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 posses 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 1991[1] 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 Engineering[3].
- 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 Engineering[4]. 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[5];
- the material available on the INCOSE (International Council on Systems Engineering) website[6];
- a curriculum for a graduate degree in Systems Engineering at the University of Maryland[7];

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[8] which contains many relevant chapters;
- the Engineering Handbook[9] 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"[10].

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 was compiled from the list of courses offered at the John Hopkins University Department of Cognitive Sciences[11] and from the ACM SIGCHI Curricula for Human-Computer Interaction[12].

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4 See http://www.msoe.edu/eecs/ce/index.htm

5 Stephen J. Andriole and Peter A. Freeman, *Software systems engineering: the case for a new discipline*, System Engineering Journal, Vol. 8, no 3, May 1993, pp. 165-179.

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

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
   - Discrete mathematics (logic, combinatorics, probability)
   - Proof techniques
   - Automata (regular expressions, context-free grammars, FSMs/PDAs/TMs)
   - Formal specifications
   - Program semantics
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

Search Engines

Data mining/warehousing

Digital libraries

Transaction processing

Data compression

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)

E-Commerce

Enterprise computing

Network-level security

11. [CN] Computational Science

Numerical analysis

Scientific computing

Parallel algorithms

Supercomputing

Modeling and simulation

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
- 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

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