How Taxonomies and Ontologies Drive Knowledge Management

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About Heather Hedden

- Independent taxonomy/ontology consultant, Hedden Information Management
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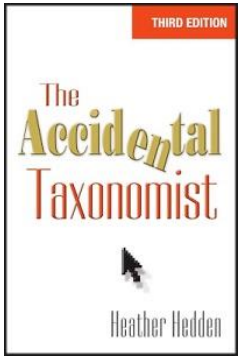
- Previously a taxonomy consultant in consulting firms, Enterprise Knowledge and PPC. Also, a contract consultant for others.
- Former taxonomy-related roles in various companies.
- Author of *The Accidental Taxonomist, 3rd ed.* (2022, Information Today, Inc.)

Hedden Information Management

Making information findable



Outline

- Introduction to Knowledge Management
- Introduction to Taxonomies
- Introduction to Ontologies
- Taxonomy & Ontology Supporting Knowledge Management

Introduction to Knowledge Management

Definitions of Knowledge Management

Knowledge management (KM): The process of identifying, organizing, storing, and disseminating information within an organization.

Originally defined (1994): "Knowledge Management is the process of capturing, distributing, and effectively using knowledge." *- Tom Davenport*

Definition expanded (1999): "Knowledge management is a discipline that promotes an integrated approach to identifying, capturing, evaluating, retrieving, and sharing all of an enterprise's information assets."
- Gartner Group analyst Bryant Duhon

KM Compared with Information Management:

Information Management asks:
How do we organize, store, govern, and provide access to information?

Knowledge Management asks:
How do we enable people and organizations to create, share, retain, find, apply, and improve knowledge?

Knowledge in Knowledge Management

Knowledge is of different types:

- Explicit knowledge: Information that is easily documented, codified, and shared, such as manuals, reports, and databases.
  - What is most obviously knowledge

- Implicit Knowledge: the practical application of explicit knowledge, the know-how people apply before it's written down, such as how to perform a task
  - Knowledge that KM programs try to "capture"

- Tacit knowledge: Personal, experience-based knowledge that is hard to formalize, such as individual intuition, skills, and professional expertise.
  - Knowledge that KM programs try to "capture"

- Embedded knowledge: Information built directly into organizational routines, standard operating procedures, and software workflows.
  - Knowledge that may be overlooked, but needs to be taken into consideration in relation to other components of KM.

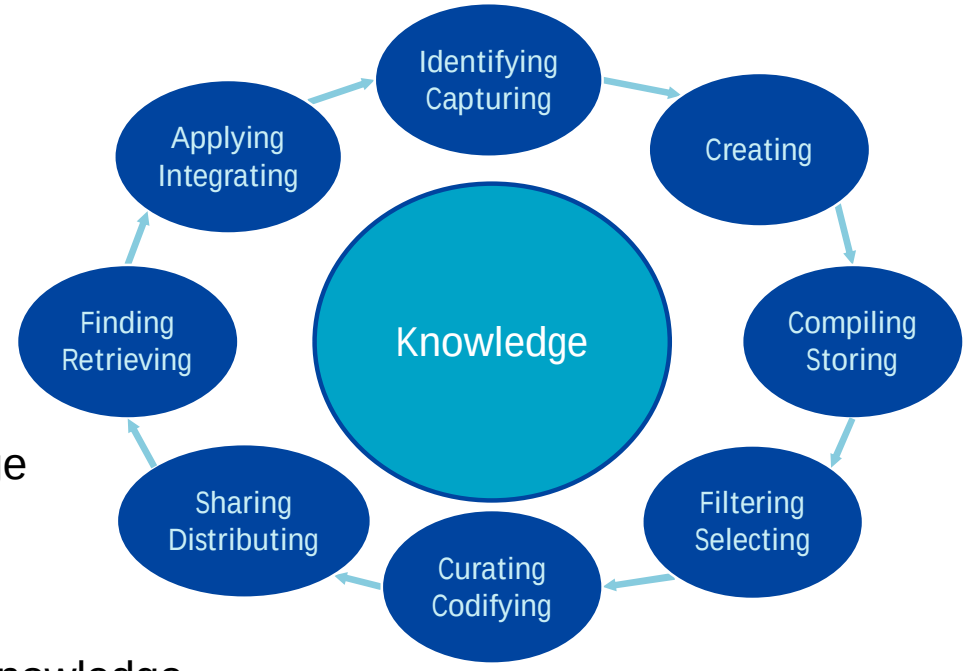
Components of Knowledge Management

Components of KM

- *Primary:* People, Process, Technology
- *Secondary:* Information, Organizational Structure, and Corporate Culture

Components of the KM lifecycle

1. Identifying/Capturing Knowledge
2. Creating Knowledge
3. Compiling/Storing/Archiving Knowledge
4. Filtering/Selecting Knowledge
5. Curating/Transforming/Codifying Knowledge
6. Sharing/Distributing Knowledge
7. Accessing/Finding/Retrieving Knowledge
8. Using/Applying/integrating/Implementing Knowledge



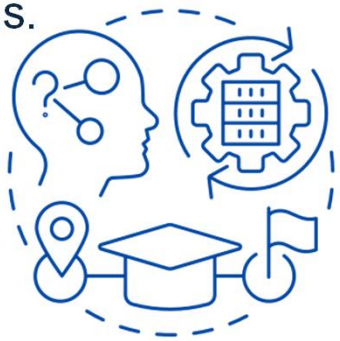
Benefits of Knowledge Management

Knowledge management benefits:

