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ontoReadiness: A meta-Ontology for Readiness Certification and Career Portability

Michael L. Brown, Karsten O. Lundquist, Shirley Williams, and Keith Baker

This paper argues the need for the information communication technology (ICT), labor exchange (job boards), and Human Capital ontology engineers (ontoEngineers) to jointly design and socialize an upper level meta-ontology for people readiness and career portability. These enticing ontology research topics have yielded "independent" results, but have yet to meet the more broader or "universal" requirement that emerging frameworks demand. This paper will focus on the need to universally develop an upper level ontology and provide the reader concepts and models that can be transformed into marketable solutions.

Keywords: Certification, Competencies, Engineering, Human Capital, Interoperability, Jobs, Labor Exchange, Ontology, Readiness, Skills.

1 Introduction

Readiness certification and career portability modeling are heterogeneous fields. The terminology and proficiency metrics lack standardization. Terms such as competence, skills, attitude, and capability have multiple synonyms. Readiness and portability programs must have a core set of common terms and definitions or the quality and scalability of the programs become suboptimized. Researchers in the readiness and portability domains recognized this looming problem and through the Leonardo da Vinci program series, have established the first generation lexicon and translation service. Realizing that skills and competencies are at the core of an effective readiness and portability system, the research team developed the European Dictionary on Skills and Competencies (DISCO)[1]. The DISCO effort is designed to provide the much needed terminological substructure for European transparency tools that support readiness and portability domains. The early ontology success of the multilingual thesaurus of vocational skills and competencies further supports the theory of a meta-ontology having multiple ontologies similar to DISCO. Such inquisition will elevate the discussion and frame the research agenda.

To realize the need for a meta-ontology is to understand the emphasis and value individuals place on their current readiness requirements and their desire to advertise and promote their competence in search of a new assignment or career opportunity. This enabler allows the individual to communicate their performance experience and highlight

[1] The DISCO project is funded with the support of the European Community and the Austrian Federal Ministry for Education, Science and Culture (bm:bwk). Superior: Skills: Solutions (3'S), <http://disco.mit.bme. hu. index.php>.

[2] Europass has been established by the Decision No 2241/2004/EC of the European Parliament and the Council of 15 December 2004 on a single transparency framework for qualifications and competences. <http://europass.cedefop. europa.eu/>.

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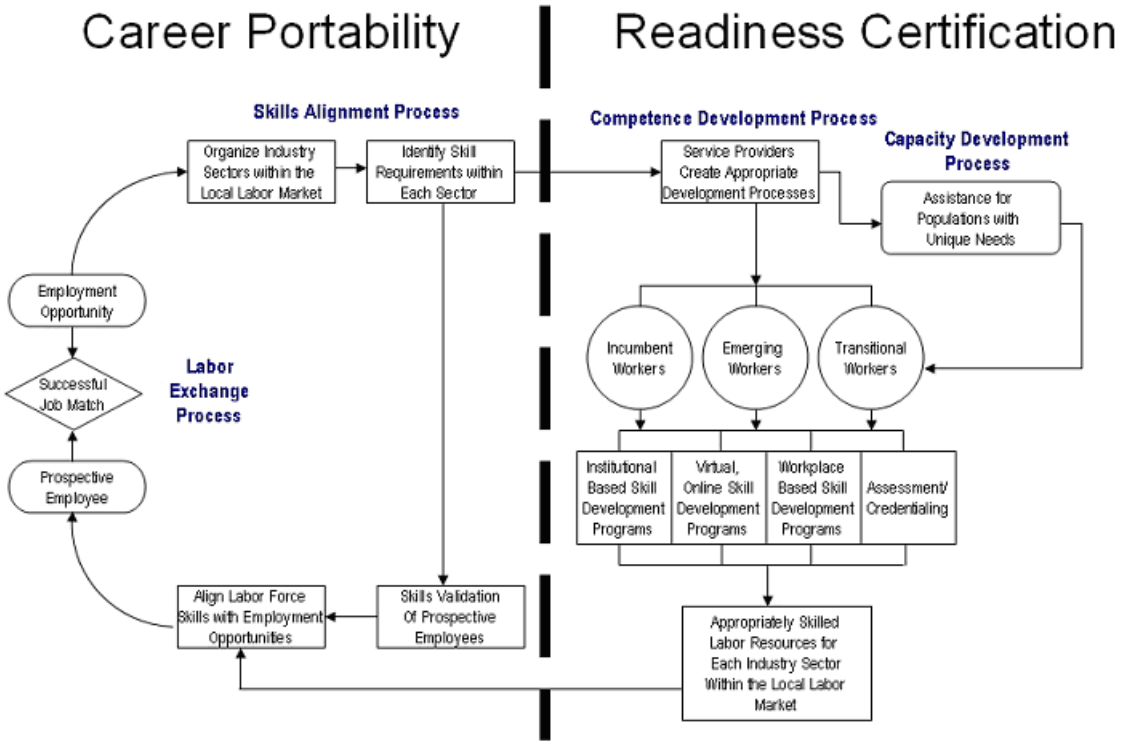

