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<p style="text-align: center;">Development and Sustainment of Process-Based Ontological Engineering based Bodies of Knowledge</p>	

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INTRODUCTION

0.1 General

Industries, organizations, and professions are reliant upon a community of competent people and individuals that possess relevant knowledge and skills for their scope of responsibility. Traditional methods of defining requisite knowledge and skills have been based on job analysis methodologies and through the development of subject-matter expert (SME) bodies of knowledge. While job analysis methodologies may suffice at a micro level, they offer little value to the professions and industrial communities. SME developed bodies of knowledge are inherently limited to the knowledge and experience by the individuals serving as SMEs.

This Standard defines a Process-Based Ontological Engineering (PBOE) methodology that combines the objective evaluation of process mapping, measurement analysis of Bloom's taxonomy, and validation by SME. It also includes requirements for on-going maintenance and long-term sustainment of bodies of knowledge that are industry-recognized.

It is the objective of this Standard to promote a common and robust methodology for professional knowledge and skill identification that facilitates the development and sustainment of defined professional bodies of knowledge to meet the actual needs of assigned professional responsibilities within organizations and industries.

It is also the intent of this document to provide a mechanism to address the requirements of ISO 9001:2008, paragraph 6.2.2, '*Competence, Training and Awareness*'.

0.2 Process Approach and Sustainment

This document is based on the recognition that knowledge within an organization and industry is dynamic and ever changing. It is therefore vitally important that a PBOE-based Body of Knowledge (BoK), and thereby the competence of people, remain relevant and accurate. The PBOE model (reference figure 1) requires competent individuals to perform process mapping within a set of business process to identify the associated tasks. Led by a Qualified Educational Professional, the tasks are analyzed, utilizing Bloom's taxonomy, to elicit the requisite knowledge and skills at the level of proficiency to successfully execute the specific task.

