CARTOGRAPHIES OF ONTOLOGY CONCEPTS

Hatem Ben Sta[1, 2], Lamjed Ben Said[1], Khaled Ghédira[1], Michel Bigand[2], Jean Pierre Bourey[2]

[1]*Unité de Recherche en Stratégies d'Optimisation des Informations et de la connaissancE (SOIE), ISG de Tunis, Université de Tunis, 41 avenue de la Liberté, cité Bouchoucha 2000 Tunis, Tunisia*

[2] *Équipe de Recherche en Génie Industriel*
Ecole Centrale de Lille, BP 48, 59651 Villeneuve d'Ascq Cedex, France

Keywords: Ontology, Conceptualization, Semantic Web, Systems of knowledge Management, Ontological engineering.

Abstract: We are interested to study the state of the art of ontologies and to synthesize it. This paper makes a synthesis of definitions, languages, ontology classifications, ontological engineering, ontological platforms and application fields of ontologies. The objective of this study is to cover and synthesize the ontological concepts through the proposition of a whole of cartographies related to these concepts.

1 INTRODUCTION

Historically, the ontological engineering emerged the engineering of knowledge. This latter was for a long time has been considered as the domain of appraisal development in the conception of systems for the basis of knowledge.

In spite of the fact that the engineering of knowledge contributed to increase this appraisal while organizing the engineer in an automated perspective, some members of the community of the artificial intelligence felt the need to spend to one engineering leaning more solidly on the theoretical and methodological foundations to improve the conception of the intelligent systems: the ontological engineering (OE) permits to specify the conceptualization of a system, providing him with a formal representation of knowledge that he must acquire, under the shape of exploitable declarative knowledge by an agent. Thus, the exploitation by a mechanism of inference, of a declarative type representation as the ontology, while following rules of definite inference in this ontology, is the source of the intelligence of the system.

The engineering of knowledge gave birth thus to the ontological engineering where the ontology is the key object on which it is necessary to bend. The necessity of ontology and an ontological engineering of systems to basis of knowledge have begun to be understood and accepted by the community.

To found the ontological engineering requires that one define its object of it and defend the specificity of it's methodological. However, if no one contests that the object of the ontological engineering is the ontology, the explicit definition and the precise cutoff of this concept raises some questions all at the same time: philosophical order, epistemological, cognitive and technique.

There are several domains of application of ontologies: (1) medical domain (MENELAS), (2) agriculture domain (AOS), (3) modeling enterprise domain (TOVE), (4) management of a shared enterprise knowledge memory domain (CoMMA), etc. The most retained definition of ontology throughout these domains was proposed by Gruber (Gruber, 1993): "Ontology is an explicit and formal specification of a shared conceptualization". The construction of ontology poses real problems relative to knowledge engineering, conception, maintenance and reuse. In spite of the existence of interesting results, problems raised by the ontology theme remain numerous and complex.

The second section of this paper presents cartography of definitions met in the literature. The third section introduces cartography of ontology languages. The fourth section presents the ontological engineering. The fifth section introduces the classification of ontologies and cartography of relative classification approaches. In sixth section, we present the most relevant application domains of ontologies. Finally, we describe some platforms used to construct ontologies.

Ben Sta H., Ben Said L., Ghédira K., Bigand M. and Pierre Bourey J. (2005).
CARTOGRAPHIES OF ONTOLOGY CONCEPTS.
In *Proceedings of the Seventh International Conference on Enterprise Information Systems*, pages 486-494
DOI: 10.5220/0002529904860494

2 CARTOGRAPHY OF DEFINITIONS

A large number of definitions exist in the literature. Divergences of these definitions are:

1) Whether an ontology must be formal (Noy, 2004) or no (Sowa, 2004).

2) Whether an ontology is a conceptualization (Roche, 2004) or a specification of a conceptualization (Gruber, 1993).

The cartography of these definitions permits, firstly, to extract the main considered concepts and, secondly, to position our definition in relation to those in the literature. We extract and describe the following main terms present in ontology definitions overhauled in this paper:

- *Conceptualization* refers to an abstract model of a phenomenon in the world, identifying the suitable concepts relative to this phenomenon.
- *Explicit* means that the used concepts and their relations are defined explicitly.
- *Formal* means that the ontology should be expressed formally in order to facilitate its translation into an interpretable language by a machine.
- *Shared* means that ontology captures the consensual knowledge which is not reserved to some individuals, but shared by a group or a community.

