Semantic Systems supporting cross-disciplinary environmental communication

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1. Introducing the notion of Semantic Systems

We introduce the concept of a semantic system as a type of social system that is based on the collective construction of sense and meaning in society. Niklas Luhmann has developed a theory of social systems (Luhmann 1984 et passim) with the concept of “Sinn” (sense and meaning) as the axiomatic concept of this theory. Another axiomatic concept is that of communication. Sense and meaning have to be communicated by those who create and change social systems. Due to the fundamental role of semantic processes in any social system, we can infer according to Luhmann that social systems are always semantic systems. In communication as a social system, social expectations regulate human action and the interaction among individuals. Structure and event are the static and dynamic elements of such systems. The reduction of complexity is the driving force of the constant change of social systems.

During communicative and cognitive processes, sense and meaning are constantly being organized by communication partners. At the personal level, cognition inevitably links new meaning to what is already known. Social cognition takes place at the collective, inter-personal level and links personal knowledge to each other.

Willke’s theory of social systems (Willke 1987) was the basis for a theory of systemic knowledge management (Willke 1998). The systemic nature of knowledge is consistent with the notion of semantic systems. Human knowledge has both a personal, subjective dimension and an inter-personal, collective dimension. These two dimensions constantly interact during the processes of knowledge organization: semantic systems as defined above organize knowledge in two ways: (1) they represent the results of knowledge organization processes as a static embodiment of the structure of knowledge; (2) they represent the events of creating new knowledge structures or changing existing structures thus creating new knowledge and changing old knowledge.

For thousands of years, human professional activities have produced elaborated knowledge organization systems such as classification systems, taxonomies, nomenclatures, thesauri, and other types of semantic systems. A change in scientific theories has usually been (or accompanied by) a change in the classification of objects of investigation, creating a new taxonomy, introducing new concepts and eliminating concepts that have turned out to be false, or modifying concepts that are part of a theory. Such “conceptual revolutions” (Thagard 1992) have been the driving force of scientific progress. Knowledge organization systems as specific types of semantic systems show a number of features, such as (1) their hierarchical structure with logical relations among the concepts that constitute such a system and with ontological relations among the objects described by the social conceptualizations, (2) their social nature as the results of the constant work of communities of practice that work towards a specific goal and choose appropriate cognitive and communicative means, (3) their varying size and complexity (ranging from small and simple classification systems to large and complex taxonomies with hundreds of thousands of concepts that are related to each other in multidimensional ways), (4) and their multiple functions in scientific work, in building and operating scientific information systems, and in professional communication.

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The linguistic dimension of semantic systems can also be described from a systemic perspective: linguistic theory is essentially systemic in nature by focusing on language as a complex system of signs, their meanings, the processes of creating texts, and all syntactic, semantic, and pragmatic processes of social discourse.

We can summarize by pointing out that the notion of a semantic system is based on a multidisciplinary convergence of theories and approaches from systems theory and cybernetics, sociology, linguistics, philosophy of science, and epistemology. A broad typology of semantic systems has been developed (Budin 2006) for the purpose of describing the processes of scientific information and communication processes.

2. Environmental communication: risk communication as an example

With the term “environmental communication” we refer to the different forms of discursive processes in professional activities in the field of environment, covering not only a range of scientific disciplines such as ecology, biology, agroforestry, chemistry, urban studies, social geography, etc. and fields of practical work such as environmental protection, environmental technologies, environmental accounting, environmental monitoring, and many others. Communication is a constant and inevitable process in all these activities of practical work, research, planning and decision making, assessment and forecasting, public and political debate, enabling the members of these communities of practice to exchange views, share knowledge, create new knowledge and new perspectives, discard old opinions, often referring to specific knowledge organization systems.

Terminologies are structured collections of concepts as units of knowledge and terms as their communicative representations in a specific subject field in a particular language (Budin 1996). This definition is also systemic in nature: terminologies are the basic building blocks of any type of semantic system. Each of these disciplines and fields of work listed above have developed their own highly specific terminologies. Lexicographical activities have led to a number of mono- or multilingual environmental dictionaries that are designed as reference works for various audiences. A number of environmentally related knowledge organization systems have been developed over the last few decades at national, European, and international levels. GEMET (the General European Multilingual Environmental Thesaurus) has become, among many others, a famous example of such an environmental knowledge organization system. GEMET is also an example of gradual semantic integration, across cultural and linguistic borders, as well as across disciplinary boundaries, of environmental knowledge.

Environmental communication also refers to the computational support by technical systems enabling individuals and groups to communicate in web-based work environments, and using environmental information systems. Environmental informatics has become a well-established and robust basis for environmental communication and computer-assisted knowledge integration (see Pillmann 2005 for systemic view on knowledge integration, and Pillmann 2000 and Pillmann/Geiger/Isenmann 2006 for comprehensive presentations of initiatives and approaches including their historical development).

In the context of this paper risk communication taking place in the context of activities related to the environment is used as an example of cross-disciplinary environmental communication. Thus the very complex concept of risk is limited to all risks perceived in relation to environmental hazards, covering natural hazards and hazards emerging from human intervention in the environment, which means that financial risks in the insurance business, for example, are excluded in this perspective, while all those health-related risks that are linked to environmental aspects are included.

