Winfried Schmitz-Esser  
University of Applied Sciences, Hamburg, GERMANY

How to Cope with Dynamism in Ontologies

Abstract: An ontology for application in non-domain specific, plurilingual, multimedia environments is outlined. A Basic Semantic Reference Structure (BSRS) allows a combination of semantic and instance-related descriptions of knowledge under the conditions of both paradigm and real-world change. Guidelines for the application of the model are given.

Ontologies are conceived as reflections of what humans think is the World and how the World proceeds. Various kinds of ontologies exist. So, when we are going to speak of dynamism in ontologies, we have to make it clear what sort of ontologies we have in mind.

1. Which Type of Ontology?

These ontologies are systems describing the World, or parts of the World, by means of authoritative natural language expressions, and in such a way that the knowledge reflected in such a system can be transferred ad hoc, safely and unequivocally, to an interested human for the sake of filling a practical need. I view ontologies as systems, which require systemic quality for the capacity of exploiting them in queries. The worlds which they reflect are “described”. I avoid saying “defined”, since, although much of what is contained in this ontology will consist of definitions, we have to allow for different views and perceptions.

The ontology requires that a description be prepared in a controlled, structured way to ensure that the entries can be stipulated and interpreted clearly and unambiguously. This is assured by means of a Basic Semantic Reference Structure (BSRS). It is presumed that the descriptions are formalised by means of terms and syntax of a natural language, and that the language encountered in specific domains, in specific fora and institutions is not excluded. What linguists call surface language is assumed to be kept under control by means of linguistic engineering. Logic would call for the description being performed by a sufficiently knowledgeable and independent authority, responsible for the entry, for its completeness and for its current update. However, there might be no one such supreme authority. Our ontology has to face the fact that there might be many, even very many, who are equally competent and who could, should or would claim the right of a say in the description.

Then there is the question of how the knowledge contained in the system can be converted and transferred in a safe and unequivocal way to the interested user. The problem of how an even fuzzily formulated interest can produce delivery of a precise piece of knowledge useful for practical work is part of this question. Truly, the ontology must be capable of filling a practical need. “Practical”, means that the message or knowledge coming out of the system must be a statement of being, of the Greek “όν, óntos”, in that it relates to phenomena that exist, or, in a philosophical sense, are. A mere reference to the source of such knowledge is not sufficient. However, wherever appropriate, source documents (text, pictures, audio, video) and referential information should be given to the information seeker along with the ontological knowledge.

2. The Challenge of Change

Having exposed the model of ontologies I have in mind, my question is: “How in such a systemised description of the world, can we cope with the fact that while describing, the world described undergoes constant, rapid change?” Linguists, in this context, might be surprised when I state: “As seen from a diachronic point of view, natural language as a means
of description proves to be by far the most stable element in the process.” Any new phenomenon can be expressed and explained by means of natural language terms that then denominate the universal. Universals are concepts or themes or topics that are common knowledge in civilized communities. All modern languages allow for a new, unknown concept to be addressed by a clear and unequivocal expression based on existing universals. This makes it possible to set up multilingual ontologies. Universals are found to relate to each other in certain ways (Fig. 1). A “welding torch “ is instrumental for “autogenous welding”, “deep rooted trees” favour the “conservation of soil humidity”, a “cat” is, or may be, a “pet”. The stipulation of such relations between universals is part of the ontological description. They prove highly stable in the course of time.

<table>
<thead>
<tr>
<th>Type of relationship</th>
<th>Up</th>
<th>Down</th>
</tr>
</thead>
<tbody>
<tr>
<td>abstract/generic</td>
<td>St. John’s trees</td>
<td>Deep-rooted trees</td>
</tr>
<tr>
<td></td>
<td>General</td>
<td>specific</td>
</tr>
<tr>
<td></td>
<td>deep-rooted trees</td>
<td>St. John’s trees</td>
</tr>
<tr>
<td>Instrumental</td>
<td>welding torch</td>
<td>Autogenous welding</td>
</tr>
<tr>
<td></td>
<td>instrumental for autogenous welding</td>
<td>by instrument of welding torch</td>
</tr>
<tr>
<td>Beneficial</td>
<td>deep-rooted trees</td>
<td>conservation of soil humidity</td>
</tr>
<tr>
<td></td>
<td>favour</td>
<td>profits from</td>
</tr>
<tr>
<td></td>
<td>conservation of soil humidity</td>
<td>deep-rooted trees</td>
</tr>
<tr>
<td>Derivative</td>
<td>carob beans</td>
<td>St. John’s trees</td>
</tr>
<tr>
<td></td>
<td>come/may come from</td>
<td>deliver/may deliver</td>
</tr>
<tr>
<td></td>
<td>St. John’s trees</td>
<td>carob beans</td>
</tr>
<tr>
<td>Derivative</td>
<td>coffee substitutes</td>
<td>carob beans</td>
</tr>
<tr>
<td></td>
<td>come/may come from</td>
<td>deliver/may deliver</td>
</tr>
<tr>
<td></td>
<td>carob beans</td>
<td>coffee substitutes</td>
</tr>
</tbody>
</table>

