BKCASE™

Body of Knowledge and Curriculum to Advance Systems Engineering

Fourth Workshop:

SEBOK 0.25 Release

and

Plan for GRCSE 0.25 Release

October 13th and 14th, 2010

Mercure Atria Hotel

Toulouse, France

WORKSHOP REPORT

Contents

1. BKCASE Project

BKCASE is the acronym for the Body of Knowledge and Curriculum to Advance Systems Engineering. The BKCASE project is led by a university partnership between the Stevens Institute of Technology and the Naval Postgraduate School with sponsorship from the U.S. Department of Defense and support from INCOSE, the IEEE Computer Society, IEEE Systems Council, ACM, and NDIA Systems Engineering Division. The project scope is to define a Systems Engineering Body of Knowledge (SEBoK) and use the SEBoK as guidance in developing an advanced Graduate Reference Curriculum for Systems Engineering (GRCSE).

The ideal outcome is that the SEBoK will be supported worldwide by the Systems Engineering community as the authoritative SEBoK for the SE discipline; and that the GRCSE will receive the same global recognition and serve as the authoritative guidance for graduate degree programs in SE. Systems engineers from across the world have volunteered as authors and reviewers on the project to collaborate over a three year period and to deliver the SEBoK and GRCSE to the public in 2012.

In December 2009, the BKCASE team held an inaugural workshop in Monterey, CA, at the Naval Postgraduate School to determine the basic rules for the project and develop a common set of objectives. At the first workshop in Monterey, California in December 2009, the team developed an initial strategy to begin work on SEBoK version 0.25, which included using ISO 15288 as the initial structure for the SEBoK. At the second workshop in Daytona Beach, Florida in March 2010, the team expanded the SEBoK contents to include many other areas of systems engineering knowledge in addition to life cycle processes and identified the initial GRCSE team. The author team broke into subteams to begin drafting materials for review at the third Workshop. At the third workshop, held in conjunction with the INCOSE International Symposium in Rosemont, Illinois, July 2010, the author team agreed to publication and review plans for SEBoK 0.25 and discussed the way-ahead for development of a draft of GRCSE 0.25.

2. BKCASE Workshop IV

The fourth workshop was held at the Mercure Atria hotel in Toulouse, France on October 13th and 14th, 2010. The workshop was graciously sponsored by EADS, AFIS, and Map Systeme. A list of the workshop attendees is available in Appendix A and the meeting agenda is in Appendix B of this report. The workshop's slide set is available online for download at the BKCASE website located at http://www.bkcase.org. In addition, a timeline of major dates can be found in Appendix C.

The objectives of the workshop were to:

1. Review the SEBoK 0.25 release and resolve any residual issues;
2. Agree on the adjudication and visibility processes for review comments;
3. Discuss proposed Wiki governance, structure, architecture and make a decision on whether to proceed with the Wiki model;
4. Review GRCSE draft materials and discuss and resolve major decision points on content and structure; and

5. Develop a way ahead for GRCSE 0.25, including a release plan and review process.

During Dr. Pyster's introductory comments, he thanked the EADS and MAP Systeme hosts Jean-Claude Roussel and Alain Fandaisier for their support in coordinating and funding the workshop. He also congratulated the author team on the completion and release of SEBoK version 0.25. The document was over twice the size anticipated; this reflects a lot of hard work on the part of the authors. It also presents a challenge in ensuring that the final product is crisp and concise.

Action Items:

1. There was a request from the author team to add the slide on partnerships/overview to the generic slide deck (from Dr. Pyster's presentation slides at the workshop).

2. If authors are engaged with organizations that may be interested in supporting BKCASE in some form, they should forward this information to Dr. Pyster and Dr. Olwell. The European Space Agency was recommended by the author team as an important target partner.

3. The Core Team will draft language on the potential roles organizations may play in the BKCASE effort (supporter, cooperator, sponsor, etc.).

3. Workshop Proceedings

3.1 SEBoK 0.25 Release and Author Response

Dr. Pyster stated that approximately one month of the three-month review period is over. Few comments have been received to date. He asked that all authors please keep engaged with their respective reviewers to encourage participation. Dr. Pyster also summarized the review process, which will include cataloguing, adjudication, and publication of all review comments, and provided an overview of SEBoK 0.25:

- The target for each chapter was 25 pages. This number was a rough estimate, but chapters actually ranged from 10 to almost 90 pages. This is due primarily to the varying levels of detail included in the chapters.

