# Collaborative Work on Ontologies - A Report

Felix Engel[1], Sören Auer[1]

[1]Technische Informationsbibliothek (TIB), Welfengarten 1B, 30167 Hannover

**Abstract**

Supply chains are vulnerable and inherently complex processes. In-creasing the resilience of supply chains is realised, if the stakeholders involved have agreed on a clear language. Only this enables a comprehensive, unambiguous and fast exchange of information. Ontologies serve as a powerful formal tool to realize an appropriate communication framework. They are designed to make communication and information exchange between stakeholders and machines unambiguous and thus efficient. This paper addresses the challenges and solutions associated with the fact that ontologies need to reflect agreed definitions of a domain, as we face them in the SC3 and CoyPu projects.

**Keywords**

Ontologies, Semantic Web, Sustainability, Visualization, Standardization

## 1. Introduction

The number of interlocking, disparate organizations and teams involved in a supply chain quickly become an unmanageable extent. This collection of involved groups may include various engineering teams, finance teams, production shippers, retail site and warehouse staff, or shipping and logistics teams required to manufacture and distribute a product. Behind these organizations and teams are decision makers who must communicate effectively with each other. Even small misunderstandings in communication between decision makers can quickly lead to far reaching consequences. Unambiguous and precise language is therefore the key to a resilient supply chains. As an example [1], in 1999 the destruction of the Mars Orbit Climater happened, because engineers have not clearly communicated between engineering teams. One of the components was jointly constructed between a US and a UK team. While some adopted metric units, others used English units. The damage amounted to 125 Mill USD. As another example [2], in a transdisciplinary project result discussion with technical terms and indicators, speaking about micro and macro nutrients. Soil scientists will discuss about nitrogen, phosphorus, potassium, calcium, magnesium and sulphur. Nutritionists in turn will discuss about carbohydrates, protein and fat. Even though the introduced examples are very striking, they are representative of the obvious problem of miscommunication large and small. They vividly illustrate the importance of agreeing on a commonly understood language throughout all participants of the supply chain, that we will call a designated community. As a designated community, we will use the ISO14721 definition [3]: *An identified group of potential Consumers who should be able to understand a particular set of information.* Application ontologies for the

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felix.engel@tib.eu (F. Engel); soeren.auer@tib.eu (S. Auer)

0000-0002-3060-7052 (F. Engel); 0000-0002-0698-2864 (S. Auer)

precise exchange of information, within and across designated community boundaries promises to provide a remedy or at least relief. However, the creation and uptake of ontologies are not trivial tasks, within this paper we will highlight reasons and introduce solutions from two research projects that address these challenges.

## 2. Challenges of working on Ontologies

An ontology is a tool that provides a formal representation of information to support its automated exchange between machines. However, the creation, extension and adaptation of the ontology is not a trivial task. In our opinion, the following four reasons are foundation for this statement:

1. The work on comprehensive and expressive ontologies must take place in close cooperation between domain experts and knowledge workers. Domain experts bring the necessary knowledge about the domain in focus and knowledge workers their expertise in creating high quality and hence usable ontologies. In order to ensure effective collaboration, the communication between these two stakeholder groups must be considered in a suitable form.
2. As the introductory example shows, interdisciplinary communities of soil scientists and nutritionists, among others, have different conceptual allocations that make error-free communication difficult. The same is true for intraorganizational teams and inter-organizational exchanges. Ontologies are thus always specific to a particular community. The provision of mappings to other ontologies is therefore an important prerequisite to communicate across organizations and not to develop another isolated solution.
3. The definitions of terms implemented in the ontology change dynamically over time. Consequently, work on ontologies is an active, lengthy, and always ongoing process.
4. The ontology must be accepted and reused by the designated community, to achieve stability and to be available in the long term. Therefore, they must be advertised and aligned with existing ontologies.

The following chapters describe how the challenges presented are addressed in the CoyPu and SC3 projects. Finally, a summary of the challenges and the solutions presented is given.

## 3. Consideration of Different Competence Levels

The first challenge, introduced in section two concerns collaborative work on creating and extending ontologies. A decisive factor here is the collaboration between the domain experts themselves and the knowledge engineers. The domain experts are familiar with the domain and contribute with their knowledge to the unambiguous definition of a resource of this domain. This through a reasoning process until a consensus is defined in the named community. The knowledge engineer can guide the process; he/she has knowledge about the structure and implementation of the ontology following various Semantic Web specifications and the tools to realise the ontology. In order to facilitate these processes of agreement between the domain

experts, as well as the communication of the domain experts with the knowledge engineer, we see the need for tools that translate the modelled information for different expert levels.

It is precisely in this regard that we are working in the *Semantically Connected Semiconductor Supply Chains* (SC3) communication and support action that is funded by the European Commission on a communication framework as a solution to this challenge. The main use case of the SC3 project concerns the creation of a unique framework for communication in semiconductor supply chains. The potential for miscommunication is very high in this environment. The SC3 project is therefore working on a lingua franca (DR, the digital reference ontology) to promote semantic interoperability between semiconductor companies and other industries. To support the collaborative work challenge of domain experts and knowledge engineer, in this project we are working on a portal for validation, visualization, mapping, and customization of DR-compliant developments. This environment is a web-based portal that enables visual translation of the ontology content between different visualization types and serves as an intuitive means to bridge the gap between different levels of knowledge and experience of involved domain experts and knowledge engineers. Within this platform, we distinguish three types of users. The Expert User is a knowledge engineer who knows how to build ontology based on the project requirements, but does not have knowledge in a particular domain. The Advanced User, on the other hand, has some knowledge in ontology developing implementation, but not enough to make full of usage expert systems tools such as Protégé. The Novice User, on the other hand, has no knowledge of how to use Semantic Web standards and tools for ontology development.