- Retain critical organizational knowledge
- Improve decision-making
- Increase employee productivity
- Reduce duplication and wasted effort
- Enable organizational learning
- Accelerate onboarding and capability development
- Support innovation and problem-solving
- Improve consistency, quality, and operational performance
- Reduce organizational risk and increase resilience
- Make better use of the company's intellectual assets

Trends in Knowledge Management

- Generative AI and LLMs are increasingly a part of KM.
- Enterprise search is evolving toward conversational answers, recommendations.
- Information and knowledge quality is becoming more critical.
- Knowledge graphs and semantics (semantic layers, semantic backbones) help make connections across multiple systems and multiple knowledge base repositories.
  - Utilizing taxonomies and ontologies
- Retrieval-augmented generation (RAG) is evolving toward Graph RAG, along with knowledge graph implementations.
  - Taxonomies and ontologies provide context for Graph RAG systems.
- Tacit and implicit knowledge are becoming more valuable and methods of knowledge capture.
  - Including expert locators and communities of practice



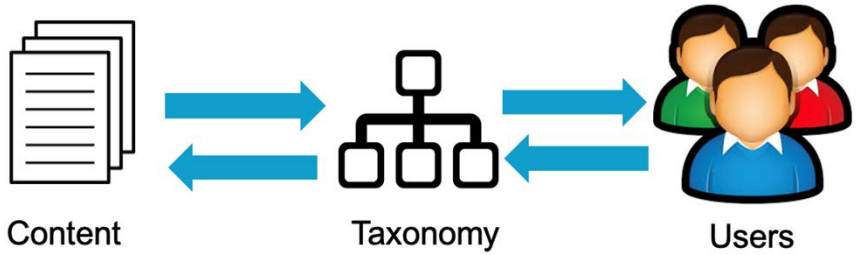
Introduction to Taxonomies

Introduction to Taxonomies

Taxonomies are a part of Information Management.

What is a taxonomy typically for?

- Concepts/terms (not mere words) are used to tag/index/categorize content for what it's *about* to make information easier to be found and retrieved
  - Supporting better findability than search engines alone
  - Supporting more transparent, trustworthy, and controllable information access than generative AI/LLMs alone.
- The taxonomy is an intermediary that links the user to the desired content.



- The taxonomy is designed to suit the context of the content and the users.

Definitions of Taxonomies

Definitions from the thesaurus standards

a collection of controlled vocabulary terms organized into a hierarchical structure. Each term in a taxonomy is in one or more parent/child (broader/narrower) relationships to other terms in the taxonomy.

ANSI/NISO Z39.19-2005 r2010 Guidelines for the Construction, Format, and Management of Monolingual Controlled Vocabularies, section 4.1 Definitions

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a scheme of categories and subcategories that can be used to sort and otherwise organize items of knowledge or information.

NOTE Taxonomies range from the very simple to the very complex. In the simplest taxonomies the categories are not necessarily divided into subcategories, while in the complex ones, multiple hierarchical levels can be found. Other features too can be present, such as all the thesaurus features described in ISO 25964-1, and/or the features commonly found in classification schemes. Outside of this International Standard, the term is often used loosely to refer to any type of structured vocabulary.

ISO 25964-2:2013(E) Thesauri and interoperability with other vocabularies — Part 2: Interoperability with other vocabularies, section 3: Terms and definitions

Taxonomies as Knowledge Organization Systems

Knowledge Organization System:

a generic term used for referring to a wide range of items (e.g. subject headings, thesauri, classification schemes and ontologies)… designed to support the organization of knowledge and information in order to make their management and retrieval easier.

ISKO Encyclopedia of Knowledge Organization
https://www.isko.org/cyclo/knowledge_organization.htm

Controlled Vocabulary:

prescribed list of terms, headings or codes, each representing a concept.

Note: Controlled vocabularies are designed for applications in which it is useful to identify each concept with one consistent label, for example when classifying documents, indexing them and/or searching them. Thesauri, subject heading schemes and name authority lists are examples of controlled vocabularies.

ISO 25964-2:2013(E) Thesauri and interoperability with other vocabularies — Part 1: Thesauri for Information Retrieval, section 3: Terms and definitions

KOS types:

- term lists
- name authorities
- taxonomies
- thesauri
- subject headings

Controlled Vocabularies for tagging and information retrieval

- glossaries
- dictionaries
- gazetteers
- terminologies
- categorization schemes
- classification systems
- semantic networks
- ontologies