In this paper we propose the following definition: "Ontology is an explicit and formal shared abstract view of a part of the real world. This view is described by a whole of tools as a vocabulary formed of concepts, relations, axioms and rules of inference".
Our definition is at the intersection of definitions whose concepts are presented in the Figure 1. This definition is inspired from terms explicitly invoked (full arrows) or implicitly invoked (dashed line arrows) in the corresponding references.

3 ONTOLOGY LANGUAGES

According to the approach of Corcho and Gómez-Pérez (Corcho, 2000), languages of ontology development are classified into three categories (Figure 2):

- *Traditional ontology languages* are divided into four categories: (1) languages relative to the logic of the first order predicate as CycL, (2) frame based languages as Ontolingua, F-Logic, CML and OCML, (3) languages based on description logic as Loom and (4) others such as Telos.
- *Standard languages of the Web* as XML, RDF
-*Web ontology languages* as OIL, DAML+OIL, OWL, SHOE and XOL.

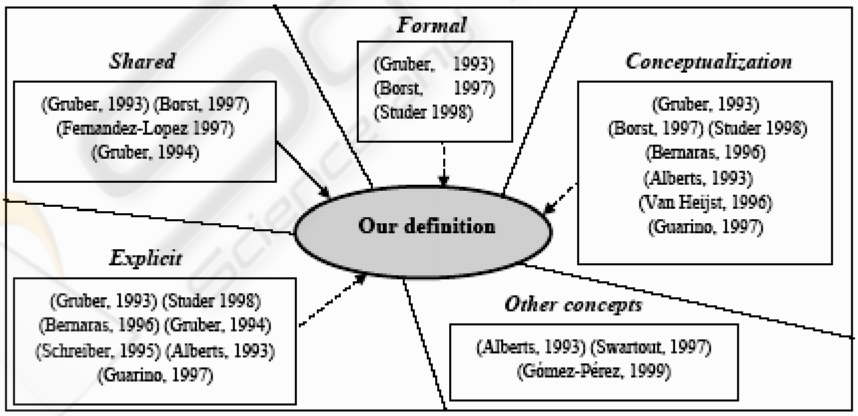

Figure 1: Cartography of ontology definition concepts.

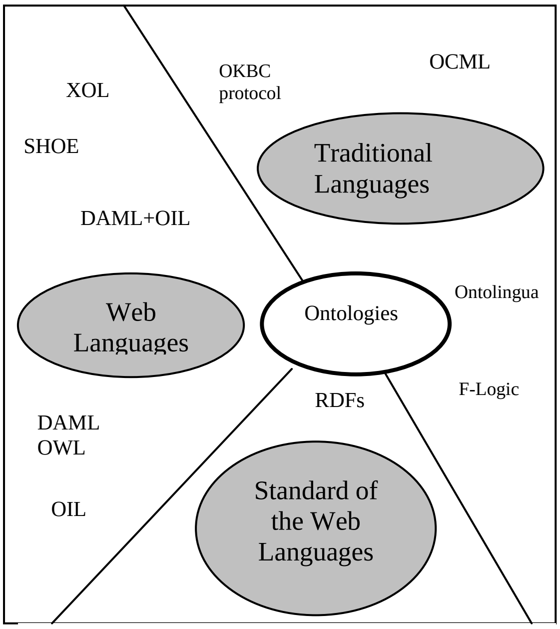

Figure 2: Cartography of ontology languages. Languages concepts

4 ONTOLOGICAL ENGINEERING

4.1 Ontology Components

Ontology components have been identified in (Gómez-Pérez, 1999) as:

- *Concepts:* called also ontology terms or ontology classes. They correspond to the applicable abstractions of a part of the reality (problem domain) that have been chosen according to the ontology objectives. According to (Gómez-Pérez, 1999) these concepts can be classified according to several dimensions: (1) abstraction level (concrete or abstract), (2) atomicity (elementary or composed), (3) reality level (real or fictitious).
- *Relations:* are the relevant associations existing between the concepts present in the analyzed part of reality. These relations include for example associations such as sub-class-of (generalization-specification), part-of (aggregation or composition), associated-with, etc. These relations enable us to analyse interrelationship of the considered concepts.
- *Axioms:* are the true assertions relative to the ontology domain.

4.2 Ontology Construction

The construction process of ontology is complex. Managing this complexity requires precise management rules in order to control costs and risks, and to insure the quality throughout the construction process. Till now, there is no consensus about the best practices to adopt during the ontology construction process or even about technical standards governing the process of ontology development. However, several methodological contributions were introduced to help ontology construction (Bernaras, 1996), (Grüninger, 1995), (Lenat, 1990), (Mizoguchi, 1998), (Staab, 2001), (Uschold, 1995).

