APPENDIX B

A LIST OF RELATED DISCIPLINES FOR THE STONE MAN VERSION OF THE GUIDE TO THE SWEBOK

In order to circumscribe software engineering, it is necessary to identify the other disciplines with which SE shares a common boundary. These disciplines are called Related Disciplines. In this regard, the mandate of the Guide to the SWEBOK project is to identify other disciplines that contain knowledge areas that are important to a software engineer. The list of such Knowledge areas would be useful to attain the fifth objective of the project: Provide a foundation for curriculum development and individual certification and licensing material.

Therefore, this appendix identifies:

- a list of Related Disciplines, based on the Strawman Guide, on the discussions of the Industrial Advisory Board at the Industrial Advisory Board kick-off meeting in Mont-Tremblant (Canada) and on subsequent work and discussions;
- a list of knowledge areas for these Related Disciplines, based on as authoritative a source as found.

These lists were to be as large as possible because we considered it easier to eliminate topics than adding them further on in the process.

The SWEBOK KA Specialists were asked to identify from these lists the Knowledge Areas of the Related Disciplines that are sufficiently relevant to the Software Engineering KA that has been assigned to them to be expected knowledge from a graduate with four years of experience. If deemed necessary and if accompanied by a justification, Knowledge Area Specialists could also propose additional Related Disciplines not already. These choices are presented in Appendix D. The level and extent of knowledge that a software engineer should possess within these knowledge areas is not specified at this point. This will be done by other projects according to their needs.

LIST OF RELATED DISCIPLINES AND SOURCES OF KNOWLEDGE AREAS.

Computer Science

- It was agreed in Mont-Tremblant that the reference for this Related Discipline would be obtained through an initiative called the IEEE Computer Society and ACM Joint Task Force on “Year 2001 Model Curricula for Computing: CC-2001”. To ensure proper coordination with this initiative, Carl Chang, Joint Task Force Co-Chair is a member of the Industrial Advisory Board and was present in Mont-Tremblant. Appendix B.1 lists the preliminary Knowledge Areas of Computer Science as determined by the CC-2001 group.

Mathematics

- It was agreed in Mont-Tremblant that the Computing Curricula 2001 initiative would be the “conduit” to mathematics. So far, we have not received such a list of Knowledge Areas (Knowledge Units in the CC-2001 vocabulary), for Mathematics but it is expected that CC-2001 will provide it. In the mean time, the project refers to the list defined by the Computing Curriculum 1991¹ initiative and found in Appendix B.2.

Project Management

- The reference for this Related Discipline is “A Guide to the Project Management Body of Knowledge”² published by the Project Management Institute. This document is currently being adopted as an IEEE software engineering standard. The list of Knowledge Areas for project management can be found in Appendix B.3.

Computer Engineering

A list of Knowledge Areas for Computer Engineering and found in Appendix B.4 was compiled from the integration of:

- The syllabus for the British licensing exam for the field of Computer Systems Engineering³.
- The Principles and Practice of Engineering Examination - Guide for Writers and Reviewers in Electrical Engineering of the National Council of Examiners for Engineering and Surveying (USA). An appendix listed Computer Engineering Knowledge Areas for which questions should be put to the candidates.
- The Computer Engineering undergraduate program at the Milwaukee School of Engineering⁴. This program

¹ See http://computer.org/educate/cc1991/
² See www.pmi.org to download this report.
³ See http://www.engc.org.uk
is considered to be a typical example of an American accredited program by the director of the Computer Engineering and Computer Science Department at MSOE.

Systems Engineering

Appendix B.5 contains a proposed list of Knowledge Areas for Systems Engineering. The list was compiled from:

- The EIA 632 and IEEE 1220 (Trial-Use) standards;
- the Andriole and Freeman paper;
- the material available on the INCOSE (International Council on Systems Engineering) website;
- a curriculum for a graduate degree in Systems Engineering at the University of Maryland;

Three experts in the field were also consulted, John Harauz, from Ontario Hydro, John Kellogg from Lockheed Martin, and Claude Laporte consultant, previously with the Armed Forces of Canada and Oerlikon Aerospace.