Comparison of Knowledge Organization Systems

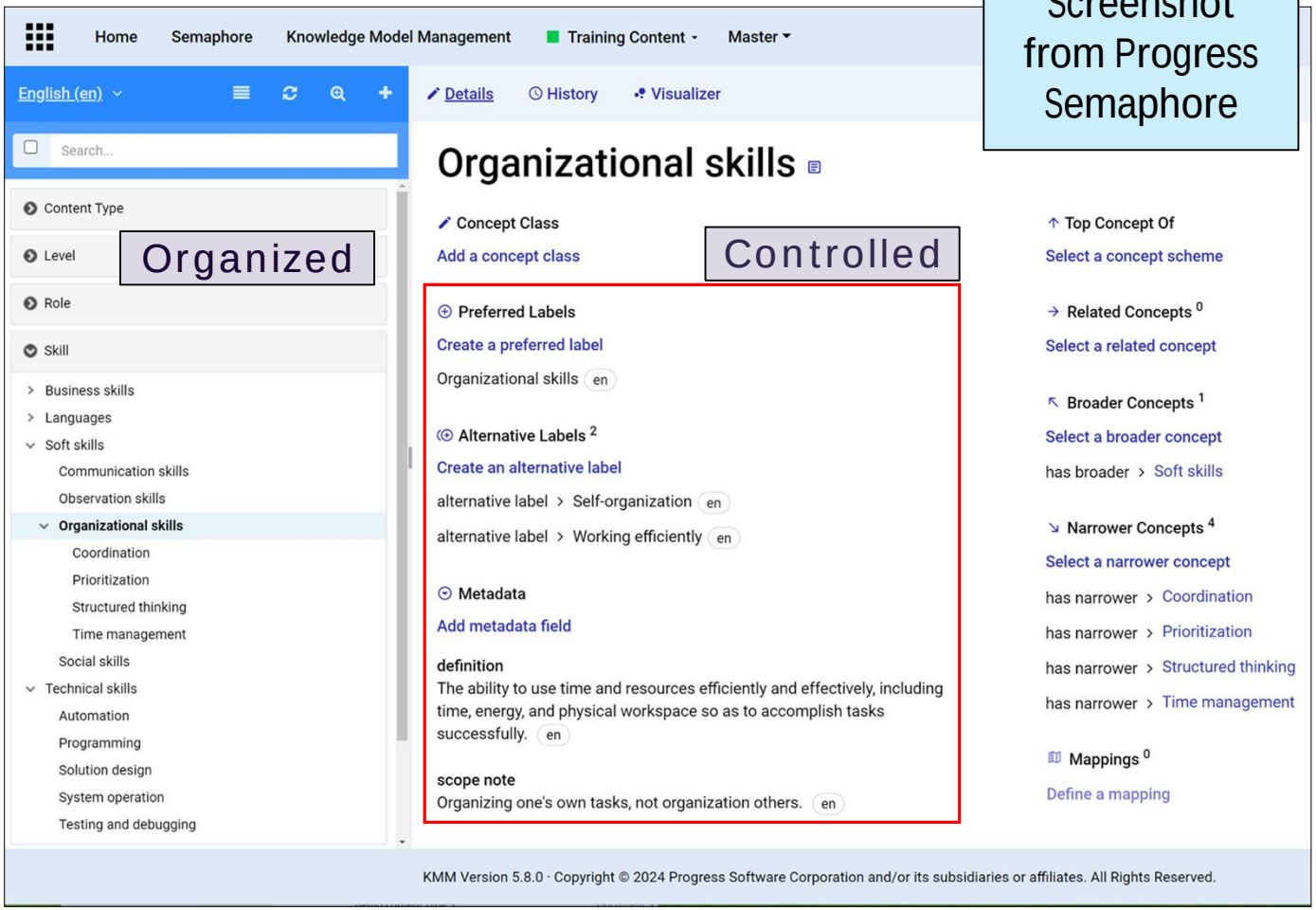
Term List	Name Authority	Taxonomy	Thesaurus	Ontology
Ambiguity control	Ambiguity control Synonym control (Attributes)	Ambiguity control (Synonym control) Hierarchical relationships	Ambiguity control Synonym control Hierarchical relationship Associative relationships	Semantic relationships Classes Attributes

Features of Taxonomies

Controlled and ***organized***

1. Controlled:
A kind of controlled vocabulary or knowledge organization system, based on unambiguous concepts, not just words: **things, not strings**

2. Organized:
Concepts are arranged in a structure of hierarchies, categories, or facets to organize them.



Screenshot from Progress Semaphore

Features of Taxonomies

1. Controlled vocabulary feature

Brings together different wordings (synonyms) for the same concept (for tagging).

- Helps people search for information by different names

2. Classification and organized structure feature

Organizes information into a logical structure.

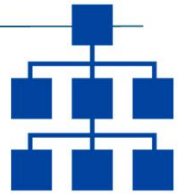
- Helps people browse for information
- Provides context and meaning for concepts, to support indexing/tagging, retrieval, and AI applications

Helps improve search results

- Retrieving only correct results
- Retrieving all relevant results
- Provides consistency to retrieve across different, separate content repositories

Taxonomy Uses

What you can do with a taxonomy



- Search: find content about…. (search string matches taxonomy concepts)
- Topic browse: explore subjects arranged in a hierarchy and then content on the subject
- Faceted (filtering/refining) search: find content meeting a combination of basic criteria
- Tagging: index content consistently so that retrieval is comprehensive and accurate
- Discovery: find other content tagged with same concepts as tagged to found content; explore broader, narrower, and (sometimes) related taxonomy topics
- Content curation: create feeds or alerts based on user profile (personalization) and taxonomy concepts tagged
- Metadata management: for retrieval, identification, comparison, analysis, etc.
- Knowledge graph development: when combined with an ontology, to retrieve data and content across different repositories

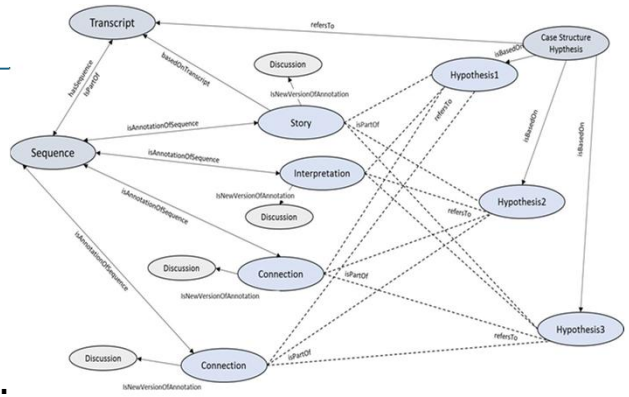
Taxonomy Uses

Applications of taxonomies for internal information and knowledge

- Managing content, including **content reuse** (proposals, presentations, images)
- Images, video, audio and other **digital asset** findability and reuse
- **Intranet** (such as SharePoint) content search
- Research information for **research and development**
- **Knowledge base** searchability for customer support representatives
- **Training** course search and recommendation
- Document management for **regulatory compliance**

