

A Cognitive Linguistics View of Terminology and Specialized Language

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1 Introduction

Pamela Faber

This book explores the importance of Cognitive Linguistics for Terminology and specialized language¹ in general. Cognitive Linguistics is understood here in its broadest sense, and includes not only work on metaphor and grammar, but also other cognitive-oriented theories such as Construction Grammar (Goldberg 1995, 2005), Cognitive Semantics (Talmy 2000), Conceptual Semantics (Jackendoff 1983, 1990, 1997), and Frame Semantics (Fillmore 1968, 1975, 1976ab, 1982, 1985).

Cognitive Linguistics is an attractive linguistic paradigm for the analysis of specialized language and the terminological units that characterize it. The emphasis placed by Cognitive Linguistics on conceptual description and structure, category organization, and metaphor coincides to a certain extent with crucial areas of focus in Terminology, such as scientific ontologies, the conceptual reference of terminological units, the structure of scientific and technical domains, and specialized knowledge representation.

However, until now, Terminology has been generally reticent about using linguistic models to analyze the semantics of terminological units, and the structure of specialized language texts². Existing studies and manuals in terminology tend to restrict themselves to a description of practical matters regarding database organization, information extraction, term entry design, language planning, etc. In the same line, research on specialized language texts generally limits itself to highlighting salient aspects of scientific discourse, such as the use of the passive voice and the concentration of semantic information in complex nominal forms. Nevertheless, such observations, though useful, are merely anecdotic if they are not placed within the richer context of a wider theoretical framework.

In a parallel way, specialized language is an interesting area of application for Cognitive Linguistics. One might ask what is so special about specialized language, why it is different from general language, and why it is worth studying in itself. Although specialized language is undoubtedly language, and thus possesses many of the same features as general language, it also can be said to have distinctive characteristics

¹ We prefer the term *specialized language* to *language for specific purposes* (LSP), which is much more general.

² An important exception in this respect is Temmerman (2000).

because of the semantic load of terminological units, which designate entities and processes within a scientific or technical field. When used in specialized discourse, these units activate sectors of the specialized domain in question, highlighting configurations of concepts within the specialized field.

Despite the fact that since Aristotle, figurative language seems to have been officially banished from the realm of scientific communication, metaphor is also present in specialized language as well as specialized language discourse. This is only natural since metaphor is an integral component of our cognition which shapes our understanding of the world. However, metaphor in specialized language has not received the same amount of attention as metaphor in general language. This is true within the context of Cognitive Linguistics and of linguistic theory in general.

In fact, one still encounters authors who affirm that figures of speech are out of place in scientific texts and that science prefers the literal to the non-literal term when this is simply not the case. As Kuhn (1993) points out, metaphors are not marginal, but instead are a crucial part of the way in which a scientific field reproduces itself. For example, metaphors are commonly used to introduce vocabulary and basic models into scientific fields: "their function is a sort of *catathresis* -- that is, they are used to introduce theoretical terminology where none previously existed" (Boyd 1993). Nevertheless, the role of metaphor in science goes beyond this as can be seen when scientific terminology is analyzed at various levels, namely, those found at the level of the: (1) specialized knowledge domain; (2) specialized language unit; (3) proposition; and (4) text (Faber and Márquez Linares 2004).

Within a much wider context, it is also true that metaphor is necessary for building models and elaborating scientific theory. Halloran and Bradford (1984: 183) affirm:

No synthesis could ever be achieved, no models postulated, no paradigms established if science relied wholly upon "careful observation" for its theories. Model-building requires an inductive leap; carefully recorded examples must be synthesized into a logical premise, and then be further verified and expanded by traditional scientific method. For this, science must exploit the power of metaphor.

Evidently, metaphor is a dynamic mechanism, essential for the elaboration and evolution of a scientific theory and not only used as an explanatory device. In this sense it can be regarded as more of a building block than a scaffold. However, an in-depth inquiry into the role of metaphor in the construction of scientific theories goes far beyond the scope of this book, which focuses on the semantics and pragmatics of scientific terminology and specialized language texts. All of our observations and assertions are illustrated and supported by examples drawn primarily from the fields of

medicine and environmental science. Even though the importance of metaphor for theory-building will be acknowledged, it will not be a principal area of focus.

The importance of Cognitive Linguistics as a methodological framework for the study of Terminology and specialized language is highlighted in this book. In this respect, we believe that scientific language is not merely a register, but important as an object of study in itself. As such, it is of interest for Cognitive Linguistics.

Specialized language texts have unique characteristics. Because their general function is usually the transmission of knowledge, they are characterized by a greater repetition than usual of terms, phrases, sentences, and even full paragraphs. This can also mean that the text shows similarities in the syntactic constructions used. Such texts are also terminology-rich because of the quantity of specialized language units in them.

Specialized language units are generally represented by compound nominal forms. They are used within a scientific or technical field, and have meanings specific of this field. The heavy concentration of such units in these texts points to the specific activation of sectors of domain-specific knowledge. As a result, understanding a terminology-rich text requires knowledge of the domain, the concepts within it, the propositional relations within the text, as well as the conceptual relations between concepts within the domain. This is a key factor in the translation of scientific and technical texts by a translator, who is obliged to quickly attain the knowledge threshold necessary to understand the entities and processes described in the source text. The need for rapid knowledge acquisition is one of the reasons that specialized domains and their structure are an important area of focus in Terminology in the form of scientific ontologies.

This book is of interest to scientists, linguists, terminologists, technical writers, translators, as well as university students who are working in and/or studying aspects of applied linguistics, terminology management, scientific and technical translation, specialized knowledge representation, or cognitive linguistics. Evidently, an important part of learning how to understand, write, analyze, and/or translate specialized texts is the acquisition of skills and strategies to deal with the terminology that encodes expert knowledge in the specialized domain. Not only is it a question of usefully understanding specialized knowledge units and being able to link them to other concepts in the same or different language, but also of storing the knowledge acquired in a useful way so that it can be activated in other contexts. This book is also of interest to teachers who must teach applied linguistics, scientific writing, terminology and translation subjects from a cognitive perspective, and who until now have been obliged to largely rely on their own

resources because there are currently few if any such books that specifically focus on specialized language.

The methodology used for the study and analysis presented in this volume is in consonance with the Communicative Theory of Terminology (Cabr  1999a) and the Sociocognitive approach to Terminology (Temmerman 2000). Our process-oriented approach is known as Frame-based Terminology (Faber, M rquez Linares, and Vega Exposito 2005; Faber et al. 2006; Faber, Le n Arauz, Prieto Velasco and Reimerink 2007). It is based on Mart n Mingorance's Lexical Grammar³ (Mart n Mingorance 1984, 1989, 1995; Faber and Mairal Us n 1999) and Frame Semantics (Fillmore 1982; Fillmore and Atkins 1998), which is applied to specialized language with a view to specifying knowledge structures.

For the codification of specialized knowledge and the analysis of corpus data, the Lexical Grammar Model (LGM) is used. This model facilitates the representation of conceptual and collocational relations. The lexical organization which the LGM proposes for the lexicon is based partially on the distinction between syntagmatic and paradigmatic relations, and the complementary principles of combination and selection (Saussure [1916] 1990; Lyons 1977: 241). This distinction is relevant because it underlies conceptual organization, independently of the linguistic system (Nelson 1985: 179).

The paradigmatic axis of the LGM codifies the configuration of concepts in the selection axis, conceptually organizing the lexicon in a hierarchy of domains and subdomains. In a parallel way, it is a determining factor in the syntagmatic axis, which codifies a term's combinatorial potential. The convergence of these two axes is the basis of conceptual structure for general as well as specialized language.

The relational approach proposed in this book focuses on meaning, and more concretely, on conceptual domains. It is based on the premise that there are a series of properties shared by all of the member concepts within a domain, and other properties that differentiate them. Semantic memory is represented as a complex network in which each node is a concept, and in which the concepts are interconnected by a wide range of different types of relations within a frame-like structure.

In regards to the Frame Semantics, it is the latest development of Case Grammar (Fillmore 1968, 1975, 1976ab, 1977, 1982). The FrameNet project (Fillmore and Atkins 1998; Fillmore et al. 2003; Atkins, Rundell and Hiroaki 2003) is based on this theory. Its objective is the description of lexical meaning by extracting contextual information from a large corpus of texts, and structuring this meaning in cognitive frames.

³ This model was previously known as the Functional-Lexematic Model (FLM).

Although since the publication of Collins *Cobuild*, there have been many corpus studies, the originality of FrameNet stems from the fact that a frame includes all the possible constellations of frame elements. This complements the traditional morphosyntactic information in each entry. Furthermore, each meaning is linked to a set of contextual information extracted from a corpus. The basic concept underlying this linguistic approach is that of the frame, which can be defined as a general or specific structure with entities that participate in these structures. Up until now, frames have only been applied to general language and not to specialized language.

Our approach also adheres to the communicative situational perspective, where words as well as terms can only be understood within the contexts in which they appear (Fillmore et al. 2003; García de Quesada 2001; Montero Martínez and García de Quesada 2004; Seibel 2004a; Reimerink et al. 2010). Like FrameNet we also use corpus analysis (Fillmore 1994; Ruppenhofer et al. 2006; Pérez Hernández 2002; Faber et al. 2006; Tercedor Sánchez and López Rodríguez 2008). Still another similarity resides in the fact that we also provide information on the semantics as well the syntactic behavior of the items under analysis (Faber and Mairal Usón 1999; Ruppenhofer et al. 2006; Faber et al. 2006). Furthermore, in our study of specialized language we study aspects of language that were originally restricted to the field of general language such as metaphor (Faber and Márquez Linares 2004). We also go beyond terms in a Wüsterian sense by analyzing how terminological units acquire their specialized meaning, and the extent to which specialized situational settings have a hand in this (Cabré 1999ab; Temmerman 2000)

Nonetheless, our approach differs from FrameNet in that a prototypical domain event provides a frame for the basic processes that take place within the specialized field. Within this context, concepts are organized around an action-environment interface (Barsalou 2003, 2008; Faber, Márquez Linares, and Vega Exposito 2005).

The second thematic section of this book introduces basic concepts, theories, and applications in Terminology and Cognitive Linguistics that are relevant to the following chapters. The chapters in the third section describe terms as specialized language units from a semantic and pragmatic perspective, and explain the Frame-based Terminology approach. The fourth section analyzes the role of contextual information in specialized knowledge representation, more specifically as reflected in linguistic contexts and graphical information. The book ends with the conclusions that can be derived from this study.

2 Basic Concepts

This section of the book discusses the concepts and premises that underlie the vision of specialized language semantics and pragmatics as well as the role of contextual information in knowledge representation. Chapter 2.1 describes the role of specialized language in society, and traces the evolution of Terminology theory from its beginnings with special emphasis on the cognitive shift that has taken place over the last decade, and which has placed it within the scope of Cognitive Linguistics.

Chapter 2.2 gives an overview of basic concepts in Cognitive Linguistics. These include concepts related to the body in the mind, cognitive abilities, and cognitive grammar. Embodiment is reflected in image schemas, metaphor, metonymy, and mental spaces. Cognitive abilities include those related to attention shifting (e.g. profiling, foregrounding, frames, construal, etc.) and to seeing similarity in diversity (e.g. categorization). Cognitive grammar is briefly summarized in reference to the two guiding principles of cognitive approaches to grammar: the symbolic thesis and the usage-based thesis. Each of these concepts is explained within the context of Linguistics. Examples are then provided of how premises of Cognitive Linguistics are also applicable to specialized language, and can afford new insights into Terminology.

Chapter 2.3 discusses metaphor and metonymy as cognitive phenomena, and highlights the fuzzy boundary between the two. Metaphor and metonymy are presented as mechanisms of lexical creation and extension in specialized language as well as in general language. In this regard, particular emphasis is placed on the Invariance Principle, conceptual blending, and the indeterminacy of domains. The section concludes with a corpus-based study of metaphor in Environmental Science.

Chapter 2.4 explores specialized language translation as a cognitive process and application of Cognitive Linguistics. It discusses the translation process as applied to specialized language texts, and underlines the role of terminology management in the interlinguistic mediation of such tasks. In this regard, there is a lack of terminographic resources capable of meeting the needs of translators and technical writers. It suggests that Cognitive Semantics could provide the theory of meaning that translation is so sorely in need of. Nevertheless, despite the fact that translation is a fertile testing ground for the Cognitive Commitment and the Generalization Commitment, Cognitive Linguistics has had relatively little to say about translation. This is paradoxical since linguistic theory as developed by Langacker, Lakoff, and Fillmore is particularly relevant to specialized language texts, the representation of specialized knowledge

units, translation correspondence, and the elusive *tertium comparationis*. The section concludes with a cross-linguistic study of terminological metaphor in the field of Marine Biology, which shows how cognitive and cultural factors in one language can constrain the formation of a specialized concept through metaphORIZATION.

2.1 Terminology and Specialized Language

Pamela Faber

2.1.1 Introduction

Terminology or specialized language is more than a technical or particular instance of general language. In today's society with its emphasis on science and technology, the way specialized knowledge concepts are named, structured, described, and translated has put terminology or the designation of specialized knowledge concepts in the limelight.

The information in scientific and technical texts is encoded in terms or specialized knowledge units, which are access points to more complex knowledge structures. As such, they only mark the tip of the iceberg. Beneath the waters stretch the tentacles of a many-splendored conceptual domain, which represents the implicit knowledge underlying the information in the text. In order to create a specialized knowledge text, translators and technical writers must have an excellent grasp of the language in the specialized domain, the content that must be transmitted, and the knowledge level of the addressees. In order to translate a specialized language text, translators must go beyond correspondences at the level of individual terms, and be able to establish interlinguistic references to entire knowledge structures. Only then can they achieve the level of understanding necessary to create an equivalent text in the target language.

2.1.2 Specialized knowledge acquisition

There has been a great deal of debate regarding how much a translator or technical writer really needs to know about the specialized domain in order to translate or write about a scientific or technical text. Some people even seem to believe that such texts should only be translated or written by experts in the field because in their opinion, it is impossible for non-experts to acquire the necessary knowledge.

Although it is not infrequent for experts with an acceptable level of a second language to try to write or translate texts because of their knowledge of terminological correspondences, they generally find that writing an article in another language is far from simple. In a parallel way, there are writers or translators who believe that their

syntactic and semantic knowledge of one or more languages guarantees an adequate scientific or technical text in the same language or another language without any other previous preparation or documentation. Both enterprises are generally destined to failure.

The reason for this lies in the fact that specialized languages are not a series of water-tight compartments. Terminological units and their correspondences possess both paradigmatic and syntagmatic structure. In other words, terms not only represent specialized concepts, but also have syntax and collocational patterns within general language. In this sense, merely knowing terminological correspondences is hardly sufficient since such units when inserted in context create ripples that affect the text at all levels.

However, it also must be said that linguistic knowledge in itself is not a sufficient guarantee to produce an acceptable text in a specialized knowledge field. A translator or technical writer must also be aware of the types of conceptual entities that the text is referring to, the events that they are participating in, and how they are interrelated.

Nevertheless, it is invariably quicker and easier to acquire knowledge of a specialized domain than knowledge of language, which is somewhat more complicated and takes considerably longer to master. However, this signifies that writers and translators of specialized texts must also be closet terminologists and be capable of carrying out terminological management as a means of knowledge acquisition. This is one of the reasons why an understanding of terminology and specialized knowledge representation is a key factor in successful scientific and technical text generation and translation.

2.1.3 Terminology as a discipline

Terminology as a discipline of study is a relative newcomer. In fact, it came into being because of the growing need to facilitate specialized communication and translation, as well as knowledge transfer between text users belonging to different language communities and with similar knowledge levels. The theoretical proposals in this field have been mostly practice-based, and focus on the elaboration of glossaries, specialized dictionaries and terminological and translation resources

As a subject field with explicit premises, terminology emerges from the need of technicians and scientists to unify the concepts and terms of their subject fields in order to facilitate professional communication and the transfer of knowledge (Cabr  2000a:37).

Precisely for this reason, Terminology has been for some time a discipline in search of a theory with premises capable of accounting for specialized knowledge

representation, category organization, and description, as well as the semantic and syntactic behavior of terminological units in one or various languages. Over the years this quest for a set of theoretical principles has led terminologists to ask themselves *inter alia* whether Terminology should be regarded as a branch of Philosophy, Sociology, Cognitive Science, or Linguistics (to name a few).

Rather than say that Terminology may stem from any or all of them, we take the position that Terminology is essentially a linguistic and cognitive activity. In this sense terms are linguistic units which convey conceptual meaning within the framework of specialized knowledge texts. In the understanding of the nature of terms, this process of meaning transmission is as important as the concept that they designate. Terminological units are thus subject to linguistic analysis. Since this type of analysis can be carried out in a number of ways, it is necessary to choose the linguistic approach most in consonance with the object of study. Such an approach should be lexically-centered and usage-based. It should also have its primary focus on meaning and conceptual representation. As shall be seen, such is the case of cognitive linguistic approaches.

In the past, Terminology and Linguistics have mostly ignored each other. In its initial phase Terminology was interested in asserting its independence from other knowledge areas, and creating a totally autonomous discipline. This goal led terminologists to go to great lengths to emphasize differences between Terminology and Lexicology even to the extent of affirming that terms are not words. In a parallel way, linguistic theory has largely ignored Terminology, probably because specialized language has been and is often regarded as merely a special case of general language. Thus, it was not considered as worthy of serious study because anything pertaining to general language was also presumed to be true of specialized language.

However, interesting conclusions about specialized language, scientific translation, and language in general can be obtained when terminology is studied in its own right. As such, it is most certainly susceptible to linguistic analysis within the framework of a linguistic model. Oddly enough, some years ago this seemingly innocuous affirmation would have caused quite a hue and cry in terminological circles. The reason for this was that the first approximations to terminology had normalization as a primary objective. Great pains were taken to strive for totally unambiguous communication through standardization. This signified univocity or one-to-one reference between term and concept. The fact that the majority of terms designate concepts that represent objects in a specialized knowledge field meant that such an objective seemed possible to achieve. Nevertheless, it soon became apparent that this was more a *desideratum* than a reality.

2.1.4 Theories of Terminology

As has often been observed, *terminology* means many things to many people (Sager 1994: 7). *Terminology* is a word that can either begin with an upper or lower-case letter. When *terminology* begins with a small *t*, it refers to the units in any specialized knowledge field. When it begins with a large *T*, it refers to the study of specialized language. As a rule, Terminology theories can be classified as either prescriptive or descriptive. General Terminology Theory (GTT), which has the virtue of being the first theoretical proposal in this area, is essentially prescriptive in nature. As shall be seen, the theories that subsequently arose in reaction to the GTT are descriptive, and show an increasing tendency to incorporate premises from Cognitive Linguistics since they focus on the social, communicative, and cognitive aspects of specialized knowledge units. The vision that they offer is more realistic because they analyze terms as they actually are used and behave in texts. One might say that these new theories are representative of a *cognitive shift* in Terminology.

2.1.4.1 General Terminology Theory (GTT)

Terminology as a discipline began in the 1930's with Eugen Wüster, the author of *The Machine Tool, an Interlingual Dictionary of Basic Concepts* (Wüster 1968), a systematically organized French and English dictionary of standardized terms (with a German supplement) intended as a model for future technical dictionaries.

This multi-volume work inspired the GTT, and set out the initial set of principles for the compilation and description of terminological data with a view to the standardization of scientific language. The GTT was later developed in Vienna by Wüster's successors, who interpreted his ideas and carried on his work. Although for many years, the GTT offered the only set of principles and premises for compiling terminological data, its view of the semantics of terminological units projected a uniformly limited representation of specialized knowledge concepts without allowing for their multidimensional nature. Needless to say, the GTT did not attempt to account for the syntax and pragmatics of specialized language, which was not regarded as relevant. In this sense, it could not be usefully applied to translation or specialized text generation.

The GTT focused on specialized knowledge concepts for the description and organization of terminological information. Within this framework, concepts were

viewed as being separate from their linguistic designation (terms). Concepts were conceived as abstract cognitive entities that refer to objects in the real world, and terms were merely their linguistic labels.

As Terminology struggled to acquire a semi-independent status, a considerable amount of effort was invested in distinguishing specialized language from general language, and in differentiating terms from words. This radical emphasis on differences often seemed to convey the idea that terms were not even language at all, but rather abstract symbols referring to concepts in the real world.

One of the basic assertions of General Terminology Theory (Wüster 1979; Felber 1984) is that terms in specialized language are inherently different from general language words because of the monsemic reference between terms and concepts. In other words, the general claim is that a term or a specialized language unit can be distinguished from a general language word by its single-meaning relationship with the specialized concept that it designates, and by the stability of the relationship between form and content in texts dealing with this concept (Pavel and Nolet 2001: 19).

However, this is an extremely idealized vision of specialized communication. Even the most cursory examination of specialized language texts shows that terminological variation is quite frequent, and that such variation seems to stem from parameters of specialized communication, such as the knowledge and prestige of the speakers, text function, text content, user group, etc. The same concept can often be designated by more than one term, and the same linguistic form can be used to refer to more than one concept. Furthermore, terms have distinctive syntactic projections, and can behave differently in texts, depending on their conceptual focus. This is something that happens in texts of all languages, and is a problem that translators and technical writers inevitably have to deal with.

Since Wüster believed that the function of Terminology was to create and standardize names for concepts, syntax was not regarded as falling within the scope of Terminology. The GTT also regarded Terminology as exclusively synchronic, and thus ignored the diachronic dimension of terms. Wüster's principal objectives (in Cabré 2003: 173) were:

- (a) To eliminate ambiguity from technical languages by means of standardization of terminology in order to make them efficient tools of communication;
- (b) To convince all users of technical languages of the benefits of standardized terminology;
- (c) To establish terminology as a discipline for all practical purposes and to give it the status of a science.

Cabré (2000a: 169) rightly points out that Terminology has suffered from a lack of innovative theoretical contributions because until very recently, there has been little or no theoretical discussion or confrontation of opinions. Another possible reason for the slow development of Terminology is the lack of interest shown by specialists in other areas of knowledge, such as Linguistics:

The fifth reason, which may explain the continued homogeneity of the established principles, is the lack of interest in terminology by specialists of other branches of science, for example linguistics, psychology, philosophy and history of science and even communication and discourse studies. For many years terminology saw itself as a simple practice for satisfying specific needs or as a field of knowledge whose signs had nothing to do with the signs of language.

However, the 1990s brought new proposals and ideas that paved the way to integrating Terminology into a wider social, communicative, and linguistic context. According to L'Homme et al. (2003), examples of such approaches are Socioterminology (Boulanger 1991; Guespin 1991; Gaudin 1993, 2003), the Communicative Theory of Terminology (Cabré 2000ab, 2001ab, 2003; Cabré et al 1998), and Sociocognitive Terminology (Temmerman 1997, 2000, 2001, 2006).

2.1.4.2 Social and communicative terminology theories

In the early 1990's Socioterminology and Communicative Terminology Theory appear on the horizon as a reaction to the hegemony of the GTT. Both theories present a more realistic view of Terminology since they base their description on how terms are actually used in communicative contexts. They describe terminological units in discourse and analyze the sociological and discourse conditions that give rise to different types of texts.

Socioterminology

Socioterminology, as proposed by Gaudin (1993), applies sociolinguistic principles to Terminology theory, and accounts for terminological variation by identifying term variants against the backdrop of different usage contexts. Parameters of variation are based on the social and ethnic criteria in which communication among experts and specialists can produce different terms for the same concept and more than one concept for the same term. Gaudin (1993: 216) writes:

[...] c'est que la socioterminologie, pour peu qu'elle veuille dépasser les limites d'une terminologie 'greffière', doit replacer la genèse des termes, leur réception, leur acceptation mais aussi les causes de leur échec et les raisons de leur succès, au sein des pratiques langagières et sociales concrètes des hommes qui les emploient. Ces pratiques sont

essentiellement celles qui s'exercent dans des sphères d'activité. C'est pourquoi la socioterminologie devait rencontrer les réflexions sur les liens qui se nouent entre travail et langage.

Pihkala (2001) points out that the socioterminological approach focuses on the social and situational aspects of specialized language communication, which may affect expert communication and give rise to term variation. According to socioterminologists, standardization is a chimera since language is in constant change. Polysemy and synonymy are inevitably present in terminology and specialized texts, and the use of one term instead of another can reflect the knowledge, social and professional status of a group of users, as well as the power relationships between speakers. It can also reflect the geographic and temporal location of the originator of the text. Terminological variation inevitably highlights the fact that concept systems and definitions are not static. This is a reality that any theory aspiring to explanatory adequacy must deal with. In this respect, the premises of Socioterminology are closely linked to Gregory and Carroll's (1978: 3-4) characterization of linguistic variation according to use and user even though this reference is not explicitly mentioned.

Although Socioterminology does not aspire to independent theoretical status, its importance resides in the fact that it opened the door for other descriptive theories of Terminology, which also take social and communicative factors into account, and which base their theoretical principles on the way terms are used in specialized discourse.

The Communicative Theory of Terminology (CTT)

Linguistics and Terminology began to draw closer to each other with the Communicative Theory of Terminology (CTT) (Cabré 1999, 2000ab, 2001ab, 2003; Cabré et al. 1998). This proposal is more ambitious than Socioterminology, and endeavors to account for the complexity of specialized knowledge units from a social, linguistic and cognitive perspective.

According to Cabré (2003), a theory of Terminology should provide a methodological framework for the study of terminological units. She underlines the fact that specialized knowledge units are multidimensional, and have a cognitive component, a linguistic component, and a sociocommunicative component. In this respect, they behave like general language words. Their specificity resides in a series of cognitive, syntactic, and pragmatic constraints, which affirm their membership in a specialized domain.

In this sense, the CTT regards terminological units as "sets of conditions" (Cabré 2003: 184) derived from, *inter alia*, their particular knowledge area, conceptual

structure, meaning, lexical and syntactic structure and valence, as well as the communicative context of specialized discourse.

Cabré (ibid) proposes the *Theory of the Doors*, a metaphor representing the possible ways of accessing, analyzing, and understanding terminological units. She compares a terminological unit to a polyhedron, a three-dimensional solid figure with a varying number of facets. Similarly, a terminological unit can also be said to have three dimensions: a cognitive dimension, a linguistic dimension, and a communicative dimension. Each is a separate door through which terminological units can be accessed. Nonetheless, one's choice of door (or focus) does not entail a rejection of the other two perspectives, which continue to reside in the background. According to Cabré, the CTT approaches units through the language door, but always within the general context of specialized communication.

At this time the CTT is probably the best candidate to replace the General Theory of Terminology as a viable, working theory of Terminology. It has led to a valuable body of research on different aspects of Terminology such as conceptual relations, terminological variation, term extraction, and the application of different linguistic models to Terminology. This has helped Terminology as a field to get its act together, and begin to question GTT premises, which previously were not open to doubt.

However, the CTT is not without its shortcomings. Despite its clear description of the nature of terminological units and the fact that it mentions a term's "syntactic structure and valence", the CTT avoids opting for any specific linguistic model. The relation of the CTT with Linguistics is more in the nature of a light flirtation with various models than a monogamous relationship with any one model in particular.

Its view of conceptual semantics is also in need of clarification. Although in a very general way the CTT bases its semantics on conceptual representation, it is more than a little vague when it comes to explaining how such representations are created, what they look like, and what constraints they might have:

[...] specialized discourse presents an organized structure of knowledge. This structure could be represented as a conceptual map formed by nodes of knowledge, which can be represented by different types of units of expression, and by relations between these nodes (Cabré 2003: 189).

Within this framework, terminological units are recognized as such because they represent knowledge nodes of a structure, and have a special meaning in this structure. If these factors are the prerequisites for term status, then one would think that conceptual representation, knowledge structure or ontology, and category

organization would be an extremely important part of the CTT. However, this does not seem to be the case.

Another area in need of clarification in the CTT is semantic meaning. According to this theory, a lexical unit is general by default and acquires a specialized meaning, when it appears in a specific type of discourse. A terminological unit is regarded to be the special meaning of a lexical unit since its meaning is extracted from the “set of information of a lexical unit” (Cabr  2003: 184). With this affirmation the CTT seems to be avoiding the question of what specialized meaning is, and what its components are. The only clue given is when Cabr  2003:190) states that terminological meaning consists of a specific “selection of semantic features according to the conditions of every speech act”, which seems to implicitly say that she is in favor of some type of semantic decomposition. However, this can only be a supposition because nothing is explicitly said about the semantic analysis of specialized language units. This is a comfortable position because it shunts any decisions in this respect back into the realm of Lexical Semantics, where there is already considerable disagreement as to the nature of word meaning and how it should be analyzed.

2.1.4.3 Cognitive-based theories of Terminology

Over the last decade, linguistic theory seems to be in the process of undergoing a cognitive shift (Evans and Green 2006), which has led it to increasingly focus on the conceptual network underlying language. The fact that linguistic form cannot be analyzed as divorced from meaning has led linguists to begin to explore the interface between syntax and semantics (Faber and Mairal Us n 1999). This trend is also happening in the area of Terminology.

Cognitive-based Terminology theories, though similar in some ways to the CTT, also differ from it. It is not an accident that such theories have arisen largely in the context of Translation. Despite the fact that they also focus on terms in texts and discourse, they make an effort to integrate premises from Cognitive Linguistics and Psychology in their accounts of category structure and concept description. Relevant proposals in this area are Sociocognitive Terminology (Temmerman 1997, 2000, 2006) and Frame-based Terminology (Faber, M rquez Linares, and Vega Exposito 2005; Faber et al. 2006; Faber, Le n Arauz, Prieto Velasco, and Reimerink 2007)

Sociocognitive Terminology

Insights from cognitive semantics (e.g. prototype structure and metaphor) began to have an impact on Terminology theory with the advent of Sociocognitive

Terminology as proposed by Temmerman (1997, 2000). Sociocognitive Terminology (Temmerman 2000) concentrates on the cognitive potential of Terminology in domain-specific language and on terminological variation as related to verbal, situational, and cognitive contexts in discourse and in a wide range of communicative environments (Temmerman et al. 2005)

Temmerman (2000: 16) criticizes General Terminology Theory, and offers examples from the life sciences to demonstrate that the basic principles of the GTT are unrealistic and incapable of describing or explaining specialized language as it is actually used in communicative situations, such as specialized translation. The GTT premises that fall under fire are the following:

- Concepts have a central role in regards to their linguistic designations.
- Concepts and categories have clear-cut boundaries.
- Terminographic definitions should always be intensional.
- Monosemic reference is the rule in terminology, where there is a one-to-one correspondence between terms and concepts.
- Specialized language can only be studied synchronically.

Temmerman (2000) argues that these premises are not valid, and asserts that:

- Language cannot be regarded as divorced from concepts since it plays a crucial role in the conception of categories.
- Many categories have fuzzy boundaries and cannot be clearly defined.
- Optimal definition structure and type should not be limited to only one mode and ultimately depends on the concept being defined.
- Polysemy and synonymy frequently occur in specialized language, and must be included in any realistic terminological analysis.
- Categories, concepts, as well as terms evolve over time and should be studied diachronically. In this sense, cognitive models play an important role in the development of new ideas.

This declaration of principles is the launching pad for Sociocognitive Terminology. This theory is also in consonance with Gaudin's Socioterminology and Cabré's Communicative Theory of Terminology since it is descriptive rather than prescriptive, and regards terms as the starting point for terminological analysis. However, in the same way as the other approaches, it has very little to say about the syntactic behavior of terms.

What makes Sociocognitive Terminology different from other theories is its emphasis on conceptual organization, and its focus on category structure from the perspective of cognitive linguistics approaches. While GTT concept systems are organized in terms of TYPE_OF and PART_OF conceptual relations, sociocognitive categories are said to have prototype structure, and conceptual representations initially take the form of cognitive models. Another significant difference is that Sociocognitive Terminology is perhaps the first and only approach to truly take on board the historical or diachronic dimension of terms

Temmerman (1997, 2001) analyzes three concepts from the same general domain of Biology, and comes to the conclusion that only one of them can be adequately described by the methods of the GTT. The other two are much more susceptible to sociocognitive terminological methods. She claims that such methods give less prominence to traditional ways of defining concepts (generic term and differentiating features), and focus more on deriving term definitions from their use in text corpora. The way a concept is described may vary, depending on a number of different parameters e.g. the type of category being defined, the knowledge level of the text sender and the receiver, and the profile of the termbase user (Temmerman and Kerremans 2003).

Category structure is prototypical, and the representations of relations between concepts in this framework are in the form of idealized cognitive models (ICMs) of the sort proposed by Cognitive Linguistics. This model of categorization is based on Rosch's (1978) Prototype Theory, which uses degrees of typicality as the pattern for conceptual categories or domains with little or no mention of their internal structure, the types of information contained, or the network formed. Nevertheless, the internal structure of conceptual categories is also important because this would presumably affect and constrain any type of interdomain mapping.

According to Prototype Theory, a conceptual map takes the form of a series of concentric circles with concepts placed intuitively either nearer or farther away from the prototypical center. However, neither prototypes nor idealized cognitive models provide a place for syntagmatic data. Nor do they solve the question of how to determine either the relevant prototypical center or the psychologically real schematic meaning within a concept. Clear disadvantages of such representations are the fact that: (1) they are totally unconstrained; (2) they are based on an open-ended inventory of conceptual relations; (3) the resulting ICM and/or prototypical category seems to be largely based on the intuition of the modeler.

One of the most interesting aspects of Sociocognitive Terminology is its focus on the study of terms and concepts from a diachronic perspective in reaction to the

exclusively synchronic analysis of the GTT. For example, Temmerman et al. (2005) study the word *splicing* to identify the history of its meaning, particularly its evolution over time, its use by different cultural groups, and its presence in both general and specialized language. In this sense, the study supports the fact that metaphorical modeling is one of the mechanisms consciously or unconsciously used in the creation of scientific terms. The objective is to gain insight into cognition as it emerges from terms and descriptions in scientific publications.

More recently, Sociocognitive Terminology has also begun to focus on ontologies as a more viable way of implementing conceptual representations. This combination of terminology and ontology is called *termontography*. Termontography is a hybrid term, which is a combination of terminology, ontology, and terminography. Its objective is to link ontologies with multilingual terminological information, and to incorporate ontologies into terminological resources. Temmerman and Kerremans (2003) describe termontography as a multidisciplinary approach in which theories and methods for multilingual terminological analysis (Temmerman 2000) are combined with methods and guidelines for ontological analysis (Fernandez et al. 1997; Sure and Studer 2003).

Termontography, as outlined by Temmerman, seems to owe a great deal to the work done by Ingrid Meyer (I. Meyer 2001; I. Meyer et al. 1992; I. Meyer and McHaffie 1994; I. Meyer, Eck and Skuce 1997; Bowker and L'Homme 2004) who was one of the first terminologists to perceive that term bases would be even more useful if their organization bore some resemblance to the way concepts are represented in the mind:

...term banks would be more useful, and useful to a wider variety of people, eventually even machines, if they contained a richer and more structured conceptual component than they do at present (I. Meyer, Bowker and Eck 1992: 159).

When term bases become terminological knowledge bases, they enhance data because the concepts and designations are linked to each other by meaningful relationships. Although the traditional generic-specific and part-whole relationships are contemplated, there is a greater emphasis on other types of relationships that enrich the resulting knowledge structure, such as cause-effect, object-function, etc. (Bowker and L'Homme 2004). This opens the door to the multidimensional representation of concepts.

Within the socioterminological framework, Kerremans, Temmerman, and Tummers (2004) state that before building a domain-specific conceptual model or ontology, it is necessary to have an excellent grasp of the categories and their existing interrelationships, independent of any culture or language in the domain of interest. Such categories are referred to as units of understanding (UoU). However, one might reasonably question the existence of 'pure' UoUs, when language and culture

permeate mental representations at all levels of conceptualization. And supposing that such language-independent entities actually do exist, one might well ask what form they would actually take.

Even though termontology originated as a brainchild of Sociocognitive Terminology, over the last few years it seems to have evolved far beyond it to the extent that it now seems to have acquired a life of its own, and to have become a totally different entity. The sophisticated knowledge engineering techniques and ontology creation processes described in articles, such as Kerremans, Temmerman, and Zhao (2005), have little or no relation to the cognitive model analysis first described by Temmerman (2001: 84-85). As it stands now, termontology seems to have undergone a complete metamorphosis to the point of bearing little resemblance to the initial premises of Sociocognitive Terminology.

For example, the conceptual representations proposed are in the form of computer-implemented ontologies. No mention is made of prototypes, idealized cognitive models, or radial categories, all of which seem to have been overridden. This is not necessarily a bad thing since, if the truth be told, cognitive linguistics representations, with the possible exception of frames, do not work well in computer applications. Nevertheless, it is extremely difficult to reconcile the ontology engineering described in recent articles with the conceptual representation advocated in Sociocognitive Terminology. The examples of termontographic conceptual relations mentioned by Kerremans, Temmerman and Zhao (2005) (e.g. 'has_subtype' and 'is_kind_of') appear to be rather similar to generic-specific relations of the traditional sort, which Sociocognitive Terminology eschews.

This seems to point to the fact that prototypes, despite being a very seductive concept, are not viable as the sole and exclusive mode of category organization because they ultimately depend on the subjective evaluation of the terminologist. It is impossible to define the exact nature of the center of prototypical categories or explain how degrees of prototypicality can be objectively measured.

Finally, as previously mentioned, in the same way as other Terminology theories, Sociocognitivism studiously avoids dealing with syntax. The reason for this is probably that any syntactic analysis, whether of general or specialized language, must be either explicitly or implicitly based on a syntactic theory, and so far Terminology and syntax have had little or nothing to say about each other.

Frame-based Terminology

Frame-based terminology (FBT) (Faber, Márquez Linares, and Vega Exposito 2005; Faber et al. 2006; Faber, León Arauz, Prieto Velasco, and Reimerink 2007) is another very recent cognitive approach to Terminology, which shares many of the same premises as the CTT and Sociocognitive Terminology. For example, it also maintains that trying to find a distinction between terms and words is no longer fruitful or even viable, and that the best way to study specialized knowledge units is by studying their behavior in texts. Because the general function of specialized language texts is the transmission of knowledge, such texts tend to conform to templates in order to facilitate understanding, and are also characterized by a greater repetition than usual of terms, phrases, sentences, and even full paragraphs. This is something that specialized translators capitalize on when they use translation memories. Scientific and technical texts are usually terminology-rich because of the quantity of specialized language units in them, and they also are distinctive insofar as the syntactic constructions used.

Specialized language units are mostly represented by compound nominal forms that are used within a scientific or technical field, and have meanings specific of this field as well as a syntactic valence or combinatory value. Naturally, such noun phrases have configurations that may vary from language to language. The heavy concentration of such units in these texts points to the specific activation of sectors of domain-specific knowledge. As a result, understanding a terminology-rich text requires knowledge of the domain, the concepts within it, the propositional relations within the text, as well as the conceptual relations between concepts within the domain. This is the first step towards creating an acceptable target language text. All of these elements are the focus of study in Frame-based Terminology.

As its name implies, Frame-based Terminology uses basic principles of Frame Semantics (Fillmore 1976, 1982, 1985; Fillmore and Atkins 1992) to structure specialized domains and create non-language-specific representations. According to Lakoff (1990:40), Frame Semantics seeks to “make one’s account of human language accord with what is generally known about the mind and brain”. Thus, it is part of the cognitive linguistics enterprise (Evans et al., 2007:16–19), specifically encyclopedic semantics. As an encyclopedic approach to meaning, it makes no distinction between semantics and pragmatics. Although the frame-like representations of the FBT initially stem from Fillmore, as shall be seen, there are several differences since they also integrate insights from other linguistic approaches. Such configurations take the form of conceptual templates underlying specialized texts in different languages, which thus facilitate specialized knowledge acquisition.

The concept of domain

The concept of *domain* is problematic both in Terminology and Linguistics. The structure of categories of specialized concepts is and always has been a crucial issue in Terminology, precisely because the GTT opted for an onomasiological rather than a semasiological organization of terminological entries. However, in the type of conceptual representations proposed by the GTT, there is no effort made to create representations with explanatory adequacy from a psychological perspective.

Domains are also essential to the CTT and Sociocognitive Terminology. It is unfortunate that this focus has not as yet been accompanied by a systematic reflection on how to elaborate, design, and organize such a structure. For example, in even the best Terminology manuals, the question of how to develop such configurations is never truly explained, and as a general rule, they are regarded as a product of the terminologist's intuition, which is afterwards validated by consultation with experts.

Regarding conceptual domains, in Terminology there seem to be two views on the matter, which are not necessarily incompatible with each other. A domain sometimes refers to the knowledge area itself, and other times, refers to the categories of concepts within the specialized field (see 3.1.12.1). Evidently, whether a domain is defined as one or the other has dramatic consequences for its internal structure.

If the concept of domain is ambiguous in Terminology, it is even more so in Linguistics (see. 2.3.2.3). In many linguistic models, conceptual structure is not mentioned or even regarded as a serious issue. However, given the close relationship between language and thought, one would think that in order to better understand language, it would also be necessary to understand the concepts that linguistic forms designate. This is extremely important in any process of interlinguistic mediation, such as translation. In this sense, cognitive linguistic approaches have the virtue of regarding conceptual structure as a fundamental part of language and targeting this issue.

Indeed, the structure of categories is a recurrent topic, and in this sense there have been many proposals regarding their organization (Evans and Green 2006). In the final analysis, however, the only consensus appears to be that a category can be virtually anything. In addition, the structure of category members shows few if any constraints.

Although in all likelihood it is difficult to create a definitive inventory of conceptual categories and category design, it is possible to propose models that are somewhat less vague. More often than not, linguistics literature gives the impression that language only reflects a weary world of cups, birds, bachelors, and commercial

transactions. What is needed is a model of categories and category structure that can be realistically applied to language on a broader scope.

Even though the notion of *domain* is central to Cognitive Linguistics, its indeterminacy is one of its most problematic aspects (Croft 1993: 339). Possibly, one way to begin to specify domains is to adhere to Goldberg's (1998: 205) view that the world is carved up into discretely classified event types, which correspond to Langacker's (1991a: 294-298) conceptual archetypes. In this case, the organization of such event types would be semantic-based since syntax is not sufficient in itself to account for meaning differentiation (Mairal Usón and Faber 2002).

Langacker (2000: 23) regards cognitive domains as conceptualizations of any type or degree of complexity, which represent the multiple realms of knowledge and experience evoked by linguistic expressions. The most prominent domains, which are the basis for linguistic meaning, would thus be those residing in the speaker's apprehension of the immediate context. This is in consonance with the concept of *situated cognition*, which is presently in vogue. However, this rather loose interpretation of a cognitive domain is conducive to an *ad hoc* specification by which domains are produced by linguistics in unending supply.

The model of categorization in Cognitive Linguistics and Sociocognitive Terminology is based on Rosch's (1978) Prototype Theory, which uses degrees of typicality as the pattern for conceptual categories or domains. In much research, even though reference is often made to specific domains, little is said about their internal structure, the types of information contained, or the network formed.

However, the internal structure of conceptual categories is also important because this would presumably affect and constrain any type of interdomain mapping. As previously mentioned, according to Prototype Theory, a conceptual map would be in the form of a series of concentric circles with concepts placed intuitively either nearer or farther away from the center.

Nevertheless, the problem may very well lie in the analysis itself since none of the representational formats described explicitly provides a place for syntagmatic data. Nor do they solve the question of how to determine either the relevant prototypical center or the psychologically real schematic meaning within a concept. The specification of exactly how this should be done and the criteria motivating such decisions are never specified.

Frames also fall within cognitive linguistics approaches, and are a type of cognitive structuring device based on experience that provide the background knowledge and motivation for the existence of words in a language as well as the way those words are used in discourse. However, frames have the advantage of making

explicit both the potential semantic and syntactic behavior of specialized language units. This necessarily includes a description of conceptual relations as well as a term's combinatorial potential. Frame Semantics (Fillmore 1976, 1982, 1985; Fillmore and Atkins 1992) and its practical application, the FrameNet Project (Fillmore and Atkins 1998; Fillmore et al. 2003; Ruppenhofer et al. 2006), assert that in order to truly understand the meanings of words in a language, one must first have knowledge of the semantic frames or conceptual structures that underlie their usage. Evidently, the same can be said for specialized language units.

Frame-based Terminology focuses on: (1) conceptual organization; (2) the multidimensional nature of terminological units; and (3) the extraction of semantic and syntactic information through the use of multilingual corpora. In FBT, conceptual networks are based on an underlying domain event, which generates templates for the actions and processes that take place in the specialized field as well as the entities that participate in them.

FBT methodology is based on deriving the conceptual system of the domain by means of an integrated top-down and bottom-up approach. The bottom-up approach consists of extracting information from a multilingual corpus of texts, specifically related to the domain. Our top-down approach includes the information provided by specialized dictionaries and other reference material, complemented by the help of experts in the field.

In a parallel way, we specify the underlying conceptual framework of a knowledge-domain event (Faber and Jimenez 2002; Faber et al. 2006). The most generic or base-level categories of a domain are configured in a prototypical domain event or action-environment interface (Barsalou 2003). This provides a template applicable to all levels of information structuring. In this way a structure is obtained which facilitates and enhances knowledge acquisition since the information in term entries is internally as well as externally coherent (Faber, León Arauz, Prieto Velasco and Reimerink 2007).

One of the basic premises of this approach is that the description of specialized domains is based on the events that generally take place in them, and can be represented accordingly (Grinev and Klepalchenko 1999). Each knowledge area thus has its own event template (see Figure 1). Accordingly, generic categories are configured in a domain event or action-environment interface (Barsalou 2003, 2008; Faber, Márquez Linares, and Vega Exposito 2005), which provides a frame for the organization of more specific concepts. The specific concepts within each category are organized in a network where they are linked by both vertical (hierarchical) and horizontal (non-hierarchical) relations.

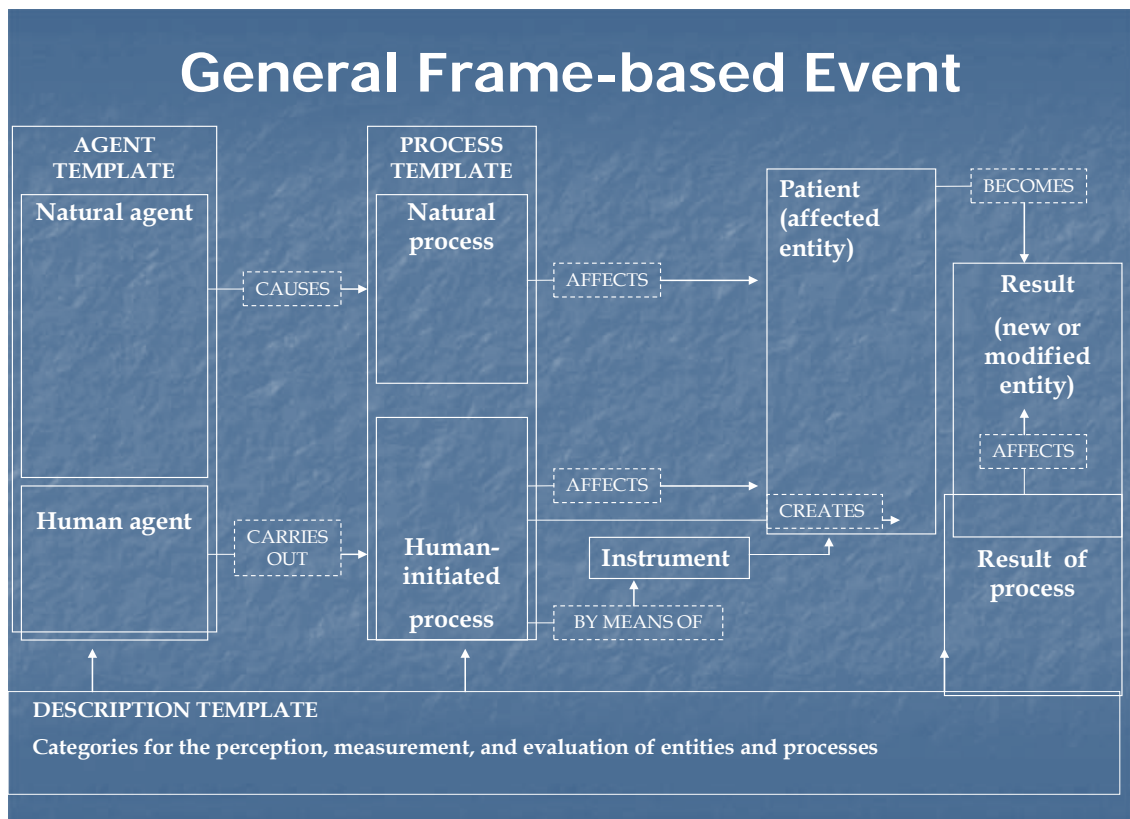


Figure 1. General Frame-based Event

This general event can be modeled to fit specific knowledge areas. For example, the EcoLexicon knowledge base (<http://ecolexicon.ugr.es>) is based on the Environmental Event (see 3.1.5), in which the General Frame-based Event has been adapted to Environmental Science. Accordingly, each subdomain within the event is characterized by a template with a prototypical set of conceptual relations. This logically places much emphasis on terminological definitions, which are regarded as mini-knowledge representations or frames. Such definitions are not entered in a cut-and-paste fashion from other resources. Rather they are based on the data extracted from corpus analysis, which is the main source of paradigmatic and syntagmatic information about the terminological unit. This is evident in the following description of erosion.

For example, EROSION is a process that conforms to the process template within the context of a Frame-based Environmental Event. A process takes place over a period of time and can be divided into smaller segments or phases. It can happen at a specific season of the year, and may occur in a certain direction. It is induced by an agent (natural force) and affects a specific geographic place or environmental entity, thus producing a certain result that is often a modification in the affected entity.

The study of corpus data (i.e. concordances from specialized language texts) is very informative of the attributes of erosion as a process as well as its relations to other entities in the same domain. These attributes will constitute its definition, map out its conceptual relations linking it with other concepts, and also give information about its combinatorial potential in one or various languages. By analyzing concordances the following information about *erosion* comes to light:

Erosion is a process:

- (1) The land formation is a result of soil weathering and **erosion** processes.

Erosion has a duration that can be short, medium, or long:

- (2) a community exhibits greater *long-term erosion* or accretion.
- (3) *Medium-term erosion* rates in a small scarcely vegetated area [...]
- (4) The cliffs are subject to both long- and *short-term erosion*.

Erosion is a time-dependent process and thus, time is reflected in references to periods or episodes or to its seasonal nature:

Erosion measured in terms of time

- (5) a multiple change of accumulation and **erosion periods**, which reflects tectonic activity

Erosion according to the season when it occurs

- (6) The contrast between *summer* and *winter erosion* rates is stark.
- (7) [...] of summertime deposition and *wintertime erosion*.

Erosion can be classified according to the affected entity, which can either be a geographic location or marine fauna:

geographic location

- (8) Coastal submergence and *marsh fringe erosion* [...]
- (9) Processes and mechanisms of *river bank erosion* [...]
- (10) The impact of afforestation on *stream bank erosion* and channel form was visible.
- (11) The causes of *coastal bluff erosion* on the Cape Cod Bay shore [...].

marine fauna

- (12) *Fin erosion* is a pathological symptom common to [...]

Erosion is a process with spatial movement and directionality:

- (13) [...] on Cape Cod Bay resulted in *downdrift erosion* for approximately 5,600 linear [...]
- (14) The stream is near base level. 1. *Downward erosion* is less dominant [...]
- (15) Rainfall (l/m²) and *vertical erosion/accretion* (cm) in Enmedio Island [...].

Erosion is a process induced by a natural or human agent:

- (16) [...] glacial environments: nivation; *eolian erosion* and deposition; and fluvial erosion
- (17) [...] sediments from *wind, water, or ice erosion*.
- (18) [...] disturbances, for instance by *flood-induced erosion*, redistribution of sediment
- (19) The most important cause of *human-induced erosion* is interruption of sediment source.
- (20) episodic, *storm-induced erosion* of dunes and barrier beaches.
- (21) [...] while *wave-induced erosion* is approximately nine acres.

This basic information about erosion is activated in the creation of the more specific terms that appear in the corpus, and which are hyponyms of *erosion*. These complex nominal forms are in reality compressed propositions, which have their own syntax. In their extended form, they would be the following:

Term	Predicate	Agent (Arg1)	Result (Arg2)
storm-induced erosion	INDUCE	storm	erosion
human-induced erosion	INDUCE	humans	erosion
wave-induced erosion	INDUCE	wave	erosion
Term	Predicate	Process (Arg1)	Location (Arg2)
river bank erosion	OCCUR	erosion	river bank
marsh fringe erosion	OCCUR	erosion	marsh fringe
coastal bluff erosion	OCCUR	erosion	coastal bluff

Table 1. Propositions underlying terminological phrasemes

These propositional representations can be activated in different ways, depending on the language involved and its rules for term formation. Such argument constructions provide the basic means of clausal expression in a language. For instance, the first three terms in Table 1 show the construction: X causes Y. Such constructions can be regarded as basic units of language. According to Goldberg (1995: 5):

In particular, constructions involving basic argument structure are shown to be associated with dynamic scenes: experientially grounded gestalts, such as that of someone volitionally transferring something to someone else, someone causing something to move or change state, someone experiencing something, something moving, and so on.

She proposes that the basic clause types of a language form an interrelated network, with semantic structures paired with particular forms in as general a way as possible. This is extremely useful in the analysis of syntax in specialized language texts and in the specification of definitional templates.

Accordingly, the organization of information encoded in definitions can be structured in regards to its perceptual salience as well as its relationship to information configurations in the definitions of other related concepts within the same category (Faber, López Rodríguez, and Tercedor Sánchez 2001; Faber 2002a). W. Martin (1998) underlines the fact that frames as definition models offer more consistent, flexible, and complete representations.

Another important aspect of Frame-based Terminology is that it has the virtue of dealing with the role of linguistic contexts and images in the representation of specialized concepts (see Chapters 4.1 and 4.2). It explains how the linguistic and graphical description of specialized entities are linked, and can converge to highlight the multidimensional nature of concepts as well as the conceptual relations within a specialized domain (Faber, León Arauz, Prieto Velasco, and Reimerink 2007). It advocates a multimodal conceptual description in which the structured information in terminographic definitions and contexts meshes with the visual information in images for a better understanding of complex and dynamic concept systems. In this way, the FBT endeavors to give a full accounting of the information necessary to fully describe a term, and which should be included in fully specified terminological entry.

2.1.5 Summary

This chapter has offered a critical analysis and overview of Terminology theories with special reference to scientific and technical translation. The study of specialized language is undergoing a cognitive shift, which is conducive to a greater emphasis on meaning as well as conceptual structures underlying texts and language in general. Terminology theory seems to be evolving from prescriptive to descriptive with a growing focus on the study of specialized language units from a social, linguistic, and cognitive perspective. In consonance with this, new voices are beginning to be heard, which offer different and complementary perspectives on specialized language, terminology management, and specialized knowledge representation.

2.2 Cognitive Linguistics and Specialized Language

Clara Inés López Rodríguez

2.2.1 Introduction

This chapter describes key concepts of Cognitive Linguistics, and discusses how they can be applied to specialized language and terminology. Cognitive Linguistics shows how real language (i.e. language in use) works, and highlights the relation between language, reality, and the way we perceive and categorize the world.

Since the 1970s (Fillmore 1975; Lakoff and Thompson 1975; Rosch 1975), the cognitive paradigm has expanded rapidly, and has evolved to encompass different areas of research that go far beyond the original interest in cognitive categories, metaphors, and the prototype model of categorization (Rosch 1975). Cognitive Linguistics currently covers a wide variety of areas such as grammar, language change, culture, literature, language acquisition and pedagogy or non-verbal communication.

Cognitive Linguistics initially arose from the desire to explain linguistic meaning (Katz and Fodor 1963; Katz and Postal 1964) as well as from research in cognitive psychology on human categorization and language acquisition. Cognitive Linguistics was also a reaction to Chomsky's generative grammar and formal semantics of the 1970s. Interestingly enough, the word *cognitive* was used for the first time by generativists to mark their opposition to behaviorism and American structural linguistics. Since then, Cognitive Linguistics has always maintained a close contact with other disciplines including anthropology, philosophy, anthropology, computer science, neurology, among others.

2.2.2 Landmarks in Cognitive Linguistics

As is well known, hallmarks in Cognitive Linguistics were publications, such as Lakoff and Johnson (1980), Johnson (1987), Lakoff (1987), Langacker (1987) and Taylor (1995). These books on metaphor, human categorization, embodiment and image schemas, and the cognitive basis of grammatical phenomena have been very influential in contemporary linguistics. They reflect the two main areas of research in Cognitive Linguistics: cognitive semantics and cognitive grammar.

Cognitive semantics studies “the relationship between experience, the conceptual system, and the semantic structure encoded by language” (Evans, Bergen and Zinken 2007: 5), and is based on the following assumptions:

- Conceptual structure is embodied (the ‘embodied cognition’ thesis).
- Semantic structure is conceptual structure.
- Meaning representation is encyclopedic.
- Meaning construction is conceptualization (Evans and Green 2006: 157).

In Cognitive Linguistics, grammar designates the language system as a whole, and incorporates sound, meaning and morphosyntax. As a result, no distinction is made between syntax and lexicon. Instead, the grammar consists of an “inventory of units that are form-meaning pairings: morphemes, words and grammatical constructions” (Evans and Green 2006: 114). Form-meaning pairings are called *symbolic assemblies* or *constructions*. Langacker’s interest in discovering the general cognitive principles that structure grammar, and relating them to cognition has run parallel to attempts to provide detailed descriptions of the linguistic units of particular languages. This approach is referred to as Construction Grammar, and is represented by Goldberg’s (1995) study of verbal argument constructions. A recent offshoot of this model is Embodied Construction Grammar, which emphasizes the relation of constructional semantic content to embodiment and sensorimotor experiences (Bergen and Chang 2005). According to this model, the content of all linguistic signs involve mental simulations and are dependent on image schemas (see 3.2.2.2)

Other landmarks are seminal contributions by Fillmore (1975, 1977), Fauconnier (1985), Talmy (2000), Fauconnier and Turner (2002), and Croft (2001), which have been responsible for notions such as frame semantics, mental spaces, the application of Gestalt psychology to concept structuring, conceptual blending, and radical construction grammar, respectively.

2.2.3 Cognitive perspectives on language

Cognitive Linguistics is an approach to language that is based on our experience of the world and the way we perceive and conceptualize it. Cognitive Linguistics represents three perspectives on language: (i) the experiential view; (ii) the prominence view; (iii) the attentional view (Ungerer and Schmid 1996: x).

From an *experiential perspective*, what language users have in their minds when they hear a particular word is not a static list of logical rules and features that define an

entity of the world. Instead, they have associations and impressions of that word that are part of their experience. These associations shift with the contexts in which a word is used and depend on the cognitive models stored in the mind. Those *idealized cognitive models* (Lakoff 1987) are constrained by human embodiment and categorization, the natural and social environment, our sensory and subjective experience, and perception. The experiential view is the basis for key notions in Cognitive Linguistics such as the prototype model of categorization and family resemblances, metaphors and image schemas.

The *prominence view* explains the fact that communication involves the selection and configuration of information. In this way, speakers highlight the most relevant aspects of their message. This explains cognitive principles such as *figure/ground*, and *iconicity*. This tendency to focus on the most prominent aspects of discourse stems from the fact that both our cognitive abilities and the attention of our hearer are limited.

The importance of attention in communication underlies the *attentional view of language*. Speaker and hearer represent the communication event from two different perspectives. The cognitive process of foregrounding certain aspects of communication directs the hearer's attention towards them. According to Talmy (2000), this act of foregrounding certain portions of an event is known as the *windowing of attention*. In this process, one or more portions of a scene are placed in the foreground of attention while the rest of the scene remains in the background. This notion illustrates the importance of perspective in language. More specifically, prominence and attention are complementary and show speaker and hearer perspectives. Ungerer and Schmid (ibid) relate the attentional view with the notion of *frame*.

These three perspectives on language have psychological validity⁴ since they take into account human cognitive abilities, and corroborate the most important Cognitive Linguistics commitments as stated by Lakoff (1990), namely, the Generalization Commitment and the Cognitive Commitment. The *Generalization Commitment* is a commitment to the characterization of general principles that are responsible for all aspects of human language, since language is an ability that cannot be separated from other cognitive abilities.

Instead of viewing language as the output of a set of innate cognitive universals that are unique for language, Cognitive Linguistics envisions language as a reflection of embodied cognition. The search for general principles explains the effort in Cognitive

⁴ Janda (2000: 2) distinguishes between what is psychologically plausible and what is psychologically real. The premises of Cognitive Linguistics are psychologically plausible because we do not have complete certainty that the models proposed actually represent the workings of our mind.

Linguistics to avoid any separation between language and thought, between phonology, morphology, semantics, syntax and pragmatics, and between semantic and encyclopedic meaning. In relation to the Generalization Commitment, Evans and Green (2006: 28-44) select key phenomena (i.e. categorization, polysemy and metaphor) and analyze their presence in different areas of Linguistics. For instance, they apply categorization and family category resemblances not only to semantics, but also to morphology, syntax and phonology. For example, some morphemes are more prototypical than others, and parts of speech can be said to constitute fuzzy categories. As a result, certain nouns and verbs are 'nounier' or 'verbier'. Moreover, as opposed to traditional distinctive feature analysis in phonology, they argue that speakers of English consider that some voiced sounds such as /r/, /n/, /m/ are more voiced than the sounds /b/, /d/, /g/, which are also voiced. Therefore, apparently discrete linguistic units fall into a continuum that goes from more voiced to less voiced.

The *Cognitive Commitment*, which is clearly related to Langacker's (1999) notion of converging evidence, states that the principles of linguistic structure should reflect what is known about human cognition from other disciplines, especially from the cognitive sciences (philosophy, psychology, artificial intelligence, computer science and neuroscience). In addition, the Cognitive Commitment claims that the human mind cannot be investigated in isolation from human embodiment, and that there is a close relationship between language, mind, and experience: "conceptual organization within the human mind is a function of the way our species-specific bodies interact with the environment we inhabit" (Evans and Green 2006: 50). Cognitive semantics thus views linguistic meaning as a manifestation of conceptual structure. This means that the meaning of words does not depend on the world itself, but rather on our perception and categorization of the world. As a result, "research on cognitive semantics is research on conceptual content and its organization in language" (Talmy 2000: 4).

Generally speaking, language is a dynamic system that directly reflects our conceptual organization and representation of the world. Consequently, there should be no strict separation between language and thought, or between semantic and encyclopedic meaning. In any case, language does not encode thought in all its complexity, but rather gives rudimentary instructions to the conceptual system to access or create rich and elaborate ideas.

2.2.4 Basic premises

Cognitive Linguistics seeks to specify the motivations behind linguistic phenomena. These motivations, which are based on the way our cognitive abilities

understand the world, yield a consistent pattern across different linguistic phenomena, all of which are meaningful (Janda 2000: 5). Our cognitive abilities integrate raw perceptual data about the world into a coherent mental image that constitutes our projected reality (Jackendoff 1983). In other words, this mental image is “a mental representation of reality, as construed by the human mind, mediated by our unique perceptual and conceptual systems” (Evans and Green 2006: 7).

In reference to specialized language, the fact that there is not a one-to-one correspondence between linguistic form and the external world can explain common phenomena in terminology such as polysemy, synonymy and homonymy, or the fact that scientific taxonomies in specialized discourse are more complex and objective than popular taxonomies. For example, in a popular taxonomy of WINE concepts, COLOR is the main parameter of classification, even though there is no consensus on the ‘objective’ color of wine based on external reality. In fact, the color of red wine is conceived in English and French as RED (*red wine*, *vin rouge*), in Spanish as DYED/TINTED (*vino tinto*), since it is derived from Latin *tinctus* and *tingere* (‘to dye’), and as BLACK in Catalanian (*vi negra*)⁵.

Considering the impact that cognitive abilities have on conceptual structure and language, many key notions in Cognitive Linguistics are based on these abilities.

2.2.4.1 The body in the mind: image schemas, metaphors, metonymies and mental spaces

As Ungerer and Schmid (1996: 278) explain, “we are very well aware of the boundaries and parts of our body, of the function that these parts serve, and of the position of our body in relation to the outside world.” This awareness of our body or embodied cognition is common to all human beings, and is reflected in language. Embodied cognition is the origin of notions such as image schemas, metaphors, and metaphorical mappings.

2.2.4.2 Image schemas

According to Johnson (1987: xix), embodied experience is present in rudimentary concepts such as CONTACT, CIRCULARITY, PART-WHOLE, CONTAINER [IN-OUT], PATH or BALANCE that are derived from our sensory-perceptual experience of our body. These basic concepts are called *image schemas*, and can be defined as gestalt structures, consisting of parts standing in relation to each other and organized into wholes, by

⁵ Adapted from Cuenca and Hilferty (1999).

means of which our experience manifests discernible order. In any case, image schemas as developed by Lakoff and Johnson (1999) are not mental images stemming from an effort to recall something visual. Instead, they are abstract and schematic representations of our bodily experience. Image schemas are composed of different elements. For instance, the image schema PATH consists of a SOURCE, a GOAL, LOCATIONS in-between that constitute the PATH or TRAJECTORY, and the MOVEMENT of an entity between source and goal.

Image schemas facilitate the understanding of more abstract concepts by providing these concepts and conceptual domains with structure. This process is called conceptual or metaphorical projection. In this sense, a conceptual domain is understood as a body of knowledge within our conceptual system that contains and organizes related ideas and experiences.

Within the context of PATH, this schema and its internal organization motivate a series of inferences. For instance, going along a path takes time. Therefore, time and human life can be understood as a journey, which generates the conceptual metaphors, LIFE IS A JOURNEY or TIME IS A JOURNEY. Our intentions take place in the future, and target the achievement of a certain goal. Therefore, the image schema PATH explains the use of the structure *be going to + infinitive* (with equivalents in other languages such as Spanish *ir a + infinitive* or French *aller + infinitive*) to indicate future actions and intentions.

The formulation of image schemas and metaphorical projections is based on the notion of *grounding*, which is based on the idea that “we typically conceptualize the non-physical in terms of the physical” (Lakoff and Johnson 1980: 59). Grounding was the foundation of the Invariance Principle according to which “metaphorical mappings preserve the cognitive topology (i.e. the image-schema structure) of the source domain” (Lakoff, 1987: 54).

Therefore, abstract concepts are systematically structured in terms of conceptual domains derived both from our bodily experience and from our experience of physical objects. They thus have properties such as motion, boundaries, parts, vertical elevation, etc.

Metaphor and metonymy

The idea formulated by Lakoff and Johnson (1980) that metaphor is present in the everyday use of language was a breakthrough in Linguistics. They also claimed that both metaphor and metonymy are conceptual mechanisms central to human language and thought. Metaphor is based on analogy, whereas metonymy is regarded as referential.

A *metaphor* involves conceptualizing or projecting one domain of experience (source domain) in terms of another domain (target domain). One of the most popular examples in Cognitive Linguistics to illustrate metaphors and metaphorical projections is the example of LOVE, an abstract concept or domain derived from basic domains such as TOUCH or SEX. LOVE is structured and understood in terms of metaphors such as LOVE IS A JOURNEY and STATES AND FEELINGS ARE CONTAINERS. The first metaphor is based on the image schema PATH, and it works by mapping roles from the source domain (JOURNEYS) onto the target domains (LOVE). This results in mappings that explain, for example, our perception of lovers as travelers (*We are at a crossroads*). The second metaphor is the origin of expressions such as *being in love* or escaping from a difficult situation or state (*Whenever I am in trouble, she always bails me out; There was no escape from his disastrous marriage*).

According to Lee (2001a: 6), source domains tend to be relatively concrete areas of experience whereas target domains are more abstract. In this sense, we normally use metaphors to conceptualize abstract and less familiar phenomena or to explain scientific or other types of specialized knowledge. For instance, in the specialized knowledge area of Biomedicine, volumes are usually measured in liters (L) or milliliters (ml/mL), based on the metaphor THE BODY IS A CONTAINER OF FLUIDS, as opposed to the common practice in Physics and Chemistry of measuring volumes in cubic centimeters (cm³). This is evident in the following concordances in Table 2 in which the volume of the pelvis, stomach, heart, and lymph nodes are measured in milliliters:

. RESULTS: The median pelvic fluid volume was 3.4 mL (interquartile range 0-16.8
eeding, the mean values of gastric volume were 20.9 +/- 18.3 ml in the control g
70 years, 58% with relative heart volume > or = 500 ml.m -2 body surface area, 4
gical complication, and a hematoma volume less than 25 ml . In the patients with
6) copies/mL, the total lymph node volume was 5.8 +/- 1.6 mL and was significant

Table 2. Concordance lines from the Oncoterm corpus⁶

Metaphor is not only pervasive in general language, but also in specialized language. For example, in legal terminology, the etymology of *impediment* reflects the image schema of BALANCE. In Law, the abstract notion of IMPEDIMENT refers to something that obstructs the making of a legal contract, whereas in general language, it means something that obstructs the progress of something. Both senses are derived from *impedire*, a Latin word meaning to put in fetters and entangle, stemming from *pes*,

⁶ The ONCOTERM project (PB98-1342) was funded by the Spanish Ministry of Education. In ONCOTERM [www.ugr.es/local/oncoterm], the analysis of terminological contexts in a corpus of medical texts within the domain of Oncology allowed our research group to identify and introduce the EVENTS and OBJECTS underlying each conceptual category, as well as the PROPERTIES connecting them.

pedis (foot). Our everyday bodily experience tells us that feet are very important to keep our BALANCE, and that stumbling involves the subsequent interruption of action or movement. The root *ped-* (from *pes*, *pedis*) is also present in many other words of Latin origin such as *impairment* or *impeachment*, reminding us of their physical or embodied origin.

The study of metaphor is important in Terminology since metaphor motivates meaning extension, and hence, polysemy (see section 1.3). Evans and Green (2006: 39) mention the following example of Lakoff (1987) to illustrate the role of metaphor in meaning extension. The CONTROL meaning of *over* in sentences like “She has a strange power over me” derives from the ABOVE meaning of *over* by virtue of metaphor. This is achieved by applying the metaphor, CONTROL IS UP, which explains expressions such as “His power *rose*” or “I’m *on top* of the situation”.

Metaphor and metaphorical mappings are also relevant because they influence our thinking about domains of human experience. For instance, in the field of medicine, the metaphor, THE BODY AS A MACHINE, has pervaded medical practice for years, although thanks to the increasing popularity of oriental medicine, many medical expressions are now based on the metaphor THE BODY AS BALANCE (see Table 3) or THE BODY AS A HARMONIOUS WHOLE. The concordances in Table 3 show that many medical texts apply this concept to processes such as oxygen supply and use, cell death and cell proliferation, acid production and excretion, and adhesive and hemodynamic forces.

Aging stress is about achieving a balance between its positive and negative aspects
tissue homeostasis depends on a balance between cell proliferation and cell death
actions that help maintain a balance between oxygen supply and oxygen use
Aging led to the development of a balance between the parasite and its host.
cells participating in a balance between cell death and proliferation
cellular reactions requires a balance between acid production and excretion
Complexes to the cell surface. A balance between production and destruction
response that is influenced by a balance of adhesive and hemodynamic forces.

Table 3. Concordances illustrating the metaphor THE BODY AS BALANCE

According to Lakoff and Turner (1989), the main difference between metaphor and metonymy is that metaphor operates between two different domains, whereas *metonymy* operates in one, and thus, there is no cross-domain mapping. Metonymy is motivated by the physical or causal associations established between entities that are closely related.

From a terminological perspective, metonymy is the origin of eponymic expressions in science and technology. For example, metonymy is the basis for the fact that the name of the inventor is often included in the new term that designates

his/her invention, or the fact that diseases and pathologies are often given the names of the physicians that discovered them. For example, Alzheimer's is a brain disorder named for the German physician, Alois Alzheimer, who first described it in 1906. In Physics, a *pascal* is a unit of pressure, named after the French mathematician, Pascal. Similar examples are the *newton*, unit of force named after Sir Isaac Newton, and the *ohm*, a unit of electrical resistance named after Georg Ohm.

Finally, reference to the metaphors motivating polysemy and metaphorical extensions can help users of dictionaries and terminological databases to understand the meaning of words. These metaphors can be activated when dictionaries include etymological information, and when the arrangement of the different senses of a word goes from the more 'embodied' sense (closer to sensory experience) to more abstract meanings. For instance, the etymology of the word *muscle* (from Latin *musculus*, 'little mouse') gives us an image of a muscle, and reflects categorization mechanisms.

Projections and mental spaces

The existence of image-schemas, metaphors, and metonymies are based on imagination and our ability to establish projections or mappings between structures. According to Fauconnier and Turner (1998: 134), projection is a central cognitive notion because it is the basis of analogy, categorization, and grammar. Even the fact that linguistic expressions are access points to the vast repository of encyclopedic knowledge stored in our minds is based on projection.

Fauconnier (1985) and Fauconnier and Turner (2002) propose a theory of meaning construction based on projection, namely, the *Mental Spaces Theory* and *Blending Theory* (see 2.3.2.2.) The Mental Spaces Theory is a reaction to the truth-conditional model of sentence meaning of formal semantics, and seeks to explain linguistic phenomena such as reference, metaphor, and conditionality. It is based on the notion of projection or mapping between mental spaces in the context of local discourse.

In relation to mental spaces, Evans and Green (2006: 363) affirm that sentences work as partial instructions for the construction of complex and temporary conceptual domains called mental spaces that are assembled in ongoing discourse. Mental spaces are linked to one another, and allow speakers to relate back to mental spaces constructed earlier in the ongoing linguistic exchange. As a result, meaning is not a property of individual sentences and words, but is constructed on-line, based on the meaning potential of linguistic expressions and context-bound mappings. Accordingly, mental spaces can be defined as partial structures or conceptual structure packets,

which contain specific kinds of information that are relevant when people think and talk in context. The difference between mental spaces and other related concepts, such as metaphor, frame, and domain is that mental spaces are constructed 'on-line' based on previous metaphors, domains, etc.

Mental spaces are set up by *space builders*. These are linguistic units that either prompt for the construction of a new mental space, or shift attention back and forth between previously constructed mental spaces. Expressions such as *in Figure 7, in 1987* or *it is very likely*, which are so frequent in specialized discourse, require the text receiver to set up a scenario beyond the here and now.

One of the advantages of Mental Spaces Theory and Blending Theory is that they explain how speakers set up mental spaces that are separate from reality. In science, this underlies processes of hypothesis and reasoning. For example, in the sentence, "If sea level rises by 1 meter, the coastline will retreat by 1500 meters" (If R then C), the marker *if* sets up a conditional or hypothetical mental space C that is separate from the reality space R. What this sentence states is that if the sea level rises by 1500 meters, then in the conditional mental space C, the coastline will retreat by 1500 meters. The presupposition holds for the mental space C, but not necessarily for the mental space R. Domain R is linked with domain C by means of the space builder *if*.

Another important notion in Fauconnier and Turner's approach is *blending*, which is the basis for Blending Theory. Blending Theory holds that meaning construction involves the integration of structures that give rise to more than the sum of its parts. Blending Theory applies gestalt psychology to explain creative aspects of meaning construction. A *blend* is a third mental space that inherits structures from its input or influential mental spaces. These input spaces are connected to a generic mental space. This generic space reflects certain abstract structures and organizational patterns shared by the inputs.

Blends are similar to metaphor in the sense that a blend involves two domains and a mapping relation. However, in a blend, both domains are source domains, and together they contribute to the creation of a third entirely new domain (Janda 2000: 14).

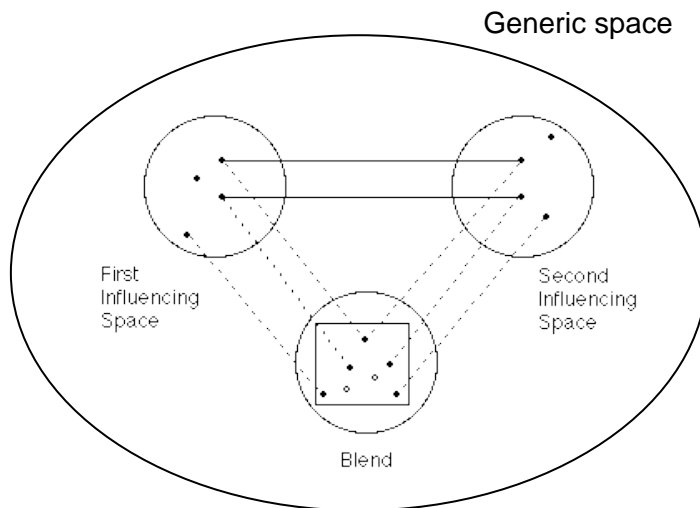


Figure 2. Blending Theory: input spaces, blend and generic space

Turner and Fauconnier (1995: 193) illustrate this notion with the word *McJobs*, used to refer to temporary jobs of low income and poor working conditions (monotony, lack of challenges, etc). In this example, the prefix *Mc* activates the input space of junk food and poor working conditions. As for *jobs*, it activates the second input space of finding a job and working in a professional environment. Both spaces have common elements (the boss, workers, wages, etc.) that allow building a generic space. In this generic space, a mapping will take place between the first influencing space (input space) and the second influencing space. This results in a blend that includes common features from both input spaces.

2.2.5 The cognitive ability of attention shifting

2.2.5.1 Figure and ground

All humans have the cognitive ability to direct their attention and to shift their attention from one aspect of a situation to another. Attention relies not only on the cognitive ability itself, but also on the natural properties of phenomena in the world. These properties are said to enhance the prominence or *salience* of these phenomena to human attention (Croft and Cruse 2004: 47). For instance, a moving object attracts our attention more than a fixed object. The moving object functions as *figure* and the stable one as *ground*. Therefore, the notion of *figure* refers to an entity that projects itself and attracts the viewer's attention because it moves, possesses a striking color or contour, or because it is closer to the viewer.

