An international Consensus on the Software Engineering Body of Knowledge

Alain Abran

P. Bourque, R. Dupuis, J. W. Moore, L. Tripp

IWSS 2004

Istanbul, Turkey

September 6, 2004

Presentation Objectives

- Give an overview of this international consensus on the “core body of knowledge” of software engineering
- Briefly present the development process used to reach this consensus
- Briefly present usages of SWEBOK Guide
- Next steps
  - Including links to System Engineering

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Presentation Plan

- **Project background**
- Project development process
- Contents of the Guide
- Usages of the Guide in organizations
- Next steps

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Guide to the Software Engineering Body of Knowledge (SWEBOK®)

- Project initiated by the IEEE CS
- International participation from industry, professional societies, standards bodies, academia, authors
- Over 500 hundred software engineering professionals have been involved
- Release of Ironman Version in 2004

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2004 SWEBOK Guide

- Endorsed by the project's Industrial Advisory Board
- Approved by the IEEE Computer Society Board of Governors
- Adopted as ISO Technical Report 19759
  - Available on www.swebok.org
  - To be published in book format by the IEEE Computer Society Press

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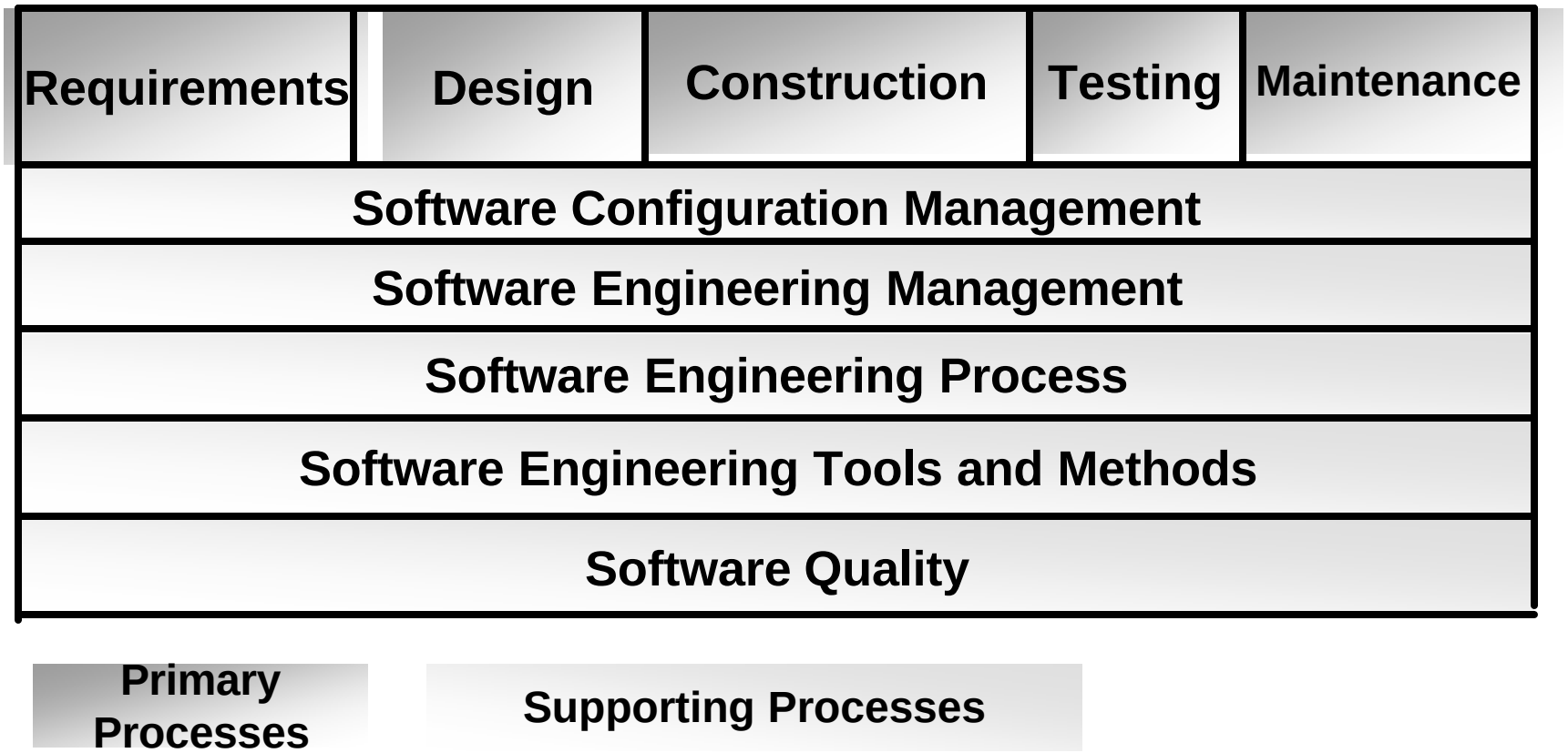
SWEBOK Guide = 10 Knowledge Areas

Mapped TO ISO/IEC 12207:1995 processes



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What is Software Engineering?

- IEEE 610.12:
  - "(1) The application of a systematic, disciplined, quantifiable approach to the development, operation, and maintenance of software; that is, the application of engineering to software.
  - (2) The study of approaches as in (1)."

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Recognized Profession?

- Starr*:
  - Knowledge and competence validated by the community of peers
  - Consensually validated knowledge rests on rational, scientific grounds
  - Judgment and advice oriented toward a set of substantive values

* P. Starr, *The Social Transformation of American Medicine*: BasicBooks, 1982.

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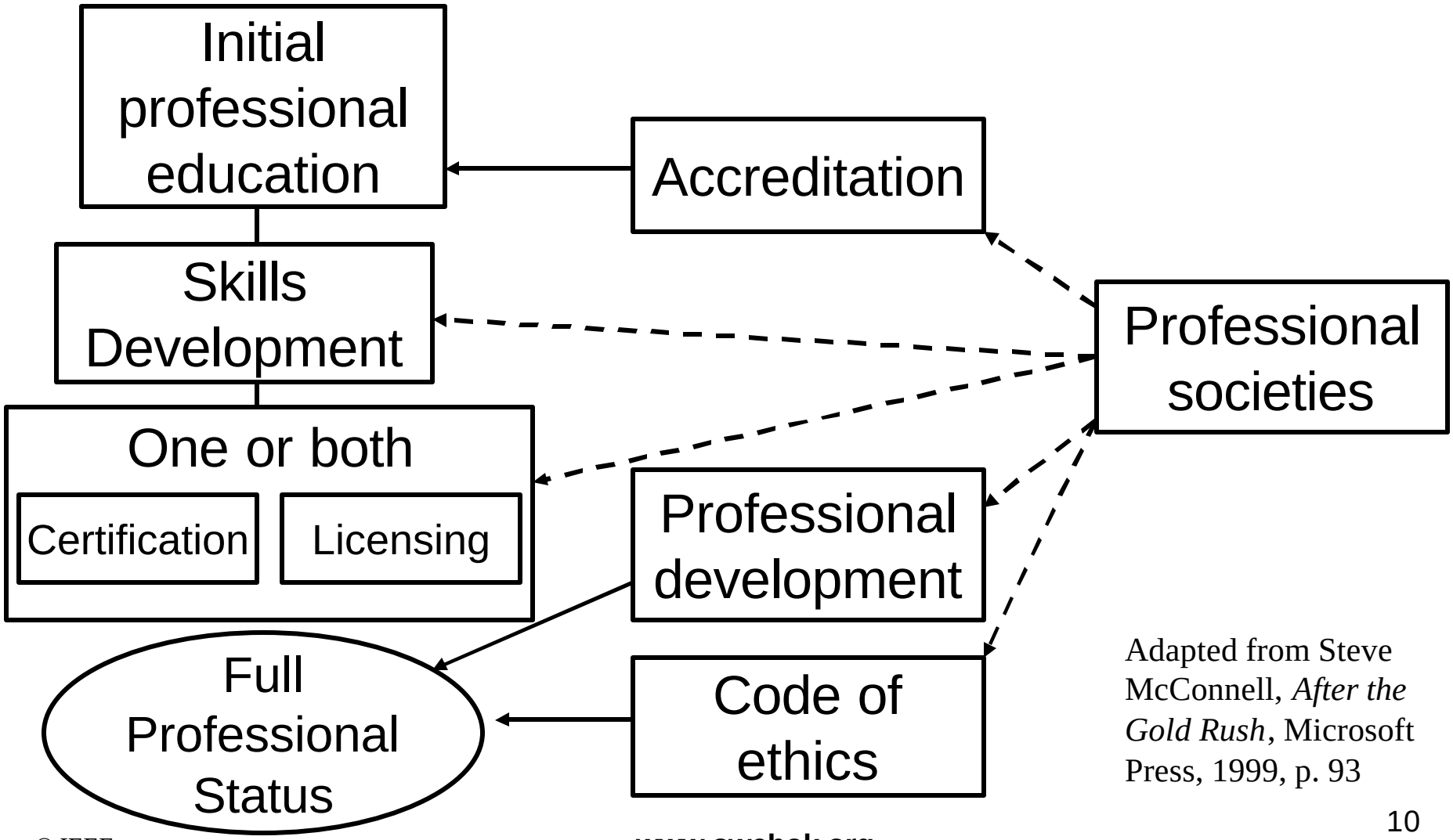
Development of a Profession



Adapted from Steve McConnell, *After the Gold Rush*, Microsoft Press, 1999, p. 93

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Presentation Plan

- Project background
- **Project development process**
- Contents of the Guide
- Applications of the Guide in organizations
- Next steps

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Project Objectives

- Characterize the contents of the Software Engineering Body of Knowledge
- Provide a topical access to the Software Engineering Body of Knowledge
- Promote a consistent view of software engineering worldwide

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Project Objectives

- Clarify the place of, and set the boundary of, software engineering with respect to other disciplines (computer science, project management, computer engineering, mathematics, etc.)
- Provide a foundation for curriculum development and individual certification and licensing material

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Intended Audience

- Public and private organizations
- Practicing software engineers
- Makers of public policy
- Professional societies
- Software engineering students
- Educators and trainers

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What was out of scope?

- Not a curriculum development effort
- Not an all-inclusive description of the sum of knowledge in the field
- Not all categories of knowledge

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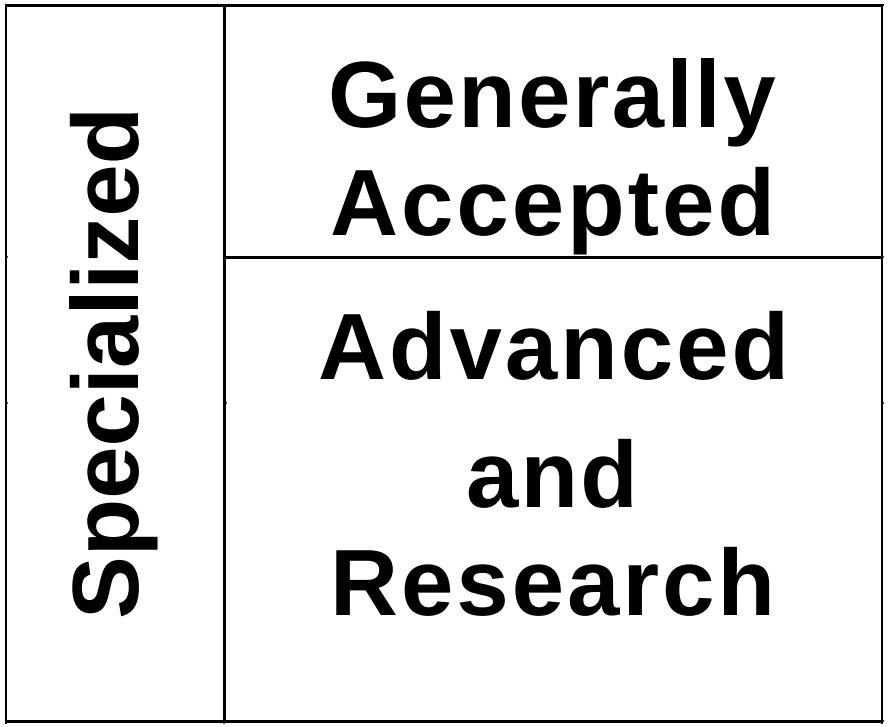
Categories of Knowledge in the SWEBOK



Target of the SWEBOK Guide

«Applicable to most projects, most of the time, and widespread consensus about their value and usefulness»

Project Management Institute - PMI

⊙ North American Bachelor's degree + 4 years of experience

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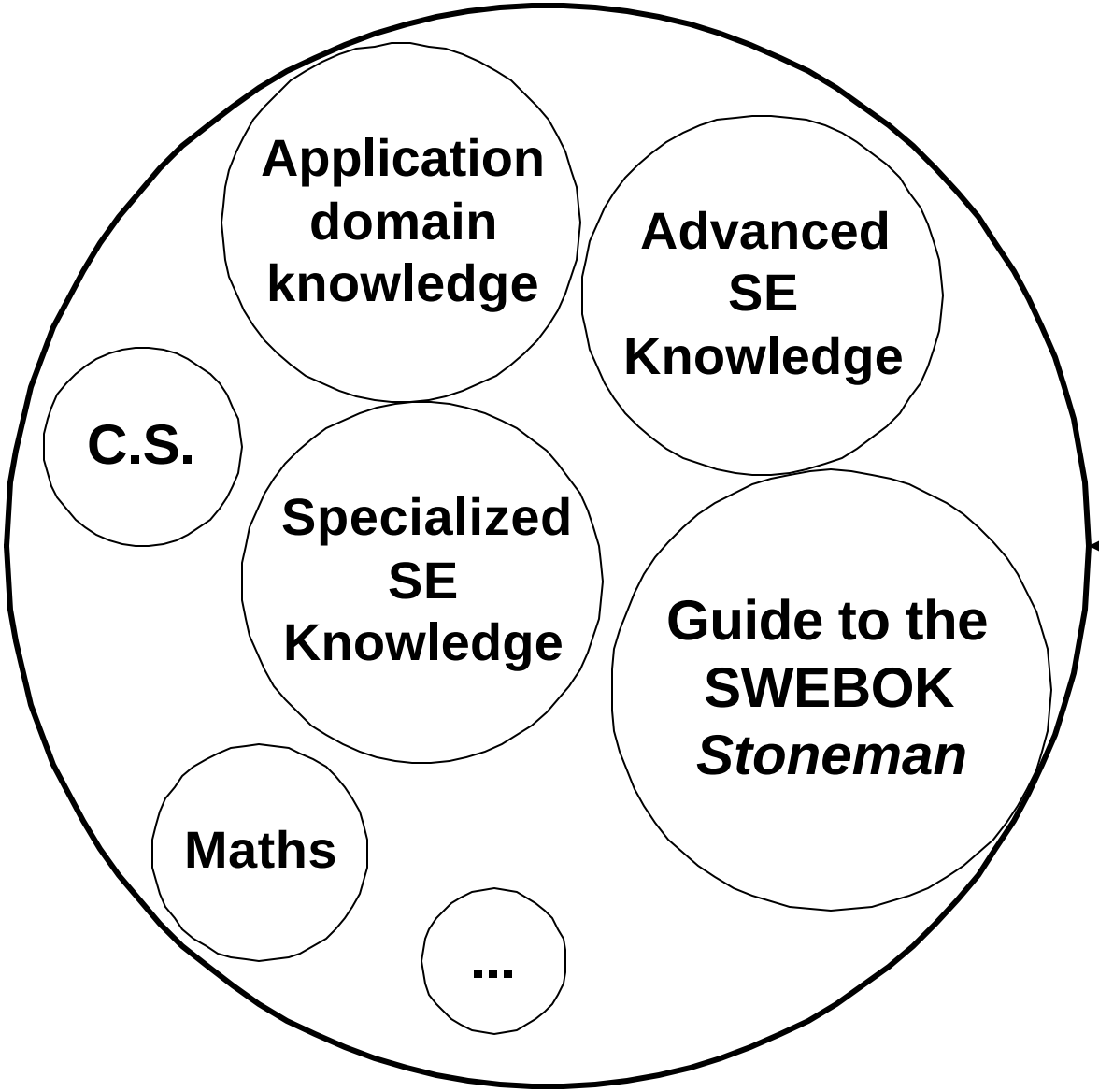