A recent survey in (Mendes, 2003) shows that there are about thirty-three proposed methodologies for ontologies construction. These methodological approaches can be divided into five categories: (1) constructing from the beginning, (2) integration or fusion with other ontologies, (3) re-engineering, (4) collaborative constructing (5) evaluation of built ontologies. (Psyché, 2003) proposed a referential frame that allows a comparative analysis of these construction methodologies and their interactions. Methodological construction approaches have been in many cases associated with the evaluation process of ontology (Friedman, 1997). Among these approaches we can mention studies relative to the following projects: Cyc (Mizoguchi, 1998), Enterprise (Uschold, 1995), TOVE (Uschold, 1996), CommonKADS and KACTUS (KACTUS Web), METHONTOLOGY (Fernández, 1997) and Ontolingua (Mendes, 2003).

Besides the above mentioned methodological construction approaches, there are other domain-specific studies that lead to some interesting experience-based construction methodologies. It is the case in (Uschold, 1995) and (Fox, 1997). Moreover, part of the methodological research is focussing particularly on a specific ontology construction phase such as the Knowledge representation or the conceptualization (Guarino, 1997) (Kassel, 2002).

5 ONTOLOGY CLASSIFICATIONS

5.1 Classification Approaches

The main contributions of ontology classifications are the following (Figure 3):

- In (Uschold, 1996) ontologies are classified according to three criteria: 1) Formality (very casual: expressed in a natural language; semi-casual: expressed in a reduced form and structured of a natural language; semi-formal: expressed positively in a definite artificial language) expressed in natural language; 2) Objective (communication, interoperability, advantages of the systems engineering (reutilisability, acquirement of knowledge, specification)); and the 3)Topic "subject matter" (subject like the domain (ontology domain), subject of problem solving (tasks, methods or ontology of problem solving), topic of languages of knowledge representation ontology of representation or mat-ontology).

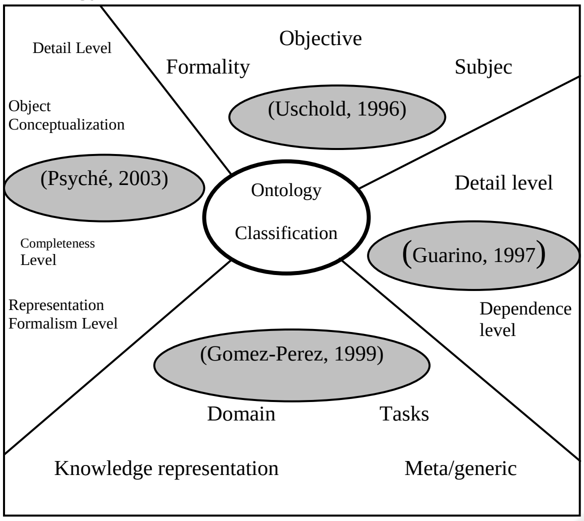

Figure 3: Cartography of ontology classification approaches.

- In (Guarino, 1995) ontologies are classified according to two criteria: 1) detail level: for example ontology meta-level, ontologies of reference, shared ontologies, domain ontologies and 2) dependence level: for example ontologies of high-level, ontologies of tasks and ontologies of applications.
- In (Gomez-Perez, 1999) ontologies are essentially classified according to the following criteria: 1) ontologies of knowledge representation (formal ontologies); 2) common/general ontologies; 3) top-level ontologies,4) meta/generic ontologies; 5) domain ontologies; 6) linguistic ontologies; 7) tasks ontologies (ontology task-domain, methods ontology, application ontology).
- In (Psyché, 2003) ontologies are classified according to the following criteria: object of conceptualization, detail level, completeness level, representation formalism level.
1) According to the object of conceptualisation, ontologies are classified by (Gómez-Perez, 1999), (Guarino, 1997), (Mizoguchi, 1998), (Mizoguchi,1996), (VanHeijst, 1997), (Vanwelkenhuysen, 1994), (Vanwelkenhuysen, 1995), (Wieliinga, 1993) in the following way: a) representation of the knowledge; b) superior / High level; c) generic; d) domain; e) task; f) application.
2) Detail level: In relation to the level of detail used at the time of the conceptualization of the ontology according to the operational objective considered for the ontology, two categories at least can be identified: fine granularity, large granularity.
3) Completeness level: has been landed by (Mizoguchi, 1998) and (Bachimont, 2000). As an example, let us describe the typology of (Bachimont, 2000). This latter proposes the classification at following three levels (semantic level, reference level, operational level).
4) Representation formalism level: In relation to the level of the formalism of representation of the language used to give back the ontology operational, (Uschold, 1996) propose a classification understanding four categories: casual, semi-informal, semi-formal, formal (Gómez-Pérez, 1999).