Management and Management Science

No definitive source has been identified so far for a list of Management and Management Science Knowledge Areas relevant to software engineering. A list was therefore compiled from

- the Technology Management Handbook which contains many relevant chapters;
- the Engineering Handbook which contains a section on Engineering Economics and Management covering many of the relevant topics;
- an article by Henri Barki and Suzanne “Rivard titled A Keyword Classification Scheme for IS Research Literature: An Update”.

The proposed list of knowledge areas for Management and Management Science can be found in Appendix B.6.

Cognitive Sciences and Human Factors

Appendix B.7 contains a list of proposed Knowledge Areas for Cognitive Sciences and Human Factors. The list was compiled from the list of courses offered at the John Hopkins University Department of Cognitive Sciences and from the ACM SIGCHI Curricula for Human-Computer Interaction.

The list was then refined by three experts in the field: two from UQAM and W. W. McMillan, from Eastern Michigan University. They were asked to indicate which of these topics should be known by a software engineer. The topics that were rejected by two of the three respondents were removed from the original list.

APPENDIX B.1 – KNOWLEDGE AREAS OF COMPUTER SCIENCE.

0. [MP] Mathematics and Physical Sciences
   1. [FO] Foundations
      Complexity analysis
      Complexity classes
      Computability and undecidability
   2. [AL] Algorithms and Data Structures
      Basic data structures
      Abstract data types
      Sorting and searching
      parallel and distributed algorithms
   3. [AR] Computer Architecture
      Digital logic
      Digital systems
      Machine level representation of data
      Number representations
      Assembly level machine organization
      Memory system organization and architecture
      Interfacing and communication
      Alternative architectures
      Digital signal processing
      Performance
   4. [IS] Intelligence Systems (IS)
      Artificial intelligence
      Robotics
      Agents
      Pattern Recognition
      Soft computing (neural networks, genetic algorithms, fuzzy logic)
   5. [IM] Information Management
      Database models

4 See http://www.msoe.edu/eecs/ce/index.htm
6 See www.incose.org
7 See http://www.isr.umd.edu/ISR/education/msse/
8 See CRC Press
9 See CRC Press
10 See MIS Quaterly, June 1993, pp. 209-226
11 See http://www.cogsci.jhu.edu/
12 See TABLE 1. Content of HCI athttp://www.acm.org/sigchi/cdg/cdg2.html
1. [CE] Computer Engineering
- Operating systems and networks
- Computer organization and architecture
- Computer arithmetic
- Computer arithmetic
- Computer arithmetic

2. [SE] Systems Engineering
- System engineering and management
- System design and analysis
- System development and implementation

3. [SC] System Science
- System science and methods
- System science and methods
- System science and methods

4. [CA] Cyber-Autonomy
- Cyberautonomy and autonomous systems
- Cyberautonomy and autonomous systems
- Cyberautonomy and autonomous systems

5. [CA] Cyber-Autonomy
- Cyberautonomy and autonomous systems
- Cyberautonomy and autonomous systems
- Cyberautonomy and autonomous systems

6. [CI] Computing at the Interface
- Human-computer interaction (usability design, human factors)
- Graphics
- Vision
- Visualization
- Multimedia
- PDAs and other new hardware
- User-level application generators

7. [OS] Operating Systems
- Tasks, processes and threads
- Process coordination and synchronization
- Scheduling and dispatching
- Physical and virtual memory organizations
- File systems
- Networking fundamentals (protocols, RPC, sockets)
- Security
- Protection
- Distributed systems
- Real-time computing
- Embedded systems
- Mobile computing infrastructure

8. [PF] Programming Fundamentals and Skills
- Introduction to programming languages
- Recursive algorithms/programming
- Programming paradigms
- Program-solving strategies
- Compilers/translation
- Code Generation

9. [SE] Software Engineering
- Software Engineering will not be a related discipline to Software Engineering
- This focus group will be coordinated with the SWEBOK project in order to avoid double definitions of the field.

10. [NC] Net-centric Computing
- Computer-supported cooperative work
- Collaboration Technology
- Distributed objects computing (DOC/CORBA/DCOM/JVM)

11. [CR] Cybersecurity
- Cryptography
- Authentication
- Access control
- Security protocols
- Security policies

12. [SP] Social, Ethical, Legal and Professional Issues
- Historical and social context of computing
- Philosophical ethics
- Intellectual property
- Copyrights, patents, and trade secrets
- Risks and liabilities
- Responsibilities of computing professionals
- Computer crime

APPENDIX B.2 – KNOWLEDGE AREAS OF MATHEMATICS

Discrete Mathematics: sets, functions, elementary propositional and predicate logic, Boolean algebra, elementary graph theory, matrices, proof techniques (including induction and contradiction), combinatorics, probability, and random numbers.