Knowledge of a Software Engineer

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Three Underlying Principles of the Project

- ***Transparency***: the development process is itself published and fully documented
- ***Consensus-building***: the development process was designed to build, over time, consensus in industry, among professional societies and standards-setting bodies and in academia
- Available ***free*** on the web

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Project Team

- Editorial Team of the Guide
- Industrial Advisory Board
- Associate Editors of the Knowledge Areas
- Reviewers

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Roles of the Industrial Advisory Board

- Provide input to ensure relevance to various audiences
- Review and approve strategy and deliverables
- Oversee development process
- Assist in promoting the Guide to the Software Engineering Body of Knowledge
- Lend credibility to the project

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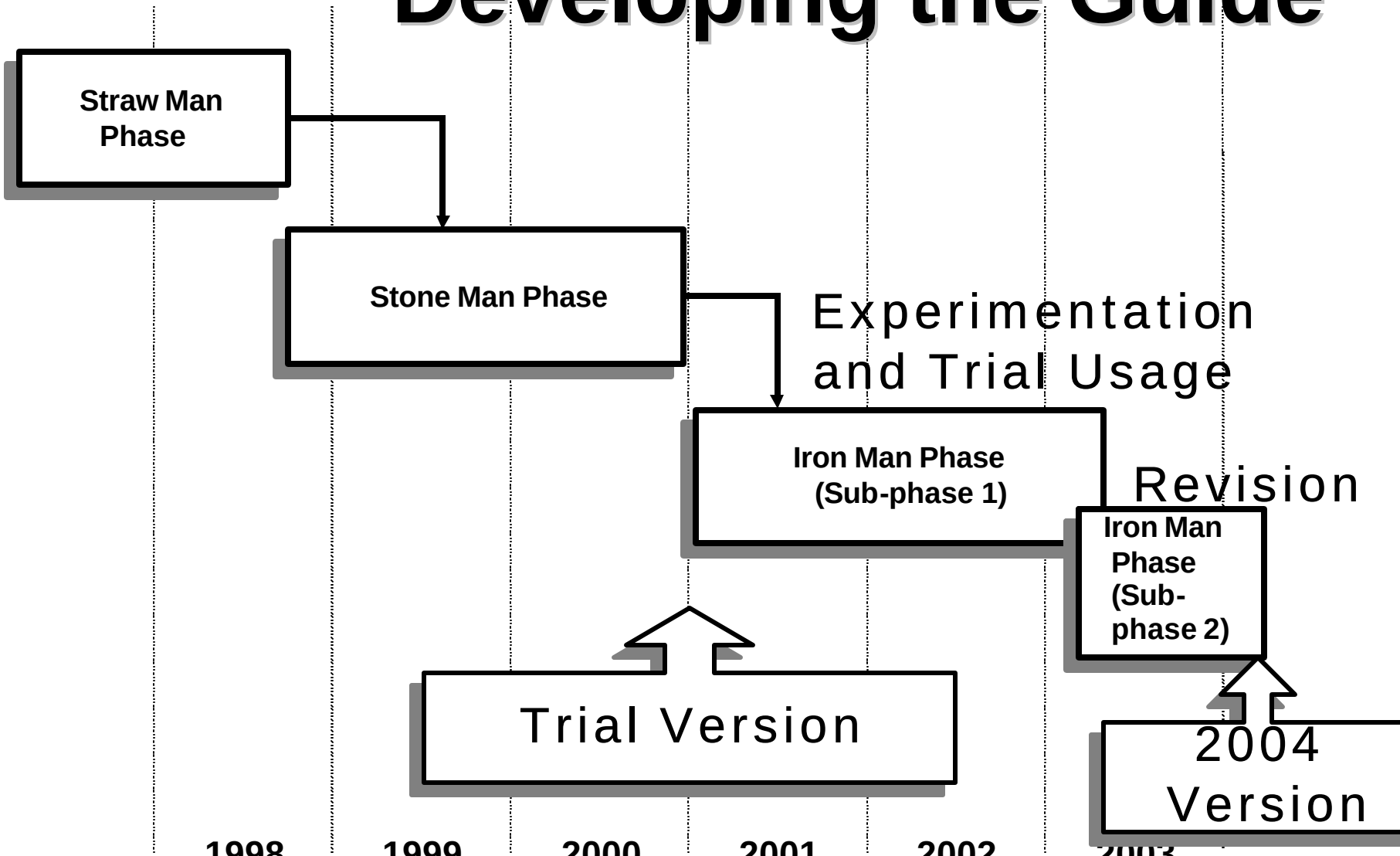
A Three-Phase Approach for Developing the Guide



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Version Review Process

- Transparency and consensus-building
  - All intermediate versions of documents published and archived on **www.swebok.org**
  - All comments made public as well as the identity of the reviewers
  - Detailed comment disposition reports

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Data on reviewers Trial Version

- Version 0,1: 33
- Version 0,5: 195
- Version 0,7: 378
  - + ISO reviews from 5 countries

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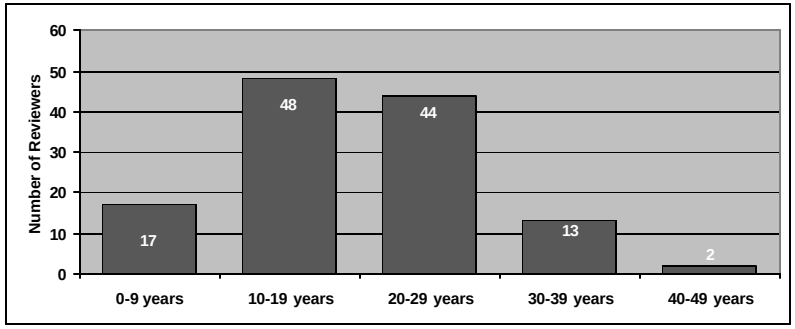
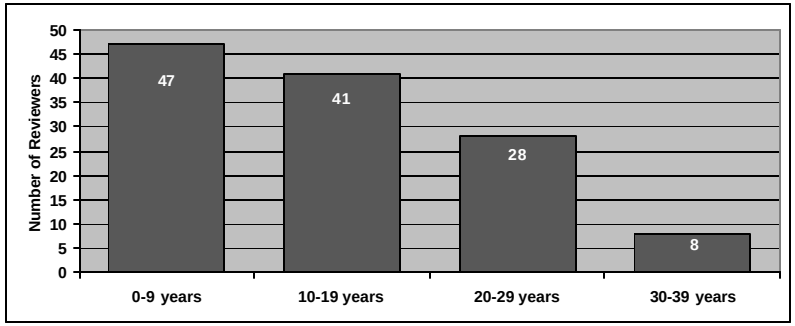
Reviewers (2004 Version)

- Registered reviewers: 573
- Number of countries: 55
- Number of comments: 1020
- Number of reviewers submitting comments: 124
- Number of represented countries: 21
- + 7 countries submitted comments through ISO voting process
- Adopted by + 25 ISO participating countries

Years in the field



Years in industry



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Project Overview Presentation Plan

- Project background
- Project development process
- **Contents of the Guide**
- Applications of the Guide
- Next steps

Deliverables:

- **Consensus** on a list of Knowledge Areas
- **Consensus** on a list of **topics and relevant reference materials** for each Knowledge Area
- **Consensus** on a list of Related Disciplines

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Knowledge Areas and Related Disciplines

- Software Requirements
- Software Design
- Software Construction
- Software Testing
- Software Maintenance
- Software Configuration Management
- Software Eng. Management
- Software Eng. Tools & Methods
- Software Engineering Process
- Software Quality

Related Disciplines

- Computer Engineering
- Computer Science
- Mathematics
- Project Management
- Management
- Quality Management
- Software Ergonomics
- Systems Engineering

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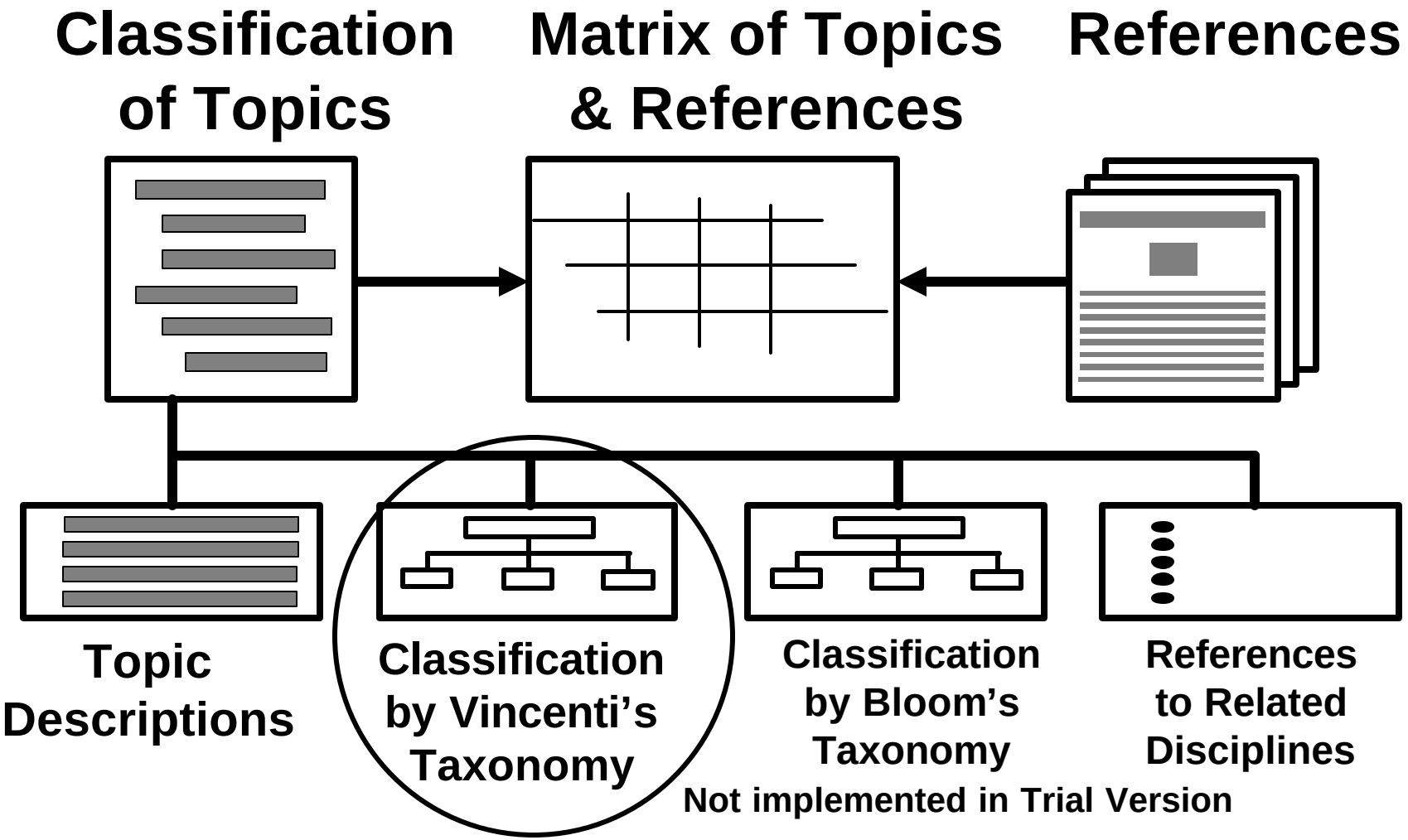
Knowledge Area Description