- Chapters differed substantially in the level of content presented. For example, some chapters included very detailed information and others a rough overview. The goal of the SEBoK is to provide a guide to the body of knowledge. Therefore, the ideal is for each chapter to provide an overview and context, but then to point to resources for detailed information. A major challenge of the transition from 0.25 to 0.5 will be to make the depth of each chapter more consistent.

- Many chapters were generated in a very short period of time. This is not a criticism, but the limited time and make up of the teams did limit some chapters. Going forward, it will be important to ensure that there are at least 4 authors for each chapter in order to ensure

requisite diversity of opinions on the knowledge areas and to avoid having any areas be too prescriptive.

- There were over 700 references for 0.25. This is a good start, but gives an approximate ratio of one reference per page. Many more references will need to be incorporated into the SEBoK in order for it to be a true guide to the BoK. In addition, there are still too many defense- and acquisition-related perspectives. The authors are encouraged to look for resources out of these areas in order to make the SEBoK more comprehensive.

It is still anticipated that SEBoK 0.5 will be delivered in a Wiki-based environment. The author team generally agreed with this, though no specific plan was agreed to. (Please see 3.3 *Wiki Discussion* for additional information).

3.1.1 Author Feedback

The authors had several specific recommendations/reactions to the SEBoK. They were asked to provide their comments using the review process, but overarching issues are discussed here.

There is still confusion on the two reference lists that were developed for 0.25 (primary references and additional references and readings). There was a recommendation to have three different reference lists (primary references, additional references, additional readings) or two lists which would be organized differently (references (all) and additional readings). Another option discussed was to provide a set of primary readings and then an additional bibliography for each chapter which would include the primary references and all other references as well as additional readings. There was discussion of whether there should be sub-topics within these reference lists. All of these options have been noted, but no formal decision on reference reorganization will be made until the comments from reviewers have been received. The author team did agree that for primary references, annotations as to the key elements of each reference should be included. It is critical that all authors try to identify the source materials (including sections or page numbers) as precisely as possible. This will facilitate SEBoK users in finding and following up on references.

Another issue was that of the level of detail included in the SEBoK. The author team re-affirmed the concept of creating the SEBoK as a guide to the BoK, and not a comprehensive document which actually includes all of the knowledge related to SE. Future changes to the SEBoK should include replacing detailed instructions with pointers to the appropriate references within the BoK. There were additional discussions regarding the use of BKCASE material in other publications or of authors developing publications which have their basis in SEBoK-related tasks. It was determined that ensuring the SEBoK is written as a guide will help to prevent any potential issues which would be caused by too much of the SEBoK content appearing in other publications prior to publication of SEBoK 1.0.

The ties of SE to software engineering (SwE) and program management (PM) are a good start. However, the authors noted that there are other disciplines that should be included in the discussion. For example, the relationship of systems engineering to traditional engineering disciplines should be explored. This led to a discussion of the possibility that the SEBoK could be used not only by systems

engineers but by engineers who want to better understand SE as a discipline. It was agreed that the BKCASE use cases would be reviewed to determine whether they correctly reflect this. It was also recommended that more discussion of how SE relates to other engineering disciplines should be included in the front matter of the SEBoK (specifically in chapter 3).

Additionally, it was recognized that the integration of all the knowledge areas was not as strong as desired. The author team discussed the possibility of creating a sub-team that would specifically focus on integration for version 0.5. The desire is to limit duplication and improve synergy as much as possible.

Though the author team recommended many possible improvements to the SEBoK, there will be no revisions of SEBoK materials until after all of the review comments have been received. The author team should, instead, review as many chapters of the SEBoK as possible and provide their feedback as review comments.

3.1.2 Review Comments to Date

Nicole Hutchison provided a brief overview of the comments received to date. As of WS IV, comments had only been received from a few reviewers, and most comments dealt with references, formatting, etc. There were no major issues identified that would require massive restructuring at the time.

SEBoK Action Items:

1. All authors are to provide additional potential reviewers with instructions to provide their information to Steph Enck (bkcase@stevens.edu). Steph will in turn provide them with all of the review materials.