5.2 Ontology Domains

Besides the above ontology classification approaches, it is possible to categorize ontologies according to their application domains. Figure 4 presents a cartography existing projects concerning different ontology application domains. There are several important ontologies developed by the artificial intelligence and the language engineering communities. These ontologies cover several domains whose features have been defined in (Friedman, 1997) as:
- *General* : (1) The objective for which the ontology was created (general or specific), (2) the size expressed by the number of used concepts, rules and linkers, (3) the formalism, (3) the used language and platform of implementation (4) scientific communications, etc. - *Conception Process* : How has the ontology has been constructed? Is there any evaluation formalism? What is the general taxonomy of the ontology organization? - *Taxonomy*: What is it the general taxonomy of ontology organization? Are there several taxonomies or only one? What is the composition of this taxonomy?
- *Internal Structure of concepts and their relations:* Do concepts have specific internal structures? Are there roles and properties? Are there other types of relation between concepts? How are part-whole relations represented?
- *Axioms*: Are there any explicit axioms? How are axioms expressed?
- *Mechanism of inference*: How is the reasoning made (if any)? What are some processes of going beyond first-order logic?
- *Applications*: research mechanisms, user-interface, the application in which the ontology has been used?
- *Contributions*: Major strengths and contributions, weakness and araised problems.

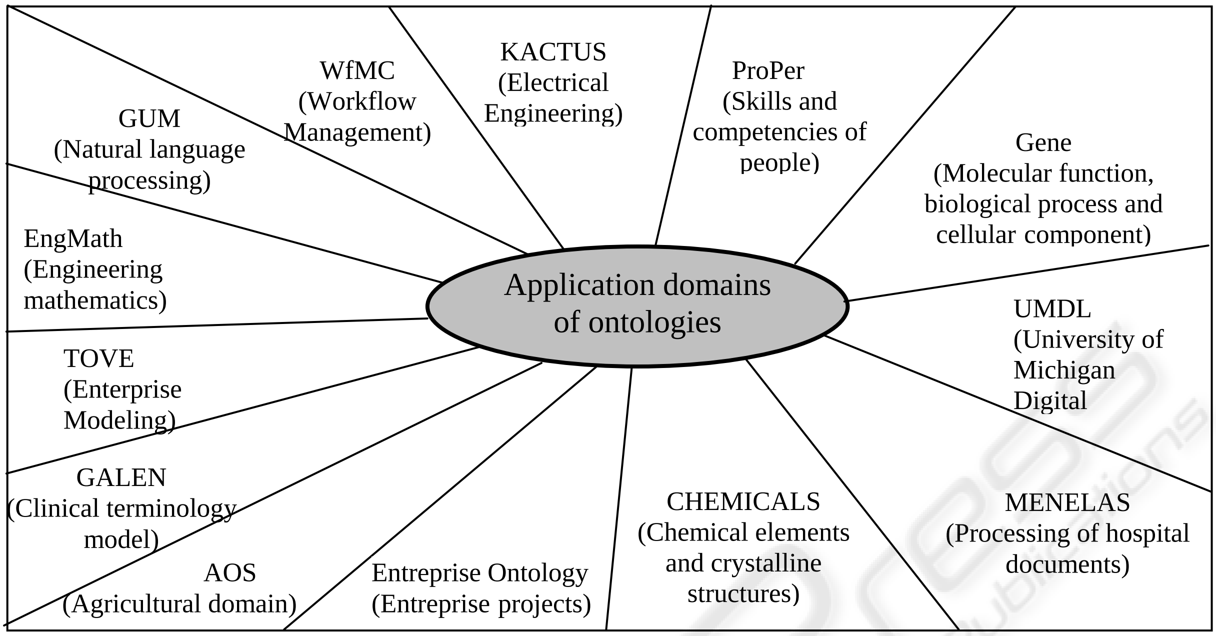

Figure 4: Cartography of ontology application domains.

6 APPLICATION FIELDS OF ONTOLOGIES

Far to be only a laboratory object, ontologies are used today in many real application fields where knowledge conceptualization and representation is needed. The object of this section is to present some applications (Figure 5) integrating ontologies and, more precisely, the role of ontologies in knowledge based systems and in the semantic Web.