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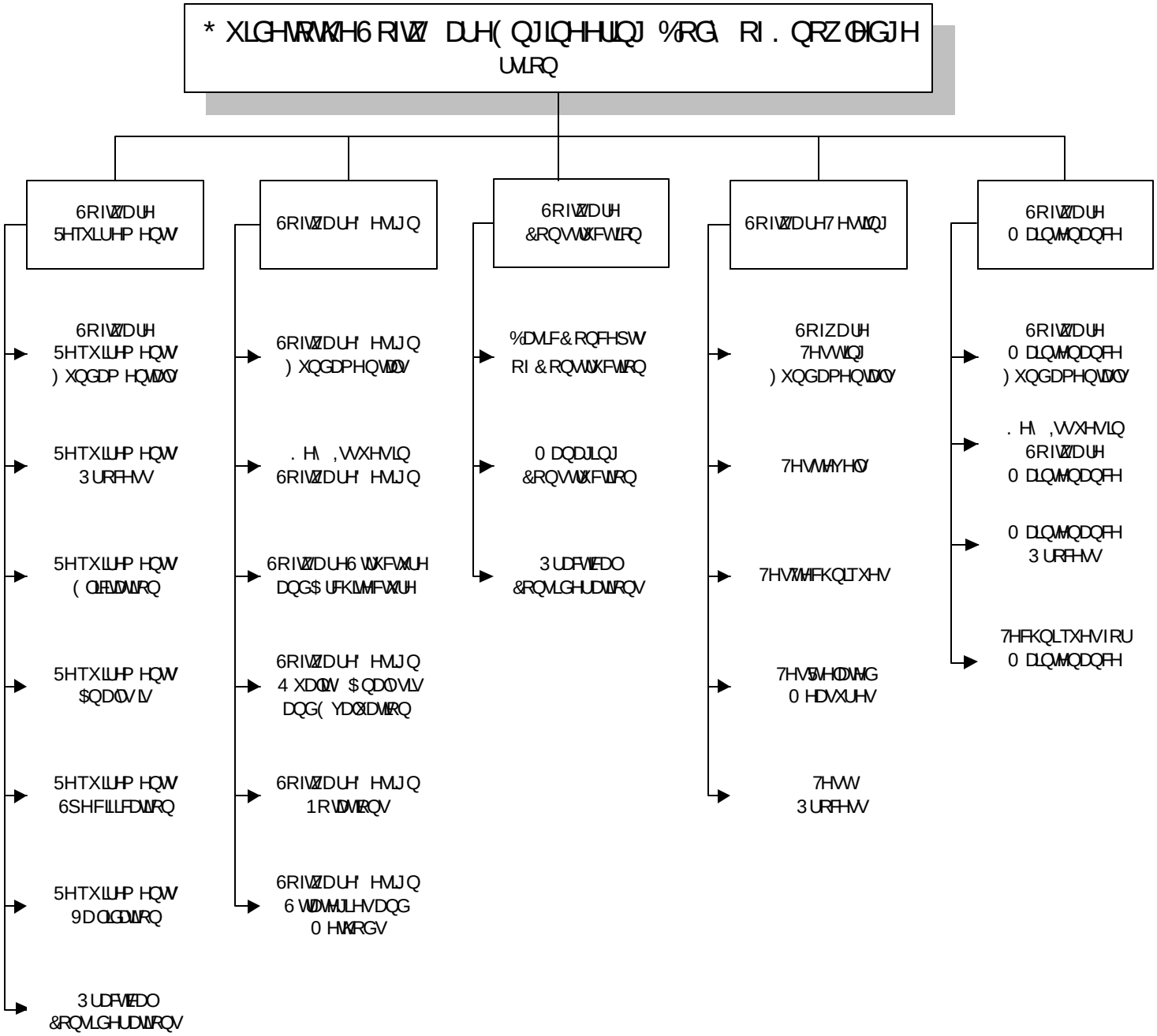
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6RIWZDUH &RQVWUXFWLRQ
6RIWZDUH7HVWLQJ
6RIWZDUH 0 DLQWHQDQFH
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5HTXLUHPHQWV (OLFLWDWLRQ
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5HTXLUHPHQWV 6SHFLILFDWLRQ
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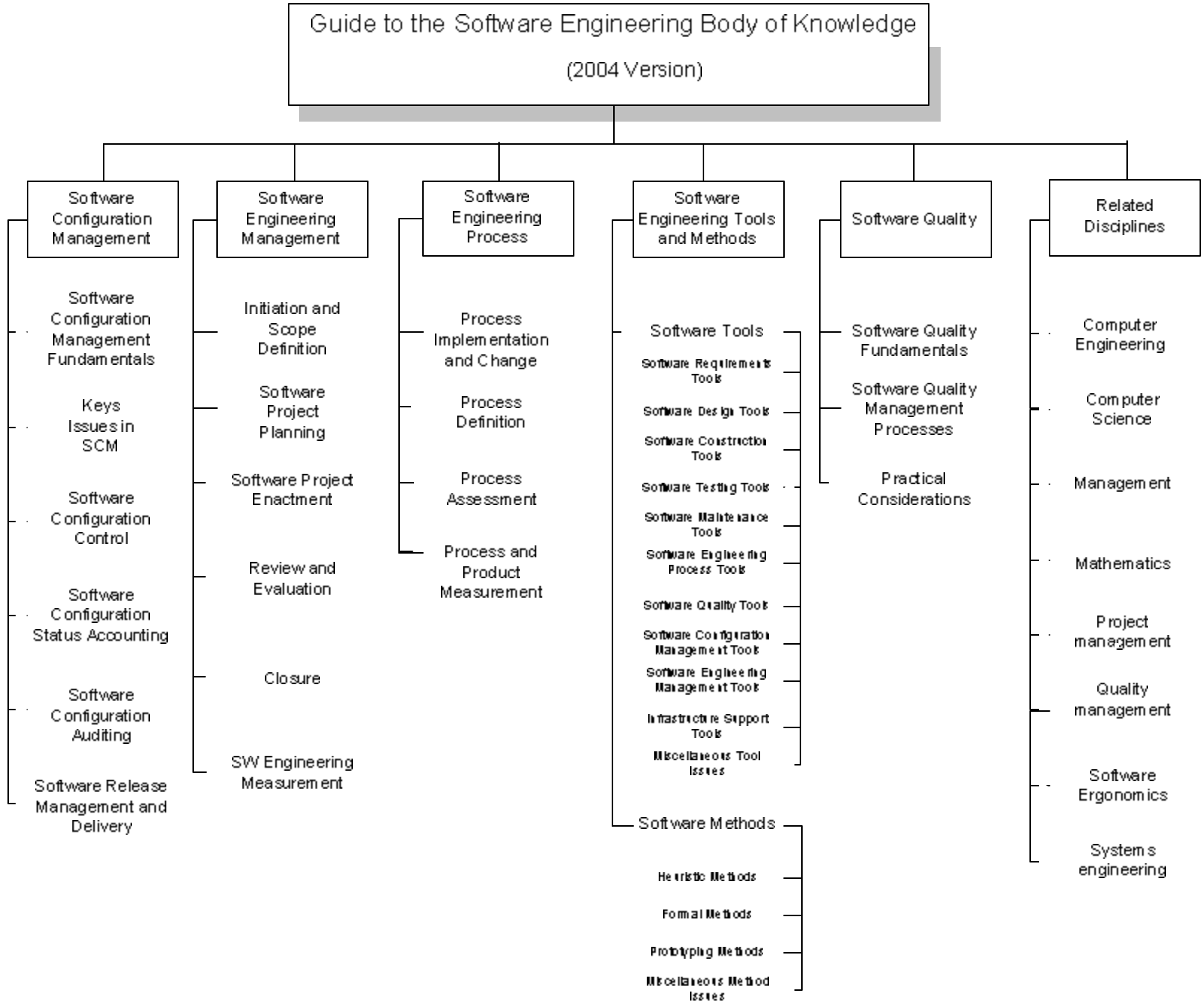

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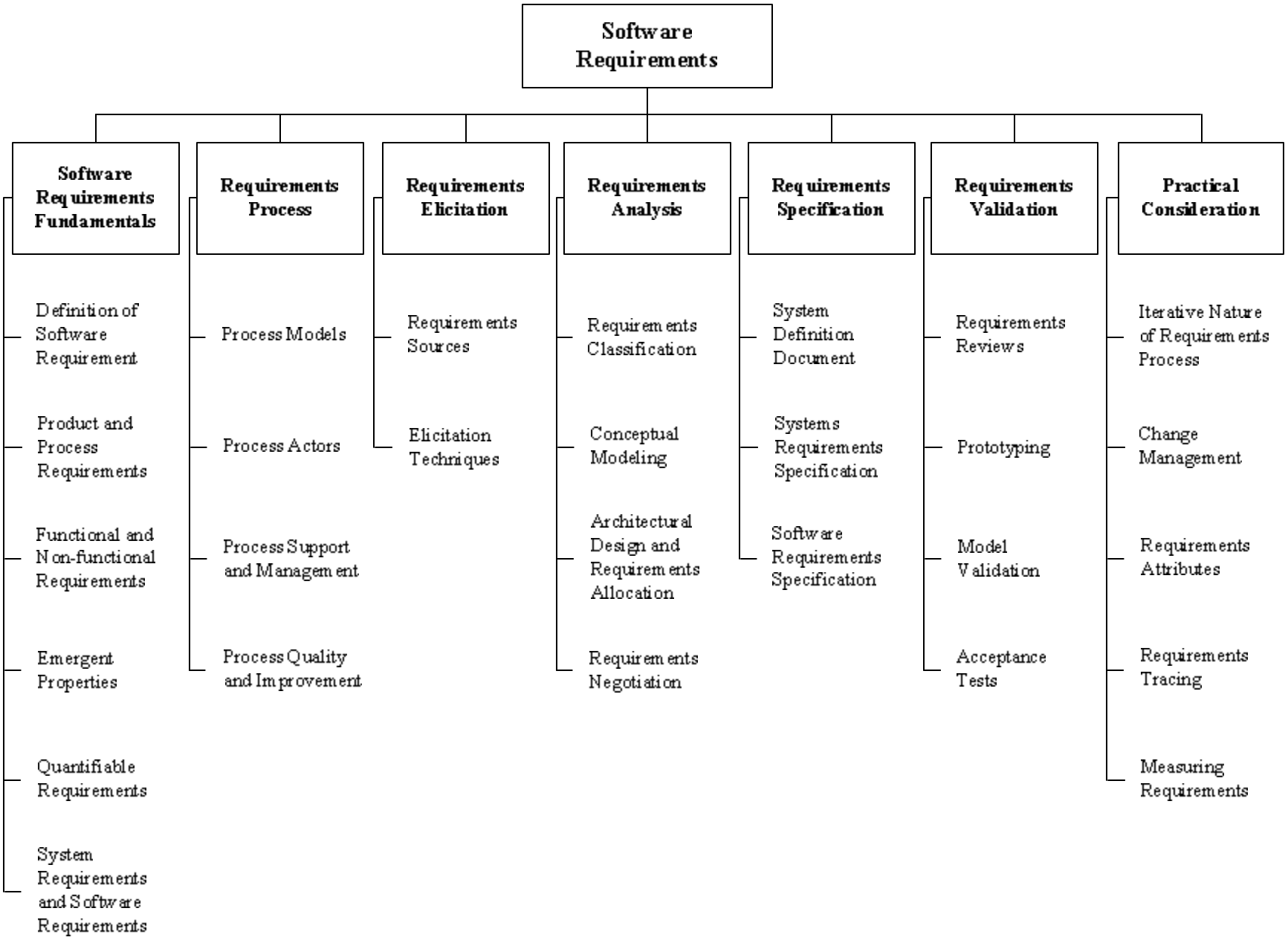
Software Requirements
Software Requirements Fundamentals
Definition of Software Requirement
Product and Process Requirements
Functional and Non-functional Requirements
Emergent Properties
Quantifiable Requirements
System Requirements and Software Requirements
Requirements Process
Process Models
Process Actors
Process Support and Management
Process Quality and Improvement
Requirements Elicitation
Requirements Sources
Elicitation Techniques
Requirements Analysis
Requirements Classification
Conceptual Modeling
Architectural Design and Requirements Allocation
Requirements Negotiation
Requirements Specification
System Definition Document
Systems Requirements Specification
Software Requirements Specification
Requirements Validation
Requirements Reviews
Prototyping
Model Validation
Acceptance Tests
Practical Consideration
Iterative Nature of Requirements Process
Change Management
Requirements Attributes
Requirements Tracing
Measuring Requirements

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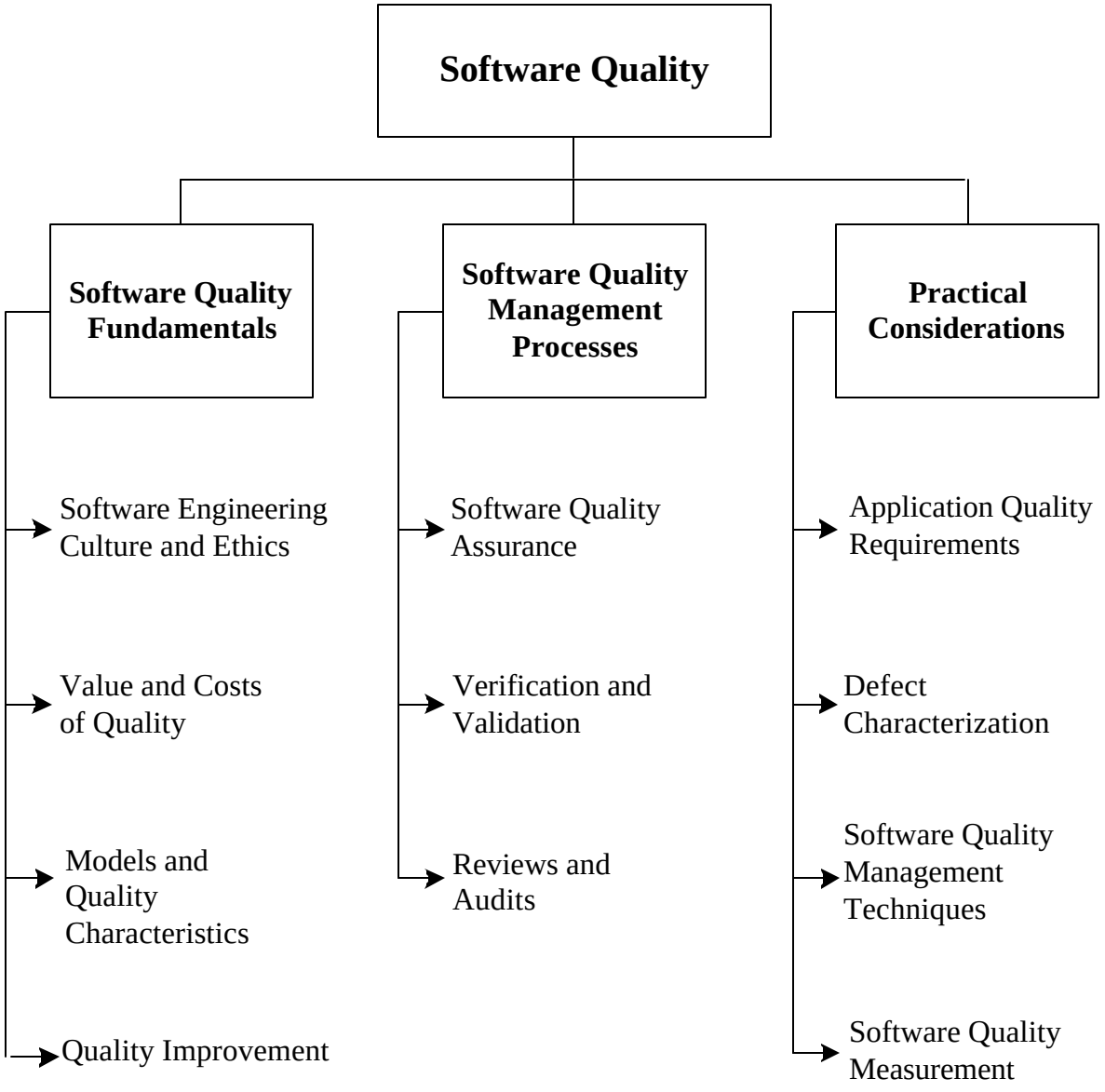
Software Quality
Software Quality Fundamentals
Software Quality Management Processes
Practical Considerations
Software Engineering Culture and Ethics
Value and Costs of Quality
Models and Quality Characteristics
Quality Improvement
Software Quality Assurance
Verification and Validation
Reviews and Audits
Application Quality Requirements
Defect Characterization
Software Quality Management Techniques
Software Quality Measurement