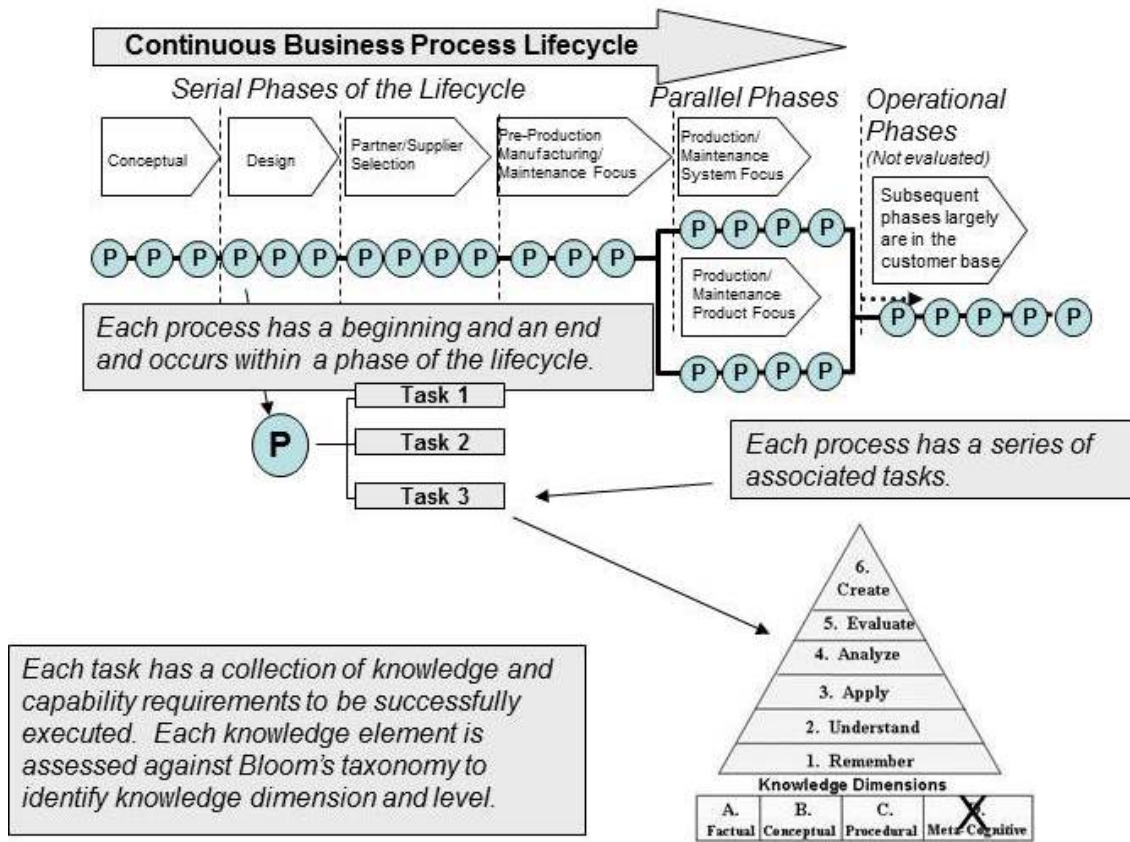


Figure 1, The Process-Based Ontological Engineering (PBOE) model (Dreikorn, 2009).

The resulting listing of tasks with measured knowledge and skills is then validated by related SME to ensure accuracy and adequacy. The SME review also ensures any unique regulatory or industry requirements that were not identified during the business processing are included in the BoK.

Validated BoK must be controlled to ensure effective alignment to the needs of the specific industry. To maintain industry relevance, and depending on the rate of change within an industry, BoKs shall be subject to reapplication of the PBOE model and revision.

BODY OF KNOWLEDGE DEVELOPMENT AND SUSTAINMENT – REQUIREMENTS

1.0 SCOPE

1.1 General

This Knowledge Management Standard provides the requirements for developing, validating, and sustaining professional bodies of knowledge within organizations and industries.

1.2 Application

All requirements of this Knowledge Management Standard are generic and are intended to be applicable to all organizations and professions, regardless of type, complexity, size and product/service provided.

2 NORMATIVE REFERENCES

The following referenced documents are relevant for the application of this document. For dated references, only the edition cited applies. For undated references, the latest edition of the referenced document (including any amendments) applies.

ISO 9000:2005, *Quality management systems - Fundamentals and vocabulary*

3 DEFINITIONS

Assessment - Systematic process of collecting and analyzing data to determine the efficiency/effectiveness of an organization, product, process, system, or a person's competence.

Autonomy - The ability to work independently.

Body of Knowledge (BoK) - Is the framework that defines the current boundaries of knowledge of a particular profession within a specific industry or organization. BoK are set out as simple validated statements of knowledge and/or skill that are measurable through the application of Bloom's taxonomy that can be used and developed by user groups such as professional groups, educational establishments, training establishments and organizations that need to define guidance and/or competencies for professionals.

Blooms Taxonomy – Bloom's Taxonomy is a multi-tiered model of classifying thinking according to six cognitive levels of complexity.

Competence – Demonstrated personal attributes and demonstrated ability to apply knowledge and skills.

Curriculum Vitae (CV) – another term for resume. A collection of personal professional information including knowledge, skills, and experience.

Domain – A major industry sector (e.g., aerospace; automotive; bio-tech; banking, medical, etc.).

Experience – The accumulation of knowledge or skill that results from direct participation in events or activities over a period of time.

Explicit Knowledge – Knowledge that has been memorialized in such a way that it can be transferred independent of a human.

Field – A related group of professions (e.g., finance, engineering, manufacturing, quality, etc.).

Knowledge – What we have learned and the information we possess (education, training, experience, etc.). The combination of data and information, to which is added expert opinion, skills and experience, to result in a valuable asset which can be used to aid decision making.

Peer Review – A generic term that is used to describe a process of self-regulation by a profession or a process of evaluation involving qualified individuals within the related field. Peer review methods are employed to maintain standards, improve performance, and provide credibility.

Personal Attributes – The expected behaviors required for a particular job, role or activity.

Position Assessment – The process of reviewing a standard, process or task to identify and define the skills & competencies required to accomplish the responsibilities of the defined position.

Profession – General term used to describe an area of responsibility by a class of professionals.

Proficiency Level – The measurable quality of having the appropriate level of skill and capability in the command of fundamentals deriving from practice, familiarity and knowledge as defined in an applicable BoK.