Figure 1: Talent Readiness Lifecycle.

key essential skills and competencies. Another Leonardo da Vinci project managed by the European Centre for the Development of Vocational Training (CEDEFOP) provides individuals the opportunity to make their skills and qualifications clearly and easily understood. The Europass[2] ontology has a set of unique, domain specific concepts that meet particular service needs and may not be interoperable with other readiness and portability ontologies.

The Europass transaction occurs in the labor exchange domain or "job boards" which is a sub-set of the Labor Market Industry (LMI) domain. The LMI ontology and inventory of concepts add to the argument that a top level ontology is an essential requirement for continued success. Beware researchers and technologist! The readiness and portability movement will soon be reaching the tipping point and the infrastructure to support the projected social demand is in the early development stages (see Figure 1). It is essential for education, industry, and government leadership to accelerate the development of a meta-ontology to meet the forecasted need.

One only needs to read WIKINOMICS to understand the need to accelerate infrastructure development. The WEB 2.0 social networks and concepts have created "weapons for mass collaboration". New low-cost collaborative systems allow thousands upon thousands of individuals to cocreate, coproduce, and market a new generation of readiness certification and portability services [1]. The full potential of these independent and narrowly defined ontologies will not be realized until a meta-ontology is designed, tested, and eventually made available to support the mass collaboration social services.

2. What is an Ontology?

An ontology defines the terms and concepts (meaning) used to describe and represent an area of knowledge, as well as relations among them. Thus, an ontology includes concepts in the domains of interest, relationships between those elements, properties (and property values) of those elements, the functions and processes involving those elements and constraints on the rules about those elements. Ontologies aim at capturing static domain knowledge in a generic way and provide a commonly agreed upon understanding of that domain, which may be reused and shared across applications and groups [2]. Therefore, one can define ontology as a shared specification of a conceptualization.

According to Gartner Research, "The objective of an ontology is to provide a formal specification of part of the real world. Ontology-based techniques are beginning to provide the structure to realize effective application discovery, maturing to yield tool and methodology frameworks that can support end users. In short, the ontology can provide design and integration time coherence".

The Leonardo da Vinci TRAnsparent Competences in Europe (TRACE) ontology, with University of Reading and Scienter leadership, is one example of how a team of scholars are attempting to define the data/content granularity for a European Union competency translator. The foundational criteria for the translator is the growing need to integrate the increasing numbers of independent ontologies to support the National Qualification Framework (NQF), European Qualification Framework (EQF), credits system, euroOccupations, vocation & education, and eSkills framework projects [3]. The TRACE team quickly learned that

content interoperability across multiple ontologies is very difficult and that the design and testing of a meta-ontology (top level) would be necessary.