Introduction to Ontologies

Definitions of Ontologies



- A form of knowledge representation
  - Not just knowledge organization
- A formal naming and definition of the **types**, **properties** and **interrelationships** of entities in a particular domain.
  - Classes, custom attributes, and semantic relationships
- A set of precise descriptive statements about a particular domain.
  - Statements as *subject-predicate-object* are expressed as triples.
- A more abstract layer in describing a knowledge organization system
  - Overlays and connects to a taxonomy or other controlled vocabulary to add semantics

Definitions of Ontologies

"An ontology defines a set of representational primitives with which to model a domain of knowledge or discourse.

The representational primitives are typically classes (or sets), attributes (or properties), and relationships (or relations among class members).

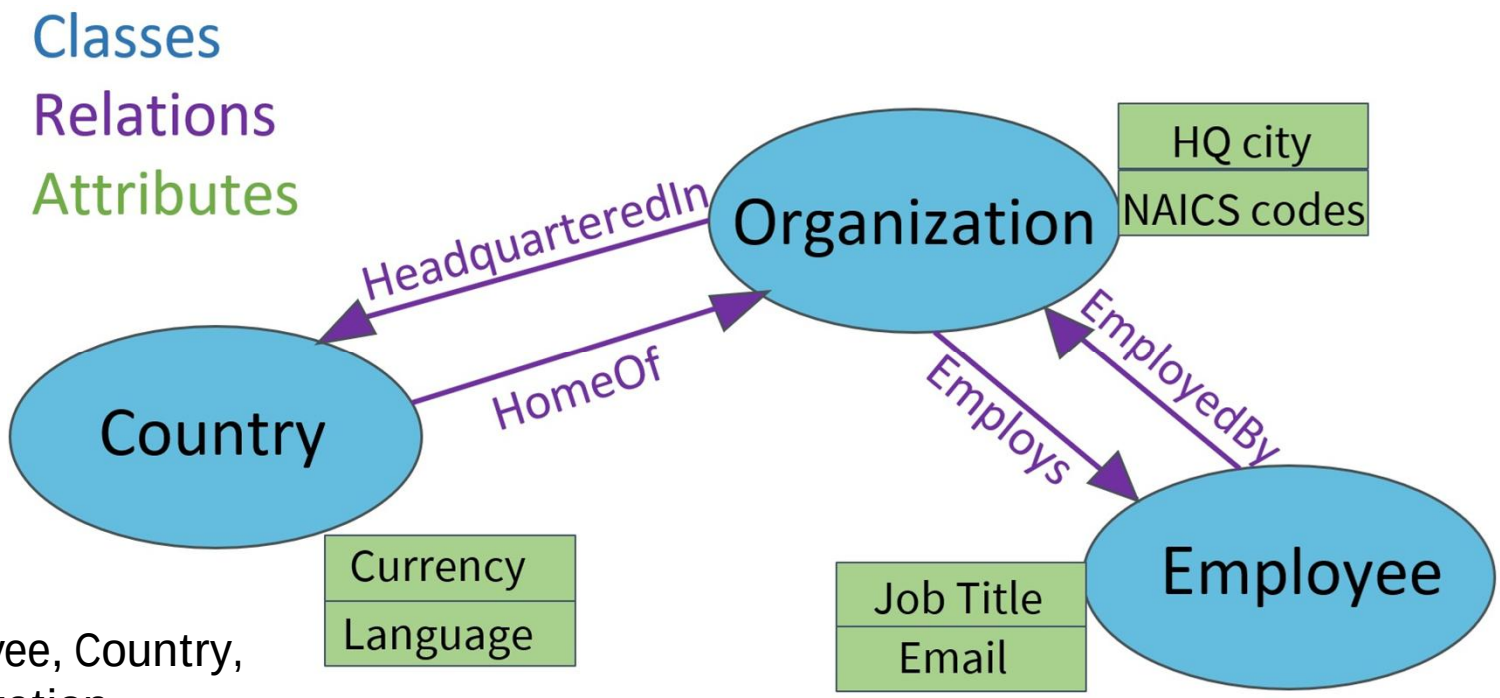
The definitions of the representational primitives include information about their **meaning and constraints on their logically consistent application**.

In the context of database systems, ontology can be viewed as a level of abstraction of data models, analogous to hierarchical and relational models, but intended for modeling knowledge about individuals, their attributes, and their relationships to other individuals."

https://tomgruber.org/writing/definition-of-ontology.pdf

Gruber, Tom (2016) Ontology. In: Liu L., Özsu M. (eds) Encyclopedia of Database Systems. Springer, New York, NY, based on his original definition in 1993.