Professional Peer – Someone that has demonstrated their professional competency within a specific industry, within the scope of a specific class of profession.

Resume – A collection of personal professional information including knowledge, skills, and experience. Also referred to as a CV.

Qualification – Documented demonstration of the ability to fulfil specified requirements, as defined in an applicable BoK.

Qualified Educational Professional – An individual who has a minimum of a graduate degree in the area of professional education and/or knowledge management, has demonstrated their ability to utilize educational research design techniques (e.g., include Bloom’s taxonomy) to evaluate and validate professional knowledge and skill requirements, and apply process mapping, and have relevant work experience within the applicable industry.

Note: For the purposes of this Knowledge Management Standard, “relevant work experience” may be defined at the organizational level differently than at the industry profession level. Each industry segment shall identify the minimum years and scope of relevant work experience for Qualified Educational Professionals. As a guideline, 15 years of relevant work experience may be considered acceptable.

Skill – Ability to perform a particular task. The quality of being able to do something that is acquired or developed through training, experience, and/or practice. Skill is synonymous with ability.

Subject Matter Expert (SME) – A person who peer-recognized as an expert in a particular area or topic.

Training – The process to provide and develop knowledge, skills and behaviors to meet requirements (reference ISO 10015:1999).

Tacit Knowledge – The knowledge that resides in the minds of individuals and not memorialized for transference.

4. BODY OF KNOWLEDGE DEVELOPMENT AND SUSTAINMENT

4.1 General Requirements

PBOE-based BoK shall clearly identify the professional domain that it is intended to describe. As a minimum the professional domain shall be identified by

- a) the industry being addressed (e.g., aerospace, automotive, medical, etc.);
- b) the professional domain within the industry being addressed (e.g., finance, engineering, manufacturing, quality, etc.); and
- c) the specific professional position within the professional domain being identified (e.g., quality engineer, safety technician, auditor, etc.).

Each PBOE-based BoK shall be

- a) developed by a Qualified Educational Professional;

- b) based on process mapping of the work process related to the described profession;
- c) representative of the common industry or organizational work practices of the described profession (when the BoK is provided as a definition of an organizational or industry-wide profession);
- d) descriptive of the minimum skill and knowledge requirements described utilizing Bloom's taxonomy;
- e) validated within industry by a panel of peer-recognized subject matter experts (SME);
- f) documented to provide objective evidence the requirements of this Standard were met; and
- g) maintained and updated at appropriately defined intervals (e.g., every 36 months), or more frequently when major changes in relevant industry standards and/or practices occur that affect the work processes of the identified profession.

Note: Updating intervals may vary depending on industry and profession. The BoK developer is responsible for the definition of updating intervals, which may be subject to acceptance by relevant industry groups.

PBOE-based BoK that are intended for industry-wide use (including for the development of training and professional certification schemes), shall be made accessible over the internet without any fees. Free access to a PBOE-based BoK in no way shall compromise the intellectual property rights of a BoK developer/owner.

Note: Free access to PBOE-based BoK may be limited to narrative descriptions and not the detailed analysis of task identification and Bloom's taxonomy.

The organization that is responsible for the custodianship of industry-wide PBOE-based BoK shall ensure the long-term sustainability of the BoK. Long-term sustainment may include transferability of the BoK in the event the organization can no longer maintain the BoK, as required by this Standard.

4.2 Documentation Requirements

4.2.1 General

As provided in this Standard, the PBOE-based BoK developer shall

- a) develop and maintain documented procedures to control the development and sustainment of BoK in compliance with the requirements of this Standard;

- b) develop and maintain records, as provided for in this Standard, that demonstrate compliance with the requirements in this Standard;
- c) maintain the aforementioned records in perpetuity; and
- d) make records available for review by relevant industry oversight representatives, as may be provided for in formal industry-recognition agreements or by other contractual agreements.

4.3 Developing a Body of Knowledge

4.3.1 General

When developing a Body of Knowledge, the developer is advised to take into consideration a range of factors. These factors shall include and involve knowledge of

- a) subject matter experts (SME);
- b) leading practitioners;
- c) those carrying out the particular activity;
- d) relevant standards;
- e) relevant specifications;
- f) relevant legal and regulatory requirements; and
- g) the utilization of quality tools, such as process mapping.