Data gradation and semantic associations continue to be the new frontier for interoperability. The TRACE team has learned that independently developed ontologies and dictionaries are invariably non-interoperable. Each has a unique perspective, purpose, and constraints that lead to divergence. For example, two ontology models may both have the data element 'Person.' One requires the 'person' to be a specific instance, with a name and ID number, while the other refers to any human being, such as the 'next person in line.' Even if the same individual independently develops multiple models, they will still not interoperate. Common practice demonstrates this fact, which is why information workers spend so much time interpreting data and entering it into other applications, and why custom interfaces must be developed to connect computer systems. It is because data developed by different people, for different purposes, and with different constraints invariably have different structures and meaning. TRACE is investigating one or more solutions for the non-interoperable problem and has chosen the skills and competencies domain to further this research.

There is a distinct relationship between Competency gradation and utility. Performance Competencies require the descriptor and performance measures to be more cross-cutting (generalized) throughout numerous professional careers, whereas Enabling Competencies for the person and/or job requirements are more discrete. Both have applicability to personal inventories, though the more discrete Competencies having greater impact on personal career growth.

An individual competency profile (see Figure 2) is needed in many situations in Human Resource Management. For instance, when describing a profile for a specific job, it is not enough to use generic terms and measures of the job. It would not be satisfactory to define that a person should have a level 6 in "Computer Programming." However, describing level 6 "Computer Programming" as inclusive of knowledge and skills in C++ and assemble would define the profile more accurately, thereby facilitating opportunities for automation (e.g., portions of the recruitment processes).

Karsten Lundqvist, TRACE ontoEngineer, prepared the following chart to illustrate the complexity of aligning one or more ontologies to satisfy the eCompetence translator requirements (see Figure 3). The elements within the TRACE box are needed to enable the translations making up the full system, and as such, should be core parts of TRACE. The tag ontologies are key elements of the mapping from an individual to the TRACE system, but should be maintained by independent bodies. Still, TRACE could ease the development and maintenance process by providing useful application programming interfaces APIs. The tags also provide extensibility and portability to non-competency management tools/processes and serve as the point of analysis for future rule-base and artificial intelligence (AI) technologies.

To develop a common understanding of the relations and terms of the different ontologies within TRACE, there is a need for a top-level or upper ontology as described in [4]. An upper (meta) ontology logically describes the different terms and relations that are possible in the task and domain ontologies. By developing an upper ontology, a

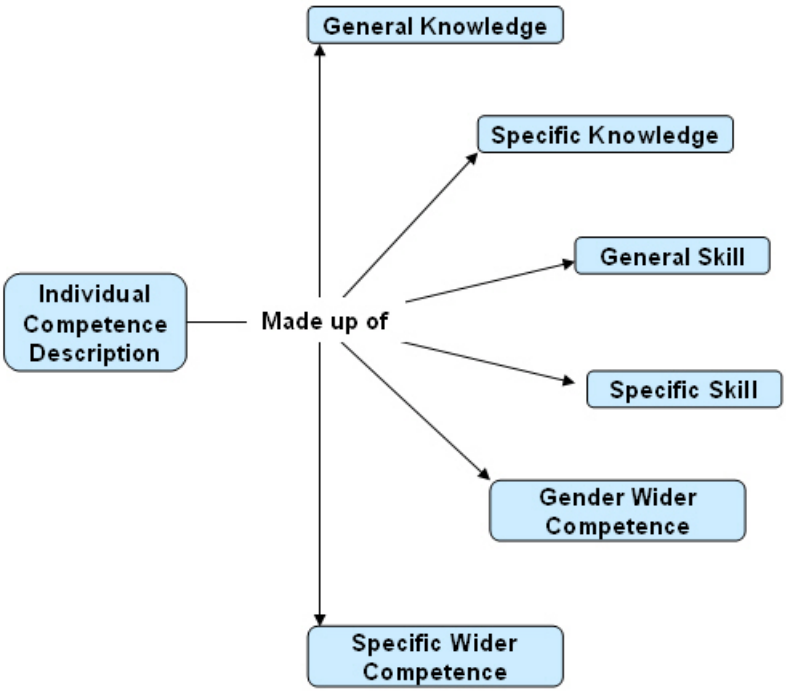

Figure 2: Individual Competence Resources.