6.1 Knowledge Based Systems

The main application of ontologies is data management for knowledge based systems. Many operational projects exist in different domains. We can mention the MENELAS project (Gandon, 2002), led in the computer services of the PUBLIC HOSPITALS OF PARIS. Its role consists in helping the management of medical reports and their analysis by a system using the conceptual graph model. Graphs are used here to represent the inclusive medical knowledge in reports. They are generated from texts and then stocked. The use of adapted reasoning mechanisms permits the interactive consultation of the knowledge. Other projects, dedicated to the management of enterprise, are currently in progress. The TOVE project (Gandon, 2002) (Fox, 1997) has for goal to create a model of enterprise expressed through an ontology, allowing a system using this ontology to manage knowledge related to the organization and activities of enterprises. The CoMMA project (Gandon, 2002), realised in the INRIA of Sophia-Antipolis, aims at permitting the management of a shared knowledge memory inside an enterprise. The use of ontologies within systems offering real possibilities of reasoning is not well developed till now. This can be explained by the inadequate existing representation of languages.

6.2 Semantic Web

The Web constitutes an ideal land of application of ontologies. Without coming back to the different definitions presented of ontologies in engineering of knowledge, it is clear that researches on these are essential for the realization of the semantic Web. Indeed, on the one hand, once constructed once and accepted by a particular community, ontology must translate a certain explicit consensus and a certain level of sharing that are essential to permit the exploitation of resources of the Web by different applications or software agents. On the other, the formalisation, other facet of ontologies, is necessary so that these tools can be provided of capacities of reasoning permitting to unload the different users of a part of their task of exploitation and combination of resources of the Web.

Of the point of ontology view, will be crucial for the semantic Web methods and tools contributing to:

- To construct ontologies, that is from primary sources, particularly the textual corpora, or while searching for a certain reusability. The construction of ontologies from the textual corpus analysis is a domain in strong evolution where a certain number of methodologies and tools are tested by a very active community. The question of the reusability that caused long proceedings in the community Engineering of knowledge permitted to progress toward the research of some genericity but remains a major stake for the semantic Web;
- To manage the access to ontologies, their evolution, with management of versions, and their fusion. Ontologies are often rich of several thousand of concepts and remain then directly accessible by their inventor. Their access by users, same professionals, requires the management of the tie between concepts of ontologies and terms of the natural language that it is for a simple understanding or for the indexing and the intended request construction to tasks of research of information. Solution implementations until now pass by methodologies separating explicitly terms and concepts of a domain and tools of visualization and navigation searching for the conceptual proximities in terms of a domain and permitting to fear the complexity of this domain intuitively;
- To insure the interoperability of ontologies while managing the heterogeneities of representation and the semantic heterogeneities. These latter are the hardest to manage and they will require some conjoined reflections to the problematic of the ontology accessibility.

Some projects have been achieved or under realization using concepts of the Semantic Web. Among these projects: PICSEL (LRI), Xyléme (INRIA-Xyleme, 2000), CoMMA (Gandon, 2002), ACACIA (INRIA, 2000), ESCRIRE (INRIALPES), COMMONV (Trichet, 2002), GEMO (INRIA-GEMO).

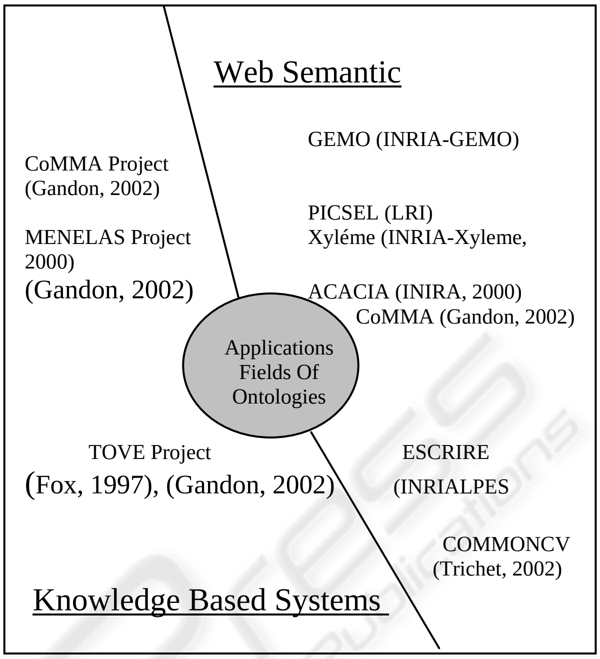

Figure 5: Cartography of some Applications Fields of Ontologies

7 SOME PLATFORMS FOR ONTOLOGY CONSTRUCTION

In this section we describe some platforms used for ontology construction.