A BPOE-based BoK shall represent the actual work processes of an identified profession and accurately define skill and knowledge requirements at a level of proficiency that the work processes can be executed successfully. As such, each skill and knowledge requirement shall be characterized by Bloom's taxonomy. Methodology design and analysis of the BoK development shall be conducted by a Qualified Educational Professional with experience in the applicable industry.

4.3.2 Identify the Profession

The PBOE-based BoK developer shall clearly identify and document as permanent records

- a) the industry for which the BoK represents (e.g., aerospace; automotive, bio-medical, chemical, etc.);

- b) the field within the industry (e.g., engineering, manufacturing, quality, etc.);
and
- c) the specific profession within the field (e.g., draftsman, engineer, auditor, etc.).

4.3.3 Identifying Work Processes within a Profession

BPOE-based BoK shall accurately reflect the needs of the industry as they relate to a defined profession. Utilizing a process mapping methodology within a representative sample of the organization or industry, each identified profession shall clearly describe the work processes for which it is responsible. Each work process shall be described to the specific task level identifying the skills and knowledge required to effectively execute the defined task.

4.3.4 Analyzing Work Processes to Determine Requisite Skill and Knowledge Requirements

Each task within a designated work process shall be analyzed by a Qualified Educational Professional to determine the requisite skills and knowledge needed to effectively execute the defined work tasks. For each work task assigned to an identified process, knowledge and skill requirements shall be defined at the “proficient” level (reference figure 2). “Experience” and “Autonomy” is not required to be identified in BPOE-based BoK, however, when they are applied as qualification criterion, the measurement shall be established at the “proficient” level.

Descriptor	Definition of Proficient
Knowledge	Sufficient to effectively carry out the defined/assigned work task.
Experience	Sufficient to effectively manage ambiguity in the defined work task.
Autonomy	Sufficient to carry out tasks autonomously within the defined work task.

Figure 2; Skill and knowledge requirements defined at the “proficient” level.

At the “proficient” level, skill and knowledge requirements shall be analyzed utilizing Bloom’s taxonomy (reference figure 3). The resulting analysis shall provide a

quantitative taxonomy assessment in at least three knowledge types: Factual, Procedural, and Conceptual.

Note: Metacognitive knowledge type may be defined as an option, but is not requirement of this Standard.

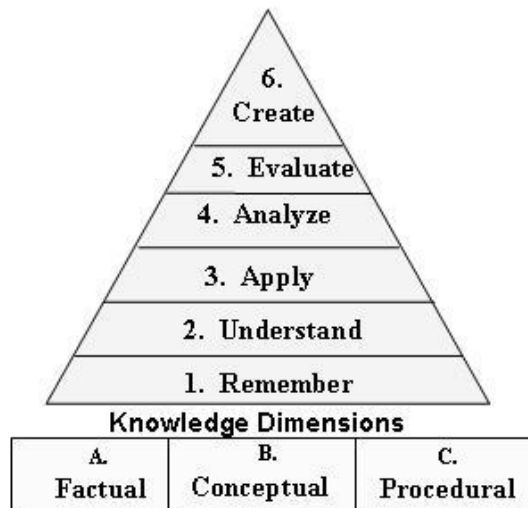


Figure 3; Bloom's taxonomy with three knowledge dimensions.

The completed skill and knowledge analysis will be documented in a matrix (spread sheet) format. Within the matrix, from the left to the right, the following data shall be provided

- a) identified work processes;
- b) description of the work process;
- c) major knowledge and skill requirements associated with the work process;
- d) tasks associated with the execution of the work process; and
- e) the Bloom's taxonomy analysis associated with each task.

4.3.5 Validate Knowledge and Skill Requirements within the Industry

The PBOE-based BoK developer shall validate the reliability of the BoK among a sample of relevant industry organizations utilizing common statistical research techniques and rigor. The methodology, to include sample selection criteria, shall be defined and documented as a permanent record.