The distinction between figure and ground has been very influential in Cognitive Linguistics, and has produced many synonyms. For instance, in Langacker's terminology, figure and ground correspond to *trajector* and *landmark*, respectively, or *profile* and *base* (also used by Lakoff). Langacker (1987: 183-184) describes the relation between the concepts, RADIUS and CIRCLE, as that of a concept that is profiled (RADIUS) against a background understanding of the concept CIRCLE. Similarly, CIRCLE is the base or background for the concept DIAMETER.

Langacker (1991b: 6) also underlines the close connection between the concepts of *foregrounding* and *frame* – vaguely understood as a conceptual domain – as shown in Figure 3. The word *hypotenuse* derives its meaning from the concept, RIGHT TRIANGLE, and profiles one particular side of a right triangle (base): the side opposite the right angle. Therefore, “the word *hypotenuse* foregrounds an element in a larger frame” (ibid). As a result, semantic value does not reside in either the base or the profile individually, but rather in the relation between the two (Langacker 2006).

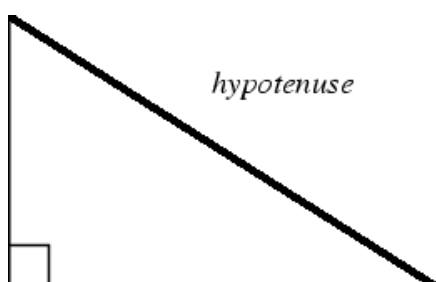


Figure 3. HYPOTENUSE profiled in a RIGHT TRIANGLE.

In order to explain the fact that one concept can be profiled in different domains, Langacker (1987: 147) proposes the notion of *domain matrix*, which is the range of possible domains against which a concept can be profiled. For example, the lexical unit *cell* points to different domains such as HUMAN BODY, PRISON, ELECTROLYSIS, and SOLAR ENERGY.

Likewise, Langacker (1987: 164-165) states that a particular phenomenon can be designated by different words when it is located in different frames. For example, *roe* and *caviar* refer to the same entity (the gonad of a fish), but their difference in meaning derives from the fact that *roe* is used in the anatomical frame of the fish reproductive cycle, whereas *caviar* refers to a gastronomic frame. As a result, *roe* and *caviar* activate different aspects of our knowledge of fish. The context and the use of one or the other will cognitively activate one facet or active zone of the concept.

Domain matrix and *active zone* are related to the notion of *multidimensionality* in Terminology, “a phenomenon of classification that arises when a concept type can be

subclassified in more than one way (i.e., in more than one dimension), depending on the conceptual characteristic that is used for the classification” (Bowker and Meyer 1993: 123). Multidimensionality is in turn related to Cruse’s idea (2000) that words have context-dependent meanings called *facets*. Each of these particular meanings is activated by specific utterances.

Understanding the concepts of *figure* and *ground* is particularly applicable to Terminology and Terminography, and in the design of terminological databases. Terminological databases should define linguistic units so that both the profile and its base are specified. In terminographic definitions, the *profile* should be placed at the beginning (coinciding with the *definiens* or generic term in a definition), and the *base* should be the background information that points to conceptual relations such as LOCATED_AT or PART_OF. Terminological databases should also include visual images that *foreground* or *profile* the word being defined against a *background* or *base* (see section 3.5).

2.2.5.2 Frames

The idea that meaning is context-dependent is the basis of the notion of *frame*, which is in consonance with the encyclopedic approach to meaning in Cognitive Linguistics. Lexical items provide access to a structured body of non-linguistic or encyclopedic knowledge. The notion of *frame* is related to the notion of *script* (Schank and Abelson 1977), and the claim that concepts such as RESTAURANT, CUSTOMER, WAITER, ORDERING, EATING, BILL ‘belong together’ because they are associated in ordinary human experience. As a result, the concept of RESTAURANT is closely linked to the other concepts in the script EATING IN A RESTAURANT. This kind of knowledge structure has received different names in Cognitive Psychology, Artificial Intelligence and Linguistics, such as frame, schema, script, global pattern, pseudo-text, cognitive model, experiential gestalt, base, or scene.

Frame Semantics as developed by Fillmore (1975, 1977, 1982) is based on a model of the “semantics of understanding”. Words and constructions in texts evoke a particular understanding (or frame) for a particular activity: “a hearer invokes a frame upon hearing an utterance in order to understand it” (Croft and Cruse 2004: 7-8).

Lee (2001a: 9) emphasizes the conceptual and cultural dimension of frames, and states that the concept of frame embraces the traditional concept of *connotation*. A word such as *holiday* carries a complex range of associations. Even specialized terms, such as *tsunami* or *acquired immune deficiency syndrome* (AIDS), carry cultural connotations and associations.

Fillmore (2006: 391) draws a subtle distinction between *semantic framing* and a general concept of framing. Evans (2007) also hints at this distinction. The first interpretation focuses on patterns of framing that are established, and which are specifically associated with given lexical items or grammatical categories. The second interpretation involves contextualizing or situating events in the broadest sense.

Semantic framing is the object of study of Frame Semantics and its practical application, FrameNet (Fillmore, 2000; Fillmore et al. 2003). The most frequent examples of the notion of frame are COMMERCIAL TRANSACTION and RISK (Fillmore and Atkins 1992). In this linguistic interpretation of frame, it is important to note that a word in a frame allows the speaker and the hearer to focus their attention on one part of the entire frame. Words evoke a frame, but by filling slots in the frame, they profile or foreground only those parts of the frame closely linked to the slot. This linguistic phenomenon manifests itself in the argument structure of sentences.

The broadest interpretation of the notion *frame* appears in Evans's (2009c) Theory of Lexical Concepts and Cognitive Models (or LCCM Theory) and in Barsalou (2003). Evans (2007: 85) defines frame as:

A schematization of experience (a knowledge structure), which is represented at the conceptual level and held in long-term memory and which relates element and entities associated with a particular culturally embedded scene, situation or event from human experience. Frames include different sorts of knowledge including attributes, and relations between attributes.

Evans also provides a diagram of the CAR frame, which includes a wide variety of knowledge. For example, it includes both general knowledge such as 'cars run on petrol or diesel' and specific knowledge about a particular car: 'my car'. Evans and Green (2006: 11) also illustrate this broad interpretation of frame as follows:

Language can be used to create scenes or frames of experience, indexing and even constructing a particular context (Fillmore 1982). In other words, language use can invoke frames that summon rich knowledge structures, which serve to call up and fill in background knowledge [...] 'Once upon a time' signals the beginning of a fairy tale. Just by hearing this expression an entire frame is invoked, which guides how we should respond to what follows, what our expectations should be.

In the same way that language use can invoke frames that summon knowledge structures that complete background knowledge, as well as knowledge about the way words are used in context, dictionaries should evoke the most relevant frames of a word, or at least provide examples of usage. In fact, as shall be seen, frames are reflected linguistically in the lexical relations codified in terminographic definitions (see 3.1.10).

2.2.5.3 Profiling and perspective

The psychological process by which an aspect of some base or domain is highlighted is called *profiling* (Langacker 1987) or *attentional windowing* (Talmy 2000). In anatomy the expression TOOTH profiles a substructure within the larger structure JAW, which functions as base. The concept JAW can also be profiled or foregrounded against the base MOUTH, which in turns can be profiled against HEAD, as shown in Figure 4.

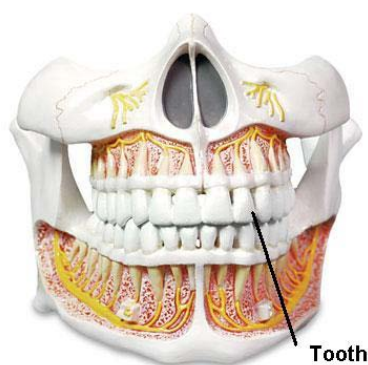


Figure 4. TOOTH profiled against JAW

Domains that cannot be profiled against other domains are basic domains. These are SPACE, TIME, and sensory experiences such as COLOR or TASTE. Taylor (1995: 85) even regards psychological states, such as PLEASURE and ENTHUSIASM, as basic domains.

Language exhibits profiling in the sense that it provides a range of lexical units and grammatical constructions that encode different aspects or perspectives of a given scene. Fillmore (1982: 121) illustrates how language provides ways of focusing our attention on a particular perspective with the example of the words *coast* and *shore*. For example, the difference between *coast* and *shore* responds to a difference in perspective. If we approach the limit between land and sea from the land, we refer to it as the *coast*. However, if we approach it from the sea, we call it *shore*.

Nevertheless, this is not always the case in specialized language. Concordances (22-25) show where the perspective of the viewer does not coincide with the one foregrounded by the word *coast* (perspective from the land) or *shore* (perspective from the sea). In concordances (22) and (23), the oceanic phenomena mentioned (*cold water, upwelling fronts*) indicate a perspective from the sea. Concordances (24) and (25) also show a peripheral use of the word *shore*.

(22)... with the **cold water observed along the east coast** of Korea,

(23) [...] the dynamics of **upwelling fronts near a coast**.

(24) [...] ultimately northerly **driving the water from the shore towards the sea**.

(25) [...] 75 percent of the U.S. **ocean shore is eroding** [...]

2.2.5.4 Construal

Language has several constructions that profile different aspects of a particular scene. For instance, given a scene where a boy kicks over a vase and smashes it to pieces, different aspects of the scene can be linguistically profiled by using the passive or the active voice (Evans and Green 2006: 42):

(26) The boy kicks over the vase.

(27) The vase is kicked over.

(28) The vase smashes into bits.

(29) The vase is in bits.

There is a difference in meaning between examples (26-29) because they construe the same situation in different ways. In (26), the active sentence profiles the relationship between the initiator of the action (AGENT) and the object that undergoes the action (PATIENT). The AGENT (*boy*) is the *trajector* or focal participant, and the PATIENT (*vase*) is the *landmark*. The passive voice in (27) foregrounds the PATIENT, and backgrounds both the AGENT and the energy transfer in the action. Example (28) profiles the change in the state of the vase, while the use of the copulative verb in (29) indicates the state of the vase: IN BITS.

Since perspective and foregrounding connect linguistic coding to visual perception, Evans and Green (ibid) visually represent each particular construal of the previous scene. For our purposes, only the image for examples (26) and (27) are reproduced. In (26), the agent, the patient and the action are highlighted, while in example (27), the agent (*the boy*) is backgrounded.

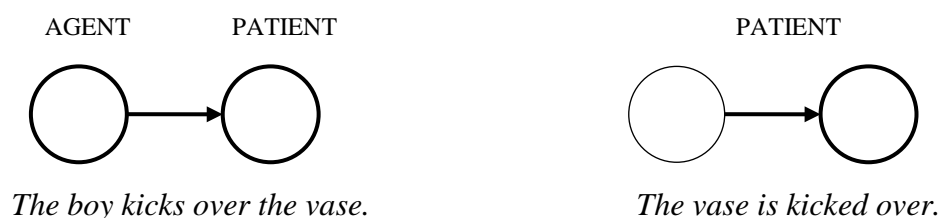


Figure 5. The role of grammar in the construal of a scene (Evans and Green 2006: 42)

Therefore, as shown in Figure 5, the existence of syntactic structures that apparently express the same meaning indicates that a particular situation can be construed in different ways, and that different ways of encoding a situation constitute different conceptualizations. Construal determines how perceived reality is sorted into foregrounded and backgrounded information with the help of language. According to Cognitive Grammar, language includes a range of grammatical constructions that permit the speaker to organize reality in a certain way, and to focus the text receiver's attention on particular elements of a scene. This focus, allowing a specific construal of a scene, is known as *focal adjustment*.

Focal adjustment depends on three parameters: selection, perspective and abstraction. Selection determines the conceptual domain of the scene. Perspective highlights the prominence of the participants of a scene, indicating the "trajector(s)" and "landmark(s)". Abstraction refers to how specific or detailed the description of a scene is (Evans 2007: 158). *Focal adjustment* and *construal* are thus important concepts in Cognitive Linguistics. In fact, Lee (2001: 6) links metaphor to the notion of construal by virtue of the fact that different ways of thinking about a particular phenomenon can be associated with different metaphors.

In essence, the use of syntactic structures is a reflection of how a situation is conceptualized by the speaker, and this conceptualization is governed by the attention principle. Salient participants, especially agents, are rendered as subjects and less salient participants as objects. Verbs are selected which are compatible with the choice of subject and object, and evoke the intended perspective on the situation (Ungerer and Schmid 1996: 280). In many languages, the subject of a sentence occupies its initial position to indicate the prominence of the agent, whereas less prominent participants are placed in other sentence positions. This is directly related to the notion of *iconicity* (Givon 1985).

2.2.6 Iconicity

Although there is no direct mapping between the elements of the external world and linguistic form, cognitive linguists, following Pierce (1958), affirm that there is a kind of similarity or *iconicity* between the structure of language (or grammar) and the structure of the world. Cognitive linguists have proposed three iconic principles in language: *iconic sequencing*, *iconic proximity*, and *iconic quantity* (Ungerer and Schmid 1996: 251-253).

In relation to *iconic sequencing*, the temporal order of events described in a sentence or a text should correspond to the order of the phrases in the sentence, or the

presentation of information in the text. For example, in a research article, its sections (Introduction, Methods, Results and Discussion) reproduce the temporal sequence of scientific research. Therefore, an article where the Discussion comes after the Introduction does not conform to the principle of iconic sequencing (see 3.2.2).

With reference to *iconic proximity*, closely related elements are placed closer together. Iconic proximity explains the order of adjectives and nouns pre-modifying a noun in English. According to Fiest (2009), the order of premodifiers has a semantic explanation. In this respect, premodifiers that act as classifiers are closest to the head because they carry referential meaning. The next closest premodifiers are those that act as descriptors, which are non-scalar. They are preceded by epithets, which have scalar meaning, and can be descriptive, expressive or social. Premodifiers furthest from the head are reinforcers, which have wholly grammatical meaning.

For example the premodifiers in the noun phrase, a *very lovely black leather jacket* follow the following order: reinforcer + epithet + descriptor + head. *Black* (color) and *leather* (material) are both descriptors and thus closest to the head, *jacket*. However, material is an integral part of the jacket, whereas the color is a property of the material. *Lovely* is an epithet because it is scalar as well as descriptive and expressive. *Very* is a premodifier that reinforces *lovely*.

Iconic proximity also explains word order in English nominal compounds. For example, when lung disease is characterized by chronic coughing and shortness of breath, we use the terminological unit “chronic obstructive pulmonary disease” (see Table 4). The word order indicates that when we describe a disease, it is important to specify the part of the body affected by the disease. *Pulmonary* is thus the closest adjective to *disease*. If the disease is to be described still further, other elements will be introduced further to the left of the phrase, so as not to alter the iconic proximity between *pulmonary* and *disease*.

Chronic obstructive pulmonary disease	
→	CO ₂ -retaining <i>chronic obstructive pulmonary disease</i>
→	Hypercapnic <i>chronic obstructive pulmonary disease</i>
→	elderly <i>chronic obstructive pulmonary disease</i>
→	pre-existing <i>chronic obstructive pulmonary disease</i>
→	severe <i>chronic obstructive pulmonary disease</i>
→	stable <i>chronic obstructive pulmonary disease</i>

Table 4. Word order and iconic proximity in the term *chronic obstructive pulmonary disease*

Finally, *iconic quantity* explains the relationship between the length of a linguistic expression and the complexity of the cognitive model evoked for the description of an entity. For example, in specialized scientific texts, entities are normally described in detail following a complex model. As a result, noun phrases that designate more specific concepts tend to be quite long.

2.2.7 The cognitive ability of seeing similarity in diversity

Linguists, lexicologists, and terminologists have long sought to discover the relation between the entities of the world, mental concepts, and the terms that designate these entities. In this quest, it is essential to understand one of the most important cognitive abilities, namely, categorization. Since language and thought are not separate, cognitive linguists claim that linguistic categories are cognitive categories. In this section, we summarize approaches in Cognitive Linguistics to how categorization works and how categories are organized.

2.2.7.1 Categorization

Taylor (1995: ix) defines *categorization* as the “ability to see similarity in diversity”. Categorization is the mental process that enables human beings to classify entities of the world by perceiving similarities and differences between them, and mentally storing concepts that represent these entities. Categorization enables humans to understand the world.

Taylor (*ibid*) also claims that categorization is both a question of motivation (categories have a perceptual base) and convention (i.e. learning). Categorization is a cognitive process involving the following activities: (i) forming a structural description of the entity; (ii) finding categories similar to the structural description; (iii) selecting the most similar representation; (iv) making inferences regarding the entity; (v) storing information about the categorization in long-term memory.

In relation to how categories are structured, modern approaches to Lexical Semantics including cognitive approaches, have adopted the Prototype Theory of categorization (Rosch 1973, 1978; Temmerman 2000). *Prototype Theory*, as formulated by Rosch, is the culmination of Wittgenstein’s (1953) notion of family resemblance, of anthropological research by Berlin and Kay (1969) on focal colors, and of linguistic research by Labov (1973) on household containers (CUPS, MUGS, etc.). As opposed to the idea that categories are defined by necessary and sufficient criteria, and that membership in them is all-or-nothing (*Classical Theory of Meaning*), Prototype

Theory states that many categories lack necessary and sufficient conditions for membership. Instead, they are graded according to their similarity to an ideal member or prototype, which best represents this category. In addition, it is usually the case that there is not a single feature shared by all the members of the category. In other words, categories display family resemblance structure. Janda (2000: 8) explains how categories are organized around the prototype:

A given category is motivated by and organized around a prototypical member, to which all other members ultimately bear some relationship. Bearing a relationship to the prototype does not necessarily entail sharing a feature with the prototype, since a relationship to the prototype may be mediated by a chain of linked members in which each contiguous pair shares features, but there may be no feature shared by category members at the extreme ends of this chain. [...] Complex categories constitute radial categories because they have numerous chains radiating from the prototype.

Taylor (1995: 261) distinguishes between prototype categories (understood in a narrow sense) and radial categories, which include the distinct senses of a linguistic unit:

Although *bird* may refer to different species of creature, we would not for this reason want to identify a range of distinct senses of *bird*. On the other hand, prepositions such as *over* and *round* may designate a number of different kinds of spatial relation, and in these cases we would want to identify a number of distinct senses of these words, related in a radial category (ibid).

There is empirical evidence in favor of Prototype Theory and its claim that conceptual categories tend to have a defining internal structure and no boundary (Janda 2000: 8). In this respect, psychologists have found that subjects can give ratings of the goodness of membership of a list of exemplars with respect to a category. The experiments devised by Rosch (1975) to investigate prototype structure in the categories of FURNITURE, BIRD, TOY, CLOTHING, VEGETABLE, etc. were called goodness-of-example ratings. Apparently, people can verify that prototypical members belong to a category faster and more accurately than they can with peripheral members. Category fuzziness seems to have effectively blocked further understanding of what constitutes the meaning of words within the framework of Cognitive Linguistics.

Nevertheless, both Prototype Theory and the Classical Theory have limitations, and it is not realistic to assume that only prototype theory accounts for categorization. Pinker and Prince (2002) have adopted a compromise position. They argue that both classical categories and family resemblance categories are psychologically real and natural. In principle, most human concepts can be explained by means of family resemblance categories, which are mainly used for the quick identification of category exemplars, based on perceptual information, or for rapid approximate reasoning.

However, when speakers of a language are asked under no time pressure if a penguin is a bird, they have no doubt that it is a bird, thus contradicting prototype theory. According to Pinker and Prince (ibid), when people are presented with a centipede, a caterpillar, and the butterfly that the caterpillar eventually becomes, they say that the caterpillar and the butterfly are “the same animal”, and that the caterpillar and centipede are not the same animal, despite their similarity in appearance.

On the other hand, certain categories (TRIANGLES, ODD NUMBERS, etc.) which are the result of explicit instruction or formal schooling are better explained and defined by the Classical Theory. Even so, experimental data shows that native speakers of a language rate numbers 1 and 3 as better examples of odd numbers than 1003. Children also say that three-legged dogs are dogs in spite of what they are taught at school.

Hampton (in Croft and Cruse 2004: 81-82) states that Prototype Theory comes in two versions (a feature-list version and a similarity version), both of which recognize the existence of borderline cases. In the feature-list version of prototype theory, concepts are represented in terms of a list of the attributes of category members, and the prototype is represented by the member with the highest number of relevant features of the category. This version is useful in the explanation of concepts such as VEHICLES or BIRDS. In the similarity version, centrality in a category is determined by similarity to the prototype. This second version is more appropriate for the description of simple concepts, such as those involving shape or color.

Evidently, Prototype Theory pervades Cognitive Linguistics, but has its limitations. To avoid indeterminacy when defining categories, Prototype Theory can benefit from Classical Theory in the identification of the core meaning of concepts. If linguists want to understand categorization processes, they should adopt a critical perspective that combines the advantages of both approaches. Fillmore (2006: 397) affirms that semanticists should take into account, not only the precise nature of the relationship between word and category, but also of the relationships between the category and the background of human experiences and human institutions.

Radial categories

Prototype Theory has been extended to encompass aspects of lexical polysemy, whereby the various senses of a word may be related to a central sense or prototype. Lakoff (1987) challenges the traditional distinction between synonymy, polysemy, and homonymy. Such distinctions are rarely, if ever, clear-cut. For example, homonymy is often a case of diachronic polysemy. Cuenca and Hilferty (1999: 134) explain that the Spanish homonyms *banco* (1), meaning ‘bank (financial entity)’, and *banco* (2),

meaning 'bench', are in fact the result of polysemy over time. When over the years, the link in the chain of meaning between the core meaning of *banco* ('bench') and the peripheral meaning of 'moneychanger's table' was broken, Spanish speakers assumed that both senses were unrelated, and thus, *banco* was considered a case of homonymy.

Following the notion of family resemblance, Lakoff recognizes the existence of composite prototypes or complex categories, which have a radial structure. In other words, they form a continuum that goes from the center to the periphery. A *radial structure* is a network around a central or core meaning represented by the prototype, which is linked to other meanings. Each non-central meaning is either a variant of the prototype or a variant of a variant.

Lakoff (ibid) as well as Brugman and Lakoff (2006) claim that polysemic lexical items display a radial structure of senses. This radial structure applies not only to meaning, but also to morphology and syntax. Studies have been made of the preposition *over* (Tyler and Evans 2003; Brugman and Lakoff 2006); the Spanish preposition *por* [for/by] (Cuenca and Hilferty 1999: 143-149); the *there*-construction (Lakoff 1987); and the Spanish structure *ir a* [to go to] (Cuenca and Hilferty 1999: 138-142). Radiality also explains the dynamicity of categories. Accordingly, exemplars can move from the prototype to the periphery and vice versa. In this way, new concepts arise that correspond to new realities as perceived and sanctioned by a particular society. In this sense, Lakoff states that categorization and the identification of a category prototype are determined by Idealized Cognitive Models.

Furthermore, radial categories are closely related to the notion of semantic network, used in Cognitive Lexical Semantics and Artificial Intelligence. The range of related senses or lexical concepts associated with a word "is assumed to form a network of senses which are related by degrees, with some lexical concepts being more central and others more peripheral" (Evans 2007: 194).

Lee (2001a: 66) also observes that radial categories are useful in explaining the process of language change:

Since the semantic networks associated with words and morphemes are open, new phenomena can be assimilated to existing categories on the basis of perceived similarities, without the need to create a new word every time we encounter a new phenomenon. Thus, a (more or less) finite system is able to cope with a world that is infinite and in constant flux.

Radiality is an essential notion in Cognitive Linguistics since it is a pervasive property of language that can explain the process of language change and phenomena, such as polysemy.

Idealized Cognitive Models

Idealized cognitive models were proposed by Lakoff (1987) in order to account for *typicality effects*, the phenomena whereby a particular instance is judged as being a good example of a given category. According to Lakoff, the prototype is not defined in relation to the real world or the knowledge of an individual, but in relation to one or various *idealized cognitive models* (ICMs). Lakoff (1987: 9-28) defines ICMs as conventional conceptual representations of the way we perceive and organize reality (encyclopedic knowledge).

ICMs are idealized because they are abstract, and do not represent specific instances of a given experience. ICMs are also schematic or simplified because they partially represent what a particular culture knows about a concept. ICMs indicate the social expectations about a particular concept within a culture, and even include myth and beliefs in a certain society. Finally, ICMs are cognitive because they can explain cognitive processes such as categorization and reasoning. In fact, according to Lakoff, exemplars not recognized in the ICM of a particular culture are considered peripheral in the category. In other words, the fact that non-central cases are placed on the periphery of the radial structure of a category is culturally determined, and is the result of the beliefs and world-view of a certain culture.

The example usually given to illustrate the relation between radial categories and ICMs is the category MOTHER. The core meaning of this radial category is represented in many cultures by 'a female who gave birth to the child, was supplier of 50 per cent of the genetic material, stayed at home in order to nurture the child, is married to the child's father, is one generation older than the child and is also the child's legal guardian' (Evans and Green 2006: 276). Other senses of the concept MOTHER that deviate in different degrees from the prototype are STEPMOTHER, ADOPTIVE MOTHER, SURROGATE MOTHER, FOSTER MOTHER, etc. as shown in Figure 6:

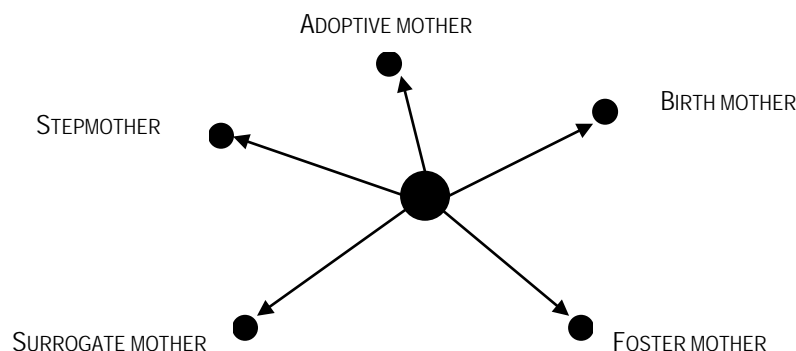


Figure 6. Radial network for the category MOTHER (Evans and Green 2006: 276)

The concepts BACHELOR and MOTHER are prototypical examples of the category IDEALIZED COGNITIVE MODEL in Cognitive Linguistics since most of the literature about ICMs includes these examples.

2.2.7.2 Levels of category organization within categories in Prototype Theory: the horizontal and vertical axes

Rosch (1978) suggests that the category systems have two dimensions: a vertical and a horizontal dimension. The *vertical dimension* refers to “the level of inclusiveness of a particular category: the higher up the vertical axis a particular category is, the more inclusive it is”. As far as the horizontal dimension is concerned, it relates to “the category distinctions at the same level of inclusiveness”. (Evans and Green 2006: 256). Taylor (1995) illustrates the two axes of categorization in nominal and verbal categories. He gives the following representation of nominal categories:

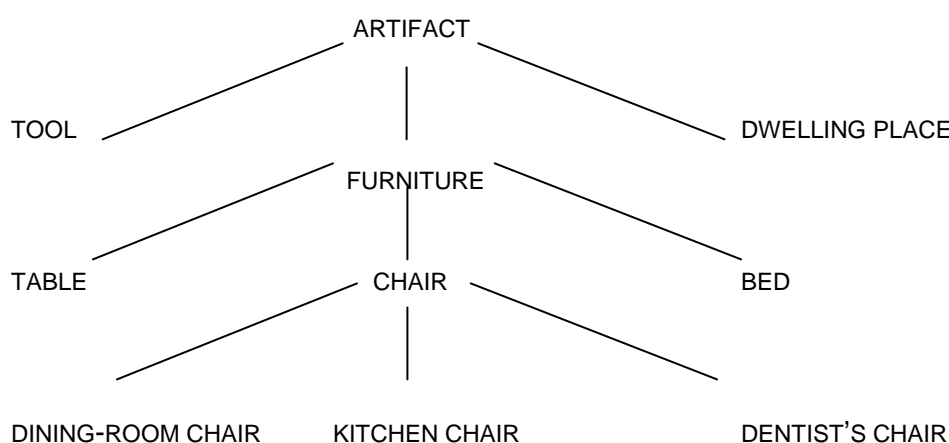


Figure 7. Two axes of the nominal category ARTIFACT (Taylor 1995: 48)

As shown in Figure 7, the horizontal dimension includes contrasting categories, which are included in the next highest category (Taylor 1995: 46). These categories at the horizontal level are similar enough to be considered members of the same category, although some of them are more central than others. For example, a DENTIST'S CHAIR is less prototypical than a KITCHEN CHAIR.

The representation of these two axes of categorization is reminiscent of conceptual trees in Terminology, and the relations of hyponymy and co-hyponymy. The problem with this sort of representation is that it does not show which elements are 'cognitively privileged categories' (Fillmore 2006: 394) as shown in Figure 8.

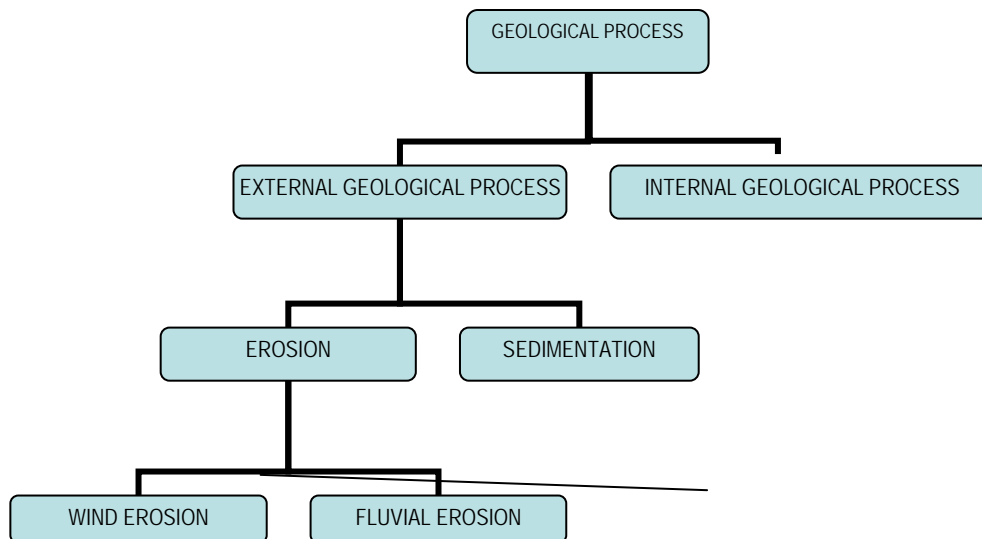


Figure 8. Two categorization axes for GEOLOGICAL PROCESS

The *vertical dimension* establishes three levels of specificity within categories: the *basic*, the *superordinate* and the *subordinate level*. When we want to express a more general or more specific meaning, we use words representing superordinate and subordinate categories. These are derived from basic level categories by highlighting salient general or specific attributes, respectively (Ungerer and Schmid 1996: 279). These levels are described in Croft and Cruse (2004: 83-87) and Taylor (1995: 46-51).

The basic level is the level of categorization that is most cognitively and linguistically salient:

Basic level terms cut up reality into maximally informative categories. More precisely, Rosch hypothesizes that basic level categories both (a) maximize the number of attributes shared by members of the category; and (b) minimize the number of attributes shared with members of other categories (Taylor 1995: 50-51).

Cognitively speaking, the basic level is the most inclusive level at which characteristic patterns of behavioral interactions are found. In other words, speakers of a language do not find it difficult to describe or mimic how they interact with objects at this level. It is easy to describe what one does with a CHAIR (basic level), but it is considerably more difficult to describe how one interacts with FURNITURE (superordinate level).

Moreover, basic level categories are associated with an image or a real-world referent. As a result, individual items are more rapidly categorized as basic-level categories than as members of superordinate or subordinate categories. For example, it takes less time to perceive and categorize a sparrow as a bird (basic level) than as an animal (superordinate level) or as a sparrow (superordinate level). What is more, basic level categories are the first words children learn. Ungerer and Schmid (1996: 279) also observe that basic level categories contribute to the conceptualization of

abstract categories, as a result of mappings from cognitive models, which are ultimately anchored to basic level categories.

On a formal and usage basis, basic-level terms have a higher frequency of occurrence. They are used for everyday neutral reference, and are generally short and structurally simple (monomorphemic). Subordinate level terms are frequently compounds consisting of the basic level term plus a modifier (*kitchen chair, rocking-chair*). Superordinate level terms are normally uncountable in English (*a piece of furniture*). In many languages, there are no superordinate terms.

Although this double internal organization of categories (vertical and horizontal) has been empirically validated, it only takes into account the semantic or paradigmatic level of language, following Saussure. Given that meaning and syntax are both an integral part of language, it seems that the internal structure of categories is much more complex than this. Moreover, apart from the relations between words and their corresponding concepts, certain concepts belong together because they are associated in experience and are clustered in frames.

2.2.8 Cognitive Grammar: a meaning-based usage-based model of language

2.2.8.1 Meaning and form

In contrast to the widespread idea that syntax is determined by the grammatical properties of words, Cognitive Linguistics defends that the primary determinant of whether linguistic units can combine with each other is meaning rather than grammar (Lee 2001a: 70). Grammar is thus conceived as a structured repository of symbolic units, and the conventional pairing between meaning and form (Langacker 1987). Cognitive Grammar follows the same principles as other aspects of human cognition.

The cognitive paradigm states that language encodes and externalizes our thoughts with symbolic units that go far beyond words. In this regard, grammar encodes meaning, and there is no distinction between syntax and lexicon. In fact, the use and selection of a specific grammatical structure instead of an apparently similar one, is meaningful. The choice of a grammatical structure profiles certain aspects of a particular situation, and provides a particular construal of reality.

As opposed to traditional semantics, closed-class function words (e.g. articles, prepositions, conjunctions, etc.) convey more meaning than one might think, and their combinatorial properties are based on meaning. For example, the preposition *under*

indicates a relationship between two entities in the domain of space. Since the landmark of *under* is an entity, and entities are normally designated by NPs, it follows that *under* is followed by NPs in language.

Even so, in the Cognitive Linguistics literature, Cognitive Grammar can be understood in two senses. In a narrow sense, grammar corresponds to the combination of syntax and morphology, and in a broad sense, grammar goes beyond syntax and morphology to explain how language works. It is grammar as a theory of language (Broccias 2006).

In this broad sense, grammar designates the language system as a whole, incorporating sound, meaning and morphosyntax. The grammar of a language consists of an inventory of units that are form-meaning pairings: morphemes, words, and grammatical constructions. Langacker calls these units *symbolic assemblies* because they unite properties of sound, meaning and grammar within a single representation. Symbolic assemblies can be words, multi-word units, idioms, morphemes, and syntactic constructions (Evans and Green 2006: 114).

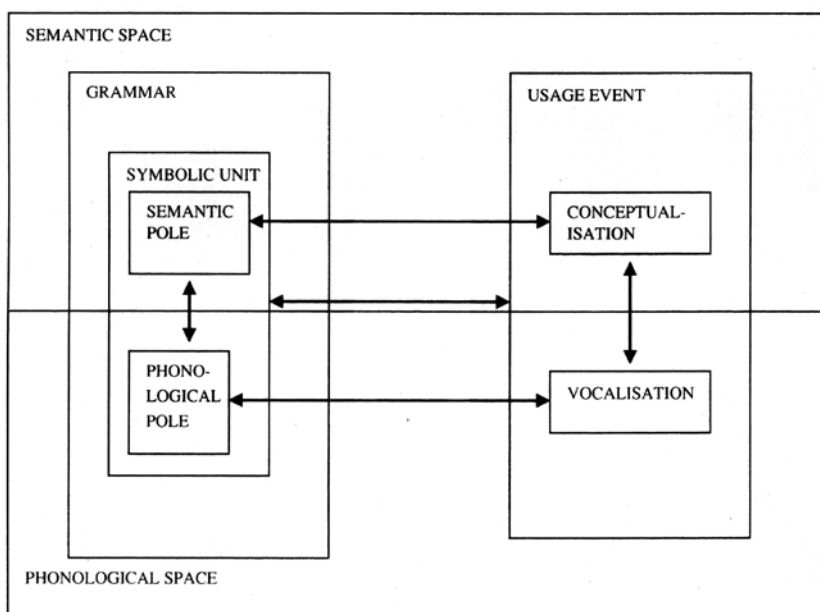


Figure 9. The cognitive model of grammar (Evans and Green 2006: 479)

Cognitive grammar is mainly the work of Langacker (1987, 1991ab, 1999), although it has evolved to Construction Grammar (Goldberg 1995), Radical Construction Grammar (Croft 2001), Embodied Construction Grammar (Bergen and Chang 2005), and the application of Blending Theory to research on linguistic structures such as resultative and caused motion constructions (Fauconnier and Turner 2002).

2.2.8.2 Meaning and usage

Evans, Bergen and Zinken (2007: 20) formulate the two guiding principles of cognitive approaches to grammar with two theses: (a) the symbolic thesis; (b) the usage-based thesis.

The *symbolic thesis* is a reinterpretation of Saussure's distinction between *signified* and *signifier* in the sense that both are understood as psychological entities since they belong within the mental system of linguistic knowledge in the mind of speakers. Since grammatical units are symbolic assemblies, *form* cannot be studied independently of meaning.

With reference to the *usage-based thesis*, the mental grammar of the speaker is formed by the abstraction of symbolic units from situated instances of language use. As a result, there is no distinction between competence and performance. Since knowledge of a language is based on language, knowledge of a language is knowledge about how language is used. Evans and Greens (2006) affirm that cognitive processes of abstraction and schematization build grammar. *Abstraction* is the process whereby structure emerges from the generalization of patterns across instances of language use. *Schematization* is a special kind of abstraction, which results in representations [*schemas*] that are much less detailed than the actual utterances that give rise to them. Schemas are based on what a set of structures have in common. For example, the schema for the preposition *in* is the abstract notion of enclosure.

In addition, grammar is not only derived from language use, but also motivates language use by sanctioning particular usage patterns. In this sense, frequency of usage is an important element in the construction of Grammar:

The language system is a function of language use, then the relative frequency with which particular words or constructions are encountered by the speaker will affect the nature of the language system. [...] Linguistic units that are more frequently encountered become more entrenched (Evans and Green 2006: 114).

In any case, this sanctioning of certain patterns is only partial because the range of constructions available in language is limited. This limitation allows both flexibility (innovation) and stability in language. Language change and neologisms exist, but there are some limitations based on meaning and on embodied cognition. For example, the basic or embodied meaning of *mouse* (a rodent) has been the origin of different symbolic units, namely, *muscle* (from Latin *musculus*, 'little mouse'), and computer *mouse*. Although these new usages are an innovation, and apparently, there is not any meaning connection between a MOUSE, a MUSCLE, and a computer MOUSE, the realities they refer to share the same shape as perceived by human cognition.

Moreover, as we previously mentioned, this partial sanction or approval of certain linguistic patterns only results in language change when it spreads through a linguistic community and becomes established as a conventional unit in its own right (Evans and Green 2006: 116). The fact that there are frequently occurring constructions in a language to codify a similar meaning (yet a different construal), ensures that these structures survive in language as distinct constructions. In this sense, Evans and Green (2006: 117) describe Langacker's model of grammar as non-reductive:

Langacker's non-reductive model stands in direct opposition to generative grammar, which places emphasis on economy of representation, the elimination of redundancy that leads to rules. In Cognitive Grammar, rules do not exist; instead, there are schemas that are derived from language use and that incorporate a meaning element.

The fact that frequency of usage correlates with entrenchment in a language is the basis for empirical research on the semantics of lexical units and constructions. Gries and Stefanowitsch (2006) include studies that combine the cognitive linguistic perspective with the methodology of Corpus Linguistics, based on the computerized analysis of language in authentic texts in computer readable format. This usage-based perspective can be actively applied to the study of specialized language and Terminology.

2.2.9 Summary

This chapter has presented a general overview of the Cognitive Linguistics approach to language. It has focused on concepts that pervade specialized language, and which are discussed in greater detail in subsequent chapters. One of the most important is embodied cognition, which is reflected in image schemas, metaphor, metonymy, and mental spaces. All of these are vitally important mechanisms in specialized language as well as in general language, and are instrumental in term formation, specialized knowledge acquisition, and relations between specialized knowledge units.

Also explained in this chapter are cognitive abilities related to attention shifting and to seeing similarity in diversity. Mechanisms for profiling concepts from different perspectives or within contexts are foregrounding, construal, and frames. These are all crucial in conceptual representation, and are the foundation of the frame-based approach to Terminology. Specialized concepts can be represented differently, depending on the knowledge field and focus. In fact, this type of multidimensionality is one of the sources of terminological diversity.

The cognitive ability to see similarity in diversity refers to categorization and category organization. In this regard Cognitive Linguistics has adopted the Prototype Theory of categorization, which is in direct opposition to the Classical Theory. However, it has been argued that both category types are psychologically real and natural, and can even be combined to integrate the benefits of both models. The mapping of specialized knowledge fields is a vital part of terminology work. Evidently, constructs in Cognitive Linguistics such as radial categories and idealized cognitive models, have a possible application in specialized language.

Finally, Cognitive Linguistics is a meaning-based, usage-based model of language. In this sense, grammatical units are symbolic assemblies in which form cannot be studied independently of meaning. Since knowledge of a language is knowledge about how language is used, corpus analysis is a valuable tool for data extraction, which reflects how terms are activated in texts.

2.3 Metaphor and Metonymy in Specialized Language

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2.3.1 Metaphor and metonymy as cognitive phenomena

Metaphor is the cognitive mechanism whereby one experiential domain is partially mapped or projected onto a different experiential domain, so that the second domain is partially understood in terms of the first (Barcelona 2003). Similarly, metonymy is also a basic cognitive process where one conceptual entity affords access to another closely associated entity. However, in this case, both concepts belong to the same domain instead of different ones. As Jakobson (1956) once pointed out, both metaphor and metonymy can be regarded as the endpoints on a continuum of conceptualization processes, and thus are closely related.

The seminal work of Lakoff and Johnson (1980) first made people aware that metaphor is not only a literary and rhetorical device, but a cognitive resource that plays an important role in our conceptualization and understanding of reality. The way that everyday linguistic expressions reflect metaphorical mappings between conceptual domains provides insights on how such mappings guide human reasoning and behavior.

Metonymy, which is also deeply rooted in cognition, is as ubiquitous as metaphor but has received somewhat less attention. One reason for this is that metonymy highlights conceptual relations between contiguous or closely related entities or between one entity and one of its parts within the same domain. Therefore, the study of metonymy necessarily entails taking a firm stance on the slippery terrain of conceptual configuration and category structure, something that few authors feel comfortable doing. However, metonymy should be explored in greater depth because it is instrumental in the organization of meaning (semantics), utterance production and interpretation (pragmatics), and even grammatical structure (Ruiz de Mendoza and Pérez Hernández 2001; Panther and Thornburg 2007: 236).

Since metaphor and metonymy are an integral part of linguistic creativity, they are present in specialized language as well as in general language. Over the last ten years the pervasiveness of metaphor in scientific and technical texts has come under closer

scrutiny, and has been studied in a wide range of specialized knowledge domains from biomedicine to mining (e.g. Stambuk 1998; Rijn-van Tongeren 1997; Faber and Márquez Linares 2005; Tercedor Sánchez and Méndez Cendón 2000; Tercedor Sánchez 2002, 2004, Alexiev 2004). Metonymy, however, has largely been ignored, and like Cinderella, has been left to sit in the ashes by the hearthside. This chapter summarizes the role of metaphor and metonymy in Cognitive Linguistics, and explains their relevance in Terminology, specialized languages, and specialized domains.

Cognitive Linguistics views both metaphor and metonymy as mechanisms that help to structure the human conceptual system. Dirven (2002) further elaborates on Jakobson's idea of a continuum, and links metonymy and metaphor to the syntagmatic and paradigmatic potential of language, respectively. Metonymy can thus be regarded as a syntagmatic operation based on combination, which exploits continuity, whereas metaphor is essentially a paradigmatic operation based on substitution, which exploits similarity.

Metaphor and metonymy are closely related in that both are non-literal applications of language. Panther (2006: 162) proposes that an iconic relation be used for metaphor and an indexical relation for metonymy. In this regard, metaphor would be based on the premise that there is an iconic relation between source meaning and target meaning, and that the source meaning has some frame or domain structure that is iconically replicated in the target domain. In contrast, he claims that metonymy is indexical, and is based on the elaboration of the source meaning, which is part of the conceptual structure of the target meaning. Consequently, the function of metonymy is to provide generic prompts, which serve as inputs for additional pragmatic inferences that flesh out the specifics of the intended utterance meaning (Kristiansen et al. 2006: 6).

The difference between metaphor and metonymy is partly based on the number of domains that each involves. In this sense, metonymy is often regarded as a single-domain operation because it only involves one domain (Lakoff and Turner 1989; Croft 1993; Kövecses and Radden 1998; Kövecses 2000), whereas metaphor is regarded as a cross-domain phenomenon because it involves two or more domains. Nevertheless, this definition has been criticized because it relies too heavily on the notion of domain, which has always been somewhat vague (Taylor 2002; Ruiz de Mendoza and Otal Campo 2002). As a way of overcoming this problem, Peirsman and Geeraerts (2006) propose that metonymy be considered a prototypical category which has spatial part-whole contiguity at its core. As dimensions for prototypicality judgments, they suggest strength of contact, boundedness, and domain.

Notwithstanding such differentiating features, the limits between metaphor and metonymy are blurred. The closeness of the relation between metaphor and metonymy has been underlined by various authors (Ritchie 2006; Barnden 2010). In fact, the question has been raised as to whether these labels should exist at all. Fauconnier (2009) claims that more important than categorizing an utterance as a metaphor or a metonymy is the study of the cognitive operations involved. Barnden (2010: 31) advocates worrying less about classification and more about the salient dimensions of the possible metaphor or metonymy. This involves analyzing it in regards to degrees and types of similarity, contiguity, link survival, imaginary identification, etc.

According to Barcelona (2003: 10), the interaction between both phenomena can be made explicit through texts, or can happen at the purely conceptual level. He underlines two types of interaction at the conceptual level: the metonymic motivation of metaphor and the metaphorical motivation of metonymy. Barcelona (2002: 234-236) offers various examples of the metonymic basis of metaphor. For instance, in Lakoff and Johnson (1980), “Mike is in low spirits” is regarded as a metaphorical expression of the conceptual metaphor SAD IS DOWN. However, Barcelona argues that expressions of sadness are often conveyed through the dimension of verticality, and so, this dimension should be regarded as part of the domain of SADNESS. In this same line, Panther (2006: 165) underlines the experiential relation between *sad* and *down* in reference to gestural expressions. In his opinion, this signifies that *down* indexically accesses *sad* though he does not go so far as to consider verticality an integral part of the sadness domain. Nevertheless, both authors believe that this example is an instance of metonymy rather than metaphor.

2.3.1.1 Metaphor

As previously mentioned, metaphor can be regarded as a cross-domain phenomenon, which can be classified in different types. Cognitive Linguistics makes the distinction between conceptual metaphor and image metaphor (Lakoff and Turner 1989; Lakoff 1993), even though both kinds of metaphor involve mapping concepts from one domain to another. The difference lies in the fact that image metaphors are conceptually simple in that only one concept of the source domain maps onto the target domain, whereas conceptual metaphors are more complex. As such, image metaphors are based on a sense-perceived resemblance between two entities, and are the result of image-to-image mappings, which results in one expression. For example, instances of image metaphor in the field of marine biology are the following:


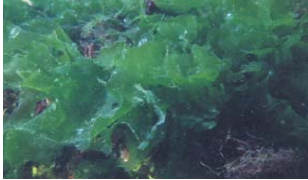
Term	Referent and metaphorical motivation	Picture
Lanternfish	Fish with light-producing organs with shoaling or courtship function	
Sea lettuce	Green alga which looks like a lettuce both in shape and color (plant-like)	

Table 5. Image metaphors in marine biology (Ureña and Faber 2010)

In Table 5, both lanternfish and sea lettuce receive their names because of their resemblance to the concepts of LANTERN and LETTUCE, respectively. In the same way as a lantern, the lanternfish also gives off light, thanks to light-producing organs, which function in certain contexts. Sea lettuce is an alga that resembles a head of lettuce in both shape and color. However, the mapping stops here since there is no consistent conceptualization of marine life as light-producing mechanisms or any conceptualization of their vital activities as illumination processes. Neither is there a systematic mapping of vegetables (e.g. carrots, green beans, Brussels sprouts, etc.) onto sea plant life. As a result, these image metaphors are not productive since they are not conducive to other related metaphors.

In contrast, conceptual metaphors (also known as multiple-correspondence metaphors in Ruiz de Mendoza 1999, 2000) are extremely productive, and emerge from the entire projection of one domain of experience onto another (domain-to-domain mapping). They involve the mapping of rich knowledge and rich inferential structure which gives rise to a more or less extensive number of linguistic expressions (Lakoff and Turner 1989: 91). In Marine Biology, for example, this would be the case of the projection of the domain of land animals onto that of sea animals (i.e. sea cow, seahorse, tiger shark, etc.).

In this sense, conceptual metaphor is a powerful cognitive mechanism that shapes our understanding of the world. General conceptual metaphors such as TIME IS MOTION, STATES ARE LOCATIONS, CHANGE IS MOTION, etc. affect and model language at very basic levels. Such metaphors can give rise to novel metaphorical mappings in consonance with the way members of a culture conceptualize experience. These can be regarded as collections of metaphorical mappings that provide the structure for more specific metaphors. An example of one of these systems is the event structure metaphor (see Lakoff 1990, 1993 for an in-depth discussion and description).

Event Structure Metaphor	
Source Domain	Target Domain
MOTION IN SPACE	EVENTS
Locations	⇒ States
Movements (rel. to bounded regions in space)	⇒ Changes
Forces	⇒ Causes
Self-propelled movements	⇒ Actions
Paths (to destination)	⇒ Means
Impediments to motion	⇒ Difficulties
Journeys	⇒ Long-term, purposeful activities

Table 6: Event Structure metaphor

For example, in the often-cited example of the cross-domain mapping LIFE IS A JOURNEY, the target domain is LIFE and the source domain is JOURNEY. The event structure metaphor sets up ontological correspondences between elements of the conceptual substrate of the cultural model of JOURNEY, and whatever structure there is in the stored cognitive representations of LIFE. These ontological correspondences can be seen in the following examples:

- (30) STATES ARE LOCATIONS →
He found himself at a dead end when he reached fifty.
- (31) CHANGE IS MOTION →
In those days young men went from adolescence to adulthood much too quickly.
- (32) CAUSES ARE FORCES →
It was his motivation that made him rise to the top.
- (33) PURPOSES ARE DESTINATIONS →
He spent all his life trying to get to corporate heaven.
- (34) MEANS ARE PATHS →
Instead of applying for the job in the usual way, he decided to take a shortcut.
- (35) DIFFICULTIES ARE IMPEDIMENTS TO MOTION →
Many obstacles were strewn in his path, but he persisted in his quest for professional success.
- (36) PURPOSEFUL ACTIVITIES ARE JOURNEYS →
He had been drifting but her words sent him on his way again.

As underlined by Lakoff (1993), the Event Structure Metaphor is very rich. This richness is reflected in its number of basic entailments, such as the following: (i) manner of action is manner of motion; (ii) a different means for achieving a purpose is a different path; (iii) forces affecting action are forces affecting motion; (iv) the inability to act is the inability to move; (v) progress made is distance traveled or distance from goal.

Such systems of metaphors, which are based on ontological correspondences, can be used to structure the meaning as well as the form of entire discourses. This is in line with Goldberg (1998: 214), who affirms that a way in which the constructional meaning of concepts, such as motion, changes of state, causation, and transfer, can be extended is through the use of systematic general metaphors. This is one of the reasons why the overall conceptualization evoked by a complex linguistic expression is never the sum of the meanings of its lexical and grammatical components, but also depends on its construal or our capacity for conceptualizing the same situation in different ways.

Both image and conceptual metaphor can also be found in scientific discourse. In fact, metaphor is crucial because it helps to shape scientific thought and theories. At a very general level, metaphors are commonly used to introduce vocabulary and basic models into scientific fields where none previously existed. According to Boyd (1993), the scientific use of metaphor does double duty in that it creates the entire range of vocabulary to describe a new domain, and at the same time makes this new domain interact with the other domain involved in the metaphor. Scientists literally and metaphorically create a world of make-believe through a web of words as shown by Ahmad (2006). This is the case of the solar system metaphor of the atom, the code metaphor for DNA, and the wave and particle metaphors, both of which are used to represent theories of light. Pinker (2007: 257) writes:

Scientists constantly discover new entities that lack an English name, so they often tap metaphor to supply the needed label: *selection* in evolution, *kettle pond* in geology, *linkage* in genetics, and so on.

Goodman (in Ahmad 2006) refers to this phenomenon as the *multiple moonlighting service* of terms. However, this recycling of terminology is hardly random. According to Hoffman (1985), metaphors in science are used for the following purposes:

- To describe novelty (i.e. *propose, give meaning, or predict*);
- To interpret existing theories (i.e. *suggest or contrast*)
- To explain consequences and new phenomena (i.e. *provide explanations or describe*)

Metaphor is also a valuable tool in the field of software design. As a field, information technology is rife with metaphors. E-mail and its accompanying desktop icons are obvious examples. E-mail is sent over the Internet, the Information Superhighway, or the World Wide Web. All of these are metaphors for tying down these abstract expressions of silicon and light (Giles 2008: 2).

The metaphors employed do not arise spontaneously, but have a very specific utilitarian function. They help users understand software programs, and are largely based on interaction between human and computers (Fineman 2004: 4-5). Besides being a way of creating new terminology, such metaphors are instrumental in the creation of a user-friendly product. According to Heckel (1991) and Schön (1993), software designers use metaphors for three different purposes: (i) familiarizing; (ii) transporting; (iii) invention.

Familiarizing metaphors make a product easier to understand by linking the program to everyday entities that the user already knows how to use (e.g. the desktop). *Transporting metaphors* allow users to view and solve problems in new ways. The example given by Heckel (1991) is a path metaphor that permits users to go back in web browsers and start again. The path metaphor can be applied to a number of other computer contexts in which the user is able to retrace his/her steps. Since going back in time is only possible in the realm of science fiction, many people find this computer functionality very satisfying because it emulates the heartfelt wish to be able to do a "restore system" in real life, and effectively start over again from a previous chronological point. *Invention metaphors* are mainly for designers, who use them as a way to generate new ideas. One example of such a metaphor is the COMPUTER IS A BABYSITTER, which led to programs, such as NetNanny, which control access to certain websites.

Functionality metaphors deal with what the software product can do, whereas *interface metaphors* deal with the mechanics of how tasks are accomplished. As applied to e-mail programs, for example, functionality and interface metaphors are based on different construals of the metaphor E-MAIL IS PHYSICAL MAIL. Designers thus take advantage of the user's knowledge, beliefs, and experiences with real mail to create programs that are based on links to this previous knowledge. Interaction metaphors focus on the human-computer relationship, which relies on direct manipulation, and are based on the general interaction metaphor, DATA IS A PHYSICAL OBJECT (e.g. drag and drop options for folders and files) (Hutchins 1989).

These different types of metaphor show how metaphor is systematically applied to technology to foster creative thought and enhance user understanding.

2.3.1.2 Metonymy

According to Lakoff and Turner (1989), metonymy is a conceptual mapping within a single domain or domain matrix, which involves a ‘stand-for’ relationship for contiguous entities, and mainly has a referential function. Kövecses and Radden (1998: 39) define metonymy as “a cognitive process in which one conceptual entity, the vehicle, provides mental access to another conceptual entity, the target, within the same domain”. This is why metonymy is often referred to as a one-domain operation. This definition differs from the one offered by Lakoff and Turner because the emphasis is on cognitive access. No mention of the referential function since non-referential metonymy does exist (e.g. speech act metonymies), and has been studied by various scholars (Thornburg and Panther 1997; Perez Hernandez and Ruiz de Mendoza 2002; Ruiz de Mendoza and Baicchi 2007). However, for our purposes, we are more interested in referential metonymy, which is the most frequent kind in specialized texts.

Within Croft’s (1993: 348) domain-based view of meaning, metonymy involves the highlighting of one subdomain, which is part of the domain matrix of the concept profile in question and the backgrounding of another

For example, the encyclopedic characterization of a violin includes the instrument as a physical object (37), the person playing the instrument (38), the music written for the instrument (39), and the music produced by the instrument (40).

- (37) He bought a new violin at the store the other day [MUSICAL INSTRUMENT].
- (38) The violin in the chamber music group is very good [PERSON PLAYING THE INSTRUMENT].
- (39) The violin in the second movement of that symphony is difficult to play [MUSIC WRITTEN FOR THE INSTRUMENT].
- (40) The violin was off-key during the entire concerto [MUSIC PRODUCED BY THE INSTRUMENT]

Examples (37-40) are in contrast with each other because they highlight different knowledge dimensions or subdomains regarding this musical instrument, and thus involve a shift of domains within the matrix. Evidently, (37) refers to the instrument itself, whereas (38), (39) and (40) are metonymic because they refer to other less central, but contiguous areas in the domain matrix or frame representation of the encyclopedic characterization of VIOLIN.

Metonymy is informative of the way concepts are categorized, and can even affect how we talk about them, as reflected in their syntax. For example, generally speaking, *water* is understood as an unbounded substance, but in specialized language communication, it can be used to refer to the location or locations where the water is found.

In environmental science, water can be metonymically conceived as a bounded entity. This is the case of *interstitial water* and *dystrophic water*, both of which refer to bounded water. In both cases the water is located in a clearly bounded space, and can be used in the plural.

- (41) In addition, **interstitial waters** might reflect ground water – surface water transition zones in upwelling or downwelling areas.
- (42)although **dystrophic waters** are found in areas of peatland/blanket bog, in practice, without survey or monitoring data for individual sites, it can be difficult to distinguish dystrophic from oligotrophic standing waters.

Metonymy is often described as based on contiguity, or part-whole relationships, and in examples (41-42), the relation between *water body* and *interstitial waters* is arguably based on this type of relationship. *Interstitial waters* in (41) refers to subsurface water contained in pore spaces between the grains of rocks and sediments. Again, the water is in a space bounded by the rock particles where it is located. Dystrophic water in (42) refers to a shallow body of highly acidic water that contains much humus and/or organic matter. As such, it designates a body of water, which is located in a certain area. Since the water is part of the water body, which contains it, this metonymy is based on a part-whole relationship.

Certain types of terminological variation, based on a shortened version of the full term, also seem to be the result of metonymic processes. For example, in the field of medicine, a *magnetic resonance image* (the product of magnetic resonance imaging radiology) is also referred to as a *magnetic resonance* (the technique used). Within this domain, another common mapping is the material used for the product. An example of this is *plain film of the abdomen* instead of *plain abdominal radiograph* or *x-ray* (Tercedor Sánchez and Méndez Cendón 2000: 95).

Another important issue that affects terminology is the relation between metonymy and vertical polysemy. According to Koskela (2005: 1), the phenomenon of vertical polysemy is also often treated as arising through a metonymic process or as involving a metonymic mapping. In vertical polysemy, a word form designates two (or more) distinct senses that are in a relationship of category inclusion or hyponymy. She agrees with Seto (1999, 2003), who affirms that treating vertical polysemy as metonymic relies on a metaphorical conception of categories and often effectively involves a confusion of taxonomic relations with meronymic part-whole relations.

Seto (1999: 91) points out that metonymy is not the same thing as category extension because metonymy operates between two real world entities, and is based on “spatio-temporal contiguity as conceived by the speaker between an entity and another in the (real) world”. In contrast, category transfer is based on our knowledge of

categories and how they are ordered in our mind. It thus relies on a relationship between conceptual categories.

Despite the fact that general language concepts are structured taxonomically, surprisingly little has been said about taxonomic relations in semantics except to beg the question, and shove them into a back drawer. Kövecses and Radden (1998), for example, assert that vertical polysemy is motivated by the metonymy A CATEGORY FOR A MEMBER OF THE CATEGORY (when meaning is narrowed) and the metonymy A MEMBER OF A CATEGORY FOR THE CATEGORY (when the meaning is broadened). In Radden and Kövecses (1999), these same authors admit that there is a certain confusion between taxonomy and meronymy, but they feel justified in analyzing such relationships as metonymy.

In Terminology, great emphasis is placed on vertical or hierarchical relationships, which are all crucial in the structuring of specialized knowledge domains. Vertical relations are IS_A and PART_OF relations (see 3.1.8). As is well-known, the IS_A relation reflects a TYPE-OF connection, which is the conceptual counterpart of hyponymy in language (the source of vertical polysemy). The PART_OF relation is the conceptual counterpart of meronymy in language. Metonymy is effectively based on the PART_OF relation, rather than the IS_A relation. The only possible justification for saying that the IS_A relation is also metonymic is to conceive a conceptual category metaphorically as a whole with its members constituting the parts that make up the category (Koskela 2005).

However, in our opinion, this would be a mistake, as can be seen in (43). In medical terminology, the category of RADIATION THERAPY is not the same thing as the process itself. Example (43) shows a segment of the category which reflects the IS_A relation between *intraperitoneal radiation therapy*, *intracavitary radiation therapy*, *internal radiation therapy*, and *radiation therapy*. In other words, *intraperitoneal radiation therapy* is a type of *intracavitary radiation therapy*, which is a type of *internal radiation therapy*, which is a type of *radiation therapy*. The IS_A relation would appear as follows.

(43) Intraperitoneal radiation therapy

IS_A (= member/part of the category of)

intracavitary radiation therapy

IS_A (= member/part of the category of)

internal radiation therapy

IS_A (= member/part of the category of)

radiation therapy

Evidently, this is not all of the category, but only a tiny segment. The category is much larger since *internal radiation therapy* is opposed to *external radiation therapy*. In internal radiation therapy, the radioactive material is placed within the body. Thus, more specific types of internal radiation therapy designate the body part or cavity where the material is located (i.e. intraperitoneal radiation therapy).

In contrast, the category of external radiation therapy, in which the radiation source is a beam projected by a machine from outside the body, has a different type of organization. For example, the terms designating more specific types of external radiation therapy specify beam type (i.e. particle beam therapy) or beam trajectory (i.e. stereotactic radiation therapy).

The IS_A type of relation is also reflected in the definitional structure of the concepts. For example, *intracavitary radiation therapy* is a type of (IS_A) *internal radiation therapy*. This conceptual relation is reflected in the definitions of the terms since the genus or conceptual label of the definition of *intracavitary radiation therapy* is *internal radiation therapy*. In this sense, the microstructure of the definitions of all of the concepts in the category of RADIATION THERAPY reflects conceptual structure as shown in Table 7:

MEDICAL TREATMENT	
	radiation therapy treatment involving the use of high-energy rays to damage cancer cells and stop them from growing and dividing.
[INSIDE] ↓	Internal radiation therapy <u>radiation therapy</u> in which radioactive material is placed in or near tumor. Also known as <i>brachytherapy</i> .
[BODY_ PART] ↓	intracavitary radiation therapy <u>internal radiation therapy</u> in which radioactive material is placed in a body cavity (e.g. uterus, chest, vagina, etc.)
[PELVIS/ ABDOMEN]	intraperitoneal radiation therapy <u>intracavitary radiation therapy</u> in which radioactive material is placed directly in the pelvic and abdominal cavities. This is a treatment for ovarian cancer. [...]
[OUTSIDE] ↓	External radiation therapy radiation therapy in which the high-energy rays used to treat the cancer patient come from a machine, located at some distance from the body.
[BEAM_ TRAJECTORY]	stereotactic radiation therapy (<u>external</u>) <u>radiation therapy</u> in which a number of precisely aimed beams of ionizing radiation coming from different directions

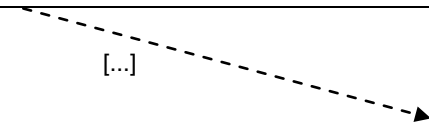
	meet at a specific point, delivering the radiation treatment to that spot.
	[...] 
[BEAM_TYPE]	particle beam therapy <u>(external) radiation therapy</u> in which high energy radiation is delivered to tumor cells through the use of fast-moving subatomic particles (protons and neutrons). [...]

Table 7. Conceptual organization of RADIATION THERAPY as reflected in the definitional structure of member concepts (Example taken from Faber 2002a).

Alternatively, radiation therapy is also a concept that has parts, and thus, can also be structured in terms of the PART_OF relation. However, since it designates an event, the parts are phases. For example, internal radiation therapy can be used to refer to the general process or one of its phases, such as seed implantation or the subsequent radiation doses by means of a delivery device. In this context, it would thus be regarded as metonymic.

In Terminology, there are also many cases of the use of the same word form for both broader superordinate and narrower subordinate meanings. A case in point is the term *berm*, which in its most general sense refers to a narrow ledge or shelf, as along the top or bottom of a slope. However, it is also used more specifically to designate a nearly horizontal or landward-sloping portion of a beach, formed by the deposition of sediment by storm waves.

2.3.2 Metaphor and metonymy in specialized language

This section describes salient features of metaphor and metonymy in specialized domains in relation to key notions in Cognitive Linguistics with a special focus on the Invariance Principle, blending, and the indeterminacy of domains.

2.3.2.1 The Invariance Principle

The Invariance Principle (Lakoff and Turner 1989; Lakoff 1993) holds that the image-schema structure of the source domain must be consistent with the structure of the target domain. This constrains possible mappings and ensures the consistency of the metaphor. The target domain thus takes precedence, and limits the forms of linguistic expression which the metaphor may motivate.

Metaphorical mappings preserve the cognitive topology (that is, the image schema structure) of the source domain, in a way consistent with the inherent structure of the target domain (Lakoff 1993: 215).

According to Lakoff and Turner (1989), topological constraints are placed on the target domain so that it preserves its conceptual integrity in the mapping process. Therefore, only the aspects of the source domain that are consistent with the target are actually mapped. Each specific-level schema thus preserves the generic-level structure, and also exhibits additional, specific-level structure. For example, in the conceptual metaphor ACTIONS ARE TRANSFERS, actions are conceptualized as objects transferred from agent to agent. In the utterance, *I gave the janitor a kiss/kick*, the source domain initially seems to indicate that as the recipient of the kiss or kick, the receiver may then possess it. However, the target domain overrides this because actions do not continue to exist after they occur. For that reason, it is possible to give someone a physical action, but without the corollary of them keeping it.

However, Ruiz de Mendoza and Mairal Usón (2007) argue that there is no override. In other words, the possession element in the source maps is not mapped onto the action of kissing or kicking, but rather onto the effects of the action. In this connection, they postulate the Mapping Enforcement Principle, which underlies all cases of metaphor-metonymy interaction and of metaphoric and metonymic chains. The principle ensures that no item will be discarded from a mapping system if the item in question may be adapted to the meaning demands of the system in terms of the Extended Invariance and the Correlation Principles.

The Invariance Principle is also reflected in specialized language. For example, specialized environmental science texts consistently show the metaphor ECOSYSTEMS ARE MEDICAL PATIENTS. The two domains involved are environmental science and medicine. This metaphor is reflected in metaphorical mappings that preserve the topology of the MEDICAL TREATMENT frame. In fact, the human health assessment model, as described by Haskell et al. (1992) specifically mapped onto the environment as though it were a patient whose illness must be diagnosed. This model has six phases in which the following actions are performed:

- identify symptoms
- identify and measure vital signs
- make a provisional diagnosis
- conduct tests to verify the diagnosis
- make a prognosis
- prescribe a treatment

Symptoms of poor environmental health can be seen in the anatomy of the environment, and are things like physical changes to the shoreline, changed sediment

patterns, or the presence of contaminants. Rather than heartbeat, temperature, and blood pressure, vital signs in the environment include the loss or reduction of species, high levels of some chemicals in biota, and changed water flows. A diagnosis is made on the basis of these signs. Tests to verify this diagnosis include monitoring for trace contaminants and algal toxins or general habitat assessment. Just as in the MEDICAL TREATMENT frame, this leads to treatment measures, which will make the environment well again. Examples of these therapeutic measures are improved sewage treatment, better aquaculture, restoration of tidal flows, etc.

Evidence of all of these mappings can be found in environmental texts. For example, when a coastal area is conceptualized as a living entity, its state is referred to as its health.

- (43) recommending and implementing an effective monitoring plan to observe indicators of **beach health** within the Santa Barbara and Ventura County coastline.
- (44) The audit was completed in 1995 and confirmed that diversion from the rivers was increasing and the **river health** was in decline.
- (45) The approach focuses on **watershed health** and the types of stressors that are important to the MPCA as we do our basin planning and TMDL restoration studies.
- (46) Although eelgrass and other sea grasses are not a direct source of food for humans, their presence is very important to **the health of a marine estuary**.

Since, the whole frame is activated, and thus mapped onto the domain of the environment, environmental areas can have symptoms.

- (47) **Symptoms** of beach erosion are repeatedly being treated through major programs, but the underlying problems remain.

A medical examination follows, which is evident in the fact that Nature, as well as parts of Nature, can have their pulse taken.

- (48) Aggregate measures of ecosystem services: can we take the pulse of nature?
- (49) Taking the pulse of the ocean explores this inter-relationship through the eyes of ocean observing systems.

The assessment of the state of a coastal area is referred to in medical terms as a diagnosis.

- (50) A groundwater sampling survey was carried out in 1991, which was designed to **diagnose the water quality status** in and around the city of Azul.
- (51) The study included a group of **diagnoses**: limnologic (with details of ichthyological aspects), sanitary, survey of the various uses, institutional and community interests, review of the current municipal laws, etc., in an attempt to obtain as comprehensive a characterization as possible.

The prognosis that results from the examination and diagnosis reflect conditions (e.g. leachate of contaminated water) that require treatment, just like health problems in human beings do. The actions aimed at solving the problems detected or diagnosed in the geographic area are lexicalized as interventions, mapping the subdomain of surgical interventions onto the environment as a way to stimulate its recovery from disease.

- (52) Leachate of contaminated water from the adjacent inundating landfill may also require **intervention** to ensure real improvements.
- (53) The towns of 'Aqaba and Eilat, located astride the Israel–Jordan border on the shores of the Gulf, provide an opportunity to investigate the interplay between physiographic constraints, **engineering intervention**, and geomorphic processes in this extremely arid environment.

The solution to environmental problems is consistently referred to as the cure or healing of a disease.

- (54) A change to wetter conditions should result in the spread of vegetation and the **'healing' of the gullies and fans**.
- (55) Similarly, **the healing of fluid filled cracks** progresses rapidly (10-100m/h) at pressures in excess of one hundred MPa and temperatures of several hundred degrees centigrade.
- (56) Furthermore, the parameterization tends to produce local anomalies of the vertical heat flux, leading to the formation of small but unrealistic polynyas directly south of the ice edge. Moderate variation of model parameters **does not cure this problem**.

Finally, just as patients sometimes need to undergo rehabilitation, ecosystems subjected to remedial therapy may recover or need further treatment to return to a fully healthy state.

- (57) This work suggests that the increases in sediment supply accompanying massive disturbance induce morphologic and hydrologic changes that temporarily enhance transport efficiency until **the watershed recovers** and sediment supply is reduced.
- (58) Onshore velocity is more effective at moving coarser sediment than the offshore velocity. This effect is essential in predicting the shoreward transport of sediment during periods of **beach recovery**.
- (59) The aim of this work is to better understand natural **recovery processes** in streams in order to help set priorities for **stream rehabilitation**.
- (60) Appropriately sited and successful wetlands restoration projects can protect or **rehabilitate watersheds** where wetlands resources are lacking due to historical degradation or conversation.

This type of metaphorical mapping is very productive and extends to all of the phases of the medical treatment process. However, it is valid only at a generic level,

since the ecosystem cannot act like a patient at more specific levels. For example, it cannot go to an outpatient clinic, undergo breast surgery, suffer from rheumatoid arthritis, or be treated for hemorrhoids. Nevertheless, the generic structure for medical treatments is a standard mapping for environmental projects.

The Invariance Principle is also valid for metonymy. Metonymy, insofar as it is domain-internal mapping, preserves the basic topological information underlying the mapping. As Ruiz de Mendoza (1998) rightly points out, the Invariance Principle only offers constraints for metaphorical mappings based on image schemas. He thus argues for an extended Invariance Principle that applies to generic level structure of the target to be preserved so that it is consistent with the generic-level structure of the source. This extended Invariance Principle would provide conceptual consistency for high level structure. This signifies that generic-level metaphors relate generic-level schemas. The list of the elements contained in a generic-level schema is the following:

- (a) Basic ontological categories (entity, state, event, action, situation, etc.);
- (b) Aspects of beings (attributes, behavior, etc.);
- (c) Event shape (instantaneous or extended, single or repeated, completed or open-ended, cyclic or not cyclic, etc.);
- (d) Causal relations (enabling, resulting in, creating, destroying, etc.);
- (e) Image-schemas (bounded regions, paths, forces, links, etc.);
- (f) Modalities (ability, necessity, possibility, obligation, etc) (Lakoff and Turner 1989: 81).

Such generic schemas are present in specialized language, and are the basis for the creation of terminological units within a specialized knowledge domain. For example, in tumor classification, terminological designations activate and highlight specific areas of generic schemas related to the nature of malignant tumors:

- (61) LOCATION: e.g. breast cancer, pancreatic cancer. [Breast cancer and pancreatic cancer are both terms which refer to the body part where the tumor is located.]
- (62) ORIGIN: e.g. embryonal carcinoma, basal cell carcinoma. [Basal cell is the type of skin cell where the cancer originates.]
- (63) EVOLUTION: e.g. invasive cervical cancer, invasive ductal breast carcinoma. [Any type of invasive cancer has evolved in that it is no longer *in situ* or confined to a specific location, but rather has acquired the ability to invade neighboring tissues.] (Tercedor Sánchez 1999)

Combinations of different dimensions were also identified, such as the following:

- (64) ORIGIN + LOCATION: small cell carcinoma of the lungs. [This type of carcinoma originates in the lungs and originates in a cell type known as *small cell*.]

- (65) LOCATION + EVOLUTION: lobular invasive carcinoma, [This type of carcinoma has invaded another location and is located in breast lobules.] (Tercedor Sánchez 1999)

With regard to metonymy, this extended Invariance Principle is delimited by the preservation of the generic-structure configuration of the domain-internal relationships. However, it is necessary to carry out further analyses of metaphoric mappings in specialized domains so as to study constraints and understand the patterns of ontological correspondences and productiveness between source and target domains.

2.3.2.2 Blending

The context-bound or situated nature of meaning construction is rooted in the notions of Blending Theory and mental spaces (Fauconnier 1985, 1998; Fauconnier and Turner 1998, 2002) (see 2.2.4.1). Conceptual Blending Theory can be applied to Terminology because it is reflected in the semantics of compound nominals, which are so frequent in specialized language. In this regard, the metaphorical relation between components in the nominal form can be accounted for by means of *blends*. Metaphorical terms often have new features that do not correspond to features of the source or target domains. These new features can be explained by means of Blending Theory, which uses the notion of the construction of a blended space in which structures can be integrated (see 4.1.2).

In specialized language, blending is a common cognitive phenomenon. In fact, many processes of neology involve a word-formation morphological process called blending, which does not differ greatly from the cognitive notion of blending. In morphological blends, a word is produced by combining parts of other words to create a new word, such as in *smog* from *smoke* and *fog*. In specialized language, this occurs frequently. For example, *sonar* is a blend of *sound navigation* and *ranging*. Similarly, *quasar* is a combination of *quasi-stellar* and *star*. Cognitive blending can result in different morphological processes, such as the combination within the same lexeme of stems of Latin or Greek origin acting as input domains to create a new reality within a generic space or the creation of compound forms.

Etymological blending is present in specialized language as evidenced by the following examples from medicine, environmental science, and sociology. The first two examples show that terms of classic origin are the result of blending processes.

Term	Definition	Input domains for the blending
Hysterectomy	Surgical incision of the uterus, as in a cesarean section.	From Greek <i>hustera</i> (uterus) and <i>tomos</i> (cutting).

	<i>(American Heritage Dictionary)</i>	
Anemometer	An instrument for indicating and measuring wind force and velocity. <i>(American Heritage Dictionary)</i>	From Greek <i>anemos</i> (wind) and <i>metron</i> (measure).
Happy slapping	Unsocial violent behavior in which an unsuspecting victim is attacked while an accomplice records the assault with a camera phone or a smartphone <i>(adapted from Wikipedia)</i>	From <i>happy</i> (initially attackers pretended the assault to seem like a comical surprise, therefore it was seen as harmless fun) and <i>slapping</i> (to strike with a flat object, such as the palm of the hand). In the generic space of teenager violent behavior, both meanings combine in a macabre and unfortunate new meaning.

Table 8. Cognitive blending and word formation

According to Fauconnier and Turner (2002), meaning construction is a synergic phenomenon which involves an integration of structures that gives rise to more than the sum of its parts. Therefore Blending Theory allows for the description of meaning construction in metaphorical expressions that do not follow conventional mappings as well as for the connection between metaphor and metonymy. Fauconnier and Turner (2002) affirm that metaphors are better accounted for in terms of the activation of multiple input mental spaces (which replace the traditional source and target domains) plus two middle spaces termed the *generic* and the *blended* space (Ruiz de Mendoza 1998; Ruiz de Mendoza and Peña Cervel 2005).

In specialized language, many metaphorical and metonymic processes seem to be based on networks in which different frames are blended in usage events. Interaction between dimensions can be observed in the blends that take place in the domain, as well as in the term variants that occur and place referential focus on a particular dimension of the domain.

