

# A General Organization of Knowledge for Natural Language Processing: the Penman Upper Model

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## Abstract

A general, reusable computational resource has been developed within the PENMAN text generation project for organizing domain knowledge appropriately for linguistic realization. This resource, called the upper model, provides a domain- and task-independent classification system that supports sophisticated natural language processing while significantly simplifying the interface between domain-specific knowledge and general linguistic resources. This report provides a more or less complete description of the upper model as released as an integral part of the PENMAN text generation system. It includes descriptions of all the concepts defined, their interrelations, and their consequences for realization through the NIGEL grammar of English.

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# 1 Introduction

This report describes in detail the PENMAN upper model<sup>2</sup> as provided with the second release of the PENMAN system in 1989; it represents the state of our thinking at that time concerning what should be in the upper model and the version which was made generally available in the first full release of the PENMAN text generation system. It supercedes **A Hierarchy for Entities** (Moore and Arens, 1985), building on that report in organization and for the definitions of some of the concepts that have remained unchanged.

The PENMAN system has been designed to be a portable, reusable text generation facility which can be embedded in many kinds of computational systems. The linguistic core of PENMAN is NIGEL (Mann, 1983), a large systemic-functional grammar of English based on the work of Halliday (Halliday, 1985) with contributions made by several other systemic linguists. The organisation of the NIGEL grammar has made it a particularly useful resource for goal-driven text generation. The construction of grammatical structure is decomposed into a large network of interdependent points of minimal grammatical contrast, called 'systems'. Each of these systems defines a collection of alternatives called grammatical features. When generating a sentence, one feature must be chosen from each system that is appropriate given the interdependency connections between features and systems that the grammar network defines. These choices are made responsive to particular communicative goals by associating with each system a decision procedure called a 'chooser'. Choosers permit the grammar to base its construction of grammatical structure on information drawn from a variety of distinct sources external to the grammar, known collectively as NIGEL's environment. This flow of information is mediated by semantic 'inquiries', which are specified questions that choosers are allowed to put to the environment. Thus, the semantic interface of the NIGEL grammar is defined by the set of inquiries that it may ask. For details of all aspects of the PENMAN system and the NIGEL grammar, see PENMAN (1989a,b).

PENMAN also provides structure for some of the grammar-external sources of information, and the upper model is currently the most significant of these to have been developed. The upper model is typically used to mediate between the organisation of knowledge found in an application domain and the kind of organisation that is most convenient for implementing the grammar's inquiries. Defining a relation between the knowledge concepts of any domain and the concepts of the upper model has been found to simplify the task of generation significantly.

The development of the upper model has thus been primarily motivated by the demands of text generation. One crucial task in text generation is to control the linguistic resources of a grammar. The upper model aids in this task by providing an organization of the 'propositional content' type meanings that need to be expressed. This organization is linked to the grammar component of PENMAN in such a way that the grammar knows how each upper model distinction may be expressed in English. Organizing one's input to PENMAN using the terms that the upper model provides therefore subsumes a significant portion of the work of deciding how that input is to

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<sup>2</sup>Or 'upper structure', as it was first named and set out in Mann (1985).

be expressed. This provides a semantically oriented specification for text generation that abstracts away from superficial details of syntactic form, thereby simplifying the control task (cf. Bateman, 1990a).

At present, the upper model is defined in a hierarchical property-inheritance network of concepts useful for deciding between differing forms of expression in English during text generation. A claim of the present conception of the upper model is that two different concepts in the upper model will differ in linguistic realization: i.e., they will differ in respect to the features that are selected within the grammar during generation. Further, these differences are respected by the property inheritance: it is possible to state for each concept in the upper model the fragments of grammatical or lexical organization that will be used to realize it (and any concept below it in the inheritance hierarchy). This is the primary use of the upper model in its present form. Subordinating a concept from an application domain to a concept in the upper model strongly constrains the range of linguistic realizations that are available for the domain concept. Since the upper model concept is known to PENMAN, information describing those realization possibilities for the domain concept need not be repeated in the input given to the generation system. Therefore, the value of the upper model for a user of the generation system is that s/he can ignore the problem of specifying grammatical form and simply work either in terms of the more abstract semantic groupings of the upper model or in terms of the domain concepts subordinated to it. Detailed examples of the use of this upper model in providing input to the PENMAN system in terms of the Sentence Plan Language (Kasper, 1989) are provided in PENMAN (1989b).

The model described in this document consists then of a hierarchy of concepts. This hierarchy is broken up into several subhierarchies as will be described below. Each concept in the hierarchy, and its positioning within the hierarchy, entails knowledge about how that concept (and therefore its descendants) is expressed in natural language. The process of expression is implemented in terms of *inquiry definitions* that the grammar makes use of during generation. In addition, the document may contain general rules about how concepts in one subhierarchy interact with concepts in other subhierarchies. Examples of specific knowledge will be seen as we discuss each of the subhierarchies and the concepts they contain. We will *not* be discussing the theoretical status of either the hierarchy itself or of the individual concepts of which it is composed. The intention of this document is to clarify the organization that has been found useful and necessary for the generation of text within the current version of the PENMAN system.

In describing the classification of entities into the hierarchy, the only motivations offered here will be the consequence of class assignment on linguistic realization. It has also been a concern during the development of the upper model to ensure that its concepts are *semantically* well motivated. We will not focus on this aspect of the upper model in this paper, nor on the theoretical issues that it raises; nevertheless, the description of a class will typically consist of an informal description of the characteristic semantic properties of members in the class and, in some cases, a "test" for determining membership in the class. These tests are meant to give the reader an idea of what entities go into a given class and to help in categorizing entities in terms of their required linguistic realizations; they are not intended to be computationally

feasible. In a few cases we give illustrative further subclassifications that could be built into the upper model if the grammar were also appropriately extended.

Classes are also described in terms of the areas of the grammar that they influence, i.e., the range of variation for which they are responsible. This must be taken as the deciding criterion as far as subordinating domain concepts to the upper model for text generation is concerned since it is this that determines the generator's behavior.

Finally, an alphabetical listing of all the concepts of the upper model, with short definitions of each, is provided as an appendix.

## 1.1 Development note

The upper model hierarchy has been under development over a number of years, and was originally outlined based on work by M.A.K. Halliday (Halliday, 1982), William Mann (Mann, 1985), and Christian Matthiessen. The upper model can be seen in part as a computational implementation of a long term ongoing project of Halliday and Matthiessen called the *Bloomington Lattice* (Halliday and Matthiessen, in preparation). The upper model's development has benefitted from attempts to extend the model for the concepts necessary for a variety of domains for which text generation has been attempted; these have included concepts in a domain of computer mail and calendars (e.g.: Sondheimer *et al.*, 1984; Mark, 1981), efforts to employ the upper model as a basis on which to build a knowledge base for an experimental (explainable) expert system for improving LISP programs — the Program Enhancement Advisor (Moore and Swartout, 1990), similar efforts for an (explainable) expert system for Digital Circuit Diagnosis (Paris, 1990), a knowledge base of navy ship deployments (Hovy, 1990), and as a basis for performing machine translation between German and English (Bateman, Kasper, Schütz and Steiner, 1989; Bateman, 1990b). Versions of the present upper model have been defined in two KL-ONE-like knowledge representation languages, LOOM (MacGregor and Bates, 1987; MacGregor and Brill, 1989) and NIKL (Moser, 1983; Robins, 1986), and also in another knowledge representation system in use at ISI, HI-FI (Swartout and Smoliar, 1987). Although the currently supported version within PENMAN is constructed in LOOM, we will assume no familiarity with the particular details of any of these knowledge representation systems here.

## 1.2 The principal criterion for placement decisions

When attempting to place new concepts within the upper model hierarchy, or to subordinate concepts of the domain to those of the upper model, one must keep in mind that the major criterion for decisions is language use. We are interested in the nature of the world as reflected *through the language people use to describe and discuss it*. Generally speaking, an entity is a member of a certain class only if the language treats the entity as it does others in that class.

For example, we have for some domains subordinated the domain concept *computer* to the upper model concept *conscious-being* and not *non-conscious-thing*. This was done because people customarily talk about computers as active,

conscious entities, typically describing the activities and knowledge states of computers in language similar to that used when discussing the activities and mental states of humans: computers are often said to send messages, to process data, to run programs, to calculate results, etc.

We are making *no theoretical commitment* in this document to any particular organization used in the upper model; the concepts defined interact with the grammar as shown and thereby provide a usable framework for controlling a text generation system such as PENMAN. Theoretical issues, relations with other existing schemes of 'semantic relations/features', and some possible directions for future development are discussed in Bateman (1990a).<sup>3</sup>

One consequence of this principal criterion for placement within the upper model is that semantically counter-intuitive placements may occasionally be made. With the conception of the upper model as presented in this document, this is an unavoidable property of the framework of which the user simply needs to be aware. Reducing the frequency of this, while simultaneously maintaining grammatically well-specified consequences for upper model assignment, is one of the problems with an upper model that is a target of current research.

In addition, the knowledge base captures only a particular view of the world. Contrary to the current classification, a computer, even a person, may at times be viewed by us and treated by the language as an inanimate object. The knowledge base is designed to reflect the view most useful to the natural language processing system based upon it. For most purposes the upper model should not require any modification. However, there may be exceptions. No guarantee can be made that the upper model described here will be suitable for any particular purpose.

In particular, the relation between semantic organization, such as that which the upper model is attempting to capture, and grammar is also affected by the strategy of creating new modes of meaning known as *grammatical metaphor* (e.g., Halliday, 1985: Ch. 10). Here meanings represented grammatically in one way are re-represented as if they were of another kind; processes are represented as if they were things, modalities as if they were thoughts, commands as if they were questions, and so on. There are many different types of such metaphor; one type involves the representation of a temporal location as a perceiver in a process of perception, as in

*1987 saw the large producers and distributors playing it safer than ever before.*

Here the reason for selecting the metaphorical strategy is textual; the structure presents *1987* as unmarked Theme (the point of departure or local context of the clause) and groups *the large producers and distributors playing it safer than ever before* as one point of (new) information. The 'congruent', i.e., non-metaphorical, version would organize the information quite differently; e.g.:

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<sup>3</sup>Although we should note here that there are similarities to be drawn with other hierarchies of 'knowledge' that are currently appearing both in the service of natural language processing and in linguistic theorizing. One of the functions of the upper model theory paper (Bateman, 1990a) is precisely to clarify the interrelationships between these approaches. Meanwhile, since the upper model has been in active use and development in a functioning text generation system since 1985, we feel that it is now time to make that experience more widely accessible — both to aid the development of other hierarchies and to be influenced by them in its future development.

*the large producers and distributors played it safer than ever before in 1987.*

At present our capabilities for producing such 'non-congruent' expressions of information with respect to the organization defined by the upper model are extremely limited: some kinds of nominalizations are possible, for example, as are a few re-expressions of inter-clausal rhetorical relations within the clause *as*, e.g., purposes realized as circumstances, etc. Widely variant semantic interpretations we cannot handle: the upper model is, in fact, 'committed' to a certain view and at present we lack sufficiently flexible mechanisms for relating it to the grammar.

### 1.3 The Upper Model Hierarchy

The top entity in the upper model hierarchy is **thing**.<sup>4</sup> It has three descendants: **object**, **process**, and **quality**.<sup>5</sup> One can draw an analogy between these classes and the familiar linguistic notions of noun, verb, and adjective. **Objects** are those things that are typically classified as nouns, **processes** correspond to verbs, and **qualities** to adjectives. This analogy is rough, but is useful to keep in mind and gives a sense of the connection between placement in the upper model and classes of linguistic realization. Most concepts call both for much finer constraints on their possible realizations and for a broader range of possible realizations.<sup>6</sup>

The **process**, **object**, and **quality** subhierarchies are presented in more detail in the following sections.

## 2 The Process Subhierarchy

### 2.1 Introduction to processes

#### 2.1.1 Systemic Perspectives on Process

Since the organization of the upper model is strongly motivated by the informational requirements of the computational systemic-functional grammar NIGEL used within the PENMAN system, it is useful to consider briefly the account of 'processes' that the systemic model adopts. Halliday (1985:101) states that a process potentially consists of three components:

- the process itself,

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<sup>4</sup>The typographical conventions in this paper are as follows: upper model concepts are written as concept; these concepts may have roles defined for them, the roles are written as *role*. Domain concepts, where used for illustrative purposes, are written as *domain-concept*.

<sup>5</sup>If you are working with an actually loaded version of the system that was defined in NIKL, rather than LOOM, and can graph the upper model online, a concept 'relation' also appears. This is a NIKL-internal concept and is not to be considered as part of the upper model.

<sup>6</sup>And indeed both of these areas are current directions of active research with the PENMAN project.



- participants in the process,
- circumstances associated with the process.

The process itself is typically realized by a verbal group. Entities classified under process can usually be expressed as verbs and are frequently the main verb in a clause. Participants in a process typically come from the object hierarchy and are realized as nominal groups, although there are, obviously, exceptions — such as processes which relate processes themselves in addition to objects (e.g., causality, or mental processes that describe propositional attitudes, etc.). Circumstances are usually taken from the circumstance hierarchy and often appear as prepositional phrases. While the participants of a process are considered to be in some sense essential to the performance, or 'actualization', of the process, circumstances provide additional contextualizing information such as temporal and spatial location, manner of performance of the process, purposes, etc. The precise distribution of participants and circumstances depends on the type of process.

From the systemic-functional perspective, process is seen as central with participants linked most tightly to that process (consisting minimally of the 'Medium' participant, see below, and then possibly others in addition as required by the process), and circumstances less tightly; this is depicted graphically in Figure 1. This broad scheme of organization is based on linguistic generalizations across the range of clause types in English. Most current syntactic theories now recognize this kind of separation into essential participants and more circumstantial elements. Terms often used are 'bound' elements, inherent roles (Fawcett, 1987:134), theta roles, thematic relations (Jackendoff, 1983, 1987), predicate-argument structures (Bresnan, 1982), etc.

Another dimension of organization drawn specifically from systemic-functional linguistics that will be of use in our descriptions of processes and participants below is that which contrasts the *transitive* model of participancy in processes with the *ergative* model (cf. Halliday, 1985:144-149). A typical transitive interpretation of clause structure is in terms of an *actor* acting upon some *goal* where what is brought into focus is a dimension of *extension*:

"the Actor is engaged in a process; does the process extend beyond the Actor, to some other entity, or not? So *the lion chases the tourist* relates to *the lion ran*: 'the lion did some running; either the running stopped there (intransitive, *the lion ran*), or else it extended to another participant (transitive, *the lion chased the tourist*).'" (Halliday, 1985:145)

Halliday suggests that it is also necessary to provide a complementary analysis in terms of an *ergative* model where the focus is one of *causation* rather than of extension. Here the question is:

"Some participant is engaged in a process; is the process brought about by that participant, or by some other entity? In this perspective, *the lion chased the tourist* relates not so much to *the lion ran* as to *the tourist*

*ran*: 'the tourist did some running; either the running was instigated by the tourist himself (intransitive *the tourist ran*), or else by some external agency (transitive *the lion chased the tourist*)'." (Halliday, 1985:145)

Pairs such as:

*The burglar broke the vase / The vase broke*  
*Mary sailed the boat / The boat sailed*  
*The news weakened my resolve / My resolve weakened*

are accordingly said to form ergative/non-ergative pairs rather than the more familiar transitive/intransitive pairs. And, in this perspective, the participant that is common to both members of a pair is functionally labeled as the MEDIUM. This is considered to be the key figure in every process: "the one through which the process is actualized, and without which there would be no process at all." (Halliday, 1985:146)

For the transitive interpretation we find basic configurations of participants such as *actor* and *goal*, whereas from the ergative standpoint we find configurations such as *agent* and *medium*. The participants *actor* and *agent*, and *goal* and *medium* need not correspond and so both dimensions of organization need to be maintained to obtain maximally adequate analyses.<sup>7</sup> In our descriptions of processes and participants below, we will occasionally refer to this interpretation of events; in particular, we will need to refer to the *medium* participant in a process as that participant most centrally concerned or effected.

### 2.1.2 Representational perspectives on process

Currently, the upper model is represented in NIKL and LOOM. Here, each process is represented as a 'concept'. NIKL and LOOM concepts may have a variety of 'roles' which take further concepts as their values. These role values may be restricted either in number, by 'number restrictions' placed on roles in the definition of concepts, or in value, by 'value restrictions', which specify which types of concepts are permitted to act as values for a given role (cf. MacGregor and Brill, 1989). Each representation of a process as a concept defines a role for each of its participants. That is, the roles that correspond to the obligatory participants of a process will be constrained (typically by a *number* restriction) to occur on all subclasses of the concept representing the process. An example LOOM definition for the process type **material-process** (described below) is shown in Figure 2. Here we see that **material-process** is defined to be a subtype of the concept **process** and all **material-processes** are constrained to possess at least one participant, which is further constrained to be a role of type *actor*. We will see as we discuss more specific classes of processes that there are particular kinds of participant roles associated with different types of processes. Furthermore,

<sup>7</sup>See Tables 5(18) and 5(20) in Halliday (1985:148 and 155) respectively for useful clarifications of the interrelationships of the ergative and transitive views on process participants.

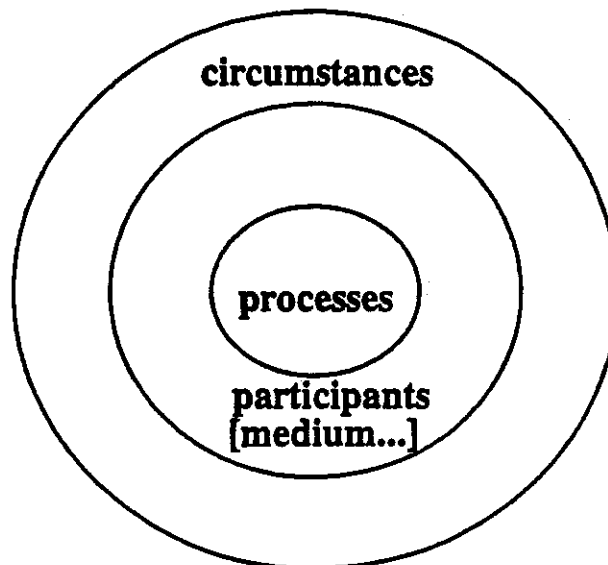


Figure 1: Clustering of process, participants, and circumstances

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```
(defconcept Material-Process
  :is (:and Process (:at-least 1 Actor)))
```

Figure 2: Example LOOM definition of the concept material-process

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the participant roles may be value restricted to different concepts in the object hierarchy for different processes, e.g., a mental-process might require an entity capable of mental processing whereas a material-process might not.<sup>8</sup>

The optionality and freedom of occurrence of process circumstances is then represented by defining them as relations of particular types between processes and concepts (typically objects) of appropriate kinds. An alternative method would be to include applicable circumstances in the definitions of process themselves. This would necessitate placing an optional role specification (represented by a number restriction of 'at least zero') for all the types of circumstances that might occur with the concept process. Instead of this, value restrictions that limit the types of processes to which the circumstance may be attributed are placed directly in the circumstance

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<sup>8</sup>Although this 'ideal' has been weakened considerably with the continuing use of the upper model in text generation; the flexibility of natural language has not responded well to the factorization of information constraints this enforces. Alternatively it could be argued that the way in which the relationship between upper model and grammatical realization has been constructed in current PENMAN prevents us from treating value-restricted participants types with sufficient flexibility. This observation applies equally to the value restriction described next on the *domain* of circumstantials. This is again an area of current research within PENMAN.

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```
(defreified-relation Circumstantial
  :is (:and Two-Place-Relation :primitive)
  (:DOMAIN process))
```

Figure 3: LOOM definition of circumstances

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definition. This is shown in Figure 3, where the concept **circumstantial** is defined to be a subtype of the concept **two-place-relation** which has a role *domain* value restricted to concepts of type **process**.

We will now turn to the description of the actual process subtypes defined within the upper model. There are four categories of processes: **relational-processes**, **material-processes**, **mental-processes**, and **verbal-processes**. This is following the essential breakdown of process types given in Halliday (1985, Chapter 5). We discuss each of them in turn.

## 2.2 The Relational Process Subhierarchy

Relational processes are currently broken down into two subclasses, corresponding to one and two place relations. No three or more place relations are distinguished by the grammar at present. The subhierarchy and immediate subclasses are shown in Figure 4.

### 2.2.1 One place Relations

One place relations have one and only one participant. The only one-place relation in the hierarchy so far is **existence**. For example,

*There is a block.*

### 2.2.2 Two place Relations

This subhierarchy contains all the concepts that can be realized as two-place relational processes, even if that is not their most common form of expression. In general, each two-place relation has two roles, *domain* and *range*. Although, given a relation such as "contains", one may like it to have the roles "container" and "contained", within the upper model these are simply named domain and range respectively. If needed, however, such roles can be defined as sub-roles of domain and range.<sup>9</sup> Two-place relations are often realized linguistically as:

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<sup>9</sup>Note that this is *not* how participant *roles* are handled in the upper model; this only pertains to *relations*. In contrast, participants are themselves fully fledged concepts under the two-place relations subhierarchy and, therefore, themselves have *domain* and *range* as roles. This avoids any circularity in placing participants under process alongside the processes with which they combine.

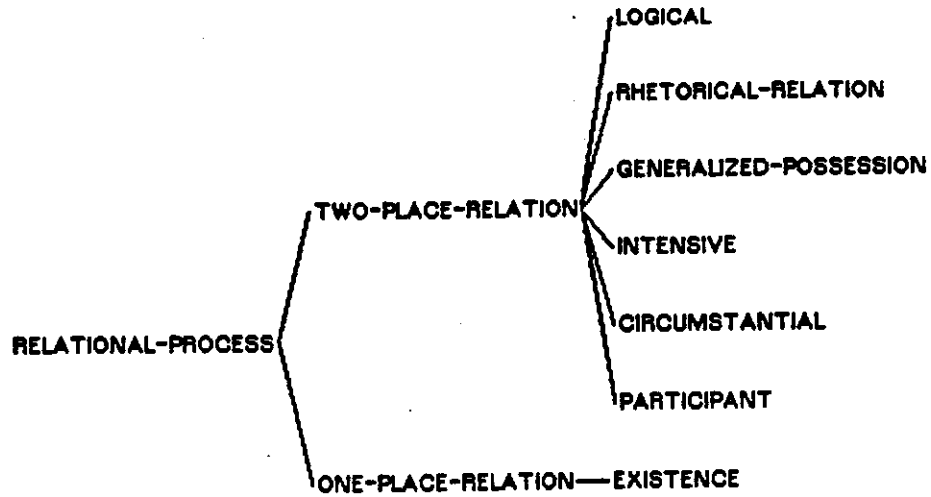


Figure 4: Relational Processes

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<domain> <relation> <range>

Placing concepts under the node *two-place-relation* is intended to capture precisely the generalization that it is *possible* to realize them as a combination of process and participants in a clause. Thus, for example, we find both participants and circumstantials as subtypes of two-place-relation: the former forms a subhierarchy under the concept *participant*, the latter a subhierarchy under the concept *circumstance*. These are considered to be two place relations that relate a process (as *domain*) to a participant or a circumstance respectively.

For the semantics of such class-subclass inheritance hierarchies see, e.g.: Schmolze and Israel (1983); here, however, we can briefly note that an  $n$ -ary predicate  $P$  with arguments  $a_1, \dots, a_n$  can be re-expressed in terms of a class  $P^c$  and a set of  $n$  role relations  $R_1, \dots, R_n$  as follows:

$$P(a_1, \dots, a_n) \Leftrightarrow (\exists b) \left( \bigwedge_{i=1}^n (R_i b a_i) \wedge (P^c b) \right)$$

Applying the same re-expression to each of the  $n$  role relations gives a further set of  $n$  classes  $R_i^c, \dots, R_n^c$  corresponding to the role relations. When these classes correspond to participants or circumstances in the upper model, they all share the special role relations *domain* and *range* as sub-classes of *two-place-relation*. Adding this to the second half of the above bi-conditional yields:

$$(\exists b) \left[ (P^c b) \wedge \left( \bigwedge_{i=1}^n (\exists p) [(R_i^c p) \wedge (\text{domain } p b) \wedge (\text{range } p a_i)] \right) \right]$$

which corresponds to how process + participant + circumstance configurations are currently represented.

Sometimes, it is desirable to realize the relation itself as a process. PENMAN can handle a number of these kinds of cases. Examples of the variation at issue here are:

circumstantial:location

*John is working in the office*

*John is in the office*

circumstantial:subject-matter

*John is writing about upper models*

*The book is about upper models*

participant:actor

*John is running*

*John is doing the running*

participant:recipient

*Fred gives the present to John*

*John is the receiver of the present*

As can be seen in Figure 4, there are six subclasses of two-place-relation: in addition to **circumstantial** and **participant**, we have **logical**, **rhetorical-relation**, **generalized-possession**, and **intensive**. Some of these have significant subhierarchies of their own and so will be described in more detail below in separate sections as identified here.

The immediate subclasses of two-place-relation are as follows.

#### 2.2.2.1 Logical

**Logical** relations combine processes or states of affairs into larger, composite processes or states of affairs, either conjunctively (e.g., 'and'), or disjunctively (e.g., 'or'), or by providing more information in an elaboration. These possibilities for expression define the three main subclasses of **logical**: **conjunction**, **disjunction**, and **elaboration** respectively. **Elaboration** further divides into four classes that are used to discriminate between possible inter-clause or inter-nominal group relationships: **restatement**, **exemplification**, **rst-elaboration**, and **rst-abstraction**. The latter two are described further in Section 2.2.3 below since they are also subclasses of **rhetorical-relation**. The classes below **logical** are shown in Figure 5.

#### 2.2.2.2 Rhetorical-relation

**Rhetorical-relations** are the ideational class of inter-clause relations specified in the theory of Rhetorical Structure Theory (RST): for details of which see Mann and Thompson (1987, 1988). Most RST relations have a central element, called the nucleus, and some supporting elements, called satellites. The domain contains the nucleus information and the range contains the satellite information. Details of the subtypes available and their realization through the grammar are given in Section 2.2.3 and graphed in Figure 10.

#### 2.2.2.3 Generalized-possession

The most typical expression of **generalized-possession** is as:

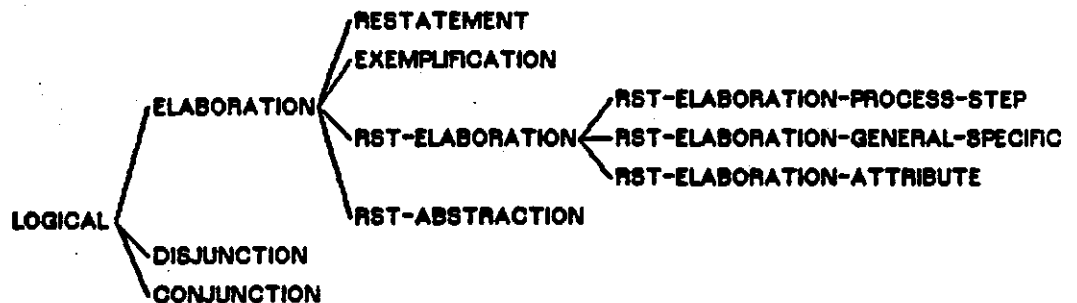


Figure 5: Logical Relations

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<possessor> *has* <possessed>.

Relations in this category can, in general, also be expressed with a possessive form, e.g., 'John's book', 'the key of the door', etc. Thus, the types of relationship covered by generalized possession, or *generalized marriage* as it is sometimes called, are rather more general than simple possession of objects and include social customs or agreements. Examples of this are kinship, lawyer/client, doctor/patient, boss/employee relationships — expressed as:

<possessor> *has* <relation>

e.g.: Henry *has* a brother

<possessed> *be relation of* <possessor>

e.g.: Henry *is the lawyer of* Joan / Joan's lawyer

Henry *is the patient of* Joan / Joan's patient

The conception of possession is thus quite general, as is intended by the use of the term *generalized possession*.<sup>10</sup> The hierarchy also currently contains a concept called *generalized-possession-inverse*. This, as its name suggests, captures the inverse relationship between its participants to that of *generalized-possession*. It has two subtypes: *part-of* and *owned-by*. Although LOOM (in contrast to NIKL) does support the automatic creation of inverse relations, we have found this so far to be problematic, and so occasionally it has been necessary to construct explicit nodes in the

<sup>10</sup>Fawcett (1987:140) remarks on this with respect to his earlier use of the term *associated* for this relation. It should be remembered that possession is here being used in this generalized fashion.

hierarchy to capture inverse relationships of this kind. We expect to remove this later, when the status and use of inverses has been clarified. The **part-of** relation has one further subtype, **element-of**.

**Generalized-possession** has three more specific subtypes that are currently used by the grammar: **part-whole**, **ownership**, and **name-of**. Clearly these do not exhaustively cover the class of generalized possession, but they are those with which the grammar is concerned in its present state of development.

**2.2.2.3.1 Part-whole** is a relation between an entity and its parts. It has two roles: *whole* and *part*. At the most general level, this relation can be expressed as:

*<part> be an element of <whole>*

or

*<part> be a component of <whole>*

or, as inherited from the **generalized-possession** superconcept,

*<whole> has <part>*

Note that how this relation is expressed in the language seems to depend on the type of object that fills the *whole* role.

There are three possible subtypes that we could add for **part-whole**, but which are not currently distinguished within the grammar:

- *consists-of* — which would be expressed as:

*<whole> consist of <parts>*  
*<parts> make up <whole>*

This relation requires a special category because the use of the terms “consist of” and “make up” seem to imply that all of the parts of an entity are being mentioned. That is to say, there seems to be a constraint that what fills the part role of a *consist-of* relation must be *all* of the parts of the whole. For example, one can say:

*An engine is a component of a car*  
*A car has an engine.*

but it is odd to say:

*An engine makes up a car*  
*A car consists of an engine*



Note that this would be a *conceptual* constraint. This means that the filler of the part role of the consists-of relation should be value-restricted to a concept representing an exhaustive set of constituents.

- *constituency* — a specialization of the part-whole relation in which the whole is value-restricted to be a **decomposable-object** (cf. Section 3.2). The justification for this sub-category is that it only makes sense to discuss “parts” of an object when that object has distinguishable parts, i.e., is decomposable into those parts. So,

*An engine is a part of a car*

is acceptable, while

*Gravel is a part of concrete*

seems less so.

- *ingrediency* — this is a relation which expresses the relation between a whole and its parts when the whole is a *mass-object*. For example,

*Gravel is an ingredient of concrete.*

Note that the sub-categories *constituency* and *ingrediency* are mutually exclusive. Note also, that the *consists-of* relation does not discriminate on the type of whole (i.e., decomposable or mass). So, both of the following are acceptable:

*A tree consists of a trunk and branches*  
*Concrete consists of sand, gravel, cement, and water*

**2.2.2.3.2 Ownership** is a relation between the owner of an object and the object. Ownership may be expressed as:

<possessor> *own* <possessed>

or

<possessed> *belong to* <possessor>.

#### **2.2.2.4 Intensive**

This is a way of relating two entities as being identical, of one symbolizing the other, or of ascribing a class membership or a quality or property. Here there is significant substructure and the details are given in Section 2.2.4.

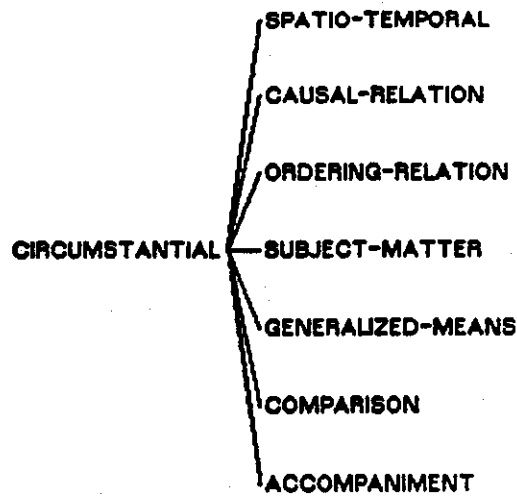


Figure 6: Circumstantial Relations

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#### 2.2.2.5 Circumstantial

This is the relationship of being a circumstance of a process — as described above (Section 2.1.2), they are represented as relations between a process and an object. Circumstances are often realized as adverbial groups or prepositional phrases. The subtypes of circumstantial relations are shown in Figure 6 and we now describe each of them in turn.

**2.2.2.5.1 Spatio-temporal** describes the relation of two entities in space or time. Further specializations include relations concerned with time, space, directions, and extents. We detail this part of the hierarchy in Section 2.2.5.

**2.2.2.5.2 Causal-relation** has two roles: *cause* and *effect*. At this most general level, causality may be expressed as:

<effect> *because* <cause>

or

<cause> *cause* <effect>.

This category is further specialized to the subcategories: **reason**, **purpose**, **concessive**, **cause-effect**, and **client**; some of these have further sub-classes that are also classified elsewhere in the upper model (see Sections 2.2.3).<sup>11</sup> This is shown in Figure 7.

---

<sup>11</sup>The appropriate positioning and status of 'rhetorical' relationships such as *rst-purpose*, *rst-concessive*, etc. is still under discussion; at present they are represented as a separate class of concepts. They may, at a later stage, be folded into possible realizations of other concepts, including, for example, the causal relations described in this section, some temporal relations, etc.

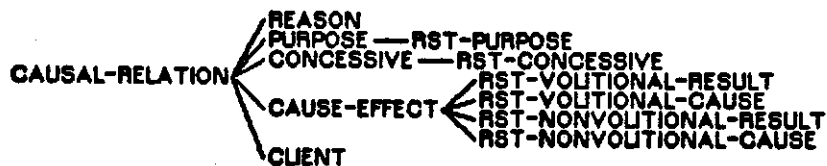


Figure 7: Causal Relations

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These sub-classes may be described in more detail thus:

- **Reason** captures the notion of motivation. Here the effect is volitional or intentional. This relation is expressed by terms such as: “since”, “because”. Examples include:

*Henry went to the store because he needed milk.  
Since it was raining, Henry brought his umbrella.*

- **Purpose** also expresses a volitional effect. However, in this case the cause is considered ‘future’ with respect to the effect. Expression of this relation uses terms such as: “for” with either a noun or verb, “to”+<verb>, “by”+<verb>-ing, and “in order to/that”. For example:

*John went to the market to buy milk.  
The funds are for education.*

This relation is useful for any system that needs to represent the causality of behavior; for example, constructions such as:

*In order to achieve <goal>, program did <plan>.  
<Plan> was executed for the purpose of <goal>.  
Program achieves <goal> by applying <plan>.*

will be common.

- **Cause-effect** is the paradigm case of a causal relation, and simply captures the relationship of one thing being the cause of another, the effect.
- **Concessive** states that some process occurred despite some other event or state of affairs. It is typically realized in English by the preposition *despite*.

- Client captures the relationship between a process and a person for whom the process was undertaken or carried out. It is typically realized in English by the preposition *for* and is also a subtype of **participant**.

Note that there may be other useful specializations of causality. For example, we may want to represent logical implication or necessary entailment as a kind of causality to account for expressions such as:

*You can switch the operands of a multiplication because of the commutativity of the operation.*

and the language of formal logic, e.g.,

*Because A implies B and A is known to be true, B.  
Since A implies B and A is true, B.  
A implies B and A is true, therefore B.*

Whether a separate concept is required here or not depends finally on whether or not the grammar makes a distinction between these constructions and those of, for example, **reason**. Only if it does make a distinction is a separate category motivated according to the definition of the upper model that we are following in this document.

**2.2.2.5.3 Ordering-relation** is the general relationship that holds between the parts of an ordered object. It is used as an additional classification of both temporal and spatial locating relations, and is described in the **spatio-temporal** subhierarchy description (Section 2.2.5). The temporal ordering subtype is also used for temporal reasoning concerning time intervals and ascertaining tense in English. That part of the upper model directly classified beneath **ordering-relation** is shown in Figure 8. Note that in this graph of the hierarchy two concepts are shown in bold face: **follow** and **precede**. This indicates that these concepts are members of multiple superclasses, i.e., in this case, of both **extremal** and the concepts **anterior** and **posterior**. This notation will be used throughout the figures in this report to avoid the complexity of a lattice display with crossing class-subclass connections. It is also important to realize that this possibility is made frequent use of within the upper model and that some knowledge representation schemes do not support multiple inheritance from multiple parents of this kind. We have found no value in such a restriction which would, in fact, make the statement of the upper model significantly harder.

**2.2.2.5.4 Subject-matter** is a relation typically expressed as: *be about*, as in

*This document is about an entity hierarchy.*

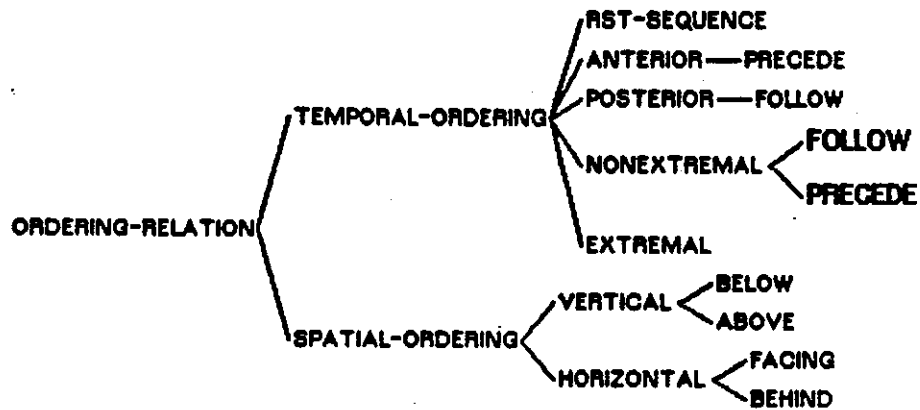


Figure 8: Ordering Relations

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**2.2.2.5.5 Generalized-means** is the generalization of the means for actualizing some process. The subtypes of generalized-means are: enablement, instrumental, manner, and agentive.

- **Enablement** refers to a possible enabling relationship between the actualization of some process or state of affairs and an entity, state of affairs, or other process. It is typically realized by <verb> + “by” + <noun phrase>, as in, e.g.:

*Henry solved the problem by hard work*

- **Instrumental** captures the notion of the instrument that is used in order to perform a process. It is typically expressed as: <verb> + “with” where <verb> cannot be “be”; e.g.:

*John hit the nail with a hammer*  
*John opened the door with a key*

- **Manner** is a circumstantial role of a process that describes the manner in which the process’ actualization is achieved. Commonly realized by adverbs in English, although there are other possibilities, for example, within the current grammar, it is realized through patterns of the form: <verb> + “by”, “like”, or “as if” + <nonfinite clause>:

*John hit the nail by holding the hammer  
Henry came into the room like lightning  
Joan leapt up as if stung*

- **Agentive** captures the notion of causal responsibility and volition for a process' performance; it is a participant from the ergative perspective on process as described in Section 2.1.1 above. It is also, therefore, a subtype of participant.

**2.2.2.5.6 Comparison** encompasses relations which indicate how similar or dissimilar two entities are. At present, the only possibility followed by the grammar is that of the subcategory: **similarity**. Difference could be presented as a further subtype, and equality could be a further specialization of similarity. Verbs articulated by this category include: "resemble", "differ from", "be similar to", "be different than", "be like", "match", "fit", etc. A grammatical characteristic of entities in this category is that they are symmetric, i.e., subject and object can be interchanged without passivization.<sup>12</sup> Note however, that the passive form is still possible. For example.

*Henry resembles Joan  
Joan resembles Henry  
Joan is resembled by Henry*

**2.2.2.5.7 Accompaniment** is a relation that holds between objects which participate jointly in some process. Accompaniment may be expressed as:

<independent-argument> + "be with" + <dependent-argument>;

or by a prepositional phrase beginning with the preposition *with* as in:

"with" + <dependent-argument>.

Note that it is not necessary for both of the participants to be aware of the participation. Thus both of the following sentences are examples of this relation:

*John went for a walk with Mary.  
John went for a walk with his umbrella.*

The relation also allows for variation in both a positive and negative direction; For example, "without" is also a type of accompaniment, albeit negative, as is "instead of", which is an accompaniment of alternative. These possibilities are captured in the subtypes of accompaniment as follows:

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<sup>12</sup>Some relations are symmetric while others are not. *Symmetric* and *non-symmetric* could well be high-level concepts from which this kind of knowledge would be inherited. In addition, at present there is no direct link between this concept and the class identity under **intensives**; arguably there should be.

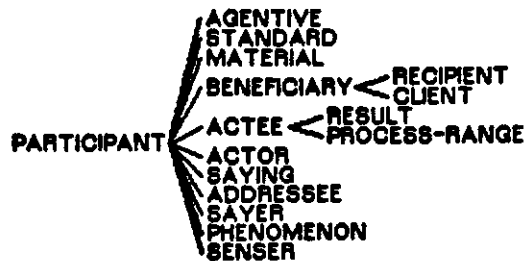


Figure 9: Participants

inclusive  
 exclusive  
 alternative  
 additive

*with*  
*without*  
*instead of*  
*as well as*

### 2.2.2.6 Participant

Again as described above (Section 2.1.1), a process/state/event is said to 'contain' some number of entities that critically *participate* in the actualization of that process/state/event. The style of these entities' particular participation in the process is identified in terms of given role names. The full list of participant relations currently required to support the distinctions drawn by the grammar is graphed in Figure 9. We will now describe each of these briefly in turn.

**2.2.2.6.1 Actor** is a transitivity function in a material-process: the participant always inherent in the clause according to the transitive model (cf. Section 2.1.1). The term Actor is distinguished from the term Agent: while the former is confined to material clauses in the transitive model, the latter is a generalized transitivity function – the 'causer' – in the ergative model. The process in which the *actor* participates may or may not extend to affect another participant, the Goal. For instance,

(Actor:) *Henry* (Process:) *dives*  
 (Actor:) *Henry* (Process:) *kicked* (Goal:) *the ugly duckling*.

**2.2.2.6.2 Actee** is a process participant describing the entity upon which a process is 'done', 'carried out', etc. The actee role is divided into two subtypes: result and process-range.

- The *result* relation holds between a process and its result. For example, the relation between “build” and “a house”, or the relationship between a function and its value.
- The *process-range* relation is a participant role where the participant is not affected or altered by the actualization of the process, but instead serves more to define the nature of the process. Examples in this category are:

Fred climbed *the mountain*  
Fred took *a bath*

etc.<sup>13</sup>

**2.2.2.6.3** *Beneficiary* is a transitivity function in the clause, according to the generalized ergative transitivity model: the participant benefitting from the actualization of the combination of Process + Medium (as explained in Section 2.1.1). In a material process, it is the Recipient (“My aunt gave *the farmer* a duckpress”) or the Client (“Pour *me* out a cold Dos Equis beer”) and in a verbal one, it is the addressee (“Joe told *us* all about Eve”). It also occurs in a few relational process types (“I owe *you* an apology”) and mental processes (“I envy *you* your luck”; “I don’t begrudge *you* your happiness”).

**2.2.2.6.4** *Sayer* is the actor in a communicative process; see verbal-process (Section 2.4).

**2.2.2.6.5** *Saying* is the information being communicated by a communicative process; see verbal-process (Section 2.4).

**2.2.2.6.6** *Addressee* is the receiver of information in a communicative process, e.g.: “Henry told *me* that dinner would be ready at 6:00pm”; see verbal-process (Section 2.4).

**2.2.2.6.7** *Senser* is the entity that undergoes the experience in a mental process; see mental-process (Section 2.5). Referents in this category ought to be restricted to conscious-beings.

**2.2.2.6.8** *Phenomenon* is the object of perception in a mental process of perceiving; see mental-process (Section 2.5).

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<sup>13</sup>These subtypes are not at present explicitly referred to by the inquiry implementations used in PENMAN since they are predictable from the process-type. For example, the *actee* of a directed-action (which is a type of material-process; see Section 2.3) can only be of the *result* type; similarly, the *actee* of a nondirected-action can only be of the *process-range* type. This will be clarified in the section on the material-process subhierarchy below.



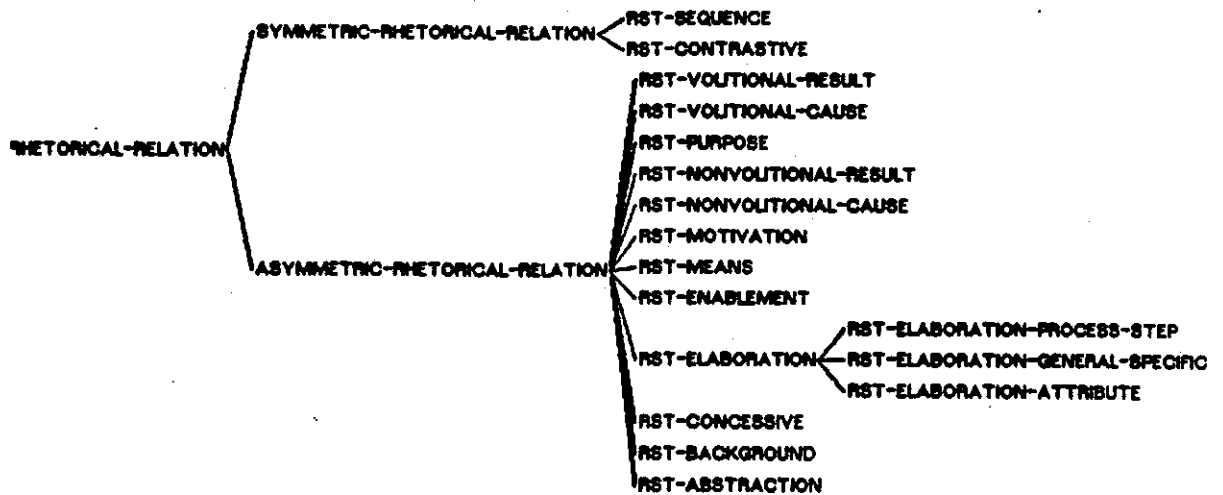


Figure 10: Rhetorical Relations

2.2.2.6.9 *Material* is a participant role that carries the information of the material from which an entity is constructed.

### 2.2.3 The Rhetorical Relation Subhierarchy

Rhetorical Structure Theory (RST: Mann and Thompson, 1987, 1988) define a set of relationships that may hold between segments of text. There are two types of RST relations: most are *asymmetric* — these have one *nuclear element* and any number of *satellites*, others are *symmetric* — these are *multinuclear* and have no satellites. Nuclear elements are those that are essential for achieving the goal of a relation; satellites serves auxiliary, supporting roles. Assymmetric RST relations assign different importance to the parts of the discourse they relate; symmetric RST relations assign equal status to all their nuclei. Symmetric RST relations are placed under the upper model concept *symmetric-rhetorical-relations*; asymmetric relations are placed under the concept *asymmetric-rhetorical-relations*; for these the nucleus is assigned to the *domain* role, and the satellite to the *range* role. The rhetorical relation subhierarchy is shown in Figure 10.

The symmetric rhetorical relations are:

**RST-contrastive** A relation between any number of parts of a text which states that those parts are to be comprehended as the same in many respects, differing with respect to a few, and are to be compared with reference to those few.

**RST-sequence** This relation relates a number of equally important nuclei; it is used

when the hearer is to recognize a succession relationship among those nuclei along any dimension (e.g., time, space, presentation, etc.).

The asymmetric rhetorical relations are:

- RST-concessive** A concession is a relation between text that presents a situation for which the speaker has positive regard and text that presents a situation that, although there is a potential or apparent incompatibility between those situations, the speaker wishes to have them accepted as compatible while simultaneously increasing the hearer's regard for the first situation.
- RST-elaboration** A relation between some subject matter and further elaborating information which is presented as being inferentially accessible to that subject matter in a number of ways as given by (at least) the subtypes: *rst-elaboration-general-specific*, *rst-elaboration-process-step*, and *rst-elaboration-attribute*. The first is a relation between some subject matter and further elaborating information which is presented as being inferentially accessible by virtue of a generalization-specific relationship; the second is a relation between some subject matter and further elaborating information which is presented as being inferentially accessible by virtue of one being a step in the process specified by the other; and the third, *rst-elaboration-attribute*, is a relation between some subject matter and some attribute of that subject matter which is being used as a basis for further elaboration. *Rst-elaboration* is also a subtype of the elaboration logical relationship.
- RST-enablement** A relationship between parts of a text such that the hearer's understanding of the *range* increases the hearer's potential ability to perform the action specified by the *domain*.
- RST-means** Used when the *range* is to be presented as a means for achieving or performing the activity given as the *domain*.
- RST-motivation** A relationship between parts of a text such that the hearer's understanding of the *range* increases the hearer's desire to perform the action specified by the *domain*.
- RST-nonvolitional-cause** This relation is used when the hearer is desired to recognize that the situation presented by the *range* is a cause for the nonvolitional action presented in the *domain*. This relation is also a subtype of the generalized cause concept causal-relation.
- RST-nonvolitional-result** This relation is used when the hearer is desired to recognize that the situation presented by the *domain* could be a cause for the nonvolitional action or result of a nonvolitional action presented in the *range*. This relation is also a subtype of the generalized cause concept causal-relation.
- RST-purpose** Used when it is required that the hearer recognize that the activity specified in the *domain* is initiated in order to realize the activity or state of affairs presented in the *range*. This relation is also a subtype of the generalized cause concept causal-relation.

**RST-volitional-cause** This relation is used when the hearer is desired to recognize that the situation presented by the *range* is a cause for the volitional action presented in the *domain*. This relation is also a subtype of the generalized cause concept **causal-relation**.

**RST-volitional-result** This relation is used when the hearer is desired to recognize that the situation presented by the *domain* could be a cause for the volitional action or result of a volitional action presented in the *range*. This relation is also a subtype of the generalized cause concept **causal-relation**.

#### 2.2.4 The Intensive Relations Subhierarchy

One functional component of the NIGEL grammar concerns what is called *relational transitivity*, i.e., the statement, questioning, negation, etc. of relations between entities in contrast to processes of doing or sensing: "The central meaning of clauses of this type is that something is" (Halliday, 1985:112). Halliday's discussion of *processes of being* analyzes this area of English grammar in terms of three primary categories: *intensive*, *circumstantial*, and *possessive*.<sup>14</sup> Halliday further divides each of these into two possible modes: *attributive* and *identifying*. These may be summarized as follows:

(1)	intensive	'x is a'
(2)	circumstantial	'x is at a'
(3)	possessive	'x has a'

each subclassifiable according to:

(i)	attributive	'a is an attribute of x'
(ii)	identifying	'a is the identity of x'

Examples of the co-variation that occurs are given in Figure 11.

The intensive relational process subhierarchy of the upper model is intended to provide the necessary semantic support for the set of *intensive* relations in the grammar. It therefore includes the subclasses **identity** and **ascription**, corresponding to the *identifying* and *attributive* modes respectively. In addition, there is also a third subclass, **symbolization**, that is intended to contain relations that hold between entities and other entities that they 'symbolize'. **Possessive** has been placed under **generalized-possession** as described above (Section 2.2.2.3), and **circumstantial** under **two-place-relation** (Section 2.2.2.5).

The classifications beneath the node **intensive** are shown in Figure 12. The **identity**, **ascription** and **symbolization** subclasses will now be described in more detail.

<sup>14</sup>See Fawcett (1987) for an alternative analysis.

mode:	(i) attributive	(ii) identifying
type:		
(1) intensive	<i>Sarah is wise</i>	<i>Tom is the leader the leader is Tom</i>
(2) circumstantial	<i>the fair is on Tuesday</i>	<i>tomorrow is the 10th the 10th is tomorrow</i>
(3) possessive	<i>Peter has a piano</i>	<i>the piano is Peter's Peter's is the piano</i>

Figure 11: The principal types of relational processes; Halliday (1985:113)

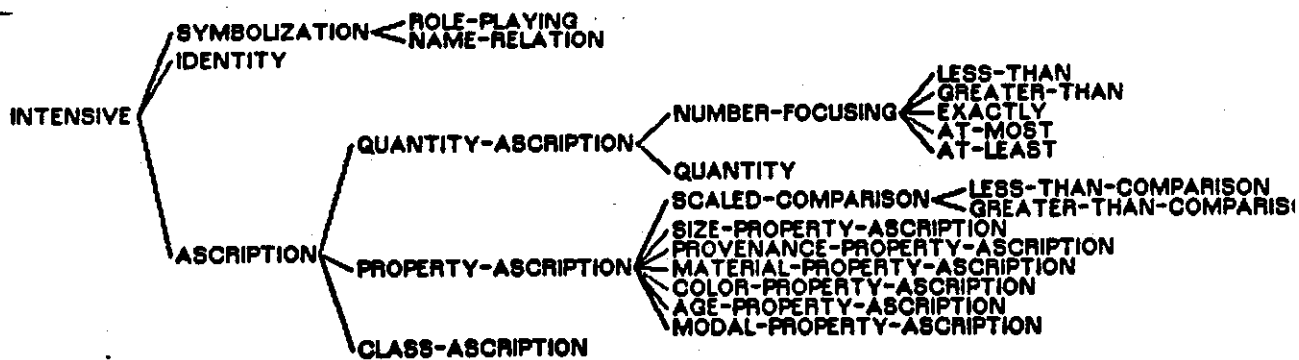


Figure 12: Intensive Relations

### 2.2.4.1 Identity

Halliday describes identity as follows:

“In the identifying mode, the meaning is ‘*a* serves to define the identity of *x*’. Here *a* and *x* are two distinct entities, one that is to be identified, and another that identifies it.” (Halliday, 1985:115)

This relationship is in contrast to ‘class membership’, which does not serve to identify. This is contained under the category **class-ascription** (Section 2.2.4.3.2 below).

### 2.2.4.2 Symbolization

This category contains relations that hold between entities and other entities they ‘symbolize’. All the notions in this category can be expressed by the verb “be”. The form of “be” here is different from the existential “be” and the ascriptive “be” because it is reversible, i.e., has a voice distinction. In addition, the verbs used to express concepts in this category are all transitive.

Relations in this category include:

- relations concerned with **signification** — as linguistically realized by such verbs as: “represent”, “mean”, “express”, “stand for” and “signify”. Note that the verb “be” can be used in place of any of these. For example,

Up represents happiness.

Up *is* happiness.

Green means go.

Green *is* go.

- the category of **role-playing**. Examples of verbs in this category are: “act as”, “play”. This concept can also be realized using the preposition “as”, e.g.

*As President of the U.S., Reagan vetoed the bill.*

Here “as” embodies the notion “playing the role of”. Note again that concepts in this category can also be expressed with “be”, e.g.

*Olivier is Hamlet.*

*Reagan is President.*

- the relation between an object and a name which identifies that object; this is called **name-relation**. For example, the written representation of a lisp function, i.e., the sequence of characters that form the s-expression, *symbolize* the function that that lisp expression performs; thus, in

*CAR is a function that returns the first element of a list.*

the name CAR is in the name-relation to the function that appears to the right of the verb 'to be'. Other examples of this relation's realization are:

*Her brother is named Gilbert*

*Storage locations referenced by access functions are called generalized variables.*

### 2.2.4.3 Ascription

This relation captures the notion of membership in a set. The roles of this relation are: *attribute* and *attribuend*. It is differentiated from identity in that it does not claim any exhaustivity for the correspondence that it defines; for example: "Sarah is wise" does not make any claim that Sarah is the only one who is wise, it is therefore not identifying; "Sarah is the wise one" does, however, make such a claim, and is, as such, identifying rather than ascriptive. In general, the *attribuend* role of an ascription relation will be filled by an object and the *attribute* role will be filled by a quality or by an object. Finer restrictions can be made based on the given attribute. This relation is again commonly expressed by the verb "be". As can be seen in Figure 12, there are a number of subclasses to this category. We now describe each of them in more detail.

**2.2.4.3.1 Property ascription** is a relation describing membership in the set of entities having a particular property. This is expressed by a property that can be used as a set descriptor. For example,

*The students are intelligent*

i.e., they belong to the class of intelligent ones. Note that "intelligent" is a quality. We need many specializations of property ascription corresponding to different types of qualities. The qualities themselves are found under the **Quality** subhierarchy, which is described in Section 4. The current correspondences are given in Figure 13. This shows the relationship of the current property-ascription subclasses and the appropriate quality concepts that may play the role of attribute. The first set applies to **objects**, the middle one to **processes**, and the last group to **quality**.

**2.2.4.3.2 Class ascription** is a relation where both *attribute* and *attribuend* are restricted to be filled by an object. It corresponds to the notion of 'super-class', which in many knowledge representation systems is treated as an *is-a-kind-of* relation. It too may be expressed by the verb "be". For example,

*Henry is a teacher.*

*Whales are mammals.*

Subtype of <i>Property-ascription</i>	Property
size-property-ascription material-property-ascription color-property-ascription age-property-ascription	<b>size</b> <b>material-class-quality</b> <b>color</b> <b>age</b>
modal-property-ascription	<b>modal-quality</b>
scaled-comparison ... less-than-comparison ... greater-than-comparison	<b>quality</b> <b>quality</b>

Figure 13: Correspondences between property-ascriptions and qualities

**2.2.4.3.3 Quantity ascription** is the relation of ascribing a quantity to an entity. Two forms of quantity-ascription are defined: either a quantity can be provided directly by the subclass **quantity**, or a quantity can be used as the basis for a further specification by the subclass **number-focusing**. This latter supplies the following types of quantity ascriptions: **less-than**, **greater-than**, **exactly**, **at-most**, and **at-least**. Ascriptions of this kind are responsible for nominal phrases such as the following:

*exactly* two answers  
*at least* three dogs  
*at most* one IBM PC  
*more than* 100 Macs

## 2.2.5 The Spatio-temporal Relation Subhierarchy

The spatio-temporal subhierarchy is organized along a number of dimensions which combine to form specific categories of relationship between entities and locations in space or time. Most of the subclasses are responsible for the appearance of specific prepositions within prepositional phrases generated by the grammar to express the spatio-temporal relationships the subclasses identify. The two top level distinctions are between:

- **locating and extent**

The **extent**-dimension is responsible for the selection of prepositions such as *for*, *along*, *across*, *during*, etc. in the prepositional phrases:

*for* three days  
*for* five miles

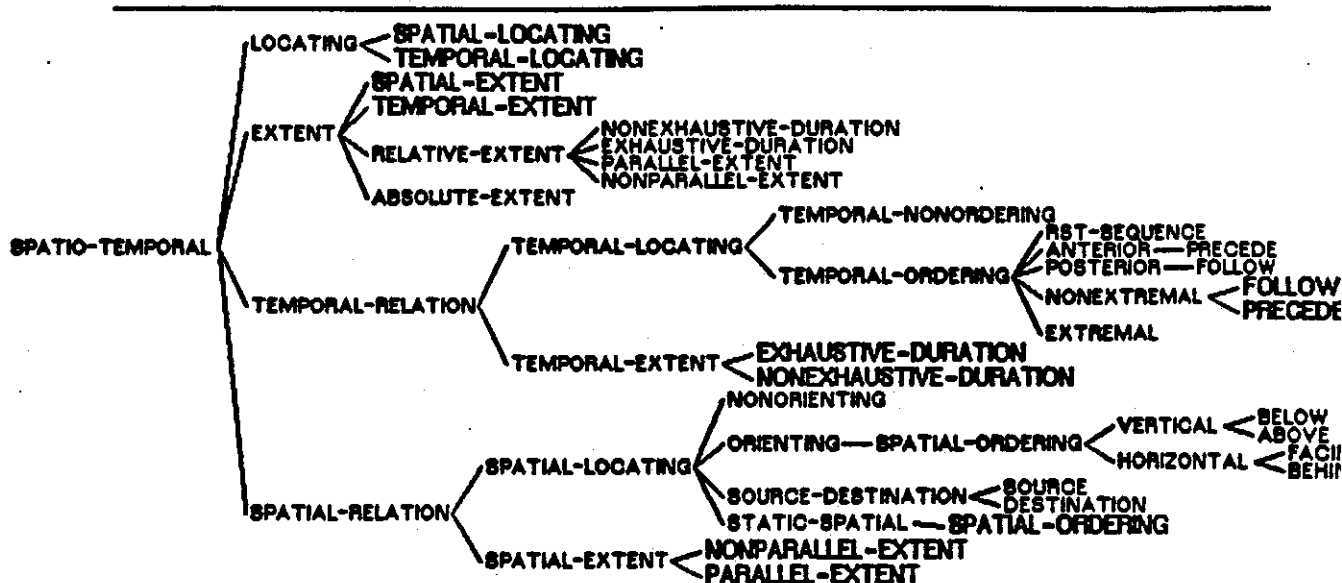


Figure 14: Spatio-temporal Relations

*across* the bridge  
*along* the road  
*during* the debate

The concept here, therefore, is one of a segment of space or time throughout which some process or state obtains, as opposed to a simple locating which picks out spatio-temporal points of location.

- temporal-relation and spatial-relation

The top level distinctions combine to give rise to a range of subcategories that are distinguished by the grammar and described below. For example, Temporal-relation and extent combine to give the subcategory temporal-extent; spatial-relation and extent combine to give the subcategory spatial-extent. The full spatio-temporal relation subhierarchy is shown in Figure 14.

### 2.2.5.1 Temporal extent

Temporal-extent further decomposes into nonexhaustive-duration and exhaustive-duration; spatial-extent into parallel-extent and nonparallel-extent. The former distinction provides the motivation for selecting between the prepositions *in* and *during*; the latter between *along* and *across*.

### 2.2.5.2 Locating



Locating combines with each of spatial-relation and temporal-relation to give the subcategories temporal-locating and spatial-locating respectively. These have the following substructure.

**2.2.5.2.1 Temporal-locating** locates a process or state with respect to a time in either an ordered or unordered fashion. The ordered-locating defines a nonsimultaneous ordering between the process/state and a time, again organized along two dimensions:

- **anterior/posterior** : expressing whether the relationship expressed is one of preceding or following in time;
- **extremal/nonextremal** : expressing the perspective that is taken on the relationship between the process/state and time with respect to whether there is an orientation to the end or beginning points of some interval or not.

This latter dimension reflects the organization of possible meanings for prepositional phrases of time as represented in the current NIGEL grammar. A preposition such as *since*, for example, is analyzed as enforcing an orientation to the *beginning* of the period identified within the prepositional phrase; it is therefore **extremal** in addition to **posterior** and is in contrast to the **nonextremal**, posterior perspective expressed by *after*. We can illustrate the contrast as follows:<sup>15</sup>

*There have been many problems since the war*  
*There were many problems after the war*  
*? There were many problems since the war*  
*? There have been many problems after the war*

The *since* temporal relationship focuses on the entire interval including the beginning point, it therefore favors the present-in-past tense ("have been") to express the explicit extension in time of the holding of the process/state; the *after* temporal relationship does not necessarily extend to the extreme of the interval, simply expressing that some process/state holds at some point within the interval identified.

The current paradigm formed by combining the classes of **anteriority** — **posteriority** and **extremal** — **nonextremal** and their realizations as prepositions by the grammar is set out in Figure 15.

In addition, it is possible to have a relation that is classified as being *ordered* but neither *posterior* nor *anterior*; this is realized as the preposition *by*; e.g.:

*By 9 o'clock there were many problems*  
*I will be back by 10*

---

<sup>15</sup>Note that with these examples the question of the perspective that is being taken is crucial and there can be no categorical statements of acceptability.

	anterior	posterior
nonextremal	anterior-nonextremal <b>precede</b> (before)	posterior-nonextremal <b>follow</b> (after)
extremal	anterior-extremal (until)	posterior-extremal (since)

Figure 15: Combinations of *extremal/nonextremal* and *posterior/anterior*

Further, in the case of *unordered* temporal locatings, the actual preposition that is selected can depend on the type of temporal 'object' with respect to which the locating is made. The types of possible temporal objects are described in Section 3.3.2 under *spatial-temporal objects*; these distinctions motivate selection in the grammar between the prepositions of time *in*, *at*, and *on*.

**2.2.5.2.2 Spatial-locating** has three immediate subcategories for finer classification:

- **Orienting**, which specifies that there is an element of relative directionality included in the relationship between process/state and the space within which that process/state is being located. It is in contrast with **nonorienting**. Examples of this dimension of contrast are given by the prepositions *to*, *from*, *off*, *onto* (**nonorienting**) vs. the prepositions *towards*, *in front of*, *above*, *below*, *behind* (**orienting**).
- **Source-destination**, which indicates the direction of directionality included in a process; i.e., either *from* the source or *towards* a destination;
- **Static-spatial**, which specifies that there is no movement involved and the spatial location is unchanging. For example,

*Joan sat at the table.*

More generally, the NIGEL grammar realizes this category by the prepositions *to*, *from*, *onto*, and *into* for motion-processes, and by *on*, *in*, and *at* for concepts which are not. As was the case with *unordered* temporal locatings, some of these selections of prepositions are also dependent on the type of spatial object with respect to which locating is occurring; for the possible types of these see Section 3.3.1 under *spatial-temporal objects*.

**static-spatial** also combines with **Orienting** to provide a classification of relative locations along vertical and horizontal dimensions. These each further divide into two to give the categories: **below** and **above**, **facing** (realized as *in front of*) and **behind**.

## 2.3 The Material Process Subhierarchy

Material-processes include both intentional actions, i.e., actions with a volitional actor such as "The mouse ran up the clock" and happenings, such as 'erosion' and 'disintegration', e.g., "The wall came tumbling down."

The essential roles of this type of process are *actor* and *actee*. The actor role of the process is value-restricted to objects excluding things created by mental processing (e.g., facts) and speech (direct or indirect).<sup>16</sup>

A test for determining whether a concept falls into the category of material actions is to look at the least 'marked', or neutral, way of expressing the concept as it is in the process of occurring. Material actions are then typically expressed in the present progressive tense; all other concepts in the process hierarchy use the simple present. Compare the following:

*My watch says it is 4:30pm.*

with

*Henry is going to the market*

Thus, for example, in

*The house collapses (non-progressive)*  
*The house is collapsing (progressive)*

the latter is less marked in that it would be the normal way to refer to a present event of a house collapsing and thus suggests that the process of *collapsing* should be classified as a material process.

Material Processes are broken up into two classes, depending upon whether or not the process + medium combination is considered to be caused by an external agent; these subclasses are: **directed-actions** and **nondirected-actions**. The material-process subhierarchy is shown in Figure 16.

### 2.3.1 Nondirected actions

**Non-directed-actions** are those material actions which require no external causation in addition to the combination of process and medium (see Section 2.1.1). Thus, a distinguishing feature of a **nondirected-action** is that, in contrast to a **directed-action**, it *cannot* be considered to involve *external agency*. Such processes are often (though not necessarily) intransitive. In the case where they are transitive, the object is not affected or created by the action: instead it specifies a 'range' of the action. For example, "I play the piano/tennis." This specifies that I am capable of a typical kind of playing. With **nondirected-actions**, therefore, the *actee* role, if present, plays

<sup>16</sup>To the extent that this is still true, this says something about the way the object hierarchy needs to be organized, i.e., in such a way that we can easily make this restriction.

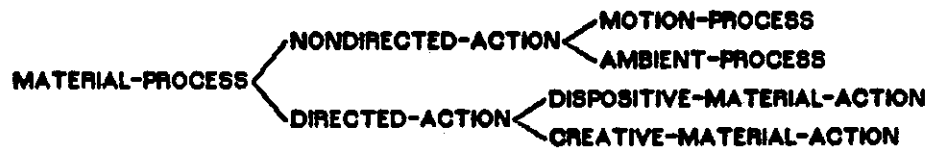


Figure 16: Material processes

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the function of 'range': it serves to further elaborate the process rather than playing the role of a genuine participant. The *actor* role of the process defines the medium.

All verbs of movement are examples of non-directed-actions, e.g., "climb", "walk", "fly", "fall", "run". Skills, such as "read (music)", "speak (French)", etc., are included in this category. In addition, the verbs "have" as in "have lunch", "take" as in "take a shower", "do" as in "do a dance", and "make" are in this category, notionally combining with the participant role *process-range* to specify what appears as the 'object', or range, of the process.

Two subtypes of non-directed-actions are explicitly represented:

- Motion-process for representing the movement verbs;
- Ambient-process for verbs concerned with the weather and other 'ambient conditions'.

These subclasses are very clearly *not* exhaustive.

### 2.3.2 Directed Actions

Directed-actions necessarily involve an external causer that brings about the action defined by the process and medium combination. The presence of a second participant requires that they have both an *actor* role and an *actee* role. Thus, they are always transitive.<sup>17</sup> In addition, directed-actions can always have a beneficiary of the client type: this is expressed by the prepositional phrase: "for" + <client>.

Directed-actions are further broken up into two subclasses depending upon whether or not the actee existed before the action occurred: **dispositive-material-action** and **creative-material-action**.

---

<sup>17</sup>Although they may be 'actee-intransitive', in which case the actee is not specified but is inferable. For example, "Henry is eating." In this case, we can infer that Henry eats something in the category of *edible-things*, perhaps even food.

- **Dispositive-material-actions** affect their actee. This category includes any verbs that describe an action on something that already exists, e.g.: "Eunice ate the cake."
- **Creative-material-actions** *create* their actee. For example, "Mary baked a cake." All actions in this category can be realized using the verbs "create" or "make".

## 2.4 The Verbal Process Subhierarchy

All processes of communication are placed in the verbal process hierarchy. Examples of verbs which fall into this class are: "say", "tell", "ask", "order", "command", "report", "request", "promise", "suggest". Some example sentences involving verbal-processes are:

*The sign says "No Parking."*  
*The newspaper says that Reagan has resigned.*  
*President Reagan said "I will resign."*

One linguistic characteristic of the communicative processes which distinguishes them from, for example, the material processes, is that the *saying* does not behave as does a direct object with material processes even though superficially it appears very similar. In particular, the passive form with *saying* as the subject is odd, rare, or impossible.

Verbal processes have three roles associated with them.

- *Sayer*: source of the communicative process.
  - mandatory,
  - this should be restricted to be an 'information-source', e.g.: speakers (**conscious-beings**), documents, watches, signs, traffic lights. However, the problem of grammatical metaphor (cf. Section 1.2) surfaces here also to defeat the actual statement of value-restrictions. That is, whereas in certain situations one might want to use language which makes inanimate objects like documents and watches seem like sources of information, in others one would like to preserve their inanimacy. This flexibility of expression is currently beyond the realizational capabilities of the released upper model and PENMAN system, although it is an area of active research.
- *Addressee*: receiver of the communicative process, e.g., "Henry told *me* that dinner would be ready at 6:00pm."
  - optional,
  - in principle value-restricted to **conscious-being**
- *Saying*: the information being communicated by the communicative process.



Figure 17: Verbal processes

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- mandatory,
- in principle restricted to be a 'direct-quotation' (e.g., "I will resign.") or a 'report', i.e., some kind of linguistic product (e.g., "that he will resign").

The verbal process subhierarchy is graphed in Figure 17; it has two principal subtypes: addressee-oriented and non-addressee-oriented.

#### 2.4.1 Addressee-oriented verbal processes

An addressee-oriented verbal process is a verbal process for which the addressee is an obligatory role — even though it may not be expressed in some cases. An example would be the process "tell."

#### 2.4.2 Non-addressee-oriented verbal processes

A non-addressee-oriented verbal processes is a verbal process that does not intrinsically require an addressee, e.g., "say". In this case, the addressee (if it occurs) must always be indirect. For example,

*John said to me that he likes his job*  
*John said that he does to the person standing by the window.*

Note that this differs from the way the addressee behaves with "told". When the addressee appears directly following the verb, it is direct. E.g.,

*John told me the story.*

An indirect addressee is used when the addressee appears after the saying, e.g.,

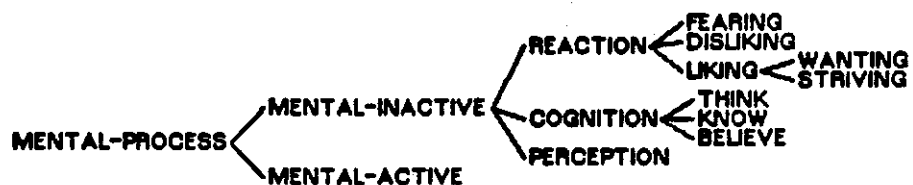


Figure 18: Mental processes

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*John told the story to me.*

But an indirect addressee following the verb, as in

*?John told to me the story.*

is marked.

One subtype of this class is provided in the current upper model: **name-event**, whereby an entity is *named*; this is an more active variant of the **name-relation** described in Section 2.2.4.2 above — i.e., a name-event brings a name-relation into being.

## 2.5 The Mental Process Subhierarchy

**Mental processes** are individual-internal processes of cognition, emotion, decision, or feeling. They are divided into two main subtypes: **mental-inactives** and **mental-actives**. The subhierarchy is graphed in Figure 18.

### 2.5.1 Mental inactives

Concepts in this category describe passive, inactive mental processing. There are three subtypes of this category: **perception** (e.g., “see”, “hear”, “taste”, “smell”, “feel”, etc.), **cognition** (e.g., “think”, “believe”, “know”, “understand”, “realize”),<sup>18</sup>

<sup>18</sup>Currently only think, believe, and know are represented in the upper model.

and reaction/Emotion/Affection (e.g., "love", "hate", "want", "wish", "fear", "desire", "like").<sup>19</sup> These concepts all have a role called *senser* which is mandatory,<sup>20</sup> and also a role for the *phenomenon* of mental processing. There is some debate as to what this role should be restricted to. Our current thought is that it should include thing, fact, and idea. Depending on how the object hierarchy is organized; this may simply be object since the others are not at present modelled.

There are several linguistic effects attributed to this category.

- The expression of mental processing can take the form of:
  1. a noun phrase
  2. a finite dependent clause (e.g., *that ...*, *whether...*)
  3. an infinitival clause (e.g., *I want to leave.*)
- Inactive-mental-processes do not normally take the progressive form. Recall that material-actions do take the progressive form.
- Passivization is rare for most of these, except in the case where the phenomenon is a noun phrase, e.g.,

*Henry likes Mary.*  
*Mary is liked by Henry.*

but not

*Henry likes to go to the races.*  
*\*To go to the races is liked by Henry.*

- Inactive-mental-processes often form *reversal pairs*. One of the mental actions in the pair is active, the other is inactive, e.g.: "I like bananas." vs. "Bananas please me." Other pairs are {fear, frighten}, {wonder, amaze}, {desire, attract}. Compare this to actions where reversal is only possible using the passive voice.

### 2.5.2 Mental actives

Processes in this class are mental processes which are treated as requiring an expenditure of energy to maintain them or bring them about, as opposed to the more 'state'-like mental processes of the inactive class. Examples of verbs which would fall into this category are: "convince", "please", etc. Mental active processes and mental inactive processes are in the same kind of relationship as directed actions and nondirected actions respectively. For mental active processes the *senser* role should again be value-restricted to **conscious-being**.

<sup>19</sup>Currently only **fearing**, **disliking**, and **liking** are present in the upper model as general types; **liking** is further divided into **wanting** and **striving**.

<sup>20</sup>Ideally, this role would be constrained by a value-restricted of **conscious-being** and a violation of this constraint would render an utterance metaphorical in the sense explained in Section 1.2. However, we cannot as yet handle this kind of variation and so, as with many other cases, the value restriction is loosened.



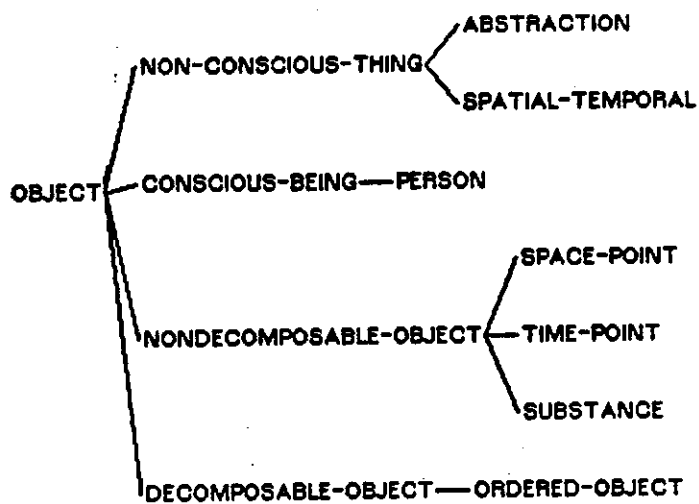


Figure 19: Objects

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### 3 The Object Subhierarchy

The object subhierarchy contains all the entities that may be regarded as *things* — either abstract or concrete, mental or physical, etc. The subhierarchy is organized at the top level along two dimensions: *decomposability* and *consciousness*. These dimensions cross-classify some of the subtypes of object, particularly those under spatial-temporal objects. For this reason, we will first describe the immediate subtypes of objects classified along these dimensions, and then describe the spatial-temporal object subhierarchy separately. The object subhierarchy as a whole is set out in Figure 19.

#### 3.1 Objects: consciousness

One subclass of objects is made according to their consciousness. In general, a *conscious-being* is taken to be an active entity that is capable of producing information and that may be ascribed 'consciousness'. Usually it is a *person*, which can either be male or female.

*Non-conscious-things* are either *abstractions*, i.e., something that exists in metaphorical or qualitative space rather than in physical space — such as 'truth', or spatio-temporal objects. These latter are described in Section 3.3 below. Two kinds of *abstractions* are provided: *words* and *numbers*. *Words* include names such as might be used by the naming relation.

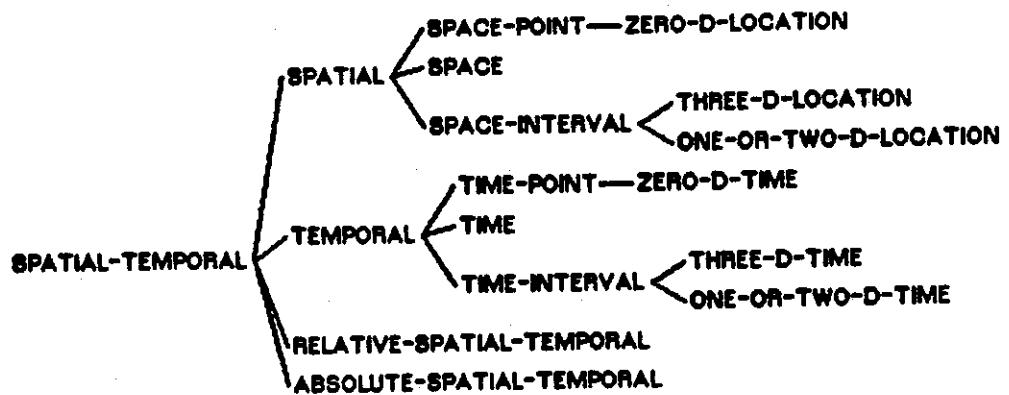


Figure 20: Spatial-temporal objects

### 3.2 Objects: decomposability

Another subclass of objects is made according to their decomposability: objects are either decomposable-objects or non-decomposable-objects. A decomposable-object is an object that is viewed as a collection of parts that may be taken apart; these parts are often given explicit recognition of their own. At present all the decomposable objects dealt with in the upper model are ordered-objects also, indicating that their parts have an intrinsic ordering to them.

The non-decomposable-objects are substance, space-point and time-point. The latter two are also classified within the spatial-temporal subhierarchy described in the following subsection. For substances, e.g., water, grass, flour, butter, their bounded region is not in the domain of physical space, since they are in principle indefinitely expandable in space. Rather, their bounded region is in the domain of some quality spectrum (taste, color, texture, solidity, etc.)

### 3.3 Spatial-temporal objects

Spatial-temporal is the category under which all time and space objects lie. These objects are divided into four subtypes: spatial, temporal, relative-spatial-temporal, and absolute-spatial-temporal. Their interrelationships are shown in Figure 20.

### 3.3.1 Spatial objects

Spatial provides a class for the general concept of spatial object, including all points, paths, volumes, undivided wholes, etc. In particular, it currently contains:

- **Space points**, which are *non-decomposable*, zero dimensional points in space; a single explicit subtype is defined here: **zero-d-location**. Zero dimensional points are usually referred to using prepositions such as "at".
- **Space**, which is the combination of **spatial** and **substance**. This is used as an undifferentiated spatial concept that might support, for example, selection of the interrogative form "where".
- **Space-interval**, which is a one, two, or three dimensional set of space points. It is also an **ordered-object**. Two subtypes are differentiated by the grammar: **three-d-location**, i.e., a volume, and **one-or-two-d-location**, i.e., a line or plane. This can condition selection of spatial prepositions such as "on" in contrast to "in".

### 3.3.2 Temporal objects

Temporal provides a class for the general concept of temporal object, including all points, paths, volumes, undivided wholes, etc. In particular, it currently contains:

- **Time points**, which are *non-decomposable*, zero dimensional points in time; a single explicit subtype is defined here: **zero-d-time**. Zero dimensional points are usually referred to using prepositions such as "at".
- **Time**, which is the combination of **temporal** and **substance**. This is used as an undifferentiated spatial concept that might support, for example, selection of the interrogative form "when".
- **Time-interval**, which is a one, two, or three dimensional set of time points. It is also an **ordered-object**. Two subtypes are differentiated by the grammar: **three-d-time** and **one-or-two-d-time**. A **three-d-time** is a portion of time that is being viewed as of sufficiently large scale to need expression as if it were a volume within which thing occurred (e.g., "in 1966"), rather than a plane on which things occurred (e.g., "on that day"). A **one-or-two-d-time** is a temporal object that is a time interval or smaller scale succession of time intervals, e.g., a day (in opposition to a year). This is clearly a matter of the perspective that is being drawn in particular cases.

### 3.3.3 Absolute/Relative spatial-temporals

A relationship of spatial-temporal locating may locate with respect to a space or time that can be classified as either absolute or relative. Absolute here refers to a posited

property of temporal and spatial relationships concerning how they are treated by the grammar of English. Absolute spatio-temporal relationships are taken to be unchanging with respect to the observer. A relative relationship is one that moves with the observer. As an example, the notion of 'today', 'tomorrow', etc. do not stand still and allow the observer to pass them by, they move with the observer; this is in contrast to the notion of a 'Monday', which can come and pass the observer by. Relative locatings are often performed using an adverbial phrase, while absolute locatings use a prepositional phrase. Examples of this distinction, which is still a working hypothesis which will probably need revision as more data on temporal expressions are admitted and treated by the grammar, are as follows:

absolute:	<i>I will come on Tuesday</i> <i>The ship is at 15 N 34 W</i>
relative:	<i>I will come tomorrow</i> <i>I will come Tuesdays</i> <i>I am turning left</i>

Again, the issue of the perspective that is being taken on the location is clearly here quite decisive for the acceptability of the various forms.

## 4 The Quality Subhierarchy

Qualities are properties of objects and processes. They participate in property ascription relations. Roughly speaking, qualities include anything that can be expressed as an English adjective or adverb. The present upper model divides qualities into two subtypes: **modal-qualities**, which are qualities of being able to do something, wanting to do something, having to do something, etc., and **material-world-qualities**, described below.

### 4.1 Modal qualities

The modal-qualities are shown in Figure 21. They are classified along two dimensions: **conditionality** and **volition**. They may be described thus:

- Modal qualities that are not conditional are expressed with modalities such as: "will", "must", "can", etc.; those that are conditional are expressed by "would", "might", "could", etc.
- Modal qualities are classified in terms of the actor's active decision or volition in the performance of a process: a nonvolitional process is one where the actor did not take, or is not expressed as taking, direct responsibility for the process; a volitional process is one where the actor did take responsibility. Volitional processes are often expressed with: "will", "won't", "would", ...; nonvolitional with: "may", "can", "must", "might" ...

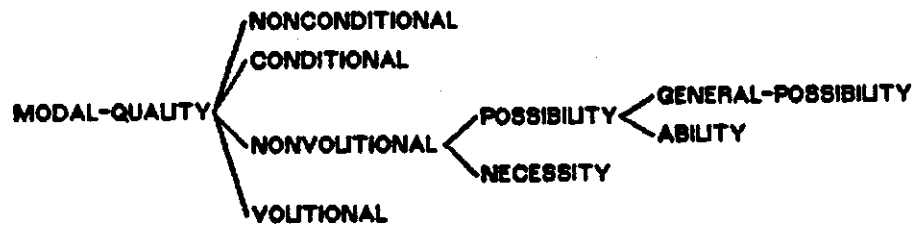


Figure 21: Modal qualities

necessity		<i>must, mustn't, might</i>
possibility	general-possibility	<i>may</i>
	ability	<i>can, can't, could</i>

Figure 22: Realizations of nonvolitional modals

The nonvolitional class breaks down further according to possibility and necessity; and possibility further to general-possibility and ability. The realizational consequences of these classes are set out in Figure 22.

## 4.2 Material-world-qualities

Material-world-qualities can be thought of as those qualities which are evident when the referent is looked at, weighed, measured, etc. Examples include: "heavy", "blue", "German", "readable", "efficient", "maintainable". The bearers of these qualities are things. The material-world-qualities are broken up into 3 properties of material-world-qualities. First we discuss these properties, then present a table which shows how these properties are distributed among the sub-categories. The entire subhierarchy is shown in Figure 23.

The properties are:

1. *scalability*: the set of possible values form a continuum. A quality is *scalable* if an object may possess it to varying degrees. For example, 'heavy' is a scalable quality. We can describe objects as being 'very heavy', or 'more' or 'less' heavy than other objects. A *non-scalable* quality is either possessed by an object or it is not. 'Dead' is a non-scalable quality.

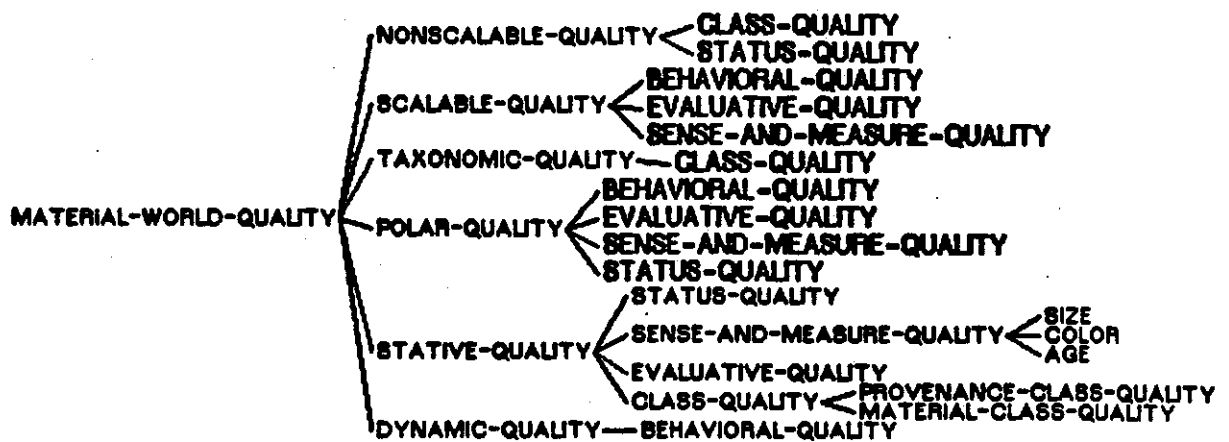


Figure 23: Material world qualities

2. *type of contrast*: the space of values may be divided in many ways

- *polar*: A quality is *polar* if it has a corresponding quality describing its opposite or the absence of this quality entirely. A polar quality is not part of a larger taxonomy. E.g., 'heavy'/'light', 'dead'/'alive'.
- *taxonomic*: All qualities which are not polar are *taxonomic*, i.e., the possible values can be listed. For example, the quality of being mammal is part of some taxonomy.

3. *dynamicness*: a quality can be stative or dynamic. A quality is *dynamic* if the entity possessing this quality must exert some effort in order to maintain the quality. *Stative* qualities hold regardless of any particular process. Dynamic qualities can be expressed using the present progressive tense, i.e., they can take the form:

*X is being <quality>*

For example, "John is being clever/skillful/creative/enthusiastic." Stative qualities cannot. "\*John is being dead/German/tall." These can take the simple present only.

The table of Figure 24 shows how these properties are distributed among the 5 subclasses of material-world-qualities currently defined in the upper model.

Further examples of qualities that are candidates for a more distinctive inclusion in the upper model are the 'states': "happy", "angry", "sad", "amused", "afraid".

	class	status	evaluative	sense	behavioral
scalable	no	no	yes	yes	yes
type of contrast	taxonomic	polar	polar	polar (except color)	polar
dynamicness	stative	stative	stative	stative	dynamic

Figure 24: Properties of Material Qualities

Constructions involving qualities in this class can also specify a fact as the cause of the mental state. For example,

*Henry was sad that he missed the performance.*  
*Henry was angry because the train was late.*

Two further classifications of qualities of this kind are in terms of whether they are *senser-oriented* or *phenomenon-oriented*, although some qualities fall into both phenomenon- and senser-oriented categories. In this case they are expressed differently depending on their classification. Compare:

I am *amazed* that the earth is flat. (senser-oriented)  
 That the earth is flat is *amazing* to me. (phenomenon-oriented)

Otherwise, the two classes have differing realizational possibilities; for example:

*That the USA has 1,000 nuclear weapons is* *frightening.*  
*/likely.*

*\*That the USA has 1,000 nuclear weapons is* *blue.*  
*/happy.*

The subclasses which are present in the upper model may be described as follows.

**Status-quality** ascribes a quality to an object, independent of the observer. For example, a specialization of this category is the quality **life-status** which is further broken down into the classes **dead** and **alive**.

**Class-quality** should contain numerous taxonomies. For the present it contains only the taxonomy **material-class-quality** that describes the quality of being made of a particular material (e.g., wood, metal, etc.) and **provenance-class-quality** that constrains according to place, institution, social group, or other social category of origin.

**Sense-and-measure-quality** is a quality that is sensed or measured by conscious beings. For example, this category would include qualities of age (young, old), of weight (light, heavy), price (expensive, cheap), etc. For the present, the defined subcategories are: **size, color, and age**. These are all motivated by differential treatments in the grammar of English nominal groups.

**Evaluative-quality** is a quality that is determined by some value system of some conscious being. Such a value system may be moral, aesthetic, or utilitarian. Moral qualities include honest, polite, generous. Beautiful, neat are examples of aesthetic qualities. Readable, easy, and thorough are some of the task-oriented qualities.

**Behavioral-quality** is a quality that characterizes the behavior of a conscious being.

## 5 The Interpersonal Attitude Subhierarchy

Within the definition of the upper model release described in this document, there appears another small subhierarchy that has not been described so far and which falls outside of the categories mentioned. This is the subhierarchy found below the concept **interpersonal-thing**, which is described here for completeness. **Interpersonal-thing** concepts refer to aspects of the speaker's 'intrusion into the speech event', including the particular stands on and modifications to the proposition that the speaker is expressing. This area therefore includes notions of **polarity and speech acts**.

In the interpretation of the SPL input specifications to the PENMAN system, a variety of feature compatibility checks and appropriate unifications of information from distinct parts of the specification are performed; this is described in PENMAN (1989b). The upper model hierarchy is used to determine some of the cases of possible compatibility and incompatibility between features. However, some types of feature for which this kind of compatibility checking is required should not, according to our current thinking on the appropriate contents of the upper model, be in the upper model at all.<sup>21</sup> The interpersonal-thing concepts are an example of this.

By placing these categories in the current upper model data structure, however, the implementation of feature compatibility used in interpreting the SPL input can operate on speech act and polarity features as required, without our providing additional mechanisms. Theoretically, then, the **interpersonal-thing** subhierarchy is *not* to be considered part of the upper model. Nevertheless, it is there in the structure so we describe it here. It is shown graphically in Figure 25.

The class **polarity** has three subclasses:

- **polarity-variable**, which is used when the polarity of a proposition is the point at issue in an utterance; for example, in a yes/no question:

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<sup>21</sup>For more on this issue, and on which kind of information should appear in an upper model and which should not, see Bateman (1990a).



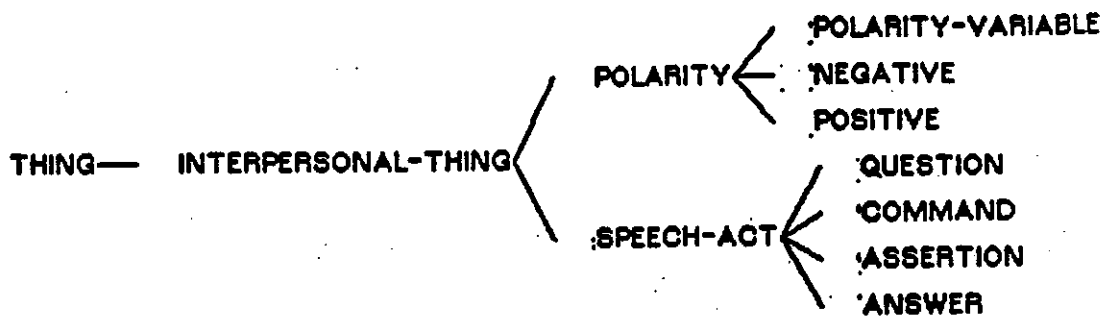


Figure 25: Interpersonal hierarchy

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*is this true?*

- negative, which indicates that the speaker is evaluating the truth-value of the *whole* proposition being expressed in an utterance negatively; e.g.:

*This is not the case.*

Note that it is important that it is the speaker's *evaluation* that is being emphasized here; this is a consequence of the assignment of this area of variability to the *interpersonal* meaning that is being expressed. The full semantics of *not* are not handled within the LOOM representation language and so, at present, we do not have a mechanism for the general representation of *propositional* negation. We therefore restrict our treatment of negation to interpersonal speaker evaluations of positive propositions and cannot negate individual parts of the proposition at issue.

- positive, which indicates that the speaker is evaluating the truth-value of the proposition being expressed in an utterance positively; e.g.:

*This is the case.*

The second class of interpersonal-thing is speech-act, and this has four subclasses:

- question, which results in a surface form interrogative clause;

- **command**, which results in a surface form imperative clause;
- **assertion**, which results in a surface form indicative clause;
- **answer**, which results in an elliptical form as may be produced as an answer to a question. At present the only possibilities the grammar supports in this area are: *yes* and *no*.

In all cases of speech acts, the relation between speech act type and surface form is straightforward; there is no attempted treatment of indirect speech acts of any kind. For the purposes of generation within the current model, reasoning of this kind, which might elect to use an assertion to communicate a question, for example, is placed at a prior level and needs to be decided *before* constructing the SPL input specification.

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## 6 Appendix A — Graph of the Upper Model Hierarchy



## 7 Appendix B — Concept Definitions

### Alphabetical list of upper model concepts and definitions

This appendix contains a list of the upper model concepts in the present upper model with a summary definition. Also, where applicable, we show the inquiries of the NIGEL grammar that rely on each entry (identified by the name of the inquiry, e.g., :absolute-extent-q or :affected-id) and the lexical realizations defined within NIGEL for that entry (e.g., the upper model concept *above* may be realized by the lexical item *above*). Further information on the grammatical consequences of any particular upper model concept can then be found by examining the choosers and systems that use the inquiries here identified. How this can be done is described in detail in the NIGEL manual (PENMAN, 1989a).

**ABILITY** A modal qualification of the process, with respect to the ability to perform that process; typically realized by 'can'.

:ability-q  
*can, could, may, might*

**ABOVE** A type of spatial relation that shows orientation with respect to a horizontal plane.

:vertical-orientation-q  
*above*

**ABSOLUTE-EXTENT** A relationship of extent that is classified as absolute. Absolute here refers to a posited property of temporal and spatial relationships concerning how they are treated by the grammar of English. Absolute spatio-temporal relationships are taken to be unchanging with respect to the observer. A relative relationship is one that moves with the observer. As an example, the notion of 'today', 'tomorrow', etc. do not stand still and allow the observer to pass them by, they move with the observer; this is in contrast to the notion of a 'Monday', which can come and pass the observer by.

:absolute-extent-q  
*for*

**ABSOLUTE-SPATIAL-TEMPORAL** A relationship of spatial-temporal locating that is classified as absolute. Absolute here refers to a posited property of temporal and spatial relationships concerning how they are treated by the grammar of English. Absolute spatio-temporal relationships are taken to be unchanging with respect to the observer. A relative relationship is one that moves with the observer. As an

example, the notion of 'today', 'tomorrow', etc. do not stand still and allow the observer to pass them by, they move with the observer; this is in contrast to the notion of a 'Monday', which can come and pass the observer by.

**ABSTRACTION** Something which exists in metaphorical or qualitative space rather than in physical space. E.g., truth.

**ACCOMPANIMENT** This relation holds between objects which participate jointly in some process. Accompaniment may be expressed as: independent-argument "be with" dependent-argument; or by a prepositional phrase beginning with the preposition "with" as in: <independent-argument> ... *with* <dependent-argument>. Note that it is not necessary for both of the participants to be aware of the participation. Thus both of the following sentences are examples of this relation: "John went for a walk with Mary". "John went for a walk with his umbrella". The relation also allows for variation in both a positive and negative direction; For example, "without" is also a type of accompaniment, albeit negative, as is "instead of", which is an accompaniment of alternative.

:accompaniment-q/id  
:accompaniment-modification-q/id  
:accompaniment-relation-q

**ACTEE** A process participant describing the entity upon which a process is 'done', 'carried out', etc.

:actualization-constrainer-id  
:agent-mention-q  
:material-act-category-q/id  
:medium-mention-q

**ACTOR** A transitivity function in a material clause; the participant always inherent in the clause according to the transitive model of transitivity. The process it participates in may or may not extend to affect another participant, the Goal. For instance, (Actor:) *Henry* (Process:) *dives*; (Actor:) *Henry* (Process:) *kicked* (Goal:) *the ugly duckling*.

:actor-id  
:actualization-constrainer-id  
:affected-id  
:agent-mention-q  
:agent-qualifier-id  
:causer-id  
:medium-mention-q  
:question-item-id

**ADDITIVE** One type of accompaniment that may holds between objects which participate jointly in some process. This form of accompaniment states that the accompaniment is positive and actual; it may be expressed by a prepositional phrase beginning with the preposition "'as well as' as in: <independent-argument> ... *as well as* <dependent-argument>. The following sentence contains an example of this relation: "John went for a walk with Mary as well as Joan."



:addition-q  
as well as

**ADDRESSEE** Receiver of the communicative process, e.g., "Henry told *me* that dinner would be ready at 6:00pm."

:actualization-constrainer-id  
:address-q  
:addressee-id  
:addressee-oriented-q

**ADDRESSEE-ORIENTED-VERBAL-PROCESS** A verbal process for which the addressee is an obligatory role.

*tell*

**AGE** A sense and measure quality pertaining to the age of an entity.

**AGE-PROPERTY-ASCRPTION** The type of ascription of property that ascribes a quality of age to an object.

:age-modification-q  
:age-modifier-id

**AGENTIVE** A type of participant and generalized-means that captures the notion causal responsibility for a process' performance.

:agentive-q  
:manner-q

**ALTERNATIVE** One type of accompaniment that may holds between objects which participate jointly in some process. This form of accompaniment states that the accompaniment is positive but replacing; i.e., that some object participated in a process or state as an alternative to some other. It may be expressed as a prepositional phrase beginning with the preposition "instead", as in: <independent-argument> ... *instead* <dependent-argument>. Note that it is not necessary for both of the participants to be aware of the participation. Thus both of the following sentences contain examples of this relation: "John went for a walk with Joan instead of Mary." "John went for a walk with his blue shoes instead of his white ones."

:alternative-q  
*instead of*

**AMBIENT-PROCESS** A process describing an ambient condition, such as the weather, temperature, etc.

**ANTERIOR** A relation between intervals that specifies their order in time. A type of temporal locating, a spatio-temporal circumstantial. Here one interval is said to be prior to another.

:anterior-q  
:anteriority-q  
:sequence-q  
:time-precedence-q  
:time-precede-q  
until, before

**ASCRPTION** This relation captures the notion of membership in a set. The logical roles of this relation are: *attribute* (the range) and *attribuend* (the domain). In general, *attribuend* will be filled by an object. The *attribute* role will be filled by a quality or by an object. Finer restrictions can be made based on the given attribute. This relation is typically expressed by the verb "be".

:ascription-q

**ASCRPTION-INVERSE** The inverse of the Ascription relation.

**ASSERTION** The speech act of assertion that something is the case.

:presuppose-existence-q  
:statement-q

**ASYMMETRIC-RHETORICAL-RELATION** The relationships defined in Rhetorical Structure Theory have nuclear elements (the domain) and satellites (the range). The nuclear element is the one that is essential for achieving the goal of a particular relation; satellites serves auxiliary, supporting roles. Those RST relations which have only one nucleus assign different importance to the parts of the discourse they relate - one part is nuclear, the others are not - these are therefore called asymmetric rhetorical relations.

**AT-LEAST** An ascription of relative quantity that puts a lower bound on the quantity ascribed.

:number-range-direction-q  
at least

**AT-MOST** An ascription of relative quantity that puts an upper bound on the quantity ascribed.

at most

**ATTRIBUEND** The participant in a scaled comparison whose possession of a quality is being compared.

**BEHAVIORAL-QUALITY** Behavioral qualities are qualities which characterize the behavior of a conscious being.

**BEHIND** A type of spatial relation that shows orientation with respect to a vertical plane.

:horizontal-orientation-q  
behind

**BELIEVE** The involuntary mental process of holding a belief.

*believe*

**BELOW** A type of spatial relation that shows orientation with respect to a horizontal plane.

:vertical-orientation-q  
*below*

**BENEFICIARY** A transitivity function in the clause, according to the generalized ergative transitivity model: the participant benefitting from the actualization of the combination of Process + Medium. In a material clause, it is the Recipient (My aunt gave *the farmer* a duckpress) or the Client (Pour *me* out a cold Dos Equis beer) and in a verbal one, it is the addressee (Joe told *us* all about Eve). It also occurs in a few relational clause types (I owe *you* an apology) and mental clauses (I envy *you* your luck; I don't begrudge *you* your happiness).

:actualization-constrainer-id  
:beneficiary-id  
:cause-id  
:possession-onset-q

**CAUSAL-RELATION** *Causal-relation* logically has two roles: *cause* (the domain) and *effect* (the range). At this most general level, causality may be expressed as: <effect> *bccause* <cause> or <cause> *cause* <effect>.

:causal-relation-q  
:causation-q  
:cause-id  
:wh-concept-q  
*cause*

**CAUSE-EFFECT** This captures the relationship of one thing being the cause of another, the effect.

:cause-condition-q

**CIRCUMSTANTIAL** A process is taken to consist potentially of three components: the process itself, participants in the process, and *circumstances* associated with the process. Circumstances are often realized as adverbial groups or prepositional phrases. Circumstances expressed as adverbial groups come from the circumstance hierarchy, while those expressed as prepositional phrases are represented as circumstantial relations.

:circumstance-q  
:circumstantial-q  
:conditioning-q  
:process-regulated-q

**CLASS-ASCRPTION** In this case, both the domain (functioning as *attribuend*) and the range (functioning as *attribute*) are restricted to be filled in by objects. This relation corresponds to the SuperClass notion of LOOM. It too is often expressed by the verb "be". For example, "Henry is a teacher."

:typic-q  
be

**CLASS-QUALITY** This category contains various taxonomies. For example, the *material-class-quality* taxonomy describes the quality of being made of a particular material, e.g., wood, metal, etc.

**CLIENT** The role of beneficiary where something is done for another person.

:behalf-q/id  
:causation-and-behalf-q

**COGNITION** Processes of cognition (e.g., "think", "believe", "know", "understand", "realize").

:cognition-q

**COLOR** A sense and measure quality pertaining to color.

**COLOR-PROPERTY-ASCRPTION** The type of ascription of property that ascribes a quality of color to an object.

:color-modification-q  
:color-modifier-id

**COMMAND** The speech act of commanding that something be the case.

:command-q

**COMPARE-QUALITY** The slot in a scaled comparison that contains that quality with respect to which an object (the *attribuend*) is being compared.

**COMPARISON** This category encompasses relations which indicate how similar or dissimilar two entities are. It is broken down into the subcategory: *similarity*. Difference could be presented as a further subtype, and equality could be a further specialization of similarity. Verbs articulated by this category include: "resemble", "differ from", "be similar to", "be different than", "be like", "match", "fit", etc. A grammatical characteristic of entities in this category is that they are symmetric, i.e., subject and object can be interchanged without passivization. Note however, that the passive form is still possible. For example, "Henry resembles Joan". "Joan resembles Henry". "Joan is resembled by Henry".

**CONCESSIVE** One type of generalized causation relationship. This relation states that some process occurred despite some other event or state of affairs holding. It is typically realized in English by the preposition "despite" therefore.

:causation-and-concessive-q  
:concession-q  
:concessive-relation-q

**CONDITIONAL** A type of modal quality. Modal qualities that are not conditional are expressed with modalities such as: "will", "must", "can", etc.; those that are conditional are expressed by "would", "might", "could", etc.

:modality-conditionality-q  
*should, would*

**CONJUNCTION** A relation of logical additive combination of process or states of affairs; often realized by conjoining with "and".

:conjunction-extension-q  
:dual-process-part1-id  
:dual-process-part2-id  
:taxis-prominence-q  
*and, also, in addition*

**CONSCIOUS-BEING** An active entity that is capable of producing information that may be ascribed consciousness; e.g., a person.

:consciousness-q

**CREATIVE-MATERIAL-ACTION** A specialization of directed-action. Actions in this category *create* their actee. For example, "Mary baked a cake." All actions in this category can be realized using the verbs "create" or "make".

:preexist-q  
*make*

**DECOMPOSABLE-OBJECT** An object that is being viewed as being made up of parts that may be taken apart and are often given explicit linguistic recognition.

**DESTINATION** In a process of (possibly abstract) motion, the relation between the process and the place to which the motion is heading.

:destination-q  
:destination-process-q  
*to, towards*

**DIRECTED-ACTION** *Directed-actions* have an *actee* role. They are always transitive, although they may be actee-intransitive. In this case, the actee is not specified, but is inferrable. For example, "Henry hunts." In this case, we can infer that Henry hunts something in the category of *hunnable-things*. Directed-actions can always have a beneficiary of the client type. This is expressed by the prepositional phrase: "for" client. Directed-actions are further broken up into two subclasses depending upon whether or not the actee existed before the action occurred.

:caused-process-q  
:medium-mention-q  
do

**DISJUNCTION** A relation of logical disjunctive combination of process or states of affairs; often realized by conjoining with "or".

*or, alternatively*

**DISLIKING** A mental reaction that is negative towards some object or state of affairs.

:disliking-q

**DISPOSITIVE-MATERIAL-ACTION** Another specialization of directed-action. Actions in this category affect their actee. This category includes any verbs that describe an action on something that already exists, e.g., "Eunice ate the cake."

**DYNAMIC-QUALITY** A quality can be stative or dynamic. A quality is *dynamic* if the entity possessing this quality must exert some effort in order to maintain the quality. *Stative* qualities hold regardless of any particular process. Dynamic qualities can be expressed using the present progressive tense, i.e., they can take the form: 'X is being <quality>.' "John is being clever/ skillful/ creative/ enthusiastic." Stative qualities cannot. "\*\*John is being dead/ German/ tall." These can take the simple present only.

**ELABORATION** A logical relationship between processes and objects of providing more information concerning those processes or objects; this includes restating and providing examples.

:generalization-direction-q  
:presentational-complexity-q  
:presentational-relation-q  
*eg, for example*

**ELEMENT** A type of part-whole relationship, such as that holding between a list and its elements.

**ELEMENT-OF** The inverse of the Element relation.

**ENABLEMENT** A type of generalized means; this relation refers to a possible enabling relationship between the actualization of some process or state of affairs and an entity, state of affairs, or other process.

:enabling-q

**EVALUATIVE-QUALITY** Qualities which belong to this class are determined by some value system of some conscious being. Such a value system may be moral, aesthetic, or utilitarian. Moral qualities include 'honest', 'polite', 'generous'. 'Beautiful', 'neat' are examples of aesthetic qualities. 'Readable', 'easy', and 'thorough' are some task-oriented qualities.

**EXACTLY** A relation of focusing or restricting an attribution of quantity.

:number-focusing-extent-q  
*exactly*

**EXCLUSIVE** A subtype of accompaniment that picks out the negative nature of accompaniment; an exclusive accompaniment indicates that accompaniment occurred at the expense of, or without some entity that did not accompany.

*without*

**EXEMPLIFICATION** The relation between some thing/process and an example of that thing/process.

:example-elaboration-q

**EXHAUSTIVE-DURATION** An exhaustive duration is a relation which specifies that the process or state participating in the relation is one which holds for the entire extent of the temporal interval participating in the relation.

:duration-q  
*during*

**EXISTENCE** A one-place relation, found, for example, in "There is a block." Note that the notion of 'state' does not come out as a category of special status in the upper model (following the semantics of English as represented by the Systemic Grammar). Instead, what we may think of as state is spread out over several concepts, e.g. relations, qualities. If considerations of inferencing require the notion of state, it will be necessary to recognize it as a separate category and subordinate that concept to the distinct linguistically-motivated categories as required for the language desired to express that concept.

:existential-q

**EXTENT** A spatio-temporal relation of specifying the time that a state of affairs or process holds (e.g., 'for 5 years'), or the extent in space taken (e.g., 'across the bridge', 'along the road').

:extent-q

**EXTREMAL** A relation of temporal locating that explicitly orients to the end point of an interval; this establishes contrasts such as "until" (extremal) vs. "before" (nonextremal), and "since" (extremal) vs. "after" (nonextremal).

:period-extremal-q  
*until, since*

**FACING** A type of spatial relation that shows orientation with respect to a vertical plane. It is typically realized in English by the preposition "in front of".

:horizontal-orientation-q

**FEARING** A mental reaction that is negative towards some object or state of affairs and which invokes fear; this is used by the grammar which, in this area, has an approximation to the systemic notion of lexis as grammar; i.e., very fine distinctions are drawn which can be used to guide word choice.

:fearing-q

**FEMALE** An object that is to be considered female, for, e.g., pronominalization purposes.

:gender-q

**FOLLOW** A temporal relationship of strict precedence; it is therefore posterior and nonextremal. It is an inverse to the precede relation that is used in tense reasoning by the grammar.

*after*

**GENERAL-POSSIBILITY** A general possibility relationship is a modal modification of a process that indicates that the process may occur; it is typically realized using the modal "may".

*may, might*

**GENERALIZED-MEANS** A type of participant which can be agentive, manner, instrumental, or comparison. It is a generalized notion that refers to the abstract concept of the means for actualizing some process.

:know-manner-q

:means-q

:multiple-process-q

:process-manner-id

**GENERALIZED-POSSESSION** Generalized-possession logically has two roles: *possessor* (the domain) and *possessed* (the range). The notion of generalized possession is often expressed as: <possessor> *has* <possessed>. In general, relations in this category can also be expressed with a possessive form, e.g., "John's book", "Henry's sister".

:generalized-modification-q

:identifiability-q

:member-set-q

:portion-modification-q/id

:possessive-q

:possessor-modification-id

*have, 's*

**GENERALIZED-POSSESSION-INVERSE** The inverse of the Generalized-Possession relation.



**GENERALIZED-ROLE-RELATION** The generalized perspective on an entity that 'has some relationship' with another. When no more specific information concerning available grammatical realizations is given, subtypes (<role>) of this relationship can be used to generate language of the form: <domain> *has* <range> *as* <role> or <domain> 's <role> *is* <range>.

:member-set-q  
:possessor-modification-q  
:process-modification-id  
*have, 's*

**GREATER** A direction of comparison in a scaled comparison: here, the quality with respect to which comparison proceeds holds more rather than less.

:exceed-q

**GREATER-THAN** A relative quantity ascription that specifies a range beginning at some lower bound.

*greater than*

**GREATER-THAN-COMPARISON** The scaled comparison that compares by stating that a quality holds more rather than less.

:exceed-q

**HORIZONTAL** The general relation of spatial locating that determines whether there is an orientation to some dimension being expressed. Horizontal naturally refers to the orientation of the plane relative to which location is to be expressed. It contrasts with vertical and is a subtype of orienting.

:axis-of-orientation-q

**IDENTITY** The type of relation between entities that states that they are in some sense identical or overlap. Examples of this type of relation are statements such as 'X is a Y', or 'X is mine'.

:identity-q  
:identity-questioning-q  
:phoric-representative-selection-q  
*be*

**INCLUSIVE** A subtype of accompaniment that picks out the positive nature of accompaniment; an exclusive accompaniment indicates that accompaniment occurred in addition to some other entity that accompanies.

:participation-q  
*with*

**INSTRUMENTAL** Instrument is typically expressed as: '<verb> + with' where <verb> cannot be "be".

:manipulation-q

**INTENSIVE** A way of relating two entities as being identical, of one symbolizing the other, or of ascribing a class membership or a quality or property.

**INTERPERSONAL-THING** Separates a portion of the hierarchy that is concerned with interpersonal entities rather than with ideational ones; i.e., entities concerned with the speaker's role in the communicative process rather than with the subject matter of what is being communicated.

**KNOW** A mental process describing the involuntary state of knowing that something is the case.

*know*

**LESS-THAN** A relative quantity ascription with respect to a higher bound.

**LESS-THAN-COMPARISON** The scaled comparison that compares by stating that a quality holds less rather than more.

:exceed-q

**LESSER** A direction of comparison in a scaled comparison: here the quality with respect to which comparison proceeds holds less rather than more.

:exceed-q  
*less*

**LIKING** An involuntary favorable mental/emotional reaction to some entity or state of affairs, or a process that presupposes a favorable reaction, e.g., to want or strive to bring something about.

:liking-q

**LOCATING** The relation of locating an entity in time or space.

:location-q  
*location*

**LOGICAL** Relations that combine process or states of affairs into larger, composite processes or states of affairs, either conjunctively (e.g., "and"), or disjunctively (e.g., "or"), or by providing more information in an elaboration.

:conditional-relation-q

**MALE** An object that is to be considered male, for, e.g., pronominalization purposes.

:gender-q

**MANNER** A circumstantial role of a process that describes the manner in which the process' actualization is achieved. Commonly realized by adverbs in English, although there are other possibilities also.

:manner-q  
:manner-condition-q

**MATERIAL** A participant role that carries the information of the material from which an entity is constructed

**MATERIAL-CLASS-QUALITY** *Material-class-quality* describes the quality of being made of a particular material, e.g., wood, metal, etc.

**MATERIAL-PROCESS** *Material-processes* include both intentional actions, i.e., actions with a volitional actor, e.g., "The mouse ran up the clock." and happenings, such as *erosion* and *disintegration* e.g., "The wall came tumbling down". The roles of this relation are: *actor*, *actee*, and *effect*. Material Processes are further broken up into two classes, depending upon whether or not they can have an actee: directed-actions and nondirected-actions.

:process-modification-q/id

**MATERIAL-PROPERTY-ASCRPTION** The general ascription of a material world quality.

:material-class-id  
:material-classification-q

**MATERIAL-WORLD-QUALITY** *Material-qualities* can be thought of as those qualities which are evident when the referent is looked at, weighed, measured, etc. Examples include: "heavy", "blue", "German", "readable", "efficient", "maintainable". The referents of these qualities are *things*. The material-qualities are broken up into 3 properties of material-qualities: *gradability*, *type of contrast* (i.e., polar or taxonomic), and *dynamicness*.

**MENTAL-ACTIVE** This is another specialization of actions concerned with mental processing. The actor role would be value-restricted to *conscious-being*, however grammatical metaphor often overrules this. Examples of verbs which would fall into this category are: "convince", "please".

:caused-process-q  
:causer-id

**MENTAL-INACTIVE** Concepts in this category describe passive, inactive mental processing. There are 3 subtypes of this category: Perception (e.g., "see", "hear", "taste", "smell", "feel", etc.), Cognition (e.g., "think", "believe", "know", "understand", "realize"), and Reaction/Emotion/Affection (e.g., "love", "hate", "want", "wish", "fear", "desire", "like").

sense

X  
**MENTAL-PROCESS** Individual-internal processes of cognition, emotion, decision, or feeling.

:mental-process-q  
:multiple-process-q  
:projection-q  
:report-q

**MODAL-PROPERTY-ASCRPTION** The ascription of a modal quality, typically to a process.

:modality-q/id

**MODAL-QUALITY** Qualities of being able to do something, wanting to do something, having to do something, etc.

**MOTION-PROCESS** A type of nondirected action that includes motion on the part of the actor.

*go*

**NAME** An accepted but possibly arbitrary label for some entity.

:favor-q

**NAMED-OBJECT** Objects which typically have names.

**NAME-EVENT** The process of giving something a name.

*name*

**NAME-OF** The relation that holds between a name and its bearer.

**NAME-RELATION** The relation that holds between a name's bearer and that name.

**NATURAL-NUMBER** A type of abstraction referring to numerical value.

**NECESSITY** An example of a modal quality.

:modal-necessity-q  
*must, should*

**NEGATIVE** An interpersonal speech act modification along the dimension of polarity - in the negative direction.

**NON-ADDRESSEE-ORIENTED-VERBAL-PROCESS** A verbal process that does not intrinsically require an addressee.

*say*

**NON-CONSCIOUS-THING** Some entities are just treated in the language used as not being conscious. They go here.

**NONCONDITIONAL** A type of modal quality. Modal qualities that are not conditional are expressed with modalities such as: "will", "must", "can", etc.; those that are conditional are expressed by "would", "might", "could", etc.

*must, will*

**NONDECOMPOSABLE-OBJECT** An object that is being regarded as not possessing significant parts, or which is not to be considered decomposable for present purposes.

**NONDIRECTED-ACTION** *Non-directed-actions* are those material-actions which either have no 'actee', or whose 'actee' is not created or affected by the action. They are often (though not necessarily) intransitive. In the case they are transitive, the object is not affected or created by the action. Instead it specifies a range of the action. For example, "I play the piano/tennis." This specifies that I am capable of a typical kind of playing.

All verbs of movement are examples of non-directed-actions, e.g. "climb", "walk", "fly", "fall", "run". Skills, such as "read (music)", "speak (French)", etc. are included in this category. In addition, the verbs "have" as in "have lunch", "take" as in "take a shower", "do" as in "do a dance", and "make" are in this category.

:affected-id  
:material-act-category-q  
:medium-mention-q

**NONEXHAUSTIVE-DURATION** An nonexhaustive duration is a relation which specifies that the process or state participating in the relation is one which does not hold for the entire extent of the temporal interval participating in the relation.

:duration-q  
*in*

**NONEXTREMAL** A relationship of temporal locating that is not oriented to the end points of an interval; examples of this distinction are: "until" (extremal) vs. "before" (nonextremal), and "since" (extremal) vs. "after" (nonextremal).

*after, before*

**NONORIENTING** A relationship of spatial locating that does not include a specification relative to some dimension or orientation axis; e.g., with respect to a vertical plane, in front vs. behind, or with respect to a horizontal plane, above vs. below. Nonorienting locations are concerned with reference points, lines, and volumes.

*at, in, on*

**NONPARALLEL-EXTENT** A spatial locating that distinguishes the dimension of the extent relative to a direction of movement; this distinguishes "across" (nonparallel) type extents from "along" (parallel) type extents.

:parallel-q  
*across*

**NONSCALABLE-QUALITY** A quality is *scaleable* if an object may possess it to varying degrees. For example, "heavy" is a scaleable quality. We can describe objects as being "very heavy", or "more" or "less" heavy than other objects. A *non-scaleable* quality is either possessed by an object or it is not. "Empty" is a non-scaleable quality.

**NONVOLITIONAL** A modal quality concerned with the actor's active decision or volition in the performance of a process; a nonvolitional process is one where the actor did not take, or is not expressed as taking, direct responsibility for the process.

**NUMBER** A type of abstraction referring to numerical value.

**NUMBER-FOCUSING** The relation of being more specific about a quantity that is being ascribed. This is a type of quantity-ascription and contrasts with quantity, which provides no additional information concerning the quantity apart from its value.

:number-focusing-q/id

**OBJECT** An entity which is not a process or a quality.

:empty-number-q  
object

**ONE-OR-TWO-D-LOCATION** A spatial object that is either a line or a plane.

:dimension-relation-q

**ONE-OR-TWO-D-TIME** A temporal object that is a time interval or smaller scale succession of time intervals, e.g., a day (in opposition to a year). This is clearly a matter of the perspective that is being drawn in particular cases.

:time-dimension-q

**ONE-PLACE-RELATION** A one-place-relation has one and only one participant. The only one-place-relation in the hierarchy so far is *existence*.

**ORDERED-OBJECT** A type of decomposable object whose parts have an intrinsic ordering of their own; for example, the elements of a list, the carriages of a train, etc.

**ORDERING-RELATION** The general relationship that holds between the parts of an ordered object.

**ORIENTING** A relationship of spatial locating that includes a specification relative to some dimension or orientation axis; e.g., with respect to a vertical plane, in front vs. behind, or with respect to a horizontal plane, above vs. below.

:orientation-q

**OWNED-BY** The inverse of the Ownership relation.

**OWNERSHIP** This is a relation between the owner of an object and the object. This is a specialization of generalized-possession. It has the same roles as generalized-possession, but the possessor role is value-restricted to *active-entity*. Ownership may be expressed as: <possessor> *own* <possessed> or <possessed> *belong to* <possessor>.

:possessor-modification-q

**PARALLEL-EXTENT** A spatial locating that distinguishes the dimension of the extent relative to a direction of movement; this distinguishes "across" (nonparallel) type extents from "along" (parallel) type extents.

*along*

**PART** One of the participants in a part-whole relation.

:member-set-q

:portion-modification-q

**PART-OF** The inverse of the Part relation.

**PART-WHOLE** This is a relation between an entity and its parts. It logically has two roles: *whole* (the domain) and *part* (the range). Note: How this relation is expressed in the language seems to depend on the type of object that fills the *whole* role. At the most general level, this relation can be expressed as: "*Part* 'be an element of' *whole*" or "*part* 'be a component of' *whole*".

:member-set-q

**PARTICIPANT** A process/state/event is said to 'contain' some number of entities that *participate* in the actualization of that process/state/event. The manner of these entities participation is identified in terms of given role names.

:extracted-variable-id

:process-modification-q

:propositionality-q

**PERCEPTION** An involuntary mental process of perceiving a phenomenon.

:perception-q

*feel, see*

**PERSON** A type of conscious being pronominalizeable by "she", "he", etc. rather than by "it".

**PHENOMENON** The object of perception in a mental process of perceiving.

:cognitive-phenomenon-q/id

:multiple-process-q

:perceptive-reactive-phenomenon-q/id

:projected-id

**POLAR-QUALITY** A quality is *polar* if it has a corresponding quality describing its opposite or the absence of this quality entirely. A polar quality is not part of a larger taxonomy. E.g. "heavy"/"light", "dead"/"alive". All qualities which are not polar are *taxonomic*, i.e., the possible values can be listed. For example, the quality of being mammal is part of some taxonomy.

**POLARITY** An interpersonal entity concerned with the speech act force; in particular, with respect to whether a speech act is positive or negative - e.g., as in assertion vs. denial.

:polarity-id

**POLARITY-VARIABLE** A third possible type of polarity in addition to positive and negative; if the polarity itself is unknown or being questioned for example - as in yes/no questions.

:polarity-variable-q

**POSITIVE** An interpersonal speech act modification along the dimension of polarity - in the negative dimension.

**POSSIBILITY** A general modal quality that has subtypes general possibility (typically expressed by "may") and ability (typically expressed by "can").

:possibility-q  
*can, could, may, might*

**POSTERIOR** A relation between intervals that specifies their order in time. A type of temporal locating, a circumstantial (somewhere under relational process) with range of a time interval and a commented out domain of a process. Here one interval is said to follow another.

:posterior-q  
*after, since*

**PRECEDE** A temporal relationship of strict precedence; it is therefore anterior and nonextremal. It is used particularly in tense reasoning by the grammar.

*precede*

**PROCESS** All of the entities classified under *process* can be expressed as verbs and are frequently the main verb in a clause. In LOOM terms, the process itself is a concept. It has a role for each of its participants. It may have roles for its circumstances. There are particular kinds of participant roles associated with different types of processes. That is, the participant roles will be value-restricted to different concepts in the object hierarchy for different processes.

:clause-as-nominal-q  
:multiple-process-q  
:perceptive-reactive-phenomenon-q  
:process-q/id



:process-modification-q/id  
:processual-q  
:prominent-purpose-relation-q  
:propositionality-q

**PROCESS-RANGE** A participant role where the participant is not affected or altered by the actualization of the process, but instead serves more to define the nature of the process.

**PROPERTY-ASCRPTION** The relation describing membership in the set of entities having a particular property. This is expressed by a property that can be used as a set descriptor. For example, "The students are intelligent." i.e., they belong to the class of intelligent ones. Note that 'intelligent' is a quality. We need many specializations of property ascription corresponding to different types of qualities.

:attribuend-id  
:attribend-qualification-q  
:generalized-modification-q  
:identifiability-q  
:status-modification-q  
:status-modifier-id  
be

**PROPERTY-OF** The inverse of the Property-Ascription relation.

**PROVENANCE-CLASS-QUALITY** Information that constrains reference by place, institution, social group or other social category of origin.

**PROVENANCE-PROPERTY-ASCRPTION** The relation of ascribing a provenance class quality to an entity.

:provenance-id  
:provenance-modification-q

**PURPOSE** *Purposes* capture the notion of why something was done. They may be motivational as with 'reasons' but look forward rather than back.

:causation-and-purpose-q  
:purpose-condition-q  
:purpose-q/id

**QUALITY** Qualities are properties of objects and processes. They participate in property ascription relations. Roughly speaking, qualities include anything that can be expressed as an English adjective.

:attribuend-id  
:class-q  
:property-q  
:singularity-q

**QUANTITY** The relation of ascribing a quantity to some entity. This is a type of quantity-ascription and contrasts with number-focusing, which provides information additional to the value of the quantity being ascribed, e.g., a range bounded by some value.

**QUANTITY-ASCRPTION** The relation of ascribing a quantity to an entity.

:multiplicity-q  
:process-modification-q  
:quantification-q/id

**QUESTION** The speech act of questioning whether something is the case.

:express-hearer-q  
:question-q

**REACTION** An inactive mental process that captures an uncontrolled emotional response to something or some state of affairs in terms of its appeal. Examples would be *fearing* and *disliking* on the negative side, and *liking* on the positive side.

:reaction-q

**REASON** Reason captures the notion of motivation. Here the effect is volitional or intentional. This relation is expressed by terms such as: "since", "because". Examples include: "Henry went to the store because he needed milk" and "Since it was raining, Henry brought his umbrella."

:causation-and-reason-q  
:reason-q/id

**RECIPIENT** The beneficiary participant role of a material process.

:beneficiary-id  
:possession-onset-q

**RELATIONAL-PROCESS** A process that relates its participants rather than describing an action of the part of one on another.

:clause-as-nominal-q  
:modifying-relation-q  
:process-modification-q/id  
:speech-act-id  
:static-condition-q  
be

**RELATIVE-EXTENT** A relationship of extent that is classified as relative. Relative here refers to a posited property of temporal and spatial relationships concerning how they are treated by the grammar of English. Relative spatio-temporal relationships are taken to 'move along with' an observer. This contrasts with absolute relationships which do not accompany the observer. As an example, the notion of

'today', 'tomorrow', etc. do not stand still and allow the observer to pass them by, they move with the observer; this is in contrast to the notion of a 'Monday', which can come and pass the observer by.

:absolute-extent-q

**RELATIVE-SPATIAL-TEMPORAL** A relationship of spatial-temporal locating that is classified as relative. Relative here refers to a posited property of temporal and spatial relationships concerning how they are treated by the grammar of English. Relative spatio-temporal relationships are taken to 'move along with' an observer. This contrasts with absolute relationships which do not accompany the observer. As an example, the notion of 'today', 'tomorrow', etc. do not stand still and allow the observer to pass them by, they move with the observer; this is in contrast to the notion of a 'Monday', which can come and pass the observer by.

:location-relation-specificity-q

:spatial-location-id

:temporal-location-id

**RESTATEMENT** A type of elaboration that provides further information by restating in different terms.

:reexpression-q

:restatement-elaboration-q

i.e.

**RESULT** A particular type of participant relationship to a process: identifies the participant that is in the role of being affected, acted upon, or brought into being by the actualization of the process.

**RHETORICAL-RELATION** The ideational class of inter-clause relations specified in the theory of Rhetorical Structure Theory; for details of which see the appropriate literature. Most RST relations have a central element, called the nucleus, and some supporting elements, called satellites. The domain contains the nucleus information and the range contains the satellite information.

:conjunctive-relation-q/id

:dual-process-part1-id

:dual-process-part2-id

:extracted-variable-id

:modification-specification-id

:multiple-process-q

:process-id

:relative-position-q

:taxis-prominence-q

**ROLE-PLAYING** A circumstantial relationship that expresses a restriction of which facet of one of the participants in a process is relevant for the actualization of the process. The participation of a participant which is specified in, and has a definite participant function (such as actor, goal, senser, and phenomenon to the process)

is restricted to a particular role, part, or function within the particular participant function being performed. It is frequently realized in English by a prepositional phrase with the preposition "as"; for example: "As a president, he was terrible, although as a golfer he was not too bad."

:role-q/id  
:role-relation-q  
as

**RST-BACKGROUND** A background relation presents some information that is necessary to understand the content or motivation for the main part of the text being presented.

*although*

**RST-CONCESSIVE** A concession is a relation between text presenting a situation that the speaker has positive regard for and text presenting a situation that the speaker does not claim not to hold, but, although there is a potential or apparent incompatibility between those situations, the speaker wants to have them accepted as compatible and, in so doing, to increase the hearer's regard for the first situation also.

:concessive-condition-q  
*although*

**RST-CONTRASTIVE** A relation between any number of parts of a text which states that those parts are to be comprehended as the same in many respects, differing with respect to a few, and are to be compared with reference to those few.

:joint-regard-q

**RST-ELABORATION** A relation between some subject matter and further elaborating information which is presented as being inferentially accessible to that subject matter in a number of ways as given by the subtypes.

:abstraction-q  
:elaboration-q  
:process-modification-q/id  
:relative-pronoun-selection-q  
*for example*

**RST-ELABORATION-ATTRIBUTE** A relation between some subject matter and some attribute of that subject matter which is being used to elaborate further upon the subject matter.

**RST-ELABORATION-GENERAL-SPECIFIC** A relation between some subject matter and further elaborating information which is presented as being inferentially accessible by virtue of a generalization-specific relationship.

**RST-ELABORATION-PROCESS-STEP** A relation between some subject matter and further elaborating information which is presented as being inferentially accessible by virtue of one being a step in the process specified by the other.

**RST-ENABLEMENT** A relationship between parts of a text such that the hearer's understanding of the range increases the hearer's potential ability to perform the action specified by the domain.

*so that*

**RST-MEANS** Used when the range is to be presented as a means for achieving or performing the activity given as the domain.

:conjunctive-relation-q  
:manner-condition-q  
:modification-specification-id  
:process-id  
*in order*

**RST-MOTIVATION** A relationship between parts of a text such that the hearer's understanding of the range increases the hearer's desire to perform the action specified by the domain.

*because*

**RST-NONVOLITIONAL-CAUSE** This relation is used when the hearer is desired to recognize that the situation presented by the range is a cause for the nonvolitional action presented in the domain.

*therefore*

**RST-NONVOLITIONAL-RESULT** This relation is used when the hearer is desired to recognize that the situation presented by the domain could be a cause for the nonvolitional action or result of a nonvolitional action presented in the range.

*because*

**RST-PURPOSE** Used when it is required that the hearer recognize that the activity specified in the domain is initiated in order to realize the activity or state of affairs presented in the range.

*in order, so that*

**RST-SEQUENCE** This relation relates a number of equally important nuclei; it is used when the hearer is to recognize a succession relationship among those nuclei.

**RST-VOLITIONAL-CAUSE** This relation is used when the hearer is desired to recognize that the situation presented by the range is a cause for the volitional action presented in the domain.

**RST-VOLITIONAL-RESULT** This relation is used when the hearer is desired to recognize that the situation presented by the domain could be a cause for the volitional action or result of a volitional action presented in the range.

**SAYER** The actor in a verbal process.

:actualization-constrainer-id  
:sayer-id

**SAYING** The information being communicated by a communicative process.

:actualization-constrainer-id  
:multiple-process-q  
:projected-id  
:propositionality-q  
:report-id  
:verbal-act-category-q/id

**SCALABLE-QUALITY** A quality is *scalable* if an object may possess it to varying degrees. For example, "heavy" is a scalable quality. We can describe objects as being "very heavy", or "more" or "less" heavy than other objects. A *non-scalable* quality is either possessed by an object or it is not. "Empty" is a non-scalable quality.

:scalability-q

**SCALED-COMPARISON** A relationship of comparison of an object with respect to its carrying a specified property to a greater or lesser degree.

:scaling-q

**SENSE-AND-MEASURE-QUALITY** Qualities that are sensed or measured by conscious beings. For example, this category would include qualities of age (young, old), of weight (light, heavy), of price (expensive, cheap), etc.

**SENER** The entity that undergoes the experience in a mental process. Referents of qualities in this category ought to be restricted to be conscious-beings. Examples include: "happy", "angry", "sad", "amused", "afraid". Constructions involving qualities in this class can specify a fact as the cause of the mental state. For example, "Henry was sad that he missed the performance"; "Henry was angry because the train was late". Note that such constructions are not possible with phenomenon-oriented-qualities. Some qualities fall into both categories, but are expressed differently depending on their classification. Compare: "I am *amazed* that the earth is flat." (senser-oriented) "That the earth is flat is *amazing* to me." (phenomenon-oriented).

:actualization-constrainer-id  
:causer-id  
:senser-id

**SIMILARITY** A sub-type of the comparison relationship that picks out positive comparison.

:similarity-relation-q

**SIZE** A property of size.

**SIZE-PROPERTY-ASCRPTION** The relationship of ascribing a size to an entity.

:size-modification-q

:size-modifier-id

**SOURCE** In a process of (possibly abstract) motion, the relation between the process and the place from which the motion is coming.

:source-q

:source-process-q

*from, away from*

**SOURCE-DESTINATION** The general relationship between a (possibly abstract) motion and the place from where it is coming or to where it is going.

:source-destination-q

:source-destination-process-q

**SPACE** Space as an undecomposable mass.

:wh-concept-q

**SPACE-INTERVAL** Space as a decomposable set of points, intervals, or volumes.

**SPACE-POINT** Space as a point.

:dimension-relation-q

**SPATIAL** The general concept of spatial object, including all points, paths, volumes, undivided wholes, etc.

:locationtype-q

:wh-concept-q

**SPATIAL-EXTENT** The relationship of a process or object to a path or interval in space.

:spatial-extent-id

:spatial-extent-specification-q

**SPATIAL-LOCATING** The relationship between an object or process and its location in space.

:place-qual-q/id

:spatial-location-id

:spatial-location-specification-q

**SPATIAL-ORDERING** The ordering relation that can hold between points or intervals in space.

**SPATIAL-RELATION** *Spatial relation* is expressed as “be at, in, on, under, above, below, etc.”. This category is further subdivided to choose the appropriate preposition.

:location-classification-q  
:space-condition-q  
:spatio-temporal-type-q

**SPATIAL-TEMPORAL** The generalized time-space object, under which all time and space objects lie.

**SPATIO-TEMPORAL** This describes the relation of two entities in space or time. Further specializations include *temporal-relation* and *spatial-relation*.

:identifiability-q  
:spatio-temporal-type-q

**SPEECH-ACT** The interpersonal type of act performed by a speech act.

:presuppose-existence-q  
:speech-act-id

**STANDARD** The standard against which comparison is drawn in a scaled comparison.

:process-q  
:standard-id

**STATIC-SPATIAL** A sub-type of spatial locating relations that do not include any element of movement with respect to the location specified.

**STATIC-QUALITY** *Stative* qualities hold regardless of any particular process. Dynamic qualities can be expressed using the present progressive tense, i.e., they can take the form: ‘X is being <quality>.’ “John is being clever/ skillful/ creative/ enthusiastic.” Stative qualities cannot. “\*John is being dead/ German/ tall.” These can take the simple present only.

**STATUS-QUALITY** Ascribes a quality to an object, independent of the observer. For example, a specialization of this category could be the quality *life-status* which would be further broken down into the classes *dead* and *alive*.

**STRIVING** A type of mental reaction that attempts to bring about some state of affairs or event.

*try*

**SUBJECT-MATTER** Expressed as: be about, as in: “This document is about the entity hierarchy.”

:matter-q/id  
:matter-relation-q



**SUBSTANCE** E.g., water, grass, flour, butter. The bounded region for substances is not in the domain of physical space, since they are in principle indefinitely expandable in space. Rather, their bounded region is in the domain of some quality spectrum (taste, color, texture, solidity, etc.).

**SYMBOLIZATION** This category contains relations that hold between entities and other entities they 'symbolize'. Concepts in this class logically have two roles: *symbol* (the domain) and *symbolized* (the range).

:symbolization-q

**SYMMETRIC-RHETORICAL-RELATION** The relationships defined in Rhetorical Structure Theory have nuclear elements and satellites. The nuclear element is the one that is essential for achieving the goal of a particular relation; satellites serves auxiliary, supporting roles. Those RST relations which have only one nucleus assign different importance to the parts of the discourse they relate. Those that have a number of nuclear elements assign equal status to those elements; these are therefore called *symmetric rhetorical relations*.

:taxis-prominence-q

**TAXONOMIC-QUALITY** All qualities which are not polar are *taxonomic*, i.e., the possible values can be listed. For example, the quality of being mammal is part of some taxonomy.

**TEMPORAL** The general concept of temporal object, including all points, paths, volumes, undivided wholes, etc.

:locationtype-id  
:wh-concept-q

**TEMPORAL-EXTENT** The relationship of a process or object to a path or interval in time.

:temporal-extent-id  
:temporal-extent-specification-q

**TEMPORAL-LOCATING** The relationship between an object or process and its location in time.

:temporal-location-id  
:temporal-location-specification-q  
:temporal-qual-q  
:time-period-modification-q  
:time-relation-q

**TEMPORAL-NONORDERING** A class of temporal relations that do not impose any ordering on the points or intervals they hold over.

*in, at, on*

**TEMPORAL-ORDERING** The ordering relation that can hold between points or intervals in time.

:time-ordering-q

**TEMPORAL-RELATION** *Temporal-relation* is often expressed using "be at". It may also be expressed as a prepositional phrase beginning with a preposition such as "before" or "after". Further discriminations select between these possibilities.

:period-modification-q  
:period-modification-part-id  
:spatial-temporal-type-q  
:temporal-enhancement-q  
:time-condition-q

**THINK** The mental process of thinking.

*think*

**THREE-D-LOCATION** A three dimensional space.

:dimension-relation-q

**THREE-D-TIME** A portion of time that is being viewed as of sufficiently large scale to need expression as if it were a volume within which thing occurred (e.g., "in 1966"), rather than a plane on which things occurred (e.g., "on that day").

:time-dimension-q

**TIME** Time as a general undecomposable substance.

**TIME-INTERVAL** A time interval.

**TIME-POINT** A time point.

:time-point-q

**TWO-PLACE-RELATION** Any relation that holds between two entities.

:attribuend-qualification-q  
:property-q

**VERBAL-PROCESS** A process of communication.

:multiple-process-q  
:projection-q  
:report-q  
:verbal-process-q

**VERTICAL** The general relation of spatial locating that determines whether there is an orientation to some dimension being expressed. Vertical naturally refers to the orientation of the plane relative to which location is to be expressed. It contrasts with horizontal and is a subtype of orienting.

:axis-of-orientation-q

**VOLITIONAL** A modal quality concerned with the actor's active decision or volition in the performance of a process; a volitional process is one where the actor takes, or is expressed as taking, direct responsibility for the process.

:volitionality-q  
*will, would*

**WANTING** A type of mental reaction that wants to bring about some state of affairs or event.

*want*

**WORD** A type of abstraction for the representation and expression of ideas.

**ZERO-D-LOCATION** A point in space.

:address-specificity-q  
:locativeaddress-q  
:position-specific-spatial-address-type-q

**ZERO-D-TIME** A point in time.