Formal Ontology meets Industry
Editorial for the Special Issue "FOMI 2005"
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In the last fifteen years Formal Ontology has become a fruitful area of research and, perhaps more importantly, has attracted interest from practitioners in a variety of applicative domains like business and knowledge management, conceptual modeling, engineering and medical science, just to name a few.
Such a success should not hide a dismaying fact, namely that after all these years, after the widespread recognition of the initial intuitions, after the excitement of the first period has faded into a more mature attitude – after all this we still have not been able to put forward clear examples of the advantage of adopting the ontology approach in implemented systems. One should not jump to the conclusion that this result marks the failure of ontology application. The resources and insights that ontology offers us are too evident and valuable to be dismissed so quickly. Instead, one must search for the reasons that brought us to such a situation. Without entering into a discussion of the (sometimes dubious) benefits of international research programs that have taken place in these years, we notice that today there are several places, including this journal and international conferences like FOIS (Formal Ontology in Information Systems, www.formalontology.org), where people can present their ontologies, advertise their tools for ontology manipulation and integration, or even discuss what an ontology is or is not[1]. However, no stable forum is provided where people from the applicative domains can share with theoreticians their ideas on how to use ontologies, why and where they are needed, and which answers an ontology should provide to prove its usefulness. On the other hand, research in ontology is quite abstract and often based on toy-examples to the point that the gap between the work of theoreticians and the needs of real applications is too wide to be crossed: researchers do not have enough domain expertise to show how to implement a formal system to make it suitable for specific problems, while domain practitioners do not seem to have a clear understanding of the subtleties of ontology to push forward innovative uses or original solutions based on this approach. We believe this gap is today one of the major reasons for not having a clear assessment of the import that Formal Ontology brings in traditional application domains like rationalization of production, financial accounting (say, in production and services), and human resource management.

The first effort in applying ontology, should be toward a good understanding of the domain at stake, to which a sufficiently deep description must follow. As of today, a major challenge is to isolate and define a stable and reliable methodology for this task. What seems a simple process to define in general terms, turns out to be very difficult to pinpoint in its details. Nonetheless, we observe that the current literature in Artificial Intelligence provides a number of interesting frameworks for developing, deploying, testing and embedding ontologies. These frameworks span the different views of what an ontology is and the various situations one can find in different domains (lack of specialized ontologies, adoption of proprietary ontologies, standardization initiatives). Within this trend Formal Ontology, as opposed to low-level or to linguistic ontologies, presents a slower pass because of its rigorous approach which requires more time and special competence in order to provide

[1] The latter is an interesting topic for the theoretically inclined people since one finds in the ontological literature systems as far apart as simple glossaries and complex logical theories.

suitable systems. This might explain why Formal Ontology is quite behind in becoming an industrial practice. Note that even today one can find researchers justifying the above situation by claiming that Formal Ontology is still a recent novelty in industry. We do not believe this is an acceptable explanation any longer. What is missing, we believe, is the mental attitude that sees Formal Ontology as a piece of the "industrial process" or, on a different perspective, as an "industrial asset".

The alternative between Formal Ontology as part of a process or as an asset is a choice of the investigators, and the submissions to the FOMI 2005 workshop show a deep interest in this topic. In particular, the four papers in this issue can be seen as taking one or the other view, with the paper by Garbacz (whose contribution is primarily at the theoretical level) facing the issue from both perspective through the analysis of the central notion of "function" in the engineering domain. This is, indeed, an industrially relevant notion related to the idea of ontology as a process (Formal Ontology *controls* the coherence of data in the industrial context) and to the idea of ontology as an asset (Formal Ontology *provides* the motivations for the product plexus of the industry).

FOMI 2005

The workshop "Formal Ontology meets Industry" (FOMI), whose first edition took place in Lazise, Verona on June 9 and 10 2005, is trying to fill the gap between Formal Ontology development and industrial needs by taking the above considerations at face value. The title reminds both of a gathering and of a challenge between opponents. The intention was to present Formal Ontology and industry as two companions that, as of now, are looking at each other from opposite sides but need to meet and interact deeply in order to produce fruitful and remarkable results. The initiative gathered more attention than what we hoped receiving a total of 39 papers, 18 of which were accepted after the review process.[2] The quality of some of these works was particularly excellent to guarantee journal publication and pushed us to prepare this special issue with extended versions of the best papers.

If the attention received by FOMI 2005 was a pleasant surprise, we must admit that this is only one small step and that the way to meet our expectations in ontology application is quite long. We know it will take time to develop constructive and profitable interactions between theoretical researchers and practitioners. This process must be undertaken if we want to produce effective evidence of the economic and strategic value of ontology implementation in traditional domain like engineering, business or medicine. But the merging of theoretical and application concerns should not be left to the search for solutions to scattered problems. There is a need to guide these interactions to exploit elaborated and general formal ontologies and to avoid ad hoc adoption of specialized or overly weak ontologies. Formally weak systems, like glossaries, taxonomies and topic maps, as well as conceptually disputable systems, like the ontologies built on-the-fly in the semantic web arena, do not seem promising to us. On the one hand, we know from the 70s the limits of taxonomies and conceptual schemas (and these have been recognized in a variety of domains from medicine to manufacturing). On the other hand, it is understood that big enterprises