Based on generic communication models, a range of specific models of risk communication have emerged. In a comprehensive study on risk management terminology used in health-related disciplines, Lewalle identified the following definition of risk communication as an empirical result of a WHO study-comparing many individual definitions given by about 50 health-risk experts as follows: “risk communication = interactive exchange of information about risks among risk assessors, managers, news media, inter-
ested groups and the general public” (Lewalle 2003). This definition relates risk communication to the exchange of information and to the public sphere, where different interest groups discuss risks as they perceive them in concrete social contexts. Similar definitions establish close relations between risk communication and risk awareness and knowledge transfer about environmental risks. In most studies on risk management and on the terminology of this subject field, risk communication is usually conceptualized as a type of risk management. Risk communication can also be seen as a horizontal meta-activity that accompanies all risk management processes.

Wallingford describes the specific problem of risk terminology in a very clear way: “Today, the term risk has a range of meanings and multiple dimensions relating to safety, economic, environmental and social issues. These different meanings often reflect the needs of particular decision-makers and as a result there is no unique specific definition for risk and any attempt to develop one would inevitably satisfy only a proportion of risk managers. Indeed this very adaptability of the concept of risk is one of its strengths. A difficulty with the terminology of risk is that it has been developed across a wide range of disciplines and activities, there is therefore potential for misunderstanding in technical terminology associated with risk assessment, since technical distinctions are made between words which in common usage are normally treated as synonyms. Most important is the distinction that is drawn between the words hazard and risk To understand the linkage between hazard and risk it is useful to consider the commonly adopted Source-Pathway-Receptor-Consequence (S-P-R-C) model. […] This is, essentially, a simple conceptual model for representing systems and processes that lead to a particular consequence. For a risk to arise there must be a hazard that consists of a 'source' or initiator event (i.e. high rainfall); a 'receptor' (e.g. flood plain properties); and a pathway between the source and the receptor (i.e. flood routes including defences, overland flow or landslide).” (Wallingford 2005).

3. Building semantic systems for the support of global risk communication

This chapter gives a very brief account of a multi-annual initiative that started in 2002 at the Council of Europe with a multi-disciplinary and multi-lingual debate on risk management in Europe. Since then a series of meetings were held that helped clarify the diversity of risk concepts that have developed in different disciplines (such as medicine and health, urban planning, chemical safety, nuclear safety, biology, etc.). In 2004 a major project started with funding by the European Commission called WIN (Wide Area Network for Risk Management in Europe), with a work package specifically dedicated to the support of global risk communication. The title of this work package “Human Language Interoperability” (HLI) refers to a crucial aspect of global information and communication systems: the need for global semantic interoperability among distributed local or regional information structures. The term “global” deserves particular attention in this context: Global risk communication means not only to overcome language and culture barriers, but also disciplinary boundaries, as well as local specificities within the same discipline that are independent of language- and culture-specific differences. The “language of risk” is also a very interesting object of investigation: “Risk language fluctuates between the most abstract and the most concrete nouns as mono-lexemes (= one word terms): assessment, awareness vs. fire, water and collocations as poly-lexemes (= nominal and verbal multi-word terms): public risk awareness, to enhance, improve, increase risk awareness. Collocations are fixed by user preferences, because, linguistically speaking, they organize knowledge by linking new to existent information, and by creating frames and scenarios among the instances involved” (Greciano/Budin 2007).

The communication support strategy of the HLI work package in the WIN project consists of the following components:

1. A tri-lingual (English, French, and German) terminological glossary on the core terminology of risk management modeled and represented as a terminology database that is also accessible on the web by a global audience. This database not only includes multiple and sometimes conflicting defini-
tions of the terms selected in 3 languages but also meta-communicative annotations with a conceptual analysis of the differences among these definitions, within a language and across the languages.

2. A lexicographical collection of terms and expressions in a glossary format

3. A comprehensive digital text corpus in English, German, and French as the basis for a linguistic analysis of the language of risk management including term frequency, co-occurrence, phraseology, and semantic differences.

4. A conceptual model of the core risk terminology as the basis for creating a digital formal ontology, i.e. a computational model of semantic relations among clearly defined risk-related terms, including a frame-based semantic model of the language of risk.

These semantic systems developed in this project represent communication tools are specifically geared towards the needs of the many risk experts working in the WIN project on satellite-based risk modelling and semantic data integration, but also beyond the scope of the project oriented towards the communication needs of a global audience of experts trying to optimize their professional communication processes on risk issues.

4. Conclusions

In summing up I would like to point out that semantic systems can indeed be designed for linguistic and conceptual support in risk communication in particular and in environmental communication in general. Current work on digital semantic systems focuses on transforming a variety of knowledge organization systems into formal ontologies that in turn become the organizational basis for semantic web services that are designed to extend and partly automate semantic support for users, in our case a broad and diverse public that is interested in environmental discourse.

Bibliography


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