There are many examples of conceptual blending in the field of marine biology (Ureña and Faber 2010). These metaphors are, in fact, clear instances of formal blending, more specifically, of compounding. A case in point is that of the archerfish (Toxotidae), a blend of two input spaces: ARCHER and FISH. The behavior of this type of fish is thus compared to the behavior of an archer. Its function is that of an archer's bow. The reason for this comparison is that an archerfish has the ability to spit water droplets at aerial insects (either on the wing or resting on surfaces above the water). In

this way, the insects are knocked onto the water surface so that the archerfish can eat them (see Figure 10).

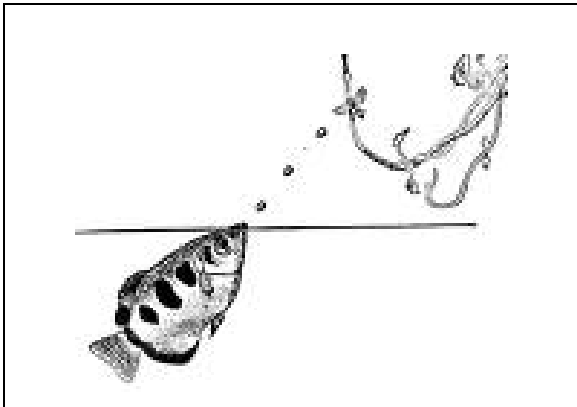
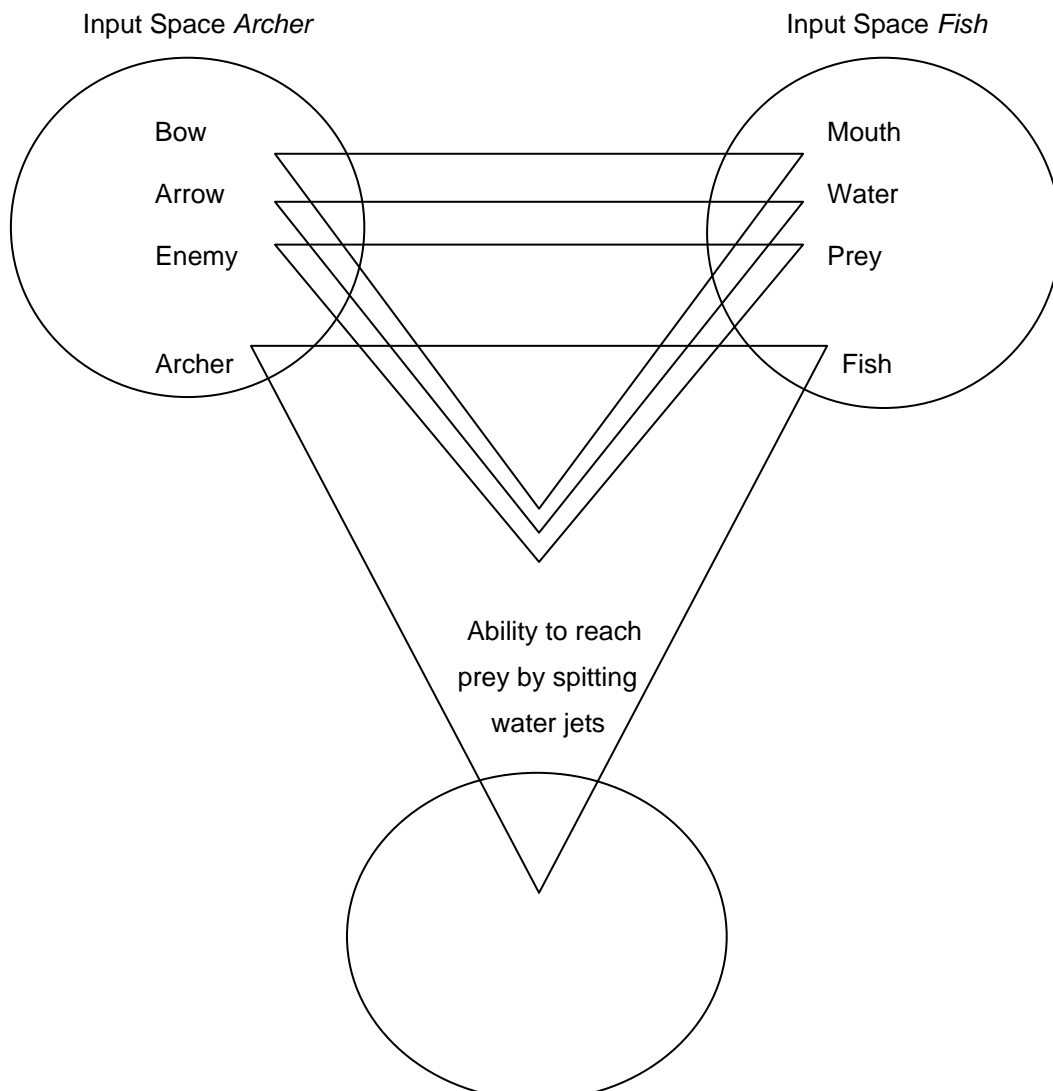


Fig. 10. Archerfish in action

In this way, the dynamic image of an archer shooting an arrow at a target is superimposed onto the image of an archerfish spitting water at an insect. The compound *archerfish* involves two input spaces relating to the forms *archer* and *fish*, plus the conventional array of meanings linked to these lexical items.



Archerfish

Figure 11. Blended space: *Archerfish* (example taken from Ureña and Faber 2010)

Nevertheless, the projection to the blended space is selective, including only a subset of semantic features associated with the concepts of ARCHER and FISH, along with their forms (what is known as word projection). Thus, both conceptual structure and linguistic structure are projected into the blend, giving rise to a novel, emergent structure. This structure is novel from the linguistic point of view since a new word is created. It is also novel from a conceptual point of view since the word has a different meaning (see Figure 11).

2.3.2.3 Indeterminacy of domains

It has been argued that a domain-based distinction between metaphor and metonymy is not sufficient in itself because the distinction between domains and subdomains is far from clear (Taylor 1995; Barcelona 2003). This criticism is in direct relation with the fact that the representation of domains and their internal structure has never been satisfactorily dealt with in Cognitive Linguistics. Even though the notion of *domain* is central to Cognitive Linguistics, its indeterminacy is one of its most problematic aspects. Croft (1993: 339) writes:

The notion of a domain is central to the understanding of metaphor and metonymy. In particular, it is critical to identify when one is dealing with a single domain or different domains. Despite, its centrality, the notion of domain has not been delineated in detail. It is related to the notion of a semantic field as in the field theories of Trier and others.

Croft's vague affirmation that a domain is related to the notion of a semantic field is not without problems, and is in need of further specification because semantic fields have been conceived in different ways.

Trier (1931) was the principal exponent of the strong version of field semantics. Within this context, a semantic field refers to a series of lexical items directly connected through paradigmatic and syntagmatic relationships. These connections semantically characterize each word and differentiate it from the rest of the group. This is perhaps too inflexible to use as a domain model since meaning is rarely, if ever, black and white.

However, according to Post (1988) and Nerlich and Clarke (2000), there is a weaker version of field semantics proposed by other authors (Meringer 1909; R. M. Meyer 1910; Gipper 1959), which shares essential characteristics with contemporary frame semantics. These authors offer a vision of semantic fields based on the premise

that language helps to structure thought to some degree, and that language can be systematized. The groups of words fall under the same conceptual heading and reflect the world as experienced by the users of a language (Nerlich and Clarke 2000: 126). In this respect, semantic field theory, in its weaker version, is similar to frames, since these semantic fields are not just systems of paradigmatic and syntagmatic relationships, but are enhanced with other types of information (Faber and Mairal Usón 1999: 74).

Langacker (2000: 23) proposes a characterization of cognitive domains. He sees them very generally as conceptualizations of any type or degree of complexity, which represent the multiple realms of knowledge and experience evoked by linguistic expressions. The most prominent domains, which are the basis for linguistic meaning, would thus be those residing in the speaker's apprehension of the immediate context.

According to Clausner and Croft (1999: 1), domains or conceptual structures represent a construal of experience. The internal organization of categories involves prototypes and is organized by at least taxonomic relations (thus leaving the door open for other types of conceptual relation). They maintain that even though the basic constructs of *concept*, *domain*, *construal*, and *category structure* go by different names, they are essentially the same among researchers in Cognitive Linguistics. However, this rather loose interpretation of a domain is confusing, and conducive to an *ad hoc* specification by which domains are produced by linguists in much the same way that a magician obligingly produces a never-ending supply of rabbits from a hat.

Since such understanding necessarily depends on a previous inventory of conceptual categories and a model of category structure, categorization is a crucial background phenomenon for the understanding of metaphor and metonymy. The target is interpreted as instantiating or accessing a pre-existing conceptual frame or category, which is activated in context. The problem is how to satisfactorily represent and model metaphorical and metonymic processes as related to category or domain representation.

Geeraerts (1995) presents three major types of formal representations for conceptual domains: the radial set model popularized by Lakoff (1987), the schematic network as defined by Langacker (1987, 1991), and the overlapping sets model introduced by Geeraerts (1989). Despite the existence of superficial differences, he argues that these three modes are in reality, notational variants because all of them account for salience effects, metaphor and metonymy, hierarchical semantic links, and discrepancies between intuitive and analytical definitions of polysemy. These representations have been applied on a very limited scale, but do not seem to solve the underlying problem of mapping out interrelated concepts in an entire domain.

In both general and specialized language, conceptual domains constitute the knowledge base of the natural language user, and as such, form a semantic network reflecting associated structure, much of which is based on metaphorization, and is often non-language specific. A case in point is the well-known metaphor which conceptualizes understanding an idea as seeing it in the mind. This link between visual perception and mental perception occurs across a wide variety of languages. It can even underline the relation between sight, thought, and speech since one can observe [VISION] a tree falling, and observe [MENTAL PERCEPTION] to oneself that the standard formula for gravitational force that affects the tree is:

$$(66) \quad \text{Gravitational force} = (G * m_1 * m_2) / (d^2)$$

where **G** is the gravitational constant; **m1** and **m2** are the masses of the two objects for which the force is being calculated; and **d** is the distance between the centers of gravity of the two masses. One can also *observe* [SPEECH] to someone else that lightning made the tree fall.

Since categorization and category structure are so central to metaphorization, it would thus seem natural that the analysis of metaphor should hinge, at least in some degree, on the existence of an inventory of conceptual domains or very general events (in the case of actions and processes) as well as a constrained inventory of conceptual relations. Any type of understanding naturally implies the generation, extension, and linkage of a structure in which new knowledge is integrated into previous knowledge in such a way as to make explicit conceptual relations (Mairal Usón and Faber 2002: 69). In this respect, metaphorical and metonymic extension is an important means of linguistic creativity and knowledge representation, but there is a need to place constraints on the characteristics of a domain as well as how it is structured.

When discussing domains, Croft (1993) underlines the fact that a concept can have various dimensions or subdomains, and may also belong to different domains. This range of domains constitutes the domain matrix of that concept. The notion of domain matrix was originally introduced by Langacker (1987), who states that the difference between dimensions and domains in a matrix is only based on cognitive independence. Thus, the difference is only a matter of gradation. Croft (1993: 340) differentiates domains and dimensions as follows:

In practice we are more likely to call a semantic structure a domain if there are a substantial number of concepts profiled relative to that structure. If there are few, if any, concepts profiled relative to that structure alone, but instead there are concepts profiled relative to that structure and another one, then those structures are likely to be called two dimensions of a single domain. The term "domain" implies a degree of cognitive independence not found in a dimension.

The idea that a concept may be simultaneously part of different domains is the basis for the notion of multidimensionality in Terminology. Multidimensionality is one of the most striking features of specialized domains (Bowker and Meyer 1993; I. Meyer and Mackintosh 1996; Bowker 1997).

For example, X-RAY is a multidimensional concept because it is used for both diagnosis and treatment in medicine. Within the specialized knowledge field of MEDICINE, it thus belongs to both the domains of DIAGNOSTIC PROCEDURE and MEDICAL TREATMENT. Quite understandably, it is often difficult in specialized language to systematically assign concepts to a particular domain or dimension. However, the natural language definition of the concept is very helpful because the nucleus or the generic term in the definition assigns the concept to a conceptual category, which is a part of a domain. The domain matrix concept is a key notion in frame-based terminology management.

As previously mentioned, the domain of MEDICINE is often mapped onto environmental science. A very clear example of how the medical examination and treatment metaphor is applied to a coastal ecosystem can be found in the following text:

Steevens *et al.* (2001) suggest a physician-like approach to the patient (a coastal ecosystem) that involves diagnosis, prognosis, treatment, and prevention. However, in practice it is often difficult to relate a symptom to a cause, and thus a cure. They noted that in the northern Gulf of Mexico [...] 90% of that area also had one or more significant environmental stressors such as sediment contamination, sediment toxicity, hypoxia, or nutrient enrichment (Boesch and Paul 2001).

However, the same metaphor can also be extended to other scientific and technical domains, such as automotive engineering. In this type of mapping, the medical patient is a vehicle, and the mechanic acts in the same way as a doctor to discover what is wrong and in need of repair. Table 9 shows the procedure to be followed, which uses the same conceptual categories as a medical protocol:

Symptom	Diagnosis	Cure
Starter turns engine slowly: lights dim or don't work	Weak or flat battery	Push start a manual gearbox car or use jump leads (Check vehicles handbook first to see if this is possible). <u>How to use jump leads.</u> Recharge battery.

	Get garage to check the battery and charging system.
--	--

<http://www.hintsandthings.co.uk/garage/diagnosis.htm>

Table 9: Medical protocol applied to a vehicle

In specialized language and texts, metaphor plays an important role in language creativity and knowledge representation in specialized domains (e.g. Temmerman 2000; Vandaele and Lablin 2005; Faber and Márquez Linares 2004; Tercedor Sánchez 2004). Metaphorical meaning is not, at least in its basic functional respects, a special kind of meaning, but rather the result of a special process for arriving at or construing a meaning (Croft and Cruse 2004: 194).

Temmerman (2000: 30) gives an overview of the role of metaphor in the sociocognitive approach to Terminology. She describes metaphor from a linguistic, decoding perspective, and claims that “the understanding of metaphor happens through decoding at the word level”. She states:

Metaphorization and generalization are the result of encoding starting from the analogical understanding of new categories. Initially, the resulting name or term for the concept cannot be fully understood in its new meaning without understanding the basis for the naming, i.e. without understanding the cognitive models and their sociocultural embeddedness.

Metaphor does not occur as an isolated phenomenon, but is rather a network of metaphorical patterns in specialized domains that give coherence to conceptual structure. Economy and creativity are the driving forces behind metaphoric and metonymic expressions in terminology. Context is central since it is crucial to situate meaning and abstractions through usage events. Contextualized uses of a particular lexical item provide clues about the location of a concept within a conceptual category, and the specifications of a particular scene (Barsalou 2003).

Context provides access to the linguistic use of the concept. In other words, it shows the term *in vivo* as opposed to the term *in vitro* (Dubuc and Lauriston 1997). The value of a terminological unit *in vivo* is reflected in contextualized uses that activate its full semantic potential, which is not readily available through compositional analysis (Taylor 2006: 63). However, it is also important for concepts to be situated in knowledge structures (frames, ICMs, domains, mental spaces) within different types of events (Faber and Tercedor Sánchez 2001: 193). Only by studying these frames from a linguistic perspective of use and experience can we access specialized knowledge, and identify relevant patterns of terminological usage in the domain in question.

One feature of a contextualized description is the existence of common spaces between concepts from apparently different conceptual domains. For example the term *hemorrhage* through its extended metaphoric meaning relates the concepts of BLOOD and MONEY (Faber and Tercedor Sánchez 2001: 198).

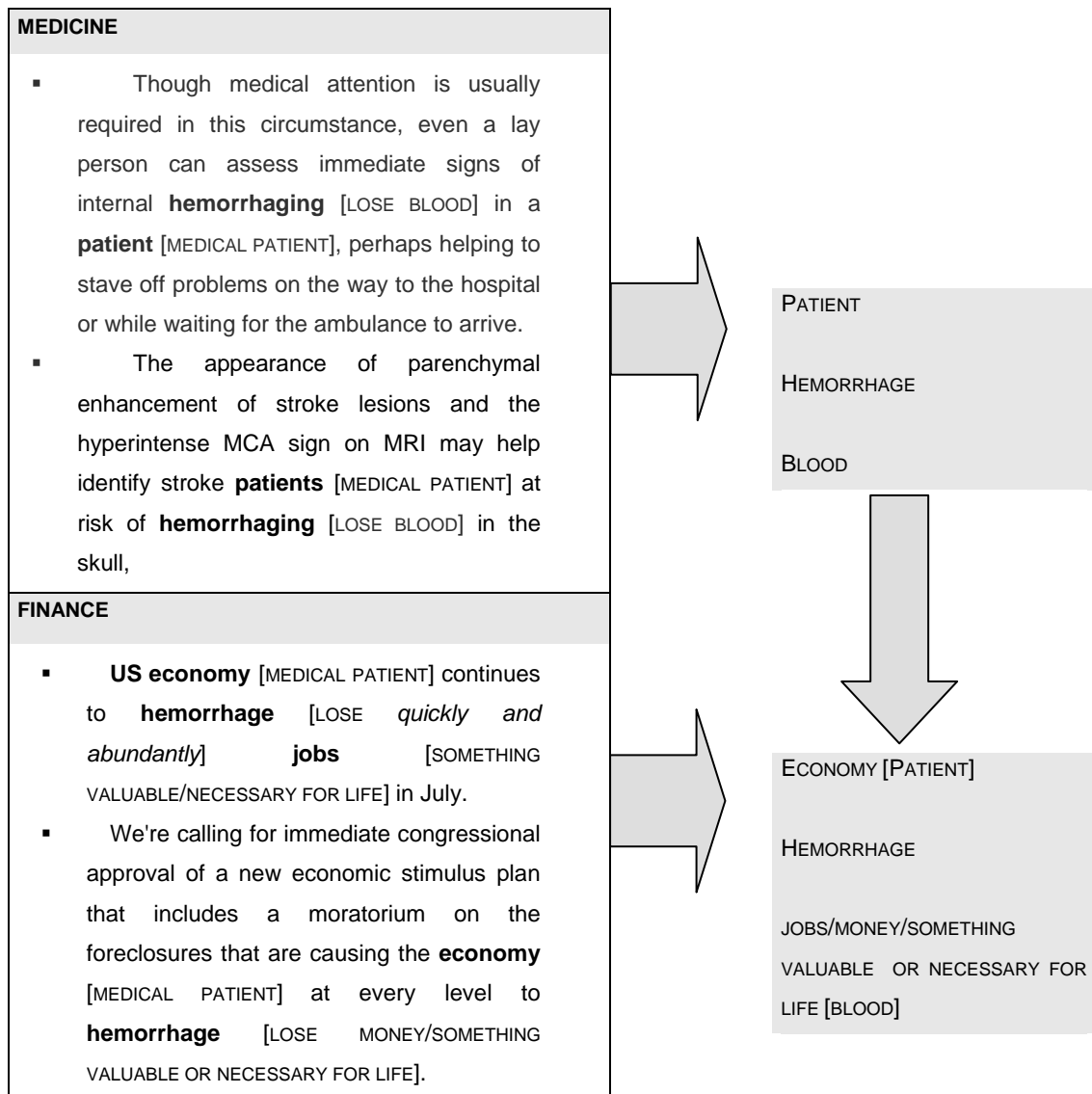


Table 10. Medical frame applied to the economy

In the texts in Table 10, the medical HEMORRHAGE frame is extended to the domain of finance. The economy is the medical patient, who, instead of hemorrhaging or losing blood, loses jobs and money. Metaphorical and metonymic patterns can be codified by studying the extensions *in vivo*, and by placing patterns in the frames or dimensions where they belong. This signifies accessing metaphor and metonymy in texts, and analyzing which patterns are recurrent and which play a key conceptual role in the domain or dimensions of a domain.

2.3.3 Metaphor in the environment: a corpus-based study

This section illustrates the principles explained so far by applying them to the corpus of specialized texts in the field of ENVIRONMENTAL SCIENCE. Metaphorical meaning extension is as much a part of specialized language as it is of general language. Meaning construal is just as pervasive in specialized language, where new concepts are constantly being created, and must be named.

However, conceptual mapping is too wide a term to designate this very rich and varied phenomenon since metaphors in specialized texts can occur at the terminological, propositional, textual, or conceptual levels (Faber and Márquez Linares 2004; Tercedor Sánchez 2004).

The conceptual level pertains to domain structure, conceived as knowledge categories. It provides essential information about lexical units. In lexicology, the meaning of any lexical concept depends on the meanings of all other lexical concepts in the domain:

Expressions like hot, cold and lukewarm designate lexical concepts in the domain TEMPERATURE: without understanding the temperature system, we would not be able to use these terms. (Evans and Green 2004: 230).

Thus, domains are highly organized structures. What Cognitive Linguistics defines as conceptual mapping is, at its core, the possibility of projecting conceptual networks of meaning from one domain onto the conceptual network of another. Such cross-domain mappings are highly productive, and give rise to many metaphorical extensions.

The term level points to how single lexical categories are understood in terms of other lexical categories. Although such instances of metaphor might resemble one-off image metaphors, they can also be very productive, and motivated by similarities which go beyond the scope of any particular domain and operate throughout the lexicon. For example, both the metaphorical extension for *foot* and *perch* in Table 11 are based on similarity in position.

	General language	Specialized language
<i>foot</i>	His foot was so huge that he had to order his shoes specially made.	Pre-Alpine basins extend at the foot of the Alps mountain-front and into the Alpine Piedmont.
<i>perch</i>	At school each morning, the raven would <i>perch</i> on the windowsill and watch her.	A <i>perched</i> aquifer is a saturated zone within the zone of aeration that overlies a confining layer. A perched aquifer sits above the main water table.

Table 11. Metaphorical extensions from general to specialized language

In the case of *foot*, it is evident this body part is mapped onto the mountain to designate the area at the base. *Perch* is also a metaphor, which refers to the location of the aquifer. The fact that *perch* is a verb derived from the noun *perch* (i.e. a rod or branch, usually a roost for a fowl) means that the aquifer is conceptualized as a bird because of its geographic configuration and position.

Kövecses (2003: 80) introduces the notion of scope of metaphor as “the full range of cases, that is, all the possible target domains, to which a given specific source concept applies”. Some metaphors take place at more generic levels, while others are specific to particular domains. A distinction can be drawn between domain-constrained metaphorical extension, which depends on conceptual mapping on a limited scale, and non-domain-constrained metaphorical extension, which is based on metaphorical extensions that are productive throughout many possible target domains.

2.3.3.1 Non-domain constrained metaphorical extensions

Within the domain of ENVIRONMENTAL SCIENCE, the most productive non-domain-constrained metaphorical extension is related to the human body. For example, geographic features are often designated by general language words for body parts.

	Specialized language
head	We examined channel response following the removal of low-head dams on two low-gradient, fine- to coarse-grained rivers in southern Wisconsin.
neck	all of the natural meanders were bypassed by man-made channels cut through the neck of the meanders.
arm	This may have formed as a result of cyclonic vorticity produced in the boundary layer, where the upstream arm of the main eddy met the vertical sidewall.
shoulder	The geomorphic evolution of Makhtesh Ramon, a feather-shaped erosional valley, and the Nahal Neqarot drainage system to the south occurred largely in response to tectonic activity along the Dead Sea Rift and its western shoulder .
toe	This playa is drained southward by Salt Creek, which flows along the toe of Hell's Gate fan and then antecedently through Salt Creek arch to the Cottonball playa.
finger	This shape is something of a cartoon of the experimentally observed shapes, with their slightly yet gracefully curved finger fronts at each end indicating some departure from complete hydrostatic balance.

Table 12. Terms reflecting the conceptual metaphor A LANDSCAPE IS A HUMAN BODY

Nevertheless, this type of metaphorical extension can vary, depending on the language. For example, *mouth* is a very productive term in English for mappings of geographic features that have a point of contact with the outside environment, such as estuary, channel, basin, bay, harbor, etc. However, even though in English, *river mouth* is a metaphorical term, the metaphorical derivation of the Spanish term, *desembocadura* ['place of coming out at the mouth'] is somewhat less evident. The same is true for the French term, *embouchure*, although in both cases the original metaphor, based on *boca/bouche* ['mouth'], is easily recognizable.

In other cases, the mapping is exactly the same, but, curiously enough, the body part naming the concept is a different. For example, the *toe* (of a slope, dike, dune, margin, bank, bulkhead) in Spanish corresponds to *pie* ['foot'], which collocates with geographic features such as *cordillera* ['mountain range'], *ladera* ['mountainside'], *presa* ['dam'], and *duna* ['dune'].

Body parts can also be mapped onto structures. For example, a **SPILLWAY** is defined as the part of a dam through which excess water is released into a downstream area to avoid overtopping or damage to the dam. In English, the upper part of a spillway is called the *spillway crest*. *Crest* is a polysemic term and has a variety of meanings in general language (as the result of a process of metaphorical extension). However, its most basic meaning is a tuft or other natural growth on the top of the head of an animal, as the comb of a rooster. Thus the use of *crest* to refer to the upper part of the dam is metaphorical and in consonance with the tendency to map body parts onto inanimate objects, which thus become personified. This is in line with Kövecses (2002), who affirms that one of the most common source domains is the HUMAN BODY (along with ANIMALS, PLANTS, FOOD, and FORCES).

Metaphorical terms in environmental science often arise because of morphological similarities to everyday objects, and produce image metaphors (Grady 1999). This is the case with geographic features such as *rock mattress* and *fan*. Figure 12 shows the similarity between *rock mattress* and a real mattress.

Mattress	Rock mattress
-----------------	----------------------



Figure 12. Rock mattress with an image-based motivation

Similarly, Figure 13 shows that an alluvial fan (geographic feature) resembles a *fan* (wedge-shaped device for creating a current of air) based on overall morphological similarity:

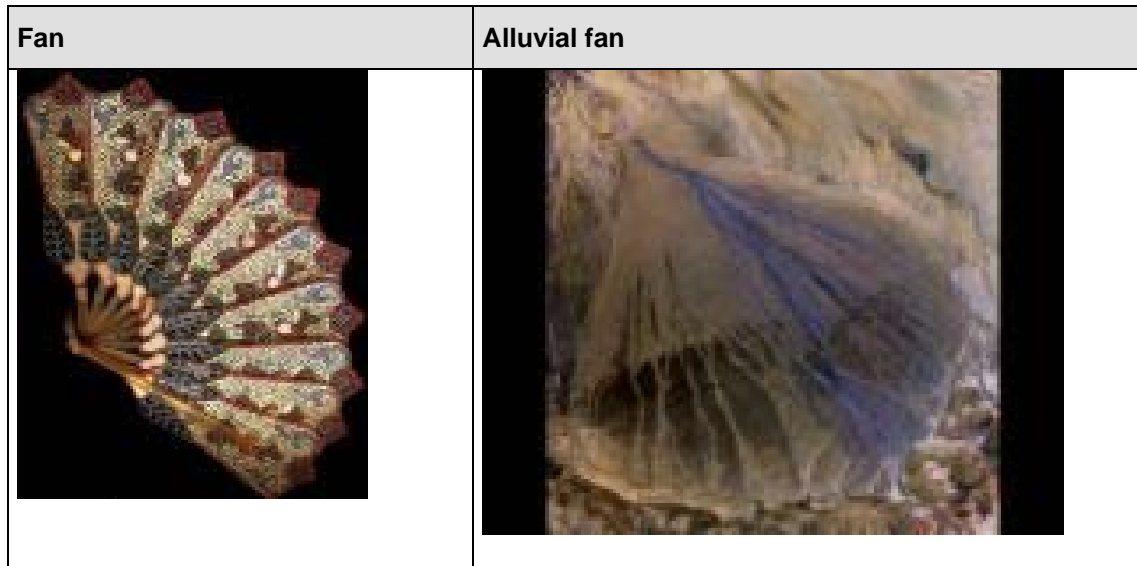


Figure 13. Alluvial fan with an image-based motivation

Many concepts in the domain of Environmental Science are conceived as containers though the type of container can vary, depending on the language. For example, the natural or artificial deposit used to store water is a *basin* in English [*reservoir basin*], whereas in Spanish, it is a *vaso* ['drinking glass'] derived from the Latin, *vas*, a vessel adapted for domestic purposes (e.g. *vaso del embalse*). The Invariance Principle is applicable here since the topology of the source domain is preserved.

Other productive instances of non-domain-constrained metaphorical extension are reflected in adjectives related to consistency, temperature, size, weight, etc. For

example, processes can be *soft* or *hard*, depending on the degree to which they affect the environment.

- (67) The information on the mechanisms by which intertidal flats and saltmarsh surfaces dissipate wave energy, and the efficiency with which they do so, places value on the role of saltmarshes as natural coastal defenses, provides input into '**soft**' **engineering** schemes for coastal defense....,
- (68) In civil engineering of shorelines, **hard** engineering is generally defined as controlled disruption of natural processes by using man-made structures.
- (69) Parliament and the public alike went for so-called "**hard** engineering" solutions, so that sea walls, breakwaters, groynes and jetties proliferated in solid Victorian tradition.

Non-domain-constrained extensions have a low productivity, such as **cloud seeding**, which represents a mapping from agriculture to weather management. Functional and morphological similarities are very powerful generators of metaphorical extension in language, and specialized language is no exception. The need to designate new real world entities often requires the use of metaphorical extension mechanisms, which are productive in other areas of meaning. The following section focuses on domain-constrained conceptual mappings, which consistently operate throughout the domain of Environmental Science.

2.3.3.2 Domain-constrained metaphorical extension

As often happens with domains related to human activity, the field of conflict is a productive resource in the domain of the environment as well as in medicine. The seacoast is a battlefield where humankind and the elements – or even the elements among themselves – fight each other. This conceptual mapping is an extension of the often-cited medical metaphor whereby the human body is a fortress, which can be attacked by external or even internal agents.

	General language	Specialized language: Environmental Science	Specialized language: Medicine
defense	Many people think of <i>self-defense</i> as a karate kick to the groin or jab in the eyes of an attacker.	The assessment of the natural sea defense value of saltmarshes is crucial to a successful sea defense and coastal management strategy.	We count on our body's immune defenses (sometimes with the help of antibiotics) to get rid of any germs that cause infection, and to protect us against new germs in the future.

Attack	Today the <i>New York Times</i> launched its latest attack on this campaign in its capacity as an Obama advocacy organization.	This is especially true along the cliffed coasts of the San Diego region, where waves directly attack the seacliffs during severe winters	An antibody is a protein that can lock onto a distinctive part of a specific foreign organism. When this happens, the antibody signals to other immune cells to attack the organism.
Battle	One of the first major battles in the civil war was the battle at Bull Run.	The rainfall peak for San Antonio in May is mostly associated with late-spring cool fronts that battle it out with moist tropical air masses from the Gulf and the Pacific	Vitamins play a key role at every stage of the immune battle . Lack of vitamin A lowers the number of T-cells, which means fewer soldiers to mount an attack.
Invade	Every time I listen to Wagner, I am overcome with a desire to invade Poland.	They observed that sediments from the Sonora's Great Desert have already started to invade areas previously dominated by the CR sediments.	Once a virus invades a living cell, it directs the cell to make new virus particles.
Incursion	Clearly, Mexican military incursions are far from a rare occurrence.	The most important climatic contrast [...] was the summer storms during the Pleistocene to Holocene climatic transition, related to [...] the monsoonal incursion of warm moist tropical air from the Gulf of Mexico	Peripheral keratoconic corneae exhibited discrete incursion of fine cellular processes into Bowman's membrane.

Table 13. The mapping of WAR on the specialized domains of MEDICINE and the ENVIRONMENT

Table 13 compares the use of *defense*, *attack*, *battle*, *invade*, and *incursion* in the generalized and specialized language. The examples show how the domain of WAR is mapped onto specialized domains, such as MEDICINE, COMPUTER SCIENCE, and the ENVIRONMENT. This type of metaphor casts environmental entities such as waves, sediments, or warm moist tropical air as invading forces. This contrasts with medicine, in which the invading or attacking forces are viruses, immune cells, and cellular processes.

However, the most productive conceptual mapping in our corpus is the EARTH IS A LIVING BEING, which is coherent with anthropomorphic views of physical entities, such

as the Gaia hypothesis (Lovelock 1979) which postulates that the physical and chemical condition of the surface of the Earth, atmosphere, and oceans has been and is actively made fit and comfortable by the presence of life itself. The mapping derives from embodied experience and links to the general understanding of our environment through our bodies. This mapping is explicit in the following text:

- (70) In geology and geomorphology theorists presented views that contained various stages of maturity, and **compared landscape evolution metaphorically to a developing organism.**

According to this conceptual association, geographic features and the Earth itself are understood as being alive, especially with the purpose of reflecting their time span.

- (71) Early History of the Earth Scientists believe the **Earth began its life** about 4.6 billion years ago.
- (72) **Dunes first begin their life** as a stationary pile of sand that forms behind some type of vertical obstacle.
- (73) Variations in the diffusivity coefficient, over **the life of the alluvial fan** is a concern because a varying coefficient will complicate the process of gully-profile evolution.

This metaphor also applies to water bodies as well as waves and water events.

- (74) The **life cycle of cascades** is subdivided into different phases
- (75) In particular, a possible **life cycle of a flow** is for shear to develop, induce an initial instability, and then trigger the transition to turbulence and significant mixing, and thus for the flow to gain a layered ambient density distribution.
- (76) These **short-lived streams** tend to have poorly developed shallow braided channels.
- (77) Icebergs normally have a **four-year life-span.**
- (78) Floods usually are local, **short-lived events** that can happen suddenly, sometimes with little or no warning.
- (79) To this end, **the life cycle duration** of the fine structure and the internal waves are very close.

The duration of atmospheric phenomena is also described as their life, and their evolution, from genesis to disappearance, is a life cycle. The categorization of a natural event as a life cycle is especially pertinent, since it is related to the idea that its intensity is variable, lower at the beginning and end, and highest in the middle.

- (80) Air mass thunderstorms normally develop in late afternoon hours when surface heating produces the maximum number of convection currents in the atmosphere. **The life cycle of these weather events** has three distinct stages.
- (81) The systems located along the west and east coast of North America are in the **middle stage of their life.** The mid-latitude cyclone east of Greenland is **at the end of its life cycle.**

- (82) Each cloud cluster within a super cloud cluster moves westward during **their life span** of about 1–2 days.
- (83) Most **hurricanes live for about a week**. However, if a hurricane remains over warm water **its life can be extended**.

Substances can also have life, but in this case their life is not related to the existence of the substance itself, but rather to the period of time when these substances are active.

- (84) Various options are available for the treatment of waste incineration residues in view of their reuse or final disposal. Such measures can be applied at **different stages of their life cycle** (from generation to reuse and/or final disposal) and can be based on different treatment approaches.
- (85) However, the presence of polar stratospheric clouds, rich in nitrogen, and sunlight facilitates a series of reactions which prolongs the **reactive life of chlorine** in the atmosphere.
- (86) The **half-life for a pesticide** defines the number of days required for a given pesticide concentration to be reduced by one-half.
- (87) Because the three week equilibration time is long with respect to the 3.82 day **half-life** of ^{222}Rn and its **short-lived** daughter products, the activities of ^{214}Bi and its daughter, ^{210}Pb , are assumed to be in secular equilibrium with ^{226}Ra .

Even constructions and structures that are the result of human activity are regarded as living entities. In this case, their life is the period of time that they are usable or in working order.

- (88) When storm activity does remove the artificial beach, generally long before its **projected life span**,
- (89) ...coastal engineers, when predicting the **longevity of a dredged beach**, fail to account for the impacts normal storm activity will have on the project.
- (90) Groins, usually constructed in groups called groin fields, have a **service life** of 25 to 30 years and need to be repaired or replaced after that time in order to be effective.
- (91) ...the **longevity of landslide dams** is controlled by a complex relationship involving the shape of the dam, the rate of reservoir filling, and the material properties of the dam.
- (92) The **useful life of such a beach**, which depends on how quickly it erodes, can be completely eliminated in a short period of time by a rapid succession of severe storms.

The “life” of such inanimate entities can also be divided into phases, such as birth, growth, reproduction, and death.

- (93) The **Birth** of a Wave Just where does a wave come from?
- (94) In Eurasia, ice sheets had their **birth place** in the Alps Mountains, Scandinavia, northern British Isles, and northern Siberia.

- (95) This prediction suggests that the initial explosion that **gave birth** to the Universe should have created radiation with a spectrum that follows a blackbody curve.

Just as living entities reproduce, inanimate entities in the ENVIRONMENTAL EVENT can do so as well. These are mainly rocks and substances that originate from other substances.

- (96) The resulting localized stressing of the Grains, if sustained, causes significant abrasion of particle surfaces, especially on corners and edges. The likely products are silt- to sand-sized **daughter fragments**, with only a slight reduction in the size of the **parent fragments**.
- (97) If the retardation of the **daughter nuclide** is greater than the retardation of the **mother nuclide**, the **daughter** concentration will be smaller in the two-phase situation and vice versa.
- (98) ^{210}Po , the effective **daughter of ^{210}Pb** , was chemically released from the sediment by leaching in 16 N HNO_3 and 6 N HCl .
- (99) The weathering rate is the rate at which **parent** rock is transformed into the **daughter** products, residuum and solutes.

If the origin of inanimate entities is described as their birth, then their disappearance is death. Thus, when water masses disappear, they are said to be *dying*.

- (100) Brackenridge was disturbed by recent long droughts and believed the river **to be dying**.
- (101) Ekman's (1905) laminar model predicts a surface deflection of exactly 45° , but the associated sub surface currents **die off** far too slowly to provide a realistic representation of the observed results.
- (102) Indeed, Gulf-Stream rings either drift away from the jet and **slowly die** by ventilation or mixing, or they interact again with the Gulf-Stream again and may be absorbed.

The disappearance of areas affected by geological processes and the cessation of atmospheric phenomena can also be referred to as dying. Even instruments that stop working are said to have died.

- (103) The divergent **secondary thrust zone** develops in a similar way before it **dies out**; the last temporary fault being sealed by deposits which onlap the tilted roof of the pop-up.
- (104) It [the sea breeze] **dies down** at sunset when air temperature and pressure once again become similar across the two surfaces.
- (105) Wave height decreases gradually as **the wind dies** and the wave approaches shore.
- (106) **ALFOS float 102** was deployed near 26.6S 7.0W but was not tracked acoustically (and **died** after 150 days) so is not included here.

When waves cease or dissipate, they are also said to die.

- (107) the time period of the **wave** is much shorter than the damping time scale so as to be observed before they completely **die out**.
- (108) Further indication of weak viscous friction was that we had to wait 20–25 min after a towing run until all visible **wavy disturbances died out**.
- (109) Internal **wave motions** were set up by small density differences across the front. These **died away** after a few minutes, leaving a distorted but essentially vertical frontal region a few centimeters wide.

Finally, beaches which disappear as a result of erosion are also “sacrificed”:

- (110) Construction of a breakwater offshore would result in **some beach being sacrificed** unless a breakwater extended along Delaware’s entire Atlantic coastline.
- (111) There are, however, several reasons for nourishing a shore. These include: Controlling erosive forces by providing a **sacrificial area** as a source of littoral material
- (112) First, beach nourishment sand directly protects the natural dune-bluffs from wave attack by serving as a **sacrificial dune** and beach buffer zone between the waves and the previously eroding natural coast.
- (113) Maybe, in fact, our needs are so high that we should — I use the term “**sacrificial streams**” —recognize that we need to manage some streams to different standards.

This metaphor indicates that the beach or coastal area is something of value, and that it has been offered in ritual slaughter for some sort of higher goal.

Consistent with the animation of inanimate entities, waves, geographic features, artificial reservoirs and the Earth itself can be described to be *juvenile*, *adolescent*, or *mature* depending on their developmental stage.

- (114) A sliver of four-billion-year-old sea floor has offered a glimpse into the inner workings of an **adolescent Earth**.
- (115) If this is true, then for 3 billion years, those microbes released oxygen into the early atmosphere of the **juvenile Earth**
- (116) The deeply weathered soils of the Guayana Shield and the **mature sediments** of the Llanos regions produce little dissolved material (Stallard and Stallard).
- (117) When those waves that are considered sea move past the area of influence of the generating winds, they **mature** and are then called swell.
- (118) **Mature hurricanes** usually develop a cloud-free eye at their center.

Juvenile water occurs as the most common term (following frequency of occurrence criteria) for the concept PRIMITIVE WATER. However, its synonym *primitive water* is more transparent, which underlines the lack of transparency or darkness of certain metaphorical compounds (Dirven and Verpoor 1998). This contradicts the often cited function of metaphor as a means of making cryptic concepts more

understandable. *Juvenile* is also productive in that it is also extended to other terms such as *juvenile lake*.

Just as living entities *behave* in a certain way, the evolution and responses are regarded as behavior:

- (119) Also horizontal heterogeneity such as burrows formed by biological activity, will affect the **erosion behavior**.
- (120) In similar situations, these two **different types of channels behave** in a very different manner.
- (121) These waves produce a rolling or swaying motion causing the Earth's surface to **behave** like waves on the ocean.
- (122) Offshore engineers have paid an increasing attention to this phenomenon over the past decade by putting their efforts in the development of numerical tools that can accurately predict the nonlinear hydrodynamic response **behavior of deepwater structures**.
- (123) The **behavior of the pre-Holocene climate** is not easily determined even though we know the general trend of climate variation, because the understanding of how varies with different variables is still insufficient.
- (124) The behavior of individual troughs and ridges can be obscured by the aggregate behavior seen in the global growth rate.

This systematic mapping of life onto the Earth and its geographic features also extends the domain of FOOD INGESTION. Since the coastal area is categorized as a living entity, the accretion of sediment and materials is described as *feeding* or *nourishment*.

- (125) The **gullies feed directly into** low-angle sand fans that cover extensive areas of the toe-slopes.
- (126) The Late Pleistocene alluvial fan successions are well exposed mainly due to incision of **younger fan head** channels that feed Holocene fans at lower elevations.
- (127) In one experiment the median size of the pulse material was nearly identical to that of the **feed sediment**.
- (128) A number of factors determine whether a community exhibits greater long-term erosion or accretion: exposure to high-energy storm waves, sediment size and composition of eroding **coastal landforms feeding adjacent beaches**, near-shore bathymetric variations
- (129) A new report from a National Research Council committee supports **beach nourishment** as a viable method for protecting the shoreline from erosion and for restoring lost beach.
- (130) **Feeding** sand to a coast is referred to as "**beach nourishment**." Beach nourishment works by reducing **sand-starved** conditions by supplying sand needed for waves and currents to rebuild and maintain the natural protective beach and sand bar system.

- (131) Although beach nourishment is not generally used as a protection measure, there are, however, several reasons for nourishing a shore.

Natural sediment accretion (127-128) is described as *feeding*, whereas artificial sediment accretion is described as nourishment (129-131). Since accretion is categorized as *feeding/nourishment*, the lack or reduction in sediment accretion logically results in the *starvation* of the affected area.

- (132) The almost total elimination of sediment supply from the Colorado River has produced a condition of **sediment starvation** in the entire northern Gulf of California.
- (133) It appears that Qa4 aggradation is a temporary phenomenon that is primarily related to the instantaneous influx of sediment to an otherwise **sediment-starved** channel.
- (134) The tectonic subsidence on the inner side of the structural hinge leads to conditions for “**starved**” **sedimentation**, because the sediment yield from the outer zone declines, relative to the rapidly increasing accommodation space of the basin.

Flowing water, such as rivers or currents that becomes a part of other water flows are also frequently described as feeding them.

- (135) The “mean” **Agulhas Current**, entering obliquely into the southern part of the Cape Cauldron appears to bifurcate into two branches: a northern branch, which **feeds into** the outflow across the Walvis Ridge.
- (136) Nevertheless, by then **such water** has been mixed to some degree with the water intrinsic to the Cape Basin and **will eventually feed into the Atlantic** with the background flow, i.e. the Benguela Drift.

Finally, streams, valleys and areas that are generally the sources of sediments and/or water to other geographic areas are said to be *feeders*.

- (137) This clay-silt dominance continues up into the low-energy **tributaries that feed** the bays.
- (138) The **feeder channel** that leads to the fan is single or bifurcates into two or more straight or slightly sinuous channels upslope.
- (139) As in bayfill, an alluvial ridge forms as the **feeder crevasse** and its levees advance basinward through their own distributary mouth bar deposits to form a Stage I splay.
- (140) However, a **feeder stream** to Glendalough Lake Upper in Co. Wicklow shows a clear indication of this impact which has been attributed to the afforestation of the stream catchment.
- (141) Small adjoining **feeder valleys** entering a large valley in a glaciated mountainous region tend to have their floors elevated some distance above the level of the main valley's floor.

As previously mentioned, Cognitive Linguistics is a usage-based linguistics. Evidently, the study of metaphor needs to move away from intuitive assumptions

derived from introspection. This corpus-based study of a specialized knowledge domain shows how metaphorical mapping can be analyzed by looking at how terminological units are used in texts, and describing the context in which they arise. In order to obtain empirical evidence of the pervasiveness of metaphor in scientific communication, metaphorical patterns should be studied through corpus analysis as has occurred in other areas of Cognitive Linguistics (Deignan 2005; Kemmer and Barlow 2000; Schönefeld 1999). Frame-based terminology also uses corpus analysis as a useful tool to discover recurrent mappings or metaphorical and metonymic extensions.

2.3.4 Summary

The pervasiveness of conceptual metaphor, image metaphor, blending, and metonymy in specialized domains is a striking phenomenon, and reflects the extent to which term structure and formation as well as the representation of technical and scientific knowledge depends on these processes. Metaphor and metonymy are crucial cognitive mechanisms in both general and specialized language. This section highlights their importance in Terminology.

Metaphor has often been described as a two-domain operation because it involves the partial mapping or projection of one experiential domain onto another. Types of metaphor include image metaphors and conceptual metaphors. Both pervade scientific and technical texts. In fact, their role in the creation and formation of new terms is often to foster creative thought and enhance user understanding. A case in point can be found in the field of computer science.

In contrast to metaphor, metonymy is often referred to as a one-domain operation because it entails conceptual mapping within a single domain. It involves a stand-for relationship for contiguous entities. Metonymy is also instrumental in terminological variation (e.g. the use of the shortened versions of terms) and terminological relations (e.g. PART_OF and TYPE_OF), which is directly linked to vertical polysemy.

The Invariance Principle is also reflected in specialized language. A relevant example is the Medical Treatment Frame, which is systematically applied to the environment in the form of the human health assessment model. The Invariance Principle is also valid for metonymy. In this sense, an extended version of this principle states that generic-level metaphors relate generic-level schemas. Such schemas motivate the creation of terminological units within a specialized knowledge domain. This extended Invariance Principle is delimited by the preservation of the generic-structure configuration of the domain-internal relationships.

Blending is also a common cognitive process in Terminology. It evidently underlies many neologisms in a wide variety of specialized knowledge fields. However, there are also cases of conceptual blending, which lead to compounding information from two input spaces (e.g. archerfish).

The notion of domain is crucial to metaphor and metonymy, which are based on inter-domain and intra-domain mapping. The indeterminacy of domains in Cognitive Linguistics and Terminology is also discussed since the representation of domains and their internal structure has never been satisfactorily dealt with. In both general and specialized language, conceptual domains constitute the knowledge base of the natural language user, and thus form a semantic network reflection associated structure. Part of terminological work is to make this knowledge structure explicit. In Terminology, concepts are regarded as multidimensional when they can be simultaneously part of different domains. As reflected in a corpus-based study of the field of environmental science, such multidimensionality is often based on metaphorical or metonymic processes.

2.4 Specialized Language Translation

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2.4.1 Introduction

Cognitive Linguistics has dealt with translation very generally: (1) at the level of cultural and conceptual metaphor common to various languages; (2) basic word-to-word equivalence; (3) one-off studies that apply premises of Cognitive Linguistics to isolated case studies in translation. Even in such studies, the focus has generally been on literary⁷ and Bible translation. However, little has been said about specialized language texts when this is precisely the most frequent kind of translation that the majority of translators deal with on a daily basis.

As outlined by Evans and Green (2006: 27), Cognitive Linguistics has two key commitments: (i) the Cognitive Commitment; (ii) the Generalization Commitment. The Cognitive Commitment states that principles of linguistic structure should reflect what is known about human cognition from other disciplines such as philosophy, psychology, neuroscience, etc. Evidently, principles of linguistic structure should be applicable not just to a specific language, but to language in general. Translation is a process of mediation between languages and cultures, which involves various types of cognitive process. It would thus seem to be a fertile testing ground for this commitment.

The Generalization Commitment is also relevant here since it involves the search for principles of language structure that hold across all aspects of language. Again, translation could presumably be used to demonstrate hypotheses in this area, which would be difficult to verify by other means. Translation adequacy or goodness-of-fit between a translation and the original text is based on the partial or total correspondence to a shared meaning representation as well as on intertextual correspondences at a wide variety of levels. Translation is evidence of how languages resemble each other in significant ways.

The term, *translation*, can refer to either the translation process itself or the text resulting from that process. The analysis and study of the translation process might

⁷ Cognitive Linguistic principles have been applied to literary translation by Tabakowska (1993).

very well reveal new insights about language processing, how languages and their correspondences are mapped in the brain, and the nature of lexical representations. This would support the Cognitive Commitment. For example, as shall be seen, terminological correspondences in different languages are based on the same or similar types of metaphorical extension. This would seem to point to the fact that the same cognitive processes are used to create specialized language designations in different languages.

Likewise, the study of translations or translated texts as products of the translation process is in consonance with the Generalization Commitment since similarities between languages can be extracted from and verified in texts which are considered to be equivalent to each other at one or various levels. Given the general goals of Cognitive Linguistics (CL), one would logically assume that of the linguistic frameworks currently in the limelight, CL would have the most to say about translation. This is for the following reasons:

- Both Cognitive Linguistics and translation focus on conceptual meaning.
- Cognitive Linguistics has adopted a usage-based perspective in which generalizations are based on the analysis of authentic usage data generally provided by computerized corpora.
- Translation is possible because both the source-language text and the target-language text have macro- and microtextual correspondences based on shared conceptual meaning. This presupposes that language is the lexicalization of entities, activities, attributes, and relations, and also that texts are the activation of selected but related parts of this general conceptual network. In a parallel way, Cognitive Linguistics focuses on categorization and conceptual domains. It studies how conceptual structures are translated into language.

2.4.2 Translation as a process

The creation of texts in a target language that transmit the same message as the text in the source language is at the core of any translation process. In specialized language translation, this also includes the understanding, structuring, and specification of correspondences between specialized knowledge units in different languages. Such units can be in the form of words or phrases. At the heart of any discussion of translation, whether of general language or specialized language texts, is the issue of correspondence or equivalence. Equivalence, based on shared conceptual

meaning in the form of interlinguistic and intertextual correspondence, is the objective that translators ultimately pursue when they perform their professional activity.

In a parallel way, texts or utterances with the same underlying meaning representation should also be an object of study for linguistic theory, which would presumably be capable of accounting for semantic and syntactic phenomena not only typical of one language, but of language in general. Nevertheless, because of its inherent fuzziness, meaning has always been more difficult to analyze than syntax or grammatical form. This has caused many linguistic theoretical frameworks to tiptoe around semantics as though it were a sleeping crocodile, and focus largely on syntactic analysis, possibly in the hope that an understanding of syntax would ultimately provide a way to understand meaning.

However, even though the jury is still out, significant syntactic insights on semantics have not been obtained nor is there much hope of this happening at least in the near future. It might be best to look for a new starting point in order to try and solve the problem in a different way. Another option would be to invert the process, and start with semantics as a way to better understanding syntax. The key to syntax might very well lie in the analysis of word meaning and semantic structure (Faber and Mairal Usón 1999). This is hardly a new proposal. Much has been written about the interface between syntax and semantics, and what it would presumably consist of, but everyone seems to agree that meaning is crucial. In this sense, both Jackendoff (2002: 267) and Evans (2000b) state that providing an account of the nature of meaning and meaning-construction processes is the Holy Grail of linguistics. However, much like the quest for the Holy Grail, a linguistic account of the nature of meaning has remained similarly elusive.

The fact that linguistic form is simpler to study (because it is easily perceptible), and that meaning is more difficult to grasp (because it is not) has also been a problem in translation theory. The quite understandable desire to base translation correspondence on explicit linguistic form has been, and still is, one of the greatest obstacles to achieving any useful goal in translation theory. In this sense, the history of translation has been witness to a long series of Byzantine discussions on translation and translation equivalence that have taken place throughout the centuries.

Although a great deal has been written about translation equivalence, much of it is repetitive, and not very useful. Apart from the traditional opposition of *faithful/free*, other pairs of terms such as *semantic/communicative* (Newmark 1981) and *formal/dynamic* (Nida and Taber 1969) have also been proposed as descriptions for the degree of perceived similarity at the level of form and/or function between a source language text and a target language text. However, it is to be lamented that these

changes of label have not been accompanied by significant new insights into the nature of interlinguistic or intertextual equivalence. Whatever the terms used, judgments of equivalence tend to be depressingly based on linguistic form instead of any sort of shared conceptual reference or meaning representation. A possible reason for always leaving semantics out in the cold is the way that the translation process has been traditionally conceived.

The standard description of the translation process generally follows some variation of the code model of communication (Shannon and Weaver 1949) in which speakers communicate by means of language as a shared coding system. This signifies that a translator would merely convey the text from speakers of one language to speakers of another. According to this model, translation deceptively appears in the guise of a relatively straightforward process in which a message travels horizontally from sender to receiver across linguistic, cultural, and conceptual hurdles with all of the expertise of an Olympic gold-medal sprinter.

The meaning of the message encoded by the text sender is supposed to be exactly reproduced in the message decoded by the receiver. Within such a context, precise word-for-word correspondence is generally regarded as a measure of translation quality. Needless to say, this has led to a rather simplistic view of translation that in computer science circles encouraged the (erroneous) belief that translation could be easily carried out by computer programs with little or no human intervention.

It soon became evident that this type of mirror-reflection equivalence is not especially desirable, and is a chimera that only exists in extremely naïve descriptions of communication (and translation). However, in the predictable reaction to this rather simplistic view, the pendulum initially swung too far in the other direction. If the code model of communication (and translation) made the process seem much too simple, it was followed by other proposals that made the process overly complex. According to Albert Einstein, proof of one's understanding of a concept is the ability to explain it to one's grandmother. In this sense, labyrinth-like flowchart models of translation such as those described in Garnier (1985) with intricate patterns of myriad boxes and arrows dismally fail the grandmother test, and are lacking in explanatory adequacy.

Any model of a process is inevitably a simplification in which it is impossible to include everything. This is particularly true in the case of translation, which, in the same way as any other cognitive process, is undeniably complex. Part of this complexity is due to the fact that the rules do not remain the same, but change with each new translation context. The best translations may be formally quite different from the source text, and there may be several excellent translations of the same text, whose acceptability depends on specific contextual parameters. Judgments of translation

quality and acceptability can vary dramatically when the translation process takes place in a different geographic, temporal, or social context. It would thus seem that cognitive factors related to the competence of the translator, and pragmatic factors related to context are the most influential when it comes to evaluating translations. It is not only necessary to study what goes on in the human brain, but also to expand this to include the whole human being and his/her history and environment.

Although certain translation theorists embrace situated and embodied cognition to the extent of questioning the importance of stored mental representations and even language in translation activity (e.g. Risku 2010), it should be underlined that as explained in Chapter 3.1 (see 3.1.4.1), such cognition is the result of storing property information on sensory modalities so that this information can later be reactivated in context (Damasio and Damasio 1994; Barsalou 2008).

2.4.3 Specialized language communication

As previously mentioned, communication even in the same language is far from being a straightforward horizontal event that seamlessly progresses from a text sender to a group of text receivers. A wide range of factors must be taken into account. Such factors pertain to the participants in the process, their shared knowledge, belief systems, expectations, and the communicative context itself. This can only be examined by analyzing real communication scenarios. This also means taking into account translation as a contextual activity in which situational factors influence thought and behavior.

Translation adds further levels of difficulty to the communication process because the translators are text receivers, whom the source text sender usually did not consider when he/she initially created the original text. It goes without saying that translators bring their own agenda to the process as well as their own perceptions of the text sender's message, and whom this message targets. This is related to previous experience. Since human beings are creative metaphorical and analogical thinkers, knowledge acquired in one frame or context can be easily implemented in others (Risku 2010: 100). This is what is done by expert scientific and technical translators, who tend to specialize in one or two knowledge fields.

In the best case scenario, the translator possesses sufficient skill to understand the message, profile the group of receivers that the source text was initially created for, and create a new text that will be admitted into the target language text system without creating any ripples. This new text should basically convey the same message to a similar group of receivers in the target language culture. In the worst of cases, the

translator will not get it right, his/her evaluation of the source and target communication scenarios will be off the mark, and the resulting text will be laced with fatal flaws. Such a translation will be condemned to an extremely short life cycle, and be inevitably regarded as an unacceptable text in the target culture if it even progresses that far.

Specialized language translation differs from general language translation because it involves the translation of texts directed to a fairly reduced group of text receivers, who are familiar with the specialized subject field, terminology, text templates, and communication patterns used in a specialized domain. In this type of translation, it would initially seem that the major difficulty lies in understanding and establishing terminological correspondences between languages. However, there is more to specialized language translation than getting the terminology right. A target language text can include more or less adequate correspondences for specialized language units, and yet be all wrong. A rather extreme case is the following authentic (Spanish-English) translation of a research article abstract on erectile dysfunction caused by nicotine addiction.

(142) ERECTILE DYSFUNCTION (ED) AND TOBACCO DEPENDENCE

Abstract

This paper intent to show the relation between tobacco dependence and erectile dysfunction, mechanisms thru nicotine produce impotence and the others effects produced by hundred cigarettes toxics. In consequence smoking cessation is the primary aim for the impotence resolution. Meanwhile this paper describe diagnosis and treatments for the smoking cessation and erectile dysfunction with cognitive, behavioral and sexual therapies, and pharmacotherapy with Bupropión, nicotine patch, 5-phosphodiesterase inhibitors (sildenafil, vardenafil, tadalafil), correction of major risk factors and changes in life style (exercises, dietary normative).

In (142), the translator/author of the text has translated many of the specialized terms in the text more or less adequately (*erectile dysfunction, 5-phosphodiesterase inhibitors, sildenafil, vardenafil, tadalafil, etc.*). One reason for the blatant unacceptability of this text lies in the errors in verb forms (*this paper intent, this paper describe*), definite articles (*the smoking cessation*), adjectival modification (*others effects*), lexical competence (*dietary normative*), among others.

Apart from these rather obvious language errors, which can be corrected, a more serious mistake is related to the poor use of logical connectors, which condemns the whole text to be rewritten. The translator's unfamiliarity with the abstract template produced the following sequence of propositions:

- The paper intends to show X.
 - a. In consequence, something is the primary aim of Y.
 - b. Meanwhile, the paper describes Z.

The fact that these propositions are presented in sequence means that the reader expects there to be an underlying logic to this order. Yet, it is not clear how the primary aim of something can result from the assertion that a research paper intends to show something else. Furthermore, since the author makes no reference to a second temporal process (implicitly indicated by the use of *meanwhile*), this leaves the third proposition (*the paper describes Z*) dangling in the air because the reader cannot know what else is going on in the background. Since the conceptual links between propositions do not reflect any sort of coherent connection, this is indeed a fatal flaw that makes the text of the abstract unacceptable.

When modeling specialized translation, it is necessary to take into account the components of the communication process: (i) text sender; (ii) text receiver; (iii) specialized text and its purpose.

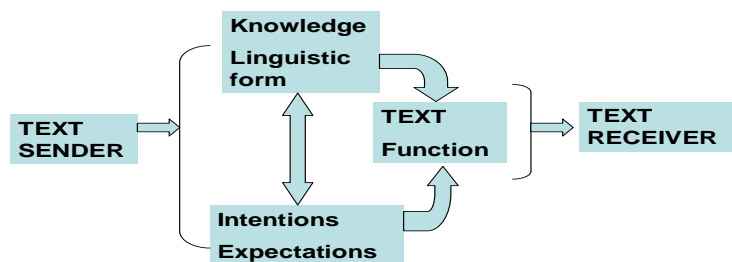


Figure 14. Schematic diagram of specialized communication

When Figure 14 is extended to include the translation process, translators find themselves in the double role of text receiver (in the source language) and text sender (in the target language).

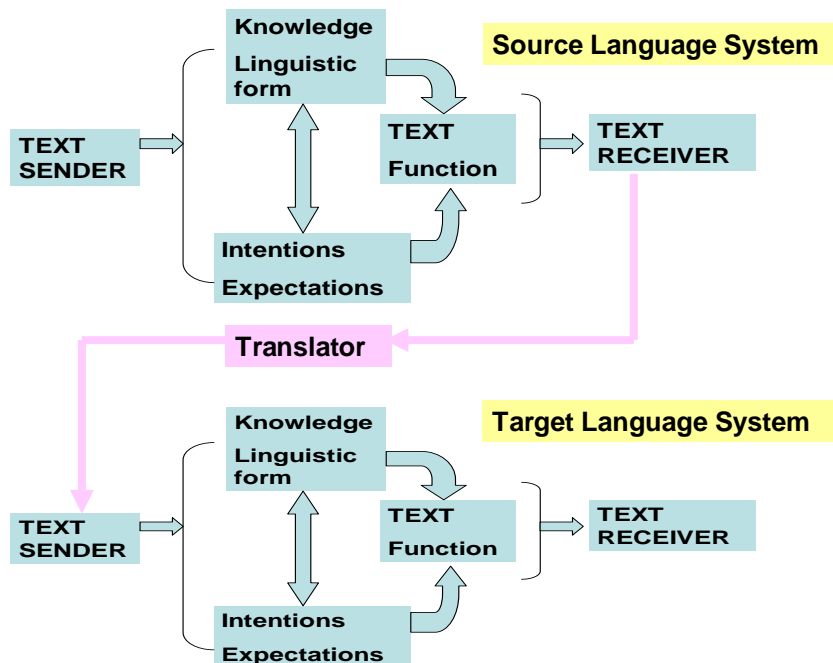


Figure 15. Schematic diagram of specialized translation process

Although this is not made explicit in Figure 15, translators are a very complex component of the specialized translation process, given that they can also be characterized in terms of a specific set of intentions, expectations, and level of knowledge. The success of the translation process largely depends on the translator's competence. Translation competence is hardly unitary, but has been subdivided into the following series of modules: (i) language subcompetence in two languages; (ii) extra-linguistic sub-competence; (iii) instrumental/professional sub-competence; (iv) psycho-physiological sub-competence; (v) transfer sub-competence; (vi) strategic sub-competence (PACTE 2003). When the translator is found to be lacking in any of these modules, the resulting translation may be flawed.

2.4.3.1 Text sender

In the translation process there is a source language text sender and a target language text sender, who is the translator. Source language text senders model textual content in accordance with their expectations about a group of receivers and the communicative objectives that they wish to achieve with their message. Their beliefs regarding shared knowledge shape the text, and have a direct effect on the linguistic forms chosen to transmit the message. In specialized communication, source language text senders are generally experts in their knowledge field, who thus have a mastery of the terminology. Their use of more or less specialized terms that focus on a

concept from one perspective or another reflects the group of text receivers being addressed. Their command of text genres in specialized language communication are reflected in, for example, the use of constructions that make the resulting text sound impersonal, and the selection of a corresponding textual macrostructure in the target language.

2.4.3.2 Text receiver

In the translation process there are also both source language text receivers and target language text receivers. One of the source language text receivers is the translator. Nevertheless, the source language text is not written specifically for the translator, but rather for the other source language text receivers, who benefit from the fact that it has been specifically created for them. The target language text receivers do not have this advantage, and must depend on the skill of the translator, who will make it easier (or more difficult) for them to understand the meaning of the original text.

2.4.3.3 The translator as text sender/receiver

In the translation process, as previously mentioned, the translator is a text receiver in the source language and text sender in the target language. In this respect, he/she is a mediator between two different linguistic and cultural contexts. This mediation process is most successful when it goes unnoticed. When the translator is most invisible, the target language receivers do not even realize that they are reading a translated text, and believe that the author initially wrote the source text in their language. However, this is not an easy task because the target language text is heavily constrained by the source language text, as well as by the translator's beliefs and predictions of what may entail comprehension difficulties for the receivers of another language and culture.

A significant source language constraint lies in the terminology used, which encodes the knowledge structure of a specialized field. The source language text has been written for a group of receivers with a certain level of expertise, and the translator must be able to recognize whom the text is being addressed to, and mentally create a potential reader profile which matches receiver groups in the source and target language. This profile is partly transmitted by the activation of clusters of specialized concepts in related knowledge domains. This is achieved by the use of specialized terms at either superordinate levels (no shared knowledge) or subordinate levels (a great deal of shared knowledge).

Even though the translator is often not an expert in the field, he/she must still be able to walk around in the skin of the source language text sender, and understand exactly whom the message is for, the content transmitted, and its purpose. He/she must also be able to predict problems that may arise when the message is transplanted to a new linguistic and cultural context, and sent to a new group of text receivers. Solutions must be found for any comprehension difficulties.

The knowledge threshold

This difference in knowledge levels between text sender and translator understandably adds to the complexity of the translation process. The translator must act as though he/she were a documentation expert, and should know how to acquire sufficient knowledge in the specialized domain until he/she reaches the minimum threshold necessary to be able to produce an acceptable target language text.

For example, in order to make an acceptable translation of textual content, the translator must be aware of the principal conceptual categories and their reference to activities generally carried out in the specialized field. He/she must also be aware of what the receivers both in the source and target languages know in order to create a text with an acceptable level of informativity.

Given the knowledge difficulties inherent in creating a good specialized translation, people often wonder why experts with a good knowledge of a second language do not try more often to translate their own texts since they are familiar with the terminology in their field. Those who have an ingenuous concept of translation sometimes make the attempt, and discover much to their dismay, that it is not enough to have a certain command of words and specialized terms to be able to translate a scientific or technical text. An expert in the scientific or technical field, who lacks the necessary linguistic and textual knowledge, finds that he/she must be prepared to acquire knowledge of the linguistic dimension of terms. If a translation is finally produced, it is often bounced back by the journal or publishing house because it is rarely if ever an acceptable text in the target language. Specialized knowledge about language is more difficult to rapidly acquire than specialized domain knowledge.

In a parallel way, there are translators who believe that their linguistic knowledge sanctions them to translate scientific and technical texts in any field without previous preparation, documentation, and terminological management. Such an enterprise is also destined to failure. As previously mentioned, translation is a complex cognitive activity that involves a wide range of competences (Gile 1995; Hurtado Albir 1999). Although linguistic competence is undoubtedly one of them, it is not the only one. In the translation of scientific and technical texts, knowledge of two languages and their

respective grammars is not sufficient unless translators also know how to couple this knowledge with conceptual and intertextual knowledge. In this regard, linguistic knowledge and specialized knowledge are intertwined. It is not easy to consider them separately, but the difference between them roughly corresponds to the distinction made between L'Homme and Leroyer (2009) between cognitive functions (e.g. acquisition of encyclopedic knowledge, general subject field knowledge, etc.) and communicative functions (knowledge of language, revision, reading, etc.).

The translator as a terminologist

Risku (2010: 103) states that working on a translation means managing relations between any number of documents and materials (i.e. terminological data, correspondence about a brief, specifications of a particular part of the translation, etc.). In this regard, Wright and Wright (1997) claim that translators frequently find themselves working as *ad hoc* terminologists and terminographers, who must reconstruct bits and pieces of conceptual systems instead of structuring entire specialized knowledge domains. It is true that specialized texts never reflect entire systems of concepts since they use concepts at more specific levels of the domain without explicitly referring to those at more general levels. Only a fragment of the conceptual system is mentioned in the text, but the translator must rebuild an important part, if not all, in order to obtain a comprehension of the content similar to that of the ideal receiver. In line with this,

More often than not, specialized terms come in the form of phrasemes and complex nominal forms, which have their own syntax. Terms often appear in specific collocations, which depend on the specialized knowledge domain and text type. According to Moon (2008: 249), technical words and words referring to concrete entities in the world as open choice items might be considered less collocationally dependent and more susceptible to ambiguity. However, thanks to the analysis of corpus data, this potential ambiguity can be easily resolved.

The specialized terminology and stylistic idiosyncrasies of specialized texts require that the translator, who is generally not an expert in the field, be able to rapidly acquire a command of the terminology in both the source and target language in order to translate this type of text. Consequently, scientific and technical translation not only differs from non-specialized translation insofar as text type is concerned, but also in the fact that the translation must also use methods of knowledge acquisition and terminology management in order to translate effectively.

Whatever the nature of the text involved and regardless of its level and degree of specialization, the translator is not a mere language decoder. He/She is more in the

nature of an interlinguistic and intertextual mediator, who must create a text in the target language with the same message as that of the source language. This entails understanding the original text with the objective of making others understand, and creating another text that seamlessly fits into the target language textual system and which does not sound like a translation. This includes a linguistic and cultural mediation process of conceptual transfer as well as the creation and organization of the target text. Examples of cognitive processes, which are a part of specialized translation, are making inferences, solving complex problems, and restructuring information.

The use of translation resources

One of the major difficulties that translators must overcome is the lack of truly useful lexical and terminological resources. When consulting dictionaries for translation purposes, the translator must try to recover and consider a wide variety of information regarding the words in the source and the target text, such as their core meaning, peripheral meaning, metaphorical extensions, position in associative networks, derivational and combinatorial potential, geographic uses, and use in particular genres and levels of expertise *inter alia* (Tercedor Sánchez, López Rodríguez, and Faber, in press). This is a very tall order since the dictionary or resource that offers all of this information has not as yet been written.

Terminographic definitions are often unsatisfactory for translation purposes because few resources target translators as a potential user group. The meaning of a term should include not only semantic information, but also information about its syntactic environment as well as the pragmatic parameters that influence its activation in different contexts. In this regard, the meaning of a term is determined by its links with other words and terms because the mental lexicon is a vast network whose organization accounts both for the existence of *signified* and *signifier*, and for the processes of word comprehension and word production as shown by a wide range of psycholinguistic experiments (Aitchison 1987; Tercedor Sánchez, López Rodríguez, and Faber, in press).

A specialized dictionary or terminological resource for translators should reflect, to the extent possible, the same organization as the mental lexicon. This means that the presentation of information should include some sort of network representation, displaying common types of links such as coordination, collocation, and superordination, as well as more complex semantic relations with other words (such as LOCATION, HAS_FUNCTION, MADE-OF, etc. Since this can even lead to different designations, information regarding situated perspectives should be provided.

2.4.4 The specialized text

The popular belief exists that specialized language translation is fairly straightforward, and as such, only a poor relation of its more glamorous aristocratic sibling, literary translation. However, this is not the case because specialized texts are just as multi-leveled as literary texts. Translating such texts not only involves knowing the terminology that designates concepts in the specialized field, but also being familiar with how these linguistic designations are activated in syntactic and semantic contexts. In this process, translators should also be aware of the location and role of terms in large textual and conceptual configurations.

According to Morini (2008: 41), texts can address their readers in a variety of ways. Scientific articles, for example, usually adopt a more impersonal stance which conceals, but does not cancel, the relationship between text and reader. Most specialized knowledge texts are written by an expert for readers of a similar knowledge level. Their purpose is usually to inform, and the focus is thus on transmitting the content of the specialized knowledge text to the receiver. However, texts can have more than one function. Besides informing readers, many research articles also try to persuade them of the validity of the results obtained.

The function of a text (to inform, persuade, argue, etc.) is reflected in the predicates used. Terminological studies normally focus on object concepts, which in most cases are linguistically represented by nominal forms. However, both in the comprehension and structure of specialized discourse across languages, verbs play an important role (L'Homme 2003). This is due to the fact that a considerable part of our knowledge is composed of events and states, many of which are linguistically represented by verbs.

These verbs set the scene for the specialized concepts, which appear on the stage in the form of terms that fill the argument slots of these verbs or semantic predicates. Though there are relatively few specialized language verbs in any specific language, the selection restrictions of the arguments generally depend on the area of meaning the predicate belongs to. The degree of abstraction of the arguments of a predicate is the result of its metaphorization and the extension of its meaning to other domains.

As semantic predicates, verbs generally determine the overall form and meaning of sentences, which are the linguistic representation of one or various propositions. Goldberg (1998: 205) calls basic linguistic representations constructions, and proposes the following hypothesis:

Scene-encoding hypothesis: Constructions that correspond to basic simple sentence types encode as their central senses, event types that are basic to human experience.

She argues that such constructions serve to carve up the world into discretely classified event types. This is in line with Langacker (1991a: 294-295) who affirms that language in general is structured around certain conceptual archetypes.

One of the ways in which such events can be extended is through the use of systematic general metaphors. A whole host of expressions and event types can be derived from metaphorical extensions of a verb's basic meaning. As shall be seen, many of them are systematic and specific to their use in a specialized domain. This type of metaphorical extension is not as evident in the grammatical construction itself as in the semantic characteristics of the arguments. In this respect, the degree of technicality of the text can also constrain the meaning of the predicate as well as the type of argument that it can take.

2.4.4.1 Case study: *Implicate/implicar*

For example, specialized medical texts of most European languages have clearly established preferences for verbs belonging to specific lexical domains. The most frequent verbs are those belonging to the domains of PERCEPTION (MENTAL and VISUAL), CHANGE OF STATE, and POSSESSION.

This is only natural if we take into account the principal objectives of medical research articles in any language, which are to prove or disprove a hypothesis, describe the study carried out, and present the results obtained. There is a statement of a specific problem, a description of the research carried out, a discussion of the results, and a conclusion. This repetition of textual macrostructure is conducive to a certain restriction of the meaning of the lexical items in the text.

In the description of a research event within a medical context certain predicates are activated more frequently than others. The semantic parameters of their arguments contribute to constrain the meaning of the predicate and limit the possibility of polysemy. In general communication such verbs are often highly polysemic, their multiple related meaning being the result of metaphorical extension. It is often the case that in specialized texts, the meaning of such predicates is restricted to one meaning, generally the one where the semantic arguments are the most abstract.

For example, a frequent verb in medical research texts is *implicate*, which can have the following meanings in general language discourse:

IMPLICATE

Longman Dictionary of Language and Culture	to show that (someone else) is also concerned (esp. in a criminal activity).
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Table 14. *Implicate*: general language meaning

Although *implicate* can also be used to signify *imply*, its principal meaning is the above. This is evident in the following sample of concordances extracted from the BNC:

- (143) by the suspect or evidence **implicating** anyone in the crime.
- (144) members of the security forces **implicated** in the torture.
- (145) Stalingrad Hitler was directly **implicated** in the catastrophe.
- (146) those letters which totally **implicated** her in the murder,

The CREA corpus of the *Real Academia de la Lengua Española* has also provided numerous examples of *implicar*, the Spanish translation of *imply*:

- (147) las sentencias del Tribunal, que juzgó a los **implicados** en los sucesos del 23 de febrero
- (148) una limpieza de todos aquellos que están **implicados** en la llamada "guerra sucia"
- (149) José Daniel Cuadrado de la Fuente está **implicado** en otro asesinato -el del

As can be seen, persons, data or evidence can be the agent/instrument that *implicate* a human entity in an extremely negative event such as *crime*, *torture*, *murder*, *guerra sucia* ['dirty war'], *asesinato* ['murder'], etc.

In specialized medical discourse, *implicate* is used very frequently (e.g. our corpus generated 1813 concordances for *implicate**), but not to refer to either a person or involvement in a criminal activity. In the following concordances extracted from our corpus, evidence/reports/data implicate a body part/activity in a disease or disease-related event (*tumor progression*, *neurodegenerative disease*, *cancer*, *Salmonella*, *pérdida de apetito* ['appetite loss'], and *patogenia* ['pathogenesis']).

- (150) at integrins have been **implicated** in neoplasia and tumor progression.
- (151) same cytokines that have been **implicated** in Alzheimer pathogenesis.
- (152) motoneuron death has been **implicated** in the neurodegenerative disease.
- (153) loss at several selected loci **implicated** in other cancers.
- (154) A pesar de que en la fiebre tifoidea los síntomas respiratorios son frecuentes, raramente se **implica** a *Salmonella* en su etiología.
- (155) la interacción de las citokinas también está **implicada** en la pérdida del apetito.
- (156) En su patogenia se han **implicado** mecanismos inmunológicos humorales.

As the concordances show, in general language and specialized texts, the verb structures the discourse in both languages since it determines the number of arguments in each proposition as well as their semantic characteristics and function. In this sense, *implicate/implicar* can be said to have three arguments in both English and Spanish.

	Predicate	First Argument	Second Argument	Third Argument
General Language	IMPLICATE/IMPLICAR	evidence	human	crime/negative activity
↓	↓	↓	↓	↓
Medical Language	IMPLICATE/IMPLICAR	evidence/data	body part/symptom	disease/negative condition

Table 15. *Implicate/implicar*

The general language meaning of *implicate/implicar* is mapped onto its use in specialized texts, and this affects the semantic parameters of the arguments. Body parts and symptoms acquire human characteristics. Disease thus becomes conceptualized as a criminal activity. This gives rise to the conceptual metaphor DISEASE IS A CRIME.

Evidently, any translation of a research article will be based on how such predicates are activated in the target language, and the nature of the arguments that fill in the slots. This is the underlying meaning that has to be transferred in a second language, and one of the principal aspects of specialized language that a translator should dominate.

At the bottom line, whatever the context involved, translation correspondence must always be based on some type of non-language-specific meaning representation. Possible candidates for a *tertium comparationis* are conceptual networks connected by a series of relations. As shall be seen, metaphor can play an important role as a means of linking clusters of related concepts.

Larger conceptual representations in the form of conceptual metaphor, metonymy, cultural references, blending, and different types of construal are also present in specialized texts, and must also be taken into account since they are an important part of textual meaning, and may be the source of translation difficulties. It is helpful to analyze these elements within the framework of a linguistic and cognitive theory since this type of analysis is an implicit part of the translation process, and can only enhance professional activity.