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Summary of changes in 2004 Version

- Structural improvements in breakdown of topics: Software Construction, Management, Quality, Process
- Better representation of text in topic breakdown : Software Requirements, Testing, Maintenance
- Standardization of the contents of the chapters:
  - topic breakdown, terminology, reference citations and writing style

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Summary of changes in 2004 Version

- Better representation of standards in chapters and a new Appendix devoted to standards
- Updating of reference material
- Handling of trial usage feedback
- Handling of reviewers comments
- New chapter on Related Disciplines (instead of an appendix)

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- Project background
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Applications of the Guide

- Licensing & Certification
  - IEEE CS CSDP exam and program
  - Input in accreditation of software engineering programs in engineering faculties - CCPE
  - Ordre des ingénieurs du Québec:
    - Input to certify software engineers

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Example Usages in Education

- Program Design/Assessment:
  - National Technological University
  - Monash University
  - CRISTEL project
- Course Design/Assessment:
  - A large number of universities
    - École de technologie supérieure

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Applications of the Guide

- Industry & Government
  - Job description
    - Bombardier Transportation
  - Career planning
    - Construx
  - Input to Policy making
    - Turkish Industry Survey

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Applications of the Guide

- Professional development
  - Security Industry Automation Corporation
  - Construx
- Dissiminations of standards
  - Introducing standards in software engineering curriculum

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Next steps:

Target of the SWEBOK Guide

«Applicable to most projects, most of the time, and widespread consensus about their value and usefulness»

Project Management Institute - PMI

⊙ North American Bachelor's degree + 4 years of experience

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Evolution process for the Guide

- Copyright belongs to the IEEE
- Transition to self-supporting, volunteer-led process—i.e. self-funded.
- Coordination with related IEEE-CS projects (internal and external)
- Time-boxed block updates
- Involvement with stakeholder groups
- Openness and transparency
- Technical excellence

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Next Steps

Research to strengthen the foundations of a body of knowledge:

- Vincenti's classification of engineering knowledge
  - Fundamental design principles
  - Criteria and specifications
  - Theoretical tools
  - Quantitative data
  - Practical considerations
  - Design instrumentalities
- Ontology of software engineering

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Next Steps

Being investigated at ISO level:

- Certification of software engineers
  - ISO standard on content of certification
  - ISO recognized certifying bodies
  - International portability of certification of software engineers

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Next steps

Consensus on the core body of knowledge is key in all disciplines and pivotal for the evolution toward a professional status

- INCOSE
  - Building a System Engineering Body of Knowledge - SEBOK

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Presentation Plan

- Project background
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- Next steps
- Appendix: Breakdown of topics

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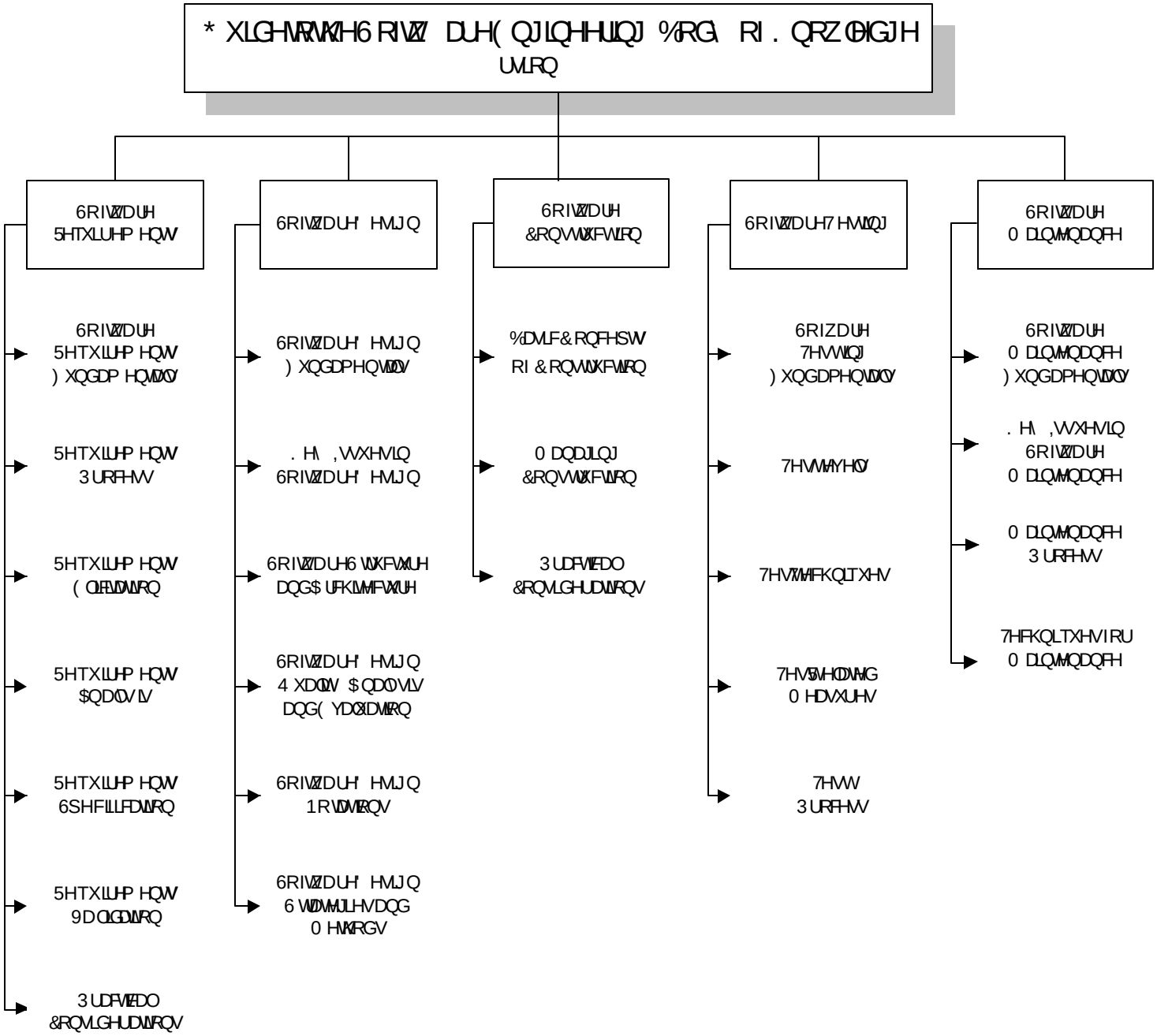
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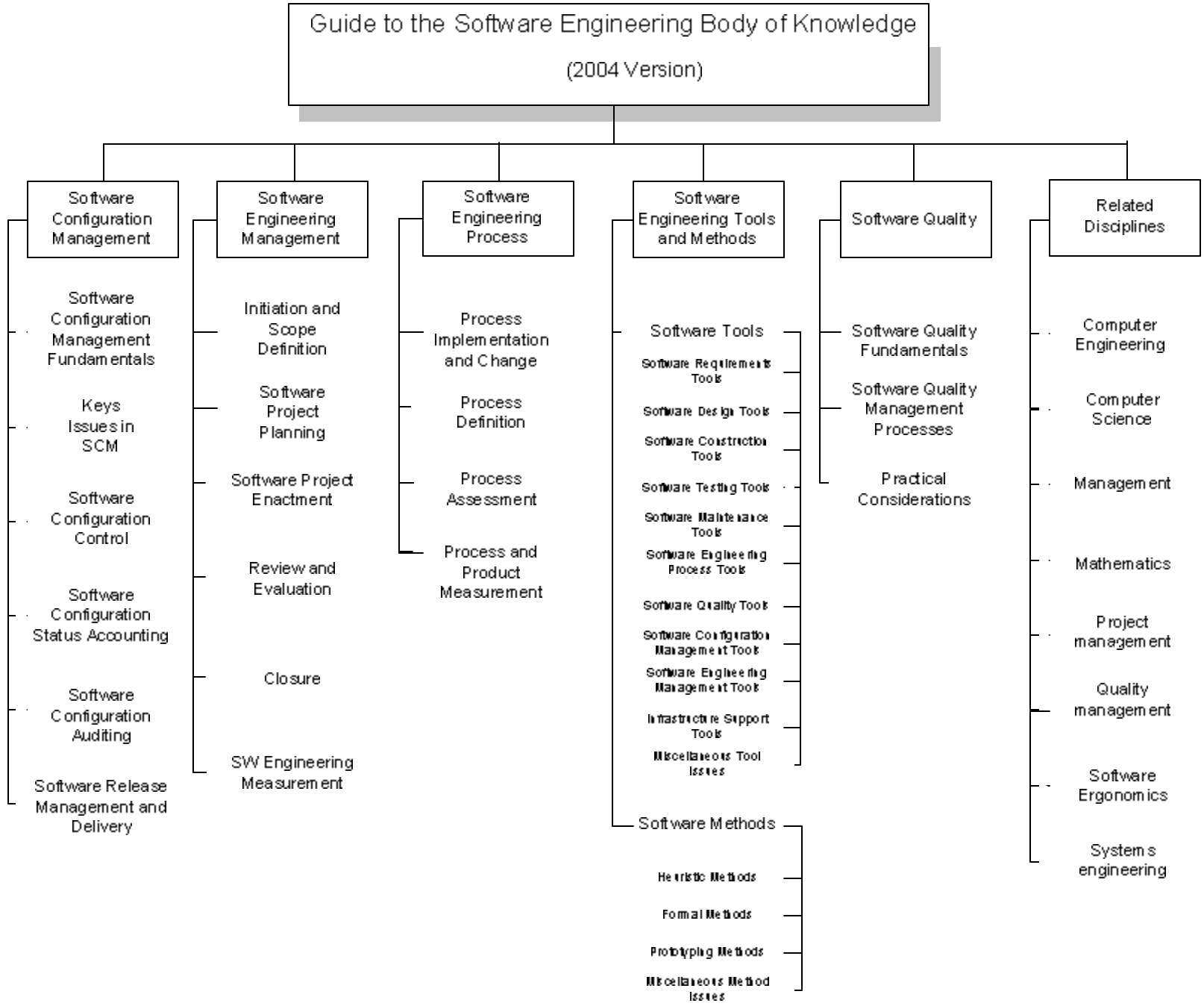
Guide to the Software Engineering Body of Knowledge
(2004 Version)
Software Configuration Management
Software Configuration Management Fundamentals
Keys Issues in SCM
Software Configuration Control
Software Configuration Status Accounting
Software Configuration Auditing
Software Release Management and Delivery
Software Engineering Management
Initiation and Scope Definition
Software Project Planning
Software Project Enactment
Review and Evaluation
Closure
SW Engineering Measurement
Software Engineering Process
Process Implementation and Change
Process Definition
Process Assessment
Process and Product Measurement
Software Engineering Tools and Methods
Software Tools
Software Requirements Tools
Software Design Tools
Software Construction Tools
Software Testing Tools
Software Maintenance Tools
Software Engineering Process Tools
Software Quality Tools
Software Configuration Management Tools
Software Engineering Management Tools
Infrastructure Support Tools
Miscellaneous Tool Issues
Software Methods
Heuristic Methods
Formal Methods
Prototyping Methods
Miscellaneous Method Issues
Software Quality
Software Quality Fundamentals
Software Quality Management Processes
Practical Considerations
Related Disciplines
Computer Engineering
Computer Science
Management
Mathematics
Project management
Quality management
Software Ergonomics
Systems engineering

