version was over 650 pages in length including the front matter as well as references and a glossary. By December, more than a hundred reviews had been received. Version 0.50 will address the first round of comments and the continued work of the author team and will be released in September 2011 for general public comment. The final version 1.0 will be released in September 2012.

It is the vision of the core team and authors that the relevant professional societies will jointly assume the stewardship and maintenance of the SEBoK after the release of version 1.0, and that the SEBoK will be periodically updated under their leadership.

B. SEBoK Lessons Learned

In the development of SEBoK, one of the first challenges the team faced was to broaden the knowledge areas of systems engineering well beyond the typical life cycle perspective. Also, coordinating and leading the efforts of a large multinational team of volunteer authors is challenging. Quarterly meetings with the personal attendance of the authors provided a way to establish consensus and to keep the effort aligned. A core editorial team was necessary to organize and support the effort. This team attended to the document management and logistical details, freeing the authors to write; the core team leadership shepherded the establishment of consensus while also contributing as authors on the project.

IV. GRCSE

GRCSE is being developed to provide a framework for establishing greater understanding of the nature of graduate programs in systems engineering. GRCSE is intended to fill a gap in the systems engineering education community that

will assist that community in establishing descriptions of programs that enable students and prospective employers of graduates to better understand the nature of the systems engineering programs available to them and the kind of attributes developed in graduates across the spectrum of such programs.

A. GRCSE Background and Evolution

To get started, GRCSE leveraged the source document of an earlier program to produce a graduate reference curriculum for software engineering [see 12]. Several of the authors of [12] are also members of the author team of GRCSE. The content of GRCSE was based upon efforts documented in [13] through [19]. The GRCSE project was initiated at the end of March 2010 and the team has documented and released a version 0.25 [20] to a broad but limited team of reviewers. In the version 0.25 of GRCSE, the authors defined and drafted initial content for all chapters and defined most of the appendices expected for the final version (see Appendix C). Most of the chapters and appendices in [20] are developed to a state of maturity that will enable reviewers to make substantial comments about both the content and the form of expression of the ideas contained in the document.

The initial approach adopted for GRCSE allowed us to identify the space that we wished to address and to assign writing to the authors quickly and efficiently to ensure clear direction and progress from the start. In particular we defined the education space for GRCSE to include the cognitive and affective domains described in Bloom's taxonomy of educational objectives, and included the education life cycle from the background expected of students entering a master's program to the expected career destinations of graduates about three to five years after graduation. Bloom's cognitive domain is included to address the considerable amount of knowledge about topics required to succeed in systems engineering. Bloom's affective domain is included to address the personal attributes associated with the ability to lead and to relate to people, combined with the need for a systems engineer to believe in the value of systems engineering activities.

The education life cycle for GRCSE begins with the background expected of students seeking to enter a master's program in systems engineering because that is the first point at which an education program has control over who is accepted. GRCSE identifies the core content expected in all systems engineering degrees and extensions to the core knowledge for two focus areas: technical management and systems design and development. GRCSE provides a flexible architecture to enable universities to design their programs to accommodate a variety of university-specific factors. Our intention is not to create a single kind of systems engineering graduate but rather to provide a framework that enables better understanding of the range of systems engineering capabilities possessed by graduates. GRCSE describes the expected outcomes, that is, the capabilities possessed by graduates at the time of graduation, in broad terms that are consistent with the GRCSE architecture.

GRCSE also describes the issue of objectives of programs. Objectives concern the career pathway of graduates after three to five years from graduation. We include the discussion of objectives to guide educators using GRCSE in the design of their programs to consider the objectives they are planning to achieve through their program. The objectives that we describe accommodate the wide range of kinds of activity performed by systems engineers but show that it is important for curriculum designers to look forward into the career of the graduates whom they hope to produce. A detailed listing of [20] content by chapters and appendices, and a short description of each, is included in Appendix C. This version of GRCSE was just over 100 pages including front matter as well as references and a glossary.

The forward plan for producing GRCSE version 0.5 is to respond to review comments, update sections and release in December 2011 for an open public review. The review period for version 0.5 will again be about three months. During 2012 the author team will respond to the second round of review comments and prepare the final version 1.0 for release to the public in December 2012.

The BKCASE team intends to hand over responsibility for future revision of GRCSE to professional societies that agree to a suitable maintenance process. The team believes that GRCSE should remain a living document with the possibility of future revisions to accommodate changes in systems engineering in response to changes in the environment and demands placed upon practitioners. These changes may include new technology to develop and support systems or to perform the engineering work; or changes in the enterprise, political, regulatory and social environment surrounding the conduct of systems engineering.