2. The Core team will create a Word form in addition to the PDF form and make both available on the hidden review website.

3. The authors are to focus on providing their own reviews on the SEBoK and not on updating their materials. Material updates will be discussed at Workshop V.

4. Review of the use cases and adjustment, if necessary, to reflect the use of the SEBoK by systems engineers as well as those in the engineering field (or others) who would want to better understand SE.

3.2 Case Study Updates

Alice Squires provided an update of the plan for case study development. The SEBoK 0.25 was intentionally designed as a domain-independent document. The purpose of the Case Studies is to provide a domain-specific perspective on the SEBoK. The Case Studies (0.25 draft) will be produced for Workshop V. The two case studies which will be developed prior to WS V will be the Air Force Institute of Technology (AFIT) study on the Global Positioning System (GPS) and the Singapore government study on the Singapore Water Management System.

The format for these first two case studies will be to map (in ~10 pages each) elements of the case study to the SEBoK and discuss unique aspects of those elements within the specified domain. The focus will be on highlighting areas which offer a good opportunity for discussion of systems engineering practices. However, it should be noted that there will be no judgments of whether the case study discusses "good" or "bad" systems engineering. Instead the case studies will highlight how SEBoK knowledge is used in a specific domain, including differences in terminology, various approaches, etc. The document will also include a discussion of the methodology and rigor used to develop the initial case study.

It is important to note that, initially, the case studies used will be those developed elsewhere. For version 0.25, the AFIT GPS case study will remain untouched and the guide will provide a mapping and discussion of that case study to the SEBoK. For the Singapore Water Management System, the case study will be elaborated upon and included in the companion guide. For version 0.25, original case studies will not be developed, although this may change in future.

Case Study Action Items

1. The case study team (Alice Squires (lead), Richard Freeman, Heidi Davidz, Alex Lee, and Aaron Chia) will draft the 0.25 version of the case study companion documents for Workshop V (January 2010).

3.3 Wiki

Hans-Peter de Koning presented materials on the work on Wiki structure to date; this work was lead by Sandy Friedenthal. Overall, there are many possible technical solutions to developing a Wiki-like version of SEBoK 0.5. However, business cases are required in order for the author team to make a detailed decision. The business case should include: an estimated labor amount for development and sustainment, the estimated monetary costs of upkeep, and the governance models required to support the options. The options which will be explored are:

1. A hyperlinked document without a semantic Wiki structure.

2. An electronic document based on a Wiki structure, which will be updated as a traditional document.

3. A Wiki structure which will updated frequently based on comments collected from the public.

4. An open Wiki structure which can be edited by anyone (the Wikipedia model).

Business cases will be built and presented for each of these options and presented at WS V. In addition, initial conversations with IEEE and INCOSE will be held to determine where their interests and abilities may lie.

Wiki Action Items

1. Nicole Hutchison is the lead for this effort, and will coordinate with the Wiki team to develop the business models.

3.4 Review of GRCSE 0.25 Draft Materials

Tim Ferris, lead for the GRCSE effort, provided a rough overview of the GRCSE 0.25 draft materials and the major decisions and assumptions that had been made to date. Dr. Ferris then walked the author team through each of the sections individually and collected comments on the materials.

3.4.1 Overview

The current draft of the GRCSE document was based on the outline of the GSwE2009 document (the software engineering curriculum). The current outline includes an introduction, discussion of the guidelines for the document, student outcomes, student objectives, entrance expectations, curriculum architecture, the Core Body of Knowledge (CorBOK), and potential program evolution. Also included are appendices for a survey of existing SE programs, a description of Bloom's taxonomy and its uses in GRCSE, and a discussion of how competency frameworks may relate to the GRCSE recommendations. The document focuses on SE-centric programs and does not currently address domain-centric programs directly. It is anticipated that GRCSE will address the latter in later versions. GRCSE is intended to be globally applicable; in areas where discussions appear to be U.S.-centric, the GRCSE team will need to refine materials to be less specific to U.S. considerations.

3.4.2 Specific Issues/Decisions

Several authors brought up the issue that the term "master's degree" has different meanings in different locales. In fact, one author stated that there is a perception that a bachelor's degree in some countries may be equivalent to a master's degree in others. It is critical, therefore, that GRCSE explicitly define the level of education covered—and not covered—by its guidelines. The GRCSE author team needs to update the discussion to reflect a professional, graduate-level degree program. This will likely be a terminal degree, though there has been some discussion of including recommendations on how to tailor GRCSE for a master's degree in preparation for a PhD program.

The GRCSE curriculum architecture includes consideration of prerequisite knowledge and experience, the Core Body of Knowledge (CorBOK) which is common to all students, extensions to the CorBOK which are specific focus areas, and university/domain-specific information. The CorBOK should include considerations for product, services, and enterprise systems. The extensions ostensibly will reflect focuses on: systems engineering design and development, systems management, systems acquisition, and systems supply. The author team debated the nomenclature and divisions for these areas. However, it was agreed that CorBOK extensions should be part of the architecture; the GRCSE team was provided with guidance to move forward with a draft for 0.25.

The authors also suggested that the systems thinking and systems approach aspects be more explicitly addressed. Currently, these are planned to be addressed through the CorBOK. As the CorBOK is not yet populated, this was difficult to discern from the draft materials. However, the GRCSE team confirmed that these elements would be part of the CorBOK. Some authors pushed back and recommended that systems thinking and the systems approach should be incorporated into the curriculum in areas outside

of the CorBOK. The team is expecting to obtain feedback from the reviewers as well on this and other areas of the CorBOK.

The authors reviewed the set of outcomes provided in the GRCSE 0.25 draft materials. In general, these were agreed to. However, authors were concerned with the use of terms such as 'master'. It is desirable that achieving the outcomes be measurable. Therefore, for outcomes which are currently unmeasurable, the GRCSE team should work to refine the language. For example, the first outcome was "Master the CorBOK." It was suggested that "Demonstrate competency at the specified Bloom's level for all required knowledge areas as specified in the CorBOK" would be a more appropriate phrasing. Other recommendations for specific rewording of the outcomes were noted and will be incorporated by the GRCSE team.

For the CorBOK, the GRCSE team will provide a table similar to that provided in the draft for WS IV. It will include the knowledge areas (KAs) and topic headings for the SEBoK, as well as related fields for the allocation of Bloom's levels for the CorBOK and the CorBOK extensions. These fields will be blank for 0.25 and the reviewers will be asked to provide recommendations for which KAs/topics should be included in the CorBOK and the extensions. The text will explain the overarching concept of the CorBOK and extensions. For GRCSE 0.5 this section will be more fleshed out, but for 0.25, this prototype structure was deemed acceptable.

The issues of acknowledgements and credit for participation on GRCSE was also discussed. The author team determined that for 0.25, the entire BKCASE author team should be included in the document. Authors who specifically contributed content to GRCSE will be marked in some way (such as bolding or with an asterisk).

For the objectives, there are no current materials. Because the objectives (what students should be able to do 3-5 years after graduation) will be highly dependent on student goals, it is unlikely that there will be a standard set of objectives that are appropriate for all programs. Instead, the GRCSE team believes it can come up with a small number of universal objectives and then a few exemplar objectives that will be related to specific types of SE roles. For version 0.25, the GRCSE team plans to develop some exemplar objectives and a discussion of how to approach objectives for an SE program. There has been concern by some that GRCSE would be too prescriptive. It is hoped that this approach will help to alleviate some of those concerns.

The entrance expectations for GRCSE include a technical or engineering bachelor's degree with at least two years of experience. The author team wanted to ensure that the types of experience best suited to a master's program be discussed. It was also cautioned that too much experience may result in students too entrenched in a single approach to SE, which would not be beneficial. That balance should be discussed in the document. It was also recommended that the recommended experience levels be tied to other elements of the curriculum, therefore strengthening the argument for its inclusion. For example, outcomes which will require some pre-program experience for accomplishment should specifically state why experience is necessary.

The GRCSE team indicated that there will be a discussion of assessment, which will tie to the assessment/competency discussion in the SEBoK. The purpose is not to duplicate information, but to discuss where competencies and assessments tie into the curriculum recommendations and how they might be used by programs wishing to utilize GRCSE. An initial overview will be included for 0.25, but it is unlikely that the 0.25 draft will include much precision or detail.

4. Way Ahead

4.1 Future Workshops

The author team agreed at WS IV that workshops V and VI should be 3-day sessions, with 2 days for traditional workshop and 1 day for break-out work sessions. It has not yet been decided if this will be the case for additional workshops.

- **Workshop V: January 26-28, 2011.** Phoenix, Arizona, USA, in conjunction with the INOCSE International Workshop. Details to be determined.

- **Workshop VI: April 12-14, 2011.** Los Angeles, CA, USA, in conjunction with the Conference on Systems Engineering Research (CSER).

- **Workshop VII: July 2011.** Denver, CO, USA, in conjunction with the INCOSE International Symposium. Exact dates TBD.

- **Workshop VIII: October, 2011.** London, England, hosted by Cranfield University. Exact dates TBD.

4.2 Publications Related to BKCASE

There are planned activities related to BKCASE which will be coordinated by the Core team. These include:

1. Submission of a paper on BKCASE to ASEE.

2. Submission of a paper on BKCASE to CSER.

3. Submission of a paper on BKCASE to IEEE Systems Conference.

4. Submission of multiple papers and a panel on BKCASE/SEBoK/GRCSE to the INCOSE International Symposium.

In addition, several authors have indicated their interest in publishing papers or giving presentations on BKCASE. The author team determined at the workshop that it was acceptable to use BKCASE materials for publications provided that the materials are clearly marked as being part of the BKCASE projects (either the SEBoK or GRCSE projects) and that appropriate references are included. The Core Team will

draft a recommended way to reference BKCASE so as to ensure that all BKCASE materials remain under the BKCASE copyright.

For areas where the author team would simply like to provide a briefing on BKCASE to a specific audience, the author team is encouraged to:

1. Utilize the generic slide deck, which is found on Sakai and which is periodically updated by the Core Team.

2. Notify Steph Enck (bkcase@stevens.edu) of the speaking engagement, so that the Core team can track all publication activities; and

3. Provide a copy of the briefing to the Core Team (bkcase@stevens.edu) which can be posted on Sakai and used in future updates of the generic slide deck.

Appendix A: Meeting Participants

In Attendance

Rick Adcock, *Cranfield University/INCOSE* (UK)

Jim Anthony, *Office of the Director of Defense Research & Engineering* (USA)

Richard Beasley, *Rolls-Royce* (UK)

Barry Boehm, *University of Southern California* (USA)

Cihan Dagli, *Missouri University of Science and Technology* (USA)

Heidi Davidz, *UTC Pratt & Whitney* (USA)

J.J. Ekstrom, *Brigham young University* (USA)

Alain Faisandier, *Association Francaise d'Ingenlerie Systeme/French INCOSE Chapter* (France)

Tim Ferris, *INCOSE/University of South Australia* (Australia)

Kevin Forsberg, *INCOSE* (USA)

G. Richard Freeman, *Air Force Center for Systems Engineering, Air Force Institute of Technology (AFIT)* (USA)

Don Gelosh, *Office of the Director of Defense Research & Engineering* (USA)

Tom Hilburn, *Embry Riddle Aeronautical University* (USA)

Nicole Hutchison, *Stevens Institute of Technology* (Support Staff) (USA)

Bud Lawson, *Lawson Konsult AB* (Sweden)

Ray Madachy, *Naval Postgraduate School* (USA)

David Olwell, *Naval Postgraduate School* (USA)

Daniel Prun, *Ecole Nationale de l'Aviation Civile (ENAC) -French Civil Aviation University* (France)

Art Pyster, *Stevens Institute of Technology* (USA)

Jean-Claude Roussel, *European Aeronautical Defence and Space Company* (France)

Garry Roedler, *Lockheed Martin* (USA)

Hillary Sillitto, *Thales Group* (UK)

Alice Squires, *Stevens Institute of Technology* (USA)

Joining via WebEx

Stephanie Enck, *Naval Postgraduate School* (Support Staff) (USA)

Marcia Enos, *Lockheed Martin* (USA)

Hans-Peter de Koning, *European Space Agency* (Netherlands)

Massood Towhidnejad, *Embry-Riddle Aeronautical University* (USA)