2.4.5 Cognitive Linguistics

The relationship between translation and linguistic theory has not always been a happy one. In translation studies, linguistic theory has gone from being embraced as the ultimate panacea to being regarded as totally irrelevant to the entire translation process. Evidently, neither of these extremes is the case, and the truth lies somewhere in-between.

In many cases, the general dissatisfaction with linguistics so typical of translators is caused by the fact that their conception of linguistic theory is often restricted to syntax-based linguistic theories that cannot be usefully applied to translation. As has been described previously, given the nature of the translation process, translation needs a theory that focuses on meaning and context, in other words, a theory that places semantics and pragmatics in the forefront. Accordingly, the linguistic theory most applicable to translation would be one that emphasizes the cognitive aspect of language since translation is itself a cognitive process. Cognitive semantics seems to offer exactly this. McElhannon (2005: 43) writes:

Translation needs a theory of meaning. Although one may rightfully regard *cognitive semantics* as representing a theory of meaning, in reality it is more than that. It is, in the first instance, a theory of human cognition, of how human cognition is very much integrated with the nature of our bodies and in how we interact with the world as we experience it.

Such a theory of meaning or cognitive semantics would presumably offer a basis for translation equivalence or interlinguistic correspondence. However, its description would have to be rather more specific than the integration of human cognition and our bodily experience. A more viable proposal is what Evans (2006b: 493) calls a *cognitive compositional semantics*. He underlines the necessity for providing an adequate account of the following: (i) the sorts of knowledge that words provide access to; (ii) how words, and their knowledge structures, are integrated or 'composed'. This seems to be very much what is necessary for a valid model of interlinguistic correspondence.

Linguistic theory as developed by Langacker (grammar as image, meaning as conceptualization, alternate scene construals), Lakoff (theory of metaphor), and Fillmore (Construction Grammar) seems particularly relevant to specialized language texts and their translation. It offers a possible solution for the problem underlined by Campbell and Wakim (2007: 2):

Despite a recognition in Translation Studies of the need to frame empirical translation research rigorously (see, for example, Toury 1995: 222–240), research into the mental processes of written translation is hampered methodologically because of insufficient theoretical underpinning, especially in research dealing with professional translation tasks.

Cognitive Linguistics is one of the few linguistic theories that make an effort to account for knowledge representation. For example, cognitive grammar considers language to be symbolic. According to Langacker (1987: 99), a linguistic unit consists of a phonological pole and a semantic pole and the relationship between them. The phonological pole is the linguistic representation. This is linked to a conceptual structure which functions as the semantic pole of the unit; a semantic structure is thus a “conceptualization tailored to the specifications of linguistic convention”.

In specialized texts much of the knowledge is encoded in specialized knowledge units. Such units are markers of access points to more complex knowledge structures that lie more or less hidden beneath murky waters. Despite the difficulties of fully representing such a structure, one cannot merely beg the question by saying that such units have no meaning or that they only acquire meaning when they appear in a text. For them to have meaning in the first place, they must possess some sort of potential. In other words, they are not empty shells or recipients, waiting to be filled.

In this regard, Evans (2006b) underlines the difference between words and lexical concepts, a distinction that has been present in terminology for quite a while.

Words are not devoid of semantic value, but rather meaning is a function of the utterance in which the word is embedded, and the complex processes of lexical concept integration, rather than wholly due to the word itself.

The important idea here is that of concept integration, which presumably would be carried out by means of constructions, frame structures or meaningful networks/clusters of concepts. These would constitute the link between texts and their translation. In this regard, neuroscientists have long claimed that semantic knowledge is heterogeneous and distributed. Words are used to designate objects, states, and events represented mentally in some sort of format. Proposed structures are various and include hierarchies, feature lists, family resemblances, and connectionist networks. How knowledge chunks are stored and how it all comes together is still a matter of debate. Nevertheless, it is generally agreed that knowledge of an object includes a wide range of information coming from various types of sensory input. In all likelihood, such types of sensory input would differ in representational format. There would thus be a correlation between the manner in which information is acquired and its format of storage. Saffran and Sholl (1999: 240) write:

Knowledge of an object embraces a wide range of properties characteristic and relations of parts, the sounds (if any) that it makes, the things that it does or is used for (its function), its origin (natural or man-made), its mode of locomotion (if any), and other types of information.

Insofar as translation is concerned, this means that instead of trying to establish links between words, it is more useful to talk about meaning and semantic

representation, and how such meaning and meaning clusters can be encoded in the language of translation.

A specialized knowledge concept can be said to have different facets or dimensions. A text and the frame in which the term is inserted highlight one or various facets, and leave the others shadowed in the background. This is in direct relation to the cognitive linguistic concepts of profiling and construal. Indeed, a text can be regarded as a multi-level network of interrelated meanings. Transmitting all of this into another language is not possible. One of the tasks of the translator is to decide what is most relevant. This means that he/she must establish priorities, and endeavor to transmit them in the target text. For example, phenomena such as metaphorical conceptualization must be identified and dealt with in the target text. According to Vandaele and Lubin (2005: 415):

Metaphorical conceptualization is a fundamental process of thought in scientific modeling, [...]. In order to understand the meaning of scientific texts, a reader must be able to grasp the conceptual metaphors of a domain. According to our working hypothesis, metaphorical conceptualization underlies not only the specificity of a domain, but also the terminology and phraseology of languages for specific purposes. To master the identification of these conceptual metaphors is to possess a powerful cognitive tool that guides the translator in making many translation decisions.

An analysis carried out within a linguistic framework makes it possible to offer a consistent and methodologically rigorous explanation of this phenomenon that is otherwise only intuitively recognized. Evidently, one of the ways that Cognitive Linguistics can offer insights into specialized translation is through the analysis of metaphor in scientific and technical texts.

2.4.5.1 The translation of metaphor in specialized language

The role of metaphor has been much studied in literature, and somewhat more recently, in everyday communication within the framework of Cognitive Linguistics, which explores the pervasiveness of metaphor (Lakoff and Johnson 1980; Lakoff and Turner 1989), metonymy (Langacker 1995; Nunberg 1995) and conceptual blending (Fauconnier and Turner 1994, 1996; Turner and Fauconnier 1995) at every level of language (see sections 2.2.4.1, 2.3.2.2, and 4.1.2). Metaphor is a powerful cognitive mechanism that triggers both lexical and textual creativity, and is a candidate for the elusive *tertium comparationis* in any model of translation. No longer considered to be an exclusively literary phenomenon, it is now regarded as an integral component of our cognition which shapes our understanding of the world. Not only does metaphor creatively expand the way the world is perceived and construed, it also makes it

possible to access less evident areas of experience via perceptually salient conceptual domains.

According to Goldberg (1998: 214), a way in which the constructional meaning of concepts such as motion, changes of state, causation, and transfer can be extended is through the use of systematic general metaphors. This is one of the reasons why overall conceptualization evoked by a complex linguistic expression is never the sum of the meanings of its lexical and grammatical components, but also depends on its construal (i.e. our capacity for conceptualizing the same situation in different ways):

As an inherent aspect of their conventional semantic value, linguistic elements impose a particular construal on the concept they evoke, and speakers adopt it for purposes of linguistic expression (Langacker 1998: 4).

Within Cognitive Linguistics, metaphor is a dimension of construal since it reflects a very general ability to conceive of and structure one entity against the background of another.

Insofar as the translation of metaphor, there is a consensus of opinion that a cognitivist account of cross-linguistic metaphoric patterns is conducive to three general translation strategies: (i) the same metaphorical conceptualization in the source as in the target language (ii) different metaphorical conceptualizations in the source and target languages (iii) metaphorical conceptualization in the source language, but none in the target language. This is also true for metaphor in specialized language, which has been studied in the field of mining and construction in Bulgarian, English, and Spanish (Alexiev 2004, 2005). Alexiev (2005) combines the Experientialist view of Conceptual Metaphor Theory, premises of Terminology, and basic translation strategies (borrowing, calquing, adaptation, etc.). He claims that “the choice of a target language conceptualization strategy and the corresponding surface realization depend both on cognitive and language- and culture-specific factors” (Alexiev 2005: 38).

Lakoff and Turner (Lakoff 1992; Lakoff and Turner 1989) distinguish between image metaphors and conventional (structural-conceptual) metaphors. Image metaphors are conceptually simple since only one concept of the source domain maps onto the target domain. This single mapping results in one expression. Furthermore, image metaphors are based on a sense-perceived resemblance between a concrete entity and another entity, which may be concrete or abstract. Lakoff (1992: 418) describes this type of metaphors as the result of image-to-image mappings.

Instead of mapping the structure of one concept onto another, image metaphors map the internal structure of one conventional mental image onto the internal structure of another image. In other words, he contends that image metaphors are mentally visualized. In contrast, conceptual metaphors emerge from the entire projection of one

domain of experience onto another (domain-to-domain mapping). They involve the mapping of “rich knowledge and rich inferential structure” (Lakoff and Turner 1989: 91), which gives rise to a more or less extensive number of linguistic expressions. In addition, Lakoff and Turner affirm that conceptual metaphors are difficult or impossible to visualize. Much of the cognitivist research on terminological metaphor is based on this twofold distinction (Alexiev 2004: 190).

Corpus data can provide an empirical basis for research in specialized communication. Faber and Márquez Linares (2005) show how metaphor consistently occurs in specialized language texts in the field of oncology. Ureña and Faber (2010) have found the same to be true for marine biology texts in which the same metaphors often occur in English and Spanish. However, there are also subtle cross-linguistic differences stemming from both cognitive and cultural factors.

2.4.5.2 Case study: image metaphors in marine biology

Living organisms in marine biology often have two types of designations: (i) a scientific name; (ii) a metaphorical name. Marine biology image metaphors fit the traditional categories for metaphorical motivation:

- Resemblance to inanimate entities (object-like): shape, color, and function.
- Resemblance to animate entities (human-like, animal-like, plant-like): shape, color, and habits/behavior.

There are also cases in which resemblance and experiential correlation interact. In such cases, function and/or habits/behavior are always the categories for metaphorical motivation. They can sometimes combine with shape, but shape alone fails to work along with experiential correlation because it does not refer to (repeated) actions. Our examples are representative of the following contrastive differences between image metaphors in English and Spanish:

- Exact pairs: the metaphorical motivation and the subsequent terminological naming are alike in both languages.
- Partial pairs: the metaphorical motivation is the same, but named differently in each language depending on the degree of semantic specificity.
- Separate pairs: the metaphorical motivation is not the same in both languages. In the analysis of these pairs, a number of conceptual differences rooted in cultural aspects were identified.
- Unbalanced pairs: just one term of the pair is metaphorical. Culturally-derived conceptual differences were found as well.

Exact pairs

The high frequency of image metaphors seems to confirm the existence of basic metaphorical conceptualization patterns grounded in our experience which permeate both general and specialized language. Given the status of English as the *lingua franca* for specialized communication, many English metaphorical terms serve as *landmarks* for other languages. For these reasons, there are a significant number of exact pairs.


English term	Spanish term	Taxonomic position and scientific name	Referent and metaphorical motivation	Image
Lanternfish	Pez linterna	Family <i>Myctophidae</i>	Fish with light-producing organs with shoaling or courtship function	

Table 16. Exact pair: metaphor based on resemblance to an inanimate entity


English term	Spanish term	Taxonomic position and scientific name	Referent and metaphorical motivation	Image
Sea lettuce	Lechuga de mar	Species <i>Ulva lactuca</i>	Green alga which looks like a lettuce both in shape and color (plant-like)	

Table 17. Exact pair: metaphor based on resemblance to an animate entity

Partial pairs

Although not abundant in the marine biology corpus, partial image metaphors can reflect subtle cross-linguistic conceptual differences in specialized discourse on account of the degree of semantic specificity. Each language construes a *partial* metaphorical concept from the overall metaphor by focusing on a specific conceptual trait of the domains mapped.

It is sometimes necessary to consider basic-level categories when an interlinguistic comparison is made between types of motivation for metaphorical transfer. When it comes to partial image metaphors, it is necessary to ascertain

subcategories derived from basic-level categories. In this sense, Alexiev (2005: 43) states:

When looking for different motivation for metaphorical transfer resulting in different TMs [terminological metaphors] standing for the same special referent in the contrasted languages, sometimes we have to consider the motivation at a lower level of abstraction, i.e. not only as form, function or position but as particular types of these.

These subcategories are related to what Kövecses (2005: 154) calls *degree of specificity* in his research on “cross-linguistic differences in the expression of the same conceptual metaphor”. According to Kövecses, this degree of specificity involves a hierarchy of things or events, which is also found in the partial term pairs in the marine biology corpus. For instance, the coral *Alcyonium digitatum* is often called *dead man’s fingers* in English because of its finger-shaped branches. In Spanish this designation usually alternates with *mano de muerto* [‘dead man’s hand’], which is an obvious example of holonymy/meronymy.

Regarding the degree of semantic specificity in terminological metaphor, it is also useful to take into account Felber’s (1984: 117–118) definition of *shape*, which is perhaps the most frequent prompt for metaphorical conceptualization in marine biology. Felber conceives shape as a set of intrinsic features included in a wide range of concepts such as design, form, size, type of material, and color. In this sense, the conceptual difference between *Hungarian capshell* and *sombrero húngaro* [‘Hungarian hat’], which is a type of mollusk, arises from specific features mainly referring to the design and form of the objects referred to.

Alexiev (2005) also argues that *function* should be considered in broader terms, which involve “not only characteristics of functioning, but also of application/use/purpose, performance, operation, etc. of an entity”. In the case of the function-induced metaphorical pair *triggerfish/pez ballesta* [‘crossbow fish’], this process activates two different though related categories in each language. In fact, by applying the *purpose* function to the entity in question, a trigger may well be a lever for activating a machine other than a weapon. However, the conceptual metaphor remains the same for both languages.

The pair *triggerfish/pez ballesta* is an example of terminological metaphor arising from the interrelation between resemblance in function/behavior and experiential correlation. We pull the trigger of a crossbow (cause) to prevent the enemy from attacking us (effect). A parallelism is established between this cause-effect action and the action that this type of fish performs: it deploys two dorsal spines as a weapon (cause) to dissuade predators from attacking it (effect). We can thus say that

resemblance and experiential correlation combine to bring about a specialized metaphorical concept.


English term	Spanish term (literal English translation)	Taxonomic position and scientific name	Referent and metaphorical motivation	Conceptual difference	Image
Cooper's nutmeg	Nuez de Cooper ('Cooper's nut')	Species <i>Cancellaria cooperi</i>	The color of this snail's shell is orange with cream or brown strips, like the inner part of a nut (meg).	<i>Nut</i> is a generic concept. A nutmeg can be considered a type of nut.	

Table 18. Partial pair: metaphor based on resemblance to an inanimate entity


English term	Spanish term (literal English translation)	Taxonomic position and scientific name	Referent and metaphorical motivation	Conceptual difference	Image
Croaker	Corvina ('raven-like')	Family <i>Sciaenidae</i>	Fish producing a croaking sound which resembles the sound of a raven's (behavior + animal-like).	The English term refers to the ravens' sound. The Spanish term refers to ravens in general.	

Table 19. Partial pair: metaphor based on resemblance to an animate entity

Separate pairs

While partial pairs are concept names with slightly different metaphorical nuances in English and Spanish, construal in separate pairs implies two entirely different conceptual metaphors. As a matter of fact, both metaphor and metaphor variation are manifestations of what Langacker (1987: 487–488) calls *construal*. *Construal* refers to different ways of conceptualizing reality, and reflects “the relation between a speaker (or hearer) and the situation that he/she conceptualizes or portrays, involving focal

adjustments and imagery”. Faber and Márquez Linares (2005) name conceptual metaphor as an example of construal:


Within Cognitive Linguistics, metaphor is a dimension of construal since it reflects a very general ability to conceive of and structure one entity against the background of another.

Lakoff and Johnson (1980: 52) also point out “the partial nature of metaphorical thinking” and affirm that such partiality is reflected in the lexicon. Tables 20 and 21 show examples of interlinguistic differences in metaphorical construal.

Culture-derived interlinguistic differences, which appear for the first time, can also be transmitted in terms of basic-level categories. As Boyd (1993: 235) states when talking about science communication, “we may explain this basic level dominance by the speakers’ primary physical and cultural interactions with these categories”. Cases of image metaphors in marine biology show that culture-bound factors may arise in the interactional projection from basic-level to subordinate categories.

For example, the popular name for *Carcharias taurus* is *sand tiger shark* in English and *tiburón toro* [‘bull shark’] in Spanish. While in English this shark is compared to a tiger because of the transversal, dark stripes on its back, Spanish relies on a more direct translation of the Latin to highlight the shark’s aggressiveness and stoutness. Thus, this shark is compared to a bull, which also happens to be a culturally prominent animal in Spain. As can be seen, the motivation for metaphorical conceptualization is culturally induced in Spanish, which gives rise to an interlinguistic culturally-based cognitive difference.

The English term in Table 20 is a case of terminological metaphor based on both resemblance and experiential correlation. A cookie-cutter is a tool for cutting cookie dough into different shapes. When a cookie cutter is used, it leaves marks on the dough (repeated co-occurrences in experience). In a parallel way, a shark resembles a cookie-cutter because of the circular marks on its skin which are similar to circular cookie cutters. Also when it bites its prey (cause), it leaves marks on their flesh (effect). Here, function/behavior and shape combine to give rise to a metaphorical concept.

English term	Spanish term (literal English translation)	Taxonomic position and scientific name	Referent and metaphorical motivation in English	Metaphorical motivation in Spanish	Image
Cookie-cutter shark	Tiburón cigarro (‘cigarette shark’)	Species <i>Isistius brasiliensis</i>	This shark leaves cookie-shaped wounds on the bodies	Elongated shark with a dark collar marking around its throat	

			of its prey (behavior and shape + object- like).	resembling a cigarette tip (shape + object- like).	
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Table 20. Separate pair: the English term is culturally motivated


English term	Spanish term	Taxonomic position and scientific name	Referent and metaphorical motivation in English	Metaphorical motivation in Spanish	Image
Boarfish	Ochavo	Species <i>Capros aper</i>	Like a boar, this fish uses its long powerful snout for probing the sand and mud for the invertebrates on which they feed (shape and behavior + animal-like).	This fish is flat and round like the Spanish coin <i>ochavo</i> , which was used between the XVII and XIX centuries (shape + object-like).	

Table 21. Separate pair: the Spanish term is culturally motivated

Unbalanced pairs

In the same way as separate pairs, the unbalanced pairs in the marine biology corpus eloquently support the claim that cognitive and cultural aspects are major factors that model languages and yield cross-linguistic conceptual differences. As Kövecses (2005: 160) writes, both cognitive and cultural elements are fused to make up speakers' conceptual schemas:

Metaphor is not only cognitively but also culturally motivated. As characteristics of cultures change, so can the metaphor and its linguistic expression. In it, the cognitive and the cultural are fused into a single conceptual complex. In this sense, what we call conceptual metaphors are just as much cultural entities as they are cognitive ones.

Interaction with the entities around us is the basis for concept formation. If one entity is prominent in a certain culture, this entity is likely to be used for metaphorical conceptualization. In fact, “the interactional properties result from our interaction with our physical and cultural environment due to our cognitive abilities” (Alexiev 2004: 198). Table 22 shows two examples of unbalanced term pairs in English and Spanish.



English term	Spanish term (literal English translation)	Taxonomic position and scientific name	Image
Anglerfish	Rape (no literal translation)	Genus <i>Lophius</i>	
Puffer	Tamboril ('small drum')	Family <i>Tetraodontidae</i>	

Table 22. Unbalanced pairs

Both examples in Table 22 show how cognitive and cultural factors in one language or another can constrain the formation of a specialized concept through metaphorization. In the first example, only the English term is metaphorically conceptualized. This fish is called an *anglerfish* because of the foremost spine of its dorsal fin, which resembles a *fishing rod* with fleshy *bait* at its tip. This spinal *fishing rod* is used as a lure for attracting preys, which are so unlucky as to stray close enough for the anglerfish to swallow. The motivations for metaphorical transfer are shape + object-like (spine like a fishing rod) as well as habit/behavior + human-like (fish like an angler).

In the second example, it is the Spanish term that is metaphorically conceptualized. What is more, a highly marked cultural factor is also at work here. In English this fish is called a *puffer* because it acquires a round shape when it blows or puffs itself up to scare away predators. In Spanish, this fish is referred to as a *tamboril*, which is a round percussion instrument typical of Spain. Therefore, the metaphorical motivation is shape + object-like. As can be seen, both languages exploit the same physical feature (roundness) to conceptualize an entity. Nevertheless, only Spanish brings metaphor and a cultural entity to bear.

In the same way as in general language, in marine biology the categorization system is largely based on basic-level categories, which are highly metaphorical and subject to interactional properties. As Lakoff (1987: 8) affirms, categories arise in our minds from (i) interaction with our environment; (ii) cognitive phenomena which stem from our imagination, such as metaphor and metonymy, and which are linguistically rendered in the form of figurative language (imagery). As has been shown, conceptual metaphorization in marine biology is modeled by cognitive and cultural aspects. This gives rise to cross-linguistic cultural differences in English and Spanish.

2.4.6 Summary

This chapter has discussed the specialized language translation process from a Cognitive Linguistics perspective. This means exploring what translation can offer Cognitive Linguistics as well as what Cognitive Linguistics can offer translation. The analysis and study of translation as a product as well as a process can offer insights into cognitive aspects of language, and provide a testing ground for the commitments of Cognitive Linguistics. In a parallel way, Cognitive Linguistics offers a theoretical framework which permits the systematic study and analysis of translations and translation correspondence, based on shared conceptual meaning instead of linguistic form.

Specialized language translation involves the translation of texts directed to a small group of receivers, who are familiar with the specialized subject field, terminology, text templates, and communication patterns in a specialized domain. Its success or failure depends on all of the participants and contextual components of the communication process, not the least of which is the translator. The translator of technical and scientific texts, who is not an expert in the field, must be able to attain the required knowledge threshold in order to convey the conceptual content of the text. When the translator is an expert in the subject field, but not an expert in translation, he/she must also attain an acceptable level of competence in multilingual text generation, terminological management, and the use of translation resources. This is considerably more difficult.

The specialized language text is a complex entity, both linguistically and conceptually. Although it is often characterized by its high content of specialized knowledge units in nominal form, a crucial linguistic element in such texts are general language verbs, which designate the events and states, represented in these texts. The meaning of such verbs is constrained in specialized language texts by the nature of their arguments. This is often conducive to a process of metaphorical extension, which extends the general language meaning of the verb and its arguments to specialized language as well.

Evidently, Cognitive Linguistics is the linguistic theory most applicable to translation, which is itself a cognitive process. Cognitive Linguistics is also one of the few theories that deals with knowledge representation, and focuses on metaphor, a powerful mechanism that triggers both lexical and textual creativity in specialized language as well as general language.

3 Terms as specialized knowledge units

As specialized knowledge units that are activated in texts, terms have both a semantic and pragmatic component. Chapter 3.1 describes and outlines our vision of specialized knowledge semantics. Chapter 3.2 discusses the pragmatics of specialized knowledge units and their activation in different types of specialized texts.

Both in the realm of general language and specialized language communication, semantics studies the meaning of words, phrases, sentences, and larger units of discourse, which are sequences of words, phrases, and sentences. In specialized language, semantics is mainly concerned with the mental representation of terminological units and their relations with other units in the same domain. Primary areas of focus in specialized language semantics include cognition (concept formation) and categorization (classifying objects into concept classes) as well as semiosis (assigning signs to concepts and concept classes) and representation (making explicit the relations between concepts). These questions are also targeted by cognitive semantics, which is based on the premise that semantic structure reflects conceptual structure.

In contrast to cognitive semantics, there is no branch of Cognitive Linguistics known as cognitive pragmatics. The reason for this is that Cognitive Linguistics takes an encyclopedic view of meaning, and thus makes no distinction between semantics and pragmatics. Although semantic and pragmatic knowledge form a continuum, we feel that it is relevant to differentiate the two. In this way, it is possible to examine the meaning, semantic structure, and representation of specialized knowledge units (i.e. their semantics), and then analyze their activation in specific communicative contexts of usage events (i.e. their pragmatics). The study of the pragmatic component of specialized knowledge units is performed from the following two perspectives:

2. A sociocultural perspective, namely, how social information enters into and affects human behavior;
3. A cognition-oriented perspective that seeks to describe the biological or cognitive foundations underlying communicative behavior, which means the formulation of principles with predictive power.

3.1 Specialized Language Semantics

Pilar León Arauz and Pamela Faber

Silvia Montero Martínez

3.1.1 Introduction

The organization of conceptual space is a key issue in cognitive semantics as well as in Terminology. Although configuring specialized concepts in networks with both vertical (hierarchical) and horizontal (non-hierarchical or associative) relations is one of the most important tasks in terminological work, only fairly recently has research in specialized language begun to recognize the need for an interdisciplinary approach and a set of theoretical premises that will make the modeling of conceptual structure less subjective.

In the vision of conceptual organization offered by cognitive semantics, lexical items are conceived as conceptual categories of distinct yet related meanings that exhibit typicality effects. Extensive studies of the meanings of single words, such as *over* (Brugman 1981/1988) or *time* (Evans 2006a) approach conceptual organization from the perspective of cognitive models. Nevertheless, considerably less work has been carried out on the conceptual structure of entire lexical domains, and constellations of concepts in semantic networks.

In marked contrast to cognitive linguists, terminologists have largely ignored terminographic meaning or the semantics of individual specialized knowledge units, and left their definition solely to experts in the field. They have mostly focused on the configuration of sets of terms and their relationships within the context of specialized domains. However, relegating definitions to the background and regarding them as the property of experts is not a good way of proceeding, and has even led many to question the quality of technical and scientific dictionaries and resources (e.g. Boguraev and Briscoe 1989; Norman 2002). Obviously, knowledge of a topic and knowledge of how to define and describe the terms related to the topic are two very different things. Engineers or scientists may very well be experts in their respective fields, but they are rarely experts in the specialized language used for communication in their knowledge field. When insufficient importance is given to definitions or concept description, this negatively affects the mapping of categories and domains.

This apparent lack of interest in terminological meaning is reflected in the fact that many specialized knowledge resources exclude definitions entirely or randomly insert them cut-and-paste from the nearest available specialized language dictionary or database. This in itself is an implicit statement that one definition is considered to be as good as another, and that the semantics of terms is far from being a priority. This disregard for meaning is even more surprising, given that one of the principal objectives of terminology work is to eliminate ambiguity from scientific communication. One of the many purposes of elaborating the conceptual structure of a domain is so that it can be a kind of safe harbor, where terms in the same language or different languages can anchor themselves to the same concept, and thus have greater assurance of unambiguous interpretation. However, if this conceptual network structure is not specifically based on meaning, it has little value.

More often than not, the specialized concepts in Terminology are objects that one can see and touch in the real world. It is perhaps for this reason that until very recently, terminologists tended to create conceptual configurations, based on their own intuitions, which were later validated by expert consultation. There was little or no regard for the fact that terms are lexical items, which can be understood and construed from different perspectives.

Still another problem is the selection of the most appropriate method for the organization of specialized concepts. Although all Terminology textbooks underline the fact that conceptual organization is an important part of terminological work, they do not offer a clear description of exactly how concepts should be organized and represented. Only very recently, have there been specific proposals regarding ways to coherently structure specialized concepts based on insights from Cognitive Linguistics, such as prototypes in Sociocognitive Terminology (Temmerman 2000) and the use of frame-like structures in Frame-based Terminology (Faber et. al. 2006, 2007; see 2.1.4.3). In the same way as cognitive semantics, both of these proposals are also based on the premise that language structure reflects conceptual structure, and that it is possible to understand human thought processes by using language as a mirror (Langacker 1987). Both Sociocognitive Terminology and Frame-based Terminology also contemplate the possibility of using ontologies as a means of representing specialized domains.

This chapter argues in favor of Frame-Based Terminology, as applied in EcoLexicon, a frame-based terminological resource for environmental science (<http://ecolexicon.ugr.es>). The conceptualization of any domain is goal-oriented, and depends to a certain degree on the task to be accomplished. In this case, one of the objectives of EcoLexicon is to achieve interoperability for multilingual descriptions of

environmental entities (concepts and roles), and specify relations between concepts. Since a major problem in modeling any domain is the fact that languages can reflect different conceptualizations and construals, EcoLexicon uses environmental texts as well as specialized knowledge resources to extract a set of domain concepts, shared by English, Spanish, and German, and analyzes language structure to obtain an inventory of conceptual relations to structure these concepts.

As a result, knowledge extraction for EcoLexicon is largely text-based. The terminological entries are composed of information from specialized texts as well as specialized language resources. It is configured in a conceptual network that is capable of adapting to new contexts. At the most general level, generic roles of AGENT, PATIENT, RESULT, and INSTRUMENT are activated by basic predicate meanings such as *make*, *do*, *affect*, *use*, *become*, etc. which structure the basic meanings in environmental texts. From a linguistic perspective, *Aktionsart* distinctions in texts are based on Van Valin's (2004) classification of predicate types. At the more specific levels of the network, the *qualia* structure of the Generative Lexicon (Pustejovsky 1995) is used as a basis for the systematic classification and relation of nominal entities.

3.1.2 Frame-based Terminology

EcoLexicon is a frame-based specialized knowledge resource on the environment. It is the practical application of Frame-based Terminology, a new approach to specialized language that focuses on: (1) conceptual organization; (2) the multidimensional nature of specialized knowledge units; (3) the extraction of semantic and syntactic information through the use of multilingual corpora.

In EcoLexicon, conceptual networks are based on an underlying domain event, which generates templates for the most prototypical states and events that characterize the specialized field as well as the entities that participate in them. As shall be seen, this environmental database is based on a linguistic ontology, which is in the process of gradually evolving towards the status of a formal ontology. The resulting structure also incorporates insights from Ontological Semantics (Nirenburg and Raskin 2004), which is based on the assumption that it is possible to reduce any natural language utterance to a language-neutral representation. In our case, this representation is obtained from the information extracted from static knowledge sources such as a multilingual corpus of texts (in English, Spanish, and German) and environmental resources.

3.1.2.1 Ontology

The term *ontology* originally comes from the field of philosophy, and refers to a particular system of categories accounting for a certain vision of the world. As such, it is a constructed world model. However, in Terminology, ontology is defined in its artificial intelligence sense as an explicit specification of a conceptualization (Gruber 1995: 908). Gruber (in Moreno and Perez 2002: 181) makes a distinction between representation ontologies and content ontologies. Representation ontologies provide a framework, but no guidance on how to represent the domain. In contrast, content ontologies make claims about how the domain should be described.

In recent years, another distinction has also arisen between formal ontologies and linguistic ontologies, which differ from each other in their degree of formalization and their size. A formal ontology is much smaller than a linguistic ontology. It is a controlled vocabulary that expresses a representation language for the specification of a conceptualization. This language has its own grammar that facilitates the expression of terms within a domain, and contains formal constraints related to the way terms can combine with others. A formal ontology is thus a set of rigorously defined terms and concepts used to describe and represent a knowledge area, as well as sets of relations, properties, and values.

In contrast, linguistic ontologies are generally much larger and strongly language-dependent since they focus on the words used in one or more languages. WordNet (Fellbaum 1993, 1998) is probably the most well-known linguistic ontology since its upper-class words are often used as top-level concepts in formal ontologies. Accordingly, linguistic ontologies can provide the basis for formal ontologies.

Evidently, one of the overriding priorities in Terminology is to define data in as standardized a way as possible. An ontology has the advantage of anchoring linguistic representations in one or various languages to the same conceptual representation and thus fomenting data interoperability. Specialized domain ontologies thus help to eliminate conceptual and terminological confusion. They specify a set of generic concepts that characterize the domains as well as their definitions and interrelationships. It is now widely acknowledged that constructing such a domain model is crucial to the development of knowledge-based systems. This initial design of the skeleton of the domain is a task that can have far-reaching consequences.

EcoLexicon can be classified as a linguistically-based ontology since its conceptual design is based on information extracted from specialized texts and the structure of terminological definitions. In the environmental knowledge domain, top-level concepts are OBJECT, EVENT, ATTRIBUTE, and RELATION. Concepts can be concrete

or abstract, simple or complex. In EcoLexicon, abstract concepts include theories, equations, and units for measuring physical entities. They are generally used by experts to describe, evaluate, and simulate reality. In contrast, physical or concrete concepts are those occupying space and occurring over a period of time. They include natural entities, geographic accidents, water bodies, constructions, and the natural and artificial process events in which they can potentially participate.

For example, a representation of coastal landforms should include a description of these formations consisting of their representation as an object or objects, relationships to other features, parts and subparts, location in absolute and relative geography, and others, designed for a specific domain of application. A STREAM, for instance, is a flow of water in a watercourse (e.g. channel or bed). A specific instance of this category has a name, course (x, y geometry), mouth, source, tributaries (numbering n), and cities located along its route. Similarly, it is bounded by ridges, flows through valleys, etc. As much of this information as possible should be accessible in the database. However, this can only happen if there is an ontology.

The most generic or top-level categories of a domain are configured in a prototypical domain event or action-environment interface (Barsalou, 2003). This provides a template or frame applicable to all levels of information structuring. The resulting general frame facilitates and enhances knowledge acquisition since the information in term entries is internally as well as externally coherent (Faber, León Arauz, Prieto Velasco and Reimerink 2007). In EcoLexicon, the prototypical domain event gives us the ontological classes and subclasses that appear in Figure 16.

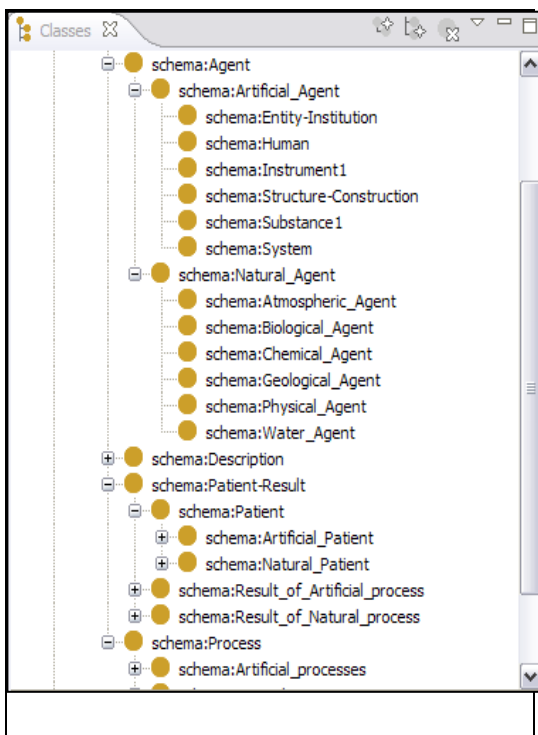


Figure 16. Ontological schema of EcoLexicon

For example, an Agent is defined as the doer or effector of an action. Prototypically, agents are animate, and usually have intentionality and control over the action that they initiate. However, we have placed natural forces in the category of agent as well. Agents can thus be natural or artificial, depending on the process that they are capable of initiating. Natural agents are divided into atmospheric, biological, chemical, geological, and water agents. Artificial agents are human since the processes that they initiate (e.g. constructions) tend to produce results that are not natural to the environment.

3.1.3 Information extraction and analysis

When designing the conceptual structure of a domain, one of the first issues to be dealt with is the extraction of information upon which conceptual organization can be based. Some terminologists prefer to collect this information from experts in the field. The knowledge structure is thus designed intuitively after discussing concepts with a group of domain experts. This method has the disadvantage of being based on a restricted set of opinions. Furthermore, despite the fact that experts may be very knowledgeable in their particular field, they are not experts in metacognition. In other words, they may know a great deal about their domain, but are not aware of how they know what they know, or how this knowledge is structured.

However, another way to extract domain knowledge is by using specialized texts and knowledge-rich contexts (I. Meyer 2001). As explained in Chapter 4.1 (this volume), part of the contextual information in EcoLexicon was extracted by searching for knowledge patterns that point to the conceptual relations found in the specialized domain of the Environment. Thus, contextual information must be based on the intersection of knowledge richness and knowledge patterns to adequately describe the terminological units and their frame of reference (Reimerink, García de Quesada, and Montero Martínez 2010). In this type of text-based approach, conceptual structure is specified on the basis of linguistic information. As in Cognitive Linguistics, language structure is thus regarded as a reflection of conceptual structure.

3.1.3.1 Dictionary analysis

One major source of conceptual information is specialized dictionaries as well as other reference material, such as encyclopedias. The information in dictionaries constitutes a lexical-conceptual network that is in direct relation to the knowledge

expressed. However, to extract conceptual parameters that can be used to create frames for the definition of conceptual categories and concept members, it is necessary to use various dictionaries, and compare definitions in terms of the conceptual relations activated in them (Faber 2002b).

For example, *aquifer* is a natural concept which has an important functional component. Its capacity for holding, storing, and supplying water is the feature that distinguishes it from other water bodies, such as *stream*, *brook*, or *creek*. In order to extract the conceptual parameters for the definition of *aquifer* as well as all the various types of aquifer, a wide range of dictionaries and glossaries were consulted. The definitions of *aquifer* and their respective tagged definitional components are listed in Table 23.

<i>Construction Term Glossary</i>
1. Strata [GENUS] of porous permeable rock or soil [MATERIAL] that is capable of holding a large quantity of water [FUNCTION].
<i>Life Science Dictionary</i>
2. A subsurface [LOCATION] layer [GENUS] of rock [MATERIAL] permeable by water. Although gravel, sand, sandstone and limestone [MATERIAL 2] are the best conveyers of water [FUNCTION], the bulk of the earth's rock is composed of clay, shale and crystalline [MATERIAL 3].
<i>Glossary of Technical Terms: Office of Underground Storage Tanks</i>
3. A geologic formation, group of formations or part of a formation [GENUS] that contains saturated permeable material [MATERIAL] that yields sufficient, economical quantities of groundwater [FUNCTION].
<i>A Dictionary of Technical and Legal Terms Related to Drinking Water</i>
4. A natural underground [LOCATION] layer [GENUS] of porous, water-bearing [FUNCTION] materials sand, gravel) [MATERIAL] usually capable of yielding a large amount or supply of water [FUNCTION 2].
<i>Drinking Water Glossary</i>
5. A natural underground [LOCATION] layer [GENUS], often of sand or gravel [MATERIAL] that contains water [FUNCTION].
<i>Guide to Environmental Issues: Glossary of Terms & Acronyms</i>
6. A water-bearing [FUNCTION] layer [GENUS] of rock (including gravel and sand) [MATERIAL] that will yield water in usable quantity to a well or spring [FUNCTION 2].
<i>Ecoview Glossary</i>

7. An underground [LOCATION] bed or stratum [GENUS] of earth, gravel or porous stone [MATERIAL] that contains water [FUNCTION].
<i>Terms of Environment: Glossary, Abbreviations, and Acronyms</i>
8. An underground [LOCATION] geological formation, or group of formations, [GENUS] containing water [FUNCTION]. Are sources of groundwater for wells and springs [FUNCTION 2].
<i>Defining Our Terms: a Superfund Glossary</i>
9. An underground [LOCATION] rock [MATERIAL] formation [GENUS] composed of sand, soil, gravel, or porous rock [MATERIAL 2] that can store and supply groundwater to wells and springs [FUNCTION].
<i>General Multilingual Environmental Thesaurus: European Environment Agency</i>
10. Layers [GENUS] of rock, sand or gravel [MATERIAL] that can absorb water and allow it to flow [FUNCTION]. An aquifer acts as a groundwater reservoir [FUNCTION] when the underlying rock is impermeable. This may be tapped by wells for domestic, agricultural or industrial use [FUNCTION 2]. A serious environmental problem arises when the aquifer is contaminated by the seepage of sewage or toxins from waste dumps. If the groundwater in coastal areas is over-used salt water can seep into the aquifer.
<i>UST Terminology Explained</i>
11. Geological formation, group of formations, or part of a formation [GENUS] that is capable of yielding a significant amount of water to a well or spring [FUNCTION]
<i>Glossary: Office of Solid Waste</i>
12. Underground [LOCATION] layer [GENUS] of rock or sand [MATERIAL] that stores water [FUNCTION]. Humans use wells to get drinking water [FUNCTION 2] from aquifers.
<i>Water Science Glossary of Terms</i>
13. A geologic formation(s) [GENUS] that is water bearing [FUNCTION]. A geological formation or structure [GENUS] that stores [FUNCTION] and/or transmits water, such as to wells and springs [FUNCTION 2]. Use of the term is usually restricted to those water-bearing formations [GENUS] capable of yielding water [FUNCTION] in sufficient quantity to constitute a usable supply for people's uses [FUNCTION 3].

Table 23. Definitions of *aquifer* in thirteen specialized dictionaries and glossaries

Despite the fact that all the dictionaries consulted provide definitions for *aquifer*, none of these definitions is exactly the same. However, Table 25 shows that all the definitions resemble each other in the basic types of information contained: GENUS (conceptual category membership); MATERIAL (what an aquifer is made out of); FUNCTION (what an aquifer is used for); and LOCATION (where it is situated). This provides us with

the blueprint for the conceptual description of *aquifer* as well as for types of *aquifer*. Table 24 shows a comparative grid of the definitional components from the various glossaries and dictionaries (León Arauz, Faber, and Pérez Hernández 2008).

	Dictionary	Location	Genus	Material	Function
1	<i>Construction Term Glossary</i>		Strata	Porous permeable rock or soil	<ul style="list-style-type: none"> ▪ Capable of holding a large quantity of water
2	<i>Life Science Dictionary</i>	Subsurface	Layer	Rock permeable by water (gravel, sand, sandstone, limestone)	<ul style="list-style-type: none"> ▪ Conveyor of water
3	<i>Underground Storage Tanks</i>		Geologic formation/s	Saturated permeable material	<ul style="list-style-type: none"> ▪ Yields sufficient economical quantities of groundwater
4	<i>Terms related to Drinking Water</i>	Underground	Layer	Porous materials (sand, gravel)	<ul style="list-style-type: none"> ▪ Water-bearing ▪ Capable of yielding a large amount or supply of water
5	<i>Drinking Water Glossary</i>	Underground	Layer	Sand or gravel	<ul style="list-style-type: none"> ▪ Contains water
6	<i>Guide to Environmental Issues</i>		Layer	Rock (including gravel and sand)	<ul style="list-style-type: none"> ▪ Water-bearing ▪ Yields water in usable quantity to a well or spring
7	<i>Ecoview</i>	Underground	Bed or stratum	Earth, gravel, or porous stone	<ul style="list-style-type: none"> ▪ Contains water
8	<i>Terms of Environment</i>	Underground	Geological formation/s		<ul style="list-style-type: none"> ▪ Contains water ▪ Source of ground water for wells and spring
9	<i>Superfund</i>	Underground	Rock formation	Sand, soil, gravel, or porous rock	<ul style="list-style-type: none"> ▪ Store and supply groundwater to wells and springs
10	<i>Environmental Thesaurus (EEA)</i>		Layers	Rock, sand or gravel	<ul style="list-style-type: none"> ▪ Acts as groundwater reservoir ▪ Supplies water to wells for domestic, agricultural or industrial use

11	<i>UST Terminology</i>		Geological formation/s		<ul style="list-style-type: none"> ▪ Capable of yielding a significant amount of water to a well or spring
12	<i>Office of Solid Waste</i>	Underground	Layer	Rock or sand	<ul style="list-style-type: none"> ▪ Stores water ▪ Supplies water to wells for drinking purposes
13	<i>Water Science</i>		Geologic formation		<ul style="list-style-type: none"> ▪ Stores water ▪ Transmits water to wells and springs for human use

Table 24. Comparative definition table of AQUIFER

As can be observed in Table 24, all the definitions of *aquifer* contain a *genus* (or generic term that designates membership in a conceptual category), and a description of aquifer function (or a specification of its purpose). Other important definitional elements (which only appear in certain definitions) are its *location* and the *material* that it is made of. However, both types of information are important because an aquifer's capacity for holding water mainly depends on the nature of its component materials and underground location. As a result, in order to obtain an overall view of the concept, a good definition of this concept should at least include a *genus*, *function*, *material*, and *location*. Only six definitions meet this criterion to a certain extent (definitions 2, 4, 5, 7, 9 and 12).

Most of the definitions express an aquifer's basic natural role in the same way: *bearing, holding or containing water*. Definition (2) is the only exception, and even then, the function is reflected implicitly. It refers to materials as "conveyers of water", rather than focusing on the actual function of an aquifer. In contrast, there is little or no consensus about the *genus*. The various definitions define *aquifer* as a *stratum*, *layer* or *geological formation*. In the first case (definitions 1 and 7), the term *stratum* would need further clarification, especially for a non-expert, as opposed to the case of *layer* (definitions 2, 4, 5, 6, 10, 12), which would be too general a term for the needs of a semi-specialized user. *Geological formation* (definitions 3, 8, 9, 11, 13) seems to be the best choice since it frames the concept by placing it in a specialized field, and constitutes what Rosch (1978) calls the basic level (the best example of a category which is related to the best designation of any referent).

Another important functional aspect of an aquifer is its purpose or what it can be used for. This is why the concept can be linked to the category of artificial (human-

initiated) event processes, such as construction, and may also be part of a wide range of specialized knowledge frames (i.e. life sciences, geology, engineering, water supply, environment, etc). In this sense, an aquifer can have different functions, depending on the user group targeted. The natural role of an aquifer, *holding water* (definitions 4, 6, 8, 9, 10, 11, 12, 13), can be described in different ways, depending on the specialized domain.

For instance, definition (3) was taken from a technical dictionary created by an agency in charge of extracting natural resources. This is why aquifer functions are only described in terms of economic profit. The definitions focus on groundwater as an economic resource. They do not focus on the natural holding capacity of the aquifer, but rather on the possibility of transferring it to the surface. Yet, neither of the two definitions shows any information about the type of materials or the location.

The rest of the definitions that include aquifer functions, apart from mentioning the natural role of the aquifer, focus on its use at three different levels of specialization: as a source of water supply in general (4, 10, 12, 13); how it can yield water to wells and springs (6, 8, 9, 11); and how stored water can be used for human purposes (13): domestic, agricultural, industrial uses (10). Evidently, none of these definitions alone includes all of the necessary information to define aquifer, nor guarantees that the definitions of more specific types of aquifer will be systematic.

However, definitional analysis allows us to extract the most pertinent conceptual information, which can be used to create a schema or frame for aquifer and all specific aquifer types. It is composed of four conceptual relations, TYPE_OF, HAS_LOCATION, MADE_OF, and HAS_FUNCTION. In this way, as shown in Table 25, it is possible to elaborate a new definition for *aquifer*, based on a consensus of existing ones.

AQUIFER	underground geological formation composed of permeable material such as rock, sand, or gravel, which holds and supplies water to springs and wells for domestic, agricultural or industrial purposes.	
▪ Underground		HAS_LOCATION
▪ Geological formation		TYPE_OF
▪ Composed of permeable material such as rock, sand or gravel		MADE_OF
▪ Holds water		HAS_FUNCTION
▪ Supplies water to springs and wells for domestic, agricultural or industrial purposes		HAS_FUNCTION

Table 25. Aquifer definition and conceptual relations

The definition in Table 25 makes category organization explicit, and is based on four conceptual relations: TYPE_OF, HAS_LOCATION, MADE_OF, and HAS_FUNCTION. As shall be seen, these relations also reflect Pustejovsky's formal, constitutive, and telic qualia roles (see 3.1.9).

However, text analysis is also helpful when it comes to validating the information extracted from dictionaries or signaling changes in concepts that require modifications to the conceptual system or domain ontology. This means that at some point, specialized knowledge can be contextualized with information derived from text corpora.

3.1.3.2 Corpus analysis

In the same way as the analysis of dictionary definitions, a multilingual corpus of texts offers the possibility of using linguistic clues to extract conceptual information regarding semantic relations. This information is semantically classified and analyzed so that the concept can be placed in the underlying conceptual framework of a knowledge-domain event (Faber et al 2006; Faber, León Arauz, Prieto Velasco and Reimerink 2007). For example, in the following concordances extracted from texts in our corpus, *aquifers* are described in terms of the following conceptual relations: TYPE_OF, HAS_PART, MADE_OF, HAS_FUNCTION, AFFECTED_BY and HAS_ATTRIBUTE (Figure 17).

This information can be derived from the identification of certain lexical-syntactic patterns, which differ according to the relation conveyed. For example, as shown by the phrases circled in Figure 17, the TYPE_OF relation is reflected in lexical markers like *such as*, *known as*, *is a* or *called*:

ISA

different types of aquatic ecosystems, such as rivers, aquifers, estuaries and wetlands. The existing methods that has already been polluted by humans. That is why aquifers and springs--natural sources of clean water-- analytical methods were chosen or designed to identify. Aquifer - any water-bearing layer of rock or unconsolidated rock formations that store groundwater are known as aquifers. Rock formations that cannot store groundwater are called aquifers. such as a multi-layered aquifer, and an aquifer classified either as aquifers or as confining beds. An aquifer is a rock unit that will yield water in a usable form. Microscopic pores that restrict the rate of water movement. An aquifer is a geologic unit that can store enough water in porous materials such as sand and gravel. A confined aquifer is a layer of water-bearing material confined by impermeable rock or other regulatory action such as cleanup or monitoring. Aquifer: a body of rock or other geologic material that can store and transmit water. There are two principal types of groundwater reservoir rocks (aquifers) in North Carolina. The Piedmont and Mountain regions are called aquifers. Aquifers are underground reservoirs. The water that recharges

Figure 17. TYPE_OF concordances of AQUIFER

In Figure 17, the phrases enclosed in rectangles show that AQUIFER can be assigned to different conceptual categories (e.g. *aquatic ecosystem*, *rock formation*,

geological unit, etc.), depending on the perspective taken. The possible genus of the definition extracted from texts is rather different from the set found in dictionaries since the conceptual category specifically pertains to the focus of the text.

For example, *aquatic ecosystem* focuses on the ecological role of aquifer; *water-bearing layer of rock* on its function and material; and *underground reservoir* on its location. *Geological unit* is the closest to *geological formation*, which is the genus in the dictionary definition selected since it points to a taxonomical hierarchy.

Text concordances can also be used to extract and validate other types of conceptual relation. In this sense, there are also lexical markers that signal the PART_OF and MADE_OF relations. As can be observed in the phrases enclosed in ovals in Figures 18 (PART_OF concordances) and 19 (MADE_OF concordances), these relations often share the same patterns (*composed of, forms, comprised of, consisting of, containing...*), since they are both part-whole relations.

PART

where there appeared to be a confining layer above the aquifer. In these instances, the Horslev analysis method is significant" (Dingman, 1994). An unconfined aquifer is an aquifer whose upper boundary is the water table. The water table is the upper boundary of the aquifer. An artesian system requires a confined aquifer with impermeable layers above and below and horizontal layers are those that are bounded by the water table. Some aquifers, however, lie beneath layers of impermeable material. $Kx(y)$ depends on the vertical location y only. If the aquifer is composed of different horizontal layers, the hydraulic conductivity K is a dimensionless parameter given by $K = \frac{1}{L} \sum_{i=1}^L K_i$. If the aquifer comprises L different layers, and the depth of the aquifer is L , wells are dug until they reach the top layer of the aquifer, the water table. The water table is not flat a

Figure 18. PART_OF concordances of AQUIFER

Figure 18 shows concordances containing the lexical markers, *composed of*, *whose*, *above*, and *beneath*. These markers show that AQUIFER is a geological formation that is configured in layers (*confining layer*, *horizontal layers*, *top layer*), which mark its boundaries. In this sense, the text concordances inform us that this is important information that should be added to the definition. The new definition of *aquifer* would be the following:

(158) **AQUIFER** underground geological formation composed of **layers of** permeable material such as rock, sand, or gravel, which holds and supplies water to springs and wells for domestic, agricultural or industrial purposes

The phrases enclosed in ovals in Figure 19 contain examples of the following lexical markers: *forms*, *consisting of*, *containing*, *comprised of*, and *composed of*. They signal the material that aquifers are made of.

MATERIAL

coarse grained, to sub-angular coastal sand forms the aquifers, whereas the clay and the clayey fine grained media and fractured aquifers. Porous media are those aquifers consisting of aggregates of individual particles and cross section for an area underlain by an unconfined aquifer composed of sand. The sand overlies a horizontal elevated in karst (carbonate) areas or where soils and aquifers consist of sand and gravel. These natural features surface because of internal pressure in the underground aquifer containing the water. An artesian aquifer is common and profoundly affects its hydrogeology. The most productive aquifers are composed of limestones of the fossil reef border at about 10 km from the seashore. The aquifer is composed of numerous sandstone and calcareous two types: unconfined or confined. An unconfined aquifer is comprised of porous materials such as sand saturated zone. The water-bearing rocks that compose aquifers consist either of unconsolidated (soil-like) and of the world's population depends on groundwater. Aquifer material is composed of water, soil, the voids

Figure 19. MADE_OF concordances of AQUIFER

According to the texts, these include sand, gravel, limestone, sandstone, water-bearing rock, and soil. Since the dictionary definition already mentions this material, no modifications are necessary.

Figure 20 shows text concordances related to an aquifer's location.

LOCATION

an, or into underground storage areas called aquifers. Aquifers are underground reservoirs. The water that reaches the saturated zone contains more water than others. An aquifer is an underground formation of permeable rock or sandstone and in overlying surficial deposits. Extensive aquifers are found in sand and gravel deposits and in

Figure 20. LOCATED_AT concordances of AQUIFER

A typical lexical marker for location is *found in*. However, in this case, the best indicator of location is the premodifier *underground* of conceptual category indicators for *aquifer*, such as *reservoir* and *formation of permeable rock*. When an aquifer (or any object) is described as manufactured or manmade, it becomes an artifact. In texts, this means that it is accompanied by lexical markers marking function or purpose (e.g. *source of*, *provide*, *used for*, *use of*, *serve as*), as shown in Figure 21.

FUNCTION

aquifer to occur (mm H₂O). 9.2.5 PUMPING If the shallow aquifer is specified as the source of irrigation water for agricultural crops; and . Recharging ground-water aquifers, which provide drinking water for nearly all (recharge rate) and thus determines the underlying aquifer's capability in water supply. Where the soil is impermeable, the permeability and specific yield of the aquifer to be used for injection (showing calculations in words, aqua, or water, and ferre, to bear or carry. Aquifers literally carry water underground. An aquifer was first used in the 1950s and, more recently, the use of aquifers for irrigation and water supply for some coastal wells are located throughout the state in the major aquifers that serve as principal sources of ground water. In this sense, and according to a strict definition, the Aquifer is indeed a filter and does provide some filtration. If the Aquifer acts as a filter, what is clear is the Aquifer definitely provides treatment. How does this occur

Figure 21. FUNCTION_OF concordances of AQUIFER

The concordances in Figure 21 tell us that aquifers provide water for *irrigation*, *drinking*, and *injection*, and even help to treat and filter water. This information is also in consonance with the general information in our dictionary definition, which states that

an aquifer holds and supplies water to springs and wells for domestic, agricultural or industrial purposes.

Contextual information that complements the definition can also be found in concordances that refer to aquifer as an affected entity or patient.

PATIENT

et al. [1992.] modeled flow and transport in a shallow aquifer that was affected by surface reservoirs. Field adation in localized areas. It confirmed that coastal aquifers are vulnerable to saltwater intrusion when h ases gradually towards the coast. The areas of coastal aquifer contaminated by saltwater are delineated in Figl it is called an aquifer. wells can be drilled into the aquifers and water can be pumped out. Precipitation eve e, industry and housing activities are responsible for aquifer contamination by nitrates. The high volume of k

Figure 22. PATIENT_OF concordances of AQUIFER

The lexical markers that signal the PATIENT relation are generally verbs (*affected by, contaminate, pollute*) that change the affected entity in some way. In this case, this change increases or reduces the quality of the water. The concordances show that aquifer can be affected by either natural processes (*saltwater intrusion*) or artificial processes (*pumping, industry and housing activities*), which highlight the multidimensionality of the environmental domain.

3.1.4 Conceptual categories and domain representation in Terminology

One of the objectives of the combined analysis of dictionaries and texts described in the previous sections is to extract the information that makes it possible to map out the conceptual organization of a specialized domain. As is well-known, a major focus in Terminology and Specialized Communication has always been conceptual organization. In fact, a great deal has been written on the topic (Budin 1994; Puuronen 1995; I. Meyer, Eck, and Skuce 1997; Pozzi 1999; Pilke 2001; Feliu 2004; Tebe 2005; Faber, León Arauz, Prieto Velasco, and Reimerink 2007; León Arauz 2009, *inter alia*). However, only in the last ten years have terminologists begun to perceive the need for a more systematic approach to this activity.

Given the fact that terms are specialized knowledge units that designate our conceptualization of objects, qualities, states, and processes in a specialized domain, any theory of Terminology should be cognitively oriented, and aspire to psychological and neurological adequacy. It goes without saying that knowledge of conceptualization processes as well as the organization of semantic information in the brain should underlie any theoretical assumptions concerning the retrieval and acquisition of

specialized knowledge concepts as well as the design of specialized knowledge resources.

It is thus surprising that Terminology has not as yet seriously taken on board recent research advances in cognition and cognitive neuroscience, which point to the inadequacy of standard theories of cognition (Gallese and Lakoff 2005). As is well-known, standard theories of cognition are based on abstract, amodal representations of entities, events, and processes that do not take into account the human and contextual factor of processors, their focus of attention, and spatiotemporal situation. As it happens, these conventional (though inadequate) theories of cognition are the same theories upon which mainstream conceptual representations in Terminology are currently based. This is reflected in Terminology textbooks as well as in the design of specialized knowledge resources (Faber 2010).

For example, most Terminology manuals mention the fact that part of terminology work is the elaboration of a graphical representation of a concept system of the specialized field with the help of an expert and the use of specialized thesauri:

A concept system is made up of a structured set of concepts organized into concept classes. The major concept classes and sub-classes, as well as concepts of the same class, are related on the basis of the characteristics they share or by their use in reality [...] Structures are usually represented in tree diagrams (Cabr  1999: 135).

In terminology work, the knowledge acquired in a given subject field is structured according to the hierarchical and associative relationships between the concepts that make up the subject field (Pavel and Nolet 2001: 15).

However, very little is ever said about how this representation is created, and the premises upon which it is based. Various authors have expressed discontent with the current shape of concept systems (e.g. Nuopponen 1994; Cabr  2000b; Temmerman 2000). Rogers (2004: 221) criticizes the fact that each node in the representation of a concept system is conventionally labeled by a decontextualized lexeme despite the fact that knowledge, as represented in texts, is conceptually dynamic and linguistically varied. Quite understandably, dynamicity is difficult to capture and believably portray in a static representation. Perhaps for this reason, there is a certain lack of proposals or viable alternatives to the current state of affairs.

What is somewhat more surprising is that conceptual organization (of any sort), despite its acknowledged importance, does not appear to have an important role in the elaboration of terminological resources. It is a fact that astonishingly few specialized knowledge resources are conceptually organized, and even those that are based on meaning merely provide an overview of a specialized field, solely based on the TYPE_OF relation. This overview usually consists of graphical representations of

concepts in the form of tree or bracket diagrams. However, even this type of organization is a fairly rare occurrence since the great majority of terminological resources available on Internet contain little or no information regarding the location of specialized knowledge concepts in larger knowledge configurations (Faber et al. 2006).

Even when conceptual representations are provided, they rarely respond to user needs or expectations. Our experience as thinkers tells us that the mainstream conceptual tree does not adequately reflect what is in our mind, and that our mental representations are much richer and more flexible than such representations of conceptual structure. Part of this perceived richness (as well as the difficulty in describing it) is due to the inherent dynamicity of conceptual processing and conceptualization, which involves change over time (Langacker 2001).

The principled configuration of concepts is essential in Terminology, a discipline that targets the understanding and acquisition of specialized knowledge. As previously mentioned, for the most part, mainstream Terminology theory is based on semantic memory models of the human conceptual system (Smith 1978), which are taxonomically organized. Generally speaking, such static knowledge representations traditionally take the form of conceptual hierarchies, such as the one shown in Figure 23.

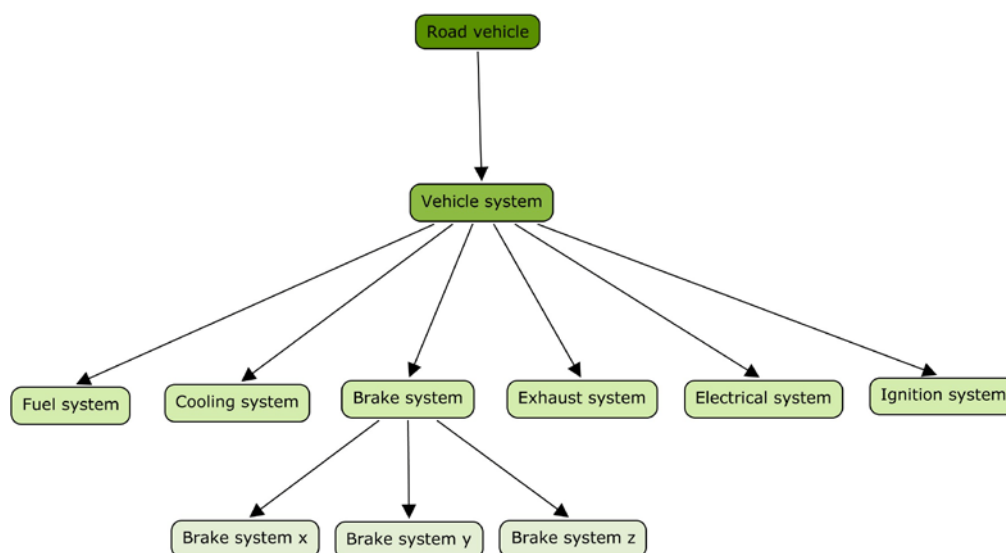


Figure 23. Example of a standard conceptual hierarchy

A surface description of such structures can be found in virtually all Terminology handbooks (Sager 1990, Cabré 1993, Wright and Budin 1997). However, recent research in cognitive neuroscience shows that this type of static, amodal vision of conceptual structure is lacking in psychological adequacy.

3.1.4.1 New theories of cognition

Recent research in cognitive psychology and neuroscience underlines the dynamic nature of categorization, concept storage and retrieval, and cognitive processing (Louwerse and Jeuniaux 2010; Aziz-Zadeh and Damasio 2008; Patterson, Nestor and Rogers 2007; Gallese and Lakoff 2005). This work underlines the inadequacy of standard theories of cognition that claim that knowledge resides in a semantic memory system separate from the brain's modal systems for perception, action, and introspection. According to standard theories, representations in modal systems are not greatly influenced by the perceiver and the context of perception, and are transduced into amodal symbols, which are not specific of the mode of perception. These symbols represent knowledge about experience in semantic memory (Barsalou 2008: 618; Mahon and Caramazza 2008: 59).

However, there is an increasing consensus in favor of a more dynamic view of cognitive processing or situated cognition, which reflects the assumption that cognition is typically grounded in multiple ways. These include simulations, situated action, and even bodily states. The embodied or grounded cognition hypothesis equates understanding with sensory and motor simulation. This hypothesis claims that interactions between sensorimotor systems and the physical world underlie cognition. When we encounter a physical object, our senses represent it during perception and action. Processing the object involves partially capturing property information on these modalities so that this information can later be reactivated (Damasio and Damasio 1994).

To date, brain-imaging experiments have largely involved everyday objects such as cups, hammers, pencils, and food, which, when perceived, trigger simulations of potential actions.

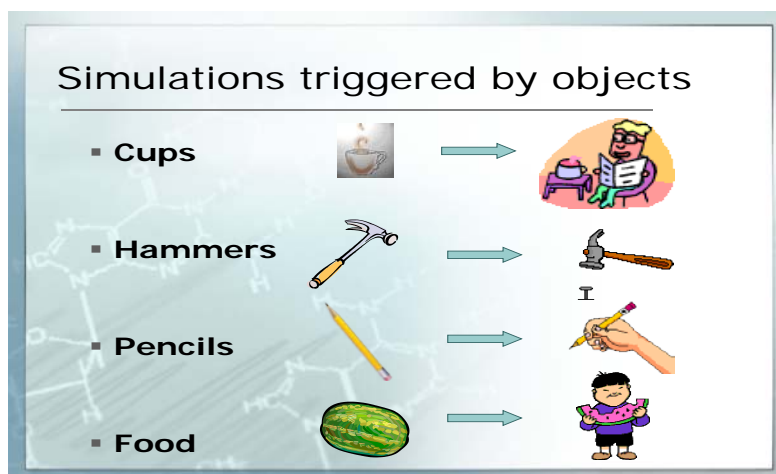


Figure 24. Simulations triggered by objects

For example, as shown in Figure 24, the handle of a cup activates a grasping (or drinking) simulation (Tucker and Ellis 1998, 2001). Food activates brain areas related to gustatory processing as well as areas in the visual cortex representing object shape (Simmons, Martin, and Barsalou 2005). Neuroimaging research thus confirms that simulation is a key part of conceptual processing (A. Martin 2001, 2007). When conceptual knowledge about objects is represented, brain areas that represent their properties during perception and action become active. In particular, brain areas that represent the shape and color of objects, the motion they exhibit, and the actions that agents perform on them become active to represent these properties conceptually.

Such reenactments not only occur in the presence of the object itself, but also in response to words and other symbols. It would thus appear that simulations have a central role in the representation of conceptual knowledge (Barsalou 2003; A. Martin 2001, 2007). For precisely this reason, they should be taken into account in Terminology and knowledge representation. Few if any neuropsychological experiments of this type have ever been performed with specialized concepts, but there is no reason to suppose that the brain would work any differently.

For example, when reading about hockey, experts were found to produce motor simulations absent in novices (Holt and Beilock 2006). In all likelihood, a similar result would be obtained if the object involved were a tide gauge or an anemometer instead of a hockey stick. The expert's brain would show motor simulations in brain areas that would not be activated in the case of non-experts to whom the object was unfamiliar. It would thus seem that the information regarding simulated interaction is thus a vital part of conceptual meaning.

The nature of such simulations is componential rather than holistic. In other words, they are not continuous streamed video recordings, but rather contain many small elements of perception, which arise from all modalities of experience. These modalities are contextually constrained and vary in accessibility (Simmons, Martin and Barsalou 2005). The way that objects are represented in our brain seems to suggest that current methods and ways of elaborating specialized knowledge representations should be modified in order to take this information into account.

3.1.4.2 Towards dynamic specialized knowledge representations

The dynamicity of terms has been explored from a wide variety of perspectives. For example, our knowledge of specialized fields evolves, and the terms used to describe the concepts in them also change (Bowker and Pearson 2002: 48).

Dynamicity is a property of term formation as explored in Kageura (2002). It underlies the idea of the emergence of terms, the coherent coming into existence of new forms through ongoing intrinsic processes. Dynamism is also reflected in the historical evolution of term meaning within sociocultural context (e.g. *splicing*, Temmerman 2007). Moreover, the dynamic nature of terms and their constant change in meanings may require human intervention in the form of terminological control (Felber 1988; Oeser and Budin 1995). However, what underlies all of these dynamic perspectives is the fact that conceptualization or concept formation itself is dynamic. This is the process through which we access and acquire knowledge.

In reference to dynamic conceptualization, Wright (2003) and Bassey et al. (2005) refer to Damasio (1994) and the dynamic variability of his earliest model of concept formation. The model of memory described is reconstructive. Concepts take the form of fleeting perceptions, which are essentially instantaneous convergences of perceptual aspects that combine in a given window of time and space. The main conclusion seems to be that concepts stem from a series of iterative processing events, and are in constant flux in the brain. Such extreme dynamism initially seems to have a very limited practical application because it is impossible to capture a process that is in perpetual motion and so individual.

However, the position that semantic memory arises from universal connectivity in the brain without a corresponding stable neural architecture is no longer tenable. (Patterson, Nestor, and Rogers 2007: 976). Although current theoretical positions regarding semantic memory share the view that much of our semantic memory relates to perception and action, in order to be able to generalize across concepts that have similar semantic significance, there must also be a single convergence zone or hub that supports the interactive activation of representations in all modalities for semantic categories (ibid: 977).

Regarding the ways that such theories might affect terminological work, there is a wide range of possible applications in Terminology that are just beginning to be explored. First of all, situated conceptualizations underline the fact that concepts are not processed in isolation, but are typically situated in background situations and events (Barsalou 2003). This signifies that context is all-important in knowledge representation. At any given moment in the perception of the entity, people also perceive the space surrounding it, including the agents, objects, and event present in it (Barsalou 2009: 1283).

This can be directly applied to specialized knowledge modeling. For example, EROSION is the wearing away of the earth's surface, but whether conceptualized as a process or the result of this process, erosion cannot be conceived in isolation. It is

induced by an agent (wind, water, or ice) affects a geographic entity (the Earth's surface) by causing something (solids) to move away. Moreover, any process takes place over a period of time, and can be divided into smaller segments. In this sense, erosion can happen at a specific season of the year, and may take place in a certain direction. All of this information about erosion should be available for activation when we think about the concept. The meaning of a concept is constructed on-line, and is modulated by context.

Secondly, although dynamicity has been regarded primarily as an attribute of event and action concepts (Pilke 2001; Puuronen 1995, *inter alia*), as shall be seen, grounded or situated cognition means that object concepts are also dynamic since they are processed as part of a frame or dynamic context which highlights the type of action that they participate in. This, in turn, affects how concepts should be represented in order to facilitate knowledge acquisition and understanding.

Thirdly, research results in this area indicate that knowledge acquisition requires simulation of human interaction with objects, and this signifies that non-hierarchical relations that define the goal, intended purpose, affordances, and result of the manipulation and use of an object (e.g. HAS_FUNCTION, AFFECTS, HAS_RESULT, etc.) are just as important (if not more so) than hierarchical ones, such as TYPE_OF or PART_OF.

Based on the assumption that category boundaries are dynamic and in constant change, depending on the activation of specific contexts, a more believable representational system is needed. A system more in consonance with empirical evidence is one that is dynamic and process-oriented, with goal-derived categories that provide mappings from roles in action sequences to instantiations in the environment. Such a system would have the following features:

- a) *Object-orientedness*. Each specialized concept is represented and stored in the knowledge resource with various types of information, and is described in such a way as to underline its relation with other concepts. Starter concepts are related to each other at the upper level in a frame-based structure that represents their most typical roles within events that take place within the context of any specialized domain. For example in EcoLexicon, each concept is stored in the knowledge base as a representation composed of conceptual, linguistic, and graphical information.
- b) *Generalization/specialization*. The hierarchical and associative or non-hierarchical relations between concepts are made explicit in the structure of their definitions as well as in dynamic conceptual maps. In this respect, conceptual relations in EcoLexicon are reflected in the definition as well as in ThinkMap representations.

- c) *Inferences*. An established inventory of conceptual relationships permits users to make a series of inferences regarding new concepts in the specialized domain. The fact that a concept belongs to a certain category means that users can infer certain of its properties. For example, if the function of an aquifer is that it holds and supplies water to springs and wells for domestic, agricultural, or industrial purposes, then it can be assumed that both *confined aquifers* and *unconfined aquifers* (since both are more specific types of aquifer) also have the same purpose.
- d) *Classification*. The conceptual templates for each category allow users to determine whether a concept is a member of a given category. Conceptual templates specify whether concepts belong to a category and whether they are more or less prototypical members of it.

All of this evidently involves elaborating a more complex representation of concepts in specialized domains. Such a representation necessarily takes propositional inferences into account and relates categories by means of a generic frame. In this sense, frames, as structures with stable associations with lexical items, have the advantage of allowing for variable boundary construal, presumably in terms of the goodness-of-fit required between perceived reality and aspects of the frame (Croft and Cruse 2004: 95).

3.1.5 Specialized knowledge frames: the Environmental Event

As previously mentioned, simulation represents the way we interact and acquire knowledge about an entity, and situated conceptualization involves a representation of how entities interact with each other. This means that no specialized knowledge concept can be activated in isolation, but rather as part of an event. When applied to Terminology and specialized communication, this has the effect of making context or situation a crucial factor in knowledge representation. Our knowledge of a concept initially provides the context in which it becomes meaningful for us. A knowledge resource that facilitates knowledge acquisition should thus provide conceptual contexts or situations in which a concept is related to others in a dynamic structure that can streamline the action-environment interface. Rather than being decontextualized and stable, conceptual representations should be dynamically contextualized to support diverse courses of goal pursuit (Barsalou 2005: 628).

Frame-based Terminology (Faber, Márquez Linares, and Vega Exposito 2005; Faber et al 2006; Faber, León Arauz, Prieto Velasco, and Reimerink 2007, Faber 2010) uses a modified and adapted version of Fillmore's Frames (Fillmore 1982, 1985;

Fillmore and Atkins 1992; Fillmore et al. 2003) coupled with premises from Cognitive Linguistics to configure specialized domains on the basis of definitional templates and to create situated representations of specialized knowledge concepts. The compatibility of Cognitive Linguistics with neuropsychological research on category-specific semantic deficits is underlined in Rodríguez-Redondo (2004).

The domain of Environmental Science exemplifies how frames or frame-like structures can be used to represent specialized knowledge domains. It should be emphasized that this representation concerns the way linguistic semantic structure is characterized in terms of its classes, individuals, and the relations between them, and thus reflects conceptual structure. According to Wiese (2001: 8), language specifies a view of the conceptual system, and provides a bridge between general cognition and grammar.

Nevertheless, our conceptualization of the domain, though based on language, makes no claims as to syntax or language structure. In this sense, EVENT designates an upper-level conceptual category. Although there are various ways of presenting the conceptualization of a specialized domain, depending on the objectives of the knowledge resource,

Figure 25 illustrates how the most generic categories and roles of Environmental Science can be configured in a prototypical domain event (Barsalou 2003: 513, Faber, Márquez Linares, and Vega Exposito 2005). This event is a general frame for the organization of more specific concepts, and a specification of the general frame-based event shown in Figure 1. As shown Figure 25, the categories are linked by the predicates, *cause*, *do*, *affect*, *use*, *make*, and *become*. These basic meanings relate roles, concepts and categories of concepts in environmental science, and link generic categories at the superordinate level. They also provide the basis for subframes that can be used to restrict contextual information to what is most relevant.

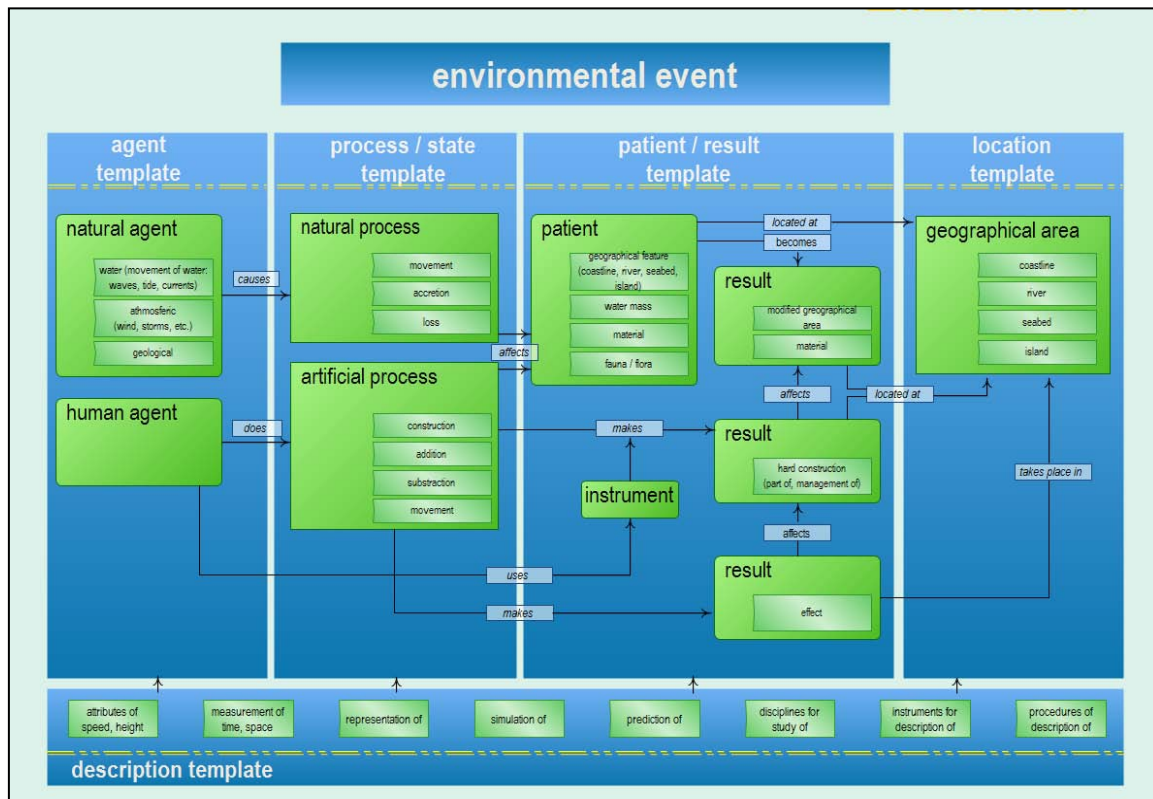


Figure 25. Environmental Event (EE)

As shown in Figure 25, the EE has two types of AGENT that can initiate processes. Such agents can be inanimate (natural forces) or animate (human beings). NATURAL AGENTS, such as water movement (e.g. waves, tides, and currents) and atmospheric phenomena (e.g. winds and storms) cause NATURAL PROCESSES such as littoral drift and erosion in a geographic area such as the coast. These processes affect other entities or PATIENTS (e.g. beaches, sea ports, and seabed) which as a RESULT, may suffer changes (e.g. loss/deterioration/creation of beaches, and modifications in seabed composition). HUMAN AGENTS can also implement ARTIFICIAL PROCESSES (e.g. constructions), which can generate or prevent EFFECTS normally caused by natural processes.