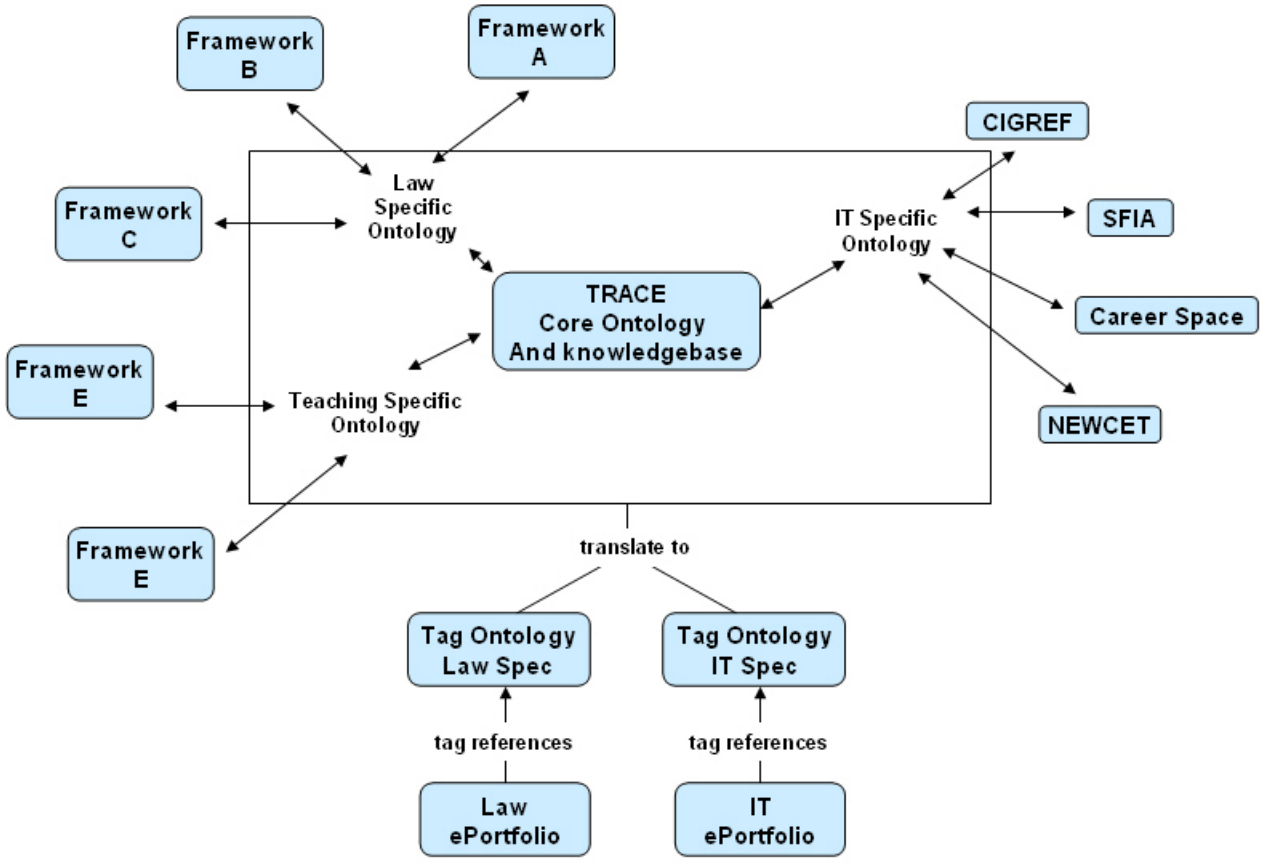

Figure 3: Ontology Alignment to Perform Translator Requirements.

common logical (and hence, computational) understanding of all the ontologies derived from the upper ontology is created. This ensures that applications and data structures that are designed to use the ontologies can be used with any of the domain ontologies and general ontologies, ensuring interoperability between different applications. With proper upper ontologies specified, it is possible to implement tools for non-technical personnel to define and describe the different domain ontologies, thereby allowing different organizations such as professional bodies to create and maintain them. The "get Fred a job" ontology illustrates the power of integrating an independently developed model into a meta-ontology (see Figure 4).