Features of Ontologies



Classes

Employee, Country, Organization

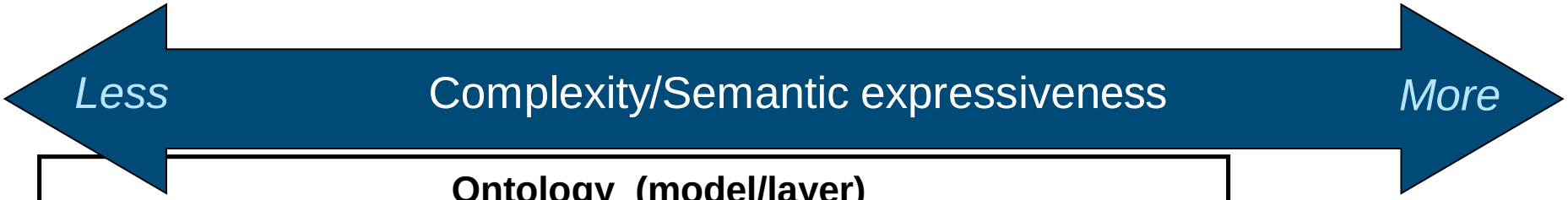
Relations: HeadquarteredIn < > HomeOf
EmployedBy < > Employs

Attributes: Email address, Job title, HQ city, NAICS codes, Currency, Language

Ontologies Related to Other Knowledge Organization Systems

Term **List**	**Name Authority**	**Taxonomy**	**Thesaurus**	**Ontology**
Ambiguity control	Ambiguity control Synonym control (Attributes)	Ambiguity control (Synonym control) Hierarchical relationships	Ambiguity control Synonym control Hierarchical relationship Associative relationships	Ambiguity control Semantic relationships Classes Attributes

Ontologies Related to Other Knowledge Organization Systems



Ontology (model/layer)			
Term **List**	**Name Authority**	**Taxonomy**	**Thesaurus**
Ambiguity control	Ambiguity control Synonym control (Attributes)	Ambiguity control (Synonym control) Hierarchical relationships	Ambiguity control Synonym control Hierarchical relationship Associative relationships

Semantic Web Standards for Taxonomies and Ontologies

For both ontologies and taxonomies/controlled vocabularies:

RDF (Resource Description Framework) www.w3.org/TR/rdf11-concepts

- "A standard model for data interchange on the Web"
- Requires the use of URIs and information modelled as subject – predicate – object triples.

For taxonomies/controlled vocabularies:

SKOS (Simple Knowledge Organization System) www.w3.org/TR/skos-reference (2009)

- "A common data model for sharing and linking knowledge organization systems via the Web"
- Encoded using XML and RDF for publication and use of vocabularies as linked data

For ontologies:

RDFS (RDF-Schema) www.w3.org/TR/rdf11-concepts

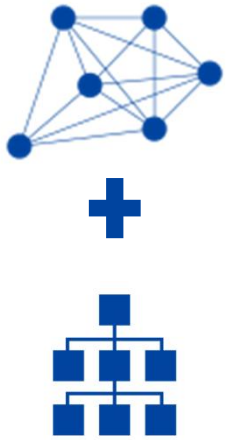
- "A general-purpose language for representing simple RDF vocabularies on the Web"
- Goes beyond RDF to designate classes and properties of RDF resources.

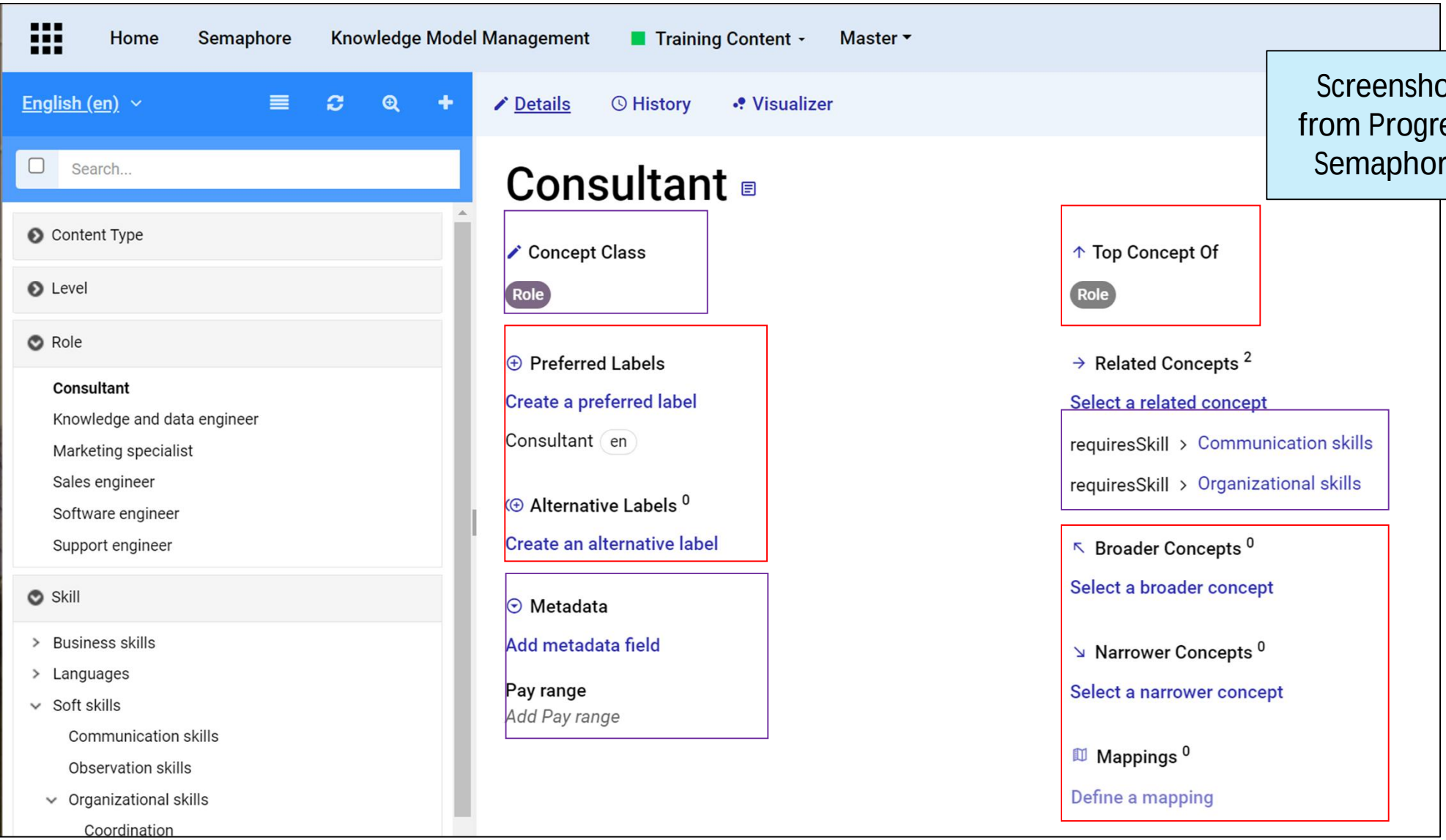
OWL (Web Ontology Language) www.w3.org/TR/owl2-overview