For instance, a coastal construction can be created with the purpose of controlling erosion. With the help of INSTRUMENTS, humans can build structures such as groynes, whose function is to protect a shore area, retard littoral drift, reduce longshore transport, and prevent beach erosion. In this type of conceptual description, it should be underlined that the semantic roles have no linguistic theoretical value as such, but are used to characterize the roles that different concepts can fulfill within different subevents or subframes.

The AGENT and EVENT templates have a parallel structure. The relationship between NATURAL AGENTS and the EVENTS that they CAUSE is parallel to the relationship between HUMAN AGENTS and the EVENTS that they consciously carry out or DO. This parallelism extends to their subcategories, which in both cases include events that involve movement, accretion or loss of material. Naturally, CONSTRUCTION is a typically human-caused event that has no corresponding natural process event. The fact that the same terms refer to both natural and artificial events (e. g. *consolidation*, *recharge*, *nourishment*, etc.) demonstrates that natural agents, perhaps because of their *agenthood*, often acquire human characteristics and are personified. The importance of the DESCRIPTION template is underlined by the complexity and diversity of its subcategories, which range from the measurement and analysis of the entities involved in the EE to the devices used for their detection and representation, which have the role of INSTRUMENT.

This general event is the pattern for more specific ones. Events and the relations linking their participants are based on premises derived from Ontological Semantics (Nirenburg and Raskin 2004). In EcoLexicon, such events include a BUILD-EVENT, FLOODING-EVENT, EROSION-EVENT, SEDIMENTATION-EVENT, DESERTIZATION-EVENT, COASTAL-DEFENSE-EVENT, etc. For example, soil erosion in one area is a complex event that includes many sub-events, such as weather change, rainfall, over-exploitation of agriculture land, deforestation, etc. These sub-events are related since they influence each other over time. Participants in this event are soil, water, and wind. The final result is that soil is eroded. Each subevent is also observable as sets of similar more specific changes.

Depending on the event type, concepts can take PATIENT or RESULT roles. Environmental Science deals with the highly dynamic events that take place in the coastal environment. Beaches, cliffs, marshes, plants (PATIENT) are affected by both natural and artificial events or may even be the result (RESULT) of a natural or artificial event. Thus, a beach is by definition a sediment deposit, and hence, the result of erosion (a natural process event of loss). However, at the same time it is affected by erosion, and thus, in another type of event, can take the role of PATIENT.

As previously mentioned, the dynamic nature of natural events can also be observed in artificial process events. Human-initiated process events result in constructions and structures, such as ports, breakwaters, or seawalls, which become a part of the environment. Once created, this type of maritime structure can be affected both by natural and human events. For example, a hurricane can seriously damage a port and a tidal wave or tsunami can wash away a seawall. Further construction can also make the port larger or lengthen a seawall. Therefore, the same entity which is the

result of an event can also be construed as a patient when it is affected or modified by another event.

However, the conceptual representation of the Environmental domain cannot be achieved simply by assigning semantic roles to concepts and categories within an event type. As research in cognitive semantics points out, categorization is naturally fuzzy, and the boundaries between categories not clearly defined. Furthermore, any interaction with other entities can influence its categorization (Evans and Green 2006: 29). Conceptual fuzziness may thus stem from the way concepts behave when they venture outside category boundaries. As a result, the dynamism of environmental science is reflected at more specific levels in the following ways:

- (i) Concepts can belong to more than one category (i.e. multidimensionality).
- (ii) The interaction of the AGENT, PATIENT, RESULT, INSTRUMENT, and LOCATION roles at more specific levels is represented by means of a set of more specific conceptual relations.
- (iii) Any specialized domain contains sub-domains in which conceptual dimensions become more or less salient depending on the activation of specific contexts. Accordingly, entities can be re-construed according to the conceptual relations that are most salient in those dimensions.

All of this signifies that the components of each EE category can often converge in new sub-event structures, whereby concepts can be framed from different perspectives.

This event-based representation facilitates knowledge acquisition in text processing since conceptual categories are bound together by event knowledge. Proof of the usefulness of event knowledge can be found in written communication since a comprehender's knowledge of events plays a central role in sentence processing. This knowledge interacts with structural interpretation at the earliest possible moment (Elman 2009: 549). Evidently, terms, whether they designate objects or processes, are powerful cues for the wider event knowledge targeted. In this regard, the choice of a specific term is enough to generate expectations and predictions that constrain the range of likely events.

Obviously, these conceptual configurations and relations are only a subset of those activated in general language. This is not surprising since specialized language has the same syntax as general language, and specialized texts follow the same grammatical rules as general language texts. Differences mainly involve the predominance of a set of conceptual categories and relations.

From a conceptual perspective, specialized knowledge communication in the environmental domain centers focuses on:

- Natural agents that cause events
- Natural entities or objects that participate in states
- Patients (usually environmental entities, such as geographic and coastal landforms, water bodies, life forms, etc.) affected by an event
- Human agents (builders, engineers, environmental policy-makers, etc.) that initiate events that produce results.
- Instruments that are used to analyze, measure, and evaluate natural process events

From a linguistic perspective, specialized texts are characterized by the predominance of compound nominal forms, the passive voice, and certain lexical patterns, characteristic of formal, impersonal style. As previously mentioned, the analysis of concordances extracted from a corpus of domain-specific texts allows us to offer an explanation of how such language structure can be analyzed and used to structure terminological units in a way that imitates, at least to some extent, how the concepts that they designate are stored in the mind.

As shown in Figure 25, the general environmental frame is defined as an event, consisting of a relatively time-unstable knowledge configuration of various conceptual categories in meaningful relationships. According to Allen and Ferguson (1997):

[...] events are primarily linguistic or cognitive in nature. That is, the world does not really contain events. Rather, events are the way by which agents classify certain useful and relevant patterns of change.

As previously mentioned, EcoLexicon is based on the structure of events and subevents that take place in the environment. An environmental process event can be composed of subevents, triggered by one or more environmental entities. Examples of broad environmental event terms are *erosion* or *transport*. Examples of more specific terms are *glacier erosion* or *longshore sediment transport*. Such events are categories with conceptual status with non-linguistic conceptual organizing principles, which can be mapped onto or translated into language.

When events are “translated” into language, they usually take the form of predicate-argument structures. It seems that their various degrees of temporality or change are what motivate their division into different types. In this respect, our classification of verb types is roughly based on Vendler’s (1967) theory of *Aktionsart*, as enriched by Van Valin (2004). Van Valin augments the four basic classes (state, activity achievement, and accomplishment) by two additional classes, semelfactives and active accomplishments. He also distinguishes causatives as a parameter cross-cutting through the six classes. Although we use this classification we have substituted

PROCESS for ACTIVITY because the term is more descriptive of what happens in the environment.

a. STATE

(158) Atmospheric conditions were favorable.

b. PROCESS

(159) The wind is blowing.

c. SEMELFACTIVE

(160) Waves hit the cliff.

d. ACHIEVEMENT

(161) Waves break in the surf zone.

e. ACCOMPLISHMENT

(162) The cliff eroded.

f. ACTIVE ACCOMPLISHMENT

(163) The ocean flooded shore lagoons.

g. CAUSATIVE

(164) The hurricane caused the flooding.

Pustejovsky also bases his verb classification on the *Aktionsart* distinctions of Vendler, (1967) and Dowty (1979), but it is not as fine-grained. He distinguishes three event types, corresponding to: (i) states; (ii) process (activities); (iii) transitions (achievements and accomplishments). However, for our purposes, the classification and annotation in RRG is more helpful because it is not language-specific.

The general Environmental Event is based on events that occur either naturally or artificially in the environment. This type of knowledge representation focuses on what the texts in the specialized domain generally talk about. Processes and states codify events that occur in the environment, and which significantly modify it in some way. These events as well as their participating entities, and results are often observed, analyzed, and measured.

3.1.6 Semantic roles and their status

Specialized knowledge representation naturally includes semantic properties that help to describe the nature of objects and events. There is, however, a group of relations that has a special semantics. These relations describe connections between events and objects or other events. In linguistic terms, this is reflected as the relation between a verb and its arguments. In other words, basic propositions are described through the specification of their semantic arguments. These arguments are typical roles that a predicate can take.

At the most general level of event, conceptual categories are combined in scene-like configurations characterized by semantic roles, whereas conceptual networks represent the way concepts interact within more concrete events according to their internal structure and nature. This dual representation is in consonance with what Talmy (2000) calls the language user's Cognitive Representation. According to Talmy, the human conceptual system is made up of two systems: (i) the conceptual structuring system, where the structural properties of a given scene are shown; (ii) the conceptual content system, where a content-rich detailed representation of a particular scene is provided.

The status of semantic roles in linguistic theory is problematic, and has been the focus of much research since the 1960s. Semantic roles generally express the set of properties which a verb entails for a given argument. Although, most linguists tend to believe that they exist, at least in some form, there is considerable disagreement as to their number, nature, and function. Currently, there are as many inventories of semantic roles as there are theories that use them. According to Nirenburg and Raskin (2004: 175), this state of affairs is caused by the difficulty of balancing the grain size of description against coverage and ease of assignment of case role status to semantic arguments.

The question inevitably arises as to how abstract or specific semantic roles should be. As Van Valin (2004) points out, semantic roles have been studied at three levels of generality: (i) verb-specific roles; (ii) thematic relations, which are generalizations across verb-specific roles; (iii) semantic macroroles, which are generalization across thematic relations. However, the question arises of how much is too much and how little is too little. If the inventory of roles is open-ended and can go on forever, then the roles have no general descriptive adequacy since one can make up roles as one goes along.

Like Nirenburg and Raskin (2004: 175), we believe that there should be a straightforwardly defined inventory of semantic roles that correspond to a clear-cut, coherent subset of reality. This means that the inventory should be small, but not too small. Our set of semantic roles largely corresponds to those in the CAMBIO/CREST implementation as well as to the list of roles given by EAGLES (1996).

As previously mentioned, AGENT, PATIENT, RESULT, LOCATION, and INSTRUMENT are the semantic roles most characteristic of the environmental domain, and the EE represents their interrelationships. In the future, we plan to add SOURCE, PATH, and DESTINATION as subroles, dependent on LOCATION. These would specifically affect all movement events, and be activated in certain events, such as TRANSPORT-EVENT.

Semantic roles are thematic relations, which are generalizations across the more verb-specific roles that we have encountered in the specialized texts of our corpus. It is true that they could be further specified and increased in number, or further generalized and reduced in number, but we have chosen the second level of generality because our focus is more on the characterization of conceptual (language-independent) entities which participate in events and less on verb meaning. This inventory of roles, which we have used for conceptual modeling, has been extracted by means of text analysis.

Our list of roles is not longer since specialized language is principally concerned with nominal forms, designating object concepts, which engage in actions encoded by a fairly reduced set of general language verbs designating basic predicate meanings. We have not used macroroles, which would obviously entail a more in-depth study of verb meaning in specialized language than we can currently offer. Our focus is also different because we are more interested in using thematic relations reflected in language as a gate to the mind rather mapping them onto syntax.

Since objects concepts carry most of the meaning in specialized texts, Terminology seems to be mostly concerned with specialized nouns and noun phrases, and very little with verbs. This is largely because specialized discourse uses the same verbs as in general language. What changes is the semantic nature of the arguments. Their specialization tends to restrict verb meaning, and make it less polysemic than in general language discourse. Semantic roles are also relevant because they are implicitly present in the many nouns and noun phrases, such as *erosion*, *sedimentation*, *transport*, *flood*, *desertization*, etc. which encode events.

Agent

An AGENT is an entity that causes [CAUSE] an action. It can be a natural agent (i.e. a natural force) or a human agent that carries out [DO] the action with intentionality. For example, both GALE and BUILDER can have the role of AGENT. GALE is a natural agent or force since gale winds can cause sediment to be transported. BUILDER is a human agent since builders do construction work.

Patient

A PATIENT is an entity that is affected [AFFECT] by an event. In the environmental domain, a PATIENT is most prototypically a physical landform, a structure, or life form that undergoes a change because of some type of event. For example, a BEACH can be affected or undergo change because of an erosion event. FLORA or the vegetation in an area is evidently affected by a desertization event.

Result

A result is an entity originated by an event. Linguistically, this entity is the result of an accomplishment. For example, a BUILDER can construct (MAKE) a JETTY, and WAVES can erode (CAUSE LOSS to) a BEACH.

Instrument

An instrument is an object used to carry out an action. INSTRUMENT generally refers to the tools, machinery, and devices that are used to carry out human process events in the environment. Since scientists seek to describe Nature in order to predict its course, it should not come as a surprise that there are many terms designating concepts related to perception, measurement, description, and analysis of environmental phenomena. For example, a wide variety of maps, measuring devices, theories, and analytical procedures belong to this category.

Location

A location is the place where an event takes place or where an object exists. For example, a BEACH NOURISHMENT event takes place at a beach; a TIDE EVENT takes place on the coastline; and a GROUYNE is located in coastal waters. However, the beach as well as the coast can also be conceived as geographic objects or landforms which are affected by artificial or natural processes. Depending on the type of event they appear in, they can either be locations or patients.

These basic roles are used to define the role of entities that participate in events. They are also intimately linked to conceptual relations that connect concepts in a semantic network.

3.1.7 The sedimentation-event

Within a geographic context, *sedimentation* can be defined as an event involving the accumulation of particles of organic or inorganic material in a specific location. As such, an agent initiates a process in which material is the affected entity. The resulting accumulation leads to a modified geographic area. However, this term really designates a complex event, which codifies an accomplishment.

(165) Sediment (organic/inorganic material) increases in a specific location.

BECOME **increased**' (sediment) & BECOME **be-at**' (location, sediment)

When an agent causes sediments to accumulate at a certain location, it can be regarded as a causative accomplishment. The proposition encapsulated in the sedimentation event is shown in (166):

(166) causes sediment to accumulate at y

[do´(x,∅)] CAUSE [do´ (sediment, [increase´ (sediment) & BECOME be-at´ (y, sediment)]]

In (166), x can be filled by wide variety of both natural and artificial entities. The following examples from our corpus of specialized environmental texts show that *sedimentation* is consistently used with causative verbs that affect or influence the event in some way. The basic event (the increase and accumulation of sediments) remains the same. The predicates merely indicate that the agents are causing the process to happen in a certain way by intensifying/diminishing its effects or by intensifying/diminishing the possibility of its happening.

(167) Mangrove removal is also reported to **change** sedimentation patterns.

(168) It [a geographic landform] probably **affected** sedimentation on the inner shelf.

(169) This feature is unlikely to **influence** sedimentation today.

(170) Phytoplankton blooms may **enhance** the sedimentation of organic material.

(171) They aimed to develop drainage design guidelines to **reduce** stream sedimentation.

(172) The study analyzes the frequency of storm-**induced** sedimentation.

(173) Detached breakwaters **promote** sedimentation and the widening of beaches.

(174) Grass beds **avored** the sedimentation of fine material.

Table 26 categorizes the predicates in terms of their basic meaning and lists their respective agents and patients

Predicate	Agent	Patient
CAUSE TO BE DIFFERENT		
change	mangrove removal	sedimentation patterns
affect	geographic landform	sedimentation
influence (neg)	this feature	sedimentation
CAUSE TO BE MORE		
enhance	phytoplankton blooms	sedimentation of organic material
CAUSE TO BE LESS		

reduce	drainage design guidelines	stream sedimentation
CAUSE TO BE		
induce	storm	sedimentation
CAUSE TO BE POSSIBLE		
promote	detached breakwaters	sedimentation
favor	grass beds	sedimentation of fine material

Table 26. Meaning-based categorization of predicates

The above examples from our corpus have the core meaning of CAUSE TO BE DIFFERENT (MORE/LESS) and CAUSE TO BE (POSSIBLE). This does not change the nature of the process itself, but rather influences its parameters in some meaningful way.

However any sedimentation process, whatever the agent causing it, also directly affects other entities, such as coral, drainage ditches, and stream channels, as shown in examples (175) and (176). In this case, the effects are negative.

(175) Heavy sedimentation can bury corals, inhibiting their growth or killing them.

(176) Sedimentation clogs drainage ditches and stream channels.

SEDIMENT, the principal participant in the sedimentation event, is a highly context-sensitive concept. Initially, as shown in the corpus examples, it can be framed as the participating or principally affected entity in SEDIMENTATION. However, when it is included in the conceptual representation of the COASTLINE frame, SEDIMENT can be defined and categorized as the material the coastline is made of.

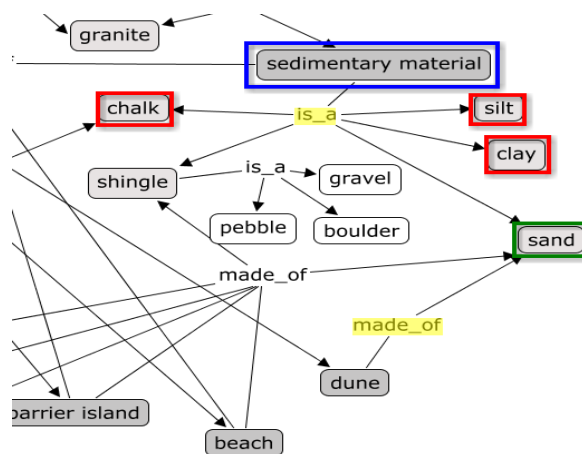


Figure 26. Sedimentary material within the coastline frame

Nevertheless, concepts are susceptible to reconstrual. In other words they can be understood in different ways when they participate in other contexts. Alternatively, within the context of the COASTAL DEFENSE EVENT, SEDIMENTATION can be regarded as an instrument concept since sediment is the material used for beach nourishment. Apart from adding new dimensions or restricting them to the context, reconstrual affects the graded centrality of the internal hierarchy of concepts. This means that the position of SEDIMENT is more or less central, depending on the sub-domain. In a general context, types of SEDIMENT are more numerous than in the context or frame of the COASTLINE, which limits sediment type to SAND.

However, in the COASTAL DEFENSE EVENT, new concepts, such as SHINGLE, NATIVE SAND and NOURISHMENT SAND, come into the limelight, and take central positions in the category.

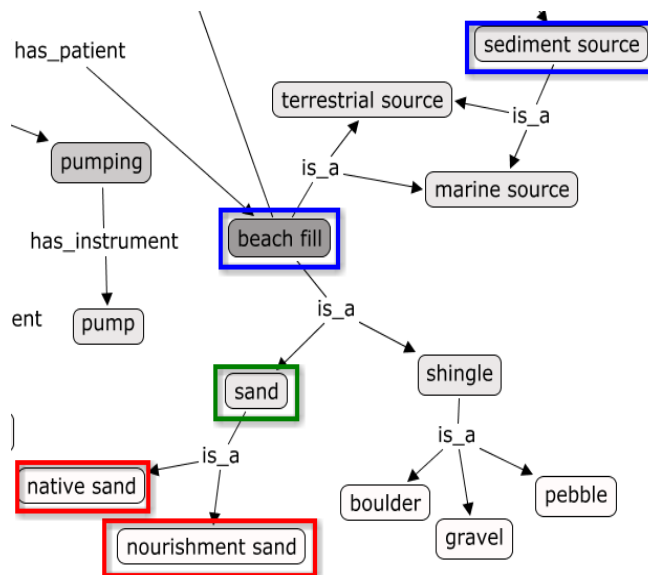


Figure 27. Sedimentation within the frame of beach nourishment

As a result, within the Environmental Event, goal-derived categories resulting from the complex interaction of different contextual dimensions can be represented at three levels. These levels materialize in the form of three types of cognitive frames: (1) a prototypical sub-event describing the semantic roles and proposition configurations of the categories in each sub-domain; (2) a conceptual network based on the hierarchical and non-hierarchical relations activated by concepts within a sub-event; (3) a terminographic definitional template for concept description in consonance with the conceptual relations in the conceptual network and at the same time with the context activated in the sub-event. After exploring the configuration of sub-events, we will first

examine conceptual networks based on hierarchical and non-hierarchical relations, and then definitional templates.

3.1.8 Conceptual relations

The second part of the human conceptual system, according to Talmy (2000) is the conceptual content system, where a content-rich detailed representation of a particular scene is provided. This means the representation of concepts in terms of a closed inventory of semantic relations. Until recently, however, conceptual relations in term bases, if they existed at all, were mainly restricted to generic-specific and part-whole relations. This was conducive to static configurations, which are at odds with the need to represent dynamic action in domain models (Barrière 2001a: 137). Rogers (2004: 218-219) writes:

Text-book versions of concept systems tend to focus on the representation of abstract genus-species relations rather than the vast array of ontological relations which are on the whole — with the exception of part-whole relations—poorly understood and documented.

Although non-taxonomic relations between concepts are a crucial part of definitions, they are not well-researched, and there is no consensus regarding what type of relationships are most useful for conceptual representation. In our experience, semantic relations largely depend on the type of entity being described, its nature, and relational power. The top-level identity of the concept influences to a great extent its core inventory of relations.

Terminological knowledge bases can acquire greater coherence and dynamicity when the range of conceptual relations contemplated is wider than the traditional generic-specific and part-whole relations. In the EcoLexicon knowledge base, each concept type is related to other concepts by a set of conceptual relations, some of which are domain-specific. Having a closed set of conceptual relations means that the knowledge structured in the term base is more coherent and easier to incorporate into a future formal ontology.

3.1.8.1 Inventory of conceptual relations in EcoLexicon

The conceptual relations exemplified and discussed in this section are the following: TYPE_OF, PART_OF, MADE_OF, PHASE_OF, DELIMITED_BY, LOCATED_AT, ATTRIBUTE_OF, RESULT_OF, AFFECTS, CAUSES, HAS_FUNCTION, and EFFECTED_BY. In this inventory, TYPE_OF and PART_OF are vertical relations. MADE_OF, PHASE_OF, DELIMITED_BY, LOCATED_AT, and ATTRIBUTE_OF can be regarded as subtypes of

meronymy. This distinction is in consonance with the typology proposed in Winston et al. (1987), since not all parts interact in the same way with their wholes. The reason why we have established six different meronymic relations is based on our domain-specific needs, but especially on ontological reasoning and consistency. For example, if LOCATED_IN were considered as a PART_OF relation, that would cause a fallacious transitivity (Murphy 2006). In the same way, if both processes and entities were connected through the same PART_OF relation, there would be no restrictions on category membership.

The conceptual relations, AFFECTS, CAUSES, HAS_FUNCTION, and EFFECTED_BY are horizontal relations. HAS_FUNCTION has three domain-specific subtypes: MEASURES, STUDIES, and REPRESENTS. Evidently, all conceptual relations in the inventory have a corresponding inverse relation: TYPE_OF ↔ GENERIC_OF; RESULT_OF ↔ HAS_RESULT; CAUSES ↔ CAUSED_BY; PART_OF ↔ HAS_PART, etc.

TYPE_OF

This generic-specific relation reflects hierarchical inheritance in the conceptual network of the domain. This relation means that the term is a subclass of its parent. For example, sheet pile groyne (*subclass*) TYPE_OF groyne (*superclass* of sheet pile groyne,) TYPE_OF coastal defense structure (*superclass* of groyne) TYPE_OF coastal structure (*superclass* of coastal defense structure) TYPE_OF construction (*superclass* of coastal structure and general *category*) TYPE_OF RESULT of an artificial process event.

All entities and events are categorized as subclasses of a particular superclass. Classes can, in turn, belong to superordinate classes, and lead to the most generic categories that are directly linked to the semantic roles categories of the event structure. Thus, any concept can be linked to its immediate superordinate concept (or several concepts in cases of multidimensionality).

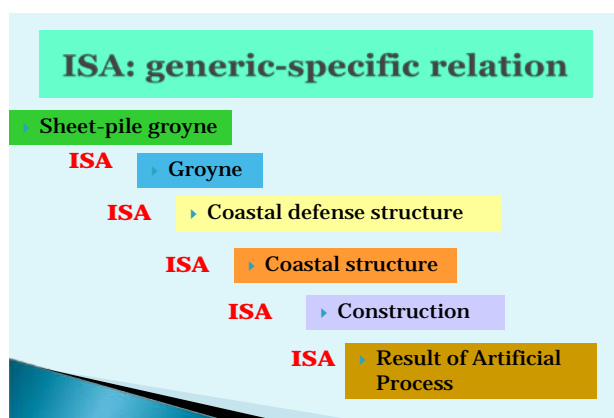


Figure 28. TYPE_OF relation

In EcoLexicon, the generic-specific relation does not appear by itself, but is one of the many relations that occur in the activation of the conceptual network. It is thus regarded as of the same importance as the other relations.

PART_OF

PART_OF is a vertical relation that also reflects the hierarchical structure of the domain. In the case of physical objects or entities, it directly refers to the parts of each concept. In ontologies, this relation can enhance semantic expressiveness, as it may be transitive under certain circumstances. However, not all parts have the same implications with regards to their wholes and in particular cases, transitivity may turn out to be misleading. For example, a river head is PART_OF a river and a river is PART_OF the hydrosphere. However, a river head cannot be considered a PART_OF the hydrosphere, since it is not a very good example of how things relate in the real world. Consequently, before considering transitivity, the PART_OF relation should be subdivided in different relation types, which may be specific of conceptual classes.

The PART_OF relation is a complex one since it is linked to perception. A part can be regarded as the component of a holistic object, member of a set, or the portion of a mass. It is also regarded as the relation between an object and the material that it is made of, a subactivity or phase of a process, and even a location in a geographic area. However, because of the relevance of these last three types for the environment, we have separated them from the more general PART_OF relation as the relational subtypes: MADE_OF, PHASE_OF, and LOCATED_AT.

Much of the complexity of the PART_OF relation lies in the fact that to a great degree, it is constrained by our perception of possession. Accordingly, it largely depends on how a concrete/abstract object is perceived to be divided. For example, a case of abstract meronymy for mental entities is that regarding the division of scientific disciplines (Microbiology PART_OF Biology). This relation may even vary from culture to culture, and can also evolve as our knowledge of an object increases

As a conceptual relation, PART_OF is also applied to the profile-base relation in Cognitive Linguistics. Langacker (1987: 183-89) argues that one can understand the geometrical concept of RADIUS only against the background of the concept CIRCLE. In EcoLexicon, radius would be regarded as PART_OF a circle. We have found that this type of profile-base relation is present throughout the structure of specialized language, in which specialized concepts can only be understood within the context of larger, more inclusive concept.

MADE_OF

The MADE_OF relation links both artificial and natural objects to the material they are made of, and thus is related to the PART_OF relation without being exactly the same. Even though the material of an object is part of it, this relation is different from the PART_OF relation since material is variable. Figure 29 shows the materials that a groyne can be used to construct a groyne.

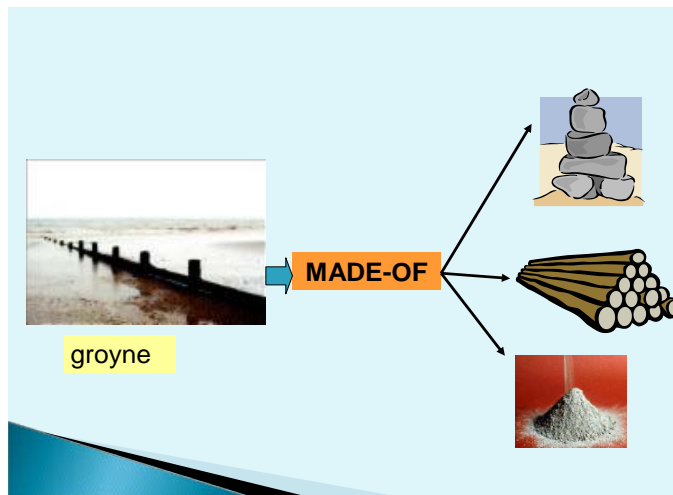


Figure 29. MADE_OF relation

For example, a groyne head is PART_OF all groynes, but the same cannot be said of the material used to make this type of construction since groynes can be MADE_OF stone, concrete, or wood, but not of all three at the same time.

PHASE_OF

PHASE_OF can be regarded as a type of PART_OF relation, which is applied to processes. In the same way that objects are incomplete and can even lose their identity without one or more of their constituent parts, processes are incomplete without one or more of their phases (*pumping* PART_OF *dredging*). Another example of this relation is any type of extreme event (tsunami, hurricane, tornado, etc.) which can be regarded as a natural agent that initiates a process (i.e. earthquakes or volcanic eruptions can produce tsunamis). However, an extreme event can also be the process itself, which occurs in time and space. It can thus have three phases: a calm cycle, a loading cycle, and a dissipation cycle.

For example, when a TROPICAL_CYCLONE is conceptualized as a process, its nature is determined by the strength of the sustained wind. In fact, its name changes at each strength level: (i) a TROPICAL_DEPRESSION has winds less than 36 mph; (ii) a TROPICAL_STORM has winds that range from 36 and 74 mph; (iii) a HURRICANE has

sustained winds higher than 74 mph. All of the preceding can be regarded as phases in the development of tropical cyclones. As a result, tropical depression, tropical storm, and hurricane would have a PHASE_OF relation with tropical cyclone, and be part of its loading cycle.

DELIMITED_BY

DELIMITED_BY is also connected to the PART_OF relation because objects are often regarded as the same whole. It is often activated in the representation of physical objects, and marks the boundaries, dividing one part of the object from another. This is a domain-specific relation, mainly for geographic entities, such as the different layers of the atmosphere or the Earth, which are contiguous. For example, the stratosphere and mesosphere are DELIMITED_BY stratopause, and the earth's crust and mantle are DELIMITED_BY Mohorovicic's discontinuity.

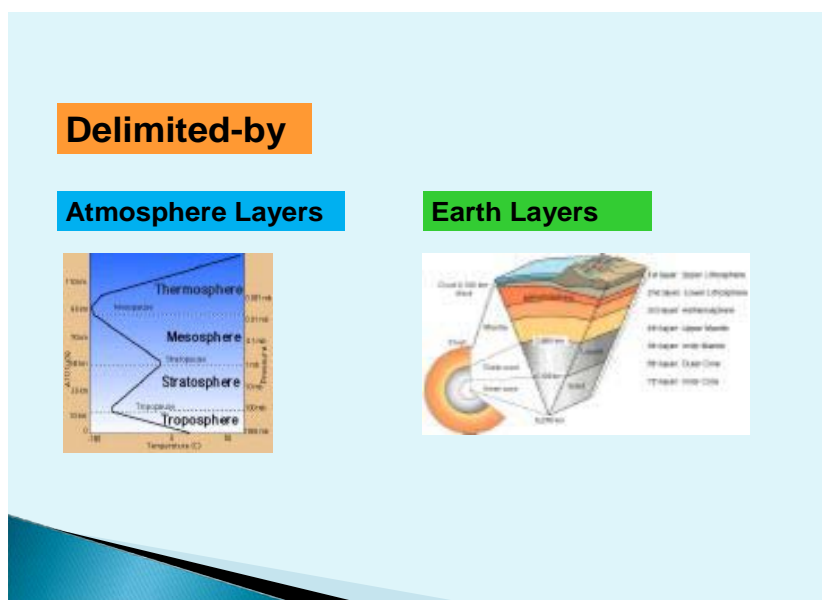


Figure 30. DELIMITED_BY: Atmosphere and Earth layers

It is also similar to the profile-base relation. A relevant example of this in specialized language can be found in the aquatic layers of the ocean, (i.e. epipelagic, aphotic, mesopelagic, bathypelagic, abyssopelagic, and the hadal zone). In order to understand the concept of the HADAL_ZONE (the deepest layer of ocean waters, just below the abyssopelagic layer and more than 4,000 m deep), it is necessary to profile it against the concept of OCEAN in its vertical dimension.

This type of profile-base relation often cannot be represented geometrically, but rather through schematic diagrams, which show the interrelations of profile concepts within the base. In a specialized language resource, the profile-base relation is best

represented by diagrams, which represent the specialized knowledge. For example, Figure 31 is a schematic diagram of ocean layers:

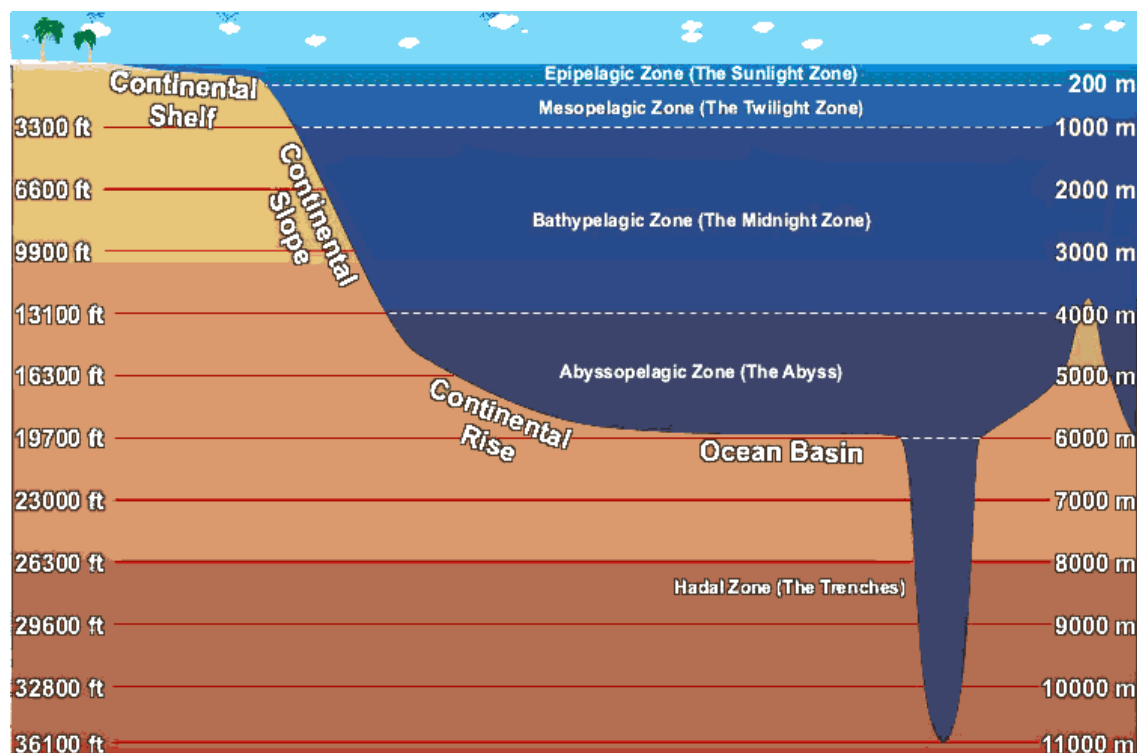


Figure 31. DELIMITED_BY: ocean layers

Evidently, the bathypelagic zone is difficult to understand without referring to the fact that it is between the mesopelagic and abyssopelagic zones. Other important boundaries to take into account are those that separate different ocean levels and the continental shelf, continental slope, continental rise, and ocean basin. In a specialized knowledge representation, it is also often helpful to mention specification of depth in meters.

LOCATED_AT

The LOCATED_AT relation is relevant when the location of a physical object is an essential characteristic for its description. For instance, a groyne is not a groyne if it is not located on the coast.

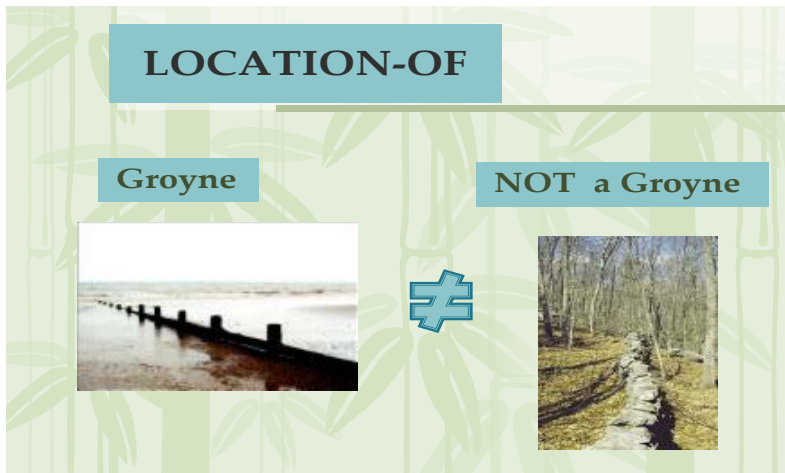


Figure 32. LOCATED_AT relation

This relation sometimes can sometimes risk being confused with the PART-OF relation. In such cases, the PART_OF relation overrides the LOCATED_AT relation. For example, a river bed is PART_OF a river instead of LOCATED_AT a river, because a river cannot exist without its bed.

TAKES_PLACE_IN

The TAKES_PLACE_IN relation describes the context of events which have spatial and temporal dimensions. The distinction between this relation and LOCATED_AT is based on the fact that events are not as bounded in space as objects, and also have a temporal dimension.



Figure 33. TAKES_PLACE_IN relation

For example, as shown in Figure 33, littoral drift TAKES_PLACE_IN the sea (a geographic location); and thermal low TAKES_PLACE_IN summer (a temporal duration).

ATTRIBUTE_OF

ATTRIBUTE_OF is mainly useful for concepts designated by specialized adjectives, such as *isotropic*, *alluvial*, *abyssal*, etc., or nouns that designate the properties of other concepts, such as *altitude*, *capacity*, *coefficient*, etc. (e.g. littoral ATTRIBUTE_OF coast; permeability ATTRIBUTE_OF permeable groyne). In each case, the attribute in question must be a crucial defining characteristic of the concept. Otherwise, it should not be included in the representation.

RESULT_OF

The RESULT_OF relation is relevant to events that are derived from other events and to entities that are created by other events. Even though both events and entities can be the result of another event, an event cannot be the result of an object entity.

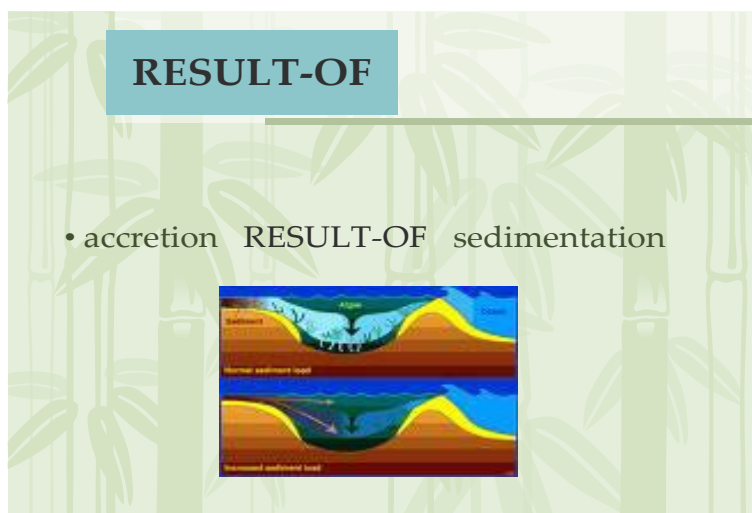


Figure 34. RESULT_OF relation

For example, accretion is the RESULT_OF sedimentation (event), but it cannot be regarded as the RESULT_OF sediments (object entity).

AFFECTS

The AFFECTS relation generally encodes the changes or modification experienced by one conceptual entity because of an event initiated by another. This relation, along with CAUSES and RESULT_OF, is a crucial relation in dynamic systems since environmental concepts have a high combinatorial potential. AFFECTS relates a wide variety of concepts to their ever-changing environments.

For example, sea water **AFFECTS** concrete, In this case, it causes concrete to participate in a **DETERIORATION_EVENT**.

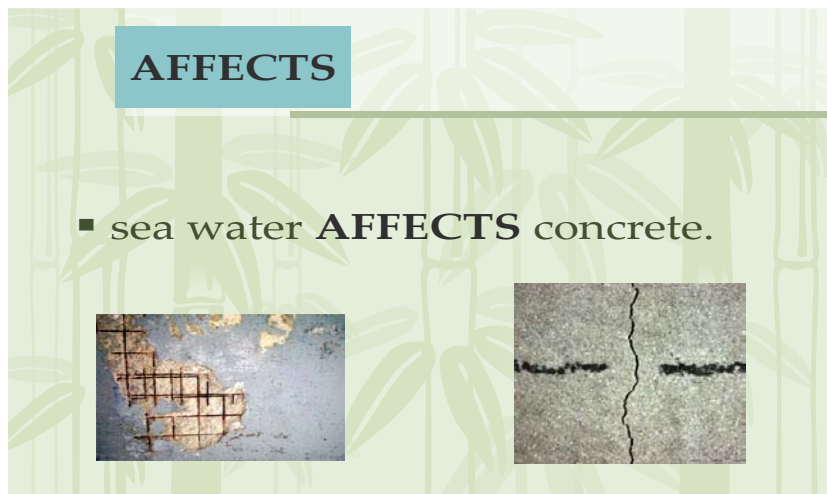


Figure 35. **AFFECTS** relation

This relation links processes that cause a change to another object or event without producing a final result (e.g. groyne **AFFECTS** littoral drift). Moreover, complex conceptual relations such as **AFFECTS**, can generate a hierarchy of domain-specific relations such as **RETARDS** (beach nourishment **RETARDS** beach erosion), **ERODES** (water **ERODES** rocks), etc.

CAUSES

The **CAUSES** relation links entities and events. For example, water **CAUSES** erosion. Even though this relation initially seems to be the inverse of **RESULT_OF**, there is a difference that stems from the active role played by certain entities. **CAUSES** is a relation that only describes the beginning of a process, whereas **RESULT_OF** may link events or entities that are the final consequence of another event. For example, a hurricane **CAUSES** floods during its passage over land, but floods are not the final (and more permanent) result of a hurricane.

HAS_FUNCTION

The **HAS_FUNCTION** relation not only links natural and artificial objects that are manufactured for a specific function or carried out with a specific purpose, but also natural entities which, despite not being goal-directed, can be used for human profit. It goes without saying that different objects can have different functions, depending on how they are contextualized. For example, wire mesh within the context of reinforced concrete [**BUILD_EVENT**] is used for reinforcement.

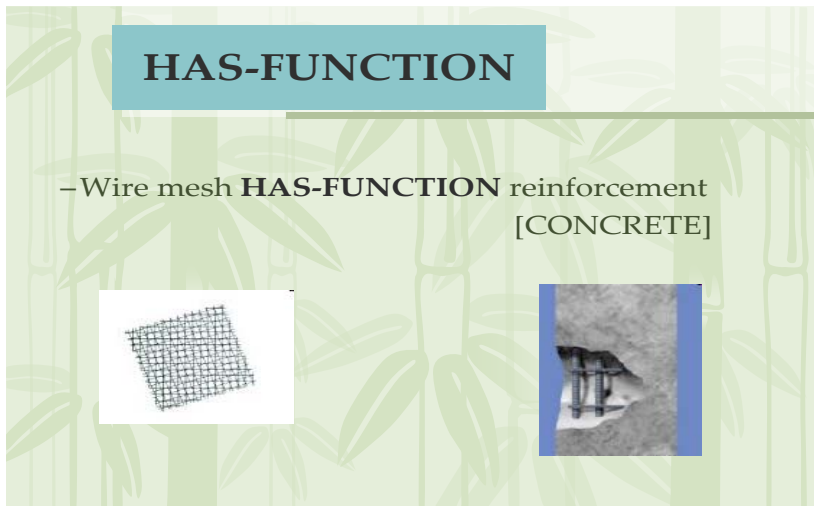


Figure 36. HAS_FUNCTION relation

Natural concepts with a function are aquifer (HAS_FUNCTION water supply), sand (HAS_FUNCTION beach nourishment), etc. As in the case of AFFECTS, the HAS_FUNCTION relation can also be associated with other domain-specific subordinate relations, such as MEASURES for instruments (a pluviometer MEASURES precipitation); STUDIES for sciences (potamology STUDIES surface currents); and REPRESENTS for graphics, maps and charts (a hydrograph REPRESENTS rate of water flow).

EFFECTED_BY

The EFFECTED_BY relation is only used for instruments that participate in an event or are used to create a new entity. For example, dredging is EFFECTED_BY a dredger and a marigram is EFFECTED_BY a tide gauge.

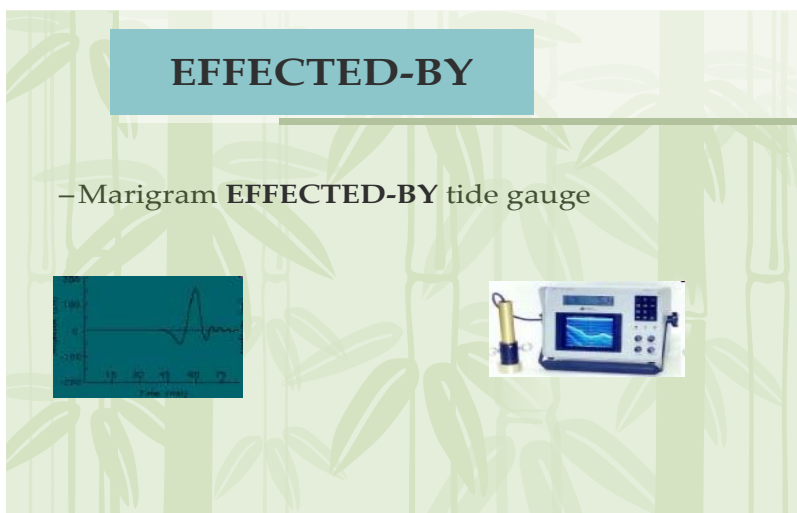


Figure 37. EFFECTED_BY relation

This relation is especially meaningful in those domains where human interaction plays an essential role as is the case of environmental contexts.

3.1.8.2 Combinatorial potential

Evidently, all the preceding conceptual relations have their inverse relation (SUPERORDINATE-OF ↔ TYPE_OF; RESULT_OF ↔ CAUSES; PART_OF ↔ HAS_PART, etc). Figure 38 shows the combinatorial potential of concept types and relation types:

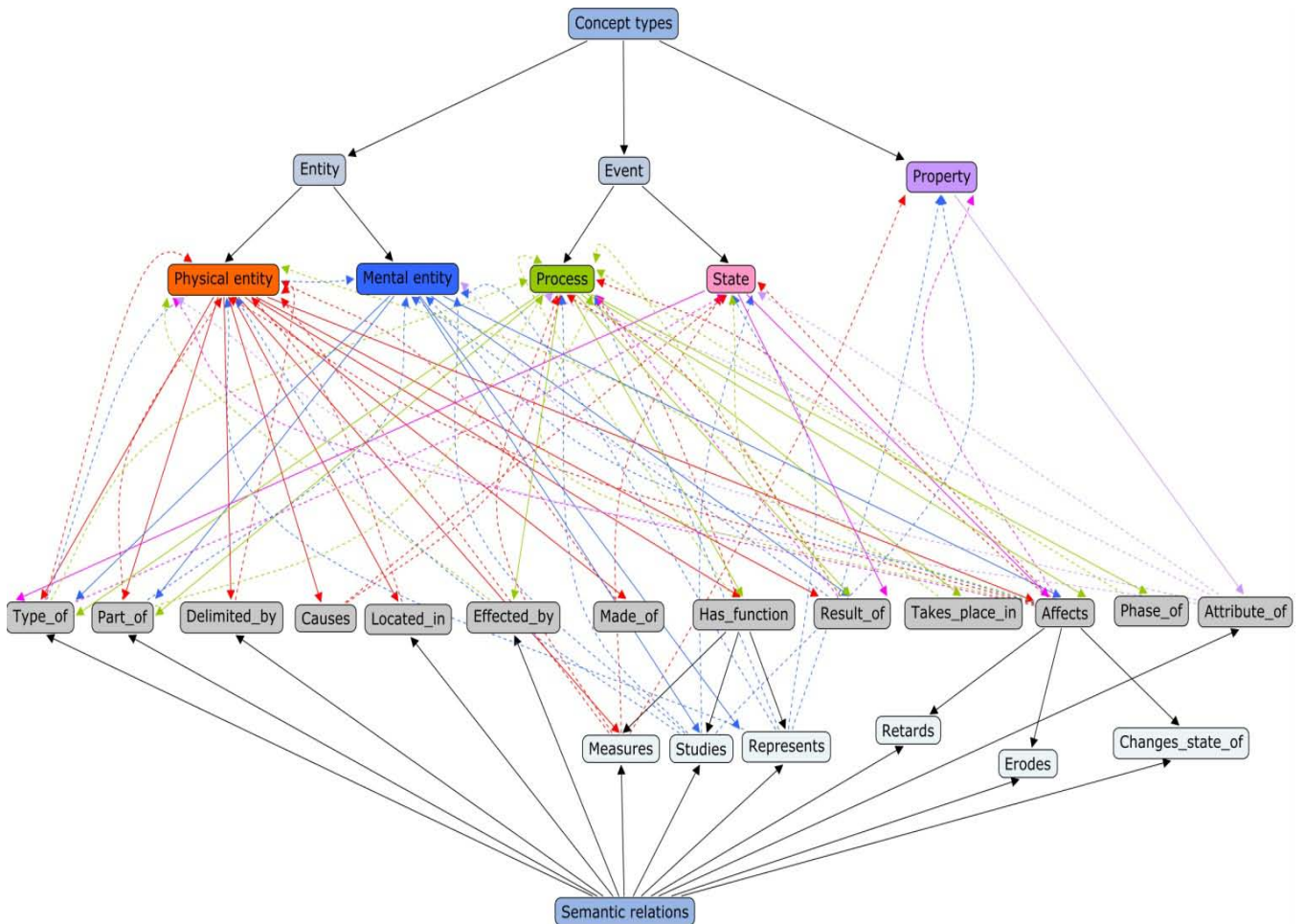


Figure 38. Combinatorial potential of concept types and relation types

Figure 38 shows that concept types are divided into entities, events, and properties. Entities can be physical objects or mental objects. Events can be either processes or states. Properties are attributes. Typical relations of physical objects are TYPE_OF, PART_OF, DELIMITED_BY, LOCATED_AT, MADE_OF, HAS_FUNCTION, RESULT_OF, and AFFECTS, though no physical object activates all of these relations.

This combinatorial potential represents certain constraints associated with the natural aspect of concepts. For instance, a process may activate the relation EFFECTED_BY, but only if it is associated with a physical entity. However, if it activates AFFECTS, it can be linked to entities, events and properties.

The environmental science domain shows a high degree of multidimensionality (Kageura 1997; Rogers 2004), which increases the number of possible relations activated by particular concepts. This is intimately linked to the semantic roles that concepts can have. In fact, in environmental science, the same concept may act as an AGENT or a PATIENT, as a PROCESS or a RESULT.

For example, a beach can be either a PATIENT (e.g. of WAVE ACTION) or an AGENT (e.g. of PROGRADATION) and the activation of semantic relations generally depends on perspective. Broadly speaking, beach (as a physical entity) may activate nearly all semantic relations, except those exclusive of events and properties. Inverse relations are included because they do not have the same behavior in terms of prototypicality. Table 27 shows how our inventory of conceptual relations is restricted according to semantic roles.

Concept Type	AGENT		PATIENT	
	Relational power			
	Relation	Concept Type	Relation	Concept Type
Physical entity	IS_A	Physical entity	IS_A	Physical entity
	GENERIC_OF		GENERIC_OF	
	DELIMITED_BY		DELIMITED_BY	
	HAS_PART		HAS_PART	
	PART_OF		PART_OF	
	MADE_OF		MADE_OF	
	MATERIAL_OF		MATERIAL_OF	
	LOCATED_IN	LOCATED_IN		
	LOCATION_OF	LOCATION_OF		
	HAS_FUNCTION	Event	EFFECTED_BY	Entity/Event
	EFFECTS	Event/Entity	MEASURED_BY	
	MEASURES	Event/Entity	AFFECTED_BY	
	AFFECTS	Event/Entity		
CAUSES	Event			

Table 27. Relational constraints according to concept nature and semantic role

Interestingly enough, hierarchical relations are invariable parameters. Physical entities may HAVE_PARTS or be PART_OF other wholes whether they are agents or patients, but that is not the case for non-hierarchical relations. This means that a concept's behavior depends on its nature and the role that it has in a particular domain.

If a physical entity behaves like a patient, it cannot EFFECT anything, as it would then become an agent. Prototypically, a patient can only activate its inverse relation, EFFECTED_BY. The same applies for relations such as MEASURES and AFFECTS. This does not imply that the same concept is unable to play more than one role in different contexts (e.g. beach), but rather that the representation of the concept is role-sensitive, and should change accordingly in each case.

Furthermore, there are two relations that are exclusive of agents or patient (CAUSES and LOCATION_OF), and which do not have an inverse. According to our relational criteria, CAUSES is only used for entities causing processes. Thus, so no patients (always entities) may be caused by other entities. On the other hand, locations are considered to be patients by default, since they cannot be agents.

Conceptual relations in EcoLexicon

This inventory of conceptual relations is implemented in the EcoLexicon environmental knowledge base to show how the concepts are related to each other. Figure 39 illustrates the EcoLexicon representation of DELTA, a type of geographic LANDFORM. It shows how a physical object can have properties, be in a certain state, or participate in an event.

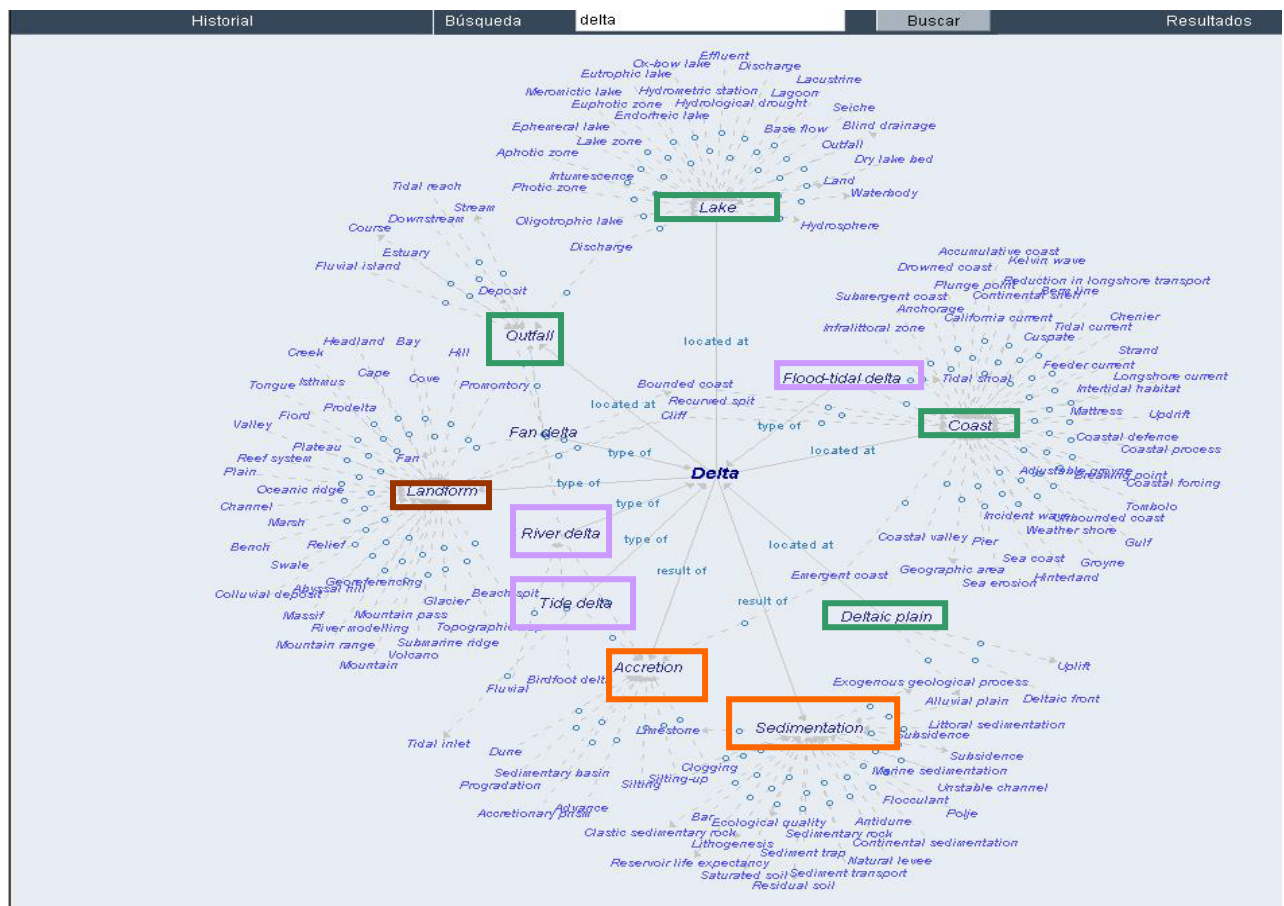


Figure 39. EcoLexicon representation of DELTA

Delta is a TYPE_OF⁸ landform (in the dark red rectangle). It is also has subtypes or is the GENERIC_OF concepts such as a river delta or a tide delta (in the violet rectangles): It is the RESULT_OF sedimentation and accretion (in the orange rectangles); and it can be LOCATED_AT a deltaic plain, the coast, or an outfall (in the green rectangles).

In contrast, a mental object, such as a theory or discipline, activates a different set of relations, such as TYPE_OF, PART_OF, and STUDIES. A mental object also may have properties, be in a certain state, or participate in a specific event. For example, Figure 40 shows the representation of Microbiology in EcoLexicon.

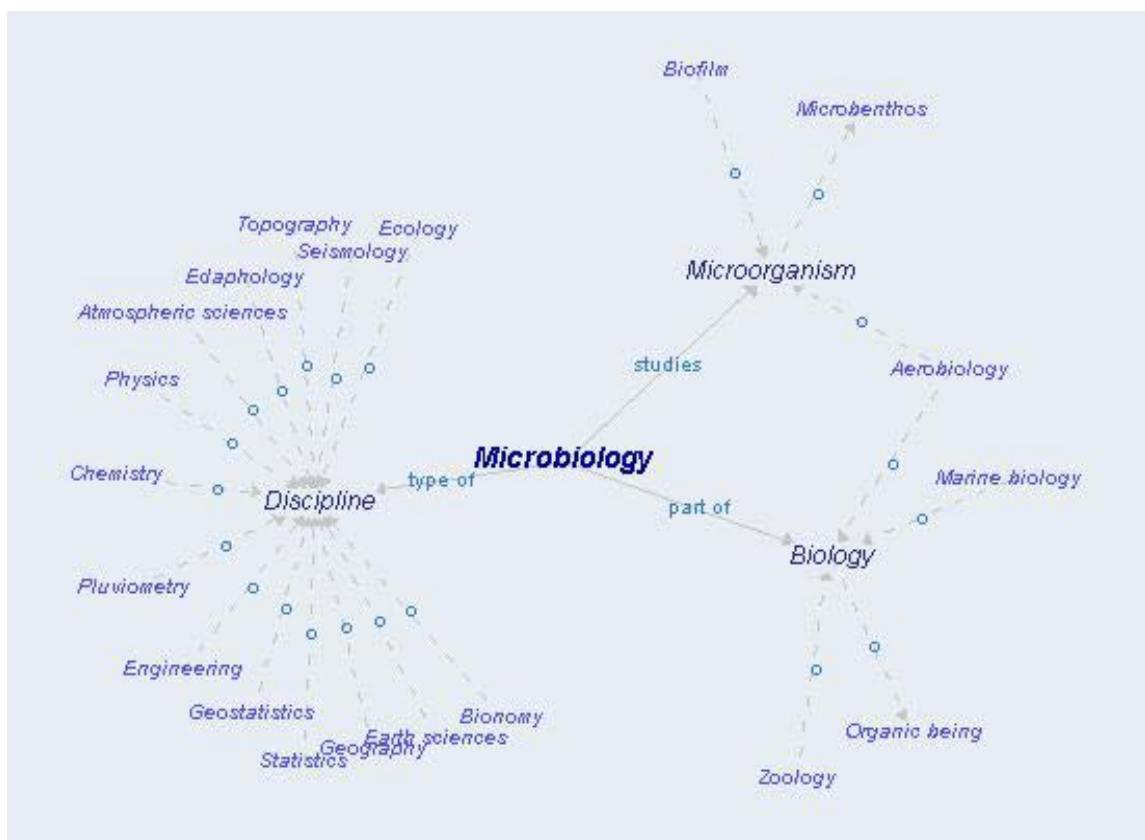


Figure 40. EcoLexicon representation of MICROBIOLOGY

As shown in Figure 40, Microbiology is a discipline, which is regarded as a mental object. It is considered PART_OF the discipline of Biology, and it STUDIES microorganisms. Each of the concepts at the second level in turn leads to other related concepts.

⁸ In EcoLexicon the IS_A relation is called TYPE_OF. Its inverse, GENERIC_OF, is implicitly represented by the directionality of the arrows.

Equations are another type of mental object. Figure 41 shows the representation of the tendency equation in EcoLexicon.

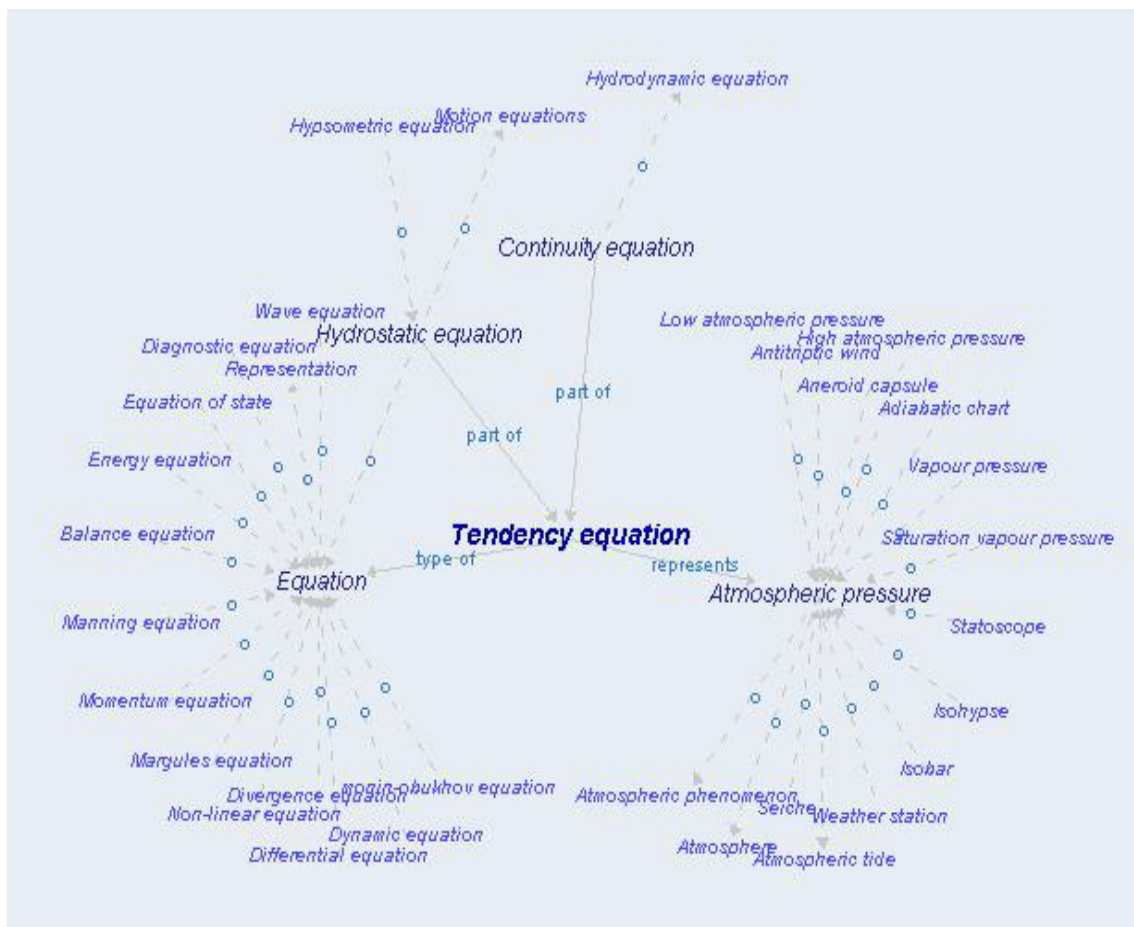


Figure 41. EcoLexicon representation of TENDENCY EQUATION

The tendency equation, for example, is a TYPE_OF equation that REPRESENTS atmospheric pressure. Since it is a combination of two other types of equation (i.e., the motion equation and the continuity equation), they are regarded as PART_OF it.

3.1.9 Qualia structure and conceptual relations

At the more specific levels of a conceptual network, the *qualia* structure of the Generative Lexicon (Pustejovsky 1995) offers parameters for the classification of concepts and conceptual relations. The Generative Lexicon is a theory of linguistic semantics which focuses on the distributed nature of compositionality in natural language. In this sense, it spreads the semantic load across all constituents of an utterance (Pustejovsky 1995; Busa et al. 1999; Lenci et al. 2000; Pustejovsky et al. 2006; Rumshinsky et al. 2006). Even though Cognitive Linguistic approaches have

traditionally rejected generative models, it is difficult to have a semantic description without some sort of decompositional analysis.

In this sense, the Generative Lexicon approach offers an elegant way to account for conceptual entities represented in language by noun phrases. Even though qualia do not exhaust the semantic content of specialized knowledge concepts, the four dimensions play a prominent role in systematizing meaning. Just as important for our purposes is the fact that it is very suitable for the characterization of entities designated by noun phrases or nominal compounds. This has been lacking up until now since most linguistic theories have paid more attention to verbs because of their important role in syntactic structure. We have also adopted qualia for the description of our specialized knowledge units because this type of description is directly related to our inventory of conceptual relations, and is extremely useful when it comes to writing semantic descriptions of words for large-scale systems.

Terms are thus described in terms of the following roles:

- Formal role: the basic type distinguishing the meaning of a word;
- Constitutive role: the relation between an object and its constituent parts;
- Telic role: the purpose or function of the object, if there is one;
- Agentive role: the factors involved in the object's origins or "coming into being" (Pustejovsky et al. 2006: 3).

Formal and constitutive qualia roles both refer to individual variables of related type and predicate (Pustejovsky 1998: 330-331). The formal role refers to the `TYPE_OF` relation, where the lexical item is included in a category, and the constitutive role refers to what an object is made of (i.e. `PART_OF` relation). Both the agentive and telic roles refer to events. The agentive role identifies a set of individual events associated with the object, whereas the telic role refers to an event description, which in the appropriate circumstances, is associated with that object as its function (Pustejovsky et al. 2006: 333).

Although the Generative Lexicon has only been applied to general language, specifically to English (i.e. the `SIMPLE` ontology and the Brandeis Semantic Ontology), it can also be applied to the description of specialized language and to terminological lexicons as described in Pustejovsky (2001). Such a description would be based on qualia structure and the *Principle of Orthogonal Inheritance*, where semantic-conceptual types are structured according to the multidimensional and orthogonal aspects of meaning. Through the *Principle of Type Ordering*, the theory establishes a typology of concepts (entities, events, and qualities) based on their nature and their qualia roles. The result is a tripartite concept lattice shown in Figure 42:

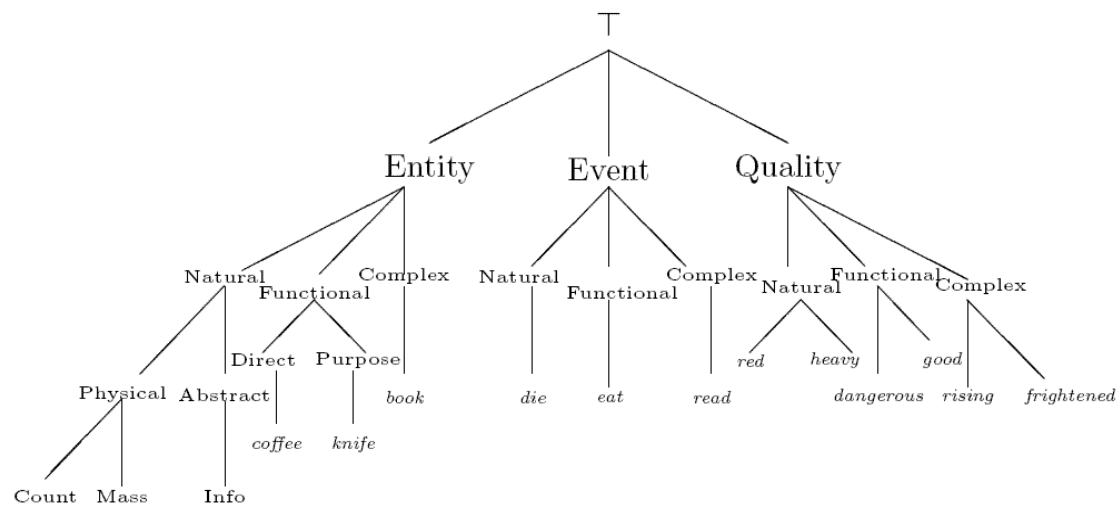


Figure 42. Tripartite concept lattice (Pustejovsky 2001)

The qualia roles of each concept type can be divided into:

- Natural types: natural kind concepts consisting of reference only to formal and constitutive qualia roles;
- Artifact types: concepts making reference to purpose, function, or origin;
- Complex types: concepts integrating reference to a relation between types (Pustejovsky et al. 2006: 1).

Even though, the Generative Lexicon also proposes this type of description for verbal predicates, such as *die*, *eat*, and *read*, we are more interested in physical object since predicates are mainly used for basic propositions within events. Complex events in EcoLexicon are mainly represented by nominal forms, such as *erosion*, *sedimentation*, *glaciation*, *flooding*, *construction*, etc., which are regarded as DOT objects by Pustejovsky (1995, 2005), and lexicalize the event-result polysemy.

The Event/Result polysemy of deverbal nouns is a special case of inherent polysemy (complex type or dot object, cf. Pustejovsky 1995, 2005), since it is dependent on the meaning of the base verb. Not only are events and objects radically distinct ontological categories, but the result-object type is temporally and causally dependent on the event type since the performance of the event is the pre-condition for the (coming into) existence of the result. In this sense, the conceptual modeling in EcoLexicon is in consonance with the proposal of Melloni and Jezek (2009), who assert that the polysemy of nominals, such as *construction*, should be classified as an event•(result-) object where the object type is a result, intended as the causal by-product of an event.

Qualia structure is especially useful for the description of this type of specialized knowledge concept because it is based on a set of basic elements that can be combined to describe complex conceptual structures. It allows for a rich semantic

description because concept types (natural, artifactual, and complex) give rise to a variety of subtyping relations, resulting from their underlying qualia structure (formal, constitutive, agentive, and telic roles).

For example, natural concepts are defined in terms of natural tangible discriminants, whereas artifact concepts are defined in terms of functional behavior. In the SIMPLE project, concept description is based on conceptual relations associated with the qualia roles of each type of concept, known as the *Extension of the Qualia Structure*:

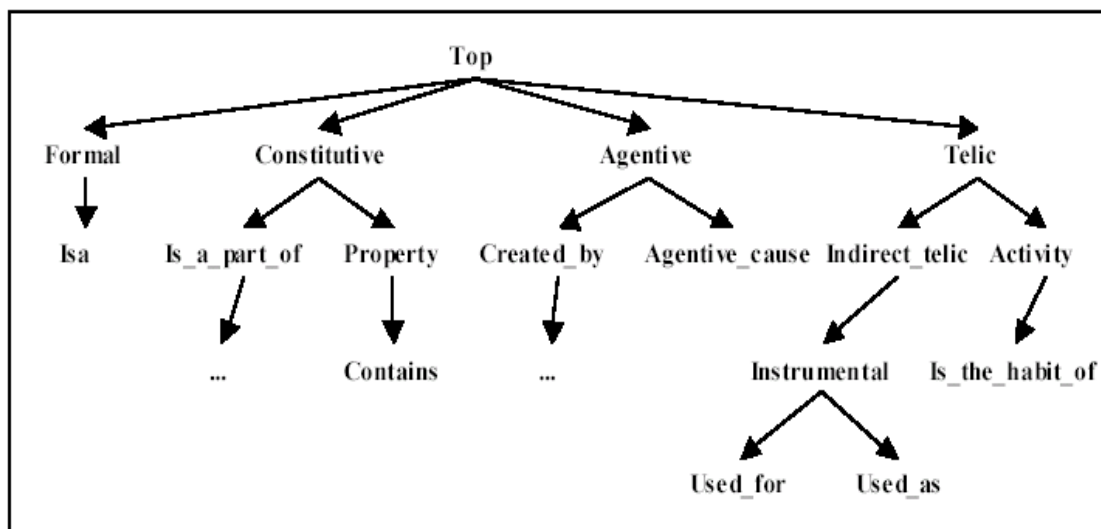


Figure 43. Extension of the qualia structure (Pustejovsky 1995)

In Figure 43, the four qualia roles are the top of a hierarchy of other more specific qualia information representing more fine-grained subtypes of a given quale which are consistent with its interpretation (Lenci et al. 2000: 251). This kind of semantic richness in conceptual description is applicable to the representation of environmental concepts. In this domain, the underlying domain event consists of complex events in which natural objects and processes are influenced by other natural events as well as human interference. As shall be seen, conceptual relations for the modeling of specialized knowledge concepts can be derived from the basic types of information described in qualia.

According to Pustejovsky (2001: 5), qualia structure provides functional tags for words, which are thus linked to a network of concepts. For example, the values of each qualia role can represent a particular conceptual dimension, and thus reveal the underlying structure of specialized concepts. Qualia roles apply to: (1) the conceptual network within the broader frame level of each sub-event; (2) the definitional structure of concepts. Depending on their general type, concepts tend to activate a certain set of

roles. This determines the way concepts relate to each other at the macrostructural and the microstructural level.

For instance, a *natural* physical entity can be described by both TYPE_OF and PART_OF relations. A glacier can thus be a geographic object, and have an ablation zone as one of its parts, but it cannot be described in terms of use, purpose, or function because it then becomes an artifact. Each qualia role represents a segment of the meaning of a lexical item. Qualia structure thus offers a systematic way of representing conceptual dimensions.

Within the environmental domain, concepts are related to their qualia roles and the EcoLexicon inventory of conceptual relations, which are crucial in models of specialized knowledge representation. In Figure 44, these conceptual relations are associated with a particular role for each concept type. The macrostructure and microstructure of all concepts in the domain can be represented in terms of these possible combinations:

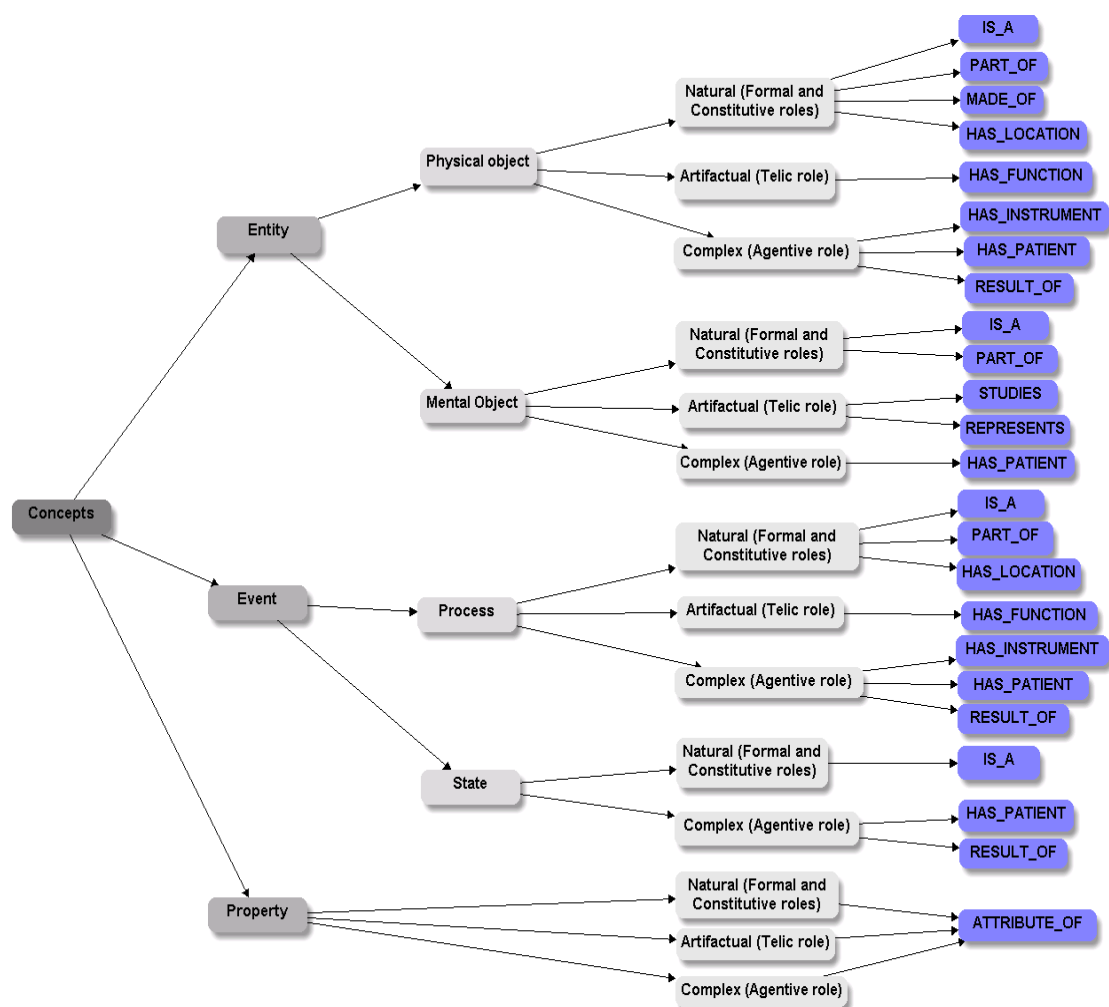


Figure 44. Combination of the concept typology and conceptual relations with qualia roles

Recurrent concepts in this domain (physical objects and events) can be linked to others by a great number of relations. Nevertheless, there are also certain relations exclusive of a single concept type, such as `ATTRIBUTE_OF` for properties, and `STUDY` or `REPRESENT`, which are only applicable to mental objects (such as sciences and knowledge fields). For natural physical object types, apart from the relations traditionally linked to formal and constitutive roles (`TYPE_OF` and `PART_OF`), two other non-hierarchical relations are sometimes necessary. More specifically, `HAS_LOCATION` and `MADE_OF` are often crucial to the description of such concepts. The material that composes the object and its location are key properties that can distinguish concepts from each other, which are at the same level. However, they are not exclusively differentiating characteristics since they can even be part of the generic classification of a concept. For instance, as previously mentioned, a *groyne* is a barrier located in the ocean. If the same structure is located on land, then it is not a *groyne* anymore, but rather a wall or a fence.