B. GRCSE Lessons Learned

The curriculum of systems engineering extends far beyond a tailored integration of existing curricula across the engineering and scientific domains. The most significant challenge for the GRCSE team has been defining a program that balances a manageable amount of required content with flexibility and value. The primary lesson the team learned was that a curriculum that focused on standardizing the core knowledge across all programs was insufficient for addressing both the diversity and needed value of the discipline; that is, the scope of SE was too broad to allow for specificity in defining a large amount of core content and knowledge levels to be achieved by all graduates. This finding led the team to develop core focus areas that extended the required core foundation to additional areas and yet allowed the tailoring of that extension based on the needs of the student, the institution, and society. These focus areas, introduced in version 0.25, require additional refinement that balances greater detail with a broader perspective and can benefit from input from systems engineering educators and those experiencing workforce challenges around the globe.

V. Anticipated Impact of SEBoK and GRCSE

Institutions such as the U.S. DoD and the U.S. Congress, as expressed in the Weapon Systems Acquisition Reform Act of 2009 [21], recognize that the profession of systems engineering is essential to securing national defense, dealing with complex systems, and addressing grand challenges. Government and industry are major employers of system engineers and academic institutions are the principal suppliers of systems engineers. Ideally, the BKCASE products will provide globally recognized guides for these stakeholders. If successful, the guide to the SEBoK will become a major reference to the knowledge required for the education, training, development and practice of systems engineering. GRCSE will support universities in defining systems engineering programs that produce systems engineering graduates with known capabilities and this, in turn, will help organizations better manage their systems engineering workforces.

Conclusion

If successful, SEBoK will contribute substantially to identifying the boundaries and context of systems engineering and therefore makes an important contribution to both the theory and practice of systems engineering. Similarly, a successful GRCSE will make a significant contribution to the understanding of a holistic educational program life cycle as a tool for educating systems engineers and demonstrates the importance of education as a means of developing a comprehensive set of attributes required for successful practice in systems engineering. Both products will benefit from feedback provided by the broader community.

Acknowledgment

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Appendix A. Conference Participation

2010 conferences in which the BKCASE team participated:

- INCOSE International Workshop (IW),
- Conference on Systems Engineering Research (CSER),
- IEEE International Systems (IS) Conference,
- Systems & Software Technology Conference (SSTC),
- European Systems Engineering Conference (EuSEC),
- American Society of Engineering Education (ASEE),
- INCOSE International Symposium (IS),
- 4th Asia-Pacific Conference on Systems Engineering (APCOSE),
- NDIA Systems Engineering (SE) Conference,
- Conference on Navy Lessons Learned at NPS, and
- INCOSE UK Annual Systems Engineering Conference.

Appendix B. SEBoK Version 0.25: Covered Content

Knowledge Areas (KAs) and topics addressed in [8]:

- *Systems Concepts:* provides a foundation for understanding systems and their role. Topics include: Types of Systems, System Topologies, System-of-Interest, System Perspectives, Complexity, and Roles of Systems.
- *Systems Thinking:* describes types of systems thinking and approaches behind successful systems engineering. Topics include: Hard and Soft Systems Thinking, Paradoxes, Models and Languages.
- *Systems Engineering Overview:* provides an overview of different perspectives and approaches for SE in the context of products, services, and enterprises. Topics include: Fundamentals of SE, Principles of SE as a Life Cycle Approach, Principles of SE as a Service Integration Approach, Principles of SE as an Enterprise Approach, Relationship to Other Disciplines, Socio-technical Issues, and SE Standards.
- *Generic Life Cycle Stages:* provides an overview of the more common systems life cycle models. Topics include: Life Cycle Characteristics, System Life Cycle Process Drivers and Choices, and Representative System Life Cycle Process Models.
- *Service SE:* is currently a placeholder chapter that will address systems engineering concepts and principles specific to the design and creation of service systems.
- *Enterprise SE:* provides insights into the engineering of enterprise systems and defines key considerations unique to enterprise systems. Topics include: The Enterprise as a System, Related Business Activities, Enterprise Systems Engineering, ESE Process Activities, and Enterprise Capability Management.
- *Enabling Systems Engineering in the Organization:* addresses the incorporation of systems engineering activities within an organization including effective governance, staffing, and resource allocation approaches. Topics include: Managing SE at the Business Level, and Stand-up, Improve, and Institutionalize SE in Organization.
- *Systems Engineering Management:* focuses on the administration and oversight of SE activities and provides insights on managing the technical aspects of SE. Topics include: SE Planning, SE Assessment and Control, SE Risk Management, SE Measurement, SE Decision Management, SE Configuration Management, and SE Information Management.
- *System Definition:* provides insight into the early stages of the systems life cycle, including needs and requirements analysis and architecture development. Topics include: Stakeholder Requirements and Mission

Analysis, System Requirements, Architectural Design, and System Analysis.

- *System Realization:* focuses on the actual construction of the system, including testing to confirm appropriate functionality and use. Topics include: Implementation, System Integration, System Verification, and System Validation.
- *System Deployment and Use:* addresses the utilization of system once it is "complete" and includes insights on how a system can be sustained over time. Topics include: Operation of the System, System Maintenance, and Logistics.
- *System Life Management:* focuses on the continuation of the system life, including changing and adding functionality to a system in operation, and retiring a system. Topics include: Service Life Extension, Capability Updates, Upgrades, and Modernization, and System Disposal and Retirement.
- *Systems Engineering Agreement:* provides insight on the contractual aspects of SE. Topics include: Acquisition Process and Supplier Processes.
- *Cross-Cutting:* provides a foundation for non-functional characteristics (the "-ilities") of systems engineering discussed throughout the SEBoK. Topics include: Integration of Specialty Engineering, Affordability/Design to Cost, Human System Integration, Safety, Security, Spectrum Management, Electro-Magnetic Interference/TEMPEST, Radiation Hardness, Reliability and Maintainability, Manufacturing and Production, Quality, Logistics/Supportability, Occupational Health/Work Environment, Disposal and Resilience.
- *Systems Engineering Competency:* addresses systems engineering competencies at the individual, team, and organization level. Topics include: System Deployment, Application, and Future Work.
- *SE Applications/Case Studies:* defines the method and criteria for accepting case studies for a companion guide that will provide domain-dependent examples for the SEBoK. Topics include: Case Study Process and Operation of the System.

APPENDIX C. GRCSE VERSION 0.25: COVERED CONTENT

The chapters and appendices included in [17] consist of the following:

- *Context and Guidance for the Construction and Maintenance of GRCSE:* This chapter describes the foundational guidance used when developing GRCSE—the twenty guiding principles, assumptions, and context for the entire GRCSE effort.
- *Expected Student Background When Entering the Master's Program:* In this chapter we describe the background that should be expected of students entering a program founded on GRCSE recommendations.
- *Expected Objectives When a Graduate Has 3-5 Years' Experience:* This chapter discusses what needs to be achieved upon graduation in order for graduates of the programs to be where they need to be in their career 3 to 5 years after graduation.
- *Expected Outcomes When a Student Graduates:* This chapter defines the expected outcomes students should be capable of when they graduate from a program that satisfies GRCSE's recommendations and includes a mix of technical, ethical, learning, and other outcomes, reflecting the diverse skills that graduates require to become successful as system engineers.
- *Curriculum Architecture:* This chapter outlines a curriculum architecture that provides a common mechanism for communicating the components of an institution's systems engineering graduate level curriculum. How the systems engineering and related topics are grouped into specific courses within the curriculum is left within the purview of the institution.
- *Core Body of Knowledge (CorBoK):* This chapter defines the CorBoK, comprised of a core foundation and a core extension comprising up to half of the graduate curriculum to be completed by each graduate. Core extensions are currently defined for two focus areas: technical management and systems design and development.
- *Assessment:* The purpose of this chapter is to recommend approaches for conducting assessment with a view to ensuring that the intended outcomes of the program are achieved through the combination of the content that is taught and the manner in which it is assessed.
- *Anticipated GRCSE Evolution:* From the beginning, it was intended for GRCSE to be a living document, with a broad, responsible, and knowledgeable community of practice. This chapter covers the anticipated evolution of GRCSE.
- *Summary of Graduate Systems-Centric Systems Engineering Programs in 2010:* Results from Master's of Systems Engineering (MSE) surveys, distributed to universities around the world, are summarized in this appendix.
- *Bloom's Taxonomy of Educational Outcomes:* Bloom's levels for the cognitive and affective domains are described in this appendix.
- *Assessment and Achievement of Learning Outcomes:* This appendix provides additional material on assessment approaches and learning outcomes.
- *Competency Based Curriculum Development Approach:* A short summary of applying a competency-based approach to curriculum development is provided in this appendix.

REFERENCES

[1] A. Squires, A. Pyster, D. Olwell, S. Few, D. Gelosh. "Announcing BKCASE: Body of knowledge and curriculum to advance systems engineering." *INCOSE Insight*, vol.12, no. 4, pp. 69-70. Dec, 2009.

[2] W. J. Fabrycky. "Systems engineering: Its emerging academic and professional attributes." *In Proceedings of the 2010 American Society for Engineering Education (ASEE) Annual Conference and Exposition,* Louisville, Kentucky, June 20-23, 2010.