There exist numerous ontological platforms using varied formalisms and offering different functionalities. These platforms offer supports for the construction process of ontology. However they do not offer a great help concerning the conceptualization. We describe here some of the most important ontological platforms:

- Ontolingua: Ontolingua is a set of developed tools written in Common Lisp. It is used to analyze and to transform ontologies that have been developed in the beginning of 20th century at the Knowledge Systems Laboratory of the Stanford University of (Farquhar, 1997). Ontolingua is composed of a server and a representation language. The server memorizes a set of constructed ontologies in order to assist the development of new ontologies (Duineveld, 1999).
- WebOnto: WebOnto has been developed by the Knowledge Media Institute of the Open University (Onto Web). WebOnto has been conceived in order to support collaborative research, creation and display of ontologies. WebOnto provides a user interface that displays ontological expressions. It

provides also an ontological tool called Tadzebao which is able to support the synchronous and asynchronous communication between ontologies. - Enterprise Toolsets: It is an agent based platform that integrates several plug-and-play tools. The main components of Enterprise Toolset are: a procedure onstructor used to capture models of a process, agent's Toolkit used to support the development of agents, administrator of tasks used for the integration and the visualization of a process, and a communication tool (Uschold, 1998).

- KACTUS / VOID Toolkit: KACTUS is an interactive environment to search, publish and manage ontologies. The VOID tool offers an experimental framework for examining and analysing theoretical ontology concepts. It permits also the organisation of developed ontology libraries and the transformation of different ontology formalisms. The KAKTUS toolkit allows also executing a set practical operation such as searching, publishing and interrogating ontologies developed using different formalisms. In order to support the reuse of ontologies, the toolkit can manipulate several formalisms of ontologies (CML, EXPRESS and Ontolingua) and can manipulate transformations between these formalisms. Other platforms are mentioned in (Duineveld, 1999).

8 CONCLUSION

The notion of ontology stems from the discipline of Philosophy. It has evolved to its current meaning in the context of Computer and Information Science where it refers to a designed artefact which formally represents agreed semantics in a computer resource.

Ontologies are becoming increasingly important in various fields. They are used to describe diverse domains in order to treat information automatically.

In this paper we tried to present some concepts bound to ontologies but from a new approach: the cartography. It will allow readers to situate their ontological needs while referring to the suitable concepts.

This paper has permitted to browse in a rather exhaustive way the state of the art relative to ontologies. Thus, we introduced several cartographies relative to definitions, languages, classification approaches and application domains. This ontological survey was supported by a progressing study that we are leading. In fact, we have finished the conceptualization of an ontology dedicated to the management of a project memory (Bigand, 2004). For the following of our researches, the development of this ontology is in progress and we intend to experiment it the case of French and Tunisian companies.

REFERENCES

Alberts, L. K., 1993. *YMIR: an Ontology for Engineering Design*, University of Twente.

Bernaras, A., Laresgoiti, I., and Corera, J., 1996. Building and Reusing Ontologies for Electrical Network Applications. In *ECAI'96, 12th Europeen Conference Artificial Intelligence*.

Berners-Lee, T., Hendler, J., and Lassila, O.,2001. The Semantic Web, *Scientific American*. www.scientificamerican.com/2001/0501issue/0501berners-lee.html/

Berners-Lee, T., Hendler, J., and Lassila, O., 2001. The Semantic Web. *Scientific American*, May, 284(5), 34-43.

Bigand, M., Mounib M., Ben Sta H., and Bourey J. P., 2004. In *CIFA'04, Conférence Internationale Francophone d'Automatique*.

Borst, W. N., 1997. *Construction of Engineering Ontologies*, Center for Telematica and Information Technology, University of Tweenty, Enschede, NL.

Bachimont B. (2000). Engagement sémantique et engagement ontologique : conception et réalisation d'ontologies en ingénierie des connaissances. In Z. M. Charlet J., Kassel G., Bourgault D., (Ed.), *Ingénierie des connaissances. Évolution Récentes et nouveaux défis* Paris: Eyrolles, 305-323.

Corcho, O., and Gómez-Pérez, A., 2000. A roadmap to ontology specification languages. In *Proceedings of EKAW'00*, France.

Domingue, J., 1998. Tadzebao and WebOnto: Discussing, browsing, and editing ontologies on the Web. In *KAW'98, the eleventh workshop on knowledge acquisition, modeling and management*, Banff, Canada.