In this way qualia can be applied to specialized language. Each concept, depending on its nature, thus has a specific combinatorial potential, and activates a certain set of relations. Qualia afford a way of systematizing the description of previously contextualized conceptual systems. They can be used to systematically categorize the prototypical conceptual information or templates for conceptual description. This is also relevant for the creation of definitions or natural language descriptions of specialized concepts.

3.1.10 Terminographic definitions

The specification and structure of specialized meaning definitions is a key factor in establishing semantic networks of specialized concepts, and thus a specialized language semantics. Traditionally, definitions have never been given their due importance (Bejoint 1997). However, terminographic definitions are now receiving closer attention in Terminology. Strehlow (1993) affirms that the representation of concepts by means of definition statements alone is inadequate for many scientific terms. He highlights the fact that the representation of a definitional structure is comparable to a conceptual representation, and shows elements such as *genus* (referring to the domain or superordinate category to which the concept belongs), *species* (referring to the sub-domain), *differentiae* (expressing essential characteristics of the concept that makes it different from others in the same category) and *accident* (expressing non-prototypical characteristics of the concept).

In this same line, W. Martin (1998: 191) underlines the fact that frames, taken as representations of stereotyped knowledge in a *slot-filler* format, can act as definition models to offer more consistent, flexible representations of conceptual structure. According to Faber and Tercedor Sánchez (2001), definitions can be regarded as mini-knowledge representations which require a definitional frame or template for each category. Sociocognitive Terminology (Temmerman 2000) also proposes the creation of a definitional template for the description of *units of understanding*, a notion different from traditional concepts. If a concept can be logically or ontologically classified, its description is intensional. In contrast, when concepts show prototypical structure, they are regarded as units of understanding on the basis of intracategorical and intercategory information. Rather than restricting definitions to conceptual intension, templates activate broader conceptual structures in the form of frames. Frames or definitional templates make explicit the prototypical structure of the conceptual description of an entity. Frame elements can be codified in terms of qualia, which are determined by the nature of the concept.

Pustejovsky's qualia roles are compatible with frames because they provide a way to systematically structure information types within definitions. In fact, qualia structure closely resembles ontological structure since these roles contain information that has traditionally been considered extra-linguistic in nature. As such, they provide the slot labels in definitional templates or frames, and supply an explicit formalization of how extralinguistic knowledge can be incorporated into a lexical entry.

As previously explained in the case of AQUIFER, the analysis of terminological resources makes it possible to extract basic meaning components, identify the type of component, and elaborate definitions with external coherence on the basis of the same schema. The systematic use of definitional frames or templates is illustrated by Faber et al. (2006). It shows that the conceptual structure of a domain can be made explicit in the form of terminographic definitions that are coherent in both their microstructure and macrostructure. Figure 45 shows an example of a segment of a definitional hierarchy in Environmental Science which shows that coastal defense is divided into two major categories: (i) hard coastal defense structure; (ii) soft coastal defense action.

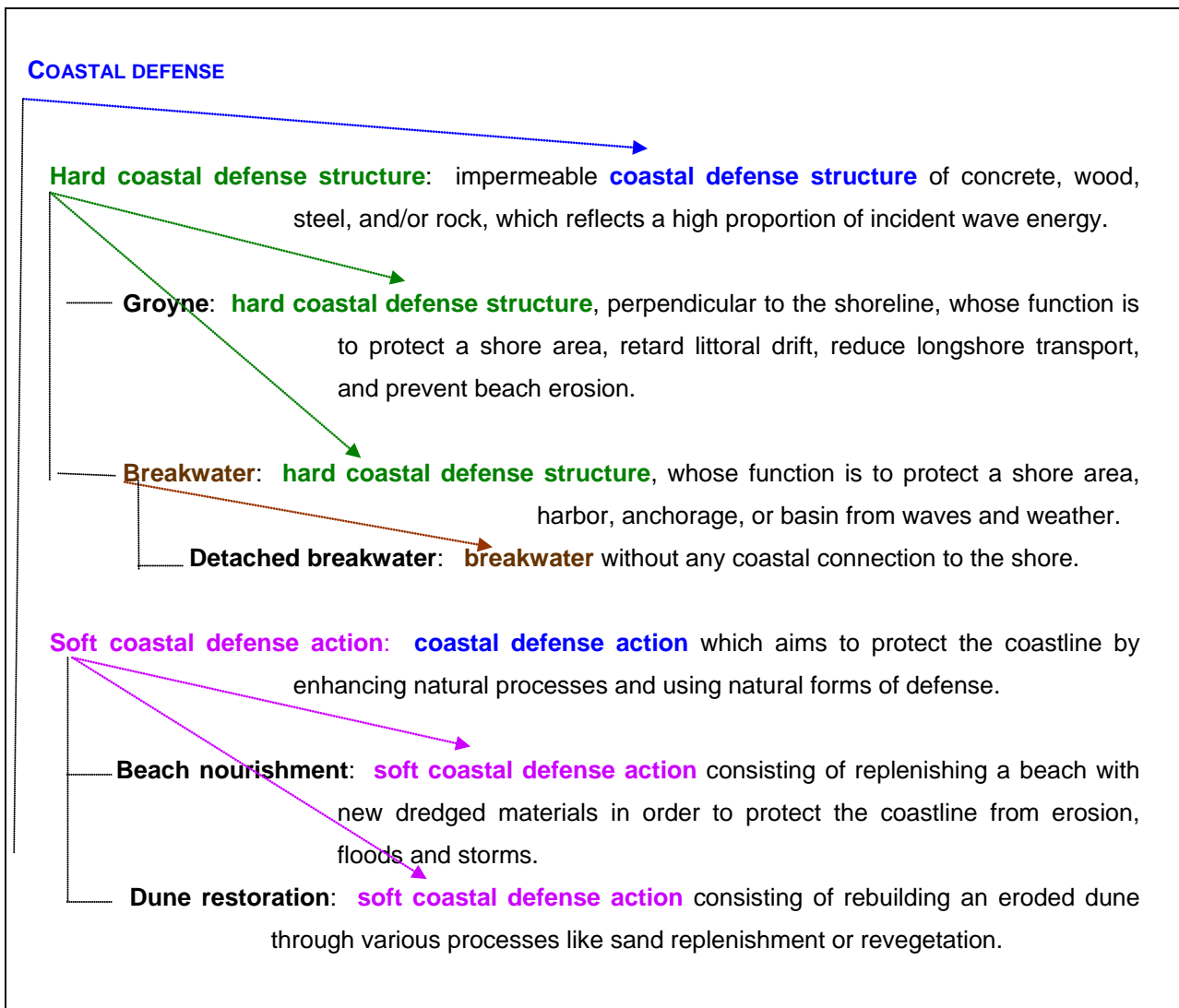


Figure 45. Segment of the definitional hierarchy of *coastal defense*

As shown in Figure 45, the category of *hard coastal defense structure* includes all structures built for this purpose. Both *groyne* and *breakwater* belong to this category, and this is evident in the genus of their respective definitions (i.e. hard coastal defense structure). As such, both types of construction can be made of concrete, wood, steel and/or rock, and reflect incident wave energy. The main difference between them resides in their function and location. Likewise, both *groyne* and *breakwater* have a wide range of subtypes which differ mainly according to parameters that are mostly related to shape and location.

In contrast, *soft coastal defense* involves an action that is carried out to protect the coastline. *Beach nourishment* and *dune restoration*, two types of soft coastal defense, thus differ from each other in the action performed (*replenishing, rebuilding*), the materials used (*sand, dredged materials, vegetation*), and the object affected by the action (*beach, dune*). As can be seen, the shared properties and conceptual relations of category members generate definition patterns or templates, which, when

applied to a category, enhance its systematicity and make it easier to map out its structure.

For instance, the prototypical definition of the many types of movement in the environment, such as *convection*, *diffusion*, *regression*, *downwelling*, etc. generally include some or all of the following information:

MOVEMENT	
AGENT	Initiator of the movement (when relevant)
TYPE_OF	Type of movement
PATH	Direction/shape of movement
AFFECTS	Entities participating in movement
RESULT	Result of movement

Table 28. Definitional template for MOVEMENT

In the case of DIFFUSION defined as *movement of particles (molecules or ions) from an area of higher concentration to an area of lower concentration*, the information would be the following:

DIFFUSION	
AGENT	---
TYPE_OF	Movement
PATH	from an area of higher concentration to an area of lower concentration
AFFECTS	particles (molecules or ions)
RESULT	more uniform distribution

Table 29. Definitional template for DIFFUSION

This is in vivid contrast to a domain, such as GEOGRAPHIC OBJECTS (*estuary*, *marshland*, *channel*, etc.), which is constrained by other types of information, directly linked to the nature of the concepts. As Smith and Mark (1999) point out, the specificities of geographic objects are the following:

- Geographic objects are intrinsically tied to their location in space [LOCATION_OF].
- They are often size- or scale-dependent [SIZE_OF].
- They are often the products of delineation within a continuum in which other objects, including human agents, live and move [DELIMITED_BY].

This cluster of relations stems from the fact that geographic objects are presumably simulated in a different way from instruments, atmospheric phenomena, coastal defense structures, and marine fauna, and this naturally affects their conceptualization and representation. Not surprisingly, within this category, there is greater emphasis on spatial orientation.

LAND_FORM	
TYPE_OF	Type of surface landform
LOCATION	Place where it is found
DELIMITED_BY	Boundaries of landform
ATTRIBUTE_OF	Shape (slope/elevation/rock exposure/soil type)

Table 30. Definitional template for LANDFORM

According to Schmidt-Wigger (1999: 3), terminological coherence depends on the terms being well defined and systematically interrelated. This means the use of a controlled language, which is terminologically coherent, and based on the information extracted from specialized dictionaries as well as a large electronic corpus of specialized texts on environmental science. Consequently, the organization of information encoded in definitions should be structured with regard to its perceptual salience as well as its relationship to information configurations in the definitions of other related concepts within the same category (Faber, López Rodríguez, and Tercedor Sánchez 2001; Faber 2002ab). In frame-based definitions, conceptual dimensions are linked to the relations they convey. In this sense, definitions thus become the bridges between terms and concepts (Faber and Tercedor Sánchez 2001).

3.1.10.1 Category templates

Category templates or frames represent the definitional structure shared by all concepts belonging to the same category. As opposed to formal approaches where concepts are ascribed to particular categories on the basis of a set of necessary and

sufficient features, the definitional problem is resolved by considering category membership as a dynamic construct based on a set of relations.

Templates thus consist of the combination of semantic roles (*agent, patient, instrument, result*), concept types (*entity, event, property*) and qualia roles (*formal, constitutive, telic, agentive*), which, along with corpus-driven data, provide the conceptual metaconstructions to be included in each definition. All of these factors are conducive to cohesion and coherence at all conceptual representation levels. This is exemplified in recurrent concept types, such as *events* and *physical objects*.

As shown in Table 31, the linguistic designations of any process event, whether natural or artificial, generally include: (i) a formal role, which is the basic meaning of the word; (ii) a constitutive role, which refers to the phases of the event; (iii) a telic role, which refers to purpose in the case of artificial process events; (iv) an optional agentive role, which is frequent in engineering events that are carried out with an instrument.

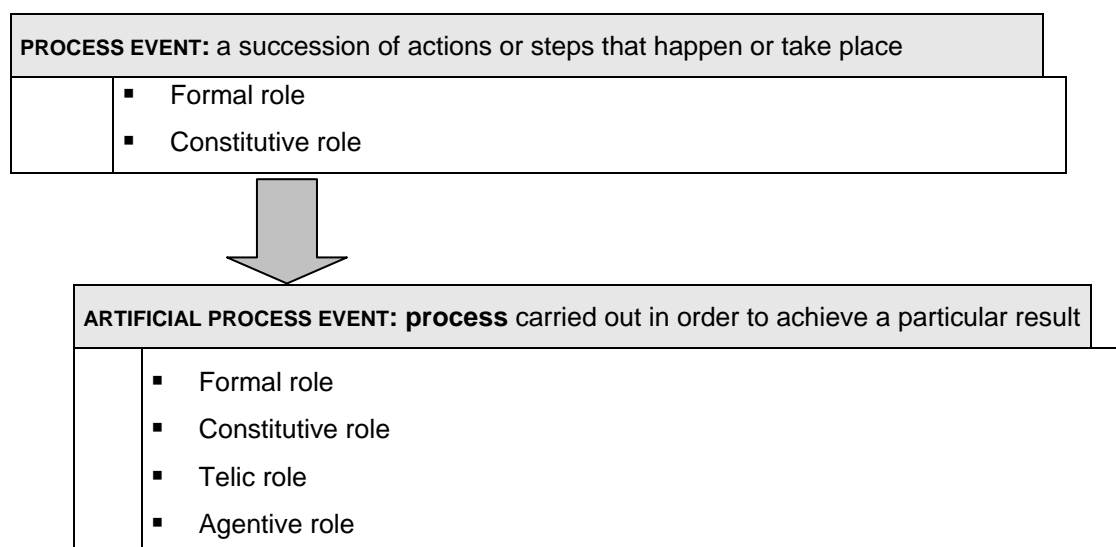


Table 31. Definitional template of PROCESS EVENT in the definition of ARTIFICIAL PROCESS EVENT

These concept types are always framed within the same EE template for *event*, which is used in its Ontological Semantics sense as a language-independent conceptual representation (Nirenburg and Raskin 2004). A complex event is defined as well-specified set of object-like entities that appear in different semantic roles throughout that sequence. This notion is clearly recursive since every component event can itself be considered complex at a different level of granularity (Raskin et al. 2003).

Generally speaking, PHYSICAL OBJECT concepts can appear either in AGENT or PATIENT slots. They also can be the RESULT of any process event. Thus, they first must be defined in terms of their formal role, which is the minimum quantity of information necessary. As concepts become more specific, other qualia roles are added. For example, when a PHYSICAL OBJECT is a PATIENT (e.g. coast), which can be affected by

an event, its formal role is sufficient for the definition (though in certain cases the constitutive role may also be necessary). When this object is regarded as a RESULT, an agentive role is then included since another concept must necessarily be involved.

However, in the case of PHYSICAL OBJECTS that can have an apparent agentive role, the telic role is essential in their definition because they are artifacts created for a purpose and produce a result. Obviously, the agent role is more apparent than real since artifacts are operated and manipulated by a human agent, but in texts, the man behind the machine is often left elliptic. For example, Table 32 shows the relation between physical object and instrument (as a type of physical object).

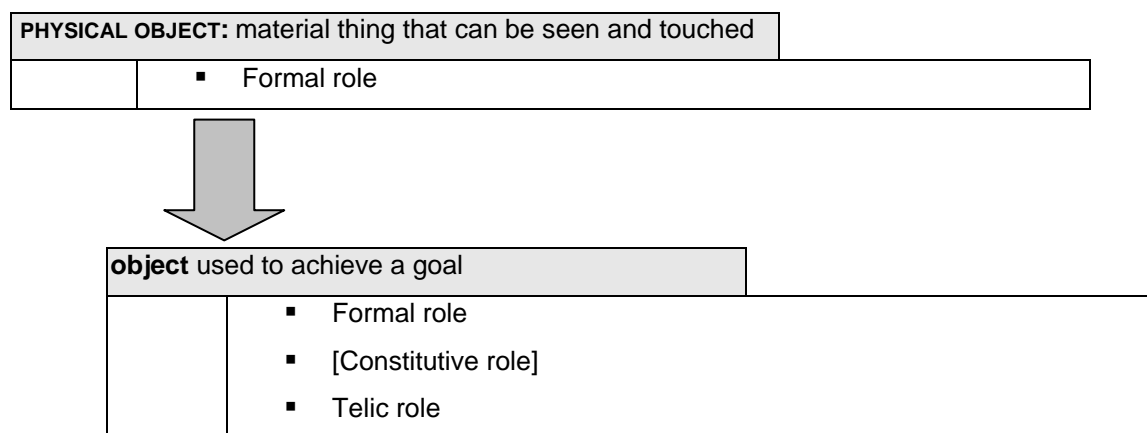


Table 32. Activation of the definitional template of PHYSICAL OBJECT in the definition of INSTRUMENT

As can be observed, the definitional template of INSTRUMENT necessarily focuses on the formal and telic roles since an instrument is best defined in terms of its function or purpose. Moreover, the constitutive role can also be optionally included, given the fact that an instrument often has different parts, which are directly involved in the way that it operates.

The definitions of all concepts in the same specialized knowledge area have the same underlying template. Definitions thus accomplish the following: (1) make category membership explicit; (2) reflect the relations of the concept with other concepts; (3) specify its essential attributes and features (Faber et al. 2006). The first two principles are achieved through the *genus*. The TYPE_OF relation of the formal role or the PART_OF relation of the constitutive role, since it maps back to the superordinate concept within the event structure. The third principle is based on the differentiating properties, which codify the non-hierarchical relations linked to the telic and agentive roles. These principles are exemplified and explained in the following sections.

3.1.11 A case study: GROYNE and BEACH NOURISHMENT

Specific examples of how definitional templates can be applied can be seen in the examples of GROYNE (a hard coastal defense structure) and BEACH_NOURISHMENT (a soft coastal defense event). As previously mentioned, a GROYNE is a wooden, concrete and/or rock barrier at right angles to the sea, which is often used to help prevent erosion along the coastline. As such, it is a maritime structure created by a human agent. One of the activities that a human agent can carry out is CONSTRUCTION (artificial process event). CONSTRUCTION can result in a maritime structure, which is the category to which GROYNE and other similar hard coastal defense structures belong.

HARD COASTAL DEFENSE STRUCTURE	
FORMAL ROLE	▪ _____ [TYPE_OF]
CONSTITUTIVE ROLE	▪ _____ [HAS_LOCATION]
	▪ _____ [MADE_OF]
TELIC ROLE	▪ _____ [HAS_FUNCTION]

↓

GROYNE: hard coastal defense structure made of concrete, wood, steel and/or rock perpendicular to the shoreline built to protect a shore area, retard littoral drift, reduce longshore transport and prevent beach erosion.	
FORMAL ROLE	▪ hard coastal defense structure [TYPE_OF]
CONSTITUTIVE ROLE	▪ perpendicular to shoreline [HAS_LOCATION]
	▪ <i>default value</i> (concrete, wood, steel, and/or rock) [MADE_OF]
TELIC ROLE	▪ protect a shore area, retard littoral drift, reduce longshore transport and prevent beach erosion [HAS_FUNCTION]

Table 33. Definitional template of HARD_COASTAL_DEFENSE_STRUCTURE in the definition of GROYNE

As shown in Table 33, the definitional frame for HARD COASTAL DEFENSE STRUCTURE displays the three qualia roles that describe a physical object with a specific purpose, conveyed by four types of conceptual relations: (i) TYPE_OF; (ii) MADE_OF; (iii) HAS_LOCATION; (iv) HAS_FUNCTION. A GROYNE has a wide range of subtypes (high, groyne low groyne, L-shaped groyne, T-shaped groyne, etc.), which contain all of the basic default information of the superordinate. However, the

difference lies in the specification of existing parameters. For example, a HIGH_GROYNE stands out because it is higher than the default height of a prototypical groyne, and thus acts as a barrier. In this respect, it is in opposition to LOW_GROYNE. This is reflected in Figure 46, which shows the EcoLexicon representation of HIGH_GROYNE.

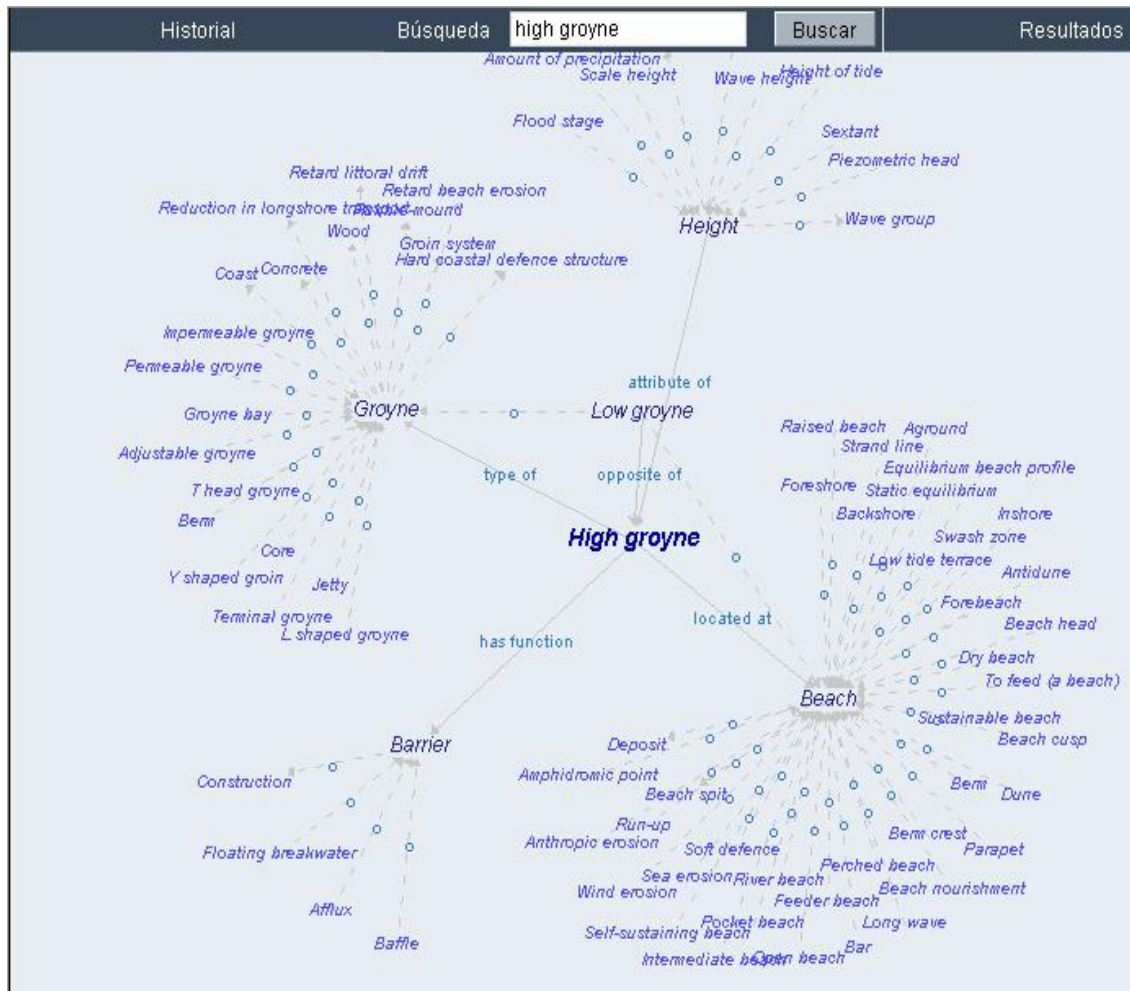


Figure 46. EcoLexicon representation of HIGH_GROYNE

The EcoLexicon representation in Figure 46 clearly shows that HIGH_GROYNE is directly linked to four conceptual constellations whose respective centers are the concepts, GROUYNE, HEIGHT, BEACH, and BARRIER. The representation thus shows that HIGH_GROYNE is a type of GROUYNE. It has HEIGHT as its defining attribute since it surpasses the prototypical default value for such a structure. It is located at a BEACH; its function is to act as a BARRIER; and it is in direct opposition to a LOW_GROYNE

In contrast, BEACH_NOURISHMENT is not a physical object, but an event that involves replenishing an eroded beach with new material in order to serve the same purpose as a groyne. Therefore, it is an artificial process event which has a human agent. It belongs to the ADDITION category (artificial process events that add something to the coastline), in a similar way to all other soft coastal defense techniques.

SOFT COASTAL DEFENSE ACTION	
FORMAL ROLE	▪ _____ [TYPE_OF]
CONSTITUTIVE ROLE	▪ _____ [PART_OF]
AGENTIVE ROLE	▪ _____ [RESULT_OF]
	▪ _____ [HAS_INSTRUMENT]
TELIC ROLE	▪ _____ [HAS_FUNCTION]

BEACH NOURISHMENT: soft coastal defense action consisting of replenishing a beach with new dredged materials in order to protect the coastline from erosion, floods and storms.	
FORMAL ROLE	▪ soft coastal defense action [TYPE_OF]
CONSTITUTIVE ROLE	▪ replenishing [PART_OF] ▪ dredging [PART_OF]
AGENTIVE ROLE	▪ dredger [HAS_INSTRUMENT]
	▪ dredged materials [HAS_PATIENT]
	▪ replenished beach [RESULT_OF]
TELIC ROLE	▪ protect the coastline from erosion, floods and storms [HAS_FUNCTION]

Table 34. Definitional template of SOFT_COASTAL_DEFENSE_ACTION as applied to BEACH_NOURISHMENT

Table 34 shows that the definitional template for soft coastal defense action has four qualia roles. The agentive role is added since any event can be the result or the cause of another event or entity. The constitutive role expresses the steps to be taken. This is conveyed by four types of conceptual relations: (i) TYPE_OF; (ii) PART_OF; (iii), RESULT_OF and HAS_INSTRUMENT; (iv) HAS_FUNCTION. This also reflects different relations to other concepts and specifies its essential attributes. Figure 47 shows the EcoLexicon representation of BEACH_NOURISHMENT, defined as a *coastal defense process that consists of replenishing a beach by the deposition of dredged material.*

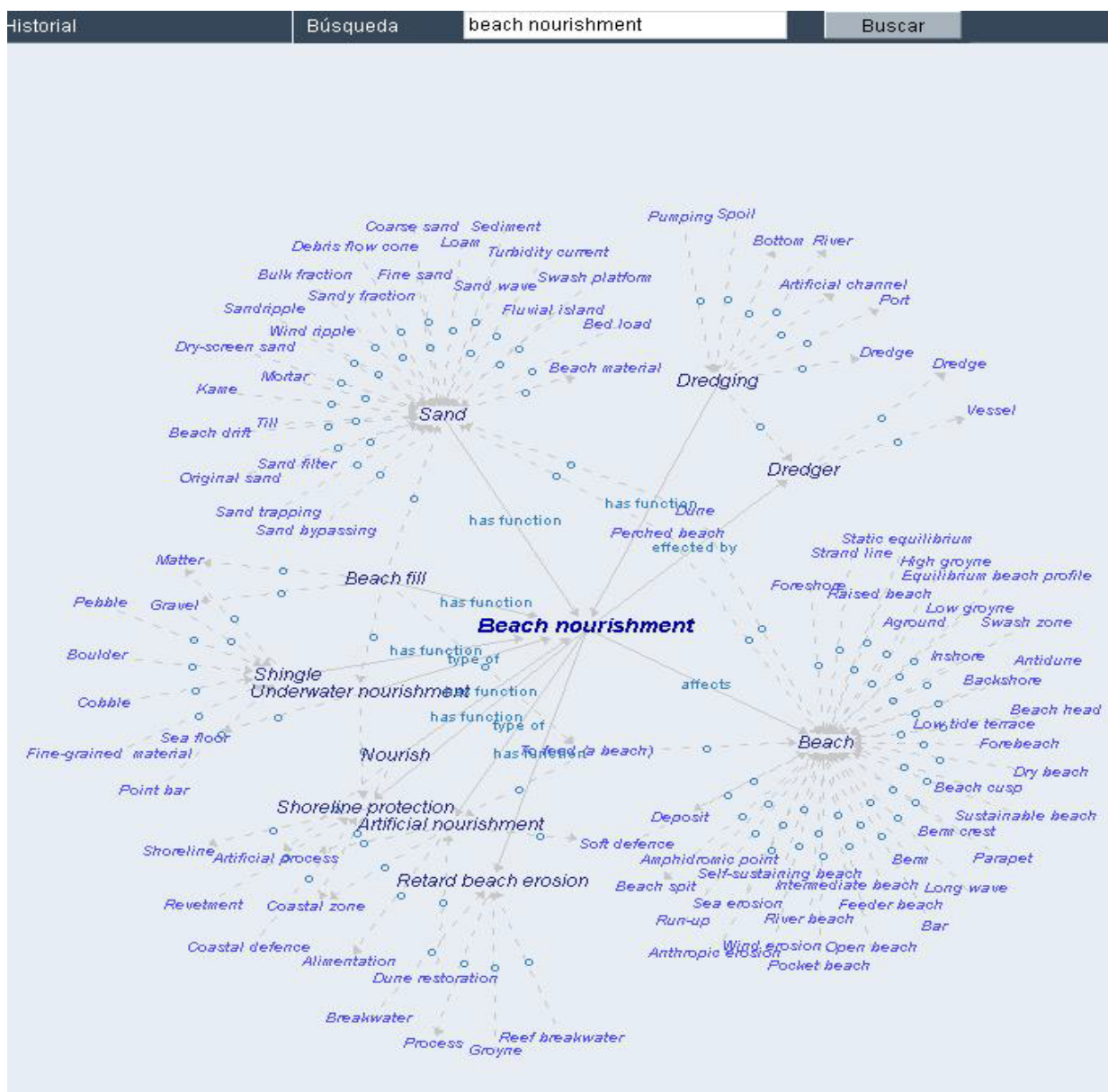


Figure 47. EcoLexicon representation of BEACH_NOURISHMENT

As observed in Figure 47, BEACH NOURISHMENT is a coastal defense action, and thus, has a more complex set of relationships than a concept, such as GROUYNE. Its relations include its function (*nourishment of various types, retardation of beach erosion, shoreline protection*). Conversely, the direction of the HAS_FUNCTION arrows shows that the process (*dredging*) as well as the material used (*sand, beach fill, and shingle*) have the function of BEACH NOURISHMENT. It is carried out or EFFECTED_BY a *dredger* and AFFECTS a *beach*.

Thus, a more general COASTAL DEFENSE template activates the relations TYPE_OF and HAS_FUNCTION through the formal role related to category membership and the telic quale, which best describes any type of coastal defense. In contrast, in the case of hard and soft solutions, conceptual relations vary in accordance with the nature of the

concepts. Since HARD COASTAL DEFENSE STRUCTURES are *objects* and SOFT COASTAL DEFENSE ACTIONS are *events*, their definitions have different types of information. The MADE_OF conceptual relation pertains to the description of a *physical entity*, whereas the RESULT_OF conceptual relation focuses on the final phase of the *process event*.

As previously mentioned, GROYNE as well as BEACH NOURISHMENT are members of the same conceptual network, which is more meaningful when placed within the context of the prototypical COASTAL DEFENSE frame. In spite of belonging to two different categories of the EE (EVENT and RESULT), the link between soft and hard beach stabilization approaches is obvious since they share the same telic role, and are both types of coastal defense solutions. Once again, this gives evidence of the usefulness of event frames.

Generally speaking, the linguistic description of GROYNE and BEACH_NOURISHMENT as well as their coordinate and subordinate concepts within the conceptual area tend to follow these templates insofar as type, quantity, and configuration of information are concerned. In this way, definitions show a more uniform structure that complement the information encoded in the conceptual network, and directly evoke the underlying event structure of the domain.

3.1.12 Knowledge structure and representation in EcoLexicon

The theoretical principles described so far have been implemented in EcoLexicon environmental knowledge base. In EcoLexicon, knowledge can be accessed from top-level categories to more specific relational structures. As previously mentioned, the most generic level is the Environmental Event (EE), which provides a frame for the organization of all concepts in the knowledge base (see Figure 24). This event-based representation facilitates knowledge acquisition in text processing since conceptual categories are bound together by event knowledge.

Proof of the usefulness of event knowledge can be found in written communication since a comprehender's knowledge of events plays a central role in sentence processing. This knowledge interacts with structural interpretation at the earliest possible moment (Elman 2009: 549). Evidently, terms, whether they designate objects or processes, are powerful cues for the wider event knowledge targeted. In this regard, the choice of a specific term is sufficient to generate expectations and predictions that constrain the range of likely events.

3.1.12.1 Domain-specific representation

EcoLexicon is structured in a network of interconnected domains in consonance with what is known about the organization of concepts in the mind. Recent research in cognitive neuroscience has implications for specialized domains and their organization. Whether conceived as a conceptual category (e.g. GEOGRAPHIC LANDFORM, MARITIME CONSTRUCTION, etc.) or as a specialized field of knowledge (e.g. GEOLOGY, ENGINEERING, etc.), domains and domain structure are central to any theory of Terminology and specialized communication. Not surprisingly, domains have also been found to exist in the brain in some form, as shown in the extensive body of research on category-specific semantic deficits (Warrington and McCarthy 1983, 1987; Warrington and Shallice 1984; Humphreys and Forde 2001; Caramazza and Mahon 2003; A. Martin 2007; Mahon and Caramazza 2008, 2009, *inter alia*).

Although initially, research did not provide conclusive evidence of the important role of categories, the domain-specific hypothesis (Caramazza and Shelton 1998) assumes that the first-order constraint on the organization of information within the conceptual system or the organization of conceptual knowledge in the brain is object domain. In this model, object domain and sensory, motor, and emotional properties jointly constrain the organization of conceptual knowledge. In addition, object domain is a first-order constraint on the organization of information at both a conceptual level as well as at the level of modality-specific visual input representations (Mahon and Caramazza 2009: 34). Although Mahon and Caramazza (2009: 30) restrict basic domains to those with an evolutionary relevant history (e.g. living animate, living inanimate, conspecifics, and tools), their observation that domains are constrained by the nature of concept members has evident implications for Terminology.

One conclusion that can be derived from this hypothesis is the fact that not all categories are structured in the same way, and that organization is constrained by the nature of the category itself. As described in previous sections, in EcoLexicon, the analysis of the properties shared by category members provides a general representational template for each category, which makes the definition of category members more systematic. In this way, definitions acquire a more uniform structure that complements the information encoded in the conceptual system, and directly refers to and evokes the underlying event structure of the domain. Such templates can even be considered a kind of conceptual grammar (Faber 2002ab; Montero Martínez and Garcia de Quesada 2003; Faber, León Arauz, Prieto Velasco, and Reimerink 2007). However, category templates are made up of different clusters of conceptual relations that depend on the nature of the category.

3.1.12.2 Domains as conceptual categories

In Terminology, there are two different ways of conceiving specialized domains. Domains can either be viewed as conceptual categories or as specialized knowledge fields. When domains are conceptual categories, categories are constrained by the nature of category members that share properties. For example, the categories of specialized instruments and geographic objects are quite different from each other. This is reflected in the conceptual relations that reflect their interconnections with other entities.

The INSTRUMENT domain, for example, is primarily constrained by information regarding properties related to manipulation, function, and result. This is in vivid contrast to a domain such as GEOGRAPHIC OBJECTS (estuary, marshland, channel, etc.) which is constrained by other types of information, directly linked to the nature of the concepts (i.e. LOCATION_OF, SIZE_OF, and DELIMITED_BY, see 3.1.9).

This cluster of relations stem from the fact that geographic objects are presumably simulated in a different way from instruments, atmospheric phenomena, coastal defense structures, or marine fauna, and this affects their conceptualization and representation. Although this would require further study, the simulation of geographic objects would involve the activation of brain areas connected with location and orientation. For this reason, in the representation of members of this category, emphasis has been placed on information pertaining to spatial orientation. Figure 48 shows the EcoLexicon representation of MARSHLAND.

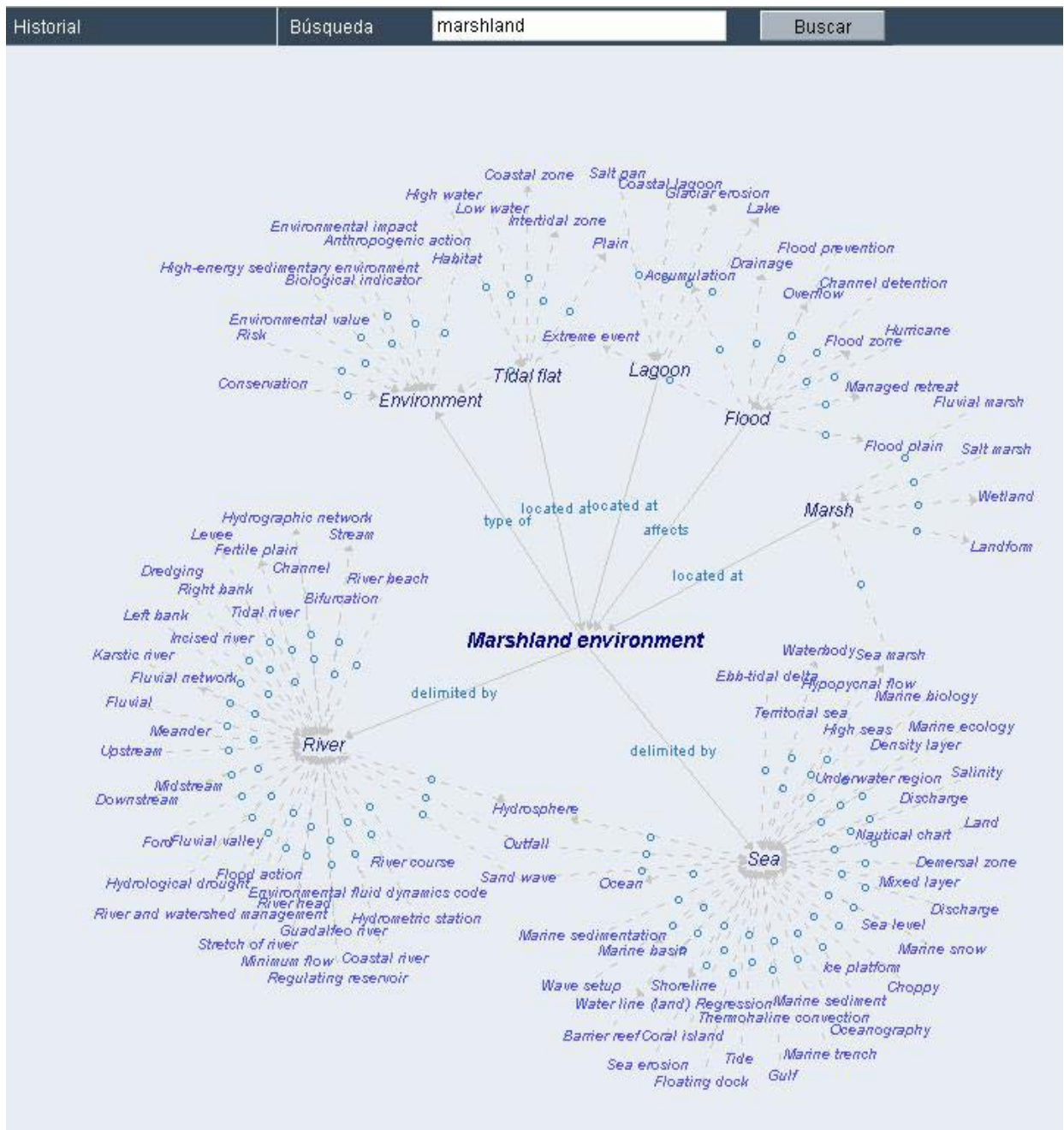


Figure 48. EcoLexicon representation of MARSHLAND

As a geographic object, the most salient conceptual relations are those related to boundaries (DELIMITED_BY) and location (LOCATED_AT). Also relevant are the TYPE_OF and AFFECTED relations. Figure 48 reflects the fact that MARSHLAND ENVIRONMENT is delimited by the sea or a river. It is an environmental area affected by floods. Lagoons, tidal flats and marshes are also geographic objects located in MARSHLAND ENVIRONMENT. This indicates its ample size, which means that it can include a wide variety of geographic concepts.

Domains as specialized knowledge fields

Figure 49 shows that there is a clear need for contextual constraints to be applied so as to eliminate noise and only activate the conceptual relations relevant to WATER in a given specialized field (León Arauz, Magaña and Faber 2009; León Arauz and Magaña 2010). For example, the fact that water is PART_OF concrete is relevant in an engineering context, but not in a geological context in which information regarding how water interacts with soil and the landscape is much more important. When such constraints are applied and only the conceptual relations for engineering are activated, the representation of WATER is the following:

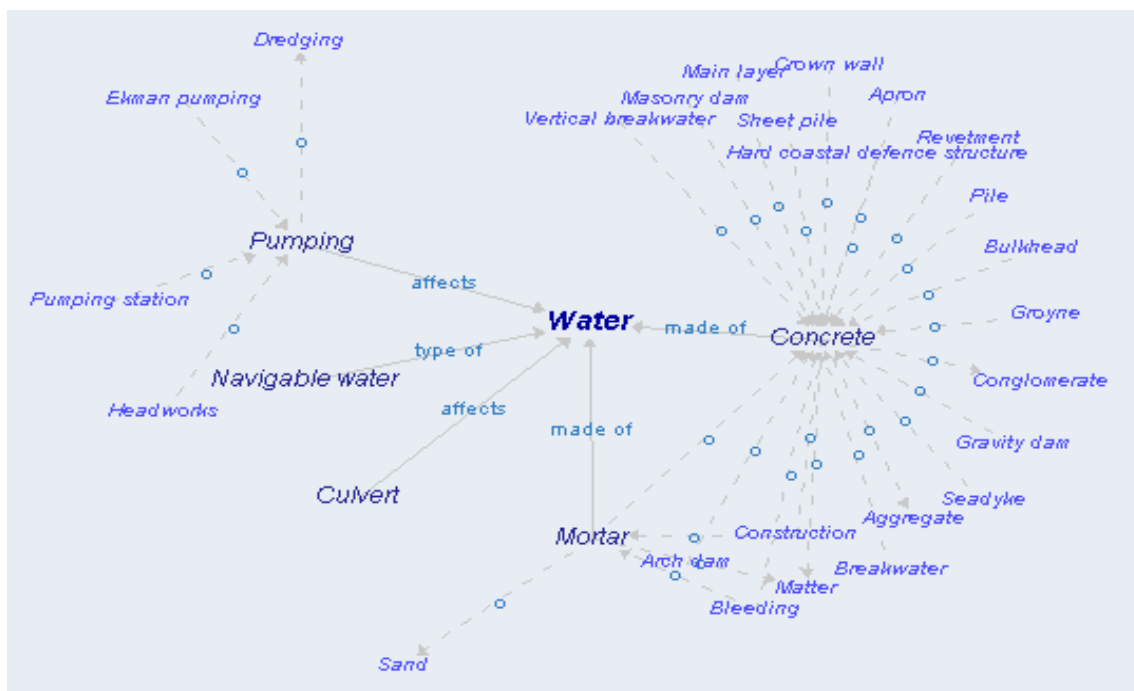


Figure 50. EcoLexicon representation of WATER in the context of Engineering

The representation of WATER in Figure 50 is much more informative for a given context because irrelevant data is blocked out. The resulting conceptual representation only emphasizes the affordances that water has for Engineering. More specifically, it highlights the fact that water is a building material for engineering structures, and is used in processes such as pumping and dredging. In contrast, when water is recontextualized within the context of geology (see Figure 51), its representation is quite different since another set of concepts and relations are activated.

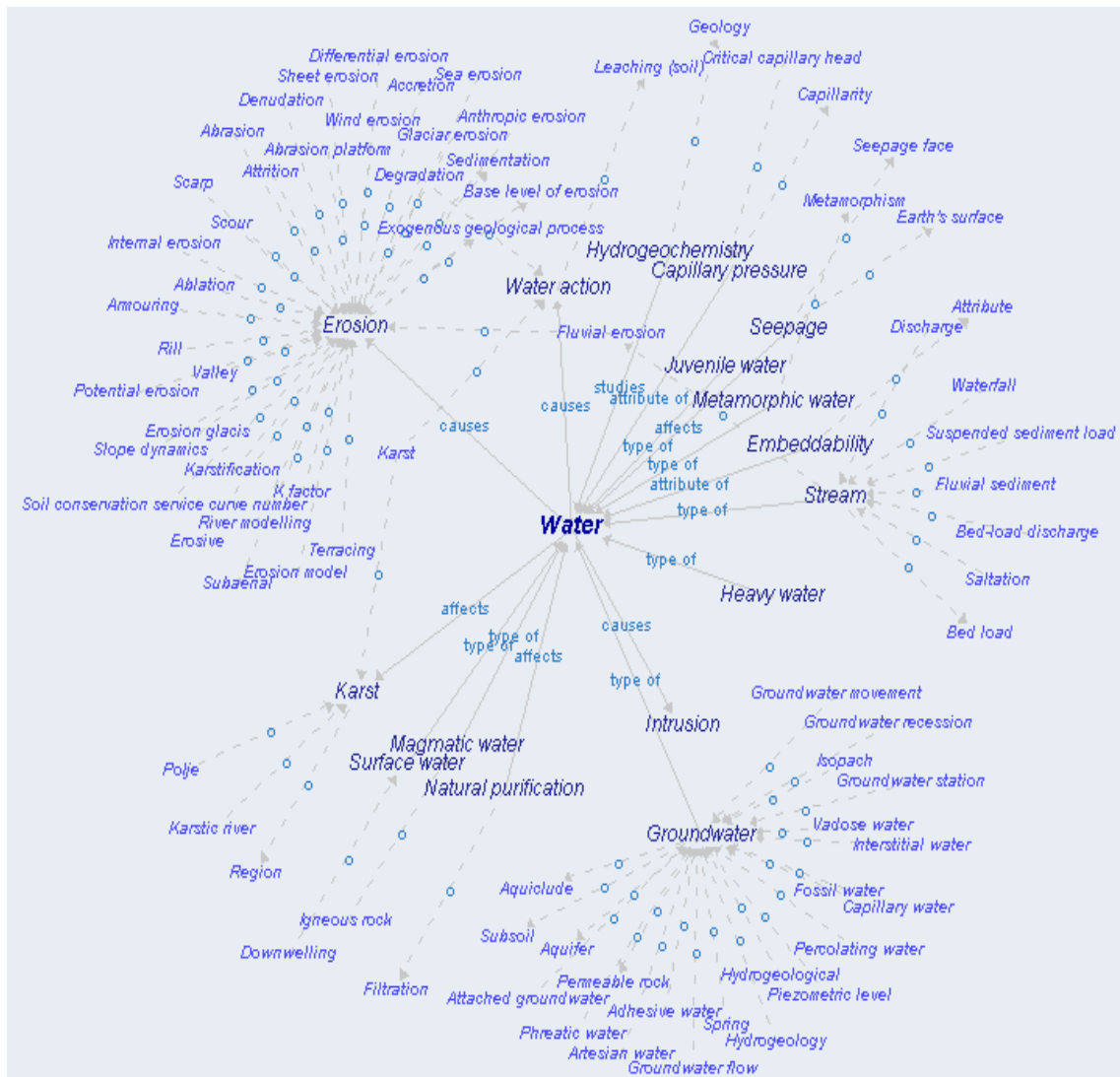


Figure 51. EcoLexicon representation of WATER in the context of Geology

Evidently, the number and type of conceptual relations vary dramatically from one network to another. This highlights the changing nature of the internal structure of WATER, according to each semantic role. For example, in Engineering, most relations to WATER are MADE_OF and AFFECTS, whereas in Geology, CAUSES and TYPE_OF are the most salient conceptual relations (León Arauz and Faber 2010). In this sense, in EcoLexicon, we are currently exploring the possibility of establishing contextual field-related constraints on the activation of conceptual relations. This would be applied to general objects and processes, such as WATER, OCEAN, SEDIMENTATION, EROSION, etc., which otherwise generate too much data and produce an information overload.

Nevertheless, reconceptualization does not involve a clear-cut distinction between different contextual domains since domains can also share certain conceptual propositions. This is due to the fact that multidisciplinary gives rise to fuzzy category boundaries, and as a result, contextual domains can form their own hierarchical

structure. Moreover, they are also dynamic and flexible structures that should evolve over time according to the type and amount of information stored in the knowledge base (León Arauz and Magaña 2010).

3.1.13 Event and object representation

One of the objectives of EcoLexicon is the dynamic representation of all concepts. Although dynamism has been underlined as a significant attribute of event or action concepts, the following sections show that object concepts can also have a more dynamic representation when placed in the wider context of an event.

3.1.13.1 Event representation: Extreme Event

For example, one of the concepts in EcoLexicon is EXTREME_EVENT in its sense of natural disaster. Disasters in the environment include great earthquakes, floods, giant sea waves, hurricanes, tornadoes, etc., and their consequences. The concept of EXTREME EVENT is very complex since it is a natural agent that initiates a process (i.e. earthquakes or volcanic eruptions can produce tsunamis), but it can also be the process itself, which occurs in time and space. This information is represented in EcoLexicon as shown in Figure 52.

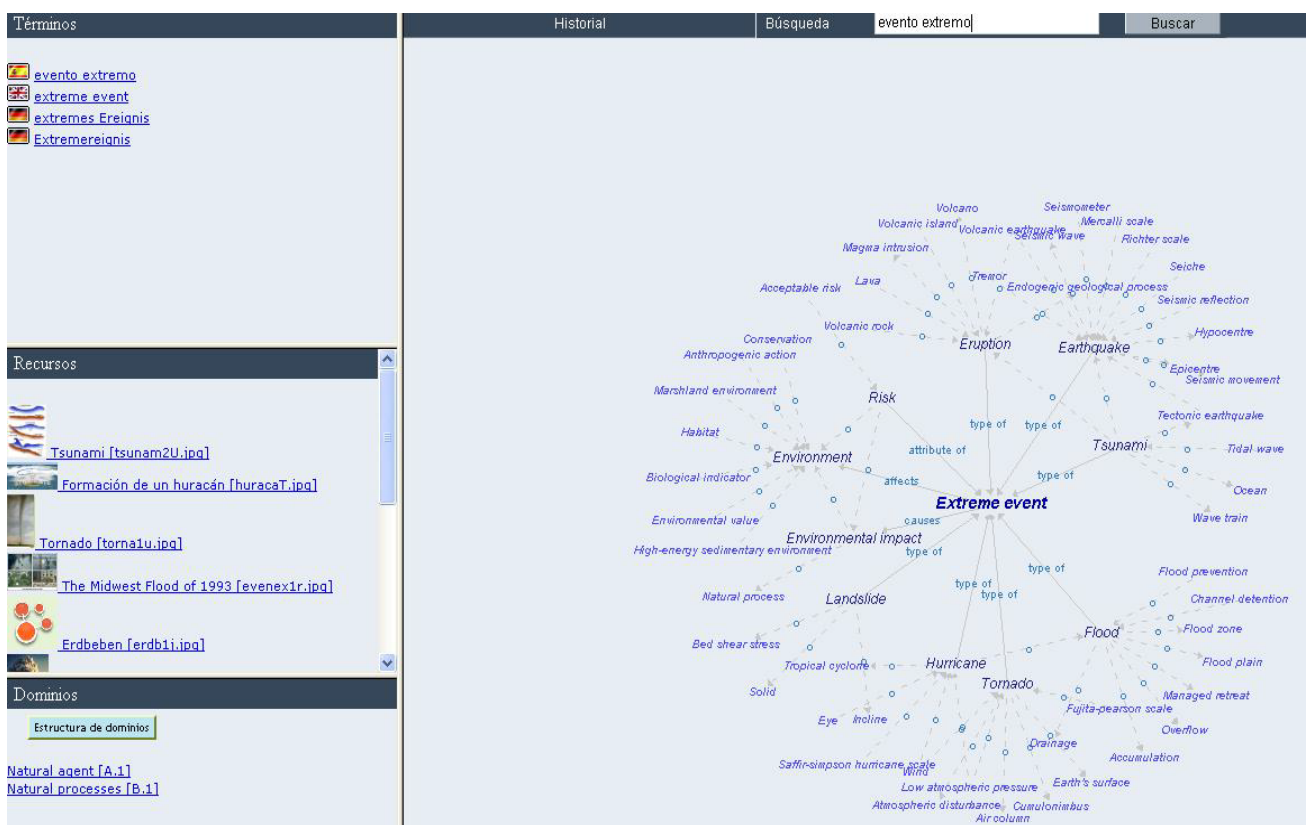


Figure 52. EcoLexicon representation of EXTREME_EVENT

In Figure 52, all of the concepts closest to the central concept are connected to it by a series of conceptual relations that are explicitly named (e.g. TYPE-OF, CAUSES, AFFECTS, etc.). Since EXTREME_EVENT is a very general concept, the only visual information that can be associated with it belongs to its subtypes (HURRICANE, TORNADO, EARTHQUAKE, FLOOD, etc.). The majority of relations at this level are thus TYPE_OF. However, EXTREME_EVENT also activates non-hierarchical relations typical of the general event frame. As such, its principal attribute is RISK; it AFFECTS the environment; and CAUSES an environmental impact. The TYPE_OF relations can be regarded as access routes to more prototypical base-level concepts (Rosch 1978), which do have a mental image, and can activate specific contexts. This set of subtypes (hurricane, tornado, flood, tsunami, etc.) take the form of constellations, each with their own set of subordinate concepts and conceptual relations, which encode more specific sub-event knowledge and representations.

According to Barsalou (2005), a given concept produces many different situated conceptualizations, each tailored to different instances in different settings. Thus, context is a dynamic construct that triggers or restricts knowledge. This general event that codifies a natural disaster can thus be recontextualized at any moment to center on any of the more specific subevents. For example, when the EXTREME EVENT representation is recontextualized to focus on HURRICANE, it takes the following form.

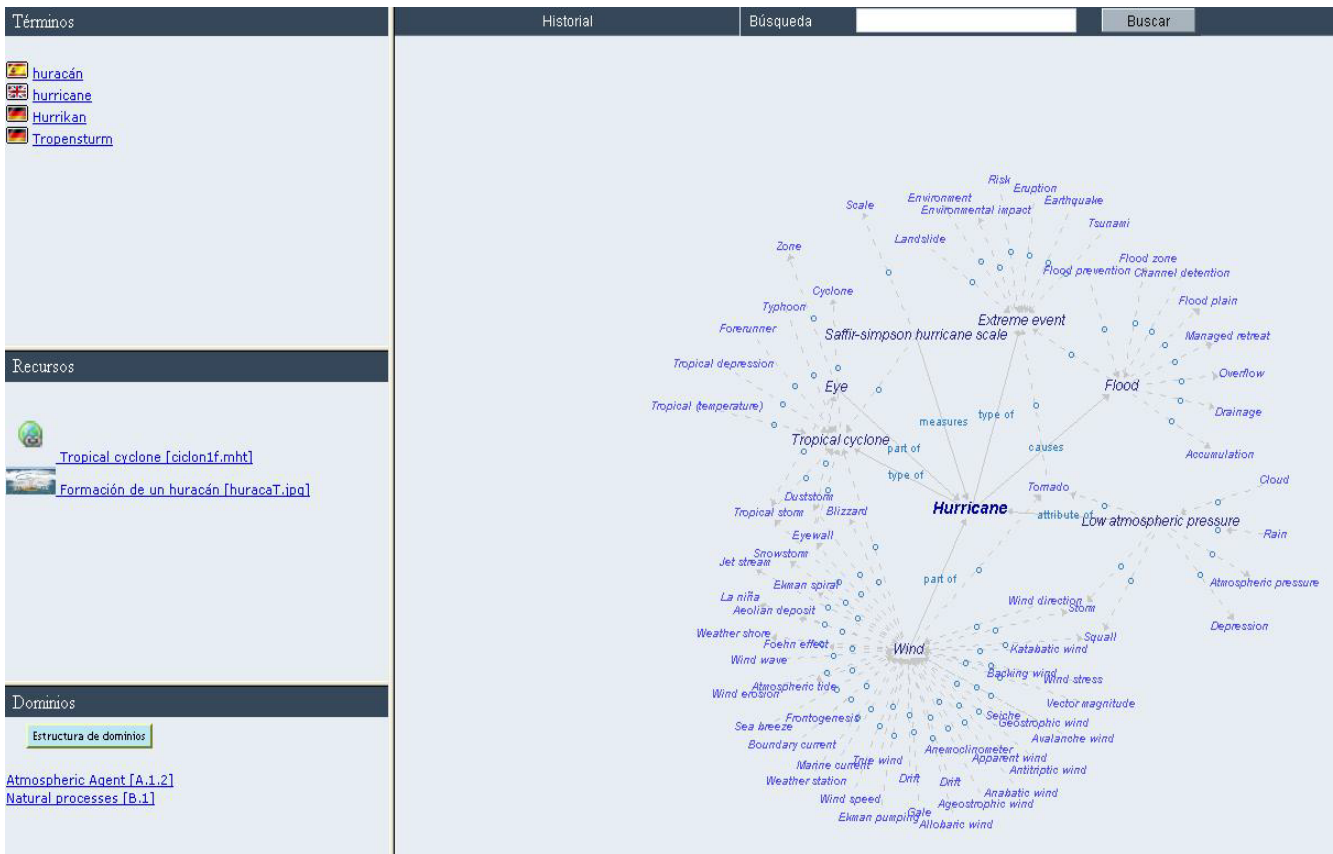


Figure 53. EcoLexicon representation of HURRICANE

This type of recontextualization of EXTREME_EVENT varies the construal, making HURRICANE the center of focus. Besides communicating the fact that hurricane is a type of extreme event, this new representation highlights the fact that wind and flooding are crucial participants in the event. Wind is PART_OF a hurricane, and a hurricane CAUSES floods. Not surprisingly, WIND and FLOOD are concepts that are susceptible to simulation since they can directly affect human life and health. It also mentions the ATTRIBUTE_OF low atmospheric pressure as well as the scale generally used for hurricane measurement (Saffir-Simpson hurricane scale), which codifies an important aspect of expert interaction with a hurricane.

3.1.13.2 Object representation: RECORDING_INSTRUMENT

Object concepts can also be represented dynamically. They are stored in semantic memory, a major division of declarative memory, which contains information about the meaning of objects and words. This is the part of our mind (or at least a small section of it) that terminologists are trying to model each time they make a concept map. How knowledge is modeled largely depends on how objects are defined, their focal properties, their perceived relations with other concepts, and how the user understands them.

and capable of automated reasoning. One of the elements necessary for such reasoning are axioms or logical sentences used to make explicit assertions about domain entities.

For example, the top level categories in INSTRUMENT represent the principal types of function that a scientific instrument can have in this domain through its subtypes: (i) MEASURING_INSTRUMENT; (ii) RECORDING_INSTRUMENT; (iii) SAMPLING_INSTRUMENT; (iv) TRANSFORMING_INSTRUMENT. The relations here include the fact that all these concepts are a type of instrument and the different instances of each class. The same is true if we focus on the conceptual level that is directly subordinate. Figure 55 shows the EcoLexicon representation for the category of RECORDING INSTRUMENT, one of the basic types of instrument:

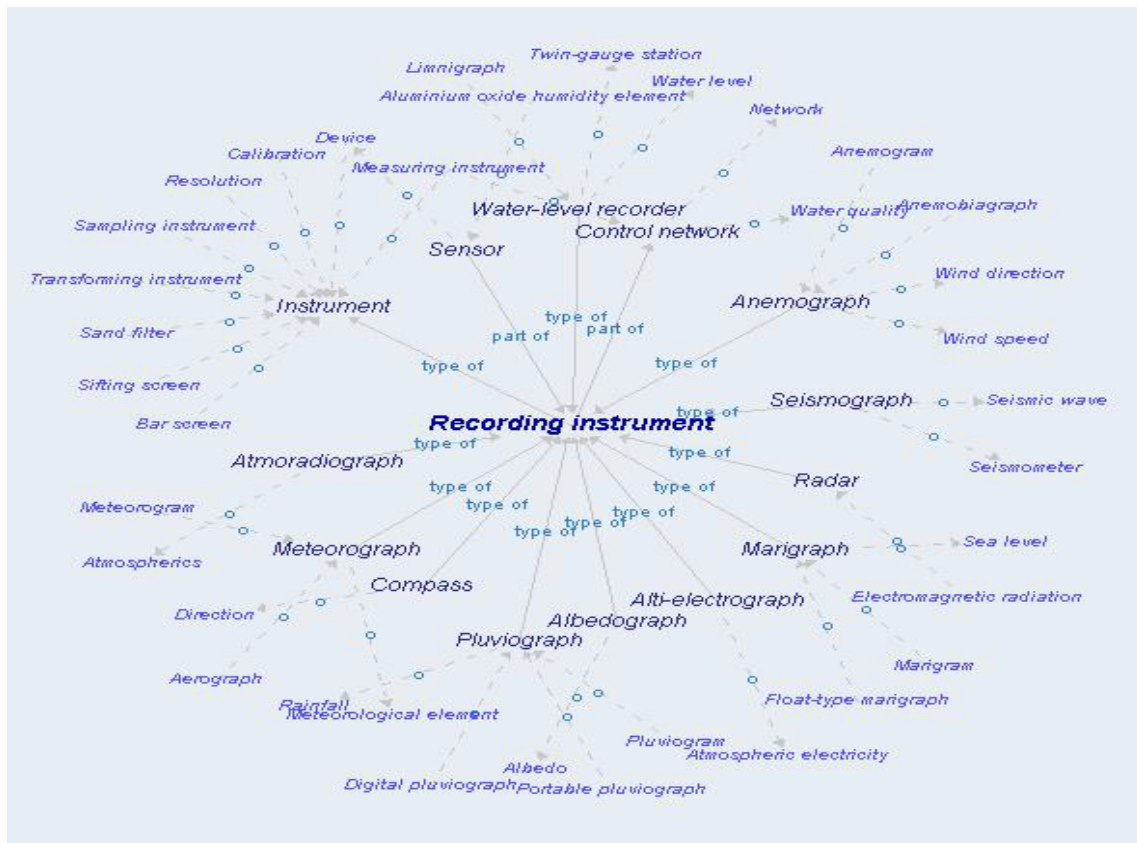


Figure 55. EcoLexicon representation of RECORDING_INSTRUMENT

For example, a RECORDING_INSTRUMENT (e.g. marigraph, pluviograph, anemograph, etc.) is a subtype of INSTRUMENT. As a manmade manipulable artifact, a recording instrument has a function (i.e. recording) as well as an object that is recorded (tides, rain, wind, etc.). As a tool, it is strongly susceptible to human interaction, and activates a simulation frame in which much of the perceiver's knowledge of the artifact involves his/her ability to handle it and in some way to extract information from it. Figure 56 shows the representation of PLUVIOGRAPH.

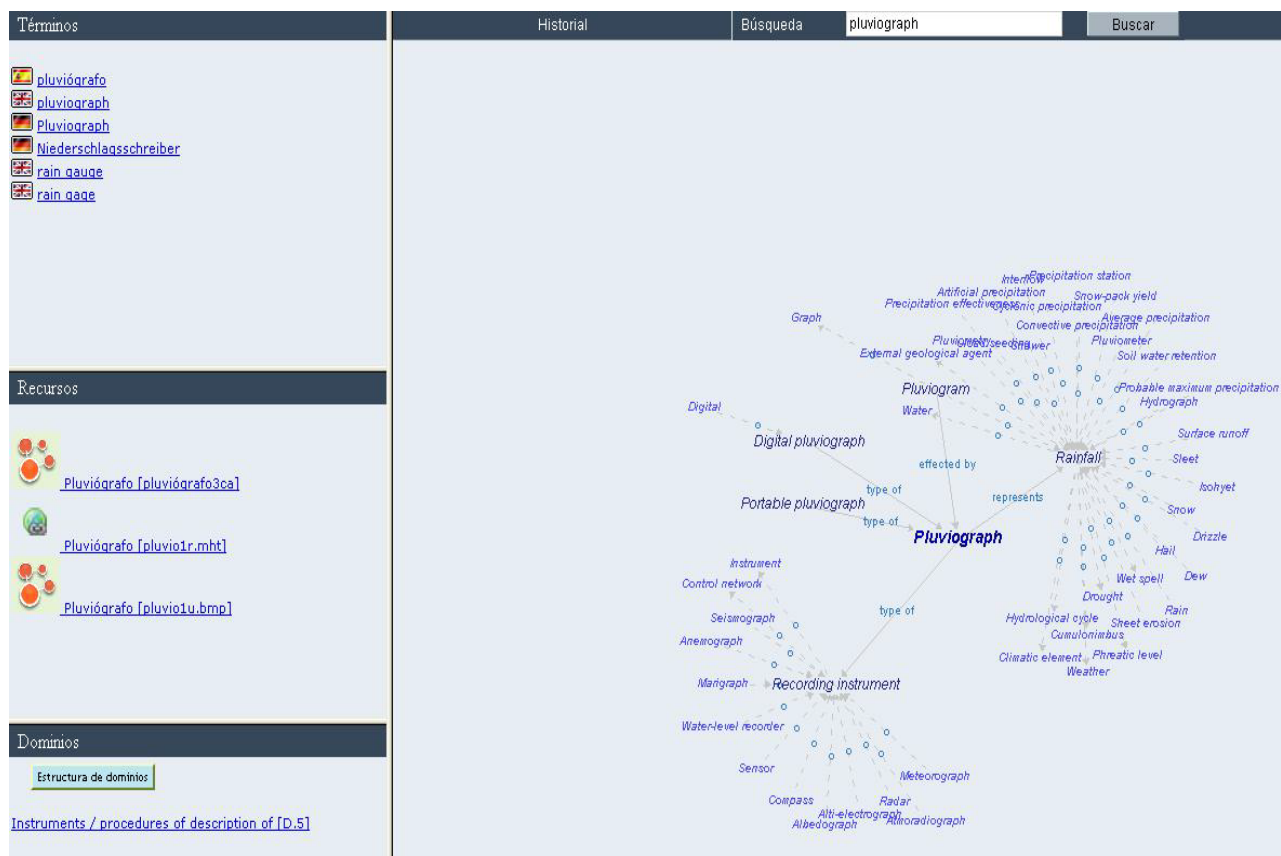


Figure 56. EcoLexicon representation of PLUVIOGRAPH

The representation of PLUVIOGRAPH, of course, includes TYPE_OF information. A pluviograph is a recording instrument, and has subtypes, such as digital pluviograph and portable pluviograph. However, it is also implicitly part of what might be called a RECORDING EVENT in which a human agent records and represents something (RAINFALL). The recording instrument used in this event is a pluviograph, which produces (or effects) a PLUVIOGRAM. As can be observed in Figure 56, this process is reflected in the horizontal relations REPRESENTS and EFFECTED_BY.

In Figure 56, it is evident that the most significant conceptual relation linking other concepts to RECORDING INSTRUMENT is the hierarchical TYPE_OF relation. For example, MARIGRAPH is one of the many types of RECORDING INSTRUMENT. However, the same is not true for the whole conceptual network activated by the concept of MARIGRAPH, as shown in Figure 57.

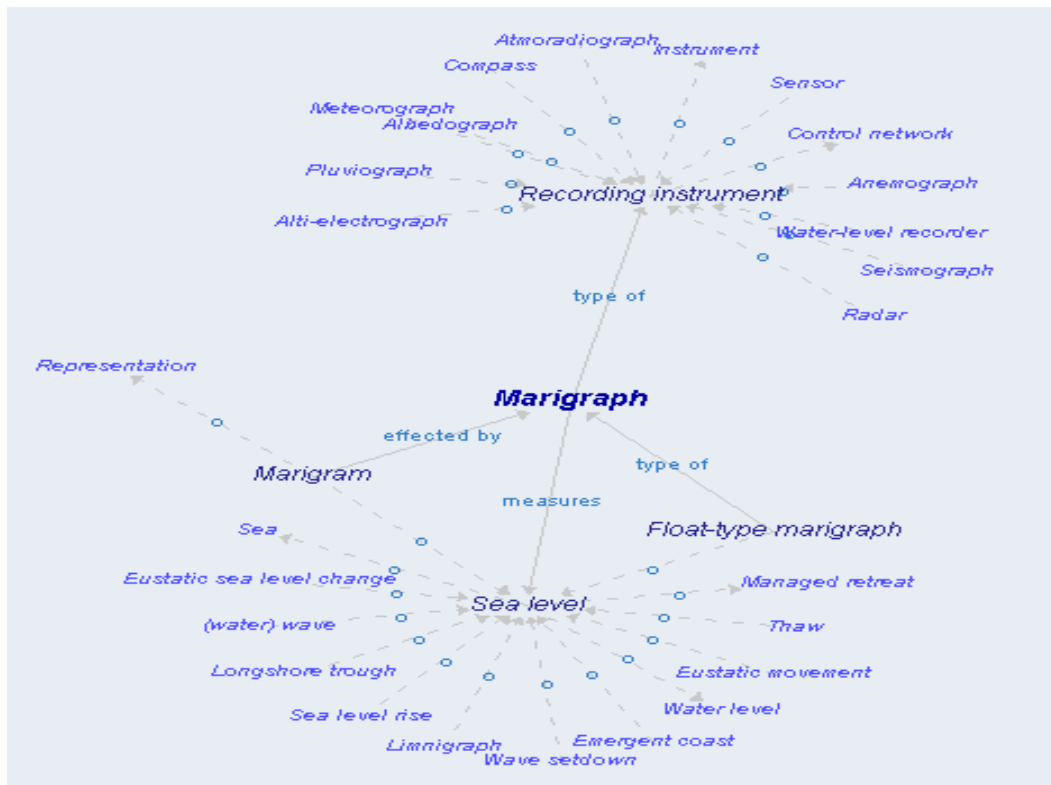


Figure 57. EcoLexicon representation: MARIGRAPH

Figure 57 shows that FLOAT-TYPE MARIGRAPH is a type of MARIGRAPH, and that MARIGRAPH is a type of RECORDING_INSTRUMENT. However, it is only at the level of MARIGRAPH, which is the middle level of specificity that the concept becomes sufficiently specialized to evoke an image. Thus, the conceptual description is enriched by non-hierarchical domain-specific relations. As shown in Figure 57, a MARIGRAM is produced or effected by a MARIGRAPH. A MARIGRAPH also measures SEA LEVEL.

Both the relations EFFECTED_BY and MEASURES are non-hierarchical, horizontal conceptual relations that describe specific conceptual properties. Such relations do not generally appear at higher conceptual levels where concepts are more generic. However, they are more common in the case of basic-level concepts that evoke an image. This is in line with the levels of conceptual specificity described in prototype theory. According to Rosch (1978), both superordinate and subordinate categories have fewer defining attributes than basic-level categories (see 2.2.7.2). The basic level is the most inclusive level at which there are characteristic patterns of behavioral interaction and for which a clear visual image can be formed (Croft and Cruse 2004: 83).

As shown in Figure 57, RECORDING INSTRUMENT represents the superordinate level, MARIGRAPH, the basic level, and FLOAT_TYPE MARIGRAPH, the subordinate level. Accordingly, domain-specific relations are only shown when the concept, MARIGRAPH is

activated, since it is at the basic level where concepts have a greater degree of intracategorical similarity as well as a lesser degree of intercategory similarity. RECORDING INSTRUMENT is too generic to have more than the most basic hierarchical relations since it is not linked to any specific mental image. As for the FLOAT-TYPE MARIGRAPH GAUGE conceptual network, it does not need any other relations, since it inherits those belonging to the superordinate concept MARIGRAM.

3.1.14 Summary

Semantics is what language is all about. It is concerned with how words mean, and the message being communicated. Describing meaning entails knowledge about how to describe the concepts behind the words as well as how to describe how each concept is related to others with a similar meaning. Cognitive semantics divides semantics (meaning) into *meaning-construction* and *knowledge representation*. However, until now, it seems to have been more concerned with representing the meaning of individual words instead of larger sets of related concepts. Terminology, on the other hand, has always focused on the representation of entire specialized knowledge domains, but has been somewhat less concerned with the meaning of single terms.

In Cognitive Semantics there are various proposals for meaning representation (i.e. frames, image schemas, idealized cognitive models, and mental spaces). This chapter proposes frames as a means of making conceptual mapping in Terminology more principled and systematic. In this sense, Frame-based terminology is a new approach to specialized language that focuses on semantic analysis and the meaning of terminological units. The data extracted from multilingual corpora and dictionaries provide the basis for conceptual maps which reflect the place of specialized knowledge units in large knowledge configurations. Concept systems are organized on the basis of definitional templates and situated representations for specialized knowledge concepts.

The design of concept systems has always been part of terminology work. However, the static representations generated do not reflect the dynamic nature of categorization, concept storage and retrieval, and cognitive processing. Recent research in cognitive neuroscience shows that cognition is grounded in multiple ways, which include simulations and situated action. It claims that interactions between sensorimotor systems and the physical world underlie cognition.

In regards to terminological work, this means that firstly, specialized knowledge concepts should be typically situated in background situations and events since no concept is processed in isolation. Secondly, although dynamicity has been regarded

primarily as an attribute of event and action concepts, object concepts are also dynamic since they are processed as part of a frame or dynamic context which highlights the type of action that they participate in. Thirdly, the fact that simulation is a crucial factor in knowledge acquisition signifies that non-hierarchical relations defining goal, purpose, affordances, and the result of the manipulation and use of an object are just as important as hierarchical relations.

All of these premises have been illustrated by examples from EcoLexicon (<http://ugr.es/visual>), an environmental knowledge base that uses environmental texts as well as specialized knowledge resources to extract a set of domain concepts, shared by English, Spanish, and German, and analyzes language structure to obtain an inventory of conceptual relations to structure these concepts. Terminological entries are composed of information from specialized texts as well as specialized language resources. From a linguistic perspective, *Aktionsart* distinctions in texts are based on Van Valin's (2004) classification of predicate types. At the more specific levels of the network, the *qualia* structure of the Generative Lexicon (Pustejovsky 1995) is used as a basis for the systematic classification and relation of nominal entities. EcoLexicon facilitates knowledge acquisition since it presents concepts as part of larger knowledge structures and permits dynamic processes such as the recontextualization knowledge representations.

3.2 Specialized Language Pragmatics

Pamela Faber

3.2.1 Introduction

Pragmatics is the study of the ability of speakers to communicate more than that which is explicitly stated. A possible exception to this is relevance pragmatics, where it is postulated that some dimensions of explicitness (explicature-derivation) can be a matter of pragmatics. Generally speaking, however, pragmatics deals with meaning arising from language in context, in other words, the meaning intended by the speaker or text sender and understood by the listener or text receiver. When the communication act is successful, these meanings coincide, and when it is not, they diverge to a greater or lesser degree. As such, pragmatics focuses on the effect of context on communicative behavior as well as on how inferences are made by the receiver in order to arrive at the final interpretation of an utterance. The scope of pragmatic meaning can be entire utterances as well as individual lexical units.

As Mey (2004: 42) writes:

Pragmatics is essentially about the users of language in a real-life situation, and about the conditions that enable those users to employ linguistic techniques and materials effectively and appropriately.

Alternatively, Verschueren (1999: 7) has described pragmatics, not as a language component, but rather as “a general cognitive, social, and cultural perspective on linguistic phenomena in relation to their usage in forms of behavior. According to this view, “pragmatics does not constitute an additional component of a theory of language, but it offers a different perspective” (ibid: 2). Verschueren thus denies that pragmatics can be regarded as a component of language with its own set of features.

However, we are more in agreement with Mey (2001: 9), who claims that a perspectivist view emphasizes the pragmatic aspects of all parts of linguistics, and can serve as an umbrella for the various components and areas of linguistics. This gives us the best of both worlds. The perspectivist view thus coexists with the component view, and serves to expand rather than narrow the horizon on pragmatics.

There is no specialized language pragmatics *per se*. Research on pragmatics in specialized language and terminology tends to exist in the form of individual studies on different aspects of specialized communication. Pragmatic studies of specialized language generally focus on: (i) interactions between user groups in some specialized context (Lehtinen 2007; Vickers 2009); (ii) parameterization of specialized contexts for

computer modeling or database design (Gero and Smith 2007; Kerremans et al. 2005ab; (iii) specialized text analysis (Myers 1992; Darian 1997); (iv) terminological variation (Bowker and Hawkins 2006; Freixa 2006); controlled language (Jimenez Hurtado 2005; Buendía Castro and Huertas Barros 2007).

Specialized language pragmatics is directly related to the situations in which this type of communication occurs, and to the ways that the text sender and receiver potentially and effectively deal with them. Such communicative situations are the focus of the external or *sociocultural* view of pragmatics (see 3.2.2.1), whereas the online construction of text and word meaning by sender and receiver refers to the internal or *cognition-oriented* view of pragmatics (see 3.2.2.2).

Research in sociocultural pragmatics may compare and contrast the communicative customs of different communities (Trosberg 1994; Mey 2004); focus on preferences in discourse organization (Gallardo 2005; Engberg 2010); or analyze conversational styles (Chatwin 2008). As such, it characterizes the norms in language communities. This is usually done by analyzing the behavior of a population sample in a series of situations with identifiable explanatory social variables, and drawing generalizations from the distribution of frequencies obtained (Escandell Vidal 2004: 2).