3 Right time for a Readiness meta-ontology

TRACE represents a good start toward developing a meta-ontology for the human resource development and job placement domains. Although very important and effective, the Readiness Certification and Career Portability model requires additional upper ontologies.

We suggest the need to establish a dimensions-based meta-ontology for each service area impacting the readiness and portability industry. The starting point for such an effort would be to first define (frame) the boundaries of each service dimension and then determine the core and cross cutting concepts that will eventually become the foundation for worker portability.

This is non trivial and there is ample research to indicate it will be very difficult to achieve. Independent ontology libraries and data interoperability should be the first priority.

Research indicates standard languages, such as RDF or OWL, do not produce interoperable data. They have substantial value in various respects, such as enabling easier comparison of models, but they do not force interoperability. They are a standard means of 'expressing' data elements or concepts, but the models or ontologies will invariably be unique. OWL does have expressions that facilitate interoperability among ontologies, i.e., that enable one ontology to import another ontology (imports) and that enables mappings between classes, properties, and individuals from different ontologies.

These languages have varying degrees of expressiveness, which are depicted on a scale known as the Semantic Spectrum (see Figure 5) [5].

At the low end of expressiveness is a 'Taxonomy', which is a hierarchy of terms, with each being a sub-class of a more general term. Humans can understand the terms and definitions provided they understand the field and context, but the simple sub-class hierarchy provides very limited clues a computer can use to determine meaning.

At the high end of the scale are languages such as OWL that can express more meaning, enabling computers to do automated reasoning. But even the most expressive of these languages will not produce data or ontologies with the same