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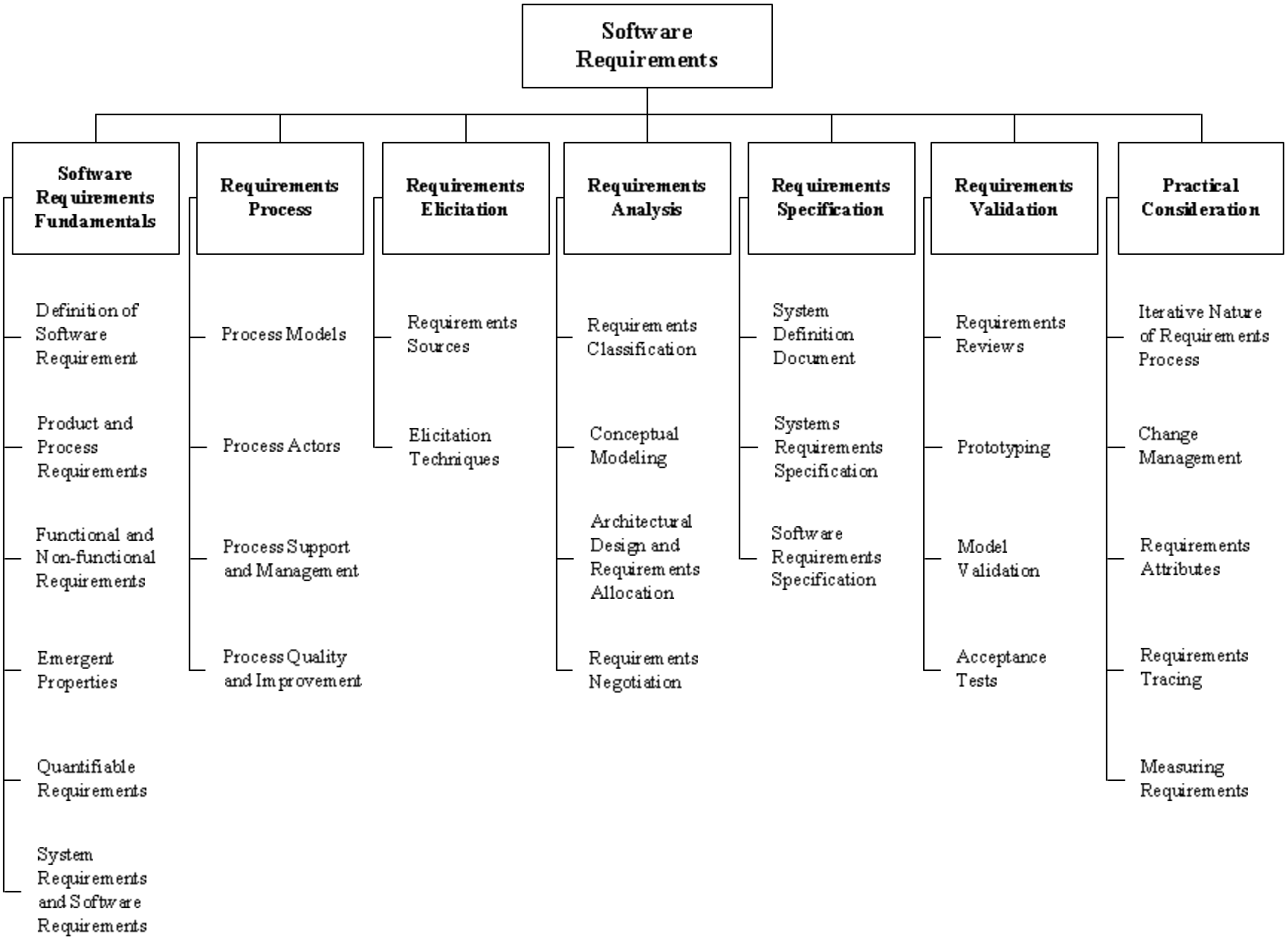
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Requirements Process
Process Models
Process Actors
Process Support and Management
Process Quality and Improvement
Requirements Elicitation
Requirements Sources
Elicitation Techniques
Requirements Analysis
Requirements Classification
Conceptual Modeling
Architectural Design and Requirements Allocation
Requirements Negotiation
Requirements Specification
System Definition Document
Systems Requirements Specification
Software Requirements Specification
Requirements Validation
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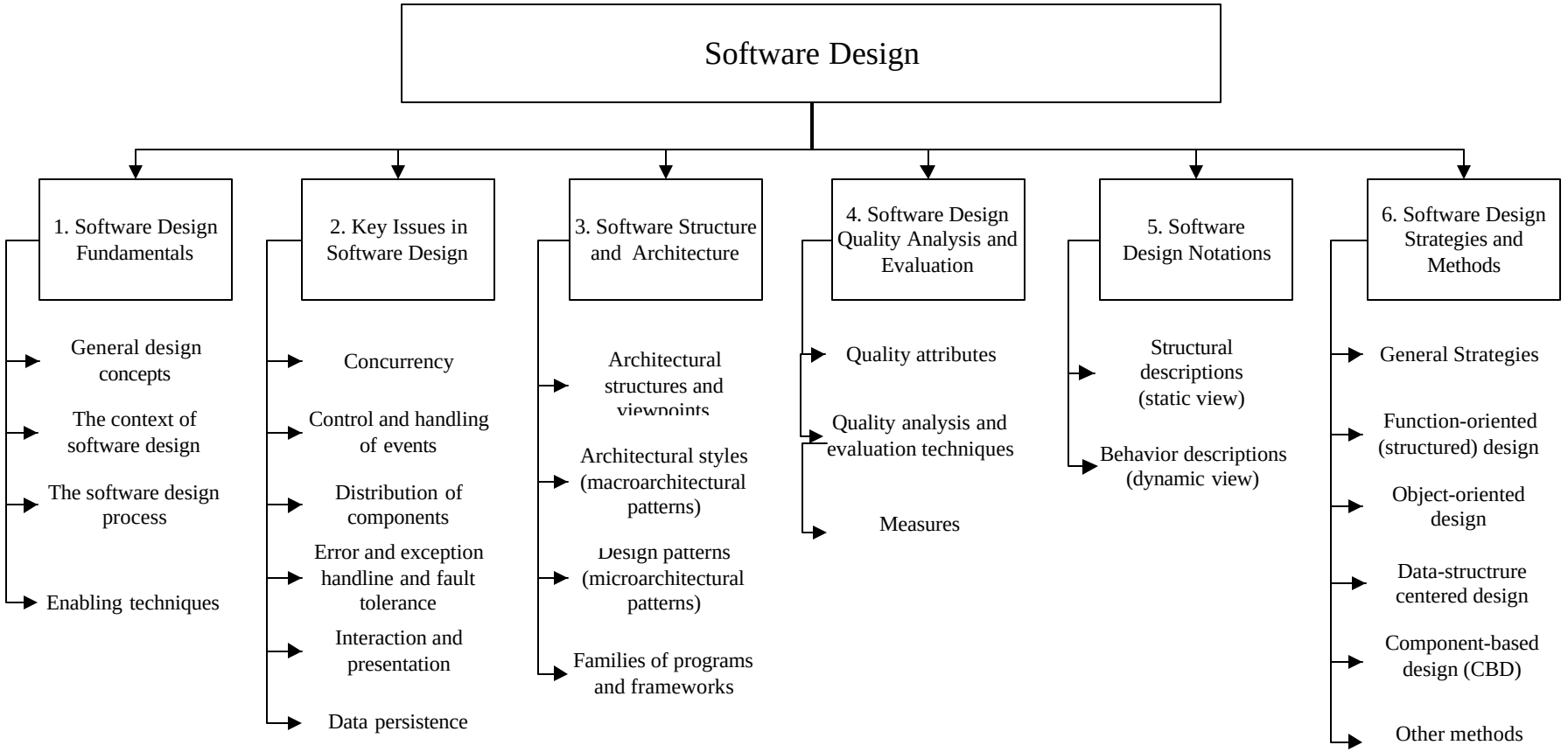

Figure 1 Breakdown of topics for the Software Design KA

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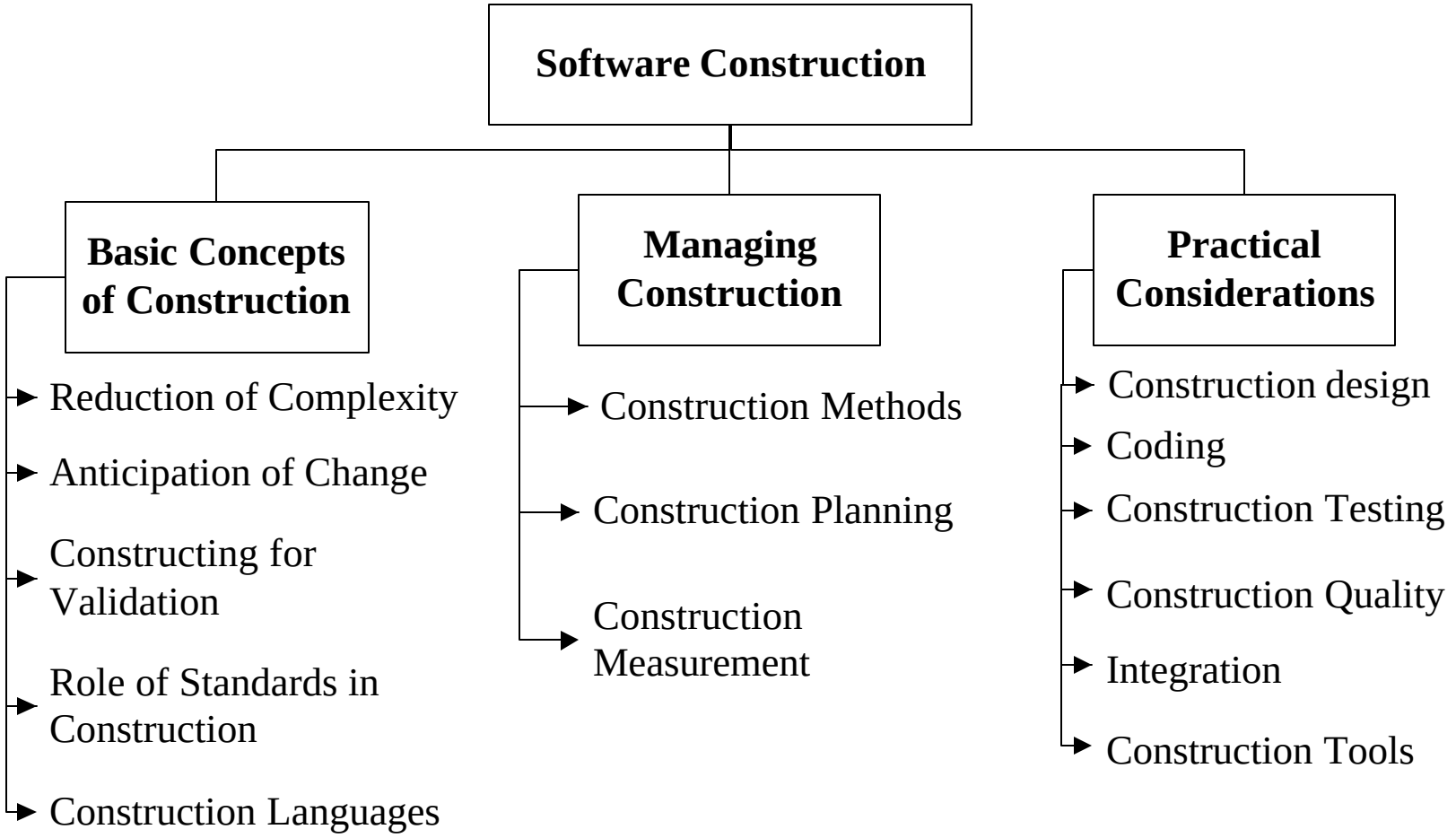

Figure 1. Breakdown of topics for the Software Construction KA.

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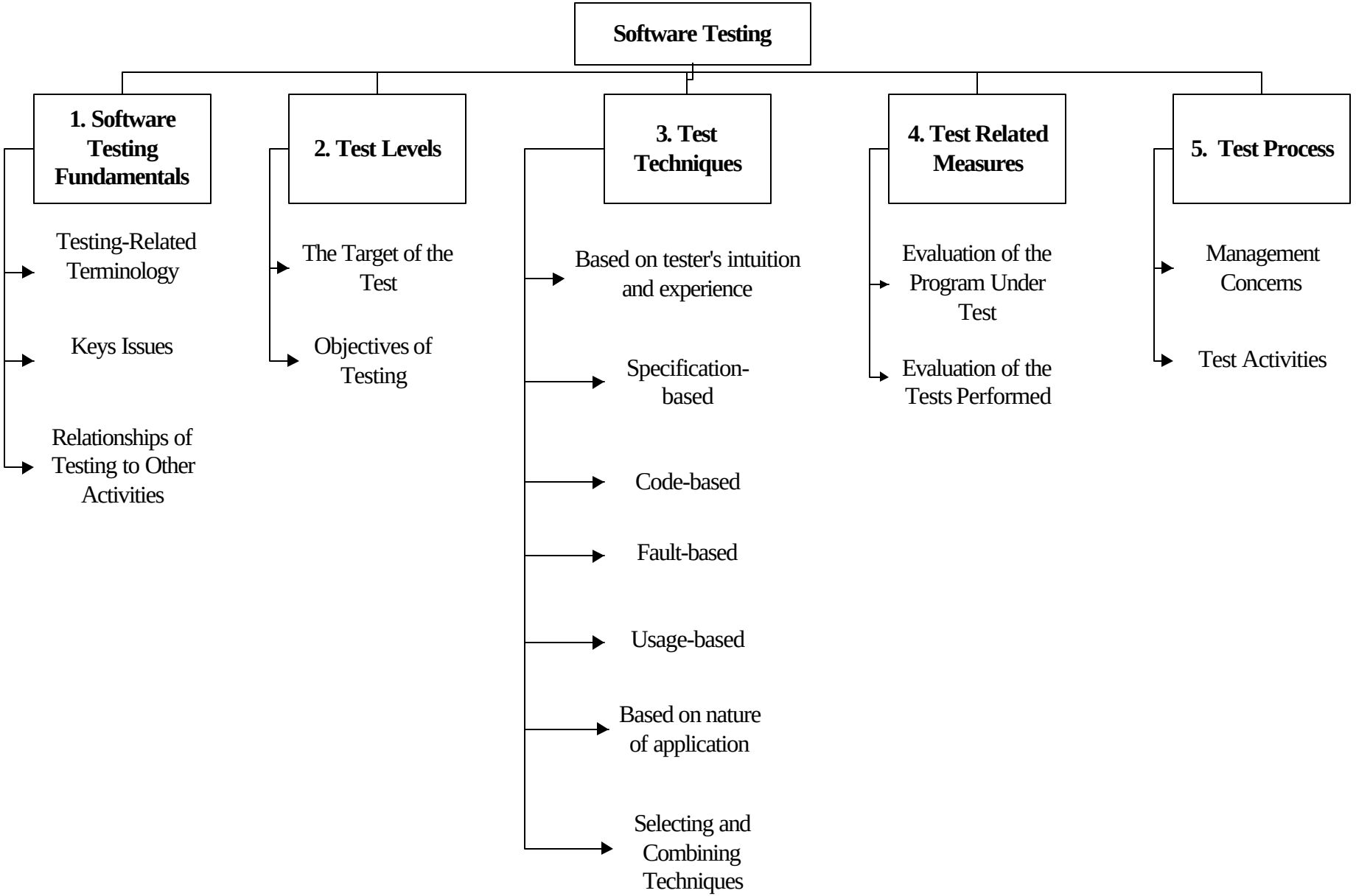
Software Testing
1. Software Testing Fundamentals
Testing-Related Terminology
Keys Issues
Relationships of Testing to Other Activities
2. Test Levels
The Target of the Test
Objectives of Testing
3. Test Techniques
Based on tester's intuition and experience
Specification-based
Code-based
Fault-based
Usage-based
Based on nature of application
Selecting and Combining Techniques
4. Test Related Measures
Evaluation of the Program Under Test
Evaluation of the Tests Performed
5. Test Process
Management Concerns
Test Activities