In contrast, cognition-oriented pragmatics explores how the text, which is the result of the communication act, is molded by the situation itself as well as the previous knowledge, intentions, expectations, and beliefs of the text sender. It should be pointed out here that despite its name, cognition-oriented pragmatics is not directly related to Cognitive Linguistics, which makes no principled distinction between semantics and pragmatics (Fauconnier 1997). According to this view, meaning, as derived from language use, is a function of the activation of conceptual knowledge structures as guided by context (Evans 2009b). Cognition-oriented pragmatics also targets how the text is finally understood by the receivers, both at the micro and macrocontextual level. Needless to say, this type of research is more difficult to carry out scientifically because of its immense complexity. Nuyts (2004) writes:

A scientific analysis of this phenomenon [intercultural communication] means, then, firstly, to determine and characterize these differences between cognitive systems, and secondly, to determine and characterize what interlocutors actually do to overcome them in their attempts to communicate, and why these attempts may (to some extent) succeed or fail.

Examples of pragmatic studies that apply these principles to language are Gibbs (2006), Chang (2007), and Carston (2002).

3.2.2 Pragmatics

Whatever the perspective used, pragmatics generally studies communication events or the intentional acts of speakers at times and places. According to Korta and Perry (2006), pragmatics deals with the following types of facts:

- Facts about the objective facts of the utterance, including who the speaker is, when the utterance occurred, and where it took place;
- Facts about the speaker's intentions;
- Facts about beliefs of the speaker and of the text receivers, and the conversation they are engaged in;
- Facts about social institutions, such as marriage ceremonies, courtroom procedures, and the like, which affect what a person accomplishes in or by saying what he does.

In specialized communication, crucial pragmatic dimensions include the beliefs and expectations of the text sender, the knowledge shared by text sender and text receivers, the communicative objectives of the oral or written text stemming from the interaction of the participants, and the factors that cause receivers to interpret the text in a certain way. Specialized language pragmatics also focuses on facts about social and academic institutions, in which events generate specific types of specialized texts.

An example of such an academic institutional event is a conference in which research results are presented within a given knowledge field, such as neurosurgery, coastal engineering, nanotechnology, etc. Among the communicative interactions typical of an academic conference, one can find oral presentations, posters, round tables, plenary lectures, etc. However, even when these discourse types all contain and convey basically the same or similar information, an oral presentation is hardly the same thing as a poster, which is different from a round table or a plenary lecture.

All of these academic discourse types in turn differ substantially from an article in a scientific journal, describing the same research results presented at the conference. The reason for this is that formal communication is constrained, and determined, at least to a certain extent, by specific events, which require and generate a certain text type even when the communication acts take place in the same setting with essentially the same set of participants. The type of text or discourse models the information conveyed as well as the language used for the presentation of the information.

Evans and Green (2006: 221) underline the importance of different types of context in the modulation of any given instance of a lexical item as it occurs in a particular usage event. Broad context types mentioned are the following:

- Encyclopedic information accessed (within a network of specialized knowledge)
- Sentential context (utterance meaning)
- Prosodic context (intonation pattern)
- Situational context (physical location where the text is emitted)
- Interpersonal context (relationship holding between text sender and receiver)

Within specialized language pragmatics, prosodic context is perhaps less important than the other four context types. In this sense, the specialized text is a communicative act that takes place within a given setting, which can be defined in terms of a set of context-related pragmatic parameters linked to a set of inferential processes. Such texts thus can be said to have depth/vertical extension as well as width/horizontal extension.

Another focus of specialized language pragmatics is the nature of specific specialized domains. Certain knowledge areas evidently influence communication between groups of participants, and generate the use of one text template instead of another. In fact, it has been proposed that expert discourses be classified in terms of functions, such as reading and writing monographs and scholarly articles, observations and analyses, giving lessons and lectures, holding press conferences or giving interviews. According to Van Dijk (2001):

These categories involve for instance the overall domain of the current communicative event (e.g., research, education or health care), the overall action(s) being accomplished (e.g., investigate, teach, etc.), the current setting (time, location, circumstances), the specific actions involved (hold a seminar, give a lecture, have a research meeting), the participants and their various communicative, social and professional roles, and their aims, interests, and especially knowledge and opinions.

Van Dijk's proposal includes some of the items mentioned by Evans and Green (2006: 221). The overall domain of the communicative event overlaps to some extent with encyclopedic knowledge; setting corresponds to situational context; and participants and roles correspond to interpersonal context. However, the field-specific actions and activities being performed evidently need to be considered as well as crucial contextual factors.

For example, a Medical Forensics report has characteristics that are unquestionably linked to the knowledge field in question. This type of report, which is a hybrid text between medicine and law, includes specific medical terminology. Nevertheless, it also has the status of a legal document, whose objective is to officially inform on or certify a given state of affairs, usually connected with a medical condition, injury, death, etc.

For example, a medical forensics autopsy report can be structured as follows: (i) final diagnosis; (ii) external examination (iii) internal examination (with subsections referring to parts of the body, such as mediastinum, body cavities, lungs, heart, etc.) (iv) microscopic description; (v) evidence. The subject, whose body has been examined, is always referred to as aseptically as possible even in high-profile murders with great emotional potential.

For example, in 1996 an autopsy report was made of JonBenet Ramsey, a six-year-old beauty queen, who had been sexually abused and strangled in Boulder Colorado in 1996. Her murderer was never officially accused (though her father was the principal suspect). In this very high-profile and emotional murder case, the coroner referred to the dead child in terms of her body parts or in the most impersonal terms possible. When he must speak of her as a whole, and not as a description of parts, it is in the following way: *six-year old female, the decedent, the Caucasian female body*. An example of this can be observed in this excerpt from the autopsy report:

REMAINDER OF EXTERNAL EXAMINATION: The unembalmed, well developed and well nourished Caucasian female body measures 47 inches in length and weighs an estimated 45 pounds. The scalp is covered by long blonde hair which is fixed in two ponytails, one on top of the head secured by a cloth hair tie and blue elastic band, and one in the lower back of the head secured by a blue elastic band. No scalp trauma is identified. The external auditory canals are patent and free of blood. The eyes are green and the pupils equally dilated [...] (J.B. Meyer 1996).

The external examination goes from the whole to the parts, beginning from the scalp and progressing downwards. The present tense conveys the impression of immediacy, and the consistent use of the passive voice suggests objectivity and uninvolvement. As is well-known, the passive voice foregrounds the action and backgrounds the agent of the action, who often is not mentioned at all. Similarly, reporters, lawyers, and government agencies often use the passive voice to dilute responsibility. In this text, the implicit message is that the pathologist cannot have an opinion, but must let the observed evidence speak for itself.

This type of report differs from a forensic psychiatric evaluation report, which instead of a physical examination is based on a structured interview with the patient in order to ascertain and certify his/her mental state. Within this context, the category of *action* is extremely important because the document itself is the report of the professional activity or activities carried out to achieve this goal as well as the conclusions reached as the result of these activities.

The same thing is true for research articles, which describe the actions carried out as part of a study or experiment. For example, the activity of presenting research

results is reflected in the structure of the prototypical scientific article in specialized domains such as Organic Chemistry, Artificial Intelligence, Electrical Engineering, etc. which generally follow the IMRAD template (introduction, materials and methods, results, and discussion). IMRAD is the standard format for research reports in Western culture, and thus, is a clear signal to the text receiver of text type, purpose, and content. It is also an example of iconic sequencing (see 2.2.6). Within each section of the text, there is a series of prototypical propositions, which, depending on the knowledge field, have one type of semantic argument or another. However, regardless of the specialized field, the basic research actions and processes are very similar.

For example, in the Materials and Methods section, typical cognitive processes are *analyze, study, assess, calculate*, etc. though exactly what is analyzed, studied, or calculated is specific to the scientific or technical field in question. In the Results and Discussion section, characteristic processes are *describe, justify, affirm, produce*, etc. This is not surprising since here is where the results are presented as well as their possible repercussions.

All of these issues must be addressed by a pragmatic theory that specifically targets specialized language, whose first task would be to try and bring together the two most common approaches to pragmatics, namely, sociocultural (external) pragmatics and cognition-oriented (internal) pragmatics.

3.2.2.1 Sociocultural pragmatics

Broadly speaking, sociocultural pragmatics targets how social information enters into and affects communicative behavior. According to Escandell Vidal (2004: 3), its main task is to identify and characterize the norms that underlie the use of language by a given social group. In specialized language, this social group comprises specialized language users within a given field or knowledge area. This type of pragmatics is initially based on the work of Austin (1962) and Searle (1969, 1975), who laid the foundations for exploring contextual constraints on communication and social conditions for appropriateness. Sociocultural pragmatics generally focuses on politeness studies, research on conversational styles, rhetoric, discourse genres, and register.

In specialized communication, *genre* and *register* are important concepts even though their definitions often seem to confusingly run together. In reality, they represent different perspectives or points of view. As Lee (2001b: 46-47) points out, register is used when a text is viewed as the instantiation of a conventionalized, functional configuration of language tied to certain broad societal situations. Relevant examples

are the conversational language used to chat on the Internet or the formal language patterns that characterize research articles. Genre is used when a text is viewed as a culturally recognized artifact, a grouping of texts according to some culturally and conventionally recognized criteria. It is thus possible to talk about the existence of a formal academic register (focus: language), and its instantiation in the genres of research articles, posters, lectures, and conference papers. Accordingly, following Lee (*ibid*), we use register to refer to lexical-grammatical and semantic discourse patterns associated with situations, whereas genre is used to refer to the membership of a text in culturally-recognizable categories, which may invoke more than one register. As such, genre is a socio-pragmatic phenomenon.

According to Unger (2002: 2), a socio-pragmatic phenomenon is a set of shared assumptions that governs the communicative behavior of members of this group. It also relates communicative behavior to the structure of cultural institutions. Although a definitive inventory and classification of specialized language genres and registers does not as yet exist, such genres would doubtlessly be linked to specialized knowledge activities and text function within the context of a specialized knowledge field.

Göpferich (1995) and Gläser (1995) have established five main functions for specialized texts: informative (e.g. technical reports and catalogues); juridical-normative (e.g. EU framework directives, international standards); didactic-instructive (e.g. instruction manuals and textbooks), popularizing (e.g. popular science articles); and compilatory (e.g. dictionaries, glossaries). Text genres are domain-specific and reflect the activities in the specialized field. Registers would presumably be subdivided primarily according to levels of formality. These formality levels would be constrained by parameters inherent in the context of specialized communication. Register relates variations of specialized language use to variations of social context in which this type of interaction generally occurs.

3.2.2.2 Cognition-oriented pragmatics

The objective of cognition-oriented (internal) pragmatics is to account for the cognitive bases of linguistic performance, which encompass the inferential processes leading to the final interpretation, or the interface relationship between grammar and pragmatics. The groundwork for this type of approach was first laid by Grice (1975), Sperber and Wilson (1986) and Levinson (2000), who endeavored to establish general principles that govern different aspects of use and understanding of language

(Escandell Vidal 2004: 348). Cognition-oriented pragmatics also studies cultural breakdowns and pragmatic failure (Moeschler 2004).

Cognition-oriented theories of pragmatics seek to specify and describe the biological or cognitive foundations underlying communicative behavior, which means the formulation of principles with predictive power. Generally speaking, cognitive pragmatics is largely based on the relevance-theoretic approach of Sperber and Wilson (1995), which envisions pragmatics as a kind of information-processing system for interpreting human communicative behavior.

Tendahl and Gibbs (2008) focus on metaphor to compare cognitive linguistics and relevance theory, and come to the conclusion that they provide complementary perspectives on metaphor and language communication.

Cognitive linguistics, with its interest in metaphorical thought, studies entrenched metaphorical mappings, and has done extensive work illustrating the range of meaning correspondences that arise in the source to target domain mappings within conceptual metaphors, for instance. Relevance theory, on the other hand, explores the meanings that arise in specific contexts, and aims to demonstrate how these cognitive effects are constrained by the principle of optimal relevance. [...] there is surely a mixture of conceptually entrenched metaphorical knowledge with immediate contextual information, all of which is once more constrained by a principle of optimal relevance, which determines the particular meanings that listeners and readers typically infer during online metaphor or interpretation (Tendahl and Gibbs 2008: 1839).

Despite the fact that relevance theory focuses more on the role of metaphor for communication, and thus the pragmatics of metaphor and cognitive linguistics focuses more on the role of metaphor in our conceptual system, these authors believe that both perspectives could be usefully combined with a broader cognitive theory of metaphor use.

However, there are other approaches that could be applied, which are specifically related to knowledge representation. For example, cognitive psychology has proposed four theories of the human conceptual system: semantic memory, exemplar models, feed-forward connectionist nets, and situated simulation theory. Barsalou (2003) compares these models on the basis of the following dimensions: (i) architecture (modular vs. non-modular); (ii) representation (amodal vs. modal); (iii) abstraction (decontextualized vs. situated); (iv) stability (stable vs. dynamical); (v) organization (taxonomic vs. action-environment interface), and offers empirical evidence which makes a strong case for the existence of situated simulations as a powerful interface between cognition and perception.

In this regard, situated simulation has also become a hot topic in Cognitive Linguistics research. Indeed, as pointed out by Tendahl and Gibbs (2008: 7),

embodied simulation is the key feature of the neural theory of metaphor since embodied experience plays a primary role in the image-schematic structure of metaphorical concepts. Lakoff and Johnson (2003: 255) mention recent work that uses computational techniques from neural modeling to show that metaphorical mappings are physical neural maps that bind sensorimotor information to more abstract ideas as part of the neural ensembles existing in different regions of the brain. As a result, many aspects of metaphorical thought are now understood as “metaphorical enactments” that occur in real-time as dynamic brain functions.

Bergen and Chang (2005) have also incorporated this notion into their Embodied Construction Grammar, a formalism for linguistic analysis, based on a simulation-based model of language understanding. In this model, linguistic constructions map phonological forms onto conceptual representations, which in turn, are constrained by the body’s perceptual and motor systems. Understanding an utterance involves at least two distinct processes: analysis and simulation. The analysis of an utterance draws on linguistic knowledge, world knowledge, and the current communicative context to produce a semantic specification. The semantic specification provides parameters for a dynamic simulation using active embodied structures. The meaning of the utterance consists of the simulation and the inferences that it produces. In this simulation-based approach to language understanding, constructions need only specify simulation parameters, allowing features of the current context and of richer embodied and world knowledge to influence the result of any particular simulation

Barsalou (2003) argues that such simulations underlie a situated, dynamic conceptual system, which would be neither fully modular nor fully amodal. This kind of situated conceptualization is conceived as a package of situation-specific inferences, which would include four types of information: (1) contextually-relevant properties of the focal category; (2) information about the background setting; (3) likely actions that the agent could take to achieve an associated goal; (4) likely introspective states that the agent might have while interacting with the category. All of these are valid candidates for cognitive parameters in a pragmatics of specialized language communication.

Evidently, the parameters related to contextual properties as well as speaker goals would also be relevant to sociocultural pragmatics. Sociocultural pragmatics, however, would evidently study them as manifestations of language behavior in a population sample, corpus of texts, or recordings of social interactions. Cognition-oriented pragmatics would analyze them empirically by the assessment of people’s language behavior, intuitions, recruitment of metaphor, etc. through questionnaires, problem-solving situations, and psycholinguistic tests.

3.2.3 Pragmatics and Cognitive Linguistics

One of the problems with pragmatics has always been its inherent vagueness. It has often been used as a convenient catch-all for all the messy bits of meaning that semantics cannot account for, and would dearly like to sweep under the table. Cognitive Linguistics has a very definite position regarding pragmatics. Although there is a Cognitive Semantics (e.g. Talmy, 2000), there is clearly no branch of Cognitive Linguistics known as Cognitive Pragmatics. Cognitive semanticists argue that “semantic” knowledge cannot be separated from “pragmatic” knowledge, and that these kinds of knowledge constitute a continuum (Evans and Green 2006: 213).

Cognitive Linguistics takes an encyclopedic approach to semantics in which knowledge of word meaning and knowledge of word use are both regarded as types of semantic knowledge. Haiman (1980) and Langacker (1987) were both pioneers in arguing in favor of the encyclopedic approach to meaning. This is in line with the fact that Cognitive Linguistics is usage-based. Langacker (1991a) was the first to make this point though it must also be said that the founders of Cognitive Linguistics (i.e. Langacker, Lakoff, and Talmy) have never been systematic in grounding their proposals on corpus-based analysis. Usage-based theories posit that language builds up a conventional inventory of units that a speaker can use for communication. This inventory of units comes from hearing and using the language and through use become entrenched (Barlow and Kemmer 2000). As language units, they designate an inventory of entrenched concepts and categories. Language acquisition thus consists of entrenching, building, and extending concepts through use.

In Cognitive Linguistics, lexical items and linguistic expressions are regarded as underspecified, and are considered to be pointers to networks of encyclopedic knowledge. Once the network is accessed, a meaning construction process takes place, which is intimately linked to the way language is used:

If meaning construction cannot be divorced from language use, then meaning is fundamentally pragmatic in nature because language in use is situated, and thus contextualized, by definition. (Evans and Green 2006: 216).

This is especially important in specialized language communication in which the meaning of a text is largely encoded in specialized knowledge units or terms belonging to the specialized field. An in-depth analysis of the pragmatic potential of specialized knowledge units and their activation in different types of specialized texts would presumably provide us with a description of the specialized communication process. The online interpretation of these units depends on the discourse context, which involves frame specification, situational context, and construal.

3.2.4 Pragmatics and Terminology

Lexical pragmatics in general language has not received a great deal of attention from researchers though interesting studies have been carried out by Bondzio (1983), Ludwig (1991), and Jimenez Hurtado (2001), related to the codification of pragmatic information in dictionary entries. This information generally pertains to geographic (e.g. *USA, British*), diachronic (e.g. *old-fashioned, obsolete*), or social usage (e.g. *formal, colloquial*) of single words. It usually involves stating valid usage conditions or the contextual restrictions of a word. This type of information can also include the usefulness of a certain word for achieving a goal in some type of interactional context.

Depending on the dictionary, its purpose, and targeted user group, pragmatic information may be formulated in the dictionary entry in different ways. Recently, Collins Cobuild 5, in an effort to enrich pragmatic markers in their dictionary, extended this type of information even further, and established category labels such as *approval, disapproval, emphasis, feelings, formulae, politeness, and vagueness* to indicate the speaker's goal when using a word. For example, a word is labeled with *approval* when it is used to show that the speaker approves of the person or thing that he/she is talking about. A word is labeled with *feelings* when the speaker uses it to express his/her feelings about something or towards someone. The dictionary entries in Figure 58 show that *angelic* is used to indicate approval, whereas *angel* indicates both feelings and approval. This information is given in the Extra Column.



Figure 58. Dictionary entries in COBUILD 5

As for terminology, the codification of pragmatic information in specialized language units has not been explored until very recently in an effort to account for terminological variation and its causes (e.g. Bourigaut and Slodzian 1999; Faulstich 2000; Freixa 2006; Seibel 2004ab). However, such information is rarely included in term entries in terminological resources.

Much of the work in Cognitive Linguistics has implicitly focused on lexical pragmatics. As previously mentioned, Cognitive Linguistics does not distinguish between semantics and pragmatics, and regards word meaning as essentially pragmatic. Lexical pragmatics is largely based on the premise that the meaning of words in use is underdetermined by the semantics of the lexical items involved, and has to be inferred in context (Unger 2005; Blutner 1998). Thus, the meaning communicated by the use of a word is context-dependent to a greater or lesser degree. Since words have underspecified meaning representations, they reach their full-fledged meanings in contexts through considerable pragmatic inference.

This is especially true of generic concepts such as “sensible”, which has different meanings, depending on who or what is “sensible”, and who is the speaker is. For example, in a “sensible woman”, *sensible* describes a woman perceived as having common sense or reason. A “sensible skirt” is a little more complicated because it does not refer so much to a skirt as to the person wearing the skirt. This unattractive garment, because of its fabric, durability, or length causes its wearer to be perceived as practical. Thus, in the same way, as “sensible shoes”, the characteristics of the piece of clothing reflect mental characteristics of the person wearing it. However, in “sensible environmental laws”, the plot thickens because the perception of what is sensible in this domain depends on the speaker. “Sensible environmental laws” would have a radically different meaning, depending on whether the speaker is the president of British Petroleum or a member of Greenpeace. Thus communicative context is often an extremely important factor in meaning representation.

Although the tendency in General Terminology Theory was initially to ignore context and contextual variables as well as the terminological variation that they produce, it soon became apparent that specialized terms are lexical items that are used in communicative contexts, and that these contexts can affect their potential meaning. The importance of the communicative nature of terminology has been underlined by Sager (1990, 1993), Gambier (1993), Wußler (1997) and Cabré (1999, 2000a). In fact, one of the major objectives of the *Communicative Theory of Terminology* (Cabré 1999, 2000ab, 2001ab) is to account for the way in which specialized knowledge units fulfill a specific function in an act of communication within a specific knowledge, situational, and cultural context.

It has often been asked why there is so much terminological variation, when the desired objective of specialized communication is precisely the opposite (Bowker and Hawkins 2006). In fact, despite emphatic assertions to the contrary, specialized texts abound with examples of terminological variation. Sager (1993) laments the fact that so little research has been carried out on this phenomenon in specialized language. The

reason perhaps lies in the fact that specialists in the field, who can distinguish between the variants of a term, are usually not interested in this type of work, or are linguistically unprepared for it. On the other hand, linguists, who wish to take on such a task, often lack sufficient knowledge of the specialized field, and thus are unable to determine regularities that underlie processes of variation in specialized communication.

Although specialized language initially aspired to the ideal of having one linguistic designation for each concept with a view to imbuing specialized communication with greater precision, reality has turned out to be quite different. The same concept has often given rise to many different types of linguistic designations. A case in point is the concept of HIGH-DOSE CHEMOTHERAPY in the domain of medicine (Figure 59) or ABS BRAKE SYSTEM in the domain of car mechanics (Figure 60).

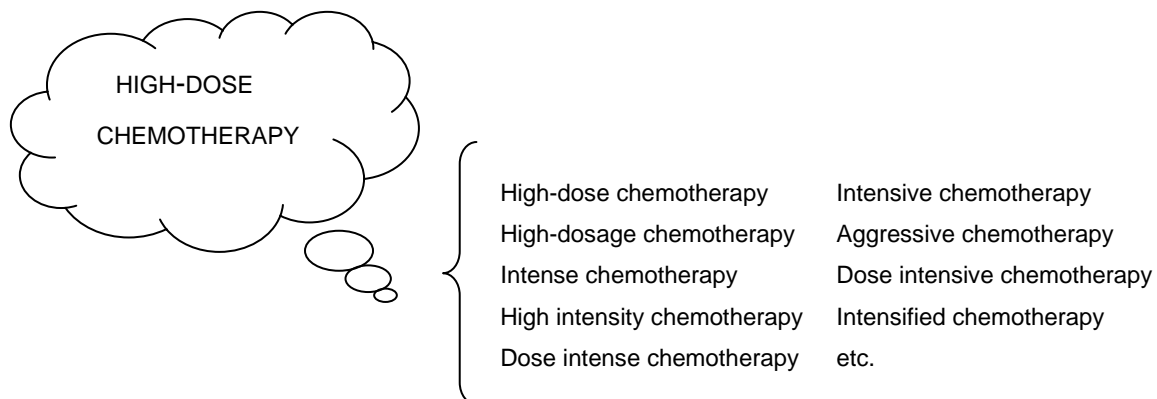


Figure 59. Designations for HIGH-DOSE CHEMOTHERAPY

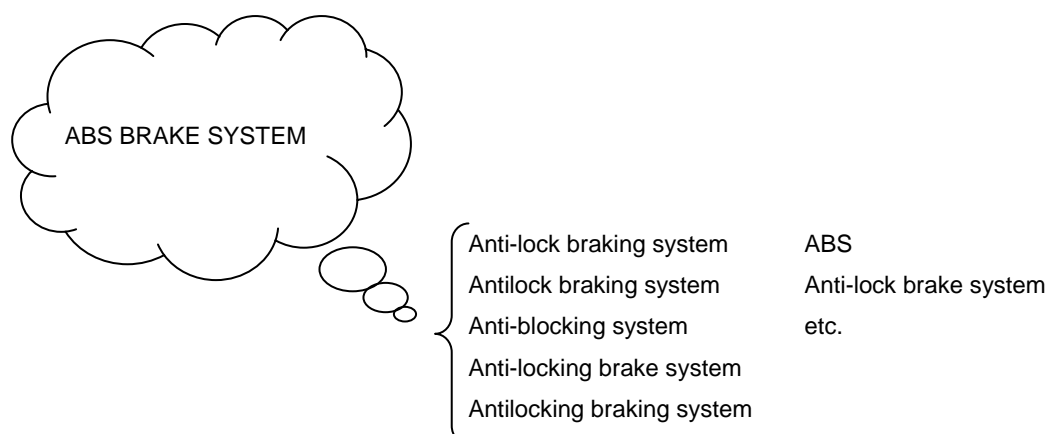


Figure 60. Designations for ABS BRAKE SYSTEM

The fact that there are so many designations for the concepts of chemotherapy administered in large quantities or ABS brake system are two examples of the proliferation of terms referring to the same idea. Although in the same way as in general language, it is possible to establish reasons for terminological variation based on user-based parameters of geographic, temporal or social variation or usage-based

parameters of tenor, field, and mode (Gregory and Carroll 1978), this is not the whole story.

Faulstich (1998) underlines the need to analyze terms both synchronically and diachronically with a view to systematizing terminological structures which change over time. This would reconstruct the conceptual structures of the period of time analyzed.

However, terminological variation occurs for reasons that are often considerably more complex and difficult to explain. Freixa (2006: 52) classifies causes for terminological variation in the following categories:

Dialectal	⇒	Caused by different origins of the authors
Functional	⇒	Caused by different communicative registers
Discursive	⇒	Caused by different stylistic and expressive needs of the authors
Interlinguistic	⇒	Caused by contact between languages
Cognitive	⇒	Caused by different conceptualizations and motivations

Along with dialectal variation resulting from geographic, temporal, and social contexts, she also mentions functional, discursive, interlinguistic, and cognitive variation. Functional variation basically refers to registers described in terms of field, tenor, and mode. Discursive causes for variation are linked to style and include the use of terminological variation in order to avoid repetition, whereas interlinguistic variation may occur when a language is in close cultural contact to another. This type of contact foments the coexistence of a term and a loanword, which in Spanish is the case of *voleibol* (English loanword) and *balonvolea* (Spanish term), both of which compete in Spanish as terms for the sport of volleyball. Finally, cognitive reasons may generate terms that represent different perspectives or even different ideologies, According to Freixa (2006: 65), this is reflected in the creation of euphemisms for negative concepts (e.g. *staff downsizing*, *redeployment of labor*, *staff slimming*, etc. instead of *layoff*).

Nevertheless, there are certain types of variation that do not appear to fall into any of these categories such as morphological variants, orthographic variants, ellipted variants, abbreviations, graphical variation, variation by permutation, etc. (Bowker and Hawkins 2006: 81). Their use in texts often seems to be random and not to respond to any pattern or regularity. Without a doubt, a more in-depth study of the pragmatic dimensions of terms is necessary to detect possible reasons behind terminological variation.

3.2.4.1 Pragmatic dimensions of terms

The pragmatic dimensions of terms or specialized language units are those specifically pertaining to the use of utterances in oral or written texts. These dimensions include frame, situational context, and construal, which by no means should be regarded as water-tight compartments. Terms belonging to different levels of specialization and knowledge fields access different conceptual configurations or frames, and appear in a given text type, which takes place in a given setting or situational context to satisfy different user needs. The text sender configures his/her discourse with a purpose in mind and construes the information for a targeted group of text receivers. If the text achieves its purpose, user expectations are fulfilled by the speech act dominating the text.

To a great extent, the success of the specialized communication act is conditioned by the terms selected and the receiver's ability to make the right inferences and correctly interpret this information. It inevitably depends on the ability of the sender to correctly judge the knowledge that he/she shares with the text receivers as well as and the receivers' identity and location in time and space. As a result of these predictions and expectations, the sender chooses the terms to be used, and configures them to transmit a message in consonance with his/her interactional goals.

Frame

Within this context, *frame* refers to the conceptual network that any given term gives access to (see Chapter 3.1). The information in this network is the source of the underspecified meaning, whose peacock feathers are displayed in all their glory when the term is activated in a specific context. However, not all knowledge that is accessible through a term has equal standing. Certain aspects are more central than others.

According to Langacker (1987), there are four types of encyclopedic knowledge associated with a word: (a) conventional; (b) generic; (c) intrinsic; (d) characteristic.

- *Conventional knowledge* is the extent to which a particular facet of knowledge is shared within a linguistic community.
- *Generic knowledge* refers to the degree of generality associated with a particular word.
- *Intrinsic knowledge* refers to the aspect of word meaning that makes no reference to entities external to the referent.
- *Characteristic knowledge* refers to the aspects of the encyclopedic information that are characteristic of or unique to the class of entities that the word designates.

This classification can also be applied to specialized language. A case in point is the specialized concept of EROSION, which refers to the displacement of solids usually by agents such as wind, water, or ice by downward or down-slope movement. In this sense, it is a process that is induced by an agent, and which affects a specific geographic or inanimate entity. Any process takes place over a period of time, and can be divided into smaller segments. In this sense, erosion can happen at a specific season of the year, and may take place in a certain direction.

According to Evans and Green (2006: 217), conventional knowledge is widely known and shared among members of a speech community. For example, conventional knowledge about erosion includes the fact that it moves soil and rock, and can leave its mark on the earth's surface, eventually carving out holes as big as the Grand Canyon. Non-conventional knowledge about erosion might include the fact that last summer you went to the beach in Malaga and found that half of the sand had been washed away because of a severe storm the previous month.

Generic knowledge is often also conventional because it can be applied to many instances of a particular category. For example, generic knowledge is that every minute of every day, the Earth is being changed by erosion. This knowledge applies to all types of erosion (water, wind, glacier, sea, and soil), and thus can be regarded as generic.

Intrinsic knowledge refers to the internal properties of an entity. The most Intrinsic property of erosion is the fact that it is a process, which may occur naturally or artificially. This means that it takes place over time, and can be divided into phases.

Characteristic knowledge is the degree to which knowledge is unique to a particular class of entity. For example, erosion is initiated by an agent (i.e. water, wind, glaciers, or sea). However, glacier erosion is less characteristic than water or wind erosion since most people may live all their lives without ever catching a glimpse of a real glacier. In contrast, the effects of water and wind erosion can be easily perceived, and are obvious in everyday geographic contexts.

Encyclopedic knowledge is the result of the interaction of these four types of knowledge. However, according to Cognitive Linguistics, there is no pragmatic meaning as such because the selection of encyclopedic meaning is informed by contextual factors (Evans and Green 2006: 220), and is thus always a function of context.

The meaning of a word is constructed on-line as a result of contextual information, and is thus modulated by context. Evidently, in the following examples, *erosion* is understood in different ways.

Context:

(177) **Erosion** is an intrinsic natural process but in many places it is increased by human land use. Poor land use practices include deforestation, overgrazing, unmanaged construction activity and road or building. Land that is used for the production of agricultural crops generally experiences a significant greater rate of erosion than that of land under natural vegetation

Erosion is a natural or human-induced process affecting the Earth.

Contexts:

- (178) Cervical **erosion** occurs when the cervix is scraped, perhaps during intercourse or by an intrauterine device, or IUD.
- (179) Dental **erosion** is the chemical or mechanicochemical destruction of tooth substance, which leads to the creation of concavities of many shapes at the enamel junction of teeth.

Erosion is a medical condition affecting the human body.

Context:

(180) Market share **erosion** and declining street prices are evidence that channel conflict is becoming destructive. Channels are responding to excessive competition by deemphasizing the brand or by giving away too much in order to keep an account

Erosion is a stock price reduction and indicative of financial crisis.

The examples show the modulation of the meaning of erosion in different specialized contexts, which by means of metaphorical extension, situates the term in different specialized domains, such as environmental science, medicine, or finance. The context activates certain segments of the frame of *erosion*, whereas other parts are not activated. For example, in the preceding examples in which erosion affects the cervix (178) and teeth (179), or the stock market (180), the most basic meaning of erosion is extended to these contexts. In (178) and (179) the tooth or the cervix has been reduced or modified as a result of the particles displaced by an unspecified agent. In (180), typical of the financial sector, market share erosion also refers to a reduction process, but this time the focus is more on the cause, which are the negative events that affect the economy.

Context

Context is one of those words, for which there is no universally accepted definition. According to Akman and Surav (1997), “denotation of the word [*context*] has become murkier as its uses have been extended in many directions and deliver the now widespread opinion that context has become some sort of conceptual garbage can”.

Here, context is regarded as a product of language use (see 4.1). Communication (and specialized communication as well) can thus be said to create contexts, and at the same time be context-dependent (Bateson 1972). In specialized language, context can be conceived as a *relational construct* in the sense of Fetzer and Akman (2002), which relates the specialized communication act to its surroundings and participants. It also helps to anchor linguistic designations to objective reality by providing background information. This situates the objects designated, and explicitly relates them to each other as well as to the agents that use them and act on them.

An optimal specialized language context is one with a high level of informativity (i.e. a knowledge-rich context), which provides relevant information about the specialized knowledge concept. It should also make explicit the pragmatic "situatedness" of the communicative act (Bach 1994; Cappelen and Lepore 2005; Mey 2001).

According to Evans (2008) the notion of context, must include, at the very least all of the following:

- the other words that make up the utterance itself;
- the background knowledge shared by the speaker and hearer;
- the physical venue, and temporal setting of the utterance;
- the communicative intention of the speaker as recognized and interpreted by the hearer in service of facilitating the interactional goals.

Even though ambiguity is eschewed in scientific texts, and text senders generally try to be as clear and informative as possible, the text (as a written or spoken message) never tells the whole story. Evidently, there is a great deal of meaning implicit in the situational context of the specialized communication event itself. In this respect, the analysis and subsequent structuring of information as represented by specialized knowledge units are motivated by a wide range of factors, such as the knowledge level, intentions, and expectations of the text sender, textual content, form, and function of the text itself, the assumed knowledge level of the text receivers and

their ability to make inferences, norms of stylistic and textual acceptability in the specialized text system, etc, which are all part of the process.

Texts as contexts

The first component of context mentioned by Evans is that provided by “the other words that make up the utterance itself”. This corresponds both to the encyclopedic information accessed by the term as well as the utterance context in which it appears. Evidently, terminological context is provided by the immediately surrounding text, as well as the text as a whole. To a certain extent, a context reflects the text sender’s intentions as well as his/her predictions of shared knowledge. Terminological contexts provide a better understanding of specialized knowledge units, and can be even more informative than meaning definitions. For example, the definition of the drug Ranitidine, is the following:

(181) **Ranitidine:** a histamine blocker $C_{13}H_{22}N_4O_3S$ that is administered in the form of its hydrochloride to inhibit gastric acid secretion (*Merriam-Webster Online Dictionary*).

Since the definition limits itself to the most basic information, the receiver only acquires a limited knowledge of the properties of the drug, such as its chemical composition and effect. However, the following excerpt (182) from a research article situates ranitidine in a more explicative context,

(182) Ranitidine hydrochloride (Zantac®) is a histamine 2-receptor antagonist (H2RA) medication used in peptic ulcer disease therapy, acute stress ulcers, gastroesophageal reflux and related disorders. This medication is often used intravenously in the operating room and during recovery in surgical departments or intensive care units, and orally in medical departments (Oliva et al. 2008).

The reader is provided with information not only about the type of medication, but also about the diseases that Ranitidine treats as well as its form and place of administration. This is why contextual information is important in any type of terminological database as a means of supplementing and enhancing definitions, and adjusting them to the user group targeted by the specialized language resource.

Context as a way to achieving interactional goals

Although the standard text function for scientific and technical texts is the informative function, this is certainly not the only one. In a specialized text, priorities are often centered on not only transmitting, but often justifying or arguing for the validity of the technical and scientific information within the text. The language used should

implicitly assert and guarantee the reliability of the information in the text. In other words, the text format and content should establish a context of complicity, which is geared to gaining the receivers' confidence and trust.

One way of establishing such a context and conveying the impression of reliability and trustworthiness is the precise use of terminology at the right level of specificity so as to convey the message in a clear, direct way. This is an implicit statement that the author of the text is an expert on the subject and is transmitting relevant information. When done well, this strategy can be extremely successful because it implicitly transmits the message that the text sender knows what he/she is talking about, as is obviously the case in the following introduction to a research report:

(183) Many climate studies have examined trends in quantities such as temperature, precipitation, and carbon dioxide (CO₂) based on time series of data collected over the last 50 to 100 years (e.g., Cayan et al., 1998; Peterson and Vose, 1997; Keeling and Whorf, 1998). These studies frequently include time-series plots showing, for example, increases since the middle of the twentieth century. In some cases, these figures include trend lines or smoothed curves to highlight the nature of a particular trend.

The statistical strength or weakness of any such trend is usually detailed in the paper. However, it is not uncommon for a graph of an especially newsworthy trend to be reproduced in the media. [...] While trends published in scientific articles have undergone review for scientific and statistical robustness, it is easy for the untrained eye to see apparent trends in other similar, relatively short time series that may not be real. The aim of this paper is to examine the apparent trend in a simulated annual climatic time series using random numbers (Comrie 2008).

Example (183), irrespective of its conceptual content, is an example of the introduction of a well-written scientific research report. The author makes a basic assertion, which is backed up by previous studies. He succinctly presents a problem of the existence of both real and apparent trends in climate data. At the end of the paragraph, he states the aim of his paper, which is to carry out a study in which random numbers will be used instead of actual data to see whether or not any trends appear.

The clear and coherent structure of his text, which goes from a general assertion to specific examples, and uses preferentially strong verbs instead of the passive voice makes the information clear even to a non-scientist. This perception is made stronger by coherent series of terms activating the knowledge fields relevant to the study. For example, *temperature*, *precipitation*, and *carbon dioxide* from the field of meteorology combine with *time-series plots*, *trend lines*, *smoothed curves*, and *robustness* from the

field of statistics to help the receiver situate the knowledge accessed by the terms and create a context for its convergence.

However, in poor scientific writing, such a strategy is often overdone. Long sentences combined with an abstruse labyrinth of conceptual mumbo-jumbo cause a breakdown in communication and produce precisely the opposite effect. This is what occurs in the following text on the electrical breakdown of nitrogen:

(184) The goal of the work was to confirm the nature of electrical breakdown of nitrogen in uniform fields at high pressures and electrode gaps which approach those obtained in engineering practice, prior to the determination of the processes which set the criterion for breakdown in the above-mentioned gas in uniform and non-uniform fields of engineering significance (Example taken from Alley 1996: 86).

Although in (184) the information is all there and there are no grammatical errors, by the time the text receiver arrives at the second *which*, he/she is cognitively exhausted. Even expert engineering knowledge cannot save the day when the linguistic context makes the meaning of the text so difficult to understand. When syntactic subordination is conducive to a spider web of garden paths, the reader may throw in the towel and decide that the text is not worth the effort.

However, for the textual context to achieve all of its communicative objectives, coherent semantic and syntactic structures are just one of the ingredients. The information must also be packaged in an acceptable (and attractive) format. In this sense, the text can also be regarded as a visual object. When successfully processed by the text receiver, the salient features of the text-object should correspond to and resemble those of a similar text profile stored in the receiver's long-term memory. In fact, this is an extremely powerful inference-making mechanism, which transfers all of the properties of the stored text profile to the text-object being perceived. Often, this type of resemblance is responsible in itself for the success of the communication act since it automatically fosters the text receiver's belief in the authority of the message source and the veracity of its contents. This "leap of faith" on the part of the receiver can even take place when the communicative goal of the sender is deception, and the message is totally false.

For example, this is the strategy used in *phishing* e-mails written by people, whose primary interactional goal is to deceive readers into surrendering their bank account information by making them believe that the message was emitted by a prestigious source. An example of such an e-mail is the following:

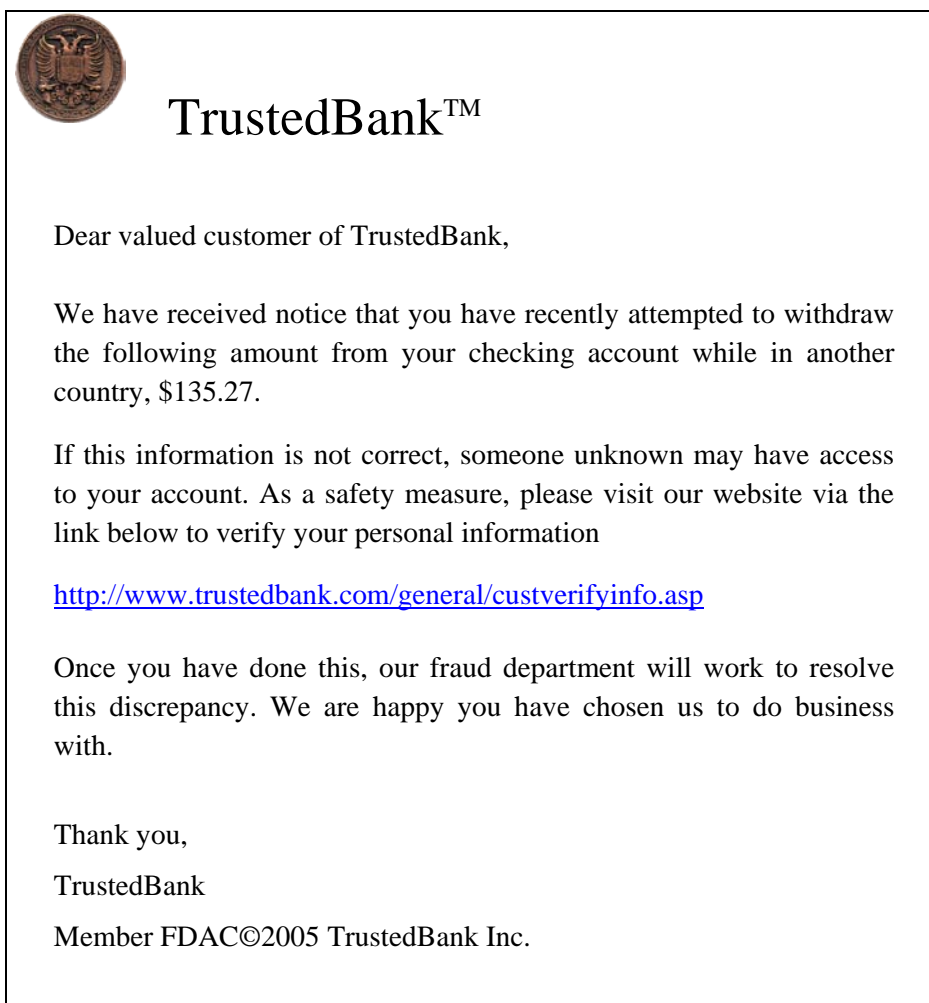


Figure 61. Example of a phishing e-mail

Receivers are lulled into a trusting mode because the elements in the text lead them to believe that the text source is a prestigious financial institution. This belief is inspired by text format, symbols (a logo), a website address, a precise numerical figure, and linguistic elements and structure, responding to an appropriate interactional frame for this type of formal communication.

An even more eloquent example of how language, textual form, and terminology can lend authority and credibility to utter nonsense is the famous spoof scientific paper, "The Endochronic Properties of Resublimated Thiotimoline", written by Isaac Asimov in 1948. Example (185) is an excerpt from the text.

(185) The correlation of the structure of organic molecules with their various properties, physical and chemical, as in recent years afforded much insight into the mechanism of organic reactions [...].The solubilities of organic compounds in various solvents has become of particular interest in this connection through the recent discovery of the endochronic nature of thiotimoline (Asimov 1972: 111).

The article, which describes experiments on thiotimoline, a totally fictitious chemical compound, has the format as well as the syntactic and semantic characteristics of a serious research article. It even includes charts, graphs, tables, and citations of fake articles in nonexistent journals. The results presented in the tables verify the patently absurd hypothesis that thiotimoline is so soluble that it dissolves in water 1.12 seconds *before* it even comes in contact with water.

(186) Feinschreiber and Hravlek in their studies on the problem have contended that with increasing hydrophilism, the time of solution approaches zero, That this analysis is not entirely correct was shown when it was discovered that the compound thiotimoline will dissolve in water – in the proportions of 1 gm./ml. – in *minus* 1.12 seconds. That is, it will dissolve *before* the water is added (Asimov 1972: 111).

Evidently, if the absurd assertion, which is formulated quite directly in (186), had been made outside the context of an extremely specialized scientific paper, and had not been backed up by the impressive display of (false) experimental results, it would have been questioned by anyone with the slightest degree of common sense. However, despite the fact that the text was published in a journal titled *Astounding Science Fiction*, the article was so convincing that a great many readers were persuaded of the veracity of the information (which given the title of the journal was rather astonishing). In fact, after the article was published, the New York City library was bombarded with inquiries from people, who wished to have access to the (nonexistent) journals cited in the article. Asimov's text is a perfect example of a scientific article in every way except for the fact that the information contained in it is absurd. It is also an example of how a suitable linguistic and textual context can be sufficient in itself to provide guarantees of the validity and reliability of textual content.

Construal

Construal is related to speaker perspective, the speech act involved, and the communicative intention of the sender when he/she uses one term instead of another with a similar meaning. As such, it is closely related to the status, shared knowledge, intentions, and expectations of the participants.

Many specialized texts are written by experts for a group of receivers with some level of specialized knowledge. The amount of presupposed knowledge is implicit in the extensive use of terms without definitions. In the case of specialized communication, the existence of a nomenclature (terms and standardized expressions that the sender knows that the receiver will recognize and understand) is indicative of this assumption of shared knowledge. However, in the popularization of scientific knowledge, the same text can be construed in another manner for another set of receivers with less

specialized knowledge. This alternate construal is evident in the use of more general, superordinate terms belonging to the same category.

For example, specialized oncology texts (written for doctors) on chemotherapy treatments for lung cancer may name combinations of drugs (*etoposide, cisplatin, carboplatin, cyclophosphamide, etc.*). The same information formulated for patients remains at the level of the superordinate term (*drug*) since it is the most basic level.

SPECIALIZED MEDICAL TEXT [INFORMATION FOR DOCTORS]	NON-SPECIALIZED MEDICAL TEXT [INFORMATION FOR PATIENTS]
<p>CHEMOTHERAPY</p> <p>↳ COMBINATION</p> <p>CHEMOTHERAPY</p> <ul style="list-style-type: none"> → EP } [etoposide, cisplatin] → EC } [etoposide, carboplatin] → CAV } [cyclophosphamide, doxorubicin, vincristine] → CAE } [cyclophosphamide, doxorubicin, etoposide] → ICE } [ifosfamide, carboplatin, etoposide] 	<p>CHEMOTHERAPY</p> <p>↳ drug</p>
<p>Combination chemotherapy with one of the following regimens and chest irradiation (with or without PCI given to patients with complete responses): The following regimens produce similar survival outcomes: EP or EC: etoposide + cisplatin or carboplatin [17,18] CAV: cyclophosphamide + doxorubicin + vincristine [19] CAE: cyclophosphamide + doxorubicin + etoposide [20] ICE: ifosfamide + carboplatin + etoposide[21]</p>	<p>Chemotherapy is the most common treatment for all stages of small cell lung cancer. Chemotherapy may be taken by pill, or it may be put into the body by a needle in the vein or muscle. Chemotherapy is called a systemic treatment because the drug enters the bloodstream, travels through the body, and can kill cancer cells outside the lungs, including cancer cells that have spread to the brain.</p>

Table 35. Chemotherapy texts for doctors and patients

Exactly the same thing occurs in the case of terms belonging to other conceptual categories such as parts of the human body, or in this case, lung parts. In

the section of the text on the areas of the lung affected by the malignant tumor, the specialized version of the text presupposes that the text receiver possesses sufficient anatomical knowledge to be able to understand the text without any problems. When the text is construed for patients, there is no presupposed knowledge. This means that all of the terms refer to concepts at the basic levels of the conceptual system.

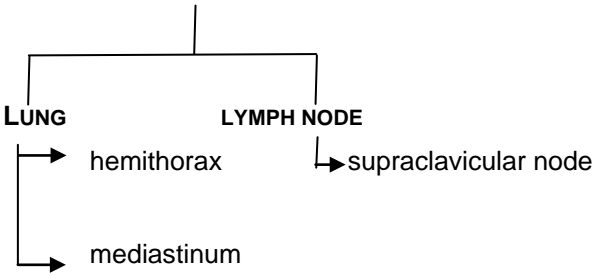
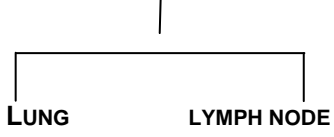
SPECIALIZED MEDICAL TEXT [INFORMATION FOR DOCTORS]	NON-SPECIALIZED MEDICAL TEXT [INFORMATION FOR PATIENTS]
<p style="text-align: center;">BODY PARTS</p>  <pre> graph TD BP[BODY PARTS] --> L[LUNG] BP --> LN[LYMPH NODE] L --> H[hemithorax] L --> M[mediastinum] LN --> SC[supraclavicular node] </pre>	<p style="text-align: center;">BODY PARTS</p>  <pre> graph TD BP[BODY PARTS] --> L[LUNG] BP --> LN[LYMPH NODE] </pre>
<p>Limited stage small cell lung cancer means tumor confined to the hemithorax of origin, the mediastinum, and the supraclavicular nodes, which is encompassable within a "tolerable" radiotherapy port.</p>	<p>Limited stage Cancer is found only in one lung and in nearby lymph nodes. (Lymph nodes are small, bean-shaped structures that are found throughout the body. They produce and store infection-fighting cells.)</p>

Table 36. Lung cancer texts for doctors and patients

As shown in Table 36, the text for doctors frequently uses very specialized anatomical terms without any sort of explicative context (e.g. *hemithorax*, *mediastinum*, *supraclavicular lymph nodes*.), whereas the text for patients even defines basic terms such as lymph node.

Each term can be said to contain the pragmatic feature of its membership in a particular domain, and refers either implicitly or explicitly to other related terms, as well as to the whole structural configuration of the domain. Both texts represent alternate construals of the same information. In specialized language, construal or speaker perspective often reflects the knowledge shared by the participants in the act of communication. This signifies that texts can be transmitted in two very different ways depending on the presupposed knowledge of the text receivers.

Another way that construal can be understood is through the use of specialized language as a way of conveying ideology. This can be seen in the text in (187), which is a description of alternative type of cancer therapy within the context of Ayurveda or Indian medical science.

(187) The Ayurvedic Approach to Healing

The physical level

Ayurveda approaches the patient on several levels of causes, including physical, emotional and spiritual. The most superficial level is approaching the symptom, which is the tumor itself. [...]

The practitioner must also decide if the patient requires tonification or purification therapy. Strong patients with **ama** require purification therapies [...] Purification therapies reduce **ama** along with excess **dosha**. By cleansing the **srotas** and the subtle **nadis** of the body, **prana** can flow freely and support the healing process.

Purification is a reducing therapy, reducing the **dhatu**s of the body as well as the **doshas**. Since this weakens the body, it should only be performed in patients who are strong enough. Purification therapy can be similarly viewed as cytotoxic, meaning it destroys cells. When applied properly, cellular destruction is directed primarily toward the cancerous cells.

[\[http://www.ayurvedacollege.com/AyurvedaandCancerPartIII.htm\]](http://www.ayurvedacollege.com/AyurvedaandCancerPartIII.htm)

As shown in (187), the terms used in the text (*ama*, *dosha*, *prana*, etc.) encode specialized knowledge as well as the author's ideology regarding healing the human body. The medical text, which describes how to treat and alleviate malignant tumors, is evidently construed for those who believe in natural medical treatments, and who are familiar with the knowledge represented in the text. The Hindu terms without any definition stand in evident contrast to "cytotoxic", a more conventional medical term, which does appear in the text with an explanation even though it is more transparent than the others.

In (188), the use of Ayurvedic terminology in the form of loanwords gives the text message an almost religious dimension. Besides conveying the principles of Vedic knowledge inherent in the terms, it also is a signal of the ideological content of the text, which has the quality of an incantation and seems to convey the implicit promise of healing. The following segment of the text in which English terms are substituted for the Hindu loanwords does not produce quite the same effect:

(188) The practitioner must also decide if the patient requires tonification or purification therapy. Strong patients with **toxins** require purification therapies [...] Purification therapies reduce the **toxins** along with excess of **disease-causing agents in the body**. By cleansing the **body channels** and the subtle **pulses** of the body, **life force/cosmic energy** can flow freely and support the healing process.

The text excerpt in (188) has been cleansed of terms with a clear ideological content, and thus can be said to have a somewhat different construal.

3.2.5 Summary

This chapter has offered a description of sociocultural and cognition-oriented pragmatics, and has explained how both perspectives can be applied to specialized language within the context of Cognitive Linguistics. The reasons for terminological variation, either in the case of individual terminological units or entire utterances, can be found in the analysis of situational parameters, such as frame, context, and construal.

Since terminological units are specialized language representations, the concept of frame is especially relevant as the conceptual network accessed by a term. Such core knowledge can be analyzed in terms of the four types of encyclopedic knowledge specified by Langacker (1987), and is the source of the underspecified meaning of a term, which acquires its full dimensions within a specific context.

Context is a product of language use, and very useful in Terminology as a way of representing the meaning of specialized knowledge units. In this sense, contexts can be either knowledge-rich or knowledge-poor, depending on the information contained. However, contexts are also a means to achieving interactional goals. This applies to both the language and the structure of the text. The text sender's use of terminology as well as his/her choice of text format can be a statement in themselves, and stand as a guarantee of the reliability and veracity of a text. Construal is related to the speaker's perspective, and is reflected in the way a text sender formulates his/her message for one group of receivers or another. Specialized texts can be construed in a variety of different ways for receivers with different levels of technical or scientific knowledge. A specialized text and the terms in it may also reflect the ideological stance of the text sender.

4 Contextual information in specialized knowledge representation: linguistic contexts and images

The notion of *context* has been extensively debated in Pragmatics, Linguistic Anthropology, and Artificial Intelligence. Different research traditions refer to context in relation to *speech acts* (Austin 1962; Searle 1969), *conventions* (Gadamer 1995), *maxims* (Grice 1975), *Relevance Theory* (Sperber and Wilson 1986, 1995), *framing* (Goffman 1974), and *common sense* (Clark 1996), among others. Although context has been defined in different ways, all of the definitions coincide in regarding context as dynamic rather than static. Thus, context includes external factors (situational and cultural) as well as internal cognitive factors, all of which can influence one another (House 2006: 342). This view goes hand in hand with the perception of language as a kind of action, where the meaning of linguistic forms is understood as a function of their use.

In contemporary Terminology, from a theoretical and methodological point of view, concepts should be studied in a contextual perspective. New proposals agree that specialized lexical units appear in particular communicative settings, and therefore, are subject to pragmatic constraints (Cabré et al 2001a: 306). Lexical units are only granted terminological value when the communicative setting and the sender's intentions activate a specific scenario, in which a text is directed towards a group of receivers with a given level of background knowledge. Specialized language resources should thus satisfy not only the communicative expectations of the users, but also their cognitive expectations. Consequently, they should offer users the terminological units that they need as well as provide them with a knowledge load that corresponds to their needs (Tarp 2005: 8-9).

However, in applied Terminology, the notion of context often refers to a textual excerpt selected according to syntactic criteria to the exclusion of any semantic and pragmatic analysis. For the creation of terminological knowledge base, this notion is too simplistic. Contexts should be studied from a more integrated approach, such as that offered by Cognitive Linguistics and Frame-Based Terminology, in which there is no boundary between the semantic and pragmatic components of language. Specialized knowledge should thus be acquired in context, more specifically, within a frame or template that includes both semantic and pragmatic information (Reimerink, García de Quesada and Montero Martínez 2010).

This chapter illustrates the usefulness of multimodal contextual information composed of both linguistic contexts and images. In this respect, definitions that effectively combine visual and verbal information have great potential. As shall be seen, the EcoLexicon knowledge base also includes combined visual and textual contexts to represent the relations between processes within the same event, and which as many terms as possible are related.

4.1 Contextual selection for term entries

Arianne Reimerink

Mercedes García de Quesada

Silvia Montero Martínez

4.1.1 Introduction

In the construction of terminological resources, the notion of *context* is reflected in many different ways. From a theoretical and methodological point of view, specialized knowledge concepts should be studied from a contextual perspective in real communicative settings. However, in most terminological resources, when terms are shown in context, *context* normally takes the form of a more or less randomly chosen sentence which includes one of the terms of the database. Although contextual information is often included in term entries, many contexts are not productive because they bear little relation to the information in meaning definitions or the graphical information in the entry. As such they do not achieve the primary objective of a context, which is to widen the knowledge horizon of the users.

In a domain-specific resource, an adequate terminological context should facilitate knowledge acquisition for the users. In this sense, knowledge-rich contexts should be selected that link all the information within the term entry to the domain event. Since this is a cognitive process, it is thus logical to adopt a cognitive perspective towards context selection.

This chapter illustrates the fact that contexts should be carefully chosen since all contexts are not appropriate for inclusion in a terminological knowledge base. For a context to be truly helpful, it should make explicit the relation between the concepts in the context as well as between the context and the concept entry. It should also contain information that does not replicate the information in the core definition of the concept.

4.1.2 Context and meaning construction

Since users of terminological knowledge bases consult specialized knowledge resources to learn something quickly, term base design should help the user activate *mental spaces* or temporary cognitive structures created during the on-line process of meaning construction. Term bases should also facilitate the creation of links between

mental spaces so that the user can conceptualize new information and arrive at a partial mental representation of a specialized domain.

According to Fauconnier (1994) information at the referential level is underspecified by linguistic information. Meaning construction relies on an elaborate system of “backstage cognition” (background knowledge) to fill in details unspecified by grammar. Consequently, when users read the definition of a concept, it should describe the most general meaning that is applicable in the widest range of communicative settings. This meaning should help term base users build a generic mental space by enabling them to combine their background knowledge with the new information in the definition of the concept. This generic space provides information that is common to both the input of background knowledge and the input space of the definition (Evans and Green 2006: 404).

However, a meaning definition is generally not sufficient in itself to give users an understanding of the term in context. Contextual information aids comprehension because it allows users to view the behavior of a term in a specific communicative setting. In this way, properly selected contextual information permits users to create a blended space conducive to understanding. It also reflects how the term is used in specialized texts.

As previously mentioned, the selection of contextual information should be in consonance with the needs of term base users. According to Fauconnier and Turner (in Evans and Green 2006: 418), conceptual blending allows users to grasp an idea by viewing it in a new way and reducing its complexity to human scale, namely, the scope of human experience (see 2.2.4.1 and 2.3.2.2). This reduction of complexity is achieved by what they refer to as a compression of vital relations.

A vital relation is a link that matches two elements or properties in different mental spaces. Examples of vital relations and their compressions are summarized in Table 37 (Evans and Green 2006: 425). Outer-space relations relate two elements that are in different input spaces. Vital relations can be compressed in the blend. The blend “tightens the connection” that holds between the elements in the outer-space relation. These compressions are called inner-space relations (Evans and Green 2006: 420).

Summary of vital relations and their compressions	
Outer-space vital relation	Inner-space vital relation (compression)
Time	Scaled time Syncopated time
Space	Scaled space

	Syncopated space
Representation	Uniqueness
Change	Uniqueness
Role-value	Uniqueness
Analogy	Identity Category
Disanalogy	Change Uniqueness
Part-whole	Uniqueness
Cause-effect (bundled with time and change)	Scaled time Uniqueness
Cause-effect	Property

Table 37. Summary of vital relations and their compressions (Evans and Green 2006: 425)

An example of how this meaning construction process works through the compression of vital relations is the following:

As we went to press, Rich Wilson and Bill Biewenga were barely maintaining a 4.5 lead over the ghost of the clipper *Northern Light*. (Fauconnier and Turner 2002: 64).

This example is from a 1993 news story in which a catamaran follows a route from San Francisco to Boston, where a clipper called *Northern Light* had held a time record since 1853. In the created blend space, the two input spaces (the one of the catamaran in 1993 and the one of the clipper in 1853) are compressed so that both events are viewed as simultaneous. The outer-space relation, *time*, is compressed by syncopation. The outer-space relation, *space*, is also compressed so that the two boats follow the same course. It is thus possible to talk about the clipper ‘catching up with’ and even ‘overtaking’ the catamaran (Evans and Green 2006: 421).

This chapter explores how contextual information in a specialized language resource can help to create blend spaces in the mind of text receivers, guiding them through links that are based on the vital relations as defined by Fauconnier and Turner. Some of these relations have been found to be more useful than others for specific kinds of concept, while others are useful for all types. As shall be seen, the outer-space relations, *representation* and *analogy*, which are compressed in the inner-space relations, *uniqueness* and *identity*, are applicable to states, events, and properties. However, the outer-space relations, *time*, *space*, *cause-effect* and *change*, are more useful in the case of events, as shown in the boat race example.

4.1.3 Context selection

An effective context in a specialized knowledge resource is one that helps users to create mental spaces through blending. Such a context provides the means to construct a partial mental space for the specialized domain that users wish to know more about. Therefore, the contexts for a term in the knowledge base must be selected according to one of the following premises:

1. The context is related to the definition of the concept through the relations expressed in the definition. By focusing on the relations expressed in the definitional template of a concept and by being able to access contexts that express those relations, users can construct a more detailed mental space of the concept.
2. The context focuses on a secondary relation (one not expressed in the definitional template). This affords users the possibility of adding new information which enlarges the mental space.
3. The context related the concept to other concepts in the same domain or to concepts in other domains. This also enlarges the mental space, and provides users with the means to create new and related mental spaces.

Another criterion that should be taken into account is speed of knowledge acquisition and the time available for text processing. Thus, contexts in a term base cannot consist of entire texts, but should in fact be as concise as possible. The number of contexts to be included in a term entry ultimately depends on the concept and the relations that it activates. If the definition of the concept includes many different types of relation, it will probably need more contexts. If the concept is part of a complex multidisciplinary domain, more contexts will be needed as well.

The first step in context selection is to establish a direct connection between the potential relations between concepts and the vital relations used to construct meaning. Table 37 shows the hierarchical conceptual relations of generic-specific (TYPE_OF) in the vital relations, *analogy*, *representation*, *identity*, and *uniqueness*, and of partonymy (PART_OF) in the vital relation *part-whole*. Non-hierarchical conceptual relations considered by Fauconnier and Turner are *cause-effect*, *object/event-location*, and *object/event-time*.

Decisions regarding the relevance of domain knowledge for context selection are based on the combined analysis of *knowledge-rich contexts* (I. Meyer 2001; Mitkov

1998, 2002), *knowledge patterns* (Barrière 2004b; Barrière and Agbago 2006) and *vital relations* (Fauconnier and Turner 2002).

The previously described criteria for defining effective contexts for knowledge acquisition evidently depend on the domain knowledge related to the concept. A first step in selecting contexts for a concept must therefore be the amount of knowledge contained in the context. Mitkov (1998, 2002) and I. Meyer (2001) distinguish between *knowledge-poor contexts* (KPCs) and *knowledge-rich contexts* (KRCs). Knowledge-poor contexts are contexts that do not include any item of domain knowledge related to the search word. In contrast, knowledge-rich contexts contain at least one item of domain knowledge that is useful for the conceptual analysis of the search word. Such contexts should indicate at least one conceptual characteristic, whether it is an attribute or relation (I. Meyer 2001: 281). However, some knowledge-rich contexts are richer in domain knowledge than others. Whereas a *meaningful context* is one that includes at least one item of domain knowledge, a *defining context* includes all or most items of domain knowledge that are needed to understand a concept.

Apart from containing items of domain knowledge, the context must be explicitly related to the concept to be contextualized. In this respect, a helpful notion is that of knowledge pattern (Barrière 2004b; Barrière and Agbago 2006), which refers to explicit domain-independent knowledge patterns, metalinguistic information regarding terms, and their conceptual structures. Such linguistic markers help the reader fully understand the meaning of a concept, and the relations of this concept to others.

Semantic relation	Sentence with knowledge patterns
Opposite	Back is the opposite of front.
Synonymy	Automobile is another word for car
Hyperonymy	An apple is a kind of fruit

Table 38. Examples of semantic relations and their knowledge patterns (adapted from Barrière 2004b)

For example, in Table 38, the sentence ‘An apple is a kind of fruit’ explicitly relates the hyperonym FRUIT to its hyponym APPLE through the knowledge pattern *is a kind of*. Similarly, in the sentence ‘Back is the opposite of front’, the knowledge pattern, *is the opposite of*, lexicalizes the antonymic relation between BACK and FRONT. The extraction of contextual information in EcoLexicon depends on knowledge patterns that express the conceptual relations found in the specialized domain of Environment

Science. Context selection should then be based on the intersection of knowledge richness and knowledge patterns that are directly related to the vital relations used.

Vital relations	Knowledge pattern examples
Time	<i>firstly, secondly, in the first place, step, phase</i>
Space (normally related to part-whole)	<i>right, left, in, on, under, find, encounter, locate, location</i>
Representation	<i>is another word for, also known as, also called, similar to</i>
Change	<i>evolve, change</i>
Role-value	<i>A, b and c are all X</i>
Analogy	<i>is a kind of, is a sort of, is classified as, refers to, means</i>
Disanalogy	<i>is different from, differs, varies, distinguish</i>
Part-whole	<i>composed of, is a part of, is a component of</i>
Cause-effect (bundled with time and change)	<i>influence, promote, lead to, prevent, control</i>
Cause-effect	<i>is a tool for, is made to, is designed for, used for</i>

Table 39. Relation between outer-space vital relations and knowledge patterns

Besides lexical knowledge patterns, there are also other typographical resources that may function as knowledge patterns, such as bold print, italics, parentheses, or quotation marks. When vital relations are related to the knowledge patterns found in texts, contexts can be selected which facilitate meaning construction. Nevertheless, not all knowledge patterns have the same explanatory power, and a careful selection must be made of knowledge patterns and their combinations. For example, an adverb, such as *firstly*, in combination with a specialized knowledge unit lexicalizing a process does not necessarily express the first step of this process.

Apart from the need for explicit relations between the selected context and the term entry to which it is related, all the information contained in the terminological resource should be internally as well externally coherent.

Coherence signifies the harmonious flow of information, cooperation, and order among the components of a larger entity, which in this case would be the knowledge resource. In this regard, internal coherence refers to the information contained in the data fields of each entry, whereas external coherence refers to how entries are interrelated within the context of a unified whole (Faber, León Arauz, Prieto Velasco, and Reimerink 2007: 41).

Therefore, contexts in a term entry should be explicitly related to the definition of the concept designated by the term. As shown in Section 3.1 of this volume, the definitional template of a category should then be the basis for context selection, apart from the vital relations expressed by the linguistic markers and knowledge patterns.

4.1.4 Case studies

This section describes how to select appropriate contexts that contribute to the representation of specialized knowledge units. The examples chosen are for the concepts, DREDGER, EROSION, and WATER CYCLE EVENT.

4.1.4.1 CASE STUDY 1: DREDGER

The first example is the concept DREDGER. A dredger is a machine used for dredging operations and as such should be linked to the activity of DREDGING in the terminological resource. The definitional template of this object and the related process are the following:

(189) DREDGER

Instrument [TYPE_OF] used for dredging operations [HAS_FUNCTION].

DREDGING/DREDGE

Removal of beach material from underwater [TYPE_OF] by pumping, extracting and piping it [PHASE_OF] by means of a dredger [INSTRUMENT_OF] in order to maintain water depths in rivers, canals or harbors and to obtain material for construction or beach nourishment [HAS_FUNCTION]

In the template for DREDGER, the non-explicit TYPE_OF underlies the genus of the definition ('instrument'), which situates the concept within the parent category. Since the core meaning of an instrument is related to its use, the relation [HAS_FUNCTION] is included in the definition ('used for dredging operations'). Here, the relation is made explicit through the knowledge pattern 'used for'. Regarding the template for DREDGING, besides the inclusion of information relative to TYPE_OF ('removal of beach material'), it also describes the different subprocesses involved in DREDGING ('pumping, extracting, and piping'). Furthermore, the definition of dredging does not contain an explicit knowledge pattern for the TYPE_OF relation. Another problem is the fact that the knowledge pattern 'by', which introduces the previously mentioned subprocesses, is not very illustrative.

Example (190) is a context that contains several elements of domain knowledge. It gives a definition of the process, *dredging*, and it explains that this process is carried out by means of a specific instrument. Therefore, it is a knowledge-rich context.

(190) Dredging is the operation of removing material from under water. In all but a few situations the excavation is undertaken by a specialist floating plant, known as a dredger.

The knowledge pattern, *known as*, expresses the vital relation, *representation*, by introducing the term that designates the concept, DREDGER. The content directly relates the instrument to its function, and thus seems to be an appropriate context for a terminological resource. The explicit relation expressed by *known as* makes this context relatively simple to extract from a corpus.

However, the relations in the context, [TYPE_OF] and [HAS_FUNCTION], are already the basic relations expressed in the definition of DREDGER and DREDGING. Adding this context to the entry in the term base does not really add any new information, but only reinforces the information in the definition. Consequently, it does not help the user to expand the mental space where the concepts are located. Therefore, the context in (191) is more appropriate since it activates the basic relations between both concepts.

(191) Dredging can be carried out wherever there is sufficient water depth to allow a dredger to operate. Thus dredgers can be found around the coasts, in rivers and in canals. They can be found in lakes and ponds far from the sea and they can be found in exposed offshore locations far from land.

The context in (191) focuses on the possible location of the instrument. The knowledge pattern that expresses this relation is the verb *find*. Location is not one of the core knowledge elements of the definitional template of DREDGER, though it is present in the definitional template of DREDGE, *from underwater*. Context (191), therefore, gives the user additional information. As shown in Table 39, the vital relation, *space*, is usually associated with the relation, *part_whole* (PART_OF) relation. In the case of this context, the location where dredging is performed can be regarded as part of the overall process since it occurs in a particular spatial setting. The knowledge pattern *found* is easily located in a corpus although some noise might be generated if the right combination of words is not searched (i.e. *dredger*, *dredge*, *found*, and *location*). This context could be included in the term base in the entry for DREDGE as well as DREDGER.

Example (192) gives additional information regarding the characteristics of the instrument without describing its function. Such information is not contained in the definition of the concept, but is helpful in the process of meaning construction since it widens the mental space.

(192) Dredgers exist in a wide variety of shapes and sizes, ranging in complexity from a simple grab crane on a floating pontoon to some of the most sophisticated and technologically advanced vessels afloat. Some dredgers can be moved from site to site by road transport; others are capable of sailing half way around the world under their own power.

Context (192) informs the reader that dredgers can come in different shapes and sizes; they can be transported by different means; and that there are different types. For instance, the knowledge pattern, 'ranging from', explicitly relates the hyponyms, GRAB CRANE and VESSELS, to their hyperonym DREDGER. This information regarding dredgers is more illustrative than the brief description in the definitional template. This knowledge-rich context supplements the definition of the concept and the term entry

However, there are contexts that provide even more specific information and have the advantage of including more explicit knowledge patterns. Example (193) is a useful context because it is knowledge-rich.

(193) In reference to type, dredgers can be broadly classified into two groups or types, depending upon the method used to transport loosened material from the sea-bed to the water surface. These are *mechanical dredgers* and *hydraulic dredgers*. However, not all dredgers fall neatly into these classifications so it is convenient to include a third, for dredgers intended for specific dredging or disposal situations.

Context (193) contains new concepts, and explicitly refers to the relations between those concepts, namely, a classification of types of dredger according to transport method. Furthermore, the presence of knowledge patterns facilitates information extraction, and the content goes beyond the relations contained in the concept entry. Users, when accessing this context, are able to enlarge their mental space for dredger. This is made possible through the vital relation *analogy* (made explicit in the knowledge patterns, *type* and *classified*), compressed in the mental space to *identity*.

Example (194) refers to a specific type of dredger.

(194) SUCTION DREDGER

A stationary dredger used to mine for sand. The suction pipe is pushed vertically into deposited sand. If necessary, water jets help to bring the sand up. It is loaded into barges or pumped via pipeline directly to the reclamation area.

Even though context (194) gives users an idea of what a suction dredger looks like, it is not easy to create a visual image of the object. For very specific objects such as this one, the context must go beyond verbal explanation, and be further enriched by a visual image. Adding the image of a typical suction dredger (see Figure 62) greatly simplifies the construction of a mental image.

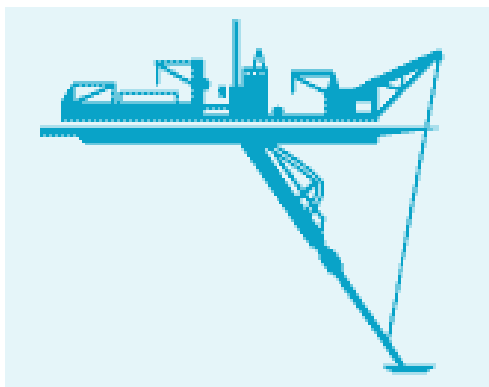


Figure 62. Suction dredger

An explanation of the selection parameters and criteria for images, videos and other non-textual types of context in a terminological resource is given in Section 4.2

4.1.4.2 CASE STUDY 2: EROSION

Erosion is a process in which weathered particles of the surface of the Earth are transported by the action of running water, wind, ice, waves, or gravity. The definitional template of this process is the following:

(195) Erosion

Geological process in which weathered particles of the surface of the Earth, soil and rock particles are transported by the action of running water, ice, waves, wind, or gravity.

(196) Erosion is the process by which soil and weathered rock particles (sediment - gravel, sand, silt, and clay) are transported, or moved from one place to another.

Example (196) is clearly a knowledge-rich context since it expresses various elements of domain knowledge. It also activates the relations expressed in the definition of the concept. Since this context only reiterates the content already expressed in the term entry definition, it does not appear to contribute any new knowledge. Nevertheless, some new information is contained in the parentheses, more specifically, the term for weathered rock particles (*sediment*) as well as different types of sediment (*gravel, sand, silt, and clay*). Therefore, this context provides users with a richer knowledge representation. However, in this case, the knowledge patterns used to express this information are the parentheses and a dash. Although this is useful information, such knowledge patterns do not make explicit conceptual relations, and thus are more difficult to extract. This example shows that some knowledge patterns are more useful than others. It also shows that a context should contain additional information.

Context (197) has similar problems to the one in (196).

(197) The agents of erosion are:

- I. **Running water**
- II. **Wind**
- III. **Ice** (glaciers)
- IV. **Waves**
- V. **Gravity** (mass wasting)

Although in (197), the agents of erosions are made explicit little new information is added to the definition. Moreover, the parentheses express two different conceptual relations: (i) the type of ice that causes erosion; (ii) the term for gravity-caused erosion.

Context (198) is different from the previous two for various reasons.

(198) Weathering and erosion are two different things. Many people mistakenly say erosion when they really mean weathering.

Weathering = breakdown
Erosion = transport

First of all, the knowledge pattern *different* expresses the vital relation *disanalogy*. It directly relates EROSION to WEATHERING, and then explains the difference between them in a straightforward way. The vital relation *disanalogy* is useful because it helps to specify the borders of the mental space that is being constructed. It also disambiguates and differentiates one concept from others that are closely related. The knowledge patterns expressing the relation of *disanalogy* are also easy to extract from a corpus, and thus are useful for terminological resource building.

Context (199) describes the ways in which running water erodes the Earth's surface.

(199) Erosion by Running Water - Rivers and Streams

Running water erodes soil and sediment in several ways:

1. **Abrasion** of the stream bed by gravel and sand carried by the water.
Potholes may form.
2. **Dissolution** of soluble rock types (such as limestone and marble, or rocks with calcite cements)
3. **Scour** or lifting of loose particles due to the turbulence of the water.

The vital relation expressed is *part_whole*, or even *analogy* (TYPE_OF). *Abrasion*, *dissolution* and *scour* are all subprocesses of erosion by running water. The knowledge patterns that express this relation are the colon as well as the enumeration. Although this context initially seems useful, the relation between the concepts is more easily expressed in the terminological knowledge base through explicit conceptual links in the conceptual representation. The concepts ABRASION, DISSOLUTION and SCOUR each should have their own entry in the term base.

Context (200) is quite a different matter since it presents the term from a domain-specific perspective.

(200) How can we control erosion from running water and wind?

1. **Contour plowing**
2. **Terraces** on a hillside
3. **Planting groundcovers**; roots hold the soil. (**Kudzu**)
4. **Windbreaks** - a barrier or baffle that causes the wind to slow down.
When wind speed is decreased, the load carried by the wind is dropped. Fences and plants are often used as windbreaks.

In Geology and related sciences, erosion is often seen as a problem that has to be controlled or prevented. Much of the research carried out in the field and many of the constructions and processes initiated by engineers have prevention or control of erosion as their goal. This kind of information, though important, is not part of the core meaning of the concept. However, term base users in the process of constructing a mental space for EROSION should be informed about the possible negative effects of this process on the natural environment and the ways to prevent or control it. The vital relation expressed in the content of the context in example (200) is *cause_effect*.

The knowledge pattern, *control*, close to the term *erosion* and *running water* is a good indication of a context expressing the vital relation *cause_effect*. This context provides new information, which is not directly related to the definition of the concept, but which is vital for meaning construction. In the case of processes, the vital relation *cause_effect* is crucial for context selection.

Consequently, of the five contexts for EROSION, only (198) and (200) are useful for inclusion in a term base although the other contexts can be used for other purposes such as definition writing.

4.1.4.3 CASE STUDY 3: PRECIPITATION, PERCOLATION, and INFILTRATION

After analyzing types of context and establishing the difference between contexts that are candidates for inclusion in the term entry and contexts that can be used for other aspects of terminological resource building, we now provide an example of context selection for related terms designating processes in the Water Cycle Event.