[2] In this perspective, a positive evaluation of the workshop comes also from the remarkable balance between research and industrial papers both at the submission stage and at the acceptance stage. Note that we did not enforce this balance in any way, not even to guarantee that a minimum number of papers were accepted in both categories.

cannot effort to rely on improvised ontologies for managing their huge (yet sensitive) amount of heterogeneous data. These organizations are structured into many, heterogeneous unities, both formally (e.g., departments, divisions, national branches) and informally (e.g., communities, interest groups). Each one of these has to manage specialized knowledge in an autonomous way, enabling coordination among others. If we succeed in guiding the efforts toward the application of robust and formal ontologies, the experience that will be obtained will allow us to answer the assessment of Formal Ontology in real applications by identifying with increasing certainty where and when ontological systems can be effectively implemented within organizations.

The Contributions Collected in this Issue

The first paper (Garbacz) focuses upon the problem of formalizing the notion of function in the engineering domain. It uses ontological arguments to analyze a well-known taxonomy of artifact functions which has been proposed in the 90s by domain experts. Besides the conclusions specific to this concept, this paper can be of interest also for the methodology it applies and for the connections it provides between an existing taxonomy and an existing foundation ontology; an important issue in developing ontology for the industry. Among the conclusions of the paper, we see the positive interaction between the process of providing ontological grounds to notions used in the application area and the process of extending a formal ontology to make it suitable for the analysis and the coverage of specific domains.

The second paper (Kitamura et al.) is concerned again with the concept of function (here seen as a role concept) in the broader context of engineering knowledge management with particular emphasis on functional knowledge, conceptual design and artifact behavior. In this case the notion of function is dealt with from an applicative viewpoint in the manufacturing domain. What constitutes an important theoretical aspect of this paper is the ability of authors to prove that functional knowledge is central for *industrial purposes* in an applicative context. The paper reports also on implementation and deployment of the approach including interesting extensions aimed at facilitating the adoption of this approach by engineers.

The third paper (Posada et al.) deals with a specific application in the field of Computer Aided Design. The authors demonstrate how the use of a Formal Ontology, coupled with traditional techniques and algorithms, can reduce in a significant way the complexity of object visualization and can facilitate the user-oriented representation of engineering components in an application of Virtual Reality for industrial plants simulation. The paper is of a general interest because it constitutes a case study of a real example in which the actual potentiality of Formal Ontology is exploited in a traditional domain and in accordance with consolidated standards like STEP.

The fourth paper (Biesalski et al.) provides another interesting example of implementation of an ontology as a tool for knowledge management in an industrial context. The authors' view is that Formal Ontology constitutes what we could call a *facilitating platform* that, together with other more applicative modules (like Training Planning, Project Team Building, etc.), makes possible a number of integrated industrial activities to support human resource management and that, we foresee, can be easily and fruitfully extended to other areas of the enterprise.

The Future of FOMI

Traditionally, information systems have been developed with the aim of making knowledge sharable and available in a general, objective, context independent form, avoiding/correcting erroneous or non-consistent information. Other studies have reduced the attention on integrity to focus on structuration theories by considering the interdependencies among human actions, institutional roles (the organizational model de facto), the technology architecture and the ontologies of knowledge management systems. One important challenge is to produce ICT technologies and ontology-based systems that satisfactorily fit these processes, practices, and organizational models in which they are implemented. In a complex organization composed by a constellation of units, which manage in an autonomous way specialized processes, ICT technologies and ontology-based systems must take into account the distributed nature of knowledge, and should allow coordination among autonomous units. In such a scenario, Formal Ontology should satisfy two different needs: supporting the creation of specialized knowledge within a unit, and facilitating the coordination of knowledge and activities through which knowledge is exchanged.

Following this perspective, the future FOMI events will continue to incentive interdisciplinary discussions on:

- theoretical studies on formal ontologies committed to provide sound bases for industrial applications and to allow formal representation for real world implementations;
- theoretical studies on organization and management science, and in particular on structuration theories, which might provide useful framework and methodology to design, implement and adopt ontology-based systems within a company;
- application experiences that single out concrete problems (and possibly solutions) which benefit from the use of formal ontologies;
- the experience analysis of practitioners that should provide useful insights on managerial and technical aspects related to the creation and deployment of formal ontologies as well as useful criteria or methods to evaluate ontologies and their effectiveness in applications.

These topics will allow participants to share knowledge and experiences, to create a common understanding on the creation, implementation and effectiveness measurements of ontologies within the firms.

In particular, we hope FOMI will become a stable forum of discussion among practitioners, computer science researchers, and organization and management scientists. The aim of this forum would be to allow:

- practitioners to

understand new theories and research result on ontology based methods, and applications;

learn a technical language that allow them to clearly understand researchers, and clearly expose their needs;

learn innovative methodologies that can stimulate new solutions for the (different levels of the) enterprise;

learn best practices from other experiences;

- researchers to
    - look at real business case in order to understand real business needs, and identify/discuss the application of some innovative theories, which seem

suitable to solve these problems;

develop new measurement methods to analyse the effectiveness of the implementations and the actual efficacy and effectiveness of ontology-based systems.