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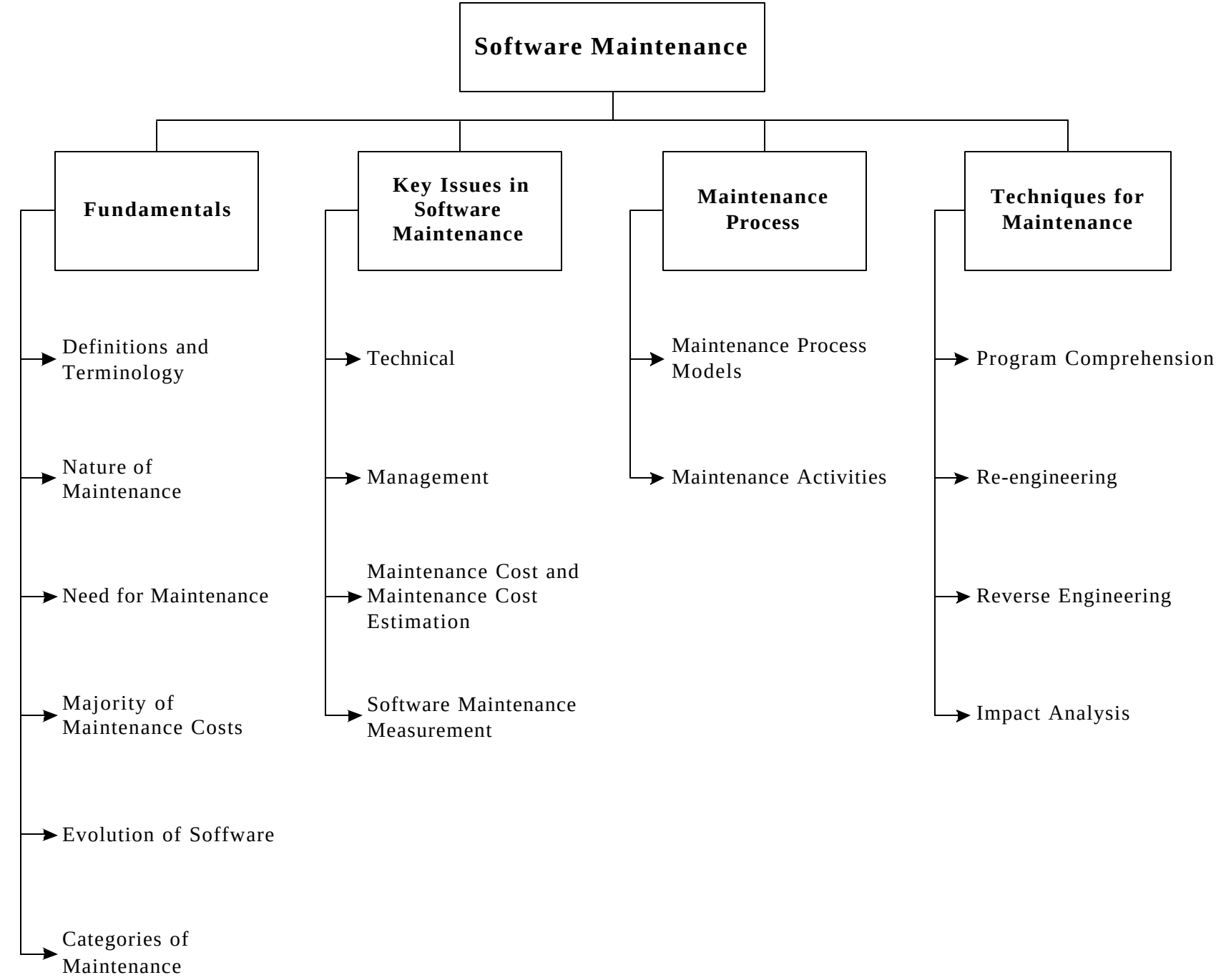
Software Maintenance
Fundamentals
Key Issues in Software Maintenance
Maintenance Process
Techniques for Maintenance
Definitions and Terminology
Nature of Maintenance
Need for Maintenance
Majority of Maintenance Costs
Evolution of Soffware
Categories of Maintenance
Technical
Management
Maintenance Cost and Maintenance Cost Estimation
Software Maintenance Measurement
Maintenance Process Models
Maintenance Activities
Program Comprehension
Re-engineering
Reverse Engineering
Impact Analysis

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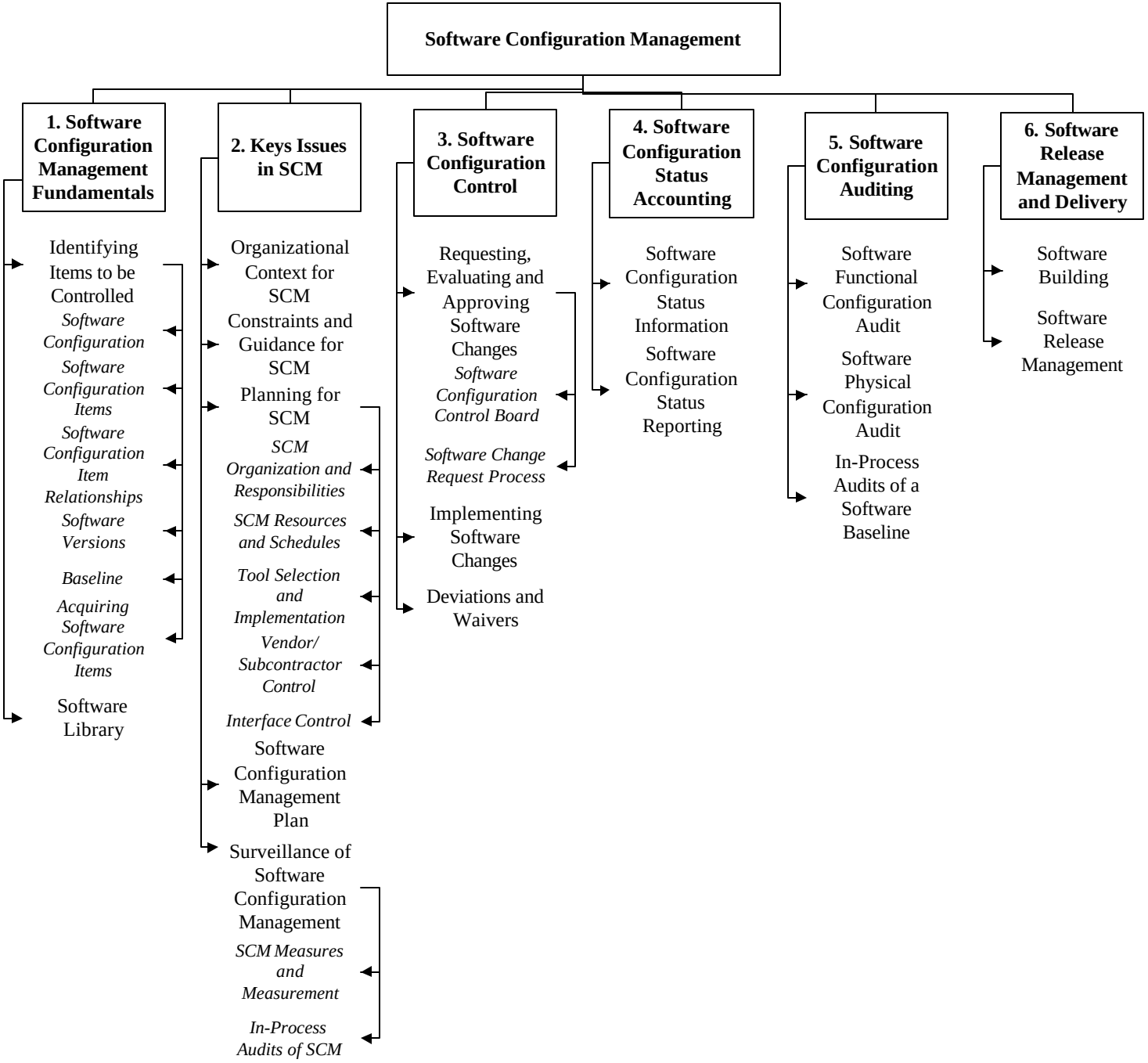
Software Configuration Management
1. Software Configuration Management Fundamentals
Identifying Items to be Controlled
Software Configuration
Software Configuration Items
Software Configuration Item Relationships
Software Versions
Baseline
Acquiring Software Configuration Items
Software Library
2. Keys Issues in SCM
Organizational Context for SCM
Constraints and Guidance for SCM
Planning for SCM
SCM Organization and Responsibilities
SCM Resources and Schedules
Tool Selection and Implementation
Vendor/ Subcontractor Control
Interface Control
Software Configuration Management Plan
Surveillance of Software Configuration Management
SCM Measures and Measurement
In-Process Audits of SCM
3. Software Configuration Control
Requesting, Evaluating and Approving Software Changes
Software Configuration Control Board
Software Change Request Process
Implementing Software Changes
Deviations and Waivers
4. Software Configuration Status Accounting
Software Configuration Status Information
Software Configuration Status Reporting
5. Software Configuration Auditing
Software Functional Configuration Audit
Software Physical Configuration Audit
In-Process Audits of a Software Baseline
6. Software Release Management and Delivery
Software Building
Software Release Management

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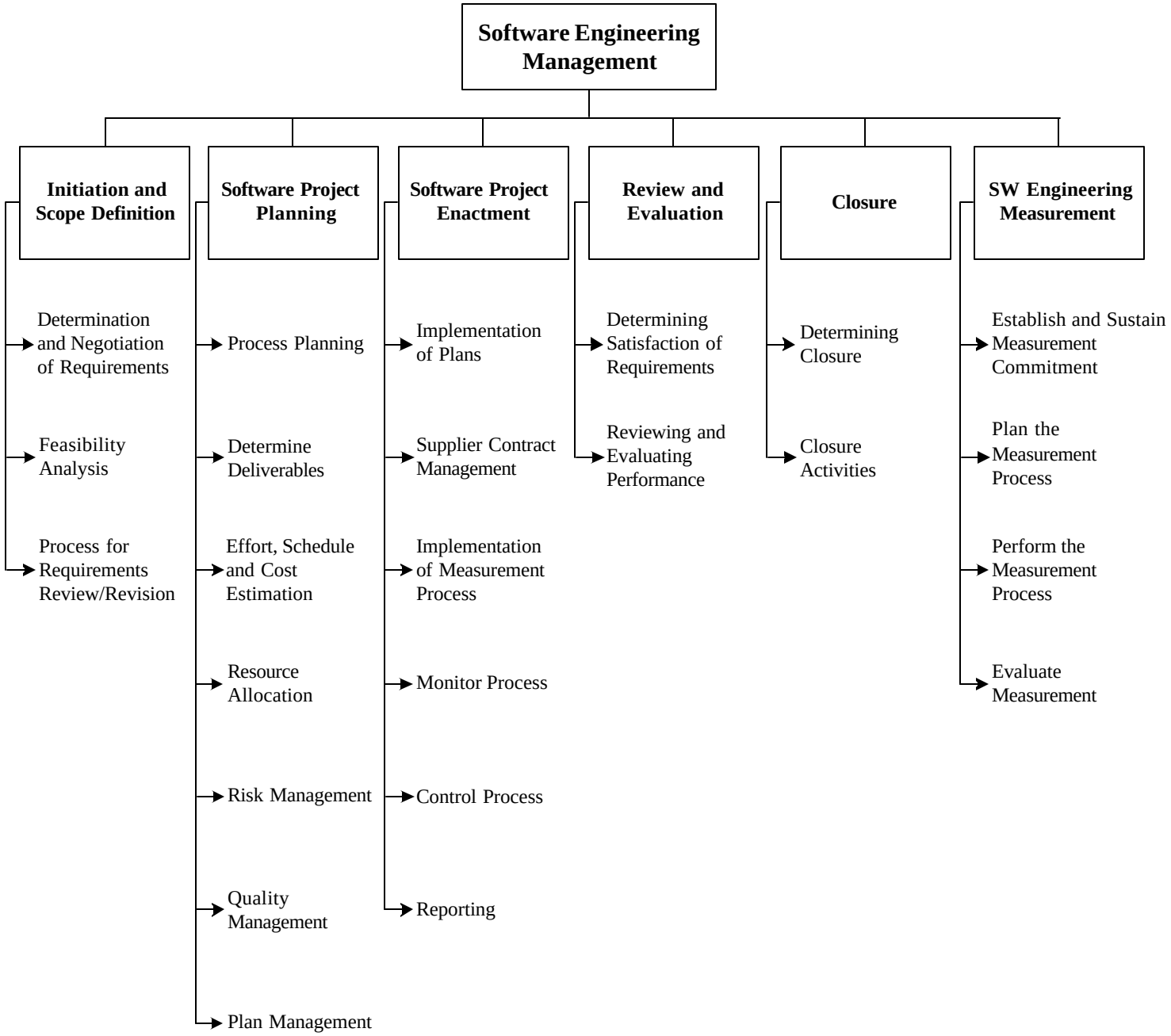
Software Engineering Management
Initiation and Scope Definition
Software Project Planning
Software Project Enactment
Review and Evaluation
Closure
SW Engineering Measurement
Determination and Negotiation of Requirements
Feasibility Analysis
Process for Requirements Review/Revision
Process Planning
Determine Deliverables
Effort, Schedule and Cost Estimation
Resource Allocation
Risk Management
Quality Management
Plan Management
Implementation of Plans
Supplier Contract Management
Implementation of Measurement Process
Monitor Process
Control Process
Reporting
Determining Satisfaction of Requirements
Reviewing and Evaluating Performance
Determining Closure
Closure Activities
Establish and Sustain Measurement Commitment
Plan the Measurement Process
Perform the Measurement Process
Evaluate Measurement