PRECIPITATION, INFILTRATION and PERCOLATION all share the core meaning of water descending. Even though these terms refer to very similar processes, which in certain contexts are interchangeable, there is a slight difference between them. *Infiltration* refers to the entry of water in the soil surface, and *percolation* refers to the downward movement of infiltrated water through soil and rock. This close relationship is

also attested in corpus data since these units frequently appear together in specialized texts. *Precipitation* refers to water particles such as snow and rain falling from the sky, and in texts, is often found near *infiltration* and *percolation*. All three share the core meaning of *water falling down*, and thus share a common frame. Table 39 shows corpus⁹ examples of contexts that include *precipitation*, *infiltration* or *percolation*.

	Term	Corpus-attested contexts	Knowledge patterns
(201)	<i>precipitation</i>	Precipitation means solid or liquid moisture falling from the sky.	bold print, <i>means</i>
(202)		Annual total precipitation refers to rain, snow and other forms of moisture such as hail.	<i>refers to</i>
(203)	<i>infiltration</i>	In this context, infiltration is the water that seeps into the ground and migrates downward below the root zone to reach the water table.	<i>in this context,</i> <i>is</i>
(204)		Infiltration, as the term is used by many surface-water hydrologists, includes all water that seeps into the ground, regardless of whether or not it ever reaches the water table.	<i>as the term,</i> <i>used</i>
(205)	<i>percolation</i>	Deep percolation is defined as the drainage of water beyond the root zone.	<i>defined as</i>
(206)		In a process called percolation, water passing through the unsaturated zone may reach the saturated zone and become groundwater.	<i>called</i>

Table 40. Corpus-attested knowledge patterns for *precipitation*, *infiltration* and *percolation*

In these cases the outer-space relations portrayed are *analogy* and *representation*. In (202) of Table 40, the knowledge pattern, *refers to*, expresses the vital relation *analogy*, which can be mentally compressed to the inner-space relation *category*. In (206), the knowledge pattern, *called*, indicates the outer-space relation *representation*, which is compressed to *uniqueness*. Readers, therefore, can obtain the information that this is the explanation of a concept or concepts. As a result, the contexts in this table seem especially appropriate for inclusion in the term entry since they help to define each of the three concepts.

⁹ All the examples and contexts were extracted from the EcoLexicon corpus.

Table 41 shows contexts in which two or more concepts of the Water Cycle Event are related. The explicit knowledge patterns appear in bold print, and highlight one aspect of the conceptual structure. This table mainly shows non-hierarchical and complex relations.

	Related terms	Corpus-attested contexts	Knowledge patterns
(207)	<i>infiltration</i> <i>precipitation</i>	In hydrology, infiltration refers to the maximum rate at which a soil can absorb precipitation.	<i>refers to</i>
(208)	<i>infiltration</i> <i>runoff</i>	Potential run-off occurs when the application rate exceeds the soil infiltration rate.	<i>occurs</i>
(209)	<i>runoff</i> <i>erosion</i>	Surface runoff is one of the causes of erosion of the earth's surface.	<i>causes</i>
(210)	<i>infiltration</i> <i>precipitation runoff</i>	"Infiltration" means the entry of precipitation or runoff into or through the soil.	<i>means</i>
(211)	<i>infiltration</i> <i>precipitation runoff</i> <i>evapotranspiration</i>	precipitation = runoff + evapotranspiration + infiltration; which means that the water that falls to the ground in the form of rain, snow, etc will either soak into the groundwater, runoff into surface streams, or be evaporated from the surface or transpired through plant leaves	<i>means</i>
(212)	<i>infiltration</i> <i>precipitation runoff</i> <i>percolation</i> <i>evaporation</i> <i>condensation</i> <i>transpiration</i>	The hydrologic cycle involves evaporation, condensation, run-off, infiltration, percolation, and transpiration	<i>involves</i>

Table 41. Contexts with more than one term

The contexts in Table 41 give explicit information about how different concepts are related to each other. These relations contribute to the construction of a (partial) event. The knowledge patterns in these contexts do not always share the same meaning, nor do they have the same explanatory power. In Table 41, the knowledge pattern, *means*, in (210) indicates the outer-space relation *analogy*, which is compressed to the inner-space relation *identity*. The context gives a definition of

infiltration, but does not explain the difference between the other two terms used for this definition, *precipitation* and *runoff*. Context (212) succinctly names the processes involved in the Water Cycle Event though it is far from exhaustive. Nor does it give any information about these processes or their relation to each other. As shown in Table 41, if contexts are to be helpful to term base users, they must be carefully selected.

For example, despite the fact that context (213) helps users to infer that both *infiltration* and *percolation* refer to a downward movement, it does not differentiate the concepts from each other.

(213) Infiltration and percolation depict a downward movement of water

Context (213) only helps to construct a partial mental space. It is true that the information regarding the downward movement of water is a core element in the definition of both concepts, but no new information is provided except that both concepts share this attribute. Context (214) is a slightly better candidate for inclusion in the term base because its knowledge patterns can be easily extracted from a corpus

(214) Although percolation and infiltration are very similar words, we use percolation here to refer to the transfer of water from the soil to the deeper aquifer -- the ground water reservoir.

In (214), the explicit knowledge patterns, *similar* and *refer to*, express the vital relation *analogy*. Nevertheless, the context only gives the exact meaning of *percolation* without explaining *infiltration*. Although it gives users the possibility of constructing a more detailed mental space, the space is still a partial one. Context (215) is quite a different matter because both concepts are explained in detail.

(215) The terms *infiltration* and *percolation* are often used interchangeably. *Infiltration* is the entry of water into the soil surface. *Infiltration* constitutes the sole source of water to sustain the growth of vegetation and it helps to sustain the groundwater supply to wells, springs and streams. *Percolation* is the downward movement of water through soil and rock. Percolation occurs beneath the root zone. Groundwater percolates through the soil much as water fills a sponge, and moves from space to space along fractures in rock, through sand and gravel, or through channels in formations such as cavernous limestone.

Both definitions are given, and the differences between both concepts are made explicit. The knowledge pattern does not express the vital relation, *disanalogy*, but rather *cause_effect*. However, the context as a whole refers to the evident disanalogy between the concepts. Even though this context is a useful one, it is not an easy type of context to find.

In (216), the symbols of the equation facilitate the compression of the outer-space relation, *analogy*, to the inner-space relation, *identity*. The explanation that follows provides the necessary information to interpret the equation.

(216) precipitation = runoff + evapotranspiration + infiltration; which **means** that the water that falls to the ground in the form of rain, snow, etc will either soak into the groundwater, runoff into surface streams, or be evaporated from the surface or transpired through plant leaves

Context (216) helps the user to construct a mental space of part of the Water Cycle Event through the symbols and the knowledge pattern, *means*. *Means* is a knowledge pattern that has the advantage of being easy to locate in a corpus. Context (216) could thus be included in the term entries of four different but related concepts of the Water Cycle Event: PRECIPITATION, RUNOFF, EVAPOTRANSPIRATION, and INFILTRATION.

4.1.5 Summary

The examples in this chapter illustrate the fact that not all contexts are suitable for inclusion in a terminological knowledge base. For a context to be truly helpful, it should be knowledge-rich. That means that it should make explicit the relation between the terms in the context as well as between the context and the term entry. It should also contain information beyond that contained in the core definition of the concept since duplicating information in data fields is not especially helpful.

The context selection process should be based on: (i) the vital relations crucial for the process of meaning construction; (ii), the linguistic markers that express these vital relations; (iii) the definitions of the concepts in the terminological knowledge source.

As shown in the examples, some knowledge patterns are more useful than others for meaning construction. Punctuation markers, such as parentheses, bold print, quotations marks, or colons, do not explicitly state the type of relation expressed. Lexical markers such as *type*, *classified*, *differs*, etc., thus seem to be more appropriate for context selection.

Certain vital relations are applicable for specific concept types, while others are useful for all types. For example, the outer-space relations, *representation* and *analogy*, which are compressed into the inner-space relations, *uniqueness*, *identity*, and *category*, are applicable to states, events, and properties alike. However, the

outer-space relations, *time*, *space*, *cause-effect* and *change*, are more useful in the case of events and processes.

A vital relation that is very useful for context selection for all kinds of concepts is the vital relation, *disanalogy* since it has the advantage of specifying the borders of the mental space. It thus aids in the disambiguation and differentiation of concepts.

4.2 Graphical information

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4.2.1 Introduction

Linguistic information is not the only means of describing concepts. Images are also used for this purpose. The inclusion of different types of visual representation is extremely helpful in specialized knowledge fields since images enhance textual comprehension and complement the linguistic information provided in other data fields. In this respect, engineering dictionaries generally include occasional illustrations as a way of offering a more complete description of certain concepts (e.g. Flack and Möllerke 1999, Ching and Adams 2000, Smit and Chandler 2000, Adrien 2003). *Le grand dictionnaire terminologique*, one of the most important terminological resources in Canada also contains illustrations as part of some of the term entries. It is also significant that almost all terminology management tools available on the market today provide the option for including graphics (e.g. MultiTerm, Termbase, etc.).

Nevertheless, despite the fact that most terminologists and lexicographers recognize the value of graphical information and make use of it whenever possible, illustrations (like linguistic contexts) are often inserted in a relatively haphazard way in lexicographical and terminological resources without sufficient reflection on how a concept should be visually represented. Given its crucial role in knowledge representation, graphical material should be selected so as to be consistent with linguistic description, the level of specialization of the text, and the recipient's previous subject knowledge (Marsh and White 2003).

Frame-based Terminology explains how linguistic and graphical information can converge to give the user a better understanding of dynamic concept systems. It proposes a grammar for visual images in which specialized knowledge concepts have a morphological, syntactic, semantic, and pragmatic component. The result is a cognitive-semiotic typology of graphical information for specialized knowledge representation.

4.2.2 Pictures in the mind: image schemas and mental images

Although graphical information has been studied from a wide range of perspectives, the psychology of images has not been a focus of attention in Terminology research. From the perspective of Cognitive Linguistics, images do not necessarily refer to visual perception, but rather to the way a given situation is categorized (Cuenca and Hilferty 1999: 79). Knowledge representation through graphical elements can thus take place at two levels: (i) internal images of what is perceived inside the mind; (ii) external images of what is perceived as objective reality (Forrester 2000: 15, 125).

According to Forrester (2000), we receive a wide range of images from the real world, and at the same time, our mental life is saturated with internal images, impressions, ideas, and associated representations. In this regard, it is important to examine relationships between external images (e.g. on billboards, television, cinema, and computer screens) and internal images or imaging processes which make it possible to recognize, understand, reflect on or otherwise comprehend images (Forrester 2000: 3). For this purpose, it is useful to focus on perception as a natural consequence of sensation and cognition. From a perceptual viewpoint, mental imagery involves mental representations, resulting from the manipulation of symbolic entities within the context of dynamic information processing.

In Frame-based Terminology, images, as internal representations, are derived from the interrelationship between propositional content and the associated meaning construal (Langacker 1993), whereas images, as external representations, are a visual device for the depiction of concepts and their conceptual relations. Since cognitive structures can be regarded as dynamic systems which model how people interact with the world in different linguistic environments (Gibbs and Matlock 1999: 267), *mental images* and *image schemas* are the two types of internal representation that best define the role of graphical information in specialized knowledge acquisition processes.

Comprehension involves extracting defining features from real-world entities to create concepts. Therefore, conceptualization can be regarded as a snapshot process during which the most significant characteristics of a concept are captured and stored in the mental lexicon. These multimodal information clusters can mentally recreate or simulate the concept along with its most salient attributes and conceptual relations in the form of mental images and image-schemas (see Figure 63).

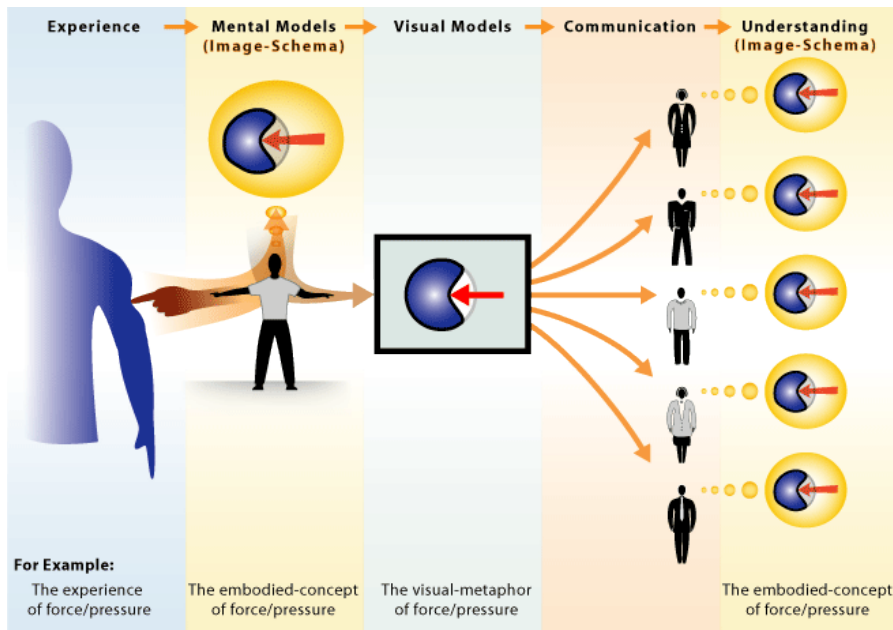


Figure 63. Image-schematic conceptualization

Source: Idiagram©

Kosslyn (2005: 337) states that images in the brain are not stored in long-term memory, but rather created by activating the stored memories in such a way that the implicit information is unpacked:

When visualizing detailed objects or scenes, representations in associative memory of spatial relations among parts or characteristics (or objects, in scenes) lead one to shift attention to the appropriate location on the imaged object, and to visualize each part or characteristic at the correct relative locations, so that a composite image is built up sequentially over time (Kosslyn 2005: 338).

From an embodied perspective of cognition, mental images are activated as the result of an analogical simulation of the object implied by linguistic stimuli, since thinking of an object, or understanding a word, involves referring to the perceptual aspects of its referent (Borghini and Scorolli 2006). For example, to represent the concept, PEACH, neural systems for vision, action, touch, taste and emotion partially reenact the perceiver's experience of a peach (see Figure 64).

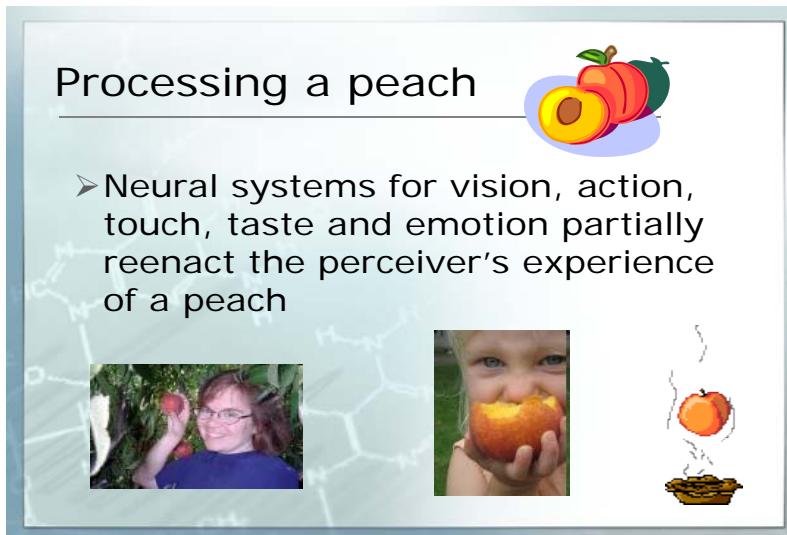


Figure 64. Experiencing a peach

Figure 64 shows that the perceiver reenacts picking it from a tree, touching it, eating it, smelling it, and making things with it. These reenactments or simulations are not quite the same thing as mental imagery, which is consciously evoked in working memory. Unlike mental imagery, these simulations seem to be relatively automatic processes that lie outside of our awareness (Simmons, Martin and Barsalou 2005: 1602).

Evans and Green (2006: 185) describe mental images as the result of an effortful and partly conscious cognitive process that involves recalling visual memory. In contrast, image schemas spontaneously arise from our interaction with the physical environment. Like simulation processes in the brain, they are derived from multimodal information.

Consequently, the knowledge visualization process implies the conversion of image schemas into mental images, or mental models into visual models to facilitate communication and link new concepts with previously stored knowledge. Mental images are part of our thought, and can be activated by linguistic inputs, direct perception, and schematic knowledge stored in our long-term memory.

Image schemas, which resemble to a certain degree what they represent, are the first step in the construction of a more elaborate mental image, and are thus the basic cognitive structure involved in the visualization of knowledge. Despite their predominantly pictorial nature, they are also multimodal. In other words, they can be derived from any sensory modality (sight, touch, hearing, or movement/balance). The nature of image schemas favors the linking of mental images of real-world objects and different types of graphical information for the depiction of specialized concepts. Inversely, when visualizing an illustration, its pictorial features (light, colors, shapes,

lines, arrows, etc.) are abstracted by the perceiver in order to recreate a virtual scene in the form of an image schema. The resulting image schema provides important conceptual information.

Consequently, image schemas, as highly schematic diagrams, can be regarded as basic cognitive structures underlying mental images. They can be described according to the following characteristics:

- Conceptual specificity
- Experiential nature
- Predictability
- Multimodality (Evans and Green 2006: 179-161)

The main properties of images schemas are applied to scientific concepts and exemplified in Figure 65.

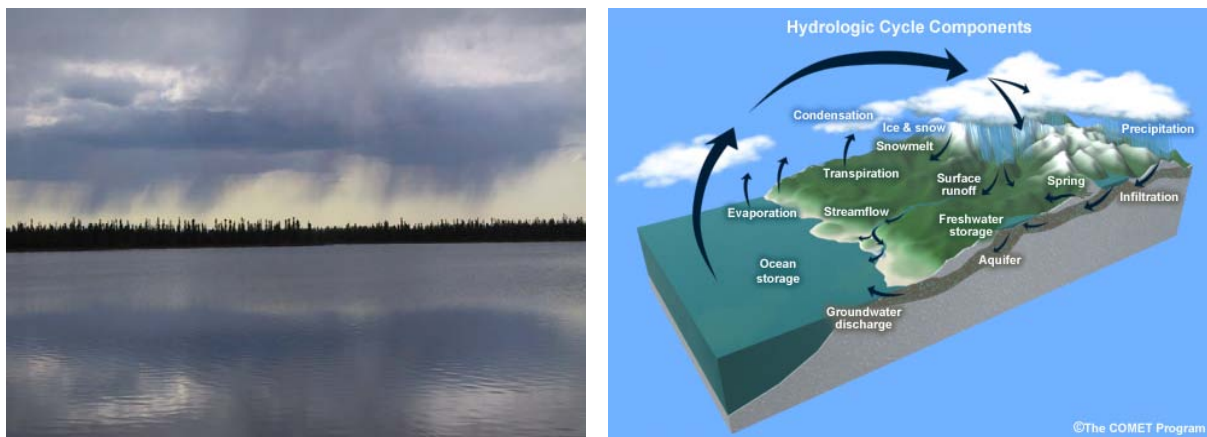


Figure 65.

(a) Photographic image of a rain scene

(b) Schematic depiction of the water cycle

Source: EcoLexicon image database

Source: University Corporation for Atmospheric Research

Figure 65(a) is the photographic image of a real precipitation scene with clouds, landscape, vegetation, rain, and sea. The perceiver's previous knowledge may include knowledge statements, such as the following: 'clouds are made of water vapor'; 'grey clouds normally bring rain'; 'plants retain rainwater'; 'rainwater penetrates the soil'; 'the sea receives rainwater', etc., These assertions are the basis for an image schema, which can give rise to the more abstract conceptual representation in Figure 65(b).

Figure 65(b) explicitly represents specific characteristics of some of the knowledge implicitly inferred in Figure 65(a). It portrays labeled specialized concepts,

which are part of the water cycle. These concepts are specifically focused on, and are interrelated by a set of conceptual relations.

As is well known, the water cycle is the continuous circulation of water in the Earth-atmosphere system. Water is transferred from the oceans through the atmosphere to the continents and back to the oceans by means of various processes, such as evaporation, transpiration, precipitation, infiltration, subterranean percolation, runoff, and other complex processes. However, the water cycle is a human-created schema that has been mapped onto an image of a segment of the real world. In Figure 65(b), the elements are arranged chronologically because all these processes are phases of the water cycle. Knowledge of the entire process allows the user to predict what will happen during the cycle.

4.2.3 Specialized language

The conceptual representation provided by image schemas can activate linguistic information in the form of specialized knowledge units. Frame-based Terminology advocates a multimodal description of specialized concepts in which the information contained in terminographic definitions meshes with the visual information in images for a better understanding of complex and dynamic concept systems (Faber, León Arauz, Prieto Velasco, and Reimerink 2007). The role of graphical information in specialized texts implies that images are non-linguistic resources for the representation and transmission of specialized knowledge which enhance the comprehension of a scientific system (Mayer and Gallini 1990). This is evident because images in a text direct the reader's attention to a particular aspect of the text. For this reason, they should be analyzed according to their function within the text and user perception as regards their relationship with concept and text. As cognitive support, the image should contain the basic-level categories of the text that it accompanies (Tercedor Sánchez, López Rodríguez and Robinson 2005). Types of images should vary depending on the level of specialization of the text. Their characteristics should also be in consonance with the most salient features of the linguistic description of the concept (Faber, León Arauz, Prieto Velasco, and Reimerink 2007; Prieto Velasco 2007).

In this regard, it is evident that images, as a type of communicative sign, need to be analyzed in greater depth. In the same way as language, they can be said to have combinatorial potential as well as a grammar.

4.2.4 A grammar for visual images: morphological, syntactic, semantic, and pragmatic components

A grammar for visual images is based on the relationship between visual and verbal communication since both types of communication overlap in many intermedial contexts (Nöth 2001: 2). Accordingly, if visual images are signs, theories of depiction should thus contain semiotic theory elements, involving a syntactic, semantic and pragmatic component (Scholz 2000: 202).

4.2.4.1 Syntactic information in images

Syntax refers to the relations and structures within a symbolic system or code. Although syntax generally refers to how linguistic units combine to form meaningful messages, syntax is not restricted to language.

This fundamental conception of syntax has the distinct advantage of being unprejudiced in favor of verbal languages, but of being instead meaningfully applicable to all kinds of symbol systems, and in particular to pictorial systems (Scholz 2000: 203).

Syntax should be understood here in its broader sense to also include other formal abstract systems of information such as graphical information. Syntax is partly responsible for the functional role of signs underlying the morphological features of any type of information system, and determines which items are to be considered signs of a given code. In this sense, image components such as arrows, color combinations, and perspective are indicative of the function of signs with regard to textual structure, communicative situation, and target readership.

According to Valverde (2001: 1), images can be defined by the selection of a segment of reality, a set of iconic elements, and a visual syntax. A visual syntax is composed of the combinatorial patterns of the morphological elements in an image, which can result in different meanings. These formal features can be classified as follows:

- ❖ Qualitative elements
 - strictly morphological elements: point, line, plane/shot, color, shape, and texture
 - dynamic elements: rhythm, and tension
- ❖ Quantitative elements
 - scalar elements: size, scale, proportion, and format

The strictly morphological elements of images are crucial for a wide variety of reasons. By favoring dynamism and suggesting movement, they direct the reader's attention towards focal points within the picture. They create vectors that organize its composition, represent the shape and structure of objects, and create cohesion and unity. They also produce an aesthetic and synaesthetic impression.

Dynamic elements transmit temporality, which is understood as spatial extension. This means that the objects depicted in the image are placed in a certain spatiotemporal context. Rhythm is thus the cadence suggested by the periodicity with which an event occurs, whereas tension is the logical tendency to restore the natural aspect of distorted images.

Finally, scalar elements are quantitative. They determine the effectiveness of iconic representations since size, scale, proportion, and format show interrelationships which influence the readability of images. In other words, they guarantee the reception of images by the user. The combinatorial patterns of such elements result in different categories of visual representations: graphs, tables, time charts, networks, structure diagrams, process diagrams, maps, cartograms, icons, and pictures (Lohse et al 1994: 44).

For example, Figure 66 is an image that illustrates the concepts of GROUNDWATER, WATER TABLE, and SURFACE WATER LOCATION. Its morphological features include arrows, color combinations, and the undulated surface.

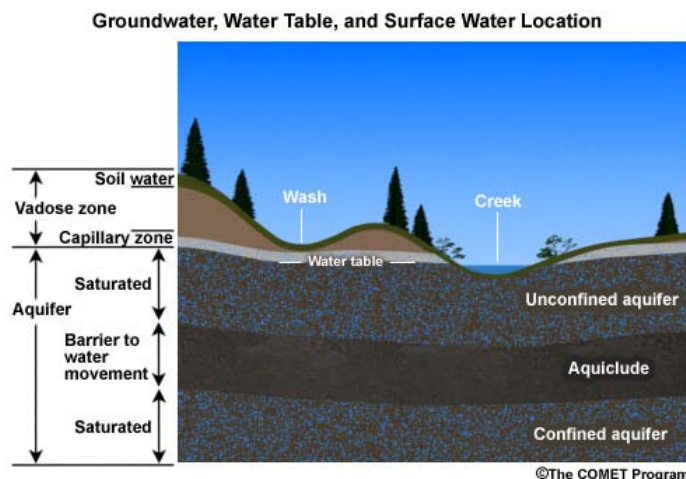


Figure 66. Groundwater, water table, and surface water location: morphological features
Source. University Corporation for Atmospheric Research

In Figure 66, the arrows are used to differentiate the soil layers which contain a confined aquifer, an aquiclude, and an unconfined aquifer. The combination of colors (blue sky, brown soil, bluish brown for permeable soil, blue water, and green vegetation) together with shapes and proportions identify the elements in the image.

Other morphological features are the undulated surface that depicts the relief, and the white lines that indicate related concepts.

4.2.4.2 Semantic information in images

Images convey different types of semantic information. They can transmit information about the real world as well as cause viewers to make conscious and unconscious inferences about the world, based on innate knowledge or learned knowledge (Wu et al 2005: 1277). Graphical information behaves in much the same way as linguistic information, insofar as both are systems of signs, and both are used to communicate ideas.

According to Pinto (2006), Lasswell's 5W (*who, what, why, where, when*) analysis can be used to extract the semantic content of an image. Figure 66 shows the application of the 5Ws to a picture of TIDAL FORCING.

5W questions	
Who?	the Moon
What?	tidal forcing
Why?	because of the lunar gravitational force and centrifugal force
Where?	water mass in the form of tidal bulges
When?	during lunar cycle

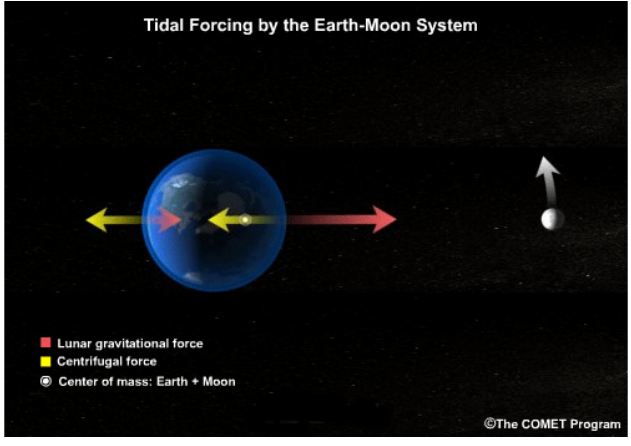


Figure 67. Semantic features of a tidal forcing image

Source: University Corporation for Atmospheric Research

These W-questions tell viewers the most basic information regarding the concept of TIDAL FORCING. They inform them that tidal forcing is produced by the moon's gravitational force, which is responsible for the tides, and that tidal forcing occurs because the gravitational field is not constant across a body's diameter. However, such questions only reveal objective information, derived from the salient semantic features of the image. These features, which comprise the denotative meaning of the concept, depict elements and facets of spatial and temporal reality. As a result, they help users recognize the representational structure of the image.

In contrast, certain semantic features in images can convey connotative meaning. Such features, which evoke associated concepts arising from the subjective reading of the image, help the viewers to identify the abstract structure of the image by focusing on key attributes.

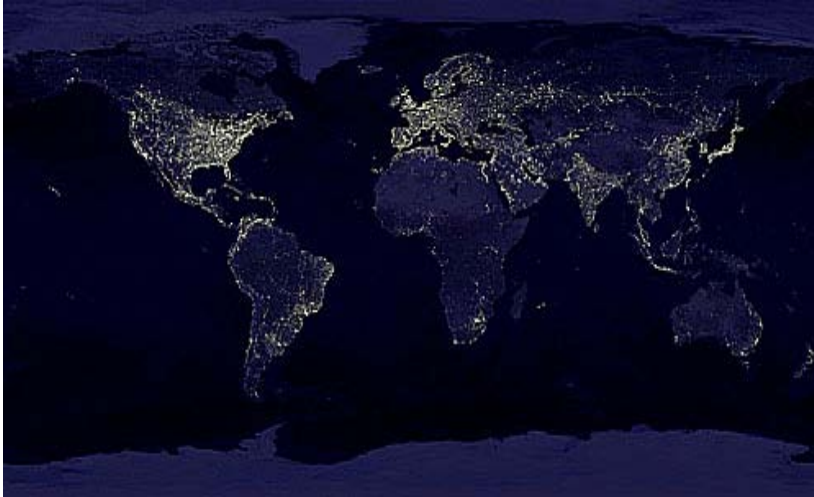


Figure 68. Connotative meaning of a luminosity map

Source: EcoLexicon image database

Figure 68 shows a nocturnal map of the most illuminated areas in the world. Yet, the absence or presence of LUMINOSITY also implicitly conveys other ideas related to world knowledge. For example, the presence of light can indicate high population density (e.g. northern hemisphere) and industrialization (e.g. the USA, Western Europe, and Japan). The absence of light can point to the irregular distribution of wealth (e.g. Africa and South America) or to less densely populated areas (e.g. central Australia and northern Canada). Although information regarding industrialization and population does not explicitly appear in the image, the light patterns and clusters afford complementary information that lead to inferences based on the previous knowledge of the perceivers.

Similarity in meaning can also produce graphical synonymy. This type of synonymy can be observed in Figures 69(a) and 69(b).

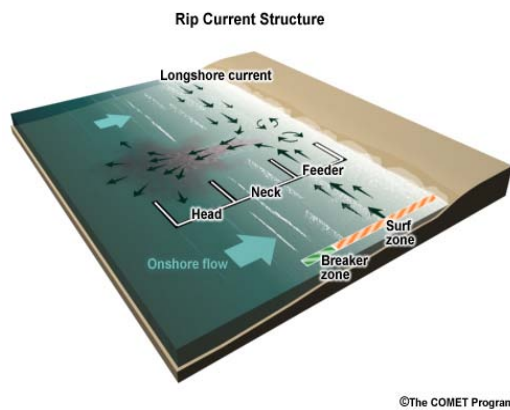
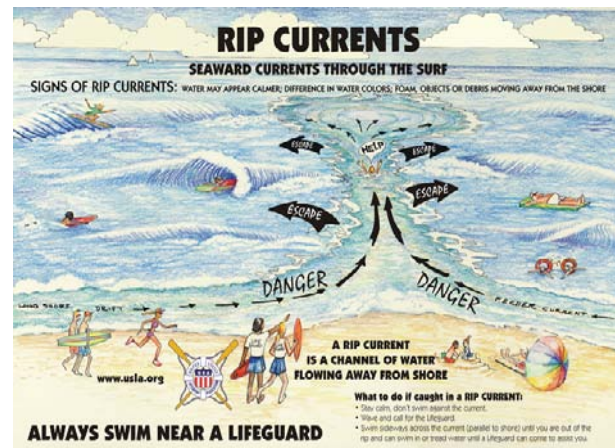


Figure 69. (a) Rip current structure
Source: University Corporation for Atmospheric Research



(b) Rip current structure with a warning function
Source: US Lifesaving Association Southeast Region

Figures 69(a) and 69(b) can be regarded as synonymous, as least to a certain degree, since both represent the concept of RIP CURRENT, a strong channel of water flowing seaward from near the shore, typically through the surf line. Although both images transmit the same basic information, they differ in their function as well as color combination, textual description, presence of human figures, etc.

Figure 69(a) depicts a rip current by focusing on the parts of the current (feeder current, neck, and head), its path along the coastline, the location where it occurs (surf zone and breaker zone), and the dynamic generation process, which is represented by the arrows. The function of the image is to explain the causes and occurrence of such a current without any other sort of implicit message.

Figure 69(b) also contains information that is similar to Figure 69(a). However, it does not explicitly point to the parts, path, or location of the rip current though this information is implicitly present in the image. Like Figure 69(a), it is dynamic because its arrows depict the path of the current and the waves reflect its motion. However, as shown by the inclusion of swimmers in the image, the primary focus of Figure 69(b) is on human interaction with the current, more specifically, on how swimmers can escape from it. Besides the explicative function, the other functions of this image are to elicit emotion (fear) and control the actions of perceivers by giving a warning of danger.

Although Figures 69(a) and 69(b) represent the same concept, each focuses on its content from different angles and for different user groups. Thus, the synonymy of these images is only partial. In the same way as for lexical units, fully synonymous images rarely if ever exist.

4.2.4.3 Pragmatic information in images

The pragmatic information in images refers to contextual factors of the communication process. Pragmatic information involves actions that the text sender performs when pictures are used to convey a message to different user groups. Accordingly, the pragmatic component of an image grammar refers to the characteristics that an image should have in order to successfully perform the projected action. These characteristics should also be in consonance with user needs, the level of specialization of the text, and the essential attributes of specialized concepts. This evidently involves the specification of their functional role.

There have been various attempts to classify the role of images in texts (e.g. Duchastel and Waller 1979; Levin 1981; Levie and Lentz 1982; Alesandrini 1984 *inter alia*). Nevertheless, as show in Table 42, the functions of images in texts often overlap.

Image functions				
Duchastel and Waller	Levin	Levie and Lent	Alesandrini	Functional Goals
descriptive	representation		representational analogical	<ul style="list-style-type: none"> • Increase specificity • Represent entities as tangible objects
expressive	decoration	attentional		<ul style="list-style-type: none"> • Direct the reader's attention • Create and maintain interest
constructional	organization	cognitive		<ul style="list-style-type: none"> • Provide organizational structure • Enhance retention • Interrelate concepts
functional	transformation			
		compensatory		<ul style="list-style-type: none"> • Help poor readers
		affective		<ul style="list-style-type: none"> • Influence emotions and attitudes
logic-mathematical	interpretation		arbitrary	<ul style="list-style-type: none"> • Represent figures • Clarify abstract or difficult concepts
algorithmic				
<i>data display</i>				

Table 42. Comparison of image functions and functional goals

In this respect, grasping image functions may require both qualitative and quantitative comprehension (Cerrato 2004). Qualitative comprehension refers to images that are abstractions of the real world, whereas quantitative comprehension refers to images which involve the processing of numerical data. Graphical material

that solely represents an object, may embellish the text, increase internal coherence by interrelating concepts, or convey qualitative information. Logical-mathematical, algorithmic and data display images transmit quantitative information. Nevertheless, the most important functions of graphical information are those that reveal the type of relation between image and text. This set of functions is useful for experts, scientists, technical writers, scientific journalists, scientific illustrators, terminologists, terminographers, translators, etc. because it provides them with conceptual support during the creative process in order to successfully communicate specialized concepts. Table 43 shows Marsh and White's (2003) classification of image-text relations and functions.

A. Functions expressing little relation to the text	B. Functions expressing close relation to the text	C. Functions that go beyond the text
<p><i>A1 Decorate</i></p> <p>A1.1 Change pace</p> <p>A1.2 Match style</p>	<p><i>B1 Reiterate</i></p> <p>B1.1 Concrete</p> <p> B1.1.1 Sample</p> <p> B1.1.1.1 Author/Source</p> <p>B1.2 Humanize</p> <p>B1.3 Common referent</p> <p>B1.4 Describe</p> <p>B1.5 Graph</p> <p>B1.6 Exemplify</p> <p>B1.7 Translate</p>	<p><i>C1 Interpret</i></p> <p>C1.1 Emphasize</p> <p>C1.2 Document</p>
<p><i>A2 Elicit emotion</i></p> <p>A2.1 Alienate</p> <p>A2.2 Express poetically</p>	<p><i>B2 Organize</i></p> <p>B2.1 Isolate</p> <p>B2.2 Contain</p> <p>B2.3 Locate</p> <p>B2.4 Induce perspective</p>	<p><i>C2 Develop</i></p> <p>C2.1 Compare</p> <p>C2.2 Contrast</p>
<p><i>A3 Control</i></p> <p>A3.1 Engage</p> <p>A3.2 Motivate</p>	<p><i>B3 Relate</i></p> <p>B3.1 Compare</p> <p>B3.2 Contrast</p> <p>B3.3 Parallel</p>	<p><i>C3 Transform</i></p> <p>C3.1 Alternate progress</p> <p>C3.2 Model</p> <p> C3.2.1 Model cognitive process</p> <p> C3.2.2 Model physical process</p> <p>C3.3 Inspire</p>
	<p><i>B4 Condense</i></p> <p>B4.1 Concentrate</p> <p>B4.2 Compact</p>	

	<i>B5 Explain</i> B5.1 Define B5.2 Complement	
--	---	--

Table 43. Taxonomy of image-text relations and functions (Marsh and White 2003)

In Table 43, column A shows the functions that have very little relation to the text; Column B shows functions expressing a close relation to the text; and Column C shows functions that go beyond the text.

In column A, the functions that do not directly refer to image-text relations are *decorate*, *elicit emotion*, and *control*. An example of the A2 function, *elicit emotion*, is when an international charity organization uses a picture of starving children to convince the viewer to make a substantial donation. A-function images make the text more attractive, and persuade readers to react or feel in a certain way.

B functions refer to graphical elements with a close relation to the text. In this sense, B-function images *reiterate*, *organize*, *relate*, *condense*, and *explain*. They are used to increase textual coherence by organizing ideas, interrelating concepts, reducing superfluous information, and making the text understandable.

Finally, C-function images go beyond the text to interpret, develop, or transform it. They facilitate the representation of complex ideas, clarify specialized information, and provide mnemonic resources for its comprehension. In *Ecolexicon* (Faber, León Arauz, Prieto Velasco and Reimerink al. 2007; Prieto Velasco 2008), functions *B1 reiterate*, *B2 organize*, *B5 explain*, and *C1 interpret* are used as selection criteria for images that complement the linguistic information in term-entry definitions, and reinforce the conceptual relations activated in term entry definitions.

Needless to say, a single image generally has several functions, which means that graphical information can be polyfunctional, as shown in Figure 70, which represents UPWELLING.

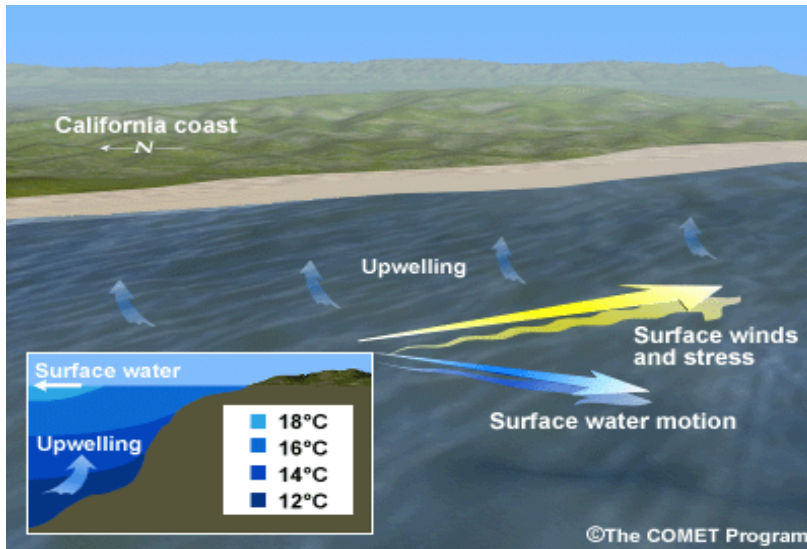


Figure 70. UPWELLING: syntactic functions

Source: University Corporation for Atmospheric Research

Upwelling refers to the rising of cold water from the deeper areas of the ocean to the surface. Although the image in Figure 70 is decorative, it also contains a great deal of information about how upwelling originates. It relates UPWELLING to other concepts (surface water, water temperature, and surface winds), and thus helps to better organize the ideas in the text. The dynamic nature of the image is reflected in the arrows, which highlight the fact that upwelling is a process that affects the coastline as well as the surface water.

Scholz (2000) argues that many semiotic acts can be performed by pictures since pictures can inform, illustrate, command, forbid, advertise, warn, etc. The most common speech act in specialized communication is *to inform* since the primary function in specialized texts, particularly in science and technology, is the referential or representative function, which links message and context.

Figure 71 (ab) shows two illustrations of the concepts of SPRING TIDE and NEAP TIDE.

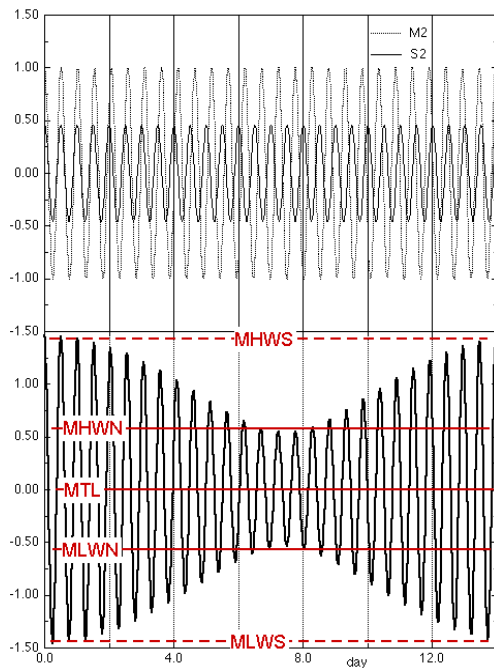
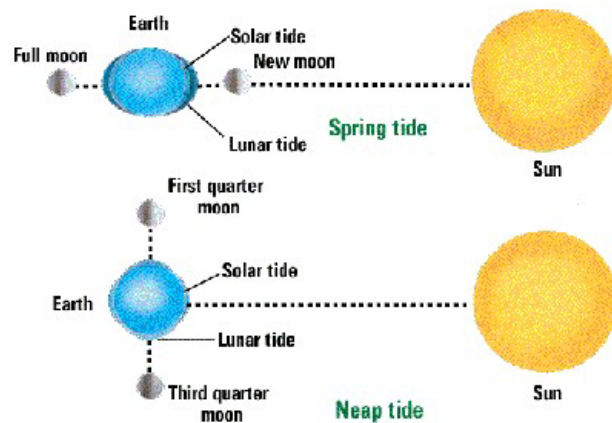


Figure 71. (a) Spring and neap tides
Source: Napier University, Edinburgh



(b) Spring and neap tides
Source: Prof. F.J. Jochem, Florida International University

As can be observed, Figure 71(b) conveys the concepts of SPRING TIDE and NEAP TIDE more effectively for the general public because it uses pictorial information, which can be decoded without expert knowledge. It limits itself to explaining the necessary configuration of celestial bodies for spring and neap tides to occur. In contrast, Figure 71(a) is more informative for users with a higher knowledge level. This figure affords more specific information, but requires the ability to decode tidal graphs as well as an understanding of acronyms such as MHWS and MLWS. Evidently, the relative usefulness of Figure 71(a) or 71(b) would depend on contextual factors, such as user needs and knowledge. Pragmatic features of an image are thus related to the adequacy of images for a given communicative context.

4.2.5 A cognitive-semiotic typology of graphical information

Traditionally, images have been classified according to their morphology in categories of photographs, drawings, animations, videos, diagrams, charts, graphics, schemes, views, etc. (Darlan 2001; Monterde 2002). However, a more useful way of categorizing images is in terms of their most salient functions (Anglin et al. 2004) or in terms of their relationship with the real-world entity that they represent. Our typology of

images is based on the criteria of iconicity, abstraction, and dynamism as ways of referring to and representing specific attributes of specialized concepts. Accordingly, illustrations should be selected so that they focus on the semantic features activated in the linguistic description of the concept. Their level of iconicity, abstraction, and/or dynamism should be the combination that best portrays the attributes of the concept and the semantic relations activated (Faber, León Arauz, Reimerink, and Prieto Velasco 2007: 63).

4.2.5.1 Iconicity

Iconic images resemble the real-world object represented through the abstraction of conceptual attributes in the illustration. Images may have different degrees of resemblance to the object that they represent. There can also be intratextual iconicity between words and pictures, when the verbal text conveys the same message as the picture. The picture is hence an icon of the text, and the text is an icon of the picture (Nöth 2001: 4).

On a scale such as that proposed by Valverde (2001: 4), the most iconic types of picture are natural images, i.e. direct visual perceptions of the world, followed by scaled three-dimensional models, such as a sculpture or a waxwork. As an example of an iconic image, Figure 72 shows a photograph of a direct visual perception of a groyne.



Figure 72. Iconic image of GROUYNE: representation of the conceptual relation MADE_OF.

Iconic images are especially useful for the representation of non-hierarchical relations, such as MADE_OF, which link the structure (i.e. groyne) to the material that it is composed of (i.e. concrete).

4.2.5.2 Abstraction

Abstraction in an illustration is a matter of degree, and refers to the cognitive effort required for the recognition and representation of the concept thus represented (Levie and Lentz 1982; Park and Hopkins 1993; Rieber 1994). Abstraction concerns legibility and intelligibility, which are two interrelated aspects of graphical information. Legibility is the degree of difficulty in reading an image, and intelligibility refers to its level of complexity. The degree of abstraction depends on how accurately graphical information represents the essence of specialized concepts. For that reason, abstraction and intelligibility are crucial when describing images from a cognitive perspective (Martínez 2000).

The level of abstraction can facilitate the understanding of conceptual relations such as `LOCATED_AT`. For example, in regards to `GROYNE`, location can be understood as the position of the coastal structure in reference to the shoreline (see Figure 73).

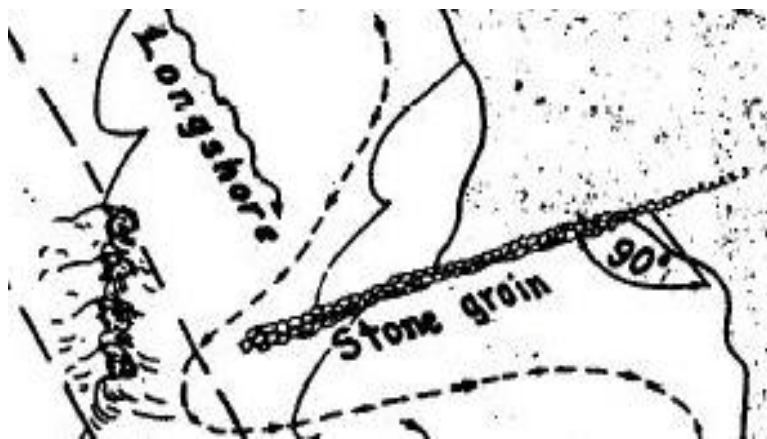


Figure 73. Abstract representation of `GROYNE`: representation of the conceptual relation `HAS_LOCATION`

The abstract nature of the image in Figure 73 highlights the conceptual relation of `LOCATED_AT`, whereas other relations, such as groyne type, material, or function, recede into the background and are not focused on.

4.2.5.3 Dynamicity

Dynamism implies the representation of movement (i.e. video and animation, as well as images showing different stages of a superordinate process). However, such a representation need not include explicit movement if it illustrates the sequence of discrete steps that make up the process.

Dynamic images seem to have a superiority effect (Paivio 1971, 1986) in the explanation of complex processes. For instance, implicit dynamism in *parts-and-steps* images facilitates the comprehension of a dynamic whole composed of various parts or a sequence of discrete steps. Dynamism describes the procedural nature of many specialized concepts in scientific and technical domains.

Figure 74 shows a dynamic image of a groyne-adjusted shoreline. In this regard, the relation HAS_FUNCTION is generally best represented by dynamic images.

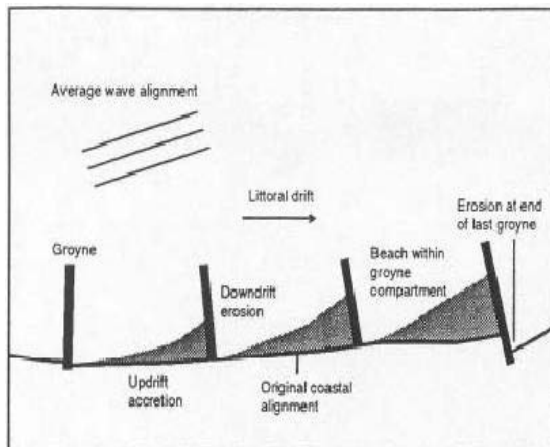


Figure 74. Dynamic image of GROYPNE-adjusted shoreline: representation of the conceptual relation HAS_FUNCTION

In Figure 74, dynamism is conferred by the use of symbols, such as arrows (representing movement), and textual information that link the pictures to the real world. Nevertheless, since arrows are non-iconic elements, a certain level of abstraction is also involved in arriving at the understanding that groynes retard longshore transport and littoral drift

Function is one of the most important features for the description of both coastal defense solutions since such structures are often constructed or implemented to cause a certain (positive) effect. However, all too often they bring about negative changes in the coastal environment that had not been foreseen. Since the illustration of a function means representing a process, dynamism is usually present, though evidently, this does not exclude the presence of degrees of iconicity or abstraction.

4.2.6 Image profiles

In this respect, few (if any) images are purely iconic, abstract, or dynamic. These features can be combined to generate eight possible image profiles. Table 44 shows

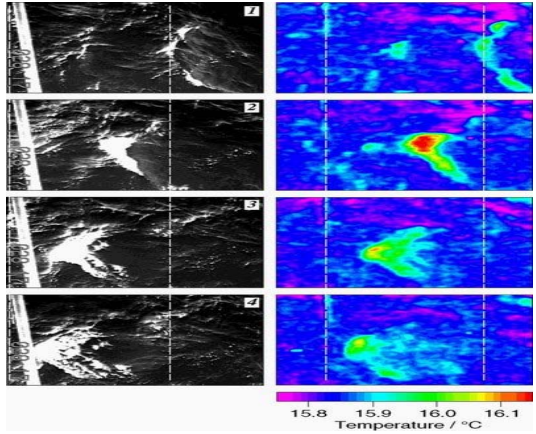
the eight possible profiles of graphical information, based on the presence or absence of these criteria.

TYPE	DESCRIPTION		
	Iconicity	Abstraction	Dynamism
A	✓	✓	✓
B	✓	✓	x
C	✓	x	x
D	x	x	x
E	x	✓	✓
F	x	x	✓
G	✓	x	✓
H	x	✓	x

Table 44. Typology of graphical information

The profile of the image is an important factor in determining its adequacy for a given representational context. From a descriptive point of view, an image is adequate for a given communicative situation, provided it shows the levels of iconicity, abstraction and dynamism needed to communicate effectively. In other words, a picture of a breaking wave in a highly specialized text is acceptable if it succeeds in transmitting a concept to experts, and providing them with new information. However, the same image may not be so effective for a reader with a lower knowledge level, who understands much less about wave generation and dissipation.

Figures 75-82 show different images of BREAKING WAVE. These images are examples of each of the eight image profiles, based on the criteria of iconicity, abstraction and dynamism.

Image profile	DESCRIPTION		
	Iconicity	abstraction	dynamicy
Type-A Image	✓	✓	Example: BREAKING WAVE 

The iconicity of this Type-A image lies in the photographic image of the wave. Its abstraction resides in the infrared images of the wave, indicative of temperature variation, which means that the perceiver must interpret them. Dynamism is reflected in the sequential images of the wave as it approaches the coastline. Such images often appear in specialized texts.

Image profile	DESCRIPTION		
	Iconicity	abstraction	dynamicy
			Example: BREAKING WAVE

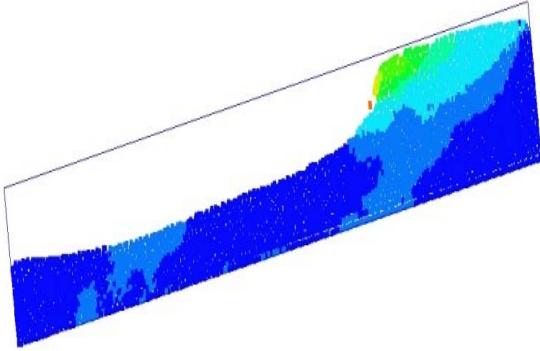


Type-B Image	✓	✓	x	
	<p>Figure 76. Type-B image http://www.anker-zemer.com/explicit_analysis.htm</p>			

Figure 76 is an image of a breaking wave in a stabilizer tank. It is a Type-B image because there is a certain degree of iconicity in the color and form of the image. Yet, at the same time, it is abstract because the perspective and construal make it difficult to immediately recognize it as a breaking wave. The image has no dynamic component.

Image profile	DESCRIPTION			Example: BREAKING WAVE
	iconicity	abstraction	dynamicity	
Type-C Image	✓	x	x	 <p style="font-size: small;">© QT Luong / terragalleria.com #hawa33303</p>
<p>Figure 77. Type-C image http://www.terrageria.com/pacific/kauai/kauai-north-shore/picture.hawa33303.html</p>				

As a photographic image, the Type-C image in Figure 77 is iconic without any abstraction or dynamicity. It provides a view of a breaking wave, but with no explanation of the process. Evidently, the image is more decorative than explanatory.

Image profile	DESCRIPTION			Example: BREAKING WAVE
	Iconicity	abstraction	dynamycity	
Type-D Image	x	x	x	 <p>Figure 78. Type-D image http://www.kuragallery.co.nz/jan-van-de-klundert-8</p>

The Type-D image in Figure 78 is a photograph of a work of art titled *Breaking Wave*. Even though it is a photograph, it is not iconic because it does not resemble a breaking wave. It is not abstract because it is a photograph, and does not include any data, which would allow the perceiver to interpret it as a wave breaking on the shore. It is not dynamic. Evidently, this type of image is not useful for the description and explanation of specialized concepts.

Image profile	DESCRIPTION			Example: BREAKING WAVE
	Iconicity	abstraction	dynamycity	

Type-E Image	x	✓	✓	
				<p>Figure 79. Type-E image</p> <p>http://jerry.ucsd.edu/BreakingWave/BreakingWave.html</p>

The Type-E image in Figure 79 is not iconic since it bears no resemblance to a breaking wave. It is abstract since it is a time-series of (equivalent) vertical displacements at and below the surface. Evidently, the perceiver must have the right level of knowledge to be able to interpret the data. The fact that the image represents the wave progression makes it dynamic.

Image profile	DESCRIPTION			Example: BREAKING WAVE
	Iconicity	abstraction	dynamcity	
Type-F Image	x	x	✓	
<p>Figure 80. Type-F image</p> <p>http://geology.csupomona.edu/drjessey/class/Gsc101/Oceanograph</p>				

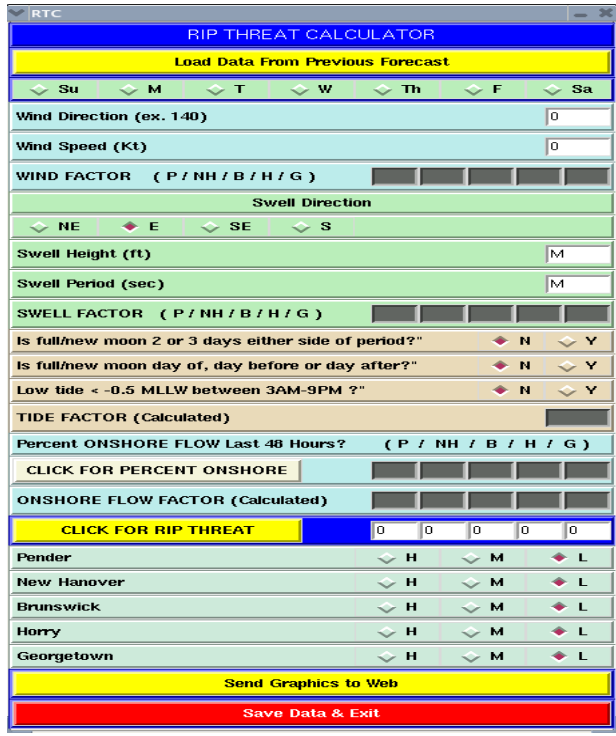
			yll.html
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Pure Type-F images evidently do not exist since all images have some degree of iconicity or abstraction. However, the image of a breaking wave in Figure 80 focuses on motion (and thus dynamicity) over the other two components. It thus has a relatively low degree of iconicity and abstraction. The emphasis is on the arrows that represent dynamicity.

Image profile	DESCRIPTION		
	Iconicity	abstraction	dynamicity
			Example: BREAKING WAVE
Type-G Image	✓	x	✓

Figure 81. Type-G image
<http://adventure.howstuffworks.com/outdoor-activities/water-sports/surfing6.htm>

Type-G images are iconic and dynamic. Iconicity is shown in the image of a breaking wave in Figure 81, and dynamicity is present in the arrows as well as the sequential representation. The level of abstraction is very low since this image is an explanation of how a wave breaks for a non-expert user group (i.e. surfers). Such images tend to appear more frequently in texts addressed to the general public. They depict core attributes of specialized concepts that make them understandable for non-experts

Image profile	DESCRIPTION			Example: BREAKING WAVE
	Iconicity	abstraction	dynamicity	
Type-H Image	x	✓	x	 <p>The screenshot shows a web-based application titled "RIP THREAT CALCULATOR". It features several input sections: "Wind" (direction and speed), "Swell" (direction, height, and period), and "Tide" (factors and onshore flow). There are also checkboxes for moon phases and low tide conditions. At the bottom, there are buttons for "CLICK FOR RIP THREAT", "Send Graphics to Web", and "Save Data & Exit".</p>
<p>Figure 82. Type-H image http://www.erh.noaa.gov/ilm/wilmingtonscience/</p>				

This Type-H image is evidently not iconic. It has a high degree of abstraction since it involves the interpretation of data regarding breaking waves and the risk of rip tides. The image is not dynamic since the presentation of data does not represent movement. From a pragmatic point of view, such images are characteristic of specialized texts for they are generally linked to abstract concepts denoting magnitudes and quantifiable data. As shown in Table 44, this typology of graphical information can be used to classify and select the right type of image for the terminological knowledge base and user needs.

4.2.7 Summary

This chapter has analyzed the role of graphical information in specialized texts. So far, Terminology theory has not as yet dealt with the importance of graphical information, but Cognitive Linguistics has emphasized the potential benefits of images

for the understanding of specialized concepts. Although a deeper study of mental and visual images may still be required, Frame-based Terminology shows how graphical information contributes to the representation of specialized knowledge by linking images and words.

With a view to encouraging a more systematic use of images in specialized contexts, we propose a communicative-oriented visual grammar, which highlights the morphologic, syntactic, semantic, and pragmatic aspects of graphical information and present a cognitive-semiotic typology of images aimed at representing the core attributes of specialized concepts.

5 Conclusions

Pamela Faber

As a discipline, Terminology started out as a practical activity without an explicit theoretical component. For quite a while now, Terminology has been in search of a theory, which can account for specialized knowledge representation, category organization, and description, as well as the semantic and syntactic behavior of terminological units in one or various languages. Over the last twenty years or so, Terminology has tried on theories and progressively shed them in much the same way as certain reptiles change their skin as they grow and develop (Chapter 2.1).

Our position, as reflected in this book, is that Terminology is essentially a linguistic and cognitive activity. In this sense, terms are linguistic units which convey conceptual meaning in specialized knowledge texts. As such, they are subject to morphological, syntactic, semantic, and pragmatic analysis. All of these aspects of terminological units are directly related to their capacity to convey knowledge in a specialized domain. The meaning transmitted by the text sender to the receiver is constrained by the nature of these specialized knowledge units as well as by the context in which the communication act occurs.

The linguistic theory that is most suitable for the analysis of specialized knowledge communication is Cognitive Linguistics because it is lexically-centered and usage-based. It is also a linguistic approach that seriously considers conceptual structure and meaning. Although Terminology has always been about concept description, in the past two decades, the cognitive aspect of Terminology has become increasingly important. In the same way as Linguistics, Terminology has also been affected by the cognitive shift, which has led both disciplines to increasingly focus on the conceptual network underlying language.

As pointed out throughout this book, Terminology is about identifying, describing and in certain contexts, even naming the concepts in a specialized field. These activities often culminate in the elaboration of standards, glossaries, specialized dictionaries, and terminological knowledge bases for specific user groups. The main objective of terminological work is initially to facilitate communication in one or various languages between different user groups in or interested in a given subject field. However, when specialized language and communication is naively approached with

little or no idea of cognition, sociocultural context, or the nature of language, one runs the risk of achieving just the opposite or, at best, rediscovering the Mediterranean.

Although terminological work often appears to be deceptively simple, it involves many activities and processes, ranging from specialized language planning to writing definitions to mapping out concept systems for the creation of knowledge-oriented terminological resources. The elaboration of databases and specialized dictionaries is particularly complex, and entails careful layout and design. It requires decision-making at many levels and affects all aspects of the resource's microstructure and macrostructure. In fact, modern databases have become so large and complicated that the conception of term bases as a series of data entries, similar to the file cards of the pre-computer era is no longer tenable. Even tree-structure databases are now old-fashioned, and more recent conceptually-organized databases in both general language and specialized language tend to opt for a network structure more in line with the organization of the mental lexicon. However, such a structure requires an underlying model of knowledge representation, which in Terminology has been sadly lacking up to the present.

Evidently, for specialized knowledge resources to be effective, they need to be theory-based. In fact, all terminological activities, such as term-entry design, definition elaboration, corpus analysis, context and graphical resource selection, etc. should be based on a set of micro-theories, which should be more than intuitive (and often naïve) folk theories of how specialized knowledge units should be managed, organized, and described.

In Chapter 2.2, we explained basic concepts of Cognitive Linguistics, and offered a preview of how they could be applied to specialized language. This chapter provided background knowledge for readers who might not be familiar with Cognitive Linguistics as a theoretical approach. The premises explained were subsequently developed in following chapters, where they were specifically related to Terminology and specialized language. Within the Cognitive Linguistics framework, metaphor and metonymy are vitally important (Chapter 2.3), and pervasive in specialized language. Since they are deeply rooted in cognition, they are the basis of many conceptual relations, and provide the foundation for a wide variety of interdomain connections. In fact, we have shown that many terms are metaphorical extensions from other general or specialized domains.

Metaphors in science are used for a wide range of purposes, such as familiarizing, transporting, and invention. The fact that they are an integral part of linguistic creativity means that they are instrumental in the recycling of existing terms or in the creation of neologisms. Besides the generation of new terminology, whole

systems of metaphors also underlie the structure and conceptualization of entire bodies of knowledge in specialized domains, such as the message-passing metaphor in biology or metaphor of the planetary system in physics.

The emphasis on metaphors as a way of linking domains has led researchers to explore the structure of domains and their internal organization. In both general and specialized language, conceptual domains, as the knowledge base of the natural language user, form a semantic structure, much of which is based on metaphorization and can even be regarded as non-language specific. In Cognitive Linguistics, the internal structure of categories can take the form of radial categories, idealized cognitive model, image schemas, and frames. Although all of these constructs have their counterpart in specialized language, in Frame-based Terminology, we have proposed frames as the principal structuring mechanism for specialized knowledge domains.

In the section on basic concepts, a chapter was included on specialized language translation (Chapter 2.4) since translation is a basic cognitive process, which is directly linked to Terminology. Scientific and technical translation necessarily includes the understanding, structuring, and specification of correspondences between specialized knowledge units in different languages. The correspondence between such units is evidently based on meaning and not on linguistic form.

One of the problematic aspects of the translation process is the frequent difference in knowledge levels between the text sender (who is an expert in the specialized field) and the translator (who generally is not). The translator must be able to reach a minimum knowledge threshold in order to be able to adequately comprehend the content of the source text and create an acceptable translation in the target language. In this sense, knowledge of the two languages and potential correspondences (communicative functions) are closely intertwined with conceptual and intertextual knowledge (cognitive functions).

Translators of specialized language are obliged to reconstruct concept systems as part of the knowledge acquisition process. They must also be familiar with scientific and technical text types in both language systems, and be able to fit the content of the source text to the linguistic, stylistic, and textual requirements in the target language. This highlights the translator's role as an interlinguistic, intertextual, and intercultural mediator. All of this must be accomplished with the help of terminological resources, very few of which have been conceived with the translator in mind.

In fact, as we have pointed out in this book, one of the problems of knowledge acquisition is precisely the lack of knowledge-oriented terminological resources that reflect the complexity and dynamicity of conceptualization. Although in Terminology

theory, great emphasis is placed on conceptual representation, reality is quite different. It is a fact that very few specialized dictionaries or glossaries are concept-based, and those that are based on meaning, only offer static representations of the TYPE_OF or PART_OF relation. Usage information is rarely included in term entries. Translation correspondences are often given in the form of an uncontextualized list, which conveys the illusion of an equivalence that does not necessarily exist.

Evidently, both Translation and Terminology need a theory of meaning that is directly linked to human cognition. Accordingly, one of the positive aspects of Frame-based Terminology theory is that it presents an account of the types of knowledge that terms give access to and how words and their knowledge structures are integrated or 'composed'. The focus is on concept integration which are carried out by constructions, frame structures, or conceptual networks.

Chapter 3.1 has presented the vision of specialized language semantics underlying Frame-based Terminology. Mainstream Terminology's long neglect of meaning is reflected in the fact that in many terminological resources, definitions are either not included in term entries or haphazardly copied from other resources. If definitions of terms belonging to the same subdomain bear little or no relation to each other, then it goes without saying that the terminological resource does not provide access to a domain-specific conceptual network, and is thus not knowledge-oriented. This is the case of the majority of terminological databases and specialized dictionaries currently available.

This state of affairs is all the more paradoxical since it is generally agreed that conceptual organization is an important part of terminological work. However, in the history of Terminology, the only theory-based proposals regarding conceptual structure have been made within the context of Sociocognitive Terminology (prototypes) and Frame-based Terminology (frames). Both proposals are in line with Cognitive Linguistics since they are based on the premise that language structure reflects conceptual structure.

Many of the examples throughout the book have been taken from EcoLexicon, the practical application of Frame-based Terminology. This online environmental knowledge base provides conceptual networks for each concept that are in consonance with its definition. EcoLexicon is based on a linguistic ontology, whose conceptual design is derived from information extracted from specialized texts (corpus analysis) and the structure of terminological definitions, using the premises of the Lexical Grammar Model for the representation of conceptual and collocational relations.

Throughout this book, terms have been described as specialized knowledge units which are conceptualizations of objects, qualities, states, and processes in a specialized domain. Since any theory of Terminology should aspire to psychological and neurological adequacy, we have based our assertions regarding knowledge representation on recent research in cognitive psychology and neuroscience that underlines the dynamic nature of categorization, concept storage and retrieval, and cognitive processing. Our assertions are based on the embodied or grounded cognition hypothesis, which claims that interactions between sensorimotor systems and the physical world underlie cognition. This more dynamic view of cognition claims that understanding is largely based on sensory and motor simulation with possibly a single convergence zone that affords the possibility to generalize across concepts that have similar semantic significance. This has evident applications to Terminology and its dynamic nature, which include the following:

- No specialized knowledge concept should be activated in isolation, but rather as part of a larger structure or event.
- A specialized knowledge resource that facilitates knowledge acquisition should provide conceptual contexts or situations in which a concept is related to others in a dynamic structure that can streamline the action-environment interface. Within this context, all concept types are regarded as dynamic because they are part of a process or event.
- Since knowledge acquisition and understanding requires simulation, this signifies that non-hierarchical relations defining goal, purpose, affordance, and result of the manipulation and use of an object are just as important as hierarchical generic-specific and part-whole relations.
- Research proposals, such as the domain-specific hypothesis, also have implications for Terminology since it asserts that domains are constrained by the nature of their members. In Terminology, this is reflected in clusters of conceptual relations that make up the general representational template, characterizing different categories.

The explanation of Frame-based Terminology in this book is based on examples from the domain of environmental science to show how frame-like structures can be used to represent specialized knowledge domains. One of these is the Environmental Event (Figure 25) in which basic predicates (i.e. *cause*, *do*, *affect*, *use*, etc.) relate roles, concepts, and categories as well as link generic categories at the superordinate level. EcoLexicon is based on the structure of events and subevents that take place in the environment.

We have described how events generally translate into language in the form of predicate-argument structures. At the most general level of event, conceptual categories are combined in scene-like configurations characterized by semantic roles, whereas conceptual networks represent the way concepts interact within more concrete events according to their internal structure and nature.

Within the Environmental Event, goal-derived categories resulting from the complex interaction of different contextual dimensions materialize in the form of three types of cognitive frames: (1) a prototypical sub-event describing the semantic roles and proposition configurations of the categories in each sub-domain; (2) a conceptual network based on the hierarchical and non-hierarchical relations activated by concepts within a sub-event; (3) a terminographic definitional template for concept description in consonance with the conceptual relations in the conceptual network and at the same time with the context activated in the sub-event.

In EcoLexicon, each concept is related to others by the following set of conceptual relations, some of which are domain-specific: TYPE_OF, PART_OF, MADE_OF, PHASE_OF, DELIMITED_BY, LOCATED_AT, ATTRIBUTE_OF, RESULT_OF, AFFECTS, CAUSES, HAS_FUNCTION, and EFFECTED_BY. In this inventory, TYPE_OF and PART_OF are vertical relations. MADE_OF, PHASE_OF, DELIMITED_BY, LOCATED_AT, and ATTRIBUTE_OF can be regarded as subtypes of meronymy. Given their importance in the knowledge representation of each specialized concept, their nature, combinatorial potential, and constraints are analyzed in detail (3.1.8.1).

At more specific levels of a conceptual network, we have used *qualia* for the classification of concepts and conceptual relations (3.1.9). The Generative Lexicon approach offers an elegant way to account for conceptual entities represented in language by noun phrases. Even though qualia do not exhaust the semantic content of specialized knowledge concepts, their four dimensions (formal role, constitutive role, telic role, and agentive role) allow for a rich semantic description of natural, artifactual, and complex concept types, which give rise to a variety of subtyping relations resulting from their underlying qualia structure. As such, they provide the slot labels in definitional templates or frames and supply an explicit formalization of how extralinguistic knowledge can be incorporated into a lexical entry. Templates thus consist of the combination of semantic roles, concept types, and qualia roles, which along with corpus-driven data, provide the conceptual meta-constructions to be included in each definition.

Specialized language pragmatics (Chapter 3.2) deals with how language is used in different contexts and the meaning arising from its use. From a sociocultural perspective, this type of pragmatics is related to the situations in which specialized

communication occurs and the parameters of interaction between the text sender and receiver. From a cognition-oriented perspective, it refers to the online construction of text and word meaning by the text sender and receiver. It was pointed out that cognition-oriented pragmatics is not a branch of Cognitive Linguistics, which does not differentiate semantics and pragmatics. We, however, have found it useful to separate the two as a way of marking the distinction between the underspecified meaning of specialized knowledge units *in vitro* and their potential meaning (or meanings) *in vivo* as activated in specific communicative situations.

A terminological unit, which occurs in a particular usage event, can be said to have different types of context: the context provided by the encyclopedic information accessed, a sentential context, situational context, and interpersonal context. However, these context types are directly related to the concepts of *frame*, *situational context*, and *construal*, which are the basic pragmatic dimensions of terms that can generate variation. More specifically, texts belonging to different levels of specialization and knowledge fields access different conceptual configurations (frames), which take place in a certain setting (situational context). The text sender configures the sentential and conceptual context of his/her discourse with a purpose in mind for a group of receivers to achieve this goal (construal).

The reasons behind terminological variation can be found in these pragmatic dimensions of terms. Texts belonging to different levels of specialization and knowledge fields access different conceptual configurations or frames, which take place in a certain setting or context. The text sender configures his/her discourse with a purpose in mind and construes the information for a group of text receivers to achieve this goal.

Frame refers to the conceptual network or encyclopedic knowledge that any term gives access to. It is the result of the interaction between conventional, generic, intrinsic, and characteristic knowledge (Langacker 1987). Meaning, however, is modulated in different specialized contexts, which are often linked by means of metaphorical extension.

Situational context is a relational construct that relates the specialized communication act to its surroundings and participants. There is also a great deal of meaning implicit in the communication event itself. The first component of a specialized context resides in the terms themselves, their collocations, and the text as a whole. Apart from the informative function, scientific and technical texts must also justify, argue, and persuade receivers of the reliability of information. One way of establishing credibility is through the precise use of terminology and the clear and coherent structure of the text. Nevertheless, for a specialized text to achieve its communicative

objectives, the information must also be packaged in the right format. When the superstructure of the text corresponds to the profile stored in the receiver's long-term memory, this is a powerful inference-making mechanism, which transfers all of the properties of the stored text profile to the text being perceived. In fact, this type of resemblance can be responsible in itself for the success of the communication act.

Construal is related to speaker perspective, the speech act involved, and the communicative intention of the sender when he/she uses one term instead of another with a similar meaning. It is directly linked to the way information is structured and conveyed in a text in function to knowledge that is presumably shared by the text sender and receivers. In a specialized text, shared knowledge is implicit in the use of terms without definitions and references to methods and process, which are not explained because the text receivers are supposed to be familiar with them.

Alternate text construal may occur when the same or similar content is transmitted in a text for a group of receivers with another knowledge level. In popularized scientific discourse, this means that terms refer to concepts at the basic level of the conceptual system. Although in specialized language, construal or speaker perspective often reflects the knowledge shared by the participants in the act of communication, it can also reflect the ideological stance of the text sender through the use terms that reflect his/her belief system.

The pragmatic dimension of terms and how pragmatic parameters affect terminological variation and information structure point to the importance of contextual information in term entries as a way of enhancing and enriching definitions (Section 4). A context should thus be more than a text excerpt containing the term, which has been randomly extracted from Internet or another outside source. For this reason, Frame-based Terminology has a micro-theory for linguistic context selection (4.1) and another for graphical or image context selection (4.2).

The main purpose of a linguistic context is to widen the knowledge horizon of text receivers since a meaning definition is always an underspecification, and is not sufficient by itself to provide the user with a full understanding of the term. A knowledge-rich context links the information within the term entry to the domain event, and helps the term base user activate mental spaces during the on-line process of meaning construction.

In fact, properly selected contextual information allows users to create a blended space conducive to understanding and reducing complexity. This is done by the compression of vital relations that link two elements or properties in different mental spaces. Contexts should be selected according to one of the following premises:

- The context is related to the definition of the concept through the relations expressed in the definition.
- The context focuses on a secondary relation (one not expressed in the definitional template).
- The context related the concept to other concepts in the same domain or to concepts in other domains.

Context selection thus entails the establishment of a direct connection between the potential relations between concepts and the vital relations used to construct meaning. Decisions regarding the relevance of domain knowledge in contexts are based on the combined analysis of knowledge-rich contexts, knowledge patterns and vital relations. This involves determining the amount of knowledge contained in the context, or whether it is knowledge-rich (i.e. meaningful or defining). Knowledge patterns reflected in linguistic markers are used to relate the context to the concept being defined. Context selection is thus based on the intersection of knowledge richness and patterns that are directly related to vital relations.

Graphical information also provides specialized knowledge contexts in term entries, and is extremely useful for describing concepts since it enhances comprehension and complements the linguistic information in other data fields. However, despite the usefulness of graphical information, it is often inserted quite randomly in knowledge resources without any consideration of the type or characteristics of the image. We maintain that graphical material should be selected so as to be consistent with linguistic description, the level of specialization of the text, and the text receivers' subject knowledge. In this regard, we have proposed a micro-theory that explains how graphical information converges with linguistic information to give users a better understanding of dynamic concept systems. It includes a grammar for images in which specialized knowledge concepts are organized in a cognitive-semiotic typology, based on their morphological, syntactic, semantic, and pragmatic components.

In Frame-based Terminology (FBT), mental images and image schemas are the two types of internal representation that best define the role of graphical information in specialized knowledge acquisition processes. The knowledge visualization process implies the conversion of image schemas into mental images to link new concepts with previously stored knowledge. They can also activate linguistic information in the form of specialized knowledge units. FBT advocates a multimodal description of specialized concepts in which the information in terminographic definitions meshes with the visual information in images. In this regard, images can be said to have a combinatorial potential as well as a grammar.

Visual syntax is composed of the combinatorial patterns of the morphological elements in an image, which can be qualitative or quantitative. Images also have a semantic component in that they transmit information about the world, and are used to communicate ideas. In this sense, images have a denotative meaning, derived from their salient semantic features. However, they can also have a connotative one, which leads the perceiver to evoke associated concepts arising from a subjective reading of the image. The pragmatic component of an image grammar refers to the characteristics that an image should have in order for a text sender to successfully convey his/her message to the receivers by using graphical material. This evidently includes the specification of the functional role of images (see Table 43).

In EcoLexicon, the functions, *reiterate*, *organize*, *explain*, and *interpret*, are used as selection criteria for images. Graphical material complements the linguistic information in term-entry definitions and reinforces the conceptual relations activated in term-entry definitions. Images are also classified in terms of their most salient function or in terms of their relationship to the real-world entity that they represent. Accordingly, the image typology proposed in FBT is based on the criteria of iconicity, abstraction, and dynamism as ways of referring to and representing specific attributes of specialized concepts. These features are combined to generate eight image profiles, which are an important factor in determining the adequacy of an image for a given representational context.

This book has provided a description of Terminology, specialized language, translation, and the elaboration of terminological resources from a cognitive perspective. We have explained how Cognitive Linguistics can be used as a theoretical basis for the analysis, representation, and configuration of specialized knowledge units as well as a foundation for micro-theories for linguistic and graphical context selection. More concretely, we have shown how basic concepts from Cognitive Linguistics have been implemented in Frame-based Terminology, and applied in the knowledge-oriented terminological resource, EcoLexicon.

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