Invited Guests

Steven Townsend, *Project Management Institute (PMI)*

Appendix B: Meeting Agenda

Wednesday, October 13, 2010

8:30a	Opening Remarks/Agenda Review — *Art Pyster*
9:00a	SEBoK Review (Concerns/Issues/Way Ahead) — *led by Art Pyster*
10:50a	Case Study Updates — *Alice Squires*
11:15a	Review Comments Received to Date – *Nicole Hutchison*
11:30a	Overview of GRCSE Materials – *Tim Ferris*
1:30p	Wiki discussion – *Hans-Peter de Koning*
2:30p	GRCSE 0.25 Draft Review – *Tim Ferris*
6:30p	*Adjourn*

Thursday, October 14, 2010

8:30a	Review of Day 1 – *Dave Olwell*
9:00a	GRCSE 0.25 Draft Review (cont.) — *Tim Ferris*
1:30p	GRCSE 0.25 Way Ahead – *Tim Ferris*
2:30p	Future Workshops/Events and Closing Remarks — *Art Pyster*
3:00p	*Adjourn Main Workshop*
3:00p	GRCSE Team Meeting

Appendix C: Primary Dates for BKCASE

The following are major dates for the BKCASE project for 2010-2011:

Oct 25-28, 2010: 13th Annual (NDIA) SE Conference
November 19, 2010: GRCSE v0.25 Final Version Due to Core Team
December 15, 2010: SEBoK 0.25 Reviewer Comment Deadline
December 17, 2010: GRCSE v0.25 Released for Limited Review
January 15, 2011: SEBoK Reviewer Comments to Lead Authors
January 26-28, 2011: BKCASE Workshop V in Phoenix, AZ at Hyatt Regency
January 28- February 2, 2011: INCOSE IW in Phoenix, AZ at Hyatt Regency
February 16, 2011: All SEBoK Comments Adjudicated and Returned to Core Team
March 8, 2011: GRCSE 0.25 Reviewer Comment Deadline
April 2011: Adjudication Matrix released for SEBoK v0.25 and Strategy for SEBoK v0.50 Finalized
April 4-11, 2011: IEEE Int'l Systems Conference in Montreal, Quebec, Canada
April 12-14, 2011: BKCASE Workshop VI in LA, CA
April 14-16, 2011: CSER in LA, CA
June 15-16, 2011: BKCASE Workshop in Denver, CO (Dates to be finalized)
June 20-23, 2011: INCOSE IS in Denver
June 26-29, 2011: ASEE Annual Conference in Vancouver, BC
September 2011: Release of SEBoK 0.5 for review
October 2011: BKCASE Workshop VIII in London (TBD)
October 24-27, 2011: NDIA 14th Annual SE Conference
December 2011: Release of GRCSE 0.5 for review

Appendix D: BKCASE Action Items

The following are major action items resulting from Workshop IV:

- There was a request from the author team to add the slide on partnerships/overview to the generic slide deck (from Dr. Pyster's presentation slides at the workshop).

- If authors are engaged with organizations that may be interested in supporting BKCASE in some form, they should forward this information to Dr. Pyster and Dr. Olwell. The European Space Agency was recommended by the author team as an important target partner.

- The Core Team will draft language on the potential roles organizations may play in the BKCASE effort (supporter, cooperator, sponsor, etc.).

- All authors are to provide additional potential reviewers with instructions to provide their information to Steph Enck (bkcase@stevens.edu). Steph will in turn provide them with all of the review materials.

- The Core team will create a Word form in addition to the PDF form and make both available on the hidden review website.

- The authors are to focus on providing their own reviews on the SEBoK and not on updating their materials. Material updates will be discussed at Workshop V.

- Review of the use cases and adjustment, if necessary, to reflect the use of the SEBoK by systems engineers as well as those in the engineering field (or others) who would want to better understand SE.

- The case study team (Alice Squires (lead), Richard Freeman, Heidi Davidz, Alex Lee, and Aaron Chia) will draft the 0.25 version of the case study companion documents for Workshop V (January 2010).

- Nicole Hutchison is the lead for the Wiki business case effort, and will coordinate with the Wiki team to develop the business models.

- The GRCSE team has a plan ahead and will develop a draft of 0.25, which will be submitted to the Core team for update/editing by 19 November. This draft will be reviewed at the next workshop.