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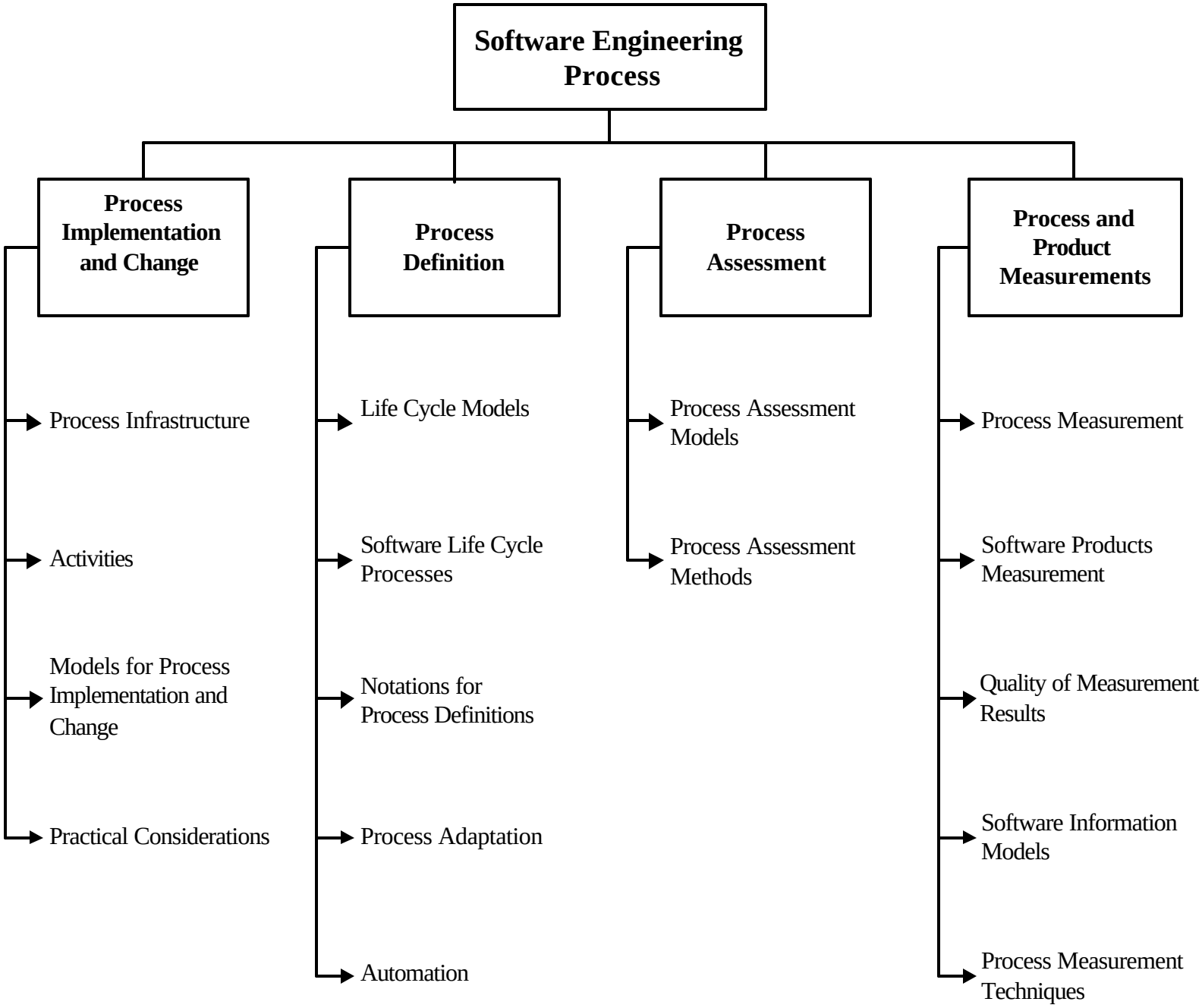
Software Engineering Process
Process Implementation and Change
Process Definition
Process Assessment
Process and Product Measurements
Process Infrastructure
Activities
Models for Process Implementation and Change
Practical Considerations
Life Cycle Models
Software Life Cycle Processes
Notations for Process Definitions
Process Adaptation
Automation
Process Assessment Models
Process Assessment Methods
Process Measurement
Software Products Measurement
Quality of Measurement Results
Software Information Models
Process Measurement Techniques

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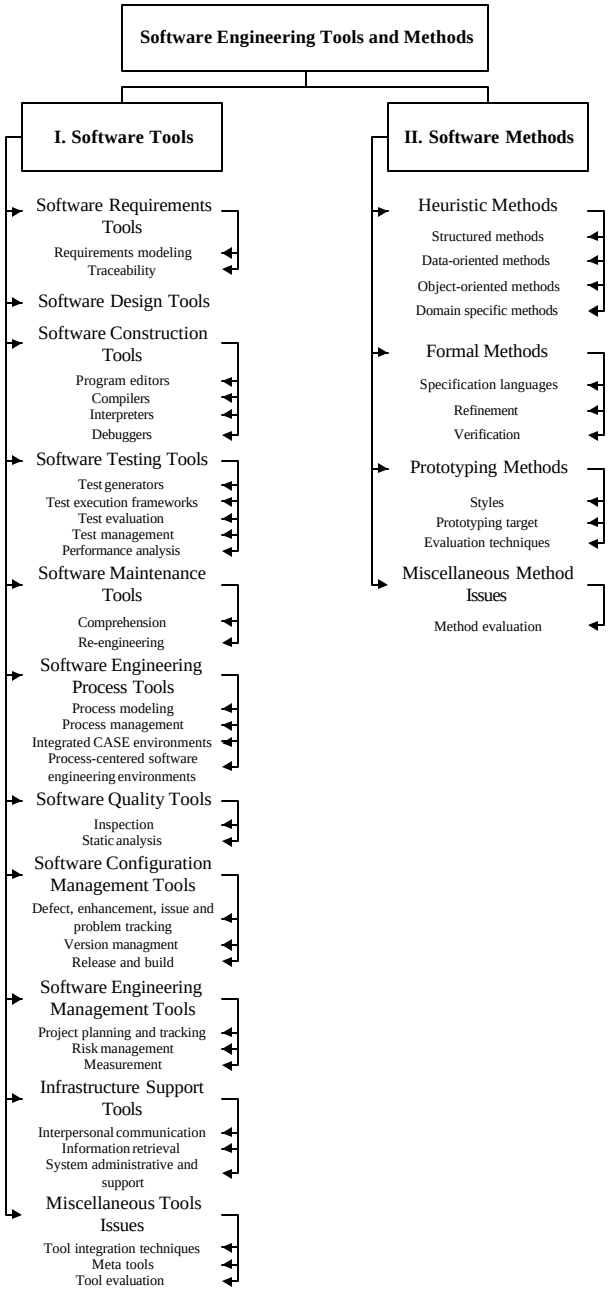
Software Engineering Tools and Methods



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List of Knowledge Areas

- Software Requirements
- Software Design
- Software Construction
- Software Testing
- Software Maintenance
- Software Configuration Management
- Software Quality
- Software Engineering Tools & Methods
- Software Engineering Process
- Software Engineering Management

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Formal resolutions

- Industrial Advisory Board (2001)
- IEEE CS Board of Governors (2001)
  - *"The Board of Governors of the IEEE Computer Society accepts the Guide to the Software Engineering Body of Knowledge (Trial Version) as fulfilling its development requirements and is ready for field trials for a period of two years"*
- *IEEE CS Board of Governors (Feb. 2004)*
  - *Officially approved the 2004 Version*
- *ISO Technical Report 19759 (upcoming)*

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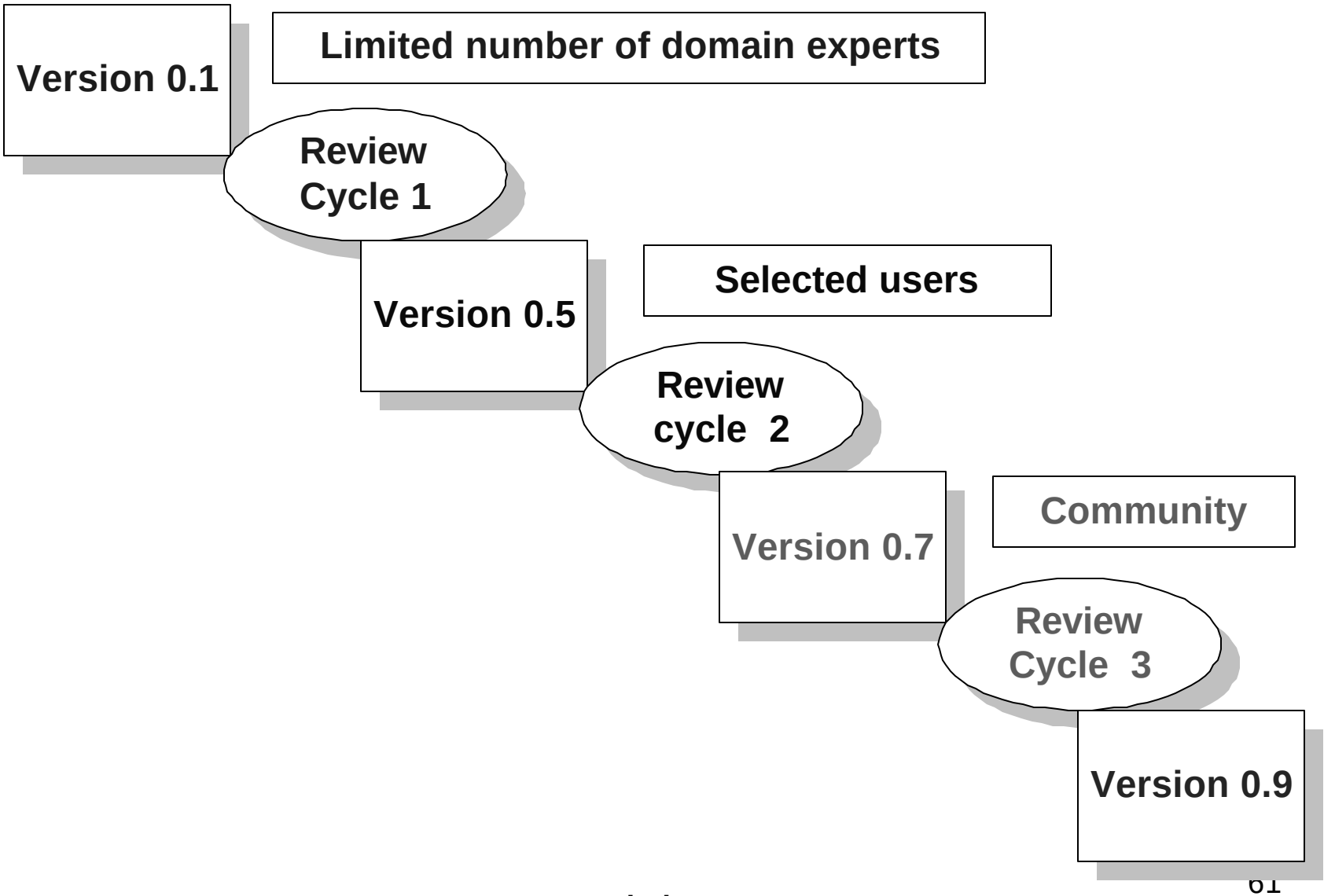
Trial Version Review Process



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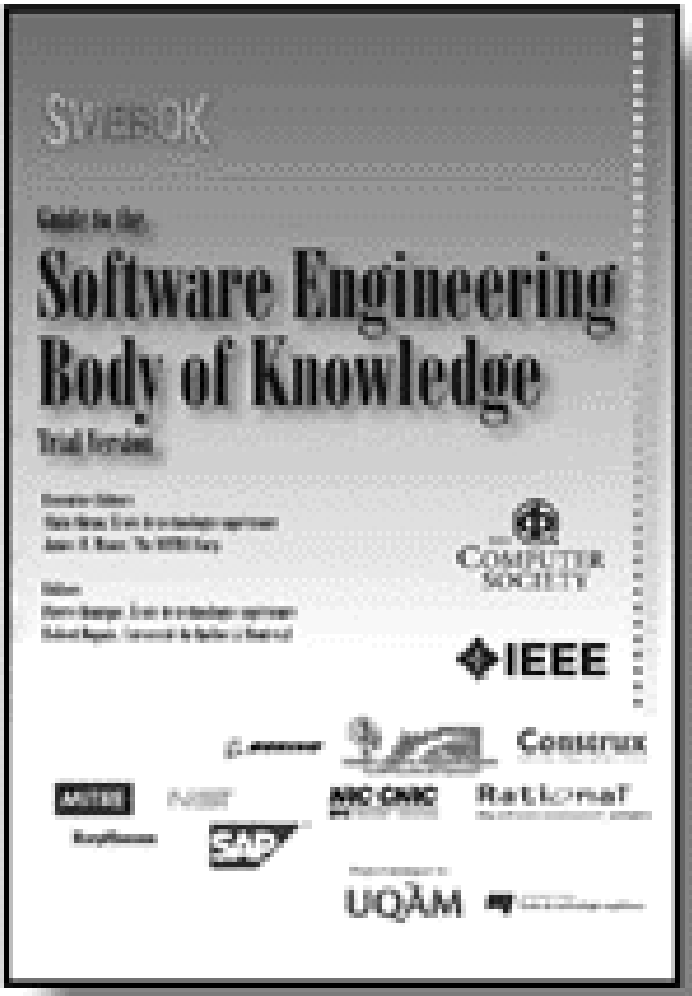
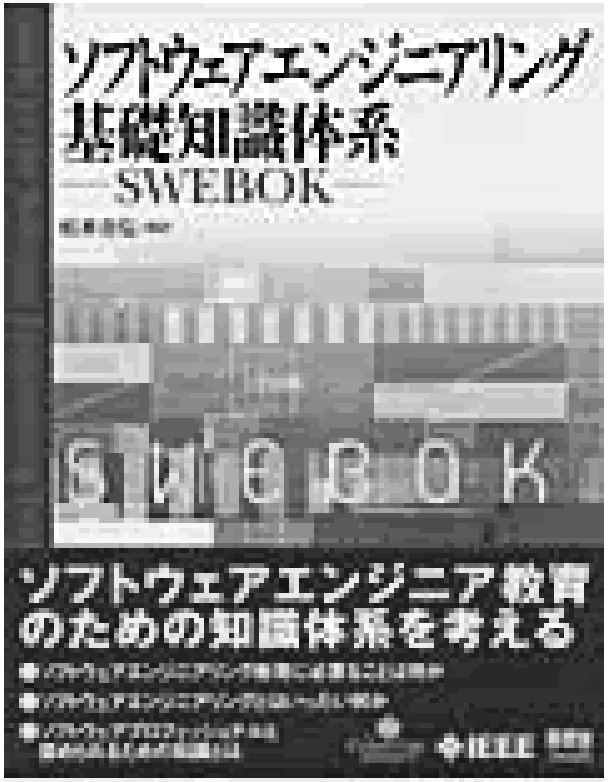
Trial Version (2001)