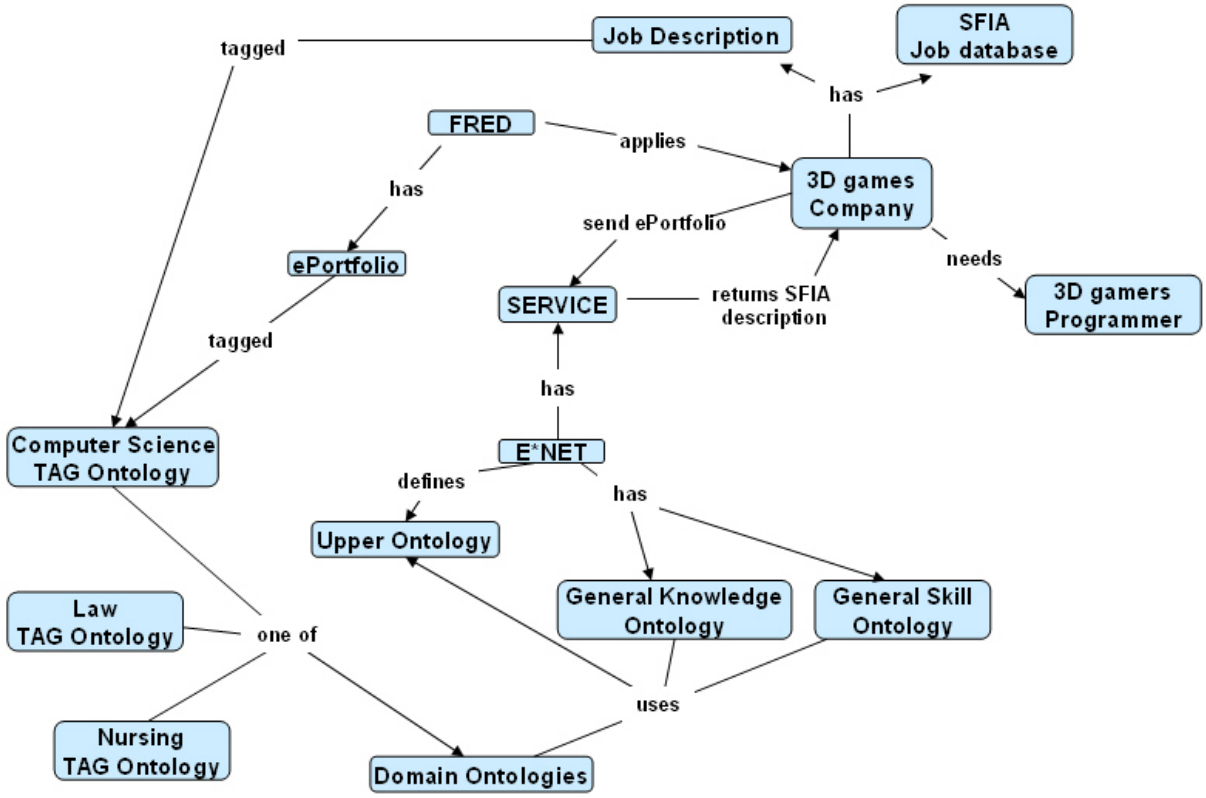

Figure 4: Upper Ontology Supports Job Placement.

meaning. Today, OWL is used by many ontology developers, yet the ontologies are not interoperable. Standard languages, regardless of their expressiveness, do not solve data interoperability [6]. The convergence of the Leonard di Vinci programs and projects will soon require a meta-ontology to serve as the foundation for the transformation of human understanding into machine readable processes in the readiness certification and portability industry.

As mentioned earlier the EQF/NQF, TRACE, ECVET, EuroOccupations, DISCO, eCompetence, Europass, and eSkills frameworks and standards are excellent independent ontologies, but will not have interoperable characteristics. A meta-ontology must be considered as the way ahead to optimize the concepts and application development.

4 Current Challenges

The author suggests the Ontology Outreach Advisory (OOA) [7] is utilized to establish a universal working group to address the ontoReadiness upper level ontology engineering requirements. The working group would enlist ontoEngineers who recognize the value of open upper ontologies, and in particular, the custodians (developers or maintainers) of the public versions of existing upper ontologies to find a way to interrelate those ontologies in such a way as to provide a freely available common ontology that has sufficient detail to precisely specify meanings of terms and concepts in domain ontologies and which is compatible with each of the starting upper ontologies. Another goal would be to develop agreement among developers of mid-level and upper-mid-level domain-spanning ontologies to use the compatible subset ontology as the common high-level ontology that will serve as their common reference ontology for specifying meanings.

5 Conclusion

Employability skills and readiness certification appears to be the new currency for the "world of work" and service demand have outstripped current system capabilities. This is due in part to a variety of powerful economic factors that are combining to change people requirements and the way work is performed. Research suggests, however, that too many workers cannot meet the basic readiness demands needed to successfully perform job duties, learn, and apply learning on the job. The success of human resource development professionals in building a globally competitive workforce is dependent on a thorough understanding of what basic employability skills are needed as well as their capacity to perform.

Current technologies such as XML, metadata, RDF, OWL, and stand-alone ontologies can achieve data interoperability, but only within individual domains with very limited core or cross cutting capability. These technologies cannot today achieve data interoperability across the many domains found in most large enterprises. To achieve this goal, leading organizations will need to invest in emerging technologies and mature them to where they are ready for enterprise-wide implementation.

Current research activity and the results of this study will further substantiate the need to establish a global readi-