Duineveld, A.J., Stoter, R., Weiden, M.R., Kenepa, B., and Benjamins, V.R., 1999. Wonder Tools? A comparative study of ontological engineering tools. In *KAW'99, Twelfth Workshop on Knowledge Acquisition, Modeling and Management*, October, 16-21, Alberta, Canada.

Farquhar, A., Fikes, R., and Rice, J., 1997. The Ontolingua server: Tools for collaborative ontology construction.*International Journal of Human Computer Studies*, 46(6), 707-728.

Fernandez-Lopez, M., Gómez-Perez, A., and Juristo, N., 1997. Methontology: From Ontological Art Toward Ontological Engineering. In *Spring Symposium Series on Ontological Engineering. American Association for Artificial Intelligence*. Stanford, USA.

Fernández, M., Gómez-Pérez, A., and Juristo, N., 1997. METHONTOLOGY: From Ontological Art Towards Ontological Engineering. In *Symposium on Ontological Engineering of AAAI*. Stanford, California.

Fox, M.S., Gruninger, M., 1998. Enterprise Modelling. *AI Magazine*, AAAI Press, Fall, 109-121.

Fox, M S., Barbuceanu, M., Gruninger, M., and Lin, J., 1997. An Organization Ontology for Enterprise Modelling. www.ei1.utoronto.ca/enter prise-modeIling/papers/org-prietula-23 aua97.pdf

Fridman, N., and Hafner, C. D., 1997. AmericanAssociation for Artificial Intelligence. www.aaai.org

Friedman, N., and Hafner, C. D., 1997. The State of the Art in Ontology Design. American Association for Artificial Intelligence.

Gandon, F., Dieng, R., and Giboin, A., 2002. *CoMMA : Une approche distribuée de la mémoire organisationnelle*, Projet ACACIA – INRIA Sofia Antipolis

Gandon, F., Quelques ontologies existantes et leurs applications.www.irit.fr/GRACQ/COURS/OntoFabienGandon2002/Partie07_OntologiesExistantes.pdf

Gandon, F., Ingénierie des Connaissances. www.irit.fr/GRACQ/COURS/OntoFabienGandon2002/Partie04_IngenierieDesConnaissances.pdf

Gomez-Perez, A., 1999. Ontological Engineering: A state of the art. *Expert Update*, 2(3), 33-43.

Gomez-Perez, A., and Benjamins, V. R., 1999. Overview of knowledge sharing and reuse components: Ontologies and problem-solving methods. In *IJCAI'99, Workshop on Ontologies and Problem-Solving Methods: Lessons Learned and Future Trends*, in conjunction with *the Sixteenth International Joint Conference on Artificial Intelligence*, August, Stockholm, Sweden.

Gruber, T., 1994. Toward Principles for the Design of Ontologies Used for Knowledge Sharing. *International Journal of Human Computer Studies*, 43(5/6), 907-928.

Gruber, T. R., 1993. A translation approach to portable ontologies. *Knowledge Acquisition*, 5(2):199-220.

Grüninger, M., and Fox, M.S., 1995. Methodology for the Design and Evaluation of Ontologies. Workshop on Basic Ontological Issues in Knowledge Sharing. In *IJCAI'95,International Joint Conference on Artificial Intelligence*, Montreal.

Grüninger, M., and Fox, M.S., 1994. The Role of Competency Questions in Enterprise Engineering. In *IFIP WG 5.7, Workshop on Benchmarking*. Theory and Practice. Trondheim, Norway.

Guarino, N., and Giaretta, P., 1995. Ontologies and Knowledge Bases: Towards a Terminological Clarification. In *Mars N. J. I. (Ed.), Towards Very Large Knowledge Bases: Knowledge Building and Knowledge Sharing*, Amsterdam: IOS Press, 25-32.

Guarino N., 1997. Understanding, Building and Using Ontologies: A Commentary to "Using Explicit Ontologies in KBS Development", by van Heijst, Schreiber, and Wielinga. *International Journal of Human and Computer Studies*, 46(2/3), 293-310.

Hollingsworth, D., 2003. Workflow Management Coalition the Workflow Reference Model. www.wfmc.org/standards/docs/tc003v l.pdf

Inria, Xyleme : exploitation des données web. www.inria.fr/rapportsactivite/RA2000/verso/domainWeb-xyleme_mn.html

Inria, 2000Présentation du projet ACACIA. Pauillac.inria.fr/cdrom/projs/acacia/fra.html

Inria. GEMO. www.inria.fr/recherche/equipes/gemo.fr.html

Inrialpes.Action de recherche coopérative Embedded Structured Content Representation In Repositories/Représentation formelle et textuelle dans les serveurs de connaissance ESCRIRE. www.inrialpes.fr/exmo/cooperation/escrire/

Kaktus Web www.swi.psy.uva.nl/projects/NewKACTUS/library

Kassel, G., 2002. OntoSpec : Une méthode de spécification semi informelle d'ontologies. In *IC'2002, Actes des 13èmes journées francophones d'Ingénierie des Connaissances*, Rouen, 75-87.