Note: Sample size will vary based on organizational/industry complexity, diversity, and dispersion. For evolving PBOE-based BoK, convenience samples may be utilized, provide such is disclosed upon release of the BoK.

4.3.6 Validate BoK with Peer-Recognized SME Panel

The PBOE-based BoK developer shall subject the validated BoK to a panel of peer-recognized SME for review and validation. The size of the SME panel will be dependent on the complexity of the BoK. The SME panel members shall have extensive experience in the specific processes addressed in the defined BoK and shall be representative of the various aspects of the identified profession. The BoK SME panel shall review and validate the BoK to ensure

- a) the processes identified for the specific profession are accurate and inclusive of what the profession is actually responsible for within the generalized expectations of the identified profession and shall not be commodity specific or specialized unless the profession is commodity or speciality focused;
- b) Bloom's taxonomy scoring is assigned for each task and that identified knowledge and skills represent current organizational/industry standards and requirements from an SME perspective; and
- c) the results of the SME panel review are documented.

The documentation records shall also include

- a) signature of the Qualified Education Professional;
- b) signature of the responsible executive of the organization developing the BoK;
- c) signatures of each of the SME panel members conducting the SME validation (may be through attachments);
- d) a description of the methodology, including sample selection and results of data analysis;
- e) the validated PBOE-based BoK provided in required skills and knowledge matrix format;
- f) copies of SME panel members CVs;
- g) copy of the qualified educational professional's CV; and

- h) a master list of the BoK developer's relevant procedures that define the requirements for BoK development and sustainment.

4.4 Maintaining BPOE-based BoK

4.4.1 General

As an industry and profession evolves so must BPOE-based BoK. It is the responsibility of the BoK developer/owner to ensure that each validated BoK is maintained at appropriate intervals to ensure consistency with the needs of the industry.

4.4.2 Maintenance of Validated BPOE-based BoK

As part of the PBOE-based BoK developer's/owner's defined control processes, the process of BPOE-based BoK maintenance must be defined, to include the provisions for objective evidence.

Maintenance shall include revision of PBOE-based BoK to reflect

- a) changes in relevant regulatory requirements;
- b) changes in industry standards;
- c) introduction of new technologies;
- d) implementation of standardized best practices; and
- e) periodic updating needs to meet other stated requirements of the relevant industry.

Updating of a BPOE based BoK may be continuous or phased and shall be configuration controlled. The PBOE-based BoK developer/owner shall define the required frequency for BoK updating, to include any special frequency criteria (e.g., changes in industry standards/regulations, changes in technology, etc.).

The updating process may require the performance of process mapping within an appropriate sample of the defined organization/industry and shall be accomplished by a Qualified Educational Professional and validated by a panel of relevant SME.

At a minimum, each validated BPOE-based BoK shall have the process mapping process reapplied every ten years from the date of the previous BoK issuance.

Maintenance records shall include the same information required as for new BPOE-based BoK. Records related to BoK maintenance shall be maintained in perpetuity.

4.4.3 Industry Oversight of BPOE-based BoK Revisions

When revisions are made to industry-recognized BPOE-based BoK, the BoK developer/owner shall implement its internal processes to ensure the BoK is reviewed and approved as required by agreement/contract and that revisions are maintained within a configuration control system.

Upon completion of revision review and acceptance by the applicable industry groups, the BoK developer/owner shall plan and release the revised BoK.

4.4.4 Configuration Control of BPOE-based BoK

Revisions of PBOE-based BoK shall not be implemented any earlier than specified by agreements/contracts. Implementation dates are to be established in consideration of other events, such as

- a) changes in other BoKs;
- b) revisions in relevant regulations;
- c) revisions to industry standards; and
- d) other relevant events considered important to timing in the specific organization/industry.

Each PBOE-based BoK shall be identified with a unique identifier that defines the appropriate revision level.

4.5 Long-term Sustainment of BPOE-based BoK

PBOE-based BoK developers/owners shall define processes that ensure the long-term sustainment of industry-recognized BPOE-based BoK. As a minimum, procedures shall define how an industry-recognized BoK is sustained and/or transferred in the event the PBOE-based BoK developer/owner becomes defunct or no longer able to maintain the BoK.