Linking Images and Words: the Description of Specialized Concepts[1]

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Abstract
A crucial issue in terminology management is how specialized concepts should be represented so as to provide the user with an adequate understanding of their meaning as well as sufficient knowledge of their location within the general conceptual structure of a scientific or technical domain. Such a conceptual representation should contain information in various formats. In this regard, linguistic and graphic descriptions of specialized entities play a major role in knowledge representation, especially when both converge to highlight the multidimensional nature of concepts as well as the conceptual relations within a specialized domain. In this article, we explore the nature of the links between the linguistic and graphic description of specialized concepts. In a multimodal conceptual description, we believe that the structured information in terminographic definitions should mesh with the visual information in images for a better understanding of complex and dynamic concept systems.

1 Introduction

Terminography focuses on the representation of specialized concepts, more specifically, on the macro and micro-structural design of term entries. Since the ultimate purpose of any terminological resource is to facilitate and enhance knowledge acquisition, the information contained in term entries should be internally as well as 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.

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The wider set of options available for linguistic resources in electronic format has generated a corresponding debate regarding how specialized concepts should be represented so as to provide the user with an adequate understanding of a particular concept as well as sufficient knowledge of its location within the general conceptual network of a scientific or technical domain. In our view, such a representation should include information in both linguistic and graphic formats. It is our assertion that linguistic and graphic descriptions of specialized entities play a major role in the understanding process when both types of description converge to highlight the multidimensional nature of concepts[6] as well as the set of conceptual relations typical of a specific subdomain.

2 Describing concepts

We are currently engaged in a research project on knowledge representation in the domain of Coastal Engineering.[7] One of the products contemplated is a multimedia terminological knowledge base for this specialized field. The elaboration of this terminological resource has caused us to explore in some depth the nature of the links between the linguistic and graphic description of concepts. In a multimodal conceptual description, we believe that the structured information in terminographic definitions should mesh with the visual information in images in order to provide a deeper understanding of complex and dynamic concept systems.

2.1 The linguistic description of concepts: terminographic definition

According to Bejoint (1997: 19-20) definitions have never been given due importance in Terminology. In many terminological databases, definitions are simply inserted in a cut-and-paste fashion from other dictionaries, term bases, or knowledge resources, without taking into consideration both their internal as well as external coherence. However, definitions are mini-knowledge representations, and accordingly, the organization of information encoded in definitions should 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 2002). As shall be seen, it is also necessary to complement and enhance this information with images that highlight the different types of conceptual information within each definition.

According to Grinev and Klepalchenko (1999), the description of specialized domains should be based on the events that generally take place in them, and can be represented accordingly. Within our coastal engineering knowledge base, concepts are organized according to their conceptual category. The most generic categories are configured in a prototypical

[6] Bowker and Meyer (1993) and Bowker (1997) advocate a multidimensional representation for concepts in specialized domains.

[7] PuertoTerm is a research project whose principal objective is the generation of terminological resources for the representation of specialized concepts in the domain of Coastal Engineering.

domain event or action-environment interface (Barsalou 2003: 513; Faber et al. 2005), which provides a frame for the organization of more specific concepts:

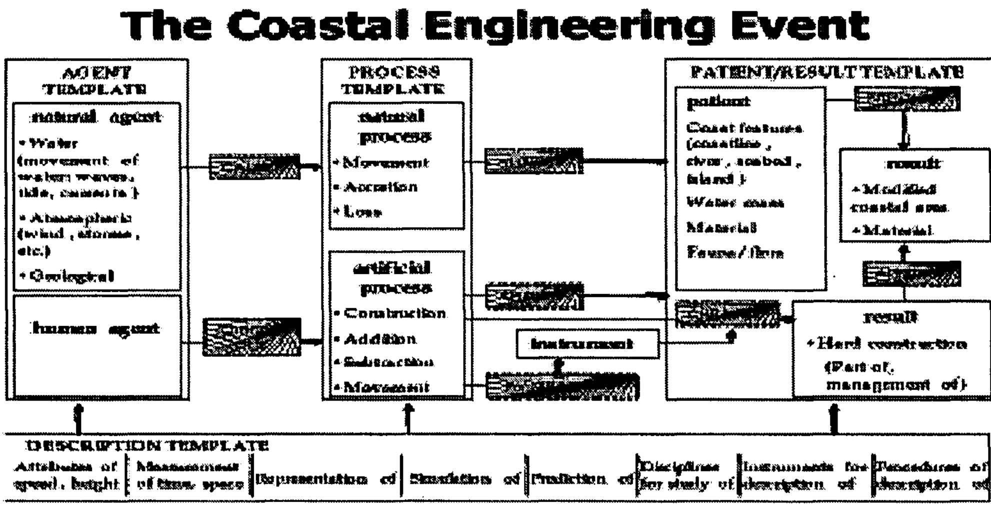


Figure 1. Coastal Engineering Event

As shown in Figure 1, our Coastal Engineering Event (CEE) is conceptualized as a dynamic process that is initiated by an agent (either natural or human), and which affects a specific kind of patient (a coastal entity), and produces a result. These macro-categories (AGENT PROCESS PATIENT/RESULT) are the concept roles characteristic of this specialized domain, and the CEE provides a model to represent their interrelationships. Additionally, there are peripheral categories which include INSTRUMENTS that are typically used during the CEE, as well as a category where the concepts of measurement, analysis, and description of the processes in the main event are included.

The more specific concepts within each category are organized in a hierarchical network in which they are linked by both vertical (hierarchical) and horizontal (non-hierarchical) relations. In the database, these concepts can be accessed by clicking and activating the hyperlink in the relevant macro-category. In the following sections, we use the concepts of GROYNE and BEACH NOURISHMENT to show how both the linguistic and visual descriptions in each term entry are used to reflect conceptual structure and relations.

2.1.1 Groyne and beach nourishment

In coastal engineering, 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 natural or human agent. One of the activities that a human agent can carry out is *construction* (artificial process). Construction results in a maritime structure, which is the category that groyne and other similar hard coastal defense structures belong to.

On the other hand, **beach nourishment** represents the process of replenishing an eroded beach with new material in order to serve the same purpose as groynes. Therefore, it entails an artificial process implemented by a human agent. It thus belongs to the *addition* category, in the same way as all other soft coastal defence techniques.

As we shall see, both **groyne** and **beach nourishment** are both part of the same mini-conceptual network, which is more meaningful since it is placed within the context of the prototypical event. In spite of belonging to two different macro-categories (PROCESS and RESULT), the link between soft and hard beach stabilization approaches is evident since they share the same basic function, and are both types of coastal defence solutions.

The linguistic description of any concept should accomplish the following: (1) make category membership explicit; (2) reflect its relations with other concepts within the same category; (3) specify its essential attributes and features. As shall be seen, the definitions of **groyne** and **beach nourishment** fulfil all of these conditions.

The definitions that we have formulated are based on those found in other dictionaries and terminological resources that reflect the shared knowledge of specialized concepts. The analysis of such 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. For this type of analysis, three or more terminographic resources (as well as expert validation) are used in order to obtain a consensus of the meaning components for each term. As shall be seen, the final structure of the definitions in each conceptual area is based on the same underlying template. The following diagram shows a segment of the definitional hierarchy in which **groyne** and **beach nourishment** are located:

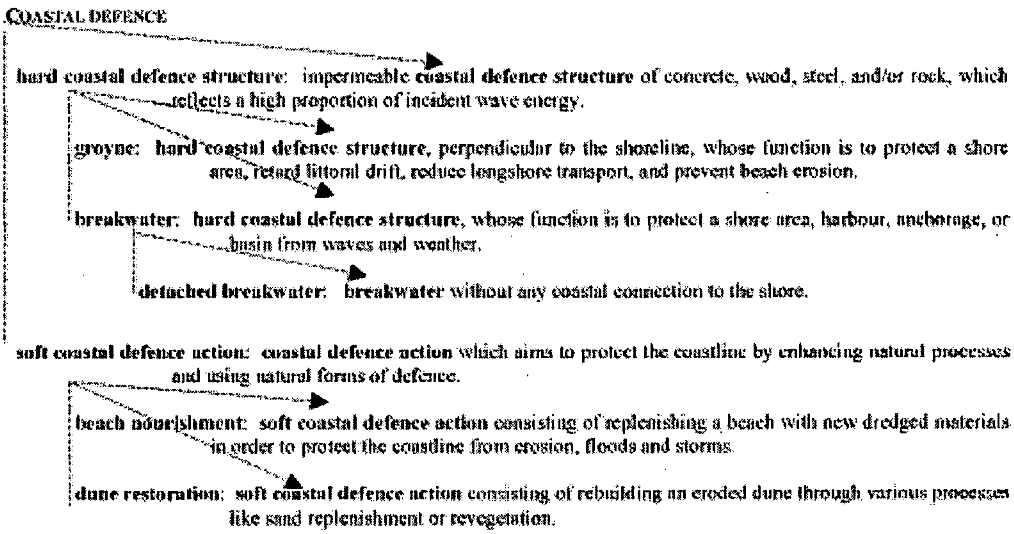


Figure 2. Segment of the definitional hierarchy of *coastal defence*

As shown in Figure 2, the genus or nuclear part of each definition is indicative of the IS-A relationship, and as a result, marks its membership in a specific category as well as its degree of specificity. In the case of **groyne**, the genus (i.e. *hard coastal defence structure*) marks: (1) its membership in the generic category of COASTAL DEFENCE; (2) its relationship to the immediately superordinate concept **hard coastal defence structure**; (3) its coordinate relationship with **breakwater**. As for **beach nourishment**, the genus (i.e. soft coastal defence action) also highlights: (1) its membership in the generic category COASTAL DEFENCE; (2) its relationship to the inmediately superordinate concept **soft coastal defence action**; (3) its coordinate relationship with **dune restoration**.

Furthermore, the adverbial modification or *differentiae* in the definitions also provides valuable information because these are the characteristics that distinguish one concept from another within the same category. In this sense, Barsalou (1992) affirms that features implicitly show a number of attributes and values that should become explicit in frames. In Terminology, they also establish parameters for the creation and organization of more specific terminological units. The analysis of the characteristics lexicalized in *differentiae* provides the defining features of **groyne** and **beach nourishment**, and also points to non-hierarchical relations that must be taken into account in any multidimensional representation of the concepts. In fact, they constitute the parameters that categorize the various subtypes of **groyne**. These parameters can be observed in the following template that underlies the definitions of all the terms designating hard coastal defence structures:

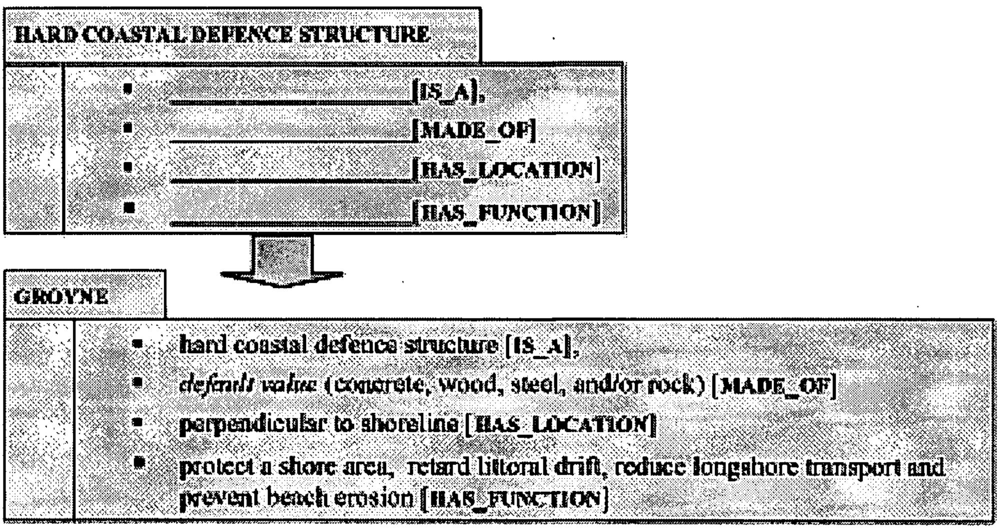


Figure 3. Activation of the definitional template for hard coastal defence structures in the definition of **groyne**

As shown in Figure 3, the definitional template for **hard coastal defence structure** has four types of conceptual relations: (1) IS_A; (2) MADE_OF; (3) HAS_LOCATION; (4) HAS_FUNCTION.

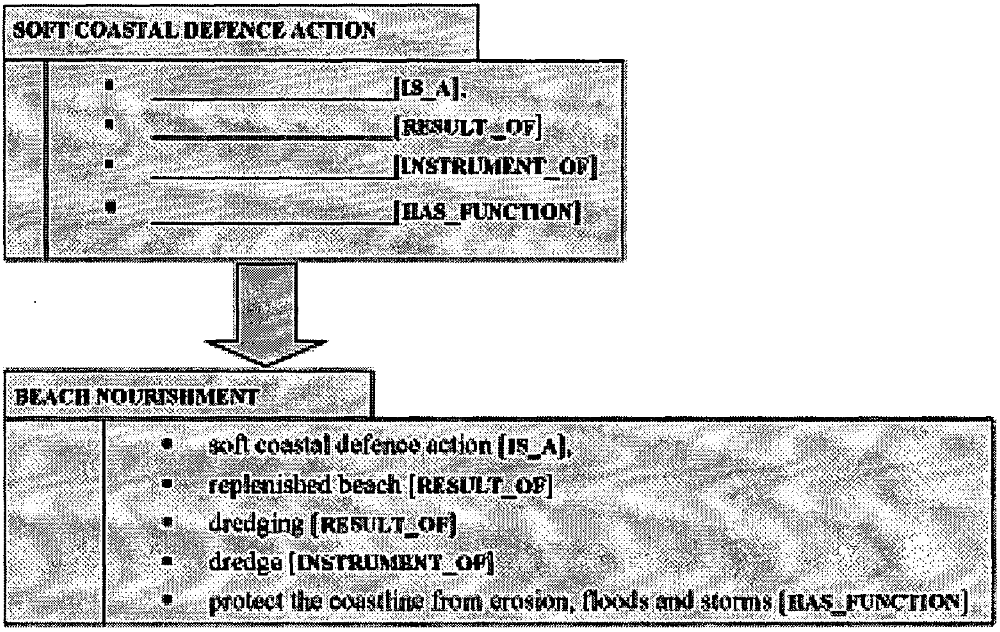


Figure 4. Activation of the definitional template for soft coastal defence action in the definition of **beach nourishment**

In Figure 4 the definitional template for **soft coastal defence action** also displays four types of conceptual relations: (1) IS_A; (2) RESULT_OF; (3) INSTRUMENT_OF; (4) HAS_FUNCTION. Thus, a COASTAL DEFENCE template would activate the common relations IS_A and HAS_FUNCTION. Whereas in the case of **hard** and **soft solutions**, conceptual relations vary in accordance with the nature of the concepts. Since **hard coastal defence structures** are objects and **soft coastal defence actions** are regarded as processes, their definitions show 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 involved.

The linguistic description of **groyne** and **beach nourishment** as well as all their coordinate and subordinate concepts within the conceptual area follows these templates insofar as type, quantity, and configuration of information are concerned. In this way, definitions show a uniform structure that complement the information encoded in the conceptual system, and directly refer to and evoke the underlying event structure of the domain. These templates can be considered a conceptual grammar for the description of all types of coastal defence within the Coastal Engineering domain, and thus ensures a high degree of systematisation at the micro-structural level.

On a macro-structural level, the template is in consonance with the dimensions specified for the designation of both concepts as shown in the network in Figure 5.

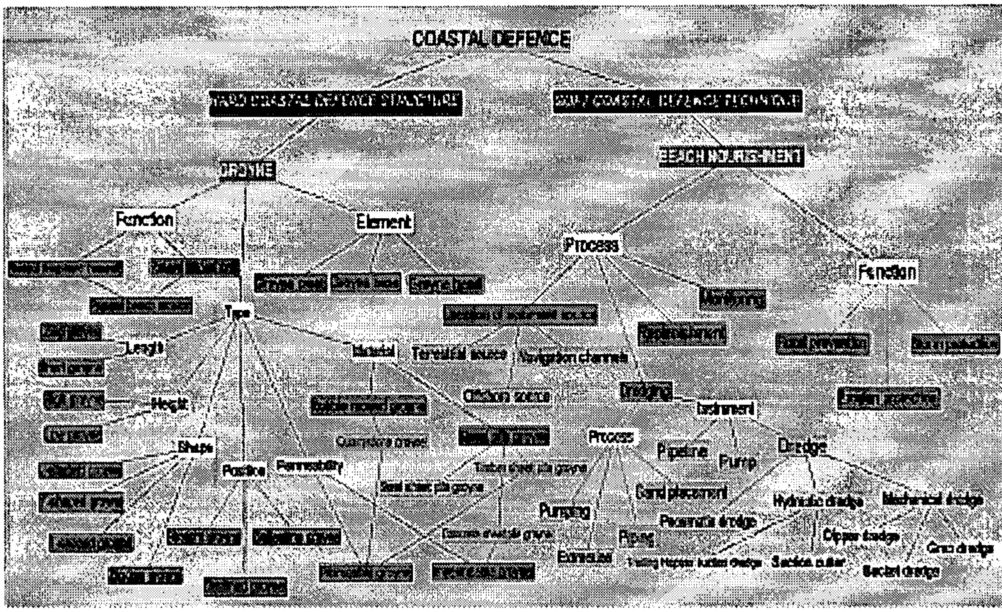


Figure 5. Conceptual network for **groyne** and **beach nourishment**

Horizontal relations are thus essential for dynamic knowledge representations, because they enhance conceptual structure by enriching networks and encoding multiple relations between concepts (Faber 1999).

2.2 Typology of graphic information

However definitions are not the only means of describing concepts. Images are also an important resource for this purpose. The inclusion of different types of visual representation is imperative in specialized knowledge fields, since images enhance textual comprehension and complement the linguistic information provided in other data fields. However, it is crucial that such images be chosen in a principled way so as to be in consonance with linguistic description.

Traditionally, images have been classified according to their morphology in categories of photographs, drawings, animations, videos, diagrams, charts, graphics, schemes, views, etc. (Darian 2001; Monterde 2002). However, it is more useful to categorize images 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. We have thus based our typology of images on the criteria of *iconicity*, *abstraction* and *dynamism* as ways of referring to and representing specific attributes of specialized concepts.

• Iconic images resemble the real-world object represented through the abstraction of conceptual attributes in the illustration.

• 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).

• Dynamism implies the representation of movement (i.e. video and animation, as well as images showing different stages of a superordinate process respectively). However, such a representation need not include explicit movement if it illustrates the succession of discrete steps that make up the process.

3 Linking conceptual descriptions and images: GROYNE and BEACH NOURISHMENT

As previously mentioned, the inclusion of images in term entries is based on the conceptual relations activated in the definition of the concept. In this respect, and in accordance with the definitional template for **hard coastal defence structure** and **soft coastal defence action**, the graphic resources in our image database highlight at least one of the following conceptual relations, IS-A, LOCATION-OF, MADE-OF, INSTRUMENT-OF, RESULT-OF and HAS-FUNCTION and for the concept that they represent. They achieve this through iconicity, abstraction, and/or dynamism.

Iconicity is widely used in the representation of different types of coastal structures. The resemblance of the illustration to the real-world entity allows the user to identify the object or process in question by inferring its basic characteristics and linking them to previously stored knowledge structures. Iconicity is also present in the linguistic description of the concept as well since the characteristics of the generic term are included in the genus of the subordinates. The use of a definitional template means that all of the definitions of category members will resemble each other to some degree.

Iconic images are especially prevalent when it is necessary to represent non-hierarchical relations, such as MADE-OF, which link the structure to the material that it is composed of (Fig. 6), and INSTRUMENT-OF which shows the entity used to carry out an action (Fig. 7).

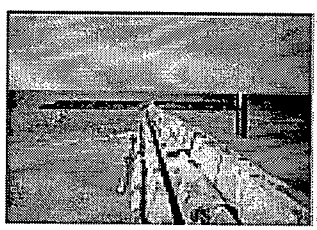


Figure 6. Concrete groyne: the conceptual relation MADE-OF.

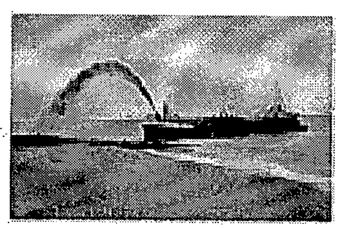
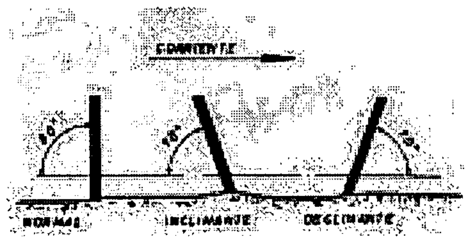


Figure 7. Beach nourishment: conceptual relation INSTRUMENT-OF.

The level of abstraction can facilitate the understanding of conceptual relations such as LOCATION-OF and IS-A. For example, in regards to **groyne**, location can be understood as the position of the coastal structure in reference to the shoreline (Fig. 8), or it can be understood as its position in reference to the sea bottom (Fig. 9). The abstraction of these images highlights this particular relation, while others such as groyne type, material, or function are left out of the spotlight and thus not focused on.



Figures 8 and 9. Representation of the conceptual relation HAS_LOCATION [POSITION] and HAS_LOCATION [SPATIAL CONFIGURATION]

In contrast, BEACH NOURISHMENT is an action, and can thus understood as a sequence of phases. In this case, the IS-A relation is encoded by images with a certain degree of abstraction. As shown in Fig. 10, the use of textual description facilitates understanding of its temporal and spatial location as well as of all of the factors of the process.

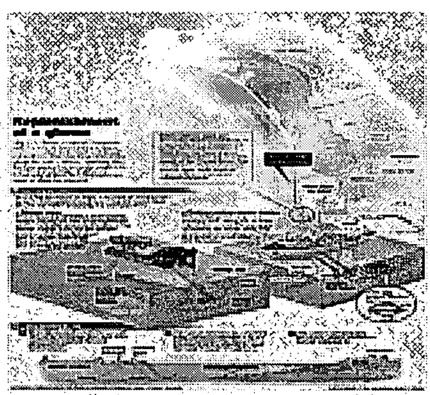


Figure 10. Representation of the conceptual relation IS_A

In a similar way, and given that BEACH NOURISHMENT is an action carried out over a period of time, the relation RESULT-OF is best represented by abstract images that make explicit reference to the temporal nature of the process (Fig. 11):

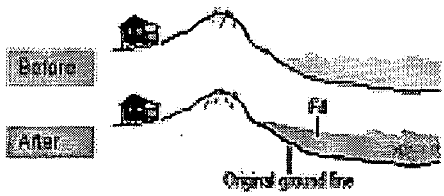
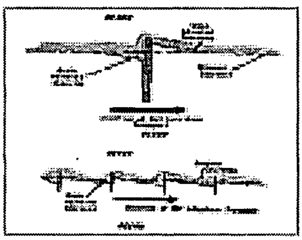
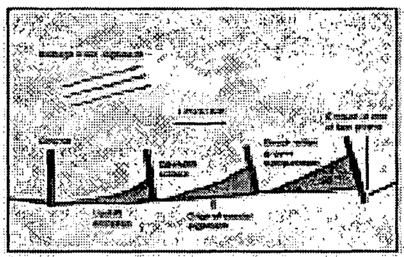


Figure 11. Beach nourishment: the conceptual relation RESULT-OF

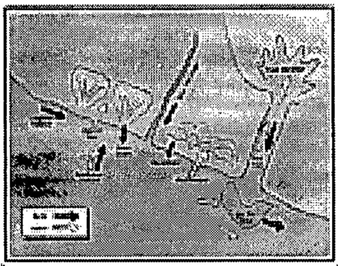
Finally, the relation HAS-FUNCTION is generally represented by dynamic images. Function is one of the most important features for the description of both hard and soft coastal defence solutions since such structures are often constructed or implemented to cause a certain (positive) effect, but all too often bring about unforeseen negative changes in the coastal environment. Since the illustration of a function generally means representing a process, dynamism should be present in the graphic representation, though evidently, this does not exclude the presence of degrees of iconicity or abstraction. Figs. 12a and 12b are two dynamic illustrations that represent the positive and negative effects of groynes on a shoreline.

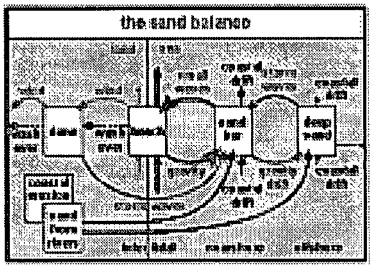




Figures 12a and 12b. Groyne-adjusted shoreline:
representation of the conceptual relation HAS_FUNCTION

Sometimes one illustration may not be enough to represent complex conceptual relations such as HAS_FUNCTION. The combination of two dynamic images (Figs. 13a and 13b) can be used to designate the protective function stated in the definition. Fig. 13a shows the different coastal processes responsible for sand gains and losses, whereas Fig. 13b represents the sand balance, whose recovery and restoration is evidently the main objective of beach nourishment.





Figures 13a and 13b. Combination of two dynamic images: representation of the conceptual relation HAS_FUNCTION

In these figures, dynamism is achieved through the use of different symbols, such as arrows (representing movement), and textual information that link the pictures to the real world. Nevertheless, since they 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 at the same time that beach nourishment provides a deposition of dredged sediments. As a consequence, they jointly contribute to an accretion of sediments in order to prevent beach erosion.

Consequently, the entries for **groyne** and **beach nourishment** are accompanied by a set of images whose iconicity, abstraction, and/or dynamism are in consonance with the information in their respective definitions or linguistic description. The visual focus of each image is centred on a specific conceptual relation that is lexicalized in the terminographic definition. The linking of linguistic and graphic information that is in accordance with a definitional template typical of the conceptual area affords a more complete description and comprehension of specialized concepts.

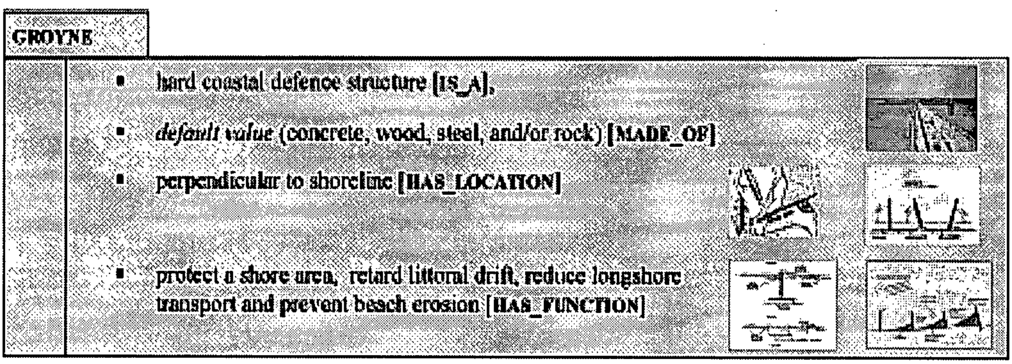


Figure 14. The convergence of linguistic and graphic descriptions of **groyne**

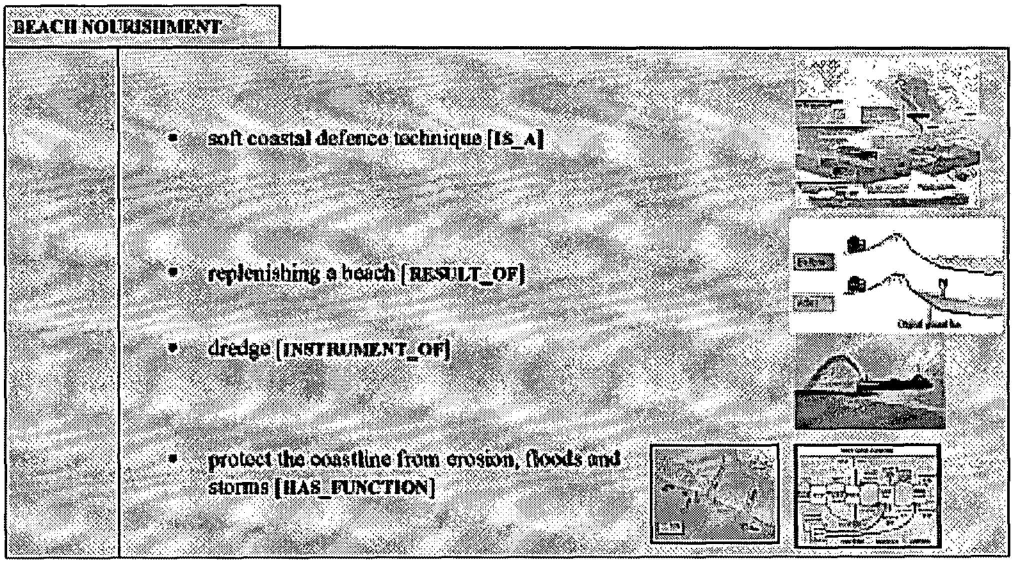


Figure 15. The convergence of linguistic and graphic descriptions of **beach nourishment**

4 Conclusions

In this article we have underlined the importance of interrelating different types of data in a terminological knowledge base in order to achieve a high level of internal and external coherence. This is a decidedly complex issue since a database that aspires to be a knowledge resource cannot be a mere repository for bits and pieces of information that have been scavenged from different sources and gathered together in a kind of terminological magpie's nest. Our assertion is that there must be interrelations between all elements in the data fields of term entries.

As shown in **groyne** and **beach nourishment**, their location within the Coastal Engineering Event informs us that they are coastal defences resulting from artificial processes initiated by a human agent. The linguistic description of these concepts must thus be in consonance with the definitions of other concepts in this area. The conceptual relations lexicalized in the templates abstracted from definitional structure form a relational set that is characteristic of all coastal defences.

In a parallel way, the graphic description of concepts cannot be random. Such images should be chosen in a principled way so as to be in consonance with linguistic description. Accordingly, illustrations must be selected that (1) focus on one or more aspects of the core template information as activated in the linguistic description of the concept; (2) possess the level of iconicity, abstraction, and/or dynamism that best portrays the attribute/s of the concept.

In conclusion, linguistic and graphic descriptions of specialized entities play a major role in the understanding process when both types of description converge to highlight the multidimensional nature of concepts as well as the set of conceptual relations typical of a specific subdomain.

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