**Figure 1 - Relations between universals (examples)**

The contrary of this, high volatility, is found with instances, i.e. phenomena unique in space and time; in short, all that has a name. These might be individuals, corporations, products, services, brands, events, etc. The ontology explains them as instances of their respective universals, following a principle, not different from the introduction of a friend to a party: “This is Mike Osborne, general manager of Asia Trading Co.”, whereby “general manager” is the universal. Other links to the instance are determined by an entry related to time and an entry related to space (Fig.2). The problem here lies not so much in the fact that a statement stipulated at a point in time \( t \) must be eliminated at a later date \( t+ \) for reasons of obsolescence. It lies in the fact that as time goes on, instances, once entered and defined in the system require steady update in order to remain valid for current use. People move, change names, retire, die. As a result, information required for the update of the entry may not be available or be very difficult to gather. Finns, once in the spotlight as potential shooting stars, might decease in silence, products may be withdrawn from the market without comment, a tour stopped, an event forgotten. An entry relating to an instance may well become a burden for the one charged with safeguarding the validity of the system – provided there is one – but this point I will touch on later in my paper.
3. New Knowledge and How It Becomes Universally Accepted

The most important point is: “How can new knowledge which one day may lead to new and unprecedented universals be detected, addressed and integrated in the ontology?”

The detection is the job of a group of peers, and in principle differs little from an established procedure in the production of scientific journals. But how can the new phenomenon be described in terms of the ontology, given the fact that (1) it is not the author or explorer who describes, and that (2) a public discussion on that new addition is still due to happen? The object in focus is still an embryo and still being fresh, its denomination is not yet part of the paradigm in society. So, the one who describes the phenomenon finds himself in a dilemma.

Take the example of an innovation like the recordable optical disc! When the technology came up, authors used various terms, the most common of which was DRAW, standing for “direct read after write”, but it could be found also as “read/write” capability. Then, this feature on a disk was addressed as DOR, for “digital optical recording”. This didn’t last long and new expressions appeared, such as WORM, which stands for “write once read many (times)”. With CDs and early standardization, the description was reduced to an –R, as in CD-R, meaning “recordable”, while the 5 1/4-inch version remained as WORM. As the technology advanced and digital optical recording became a quite normal thing, a multitude of other names indicated new, more specialized characteristics of higher interest. While the technology is still there, its denomination finally has vanished completely.

The process seems typical. Universal formulas like “genetic fingerprint”, “peace process”, or “millennium bug” are the outcome of a complex, multi-layered process of social awareness and recognition. Peers must describe the new phenomenon and from then on must monitor the public dialogue around it, and possibly adjust the expression favoured by themselves, in a controlled way. Different stages of the concept evolution must find their reflection in the ontology, and the ontology must be hospitable enough to allow such consequential reflections. Patents, trademarks, standards, all play a special role in the denominative process, each at a typical stage. To keep track of the process, observation of the terms used in the media is of prime importance.
4. Essential Elements

These are some essentials for a dynamic ontology, in particular for the model I have in mind.

1. The model must provide the articulative instruments to allow for the precise description of the consequent stages in the process. The BSRS of (Fig. 2) ensures this.

2. Control of the surface of an individual natural language by means of linguistic engineering. Mere vocabulary control as in traditional thesauri does not suffice (Fig. 3).

3. Control of concept relationships and concept networking according to a set of different, well-defined relationships. They embody the articulative power of the ontology (Fig. 4).

4. A number of small teams of peers, empowered by technical apparatus, are provided for the performance of the following functions (Fig. 5).

4.1 Detection and evaluation of new elements of knowledge, description in a natural language and formalization as BSRS statements.

4.2 Monitoring the course of the innovation both in the real world and in common perception. The result must be woven into the semantic net. In parallel, the respective BSRS statements (descriptions) are formulated.

4.3 Safeguarding continuity and consistency in the monitoring process, and in the descriptions. This seems still more important than completeness, since it is assumed that the user might tolerate more readily a missing object rather one that lacks updating or reveals a break in consistency.

4.4 Full integration of the instances observed in the real process, and in the stipulation of existing links to the universals, in line with the format of the BSRS.

4.5 Ergonomic input interfacing for the describing peers, with all linguistic and semantic aids at hand.

4.6 Language-engineered interfacing for the ontology users.

4.7 Full range of authoritative and other sources as needed for peer revision, but also for document and index delivery, and links to third party classification and cataloguing of multi-media sources.
5. Organization and Responsibility

The intellectual work involved in the construction and maintenance of such an ontology calls for a strong institution. Its cost alone will restrict first applications to very special, high value-added purposes. The scope and choice of topics described in the ontology will then largely depend on the mission of the institution. Large-scale applications for a broad public are conceivable as co-ordinated ventures to which various ontology providers contribute. A common understanding of the BSRS, some basic linguistic procedures and the semantic relationships applied would then be a prerequisite for distributed cooperation (Schmitz-Esser, 1999).