Calculus: differential and integral calculus, including sequences and series and an introduction to differential equations.

Probability: discrete and continuous, including combinatorics and elementary statistics.

Linear Algebra: elementary, including matrices, vectors, and linear transformations.

Mathematical Logic: propositional and functional calculi, completeness, validity, proof, and decision

APPENDIX B.3 – KNOWLEDGE AREAS OF PROJECT MANAGEMENT

The list of Knowledge Areas defined by the Project Management Institute for project management is:
- Project Integration Management
- Project Scope Management
- Project Time Management
- Project Cost Management
- Project Quality Management
- Project Human Resource Management
● Project Communications Management
● Project Risk Management
● Project Procurement Management

APPENDIX B.4 – KNOWLEDGE AREAS OF COMPUTER ENGINEERING

Digital Data Manipulation
Processor Design
Digital Systems Design
Computer Organization
Storage Devices and Systems
Peripherals and Communication
High Performance Systems
System Design
Measurement and Instrumentation
Codes and Standards
Circuit Theory
Electronics
Controls
Combinational and Sequential Logic
Embedded Systems Software
Engineering Systems Analysis with Numerical Methods
Computer Modeling and Simulation

APPENDIX B.5 – KNOWLEDGE AREAS OF SYSTEMS ENGINEERING

PROCESS

Need Analysis
Behavioral Analysis
Enterprise Analysis
Prototyping
Project Planning
Acquisition
Requirements Definition
System definition
Specification trees
System breakdown structure
Design
Effectiveness Analysis
Component specification
Integration

Maintenance & Operations
Configuration Management
Documentation
Systems Quality Analysis and Management
Systems V & V
System Evaluation
Systems Lifecycle Cost Estimation
Design of Human-Machine Systems
Fractals and self-similarities

ESSENTIAL FUNCTIONAL PROCESSES: (IEEE 1220)

Development
Manufacturing
Test
Distribution
Operations
Support
Training
Disposal

TECHNIQUES & TOOLS (IEEE 1220)

Metrics
Privacy
Process Improvement
Reliability
Safety
Security
Vocabulary
Effectiveness Assessment

APPENDIX B.6 – KNOWLEDGE AREAS OF MANAGEMENT AND MANAGEMENT SCIENCE

BUSINESS STRATEGY

FINANCE

EXTERNAL ENVIRONMENT

Economic Environment
Legal Environment
Regulation processes

ORGANIZATIONAL ENVIRONMENT

Organizational Characteristics
Organizational Functions
Organizational Dynamics

INFORMATION SYSTEMS MANAGEMENT

Data Resource Management
Information Resource Management
Personnel Resource Management
IS Staffing

INNOVATION AND CHANGE

ACCOUNTING

TRAINING

MANAGEMENT SCIENCE
Models
   Financial Models
   Planning Models
Optimization
   Optimization methods
   Heuristics
   Linear Programming
   Goal Programming
   Mathematical Programming
Statistics
Simulation

APPENDIX B.7 – KNOWLEDGE AREAS OF COGNITIVE SCIENCES AND HUMAN FACTORS

Cognition
Cognitive AI I: Reasoning
Machine Learning and Grammar Induction
Formal Methods in Cognitive Science: Language
Formal Methods in Cognitive Science: Reasoning
Formal Methods in Cognitive Science:
   Cognitive Architecture
Cognitive AI II: Learning
Foundations of Cognitive Science
Information Extraction from Speech and Text
Lexical Processing
Computational Language Acquisition
The Nature of HCI
   (Meta-)Models of HCI
Use and Context of Computers
   Human Social Organization and Work
   Application Areas
   Human-Machine Fit and Adaptation
Human Characteristics
   Human Information Processing
   Language, Communication, Interaction

Ergonomics
Computer System and Interface Architecture
   Input and Output Devices
   Dialogue Techniques
   Dialogue Genre
   Computer Graphics
Dialogue Architecture
Development Process
   Design Approaches
   Implementation Techniques
   Evaluation Techniques
   Example Systems and Case Studies