Lenat, D. B., and Guha, R. V., 1990. *Building large knowledge-based systems*, Addison-Wesley Publishing Company, Inc.

LRI (Laboratoire de Recherche en Informatique), Equipe IASI. Thèmes de recherche. http://www.lri.fr/~picsel/

Mendes, O., 2003. État de l'art sur les méthodologies d'ingénierie ontologique. Centre de recherche LICEF Montréal, Québec, Canada.

Mizoguchi, R., 1998. A Step Towards Ontological Engineering. In *JSAI'98, 12th National Conference on Artificial Intellegence, Journal of Japanese Society for Artificial Intelligence*.

Motta, E., 1998. *Reusable Components for Knowledge Models*. PhD Thesis, Knowledge Media Institute, the Open University, UK.

Mizoguchi R. and Ikeda M. (1996) Towards Ontological Engineering (AI-TR-96-1,). Osaka : ISIR, Osaka University.

Noy N.L. and D.L. McGuiness 2004. Ontology development 101. protégé.stanford.edu/publications/ontology de developpement/ontology101-noy-mcguiness.html,

Onto Web

www.OntoWeb.org

Psyché V., Mendes O. and Bourdeau J., 2003.

Apport de l'ingénierie ontologique aux environnements de formation à distance. In *Revue Sciences et Technologies de l´Information et de la Communication pour l´Éducation et la Formation.* www.sticef.org

Roche C. 2004, Condillac Group Ontology.univsavoie.fr/activities/recherché/ontologie/notreDefinitionEng.asp

Schreiber, G., Wielinga, B., and Jansweijer, W. , 1995. The KAKTUS View on the 'O' Word. In *IJCAI'95, Workshop on Basic Ontological Issues in Knowledge Sharing*, Montreal, Canada.

Sowa J.F, 2004 K.R Ontology. www.jfsowa.com/ontology/

Staab, S., Studer R., Schnurr, H. P., and Sure, Y., 2001. Knowledge Processes and Ontologies. *IEEE Intelligent Systems*, January-February, 26-34.

Studer, R., Benjamins, R., and Fensel, D., 1998. Knowledge Engineering: Principles and Methods. *Data Knowledge Engineering* .

Swartout, B., Patil R., Knight, K., and Russ T., 1997. Towards Distributed Use of Large-Scale Ontologies. In *Spring Symposium Series on Ontological Engineering*, 138-148.

Trichet, F. CommOnCV. 2002 www.sciences-nantes.fr/irin/commoncv/French/Objectifs.html

Uschold, M., and Gruninger, M., 1996. Ontologies: principles, methods, and applications. *Knowledge Engineering Review*, 11(2), 93-155.

Uschold, M., King, M., Moralee, S., and Zorgios, Y., The Enterprise Ontology, 1998. *The Knowledge Engineering Review, Special Issue on Putting Ontologies to Use (eds. Mike Uschold and Austin Tate)*, Vol. 13.

Uschold, M., 1998. Knowledge Level Modelling: Concepts and Terminology. *The Knowledge Engineering Review*, 13(1).

Uschold, M., and King, M., 1995. Towards a Methodology for Building Ontologies. In *Workshop on Basic Ontological Issues in Knowledge Sharing. IJCAI'95, International Joint Conference on Artificial Intelligence.*

Uschold, M., KING, M., Moralee, S., and ZORGIOS, Y., 1997. The Enterprise Ontology. www.tm.tue.nl/staff/awagner/EnterpriseOntology.pdf

Van Heijst, G., Schreiber, A. T., and Wielinga, B. J., 1996. Using Explicit Ontologies. In KBS Development. In *International Journal of Human and Computer Studies*.

Vanwelkenhuysen J. et Mizoguchi R. (1994). Maintaining the workplace context in a knowledge level analysis. Paper presented at the Proc. of JKAW'94, Hatoyama, Japan.

Workplace-Adapted Behaviours: Lessons Learned for Knowledge Reuse. Paper presented at the KB&KS '95.

Wielinga B. and Schreiber A. (1993). *Reusable and sharable knowledge bases: A European perspective.* Paper presented at the KB & KS'93, Tokyo.