[3] A. Squires, A. Pyster, B. Sauser, D. Olwell, S. Enck, D. Gelosh, J. Anthony, "Applying Systems Thinking via Systemigrams for Defining the Body of Knowledge and Curriculum to Advance Systems Engineering (BKCASE) Project", *Proceedings of the 20th Annual International Symposium, INCOSE 2010,* Chicago, Illinois, July 12-15, 2010.

[4] A. Pyster, M. Ardis, D. Frailey, D. Olwell, A. Squires (2010). "Global workforce development projects in software engineering". *Crosstalk-The Journal of Defense Software Engineering*, Nov/Dec, 36-41.

[5] INCOSE. "INCOSE-TP-2003-002-03.2: Systems Engineering Handbook: A guide for system life cycle processes and activities, version 3.2" INCOSE-TP-2003-002-03, International Council on Systems Engineering, 2010.

[6] ISO/IEC/IEEE 15288:2008(E). 2008. Systems and software engineering — System life cycle processes, IEEEStd 15288-2008, Second Edition.

[7] A. Abran, J.W. Moore, P. Bourque, R. Dupuis, L.L. Tripp, "SWEBOK: A guide to the software engineering body of knowledge," IEEE Computer Society Press, Los Alamitos, CA, USA, 2004. Available at http:www.computer.org/portal/web/swebok

[8] A. Pyster, D. Olwell, A. Squires, N. Hutchison, S. Enck, Eds., "A Guide to the Systems Engineering Body of Knowledge (SEBoK). Version 0.25." Stevens Institute of Technology, Hoboken, NJ, USA. Released for limited review 2010.

[9] INCOSE Insight. "Guide to the systems engineering body of knowledge (g2sebok)." *INCOSE Insight,* vol. 5, issue 1, pp. 1–52, April, 2002.

[10] INCOSE Insight. "The INCOSE fellows edition: The technical vision of systems engineering; the intellectual content of systems engineering" *INCOSE Insight,* vol. 8 issue 2, pp. 1-64, March, 2006.

[11] INCOSE Insight. "The use of systems engineering in large scale systems." *INCOSE Insight,* vol. 8 issue 3, pp. 33-36, July, 2006.

[12] A. Pyster, Ed., "Graduate Software Engineering 2009 (GSwE2009): Curriculum guidelines for graduate degree programs in software engineering. Version 1.0." *Integrated Software and Systems Engineering Curriculum (iSSEc) series.* Stevens Institute of Technology, Hoboken, NJ, USA. September 30, 2009.

[13] R. Jain, A Squires, D Verma, and A Chandrasekaran. "A reference curriculum for a graduate program in systems engineering." *INCOSE Insight*, July vol. 10, issue 3, pp. 9-11, July 2007.

[14] R. Jain, D. Verma. 2007. "INCOSE-PP-2007-001-01: A Report on Curriculum Content for a Graduate Program in Systems Engineering: A Proposed Framework" *INCOSE,* Stevens Institute of Technology. 2007.

[15] B. Tufts. "Model Curriculum for Master of Systems Engineering Degree: Draft Proposal." *INCOSE,* 2002.

[16] A. Squires, W. Larson, and B. Sauser. "Mapping space-based systems engineering curriculum to government-industry vetted competencies for improved organizational performance." *Systems Engineering,* vol. 13, issue 3, pp. 246-260, 2010.

[17] A. Squires, R. Cloutier. "Evolving the INCOSE reference curriculum for a graduate program in systems engineering." *Systems Engineering,* vol. 13, issue 4, pp. 381-388, 2010.

[18] A. Squires, W. Larson. "Improving systems engineering curriculum using a competency-based assessment approach." *Special Issue on Systems Engineering Education of the International Journal of Intelligent Defence Support Systems (IJIDSS)*, vol. 2, issue 3, pp. 184-201, 2009.

[19] A. Squires, R. Cloutier. "Evaluating the effectiveness of classroom discussion approaches used in the remote delivery of systems engineering education." *In Proceedings of the 2010 American Society for Engineering Education (ASEE) Annual Conference and Exposition Conference*, Louisville, Kentucky, June 20-23, 2010.

[20] A. Pyster, D. Olwell, A. Squires, N. Hutchison, S. Enck, Eds.,; T. Ferris, Lead Author. "Graduate Reference Curriculum for Systems Engineering. Version 0.25." Stevens Institute of Technology, Hoboken, NJ, USA. Released for limited review 2010.

[21] S. 454--111th Congress: Weapon Systems Acquisition Reform Act of 2009. May 21, 2009. Available at: http://www.govtrack.us/congress/billtext.xpd?bill=s111-454.