- "A Semantic Web language designed to represent rich and complex knowledge about things, groups of things, and relations between things"
- Based on RDF and RDFS; OWL is an extension of RDFS.
- Enables inferencing & reasoning

Extending a Taxonomy with an Ontology

- May utilize existing taxonomies.
- Taxonomies based on SKOS can integrate with RDFS and OWL ontology resources, as all are based on RDF.
- Ontology class labels correspond/match the SKOS concept schemes or concept labels to which they will be applied.
  - The ontology “layer” is not an upper hierarchical layer, but an **overlay** to the higher levels of the SKOS taxonomy.
- Combined taxonomy/ontology management software, such as Progress Semaphore, supports this seamlessly.





Screenshot from Progress Semaphore

Ontology Uses

What you *cannot* do with a taxonomy alone, but can with an added ontology

- Complex multi-part searches: “chained” queries beyond just “about a subject.” (e.g. contacts in a location, employed by companies, which belong to certain industries)
- Search on data: obtain specific data, and not just content/full documents
- Relationship-based recommendations: recommendations based on what has tagged with concepts semantically related.
- Knowledge graph or semantic layer creation: to connect data and content from different repositories and to search, analyze, and infer across all sources

What else you can do with an ontology

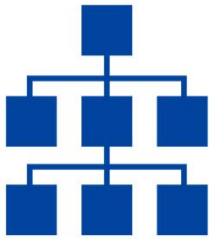
- Modeling complex interrelationships: to understand operations and systems better (e.g. in product approval or supply chain processes)
- Exploring explicit relationships: between concepts (not just broader, narrower, related)
- Visualization: graph representations of concepts and semantic relationships
- Reasoning and inferencing: based on logic, to gain new knowledge

Taxonomy & Ontology in Knowledge Management

Taxonomies as a Part of KM

The trend of more taxonomies in KM

- The majority of implementations of taxonomies has shifted over the past two decades from serving *external* users to serving *internal* enterprise users.
- The management of the majority of taxonomies has shifted from the roles and departments of product management or marketing to corporate KM.
- Formerly siloed taxonomies are being linked to create enterprise taxonomies, supporting enterprise KM.
- KM has evolved from a focus on HR and corporate culture to a greater focus on content management, information management, and taxonomy.

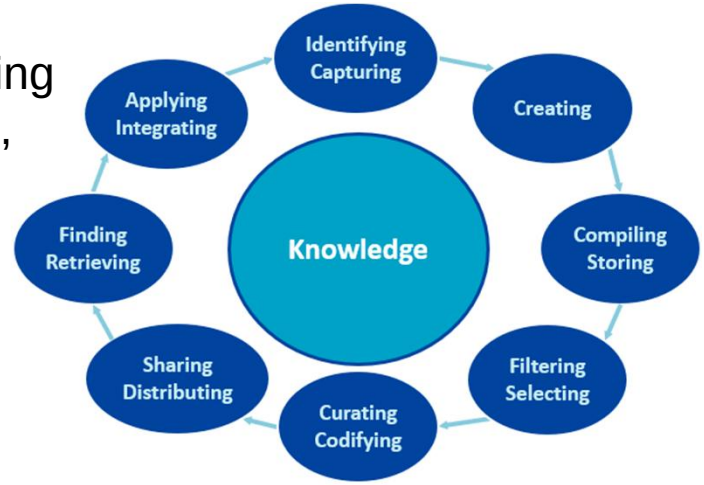


Taxonomy & Ontology Alignment with KM Components

KM Component	Taxonomy/Ontology Role
People	The creation of taxonomies and ontologies engage people (stakeholders), who contribute to the taxonomy through interview questions and activities.
Processes	Building and updating taxonomies and ontologies involves certain processes (research, testing, feedback, and approval).
Technology	Taxonomy/ontology management, automated tagging, and user-interface implementations all require technology, which connects to the other systems involved in KM.
Information	The main purpose of taxonomies and ontologies is to make information (content and data) findable.
Organizational Structure	Taxonomy/ontology *governance* should align with an organization's structure of roles and decision-making.
Culture	The choice and names of ontology classes and of taxonomy concept labels reflect corporate culture. Taxonomy/ontology creation can reaffirm or challenge the choices.

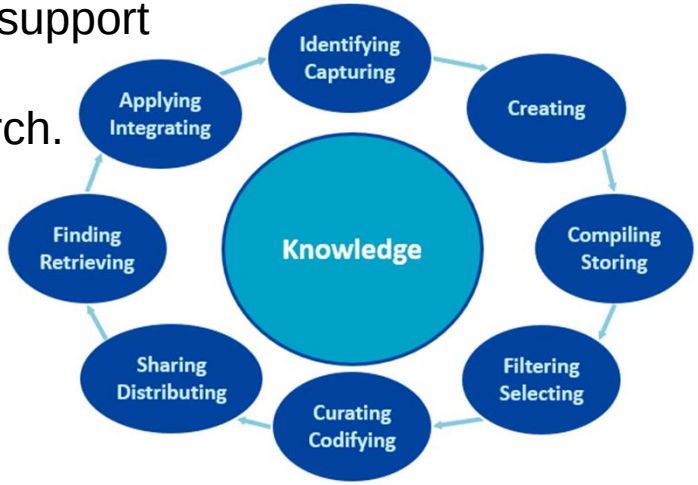
Taxonomy & Ontology Support of KM Lifecycle Phases

1. **Identify and capture knowledge** – Tagging and retrieval with a taxonomy/ontology can identify and capture explicit knowledge. Taxonomies can identify areas of tacit knowledge.
2. **Create knowledge** – The creation of an enterprise taxonomy and ontology is also a form of knowledge creation.
   A published domain ontology or AI-generated taxonomy in the domain can be used to identify gaps needing new knowledge creation.
3. **Compile, store or archive knowledge** – Metadata using controlled vocabularies facilitates organization, storage, and archiving.
4. **Filter or select knowledge** – Faceted taxonomies can serve as refinement filters to select specific content/knowledge.



Taxonomy & Ontology Support of KM Lifecycle Phases

5. **Curate, transform, codify, or refine knowledge** - Comprehensive enrichment of the knowledge assets by tagging with taxonomy concepts and linking them with an ontology make them more accessible.
6. **Share, distribute, or disseminate knowledge** – Taxonomies that are linked to each other (through mapping relations or ontologies) enable the sharing of knowledge more broadly, from different sources and into different end-user applications.
7. **Access, find, and retrieve knowledge** – Taxonomies support various methods for findability and retrieval with search matches, hierarchical browse, and faceted browse/search.
8. **Use, apply, integrate, or implement knowledge** – Taxonomies & ontologies can support analysis and comparison of information based on category/class.



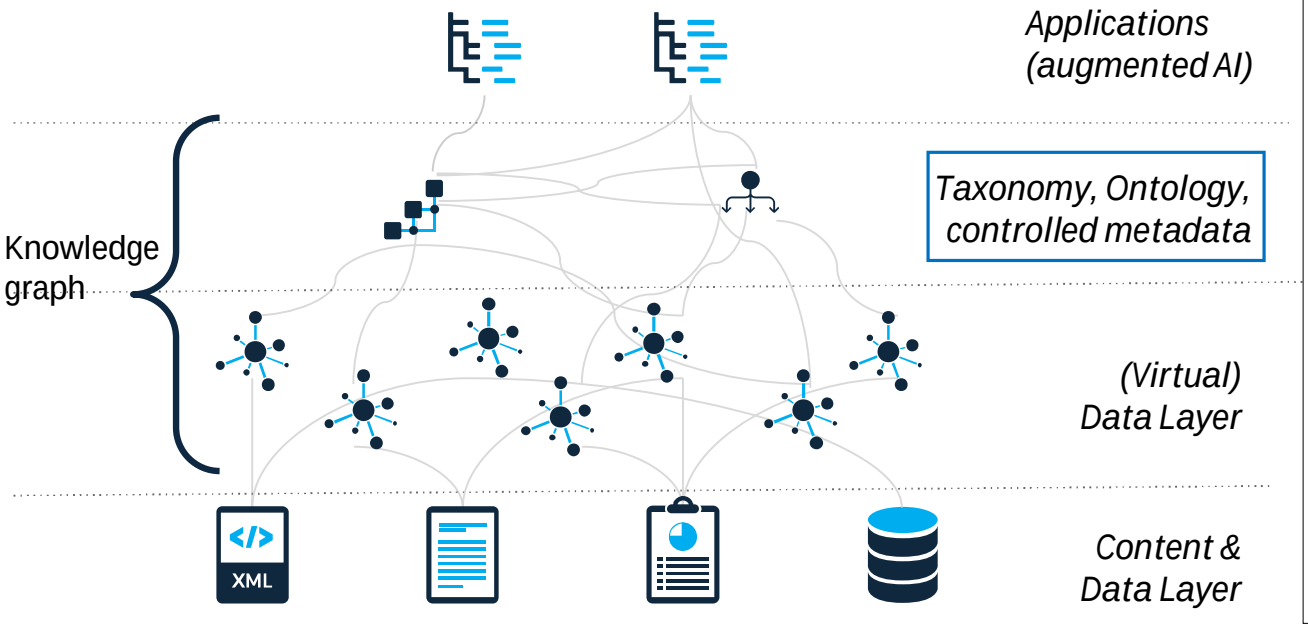
Taxonomy & Ontology Alignment with KM Trends

When taxonomies and ontologies align with KM trends, they can *drive* KM.

KM Trend	Taxonomy/Ontology Role
Generative AI	GenAI is being used to assist in taxonomy/ontology creation.
Conversational Answers	Taxonomies/ontologies support chatbots and question-answering systems, based on concepts within the questions and answers.
Recommendations	Ontologies semantically link related concepts that are relevant for recommendations.
Information Quality	Taxonomies/ontologies depend on and thus drive information quality.
Knowledge Graphs & Semantics	Taxonomies and ontologies are the backbone of knowledge graphs and semantic layers.
RAG and Graph RAG	Taxonomies/ontologies provide context to improve GraphRAG retrieval.
Capturing Tacit & Implicit Knowledge	Taxonomy/ontology research methods involving people are applicable to knowledge management knowledge capture.

KM Trends: Knowledge Graphs

Knowledge Graphs:
taxonomy + ontology + instance data

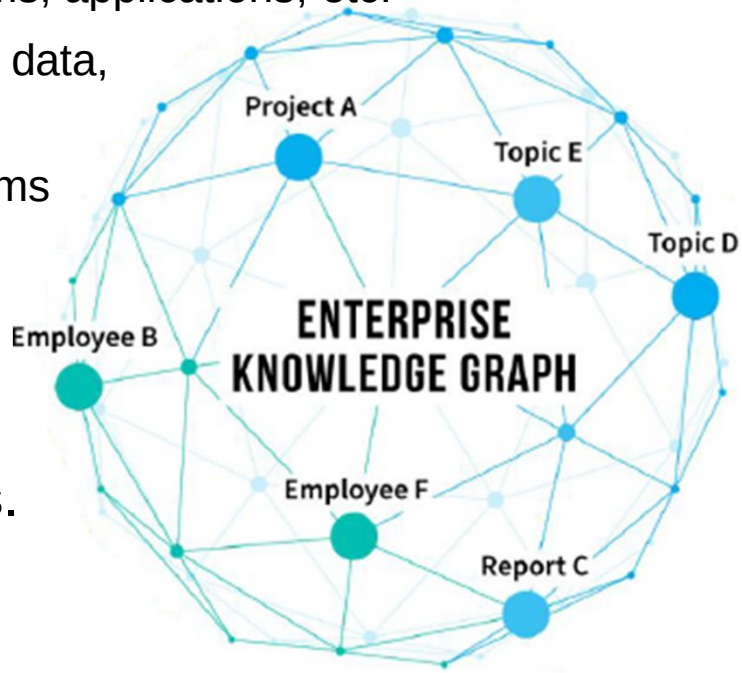


- Extracted **data**
- Stored in a **graph database**
- which are tagged/linked with metadata or concepts in **taxonomies** and other **controlled vocabularies** to label and organize the data
- which are semantically linked to represent conceptual relationships and enriched with additional metadata attributes in an **ontology**.

KM Trends: Knowledge Graphs & Semantics

What you can do with a knowledge graph

- Search expanded to data in different repositories, platforms, applications, etc.
- Search and discovery across heterogeneous content and data, both structured and unstructured
- Create better personalization and recommendation systems
- Provide visualizations of curated data
- Develop additional AI-based applications.



Semantic layers are related to knowledge graphs.

- Less formal
- More flexible
- Broader than and often *include* a knowledge graph.
- Always includes semantic structures, such as taxonomies and ontologies.

KM Trends: RAG an Graph RAG

Strengthening Retrieval Augmented Generation (RAG)

- The LLM retrieves additional information from an organization's data sources (corporate databases, documents, etc.), before generating an answer.
- Answers are more current and relevant, with less hallucination, and include proprietary corporate information.

Taxonomies further enhance RAG systems by providing:

- Context of meaning for a concept, based on its position in a taxonomy hierarchy
- Broader or narrower concepts for retrieval, to expand or narrower a query
- Concept synonyms to resolve meaning when matching different user query terms
- Concept definitions to provide further meaning
- Improved retrieval speed
- Enhancements to ontologies to create a knowledge graph, used in Graph RAG systems, which provide more complete information for complex questions based on semantic interconnections.

KM Trends: Capturing Knowledge

Capturing tacit knowledge and implicit knowledge

Taxonomy and ontology development involves stakeholders, information system users, knowledge workers, employees of different departments in:

- Interviews (one or two at a time) or focus groups (several in similar roles)
- Questionnaires or surveys
- Brainstorming sessions involving representatives of different departments
- System demo walk-throughs (explaining use)
- Requested lists of terms or proto-taxonomies from subject matter experts
- Search logs and GenAI prompt logs

- Activities that serve taxonomy design and ontology modeling, can also capture of tacit and implicit knowledge, and thus drive these KM initiatives.
- Generative AI should not replace this part of taxonomy creation, but it can assist.

Conclusions

- A knowledge management program is very valuable for an organization.
- Taxonomies and ontologies have many uses and benefits.
- A combination of taxonomies with an ontology has additional benefits, which can extend to entire enterprise.
- Taxonomies and ontologies have a growing role in knowledge management.
- Creating customized, high-quality taxonomies and ontologies can support and even drive knowledge management initiatives.
- Focus should not be on taxonomies and ontologies merely as products, but on their role in the processes of KM as well.

Questions/Contact

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Making information findable

Hedden, Heather. (2022) *The Accidental Taxonomist, 3rd edition.* Medford, NJ: Information Today Inc.
www.hedden-information.com/accidental-taxonomist