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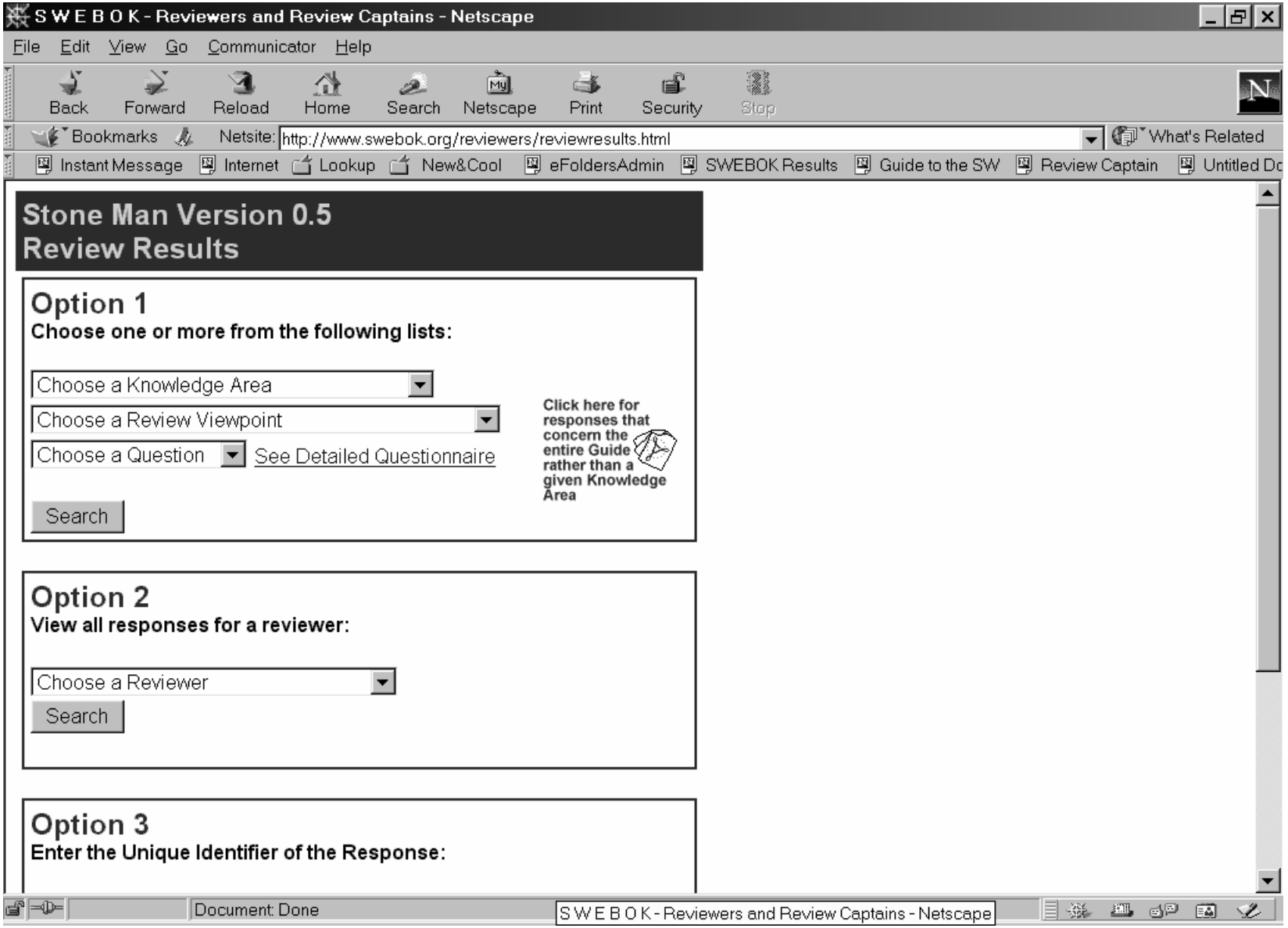
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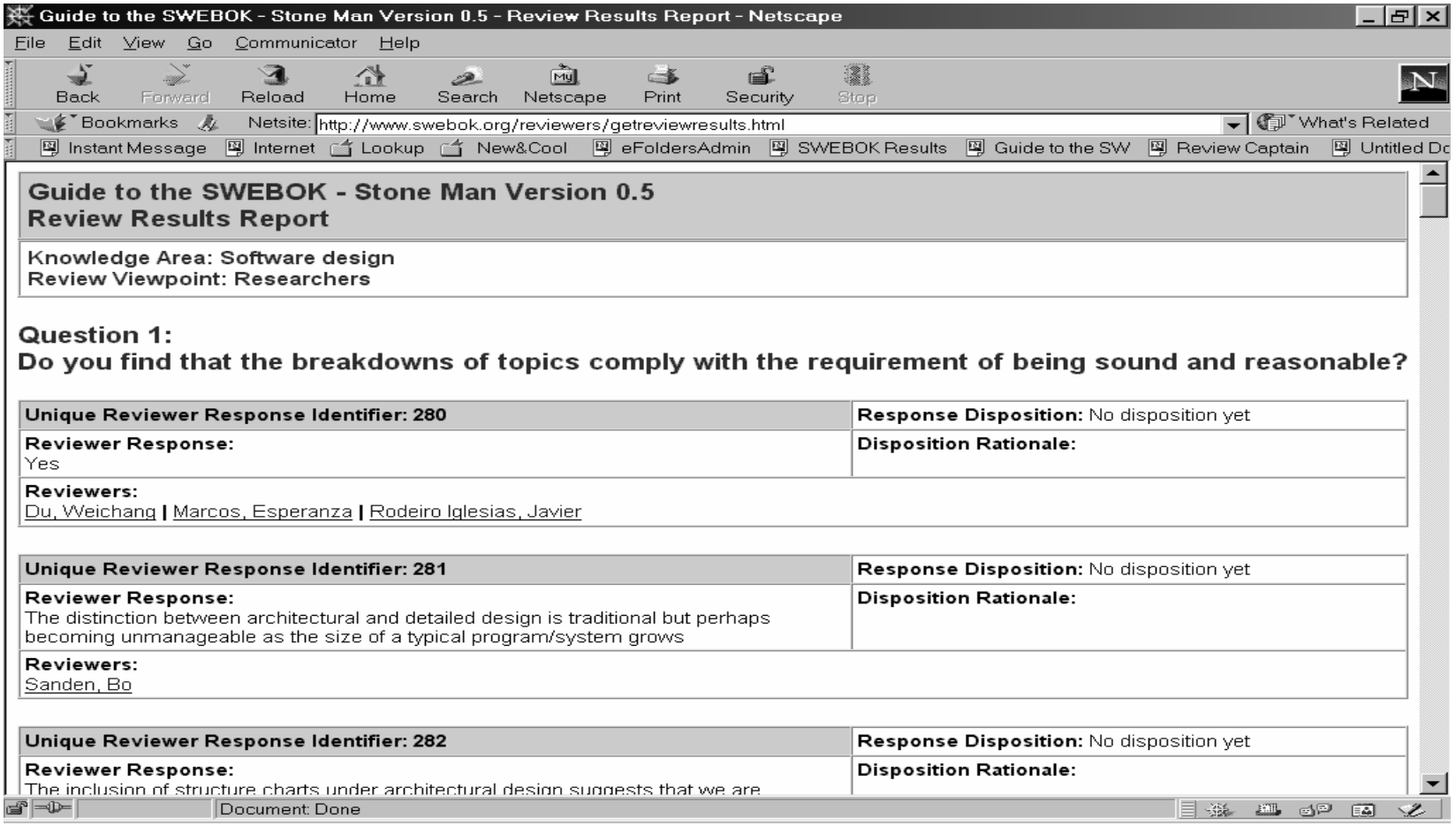

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Geographic Distribution of Reviewers Trial Version

- USA: 55%
- Europe: 18%
  - 90 reviewers from 25 countries
- Canada: 10%
- Australia: 5%
- Asia: 5%
- Latin America: 4%

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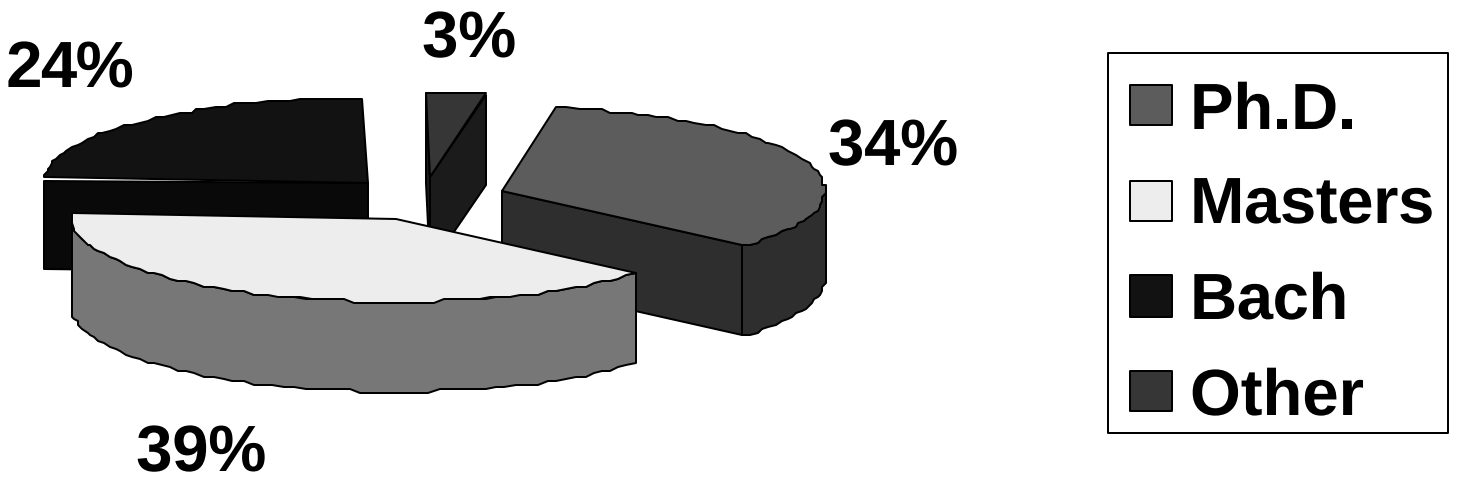
Education level of reviewers (Version 0,7)



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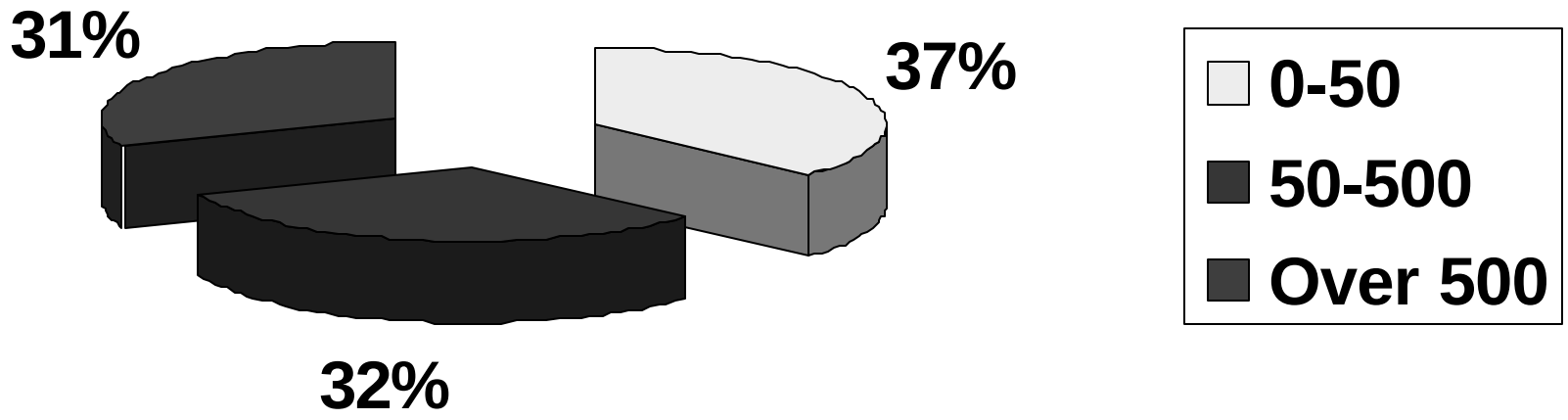
Number of employees at reviewer location (Version 0,7)



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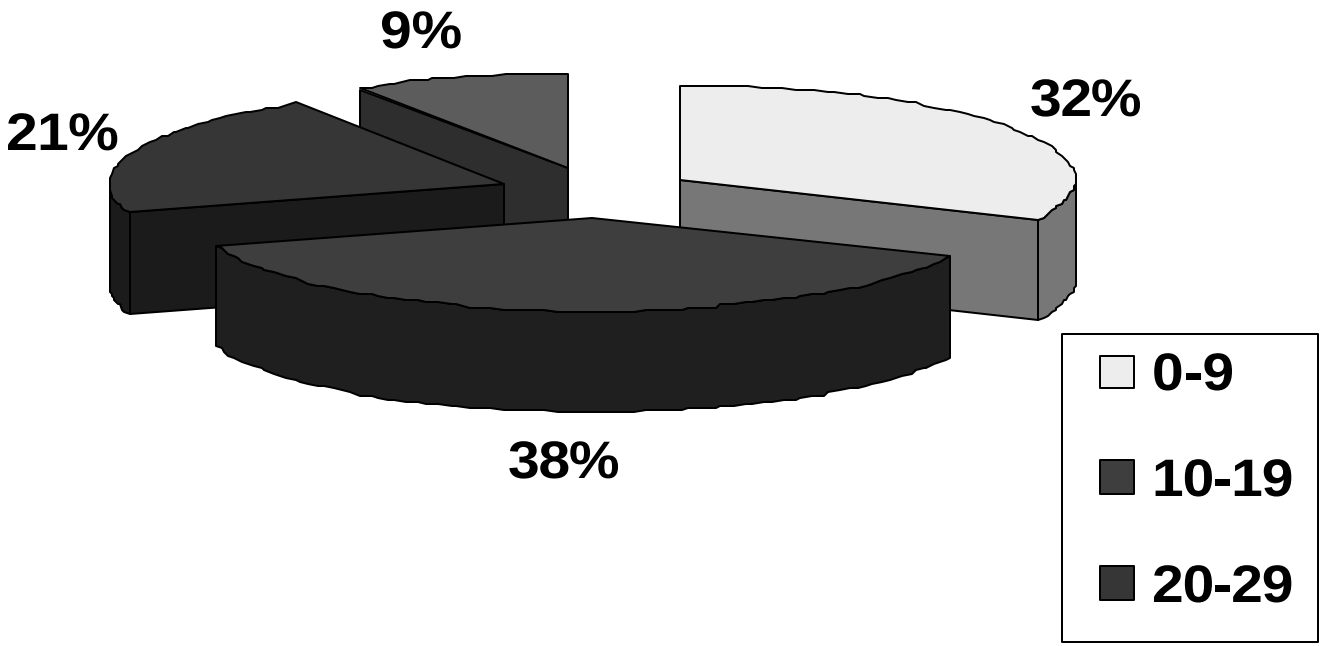
Number of years of practical experience (Version 0,7)



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