Our assumption is that expert users must most likely be knowledge workers. These workers are interested in a fully comprehensive and accurate information representation. Therefore, we provide formal visual representations for these stakeholders in expert mode. These are a UML-based and a text-based representation of the ontology. The advanced users of our portal, on the other hand, may already have experience with Semantic Web technologies and may have some initial experience with tools such as Protégé. For this user group, we therefore provide tree- and widget-based visualizations of ontologies. These forms of visualization can be used to query information, while still keeping the overview relatively simple. Finally, there is the Novice User. For this user, we have provided rather simple graph-based visualizations that focus on visualizing direct relationships of definitions of resources of the domain. To simplify these very different collaborative editing requirements, our system uses the Relation Resource Model (RRM). This model serves as a neutral representation format and as such allows the ontology to be represented in all of these different formats mentioned. Our thesis is that these different visualization types enable and stimulate collaborative work on ontology development by serving as translators that translate the information encoded in an ontology between different levels of performance.

## 4. Ontology Take Up and Reuse

Projects that aim to create or revise ontologies face the challenges 2 – 4. An inherent interest of these projects therefore is to work towards the long-term availability of the developed ontology. We see as a core factor for this that care is taken during development to use established ontologies

as much as possible and to build as extensive and active a community as possible. This is the only way to ensure that work on the ontology will continue after the end of a funding phase. In the BMBF-funded project *Cognitive Economy Intelligence Plattform für die Resilienz wirtschaftlicher Ökosysteme* (CoyPu), research is being conducted on realising an AI based platform to support economic resilience. This is based on semantic technologies to allow efficient crisis management. In this project, we are working on a communication framework to find a common language and understanding in the supply chain environment. In particular, the aim is to identify the interrelationships of influential events at an early stage, visualize them in the context of other information, and communicate them in order to define strategies for the further preservation of the supply chain. Agreeing on a common language for information exchange between such supply chains is a complex endeavor, which we address by developing COY ontology [4]. The COY ontology should help us to visualize the relationships between entities and their dependencies on events. For example, we may consider environmental events that affect the transportation infrastructure or political unrest or pandemics that affect the production and delivery of components of a production. For the development of this ontology, we follow best practices, as a first step to work with our use case partners in order to develop competency questions. In a next step, we have evaluated existing ontologies for their applicability to the challenges arising from the competence questions. The goal here is to achieve as much overlap as possible with established ontologies in order to achieve a cross-community understanding (see point 2 of the challenges) of our ontology outside our consortium as well. To address the problem of reuse and alignment with established ontologies, but also to make our COY ontology known and accessible to a wide audience (see point 4 of the challenges), we agreed to use a Terminology Service provided by the NFDI [5] initiative. The Terminology Service (TS) is a web-based platform that supports the adoption and standardization of ontologies by providing data and knowledge management capabilities for accessing, maintaining, and subscribing to domain-specific terminologies. Initially, we plan to use the TS to compile a comprehensive collection of relevant ontologies so that they are available to all partners in one place. This enables especially easy search in those ontologies for resources that we can reuse in the COY ontology. On the other hand, we have also made our COY ontology visible and accessible to other users of the TS. This is already a first step of the integration of the COY ontology into external applications. Various external applications are connected to the TS, which query the managed ontologies and integrate them into external applications using a REST interface. Among other things, this integrates the COY ontology directly into the browser plugin TermClick [6]. This plugin is configured to retrieve concepts from the ontology for a selected text. This can be done by checking whether a term is used correctly in the corresponding domain by definition, or simply to view its definition.

## 5. Conclusions

In this paper, we introduced and discussed two projects in which the creation of ontologies is pursued from different perspectives. From these projects, we have derived some overlapping requirements. These requirements are of a general nature and can therefore be transferred to the work with ontologies in other projects. In general, they concern the interaction between

domain experts and knowledge engineers. Therefore, we need a mean to help these two parties to gain the same understanding about the information encoded in the ontology. In this context, we have presented a solution approach that allows meeting the different needs on a visual basis. To this end, we are working on a web-based solution that allows overcoming an existing communication barrier in a collaborative way and using visual tools. The development of this solution is currently still in demonstration mode. In addition to the challenge of mediating between domain experts and knowledge workers, we also see the major challenge of ontologies being community specific in order to help achieve a common understanding as such. Therefore, in order to achieve the highest possible level of agreement within this community, we think that early and comprehensive alignment and harmonization with established ontologies is a crucial part of development. This is then, of course, conducive to other communities. Because of this basis other communities can likewise achieve an increasing harmonization with the COY ontology. We address the above challenges with the help of the TS. This service enables the unification of the ontology under development by allowing a comparison with established ontologies. In addition, the TS make the ontology amenable to a larger community, as well as for use in third-party applications. This is, among other things also a decisive factor, which it can succeed to keep ontology in active development even beyond a funding period. In this respect, we also see a great potential for the connection of tools like the TS with the SC3 tools and WebProtégé.

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