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Levels of Reality, Seminar, Bolzano (Bozen) Italy, 26-28 September 2007

Ontologies, the knowledge organization systems now widely used in knowledge management applications, take their name from a branch of philosophy. Philosophical ontology deals with the kinds and the properties of what exists, and with how they can be described by categories like entity, attribute, or process. Readers familiar with facet analysis will notice some analogy with the "fundamental categories" of faceted classifications, and this resemblance is not accidental. Indeed, knowledge organization systems use conceptual structures that can be variously reconnected with the categories of ontology. Though having more practical purposes, the ontologies and classifications of information science can benefit of those of philosophy (see Poli 2002).

A running series of seminars in ontology is organized by the Mitteleuropa Foundation, a little but lively institution based in Bolzano, near the Austrian border of Italy. As its name expresses, the foundation especially draws from the central-European philosophical tradition across 19th and 20th century, particularly by Franz Brentano and his followers: a relevant corpus of sources, not known as it deserves outside German-speaking countries. The latest seminar was held in September in the Foundation seat, an old palace which hosted the Tyrol Diet in the past: indeed, an Hapsburg eagle painted on the wooden ceiling suspended over the 35 participants, coming from a wide variety of research centres and disciplines.

The seminar theme was introduced by its organizer and moderator, Roberto Poli (University of Trento, Italy), also an ISKO member. He began by emphasizing how ontology should avoid the trap of reductionism: along with the famous epistemological principle known as Occam's razor, recommending that *entia non sunt multiplicanda sine necessitate* i.e. that one should not introduce any artificious notion not required by experience, Poli also recommends that *entia non sunt diminuenda sine necessitate*: the razor must not be used in ways forcing the richness and complexity of reality, which maybe is why Poli's beard seemed so Germanically flourishing! In other words, ontology must model carefully all the structured articulations of reality as we observe them, rather than oversimplify them according to a pretended single "really real" principle, such as "everything existing can be reduced to physical entities."

A strong reason for this is the observation that reality is structured into levels, each showing its own emergent properties and its categories, which cannot be entirely reduced to those of the lower levels. Active behaviour is a property of living beings, and is not satisfyingly described just as a summation of physical movements. The ontological inventory must include everything that has some effect; and sometimes higher levels (say political decisions) have important effects on lower ones (say greenhouse gas concentration). Levels obey laws of stratification, of dependence, and of coherence between their categories.

The main levels usually recognized (*strata* or *realms* in the terminology of Nicolai Hartmann) are the material, the organic, the mental, and the social. By the way, such subdivisions have also inspired many authors of bibliographic classification schemes, like Brown, Richardson, Bliss, Foskett, and Dahlberg; ISKO Italy's Integrative Level Classification project has recently resumed work in this direction, and two more ISKO members, Enzo Cesanelli and the present author, attended the seminar.

Each of the mentioned strata can be further subdvided into layers, e.g. the material stratum into the physical, the chemical, the geological layers. The internal structure of higher strata is more complex and less analyzed yet: in Bolzano the task was addressed by Liliana Albertazzi (University of Trento, Italy) for the psychical stratum, and by Mark Bickhard (Lehigh University, USA) for the social stratum.

A major task for the future is how to relate levels with the notions of wholes and their parts (another category often used by knowledge organization systems). Levels are within individuals, but not as their parts. Each of us is at the same time material, or-

ganic, mental, and social, but we cannot separate each of these levels in the same way that head or liver.

The plurality of levels implies a variety of frameworks of analysis, and a rich series of categories; the ontology of categories was especially discussed by Jorge Gracia (State University of New York at Buffalo, USA). These are characteristics of "the new ontology", which also features a peer-to-peer interplay with the sciences (as opposed to imposing abstract principles on them from above), and an attention to the dynamic aspects of reality grater than it was the case with Aristotelean-medieval ontology. Johanna Seibt (University of Aarhus, Denmark) even makes dynamics the key element of her *processual ontology*: the classical notion of *substance*, postulating that a given part of reality is substantial while the others are accidental, has brought to inappropriately static ontological models. Seibt suggests reversing the perspective, taking processes as the basic feature of reality, that we can typically observe in phenomena like snowing or flowing. Other participants are perplexed: "what is, then, a table?" asks Matthew West (Shell); Seibt readily answers that "it is like snowing, but slower!" Instead of saying that "a white cat faces a dog and bristles," we could say that "it's catting whitely, bristlingly, and dogwardly." In this perspective, levels are types of dynamic organizations, defined in terms of characteristic internal and external interactions. So, to analyze a system, we should first ask ourselves "what is happening?"

Another conceptual tool for explaining the emergence of levels and the relations between them is that of networks. Reduction, argued Roy Clouser (College of New Jersey, USA), is a bad explanatory strategy because everything has links with other aspects of the world. The only unconditioned reality is the divine, on which everything depends: this leads to reconsider even religion in ontology. John Symons (University of Texas at El Paso, USA) showed simulation models used to analyze complex networks of agents, like cicadas recognizing the call of their species mates, people walking through a Chinese city and converging towards certain stores under influence of phone calls, or adherents to the US Republican and the Democratic parties developing relations between them (DubiousNet). Network effects are also relevant in home or working environments enriched by ubiquitous computing technologies, like those shown by Achilles Kameas (Hellenic Open University, Greece). Jerzy Perzanowksi (Jagiellonian University, Poland) suggests a relational approach to ontology, in terms of configurations, networks, and structures. This makes use of the procedures of analysis and synthesis, and of their basic operations, like "to be simpler than" and "to be a component of"; the emergence of a new level would be related to Cantor's mathematical transgression from finite to infinite. Mathematics is also considered by Costas Drossos (University of Patras, Greece), who points out the influence of different cognitive functions of the left and the right hemispheres in the brain, and by Michael Healy (University of New Mexico, USA) working with category theory as a mathematical language for ontology.

Ontology can be subdivided into three subbranches: descriptive ontology, devoted to collecting the data which comes from reality; formal ontology, devoted to filtering, codifying, and organizing those data according to categories; and formalized ontology, translating these organizations in terms of formal logic, with axioms and deductions. The last approach is widely used in the application of ontologies to computer science, leading to build knowledge bases that can be used in artificial intelligence. One general formalized ontology is developed in the DOLCE project, leaded by Nicola Guarino (National Research Council, Italy), editor-in-chief of the journal *Applied Ontology*, who also attended the seminar.

However, John Sowa (Vivomind, USA) argued in his speech that the formalized approach, already undertaken by the pioneering project Cyc now having run for 23 years, is not the best way to analyze complex systems. People don't really use axioms in their cognitive processes (even mathematicians first get an idea intuitively, then work on axioms and proofs only at the moment of writing papers). To map between different ontologies, the Vivomind Analogy Engine throws axioms out, and searches instead for *analogies* in their structures. Analogy is a pragmatic human faculty using a combination of the three logical procedures of deduction, induction, and abduction. Guarino comments that people can communicate without need of axioms as they share a common context, but in order to teach computers how to operate, the requirements are different: he would not trust an airport control system working by analogy.

Information applications are also addressed by Heinrich Herre (University of Leipzig, Germany) with his group working on GFO: General Formal Ontology, a development of the medicine ontology *OntoMed*. Modeling of biomedical domains employs the notion of levels of reality, and requires three

kinds of categories: for the principal object of a domain, for its taxonomies, and for its aspects or facets. Again, this shows resemblances with bibliographic classification. It is another signal that philosophical ontology should be taken into account in knowledge organization, and that much remains to be done for a fruitful integration of its experience with those of other fields like computer science, information architecture, psychology, linguistics, library and information science.

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