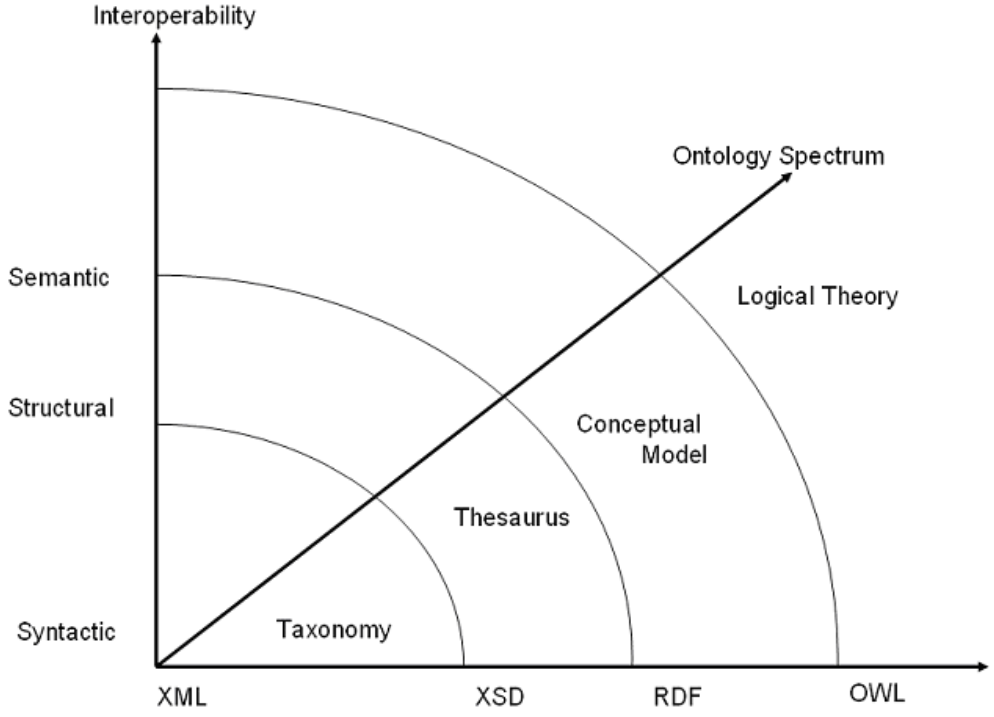

Figure 5: Semantic Spectrum.

ness ontology with local or context implementation. The research further indicates it will be difficult to implement a large scale ontology standards project until education/industry leaders, policy makers, and readiness certification industry scientists elevate their thought and design activity to meet this emerging need. A meta-ontology will increase use and reuse of technology solutions and allow content registries to increase their utility. Finally, we argue the need to standardize ontology engineering requirements. The scale of use, ease of use, breath of use, and choice of use are essential components of a successful ontoReadiness program.

Individuals should be able to study and work throughout Europe, thus making full use of their readiness qualifications, no matter where their educational or professional career path leads them. National companies in Europe should learn to cross borders and take advantage of the great pool of talent a European-wide labour market provides. Transparency of diplomas and qualifications is an indispensable prerequisite for this ambitious goal. In recent years EU institutions have developed several tools to support the transfer and recognition of skills and competencies. But all these suffer from the same weakness: the core concepts of these tools (terms for skills and competencies) are neither standardized nor internationally compatible.

Providing a meta-ontology for those active in the readiness, certification, and portability research, ontoReadiness will be promoting scientific rigor and social inclusion. As stated this will not be a simple task. The reuse of available ontologies cannot yet easily be performed optimally as it still requires considerable manual work. There is a need for tools to assist the ontology engineer and for practice-oriented case studies and guidelines in the readiness and portability industry.

References

[1] Don Tapscott, Anthony D. Williams. WIKINOMICS. How Mass Collaboration Changes Everything, pp. 11.

[2] B. Chandrasekaran, J.R. Josephson, V.R. Benjamins. "What are ontologies, and why do we need them?", Intelligent Systems and Their Applications, IEEE, Vol. 14, No. 1, pp. 20-26, 1999.

[3] M. Brown, K. Lundqvist. ePortfolios, Ontologies and TRACE (**TRA**nsparent **C**ompetences in **E**urope), 2006.

[4] Nicola Guarino. "Semantic Matching: Formal Ontological Distinctions for Information Organization, Extraction, and Integration". In Maria Teresa Pazienza, editor, Information Extraction: A Multidisciplinary Approach to an Emerging Information Technology, Vol. 1299 of Lecture Notes in Artificial Intelligence, chapter 8, pp. 139-170. Springer. International Summer School, SCIE-97. Frascati, Italy, July 14-18, 1997.

[5] Ontology Spectrum. <http://en.wikipedia.org/wiki/Semantic_spectrum>.

[6] Cross-Domain Semantic Interoperability (CDSI). Working Group and its parent organization, Semantic Interoperability Community of Practice (SICoP), Editor James Schoening, U.S. Army.

[7] Out Reach Advisory. <http://www.starlab.vub.ac.be/OOA/>.