Is the institution then responsible for the content? What does “responsible” mean here? Does it guarantee that the entry is “true”? If so, is this “trueness” in the sense of an intelligent, knowledgeable human’s world perception (which would be very much), or trueness in the sense that the user will be referred to the right instrument for the right purpose (e.g. medicament X to fight disease Y), or trueness in an ontological, philosophical sense? The answer can only be: not in the philosophical sense.

This ontology aims at practical use. The results extracted from the entries must be fresh, reliable, consistent and exhaustive. Authors and sources are offered, together with the content of the BSRS statements, the media themselves, plus overviews and indexes to sources and links to third systems (e.g. library classifications). To make an understandable product for the knowledge seeker, the statements have to be transposed/translated for delivery in plain language. The system must be hospitable enough so as to house differing statements on single subjects, even contradictory ones, the prime condition being that the user has unhampered access to the source of the statement (i.e. names of the authors, their background etc.).

6. Responsibility for Entries as Universals

The peers performing their entries in the BSRS are then in charge of, and responsible for:
1. The choice, evaluation and correct description of the knowledge objects in the BSRS;
2. Current monitoring of the development of the knowledge objects, in relation to other objects, and current updating of the ensuing entries;
3. Monitoring of the paradigm in the society relating to the knowledge object, introducing the new vocabulary insofar as this refers to universals, and stipulating the semantic relationships discerned vis-à-vis the other universals contained in the ontology;

4. Observation of the paradigm in these other languages plus translation is required, if the ontology has input/output functionality in more than one language.

So, the value of the entry as a universal will be determined by the degree of validity in practical use. As correctness in the strict ontological sense is not claimed, the question of false or true in this section need not be posed, being reduced to correctness of form and mention of authors and sources. However, the choice of terms and statements – a fruit of alertness, evaluation, and steady, consistent observation – indicates a highly sensitive area, and a corresponding responsibility. But this is not much different from other journalistic work. So, it is the renown and the authority of the peers that are at stake.

![Figure 5. - The Dynamism](image)

7. Responsibility for Entries as Instances

Since the model is to serve a distinct purpose in work, learning or leisure, it can be assumed that individuals, producers, politicians, etc. have an interest in showing up in the ontology. One could have them pay for the entry. This entry is their liability. The respective entries would have to be prolonged and updated by the interested party from time to time, in defined intervals. The wealth of semantic and linguistic knowledge, however, including the link ware devices necessary for the link with the universals available in the semantic network, would stream from the work of the peers. The peers would also take charge of new additions suggested by the subscribers. The ontology would thus constantly be further enriched.

Since the linguistics relating to the denomination of the universals are supposed to be under control, the entry of statements equal in meaning would be avoided – a tremendous advantage over most other collections of knowledge with all their tiring redundancy. Probably, the part with the instances in the ontology would soon become the larger and more frequently consulted part of the ontology, with its inherent frequent change and high volatility. Concept control, the more stable part, would be maintained by the peer groups, whereby the linguistic engineering tools would safeguard formal conformity with the requirements of the BSRS, i.e. clear and unambiguous reading of the entries.
8. Definition of Position

Three factors, according to Wijnhoven F. et. al (Wijnhoven, 1996), are decisive for the quality of an ontology: complexity, dynamics and social dispersion. Where in this triangle is my ontology located?

Social dispersion: In that ontology which basically reflects the World of general interest communication, social dispersion would be extremely high, and with it corresponding uncertainties. Since under the conditions of linguistic and semantic formal correctness, differing views are accepted and disclosed to the information seeker, uncertainty can be reduced to a minimum.

Complexity: With well-defined types of semantic relationships, with a fine apparatus of linguistic engineering working on four World languages, plus a BSRS of the proposed type, the defined, articulative power of the model is high. As to how far the corresponding degree of complexity envisaged will be up to the demand in terms of practical validity for the purpose, this has still to be proven.

Dynamics: To keep up with a high degree of dynamics, two motors will drive the ontology: (1) The peers with their knowledge, ambition and prestige. They safeguard diachronic stability of the dialogue in a world of changing paradigms; and (2) The interested parties. Their entries tell us who acts and what the aim or outcome of their actions is. It is their self-interest which ensures that their data are always valid and fresh.

9. Conclusion

Ontologies as systemized descriptions of what “is” can keep up with real change and dynamism. Provision, of course, must be taken for:
- Individual language surface control by efficient linguistic engineering;
- Semantic control of universals including rich, defined, multi-dimensional interlinking between the concepts;
- Reference to a basic semantic structure (BSRS) which ensures unequivocal, time-related entry and interpretation of the entry, and good hospitality as to potential combinations of word meanings.

The model is open to any meaningful interpretation of the world, tolerates differences of view, and even contradictions. What it reveals about actors and their doings is a reflection of their particular, divergent interests. So, also in that respect it takes on a democratic allure. Nevertheless, the public status of the different realisations in society will still have to be discussed. Suffice it to say that no all-embracing, self-imposing super brain is on the horizon. The model described follows the course of the times and should well cope with dynamism. One thing, admittedly, seems sure: The model will be rather expensive.

References: