The use of semantic analysis in the development of information systems

James Backhouse
London School of Economics and Political Science

Submitted in fulfilment of the requirements of the award of the degree of Doctor of Philosophy of the University of London.

ProQuest LLC
789 East Eisenhower Parkway
P.O. Box 1346
Ann Arbor, MI 48106-1346

ABSTRACT

This research has accomplished a clarification of what exactly constitutes semantic analysis using the specification language NORMA. Having clarified the essential elements of the language, this work has shown how the language can be put into practice. The technique has been exemplified on three applications. This process of indicating how the technique can be applied to a case is necessary if we are to show the practical usability.

Another important contribution has been the setting out of more precise rules for the constraints; the sketching out of a metaschema. Although more work is needed here to express the full range of metaphysical relationships that underlie any semantic schema in NORMA, a start has been made. This work will support the building of a computer system to aid the analyst.

With the large range of constraints and fundamental assumptions associated with NORMA, the need for a method of applying them was paramount. In this work we have attempted to set out a rational agenda of work comprised in the performing of semantic analysis, and in a manner which is easily accessible. A simple set of ten stages in the work spans the range of tasks that are required. At no stage has there existed such a straightforward introduction, rather, the tendency has been to point to the possibility of beginning the analysis in a number of ways.

As a further contribution this work has examined some of the examples of semantic analysis and identified a few 'classic' errors. The importance of this is to focus on what are likely to be common mistakes that spring from an inadequate grasp of the language, which if corrected can lead to better results quite quickly and avoid a significant part of the problems associated with the 'learning curve'.

To Marisa

Certis rebus certa signa præcurrunt

CICERO

Certain signs are the forerunners of certain events

Often do the spirits
Of great events stride on before the events,
And in to-day already walks to-morrow.

COLERIDGE

TABLE OF CONTENTS

The Applications:

Synthesis:

LIST OF FIGURES

Chapter 1
Introduction

The analysis and design of information systems has become an industry of major proportions, employing tens of thousands of people in the United Kingdom alone. Their work concerns either the creation *ex-novo* of information systems, or the reshaping of existing ones, often with the addition of computer-based support. In performing this work, analysts and designers make use of various specification techniques which permit them to represent the information structure of the organisation, and to proceed to develop programs to run on the technical system. Just as with any other analysis and design work, whether it be architecture or civil engineering, the professionals involved need to have a way of understanding and representing the structures with which they are concerned, so that they may refer to their plans and intentions for the future with their colleagues and with their clients. More often than not this way of understanding the particular domain is circumscribed by a special terminology, perhaps impenetrable to the lay person, and by a specific conceptual perspective on the problems in hand.

Techniques, technicians and academics

The techniques used can be often acquired by technicians who do not necessarily aspire to command the global perspective —that can be left to the academics in the field. However, those techniques rest on a set of underlying assumptions which do have to be in place to render them meaningful. In some cases these assumptions may be explicit, in others not. For those of us working the field of information systems there is undoubtedly a need for a model upon which to base our understanding. To be able to analyse an organisation as an information system, we must have a conceptual basis from which to work. This can take the form of a metaphor, such as the information-processing metaphor of the mind (Stamper 1988a), or a more developed model such as is found widely in the literature. Beyond the models used typically in specification methods is the larger paradigm in which thinking in the field is anchored, where practitioners and academics

subscribe, even unconsciously, to a set of metaphysical assumptions which shapes their theory and practice (Kuhn 1970). Such an intellectual framework is a prerequisite for a rich and mature professionalism capable of delivering high-quality outputs.

As the aim of this research is to test out a radically different approach to the analysis and development of information systems, manifested in the form of a specification language, it is appropriate to indicate the differences. Information systems analytical methods usually revolve around two principal pillars: data analysis and functional analysis. A large amount of heat is generated discussing which of these should take priority when performing requirements analysis. From our point of view they are an example of one of the laws of dialectics—the interpenetration of opposites—and are as irrevocably bound to one another as the concept of debit is to that of credit. They are both conceptual children of the same parent metaphysics, where the model of the information system is comprised of data elements which flow between functional processes wherein the data are metamorphosed for further reprocessing.

Such a model can only express an information system as a message and recording system. It cannot capture the rich world of intention and meaning within its formalism, primarily because it is predicated upon a set of metaphysics which is inadequate to cope with anything except the closed world of an objective reality.

The role of underlying philosophy

Thus growing dissatisfaction with the systems produced by such analysis and design methods has begun to draw attention to some of the philosophical assumptions behind these methods, for example in the work of the Dreyfus brothers (1986) and Winograd (1986). The belief in an objective reality fails to deal adequately with the problems of semantics: that people hold fundamentally different views about the world in which they live and work. This problem has been recognised before, however the onset of the information society has meant that the growth in large computer systems storing and processing billions of symbols places the problem of making meaning from them much higher up the agenda than before.

Meaning and communication are inextricably linked. The very process of communication necessarily involves two persons at the least, or two agents, such as a company, an institution or a sovereign state. In engaging in communication the parties concerned want their interlocutor to respond in an appropriate fashion, perhaps to switch on the light, sign a contract or agree to an international treaty. We assume that the context of all communication is purposeful behaviour and that the parties are motivated by intentions.

In order for them to externalise their intentions the parties involved must have recourse to signs, explicit mechanisms, which permit the communication of intentions to take place. Here we encounter the problem of meaning: the agent who uses the sign to embody an intention must rely upon the interlocutor to interpret the sign in the way intended. For much of our communication language, natural language will be the medium for the signs to be expressed in, although bodily gesture will play its part.

So far we have referred to just two levels, the pragmatic and semantic of the six-level semiotic model which has been proposed by researchers working in this field (Stamper 1988b), and summarised in Figure 1.1. The notion of the semiotic approach to organisational information, incorporating for empirics what was hitherto known as "information theory" (Shannon 1963), is the product largely of Stamper, but the idea of approaching semiotic analysis from a number of levels has been widely espoused by many investigators working in many fields and over a long period of time. The Figure 1.1 model views an information system as an informal system of behaviour held together by norms. Responsible agents communicate their intentions through using signs and these signs can be analysed for their semantic, their syntactic, their empiric and physical qualities.

Breakdown in communication can be analysed according to the semiotic level concerned. A manager who finds that requesting staff to arrive punctually has no effect, might consider the problem from these different analytical levels. Perhaps at the simplest physical level the memorandum sent did not arrive and was mistakenly shredded instead. Or it could have been that the ink cartridge in the printer was beginning to run out and the finished copy was too faint to command

Semiotic level	Area of concern
Business	Prime tasks
Pragmatic	Beliefs and expectations
Semantic	Meaning
Syntactic	Rules and form
Empiric	Patterns and codes
Physical	Physical objects

Figure 1.1 the semiotic model in six levels (from Stamper 1988b)

any proper attention. At the syntactic level, perhaps there were errors of grammar in the text which obscured the intent of the message. Coming to semantics, the notion of punctuality could be variously interpreted by a cosmopolitan staff. At the pragmatic level, in a given cultural context perhaps the notion itself of punctuality is inappropriate, for example where the staff work flexi-hours or work by tele-commuting.

Any one or more of these levels could prove to be the locus for the manager's problem. In offering a framework for understanding the whole process of realising information from signs used in a context of communication, the semiotic model offers a systematic basis for the development of tools appropriate to, and adapted for, each level. The work of Shannon (1963) can be pressed into service for the level of empirics, offering tools for improving the efficiency of codes and signalling. At the syntactic level, a great deal of work has been done by logicians and mathematicians which is directly applicable to information systems for example, predicate, modal and propositional logic. The work of Kowalski (1979) has been largely built upon predicate logic, as expressed in the form of the logic programming language Prolog. More recently the work of Sowa (1984) has provided another case of classical logics being adapted for use as specification

languages. For the pragmatical level the work of Searle (1984), Austin (1962) and Bloor (1983) amongst numerous others has provided analytical techniques which may be adopted by professionals in the information systems field.

This work will confine itself to that of semantics. By placing the notion of semantics in this context, we are able to turn our attention away from these other levels and focus upon problems of meaning. At the level of semantics there are fewer tools available. The structuring implicit in techniques such as normalisation and entity-relationship analysis offer some support but these techniques are inextricably intertwined with the objectivism that underlies many analysis and design tools. They cannot be easily employed for representing subjectively the understanding of a domain.

Semantic analysis, the subject of this research, provides just such a facility. Its importance is precisely in furnishing a tool at the semantic level which can permit analysts to detail the connections between the signs used in organisational communication and the behaviour to which they refer in the world of action. The analysis itself involves the application of the system specification language NORMA to any given problem, so that the knowledge and behaviour under scrutiny is reconfigured in the shape required by the formalism. In the same way as applying the Entity-Relationship model (Chen 1976) demands that the analyst view the domain in terms of the primitives of entities and relationships, so performing semantic analysis requires that the analyst reconfigure the domain in terms of the primitives of NORMA (developed in detail in Chapter 4). Ultimately the justification for favouring one method to another lies in its superiority as a specification method. Such superiority has to be proven, and this is one of the aims of this research.

Overview of research in this work

The model of information systems that has been proposed is one that demands attention to the semantics of the signs processed by the participants. So often ambiguity results in the misinterpreting of directives, instructions, regulations and so forth. In the here-and-now of face to face social interaction, when the

participants work perhaps in close physical contact and share similar beliefs and expectations, such misunderstandings can usually be overcome. But when there are added difficulties of clashes in culture and of physical distance, the misinterpretation can be fatal for an organisation. Consequently this question is one that deserves the attention of the information systems academic community.

Semantics therefore plays a key role in any information system, and yet perhaps less attention has been devoted to it than to many other aspects.

This work introduces one tool for addressing this problem area —semantic analysis. With many analytical techniques the practitioner may be able to suppress concern with the broader underlying philosophy of the particular tool or technique being applied and simply concentrate upon the sometimes mechanistic working through of the steps: the data analyst may never acknowledge the set of assumptions about the world that his technique requires him to adopt. On the other hand, semantic analysis demands constant attention to—and a deep understanding of—its philosophy.

Performing semantic analysis entails the application to the problem of the semantic constraints of the specification tool, in this case NORMA. The tool may have just a few constraints, such as with the Entity Relationship model, or it may have a vocabulary and a grammar of its own, which is complete enough to be called a language, as with NORMA. In either case, the task is to translate the information systems problem and express it in the specification formalism. We may work from textual material, observation or interviews. The aim is to produce a representation of the problem where the terms used are semantically normalised, that is, subjected to rigorous constraints that ensure no ambiguity exists. What we are doing is applying a semantic model to the information system we are analysing.

At the outset of this work NORMA had already developed from the work of what was then the LEGOL (Legally Oriented Language) project (Stamper 1989). Earlier versions of LEGOL had been developed and implemented on a computer. By testing each version on a wide range of business and legal problems, defects in the semantic models were gradually eliminated. NORMA (NORMS and

Affordances), outlined in Stamper (1985b), formed the culmination of this series of languages.

Although the grammar of this language had been developed when this work began, there existed no body of case studies where semantic analysis using NORMA had been thoroughly applied. This work had as its objective the setting out of a method for applying the semantic constraints and the construction of precise rules where possible, and general principles where not, for the performing of the analysis. Unfortunately many of the LEGOL papers have been criticised for their impenetrability and do not provide a feasible body of support material to those wishing to use the methods being developed. Therefore the aim of producing clearer guidelines was seen as paramount. The present author's own involvement with the LEGOL/NORMA project (from autumn 1986 until summer 1990) placed him in good position to accomplish this aim.

The research method

The research method which has been used is built around the testing of the theoretical structure of NORMA, and consists of four stages. First, the acquisition of the theoretical foundations of NORMA. Second, the application of the language to a number of problems, testing the ability of the language to handle different types of domains. Third, the synthesising of the experience of performing the analysis. Last, the setting of refinements to the analytical technique on the basis of this synthesis.

The theoretical structure of NORMA developed over the course of the LEGOL/NORMA project from its inception in 1973 to date, and the present author, as a member of the team for some four years, was able to acquire the theoretical background in this period. The specification language was applied to a number of problems and in this application stage its efficacy was tested. Testing in this sense meant taking the syntax of the language and using it to normalise semantically the terminology and sign structures which are used in each domain. What resulted from this testing for each application was a semantic schema and a number of

norms, which could provide the basis of a specification of the information system requirements of the problem area.

A key question was the choosing of the problem domains. In no sense do they represent problems which are typical of the problems faced in the information systems area. It would be difficult, in any event, to say what would be a typical case. The applications chosen instead might be seen as idiosyncratic and varied, and perhaps all the more interesting for that, in their contrasts of breadth, range and problem character. They represent three totally different situations and in a way because of this prove more testing than might otherwise have been the case.

Following the application of the analysis method came the matter of synthesising and developing refinements to the formalism. In this regard the experience of the applications themselves was invaluable in permitting these refinements to be realised: the sketching of a meta-schema by means of norms for the process of analysis itself, the determining of a rational order of work, and the identification of common pitfalls when performing the tasks. At this point the research method manifests a feedback loop onto the earlier steps of determining the theoretical structure and its refinements.

This research method is different from using case studies, in that the case studies reflect the whole empirical world of the domain of inquiry. Typical cases, average cases or extreme cases might be taken to exemplify the domain. This approach is also different from action research, where the research itself results in changes in the world of inquiry. Instead this method allows us to refine the analytical tool used in application and so improve the tool itself.

The work presented in this research falls into three stages. The first, theoretical, part is devoted to investigating the requirements of a semantic model and specification language; the second, practical, part takes the language NORMA and applies it to three applications; the last, synthetic, part develops the rules and guidelines in synthesising the work of the previous two.

The work begins by examining various approaches to the question of meaning, whether in the database area or in what has been loosely grouped under the category of information systems, which includes linguists and semioticians and

researchers in computers and law. Emerging gradually in this part is the stress being placed upon the need for a match between the metaphysics of the formalisms developed and those of the domain to which they are to be applied. At no stage is the contention made that only one particular set of assumptions is appropriate; it is a matter, in this as in many other arenas, of 'horses for courses'. This section continues with an exposition of the semantic grammar of NORMA, suggesting how its structures are particularly appropriate for the specifying of information requirements in business and social affairs.

The second part consists of the applications which represent three of the problems analysed semantically during the course of this research. In this section we present the results of applying NORMA to some very different domains with the aim of ascertaining whether the tool is applicable to problems of a disparate nature.

In the final part of the work there are three objectives: to develop a method for performing semantic analysis; to develop a set of precise rules and principles; to examine where common errors tend to occur in using semantic analysis and show how they may be corrected. The thesis ends with the implications of the research for the analysis and development of information systems, a number of issues raised by the work are described and further possible areas for research are considered.

Contributions of this research

Conventional tools used in information requirements analysis depend for their success upon the presumption of an objective reality, or at least a reality where the degree of consensus about what constitutes reality is high. This thesis argues that this presumption is inappropriate since it fails to account for differences in conceiving and understanding the world, differences which ultimately result in the information systems which fail to reflect the rich and diverse cultures and sub-cultures on which it rests.

The work shows that semantic analysis can be successfully be applied to wide-ranging domains. It provides analysts with a method for performing it, together with a set of rules which provide tight constraints to operate within, and

indicates how common pitfalls may be avoided. No literature exists yet which deals with these latter and so the work represents a genuine contribution to this field. These contributions are already enabling students to utilise semantic analysis, and a number of MSc projects at the LSE bear testimony to the transparency of the material, despite fears of impenetrability. Some progress is being made to build a computer program which can support the analysis, now that the rules have been formalised.

Overview of the thesis

Chapter 2 surveys some of the notions of meaning which abound in what we have loosely referred to as the 'information systems' field. Some contributions to this debate from psycholinguists and legal expert systems researchers have been analysed, and it becomes apparent that there are many different approaches to the problems of semantics.

Chapter 3 addresses the same theme but this time in respect of those working in the database arena. Here too a variety of approaches is presented and compared. A fundamental problem is highlighted: the role of the objectivist assumptions that underlie much of research in this area. Chapter 4 introduces a specification language which was designed to remedy the inadequacies of the immanent objectivism of the standard models employed.

Chapters 5, 6 and 7 document the application of this specification language to three applications, each one rather different from the other two. Chapter 5 deals with the problem of developing a schema for a body which handles behaviourial problems in school students. Chapter 6 attempts the same task for an organisation which provides welfare assistance for Italian emigrants. Chapter 7 takes up the same question with respect to a system for running Working Conferences for the International Federation of Information Processing (IFIP), now a standard problem for researchers to try to resolve.

Chapter 8 sets out a method for performing the semantic analysis, based upon the experience gained in the applications and from teaching students. On the other hand Chapter 9 tackles the question of writing out precise rules for the

analysis with a view to building a computer interpreter for an analyst workbench. Some more general principles are stated as well.

Chapter 10 summarises some of the common errors made by analysts when performing semantic analyst, drawing upon work by students and others who have been taught the method and then applied it themselves. The aim is to identify some of the more typical mistakes which novice analysts might commit.

Finally, Chapter 11 summarises the work described in the thesis, describing the benefits and drawbacks in the method. It discusses the implications of the thesis for the design of information systems and proposes further areas of research.

Chapter 2
Theories of Meaning in Information Systems

For many who work in the field of information systems analysis and design, the problem of semantics has a very low priority. For them the most pressing problems are others: technical, financial and strategic. The question of semantics could seem a matter of academic interest only. However there is another way of formulating the work that they are doing which bears more directly on the key issue of semantics: the work of information systems analysts and designers is characterised by the task of determining the formal relationship between the signs held in recording systems, such as manual filing systems and computer based information systems, and what goes on in the world of business and social affairs that surrounds them.

This problem of what signs mean has occupied the minds of scientists and researchers from a wide range of disciplines, and it is not our intention to encroach upon the terrain of others. Instead we would like to draw the focus of attention, at least for this present work, upon the problem of meaning in information systems—how signs are used to get things done in organisations—and not concern ourselves with the psycholinguistic aspects *per se*. In this chapter we examine the approach taken by a number of researchers whom we have grouped together loosely under the heading of information systems, mainly to distinguish them from those whose work falls more directly into the database category, dealt with in the next chapter. For information systems generally and for databases in particular, the matter of meaning is not something that can be taken for granted, at least not any more. Large organisations embrace many persons who do not necessarily share the same culture and whose perceptions of ostensibly the same phenomena vary greatly, and given this scenario it is essential to have an understanding, a theory, of how meanings are made so that better systems may be constructed on the basis of sound ideas about how intentions are communicated in organisations.

Fodor and semantic theory

A great deal of work has been done by psycholinguists, for example Fodor (1974) and Katz (1972), in researching the domain of semantics for a theory of semantics, and this work is valuable for our discipline. For Locke, the seventeenth century English philosopher: 'The problem of language is the problem of meaning. The problem of meaning is the problem of reference. And the problem of reference is to explain how words name things (in Fodor 1974).' Fodor tackles the problem of defining semantic theory by first discounting what he calls the 'naming paradigm of meaning', which Locke espouses. In this paradigm, Fodor maintains, proper nouns name objects, common nouns name sets of objects, verbs name actions, prepositions name relations, while adjectives and adverbs name properties of objects and actions.

As a theory of meaning for Fodor this has several shortcomings, not least of which is the inability to handle in the same manner terms such as 'hello', 'for example' and 'and'. What about proper nouns?:

> Another way to point out the implausibility of the view that a homogeneous relationship of naming is fundamental in semantics is to remark upon a striking difference between true names and all other sorts of words: proper nouns are undefinable. Hence, in the sense of 'meaning' in which having a meaning is having a definition, proper nouns have no meaning. (Fodor 1974 p.145)

This problem of individuation and identity we will turn to later in this work. Fodor also castigates this 'naming paradigm' for its apparent lack of homogeneity, which would demand that all names, occurrences and past events should be treated in the same way and yet the referents of proper nouns will have a location, a date, an individual history, whereas none of these things could be said of the referents of adjectives. The underlying problem is that of attempting to take natural language grammar and use it as the basis for a theory of semantics. Why should one be needed for the other?

Another approach which Fodor examines is that of the 'Empiricist School', typified by Hume, which distinguishes between 'the problems of meaning and the problems of reference' (Fodor 1974 p.141) Their proposal was the two-stage or

'mediational' account of meaning, where between the word and its referent is the memory image of the referent. This is the forerunner of the 'mentalistic' notions of meaning which pervade much of our field. By mentalistic we refer to the approach to semantics which relates the words or signs we perceive to the mental constructs that each person holds for these signs. These mental constructs are seen as the meaning of these words or signs. As long ago as 1710 the philosopher Berkeley criticised this account of meaning on a number of grounds. First, the images that individuals have are of particulars[1], rather than universals. Second, there is the problem of explaining away how an image can represent an abstract property. Third: the problem of different persons realising different images. Lastly, the problem of the image of words such as 'but'.

Each of these four objections is a recurring problem for any semantic theory, and indeed for any knowledge representation language. First, the question of the **metaphysics** of any representation language, for example universals and particulars. This concerns the matter of relating instances in the world of experience of the agent to universal categories; how do we know that a particular bird is an exemplar of the whole category. Fodor's rebuttal of the 'naming paradigm of meaning' involved his juxtaposing of two sets of metaphysical categories: the common nouns, proper nouns, verbs and adjectives of natural language syntax with the objects, actions, and properties of some unstated represesentation language. What we need to know is how adequate are the metaphysics for the tasks set for the languages used.

Second, the **relationship between on the one hand the physical, social and legal, and on the other the semiological levels** of the world. How can we make an accurate connection between the 'image' or sign and what it refers to in the physical and social world.

Third, the matter of **subjectivism**: how can we reconcile the different 'images' that different persons may have which refer to the same object? This is the age-old problem of semantics which has to be overcome for meaningful discourse to take place.

[1] This implies that each person has his own particular concept for any universal—c.f. "templates" in Aitchison (1988).

Lastly, the **problem of metalanguage** and metalevels: separating those elements in any expression which refer to objects in the world of discourse and those elements which are 'reserved words' playing a syntactical role in the metalanguage. Although they are not exhaustive, each of these elements forms a crucial nettle that must be grasped by any formalism that may be used to represent knowledge. Unfortunately an explicit recognition of all these issues and a commitment to a proposed solution to them is rarely made.

Having reviewed some of the earlier ideas on semantics, Fodor sets out his own ideas on what constitutes the goal of a semantic theory of a natural language:

> to explain how the semantic properties of its sentences are determined by their lexical content and syntactic structure. That is, a semantic theory of a language L may be thought of as a device which, given a full syntactic structural definition of any sentence in L and a specification of the lexical terms it contains, automatically predicts the semantic properties of the sentence (Fodor 1974 p.175).

Perhaps this might be seen as the holy grail of the group of researchers who worked on these problems of natural language processing in the 1960s and 1970s, and whose work led directly to the development of artificial intelligence as a branch of computer science. The need to divorce language from its social setting, to define a universe where semantics can be as cleanly cut as syntax, to ignore completely the pragmatics of language, has led this research away from developing tools for open systems, to concentrating on domains where automatic prediction may be possible. We hope to show in this work the inappropriateness of this at least insofar as the overriding need is to develop theories and tools for tackling the practical problems of business and social affairs.

An important notion which arises out of the work of Fodor and Katz in their research into semantic theory is that of compositionality: whereby the meaning of complex structures may be gradually constructed from the constituent parts by applying the rules for deriving meaning. A good representation language should support this process. The same rules should apply to the analysis of any structure so that modularity and division of labour may be permitted.

Winograd's 'Blocks World'

Another working in a similar area at the same time was Terry Winograd. His early work (1972) on natural language processing marked a period where it was felt that quite rapid progress could be made in developing machine systems to understand human discourse. His later disillusionment (1986) and refutation of this position stands in sharp contrast to the enthusiasm that he and others, such as Katz (1964, 1972), Fodor (1974) and Schank (1973) felt at the time. Winograd's Blocks World (1972) was created as a testbed for the development of natural language processing. It was apparent to Winograd and the others that the problems of semantics would always cause more trouble that those of syntactics.

In the blocks world there is a robot with a mechanical hand that can manipulate various objects on a table, given instructions which are interpreted by the program. The semantics of the Blocks World are based upon those of the language 'PLANNER' which Winograd uses for knowledge representation. The primitives of this language are Objects, Properties and Relations—not so very different from those behind relational database and entity-attribute-relationship models. These three concepts must be used to model the object domain and Winograd recognises the problem of closure (to employ a term from the database world). For example the phrase 'De Gaulle is old' could be represented as

OLD DE GAULLE (where OLD is a property of an object)

or

AGE DE GAULLE (where AGE is a relation between and object and its age).

Problems of identification are resolved by permitting relationships and objects to be given names: eg. #HOUSE374 or #REL76, and effectively names, used as identifiers, are invented for the formal system. In this way a sentence such as 'Harry slept on the porch after he gave Alice the jewels' would become a set of assertions:

(#SLEEP:HARRY:REL1) (#LOCATION:REL1:PORCH)
(#GIVE:HARRY:ALICE:JEWELS:REL2) (#AFTER:REL1:REL2)

We notice here that time is introduced as an individual in the discourse, for example with the term '#AFTER', a relationship presumably, between the two

relationships '#REL1' and '#REL2', and is not handled integrally by the operators of the representation language.

In the domain of the Blocks World, many tricky matters are avoided, since the room for diverging subjective interpretations is limited. There are

Objects: #ROBOT, #PERSON, #TABLE, #BOX, #HAND, #STACK, #BLOCK, #BALL, #PYRAMID

Properties: #COLOR, #SHAPE, #SIZE (#HEIGHT, #WEIGHT, #LENGTH), #LOCATION

Relations: #SUPPORT, #CONTAIN, #PART, #RIGHT, #BEHIND, #ABOVE, #MORE, #ASMUCH, #OWN

Further layers of complexity are indicated by the generic categories of PHYSICAL OBJECT: table, box etc. and MANIPULABLE OBJECT: block, ball and pyramid. In addition there are actions for the robot to perform: MOVETO, GRASP, and UNGRASP, and it is here where the relevance of Winograd's work for our field is most felt. Essentially the underlying conception is of a hierarchy of actions, to be traversed in order to accomplish any given goal. The robot can only GRASP one object at a time and thus planning and checking the possibility of effecting the plan of action is necessary. Building a stack requires a clear top for part of the table, and objects which have the properties of supporting others, unlike the pyramids for example. There are elements of an ontological perspective in this approach: an object cannot MOVETO a location unless it is free; the HAND cannot grasp an object if it is already grasping another. In a sense these represent behaviourial limitations to the freedom of action of the robot at any time. They do not amount to normative or rule based parameters of the scope of action. What Winograd lays the basis for is the idea of a representation language that reflects the structure of the world it seeks to represent. So that in the world of the robot certain actions are only possible given certain preconditions, and in the language structures exist to check whether these preconditions have been met. The world is not seen as a flat featureless terrain, but instead as a richer context where any particular setting predicates the possible courses of action.

Morris and semiosis

For studying the relationship of the semiological to the physical, social and legal worlds we have a great debt to pay the semioticians Morris, Peirce and Austin and the many who have built upon their work. As shown earlier the question of relating signs and images to represent abstract properties (and for that matter physical objects) is a continuously recurring one, and of particular significance in information systems analysis and design. For Charles Morris (1964) the problem of meaning has to be tackled from the perspective of semiosis:

> the basic terms of semiotic can be introduced as follows: Semiosis (or sign process) is regarded as a five-term relation -v, w, x, y, z-in which *v* sets up in *w* the disposition to react in a certain kind of way, *x*, to a certain kind of object *y* (not then acting as a stimulus), under certain conditions, *z*. The *v*'s, in the cases where this relation obtains, are *signs*, the *w*'s are *interpreters*, the *x*'s are the *interpretants*, the *y*'s are *significations*, and the *z*'s are the *contexts* in which the signs occur (Morris 1964 p2).

Morris quotes the example of the dance of the bees, where a bee which finds nectar on returning to the hive dances in such a way as to direct the other bees to the food source. In this case the dance is the sign; the other bees are the interpreters; the disposition to react in a certain way is the interpretant; and the kind of object toward which the bees are prepared to react in this way is the signification of the sign; and the position of the hive is the context.

Notice that the disposition to act in a particular way does not amount to the commission of the act itself. Whilst the bees may be intent upon returning to the spot where the nectar lies, there may be many circumstances which may confound them in their attempts. It is important also to note that the word 'meaning' as such does not appear yet in this exposition, in fact Morris suggests eschewing entirely the term for discussions of semiotics, or at least, he maintains, the 'meaning' of sign could be said to be *both* its signification and its interpretant and neither alone (Morris 1964 p.2). For our example, the dance of the bee and the readiness of the other bees to react in a particular way toward it together amount to the 'meaning' of the sign.

What is crucially different here from commonly held notions of meaning is the rejection of the idea of an intrinsic meaning to a sign, which it carries inherently within itself when employed, and its replacement by a model which relies upon two agents or groups interacting in a complex exchange whose efficacy is tested in the actual behaviour of the parties involved. Morris's approach permits the representation of differing, and therefore subjective, interpretations of signs employed in a particular context. What it does not and cannot do is provide an explanation for why the intended and the actual interpretation of the sign by two separate parties in a communication manage to coincide in a consistent and regular manner so as to allow business and social intercourse to progress. To do that we must analyse more deeply the part played by the context.

A similar conclusion has been reached by other researchers including Stamper (1988a) who in rejecting the information-processing model of the mind[2]:

input--------process---------output

amends it firstly to:

signs------encode------process-----decode----------signs

where

> nothing flows but there is a cause-and-effect chain linking one lot of signs to another. Nothing is actually carried by the signs, they only (literally) have any significance in the context of the social groups of the people who interpret them:

and then to:

signs ----- encode ----- process ----- decode ----- signs
[interpreter .....interpreter]
common culture

[2] This is a model or metaphor which is most pervasive in the literature, for example Marr (1982), a mathematician turned experimental psychologist and AI researcher. In Marr's theory of vision the brain is seen as an interpreter of signs performing computations rather as a computer.

If this relationship between a sign and what the sign refers to is to be understood and acted upon, it requires support of the underlying common culture[3] which ensures the degree to which this signification process is successful. Where the context is ambiguous and the signs may be misread or misunderstood, then effective communication is endangered.

Morris's work has contributed greatly to the understanding of the sign function in social organisation, and in particular in applying three different analytical levels of semiotics to semiosis: these being *pragmatics*, *semantics* and *syntactics*.

By 'pragmatics' Morris refers to the science of the relation of signs to their interpreters. 'Pragmatics' must be distinguished from 'pragmatism' as must 'pragmatical' from 'pragmatic'. At this level semiotics is concerned with the habits of the interpreters to use particular signs under certain circumstances and, conversely, to expect certain circumstances to prevail when a given sign is employed. We can assume for the purposes of the pragmatical analysis that the problems of semantics and syntactics are resolved. Here we are deeply into the area of anthropology and culture, and having made this analytical distinction between the separate levels, we can draw upon the work of Searle (1969, 1984), Bloor (1983, 1976) and others for tools to analyse this level of expectations, intentionality and commitments.

Moving now to semantics, Morris addresses another range of concerns in the sign process: 'Semantics deals with the relation of signs to their designata and so to the objects which they may or do denote' (Morris 1955 p99). The overlapping of cultural reference groups: ethnic, linguistic, social class, regional, organisational and professional, for example, ensures that numerous possible semantics can be intended and applied in any given communication. Advertising for British Airport Authority[4] has drawn attention to the varied use of 'body-language' employed in different ethnic contexts. Unless the interlocutors relate the signs correctly to their designata in a particular context then considerable misunderstanding may ensue.

[3] we might use the term "thought community" to refer to both sub-cultures and larger social groupings

[4] An example would be the BAA advert in The Economist, October 16th 1990.

Particular signs (especially linguistic signs), through constant practice and rehearsal, have different significations in each cultural reference group. We can use our knowledge of these different reference groups to apply different meanings in their context. When our friends tell us to be over for dinner at a certain time, we understand that this implies a degree of leeway, perhaps 15 minutes on either side of the time agreed, before eyebrows are raised. Were we to apply the same meaning of punctuality to appointments with our superiors at work, we might find more than raised eyebrows to contend with. The semiotic level of semantics is concerned with the investigation of this area of meanings and with the search for tools to aid us in the process of navigation through this minefield.

Syntactics concerns the formal conception of language, with the manipulation of symbols regardless of their meanings. As the study of these syntactical relations of signs to objects or to interpreters, it is the best developed of all the branches of semiotics, and draws the attention of logicians and linguists, as well from the information systems field. The work of Winograd (1972), Fodor (1974) and Chomsky (1980) sought to test whether it was possible to define grammars, rules for the use of language, which were context-free, in other words where the context of use of language was immaterial and the syntax would provide sufficient guide to the use and meaning of expressions. If this quest had proved successful the course of Artificial Intelligence might have been different; machines could make sense of human language since the mere application of syntactic rules would lead to accurate interpretation. We hope to explain in this work the extent to which such fine intentions were misplaced.

Gibson's Theory of Affordances

Gibson's (1977) work in the 'direct perception' school of psychology has provided some important theoretical insight into the way we might approach the question of subjective worlds. This school uses the word 'affordance' for whatever behaviour some feature of the world makes available to an organism. So that the water in a farmyard pond affords swimming (or drowning!), whereas the dry land of the farm track affords walking and running. The agent concerned, a dog, perceives the world in terms of these affordances. The dog does not have to run or swim in

order for the farm to afford these behaviours, they are inherent in the dog and the environment. When the dog actually runs or swims, it *realises* those potentials in the world. Both of those actions are vital to the animal's survival and it perceives them as *invariants* in a complex and dynamic physical process. Gibson's notion of perception rejects the mind-body dichotomy, which has plagued many linguistic and psycholinguistic investigations into semantics, and holds that the agent perceives invariants through the whole of its sensory faculties.

What is important here is the stress upon direct knowledge of the world through action. The agent in its environment has a vast range of affordances, mechanisms which have been rehearsed so that they have become invariants in the flow of experience. This range of possible behaviours can be viewed as a schematic backdrop for any actual realised instances.

Stamper, as we shall see in Chapter 4, has taken this theoretical structure and used it as a support, in parallel to that of the theory of semiotics, to construct NORMA—a logic of action. At a social level, in Stamper's (1985a) reworking, the agent might be not one individual but a socially cohesive group of individuals whose invariants are complex pieces of behaviour, represented in the norms of that group. By adding to this the notion of semiological affordances, signs that stand for affordances of direct experience, the resulting theoretical construct provides a very complete logic for the representation of knowledge.

Minsky's Frames

Marvin Minsky has been one of the most influential contributors to the field of knowledge representation. His development of the notion of 'frames' (Minsky 1975) has laid the basis for a generation of formalisms in the area, and as such deserves attention in this chapter. In particular the recent advances in object oriented programming languages, with their ability to handle text, graphics, and any structures capable of being produced by computer systems, have lent more credence to the suitability of frames as semantic models for knowledge representation.
Minsky (1975 p.246) tells us:

> A frame is a data-structure for representing a stereotyped situation, like being in a certain kind of living room, or going to a child's birthday party.....The top levels of a frame are fixed and represent

> things that are always true about the supposed situation. The lower levels have many terminals—slots that must be filled in by specific instances or data. Each terminal can specify conditions that its assignments must meet.

The assignments for each of the terminals may be smaller sub-frames. Assignment conditions are specified by *markers* requiring the assignment to be a person or an object or they might point to a subframe of a certain type. Each frame corresponds to objects, actions and attributes of interest. Each frame has in turn a set of slots representing other frames closely related to it. Additionally, frames have unary predicates specifying what frames may fill other slots (guests must be people, food at party must be edible, attractive etc), and n-ary predicates among the slots (no alcohol at children's parties). Slots may have defaults for likely fillers if no other information is forthcoming and procedures or 'daemons, which when appropriate calculate some value. These daemons act as rather as pre- and post-triggers'. Complex conditions can specify relations among the things assigned to several terminals or slots.

Minsky uses the example of a child's birthday party as an illustration, and points out the inadequacy of any dictionary definition such as 'a party assembled to celebrate a birthday' to provide the full flavour of the event. The frame would include terminals and their assignments such as: dress: Sunday best; present: must please host, must be bought and gift-wrapped; games: hide and seek, pin tail on donkey; and so forth. In developing his exposition Minsky (1975 p.253) reinterprets the central concept: 'A frame is a collection of questions to be asked about a hypothetical situation: it specifies issues to be raised and methods to be used in dealing with them.' He draws a parallel between the collection of questions at terminals of the frame and what Schank (1973) refers to as 'conceptual cases'. Certain cases or collections of questions are then generic to each frame terminal, so for a narrated or perceived action they might include the search for the agent, the intention, the side-effects, the recipient and the instrument.

What emerges is not so much a semantic model, relating signs in the formalism to behaviour in the world of social and business affairs, but rather (as Minsky himself states) a data-structure for representing situations within a computer

system. The structure is geared to supporting the storage and manipulation of data (objects) and has little to say about what those objects mean. They may refer to persons in the world outside the computer, or to operations performed within the computer. Problems of conflicting views of the world, of individuation and identification are not addressed. However the freedom to link together frames containing totally different data elements: text, graphics and pieces of executable program, is most attractive and valuable for those developing computer systems today. A frame has little explicit semantic theory to guide the analyst in deciding what shall be considered frames, slots, predicates and daemons, and therefore suffers from the same arbitrariness noted in other representation languages.

The stage-prop-actor (SPA) approach to legal representation

In the area of legal representation computer models have long been used, for example Cory (1984), the LEGOL project (Crooks 1981, Mason 1980, Stamper 1978, 1980) and more recently Susskind (1987) the question of what models to employ is coming to the fore. Criticism has been levelled at the shortcomings of purely rule-based systems (Leith 1988), and models have been developed to permit the representation of legal knowledge in a more satisfactory manner.

The stage-prop-actor model proposed by researchers at the Catholic University of Leuven (Goossenaerts 1988) has the same aims as those of the LEGOL project from where the central thrust of this work comes, the development of a language for the representation of legislation and the structure of rule-base organisations, but whose construction of a semantic model is based upon the techniques of object-oriented programming and frames. Since the model has many similarities with NORMA, whose applicability in information systems analysis and design is the subject of this work, more space is devoted to its consideration than might have been the case otherwise.

For the Leuven researchers, an underlying conception of the task facing a representation language can be encapsulated in what they refer to as the 'representation square' (Figure 2.1), where (A) is abstraction, (E) encoding and (R) reconstruction. Hence primitive entities are abstracted from physical systems (although the term 'social system' might be more appropriate). These abstracted

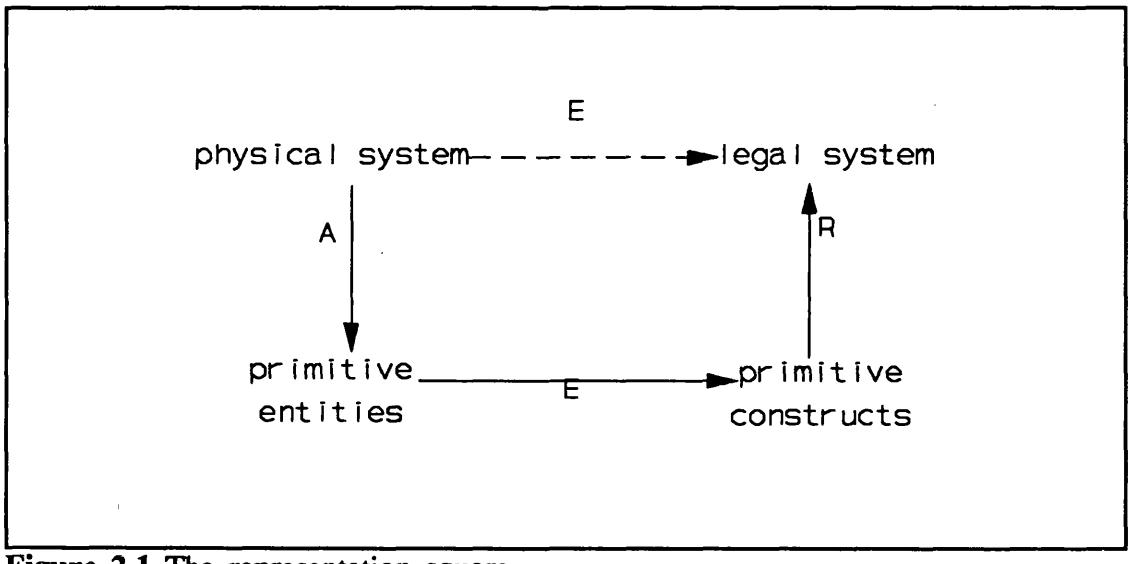


Figure 2.1 The representation square

entities are encoded, and then reconstructed into a representation of the legal system. In the SPA model these primitive legal entities are called *sites*, *objects* and *causers*. They are encoded into the constructs *stage*, *prop (from stage-property)* and *actor*. *Sites* and *objects* are manipulated by *causers* of human and other nature. Goossenaerts et al. give examples of sites as: countries, villages, houses, prisons, safes and airports; causers as: citizens, companies, courts, armies, engines and dogs; and objects as: goods, forms, guns, houses and people. A single physical entity may be in different roles at one time: a passenger in plane is a passive object with respect to the plane, a causer when talking to his or her neighbour and a site for his or her heart.

Two distinct types of stages are defined: *actor-stages* that model the sites or rooms where people work and act and the *prop-stages* that model the contents of the rooms, permitting 'the organized preservation of the props'. Prop-stages are connected to some of the actor-stages. *Indexed-stages* are defined for the cases that many similar props are to be preserved, or many actors with similar access-rights to distinct stages are required. For example, consider the catalogues in a library in the library case the authors make use of. Each book has a unique number and is classified according to its title, author and keywords, so that indexed prop-stages *book/,title/,authors/* and *keywords* are defined. For Hemingway's book 'The Old

Man and the Sea', the indexed objects are shown in Figure 2.2 (the choice of fishing as an index term seems peculiar)

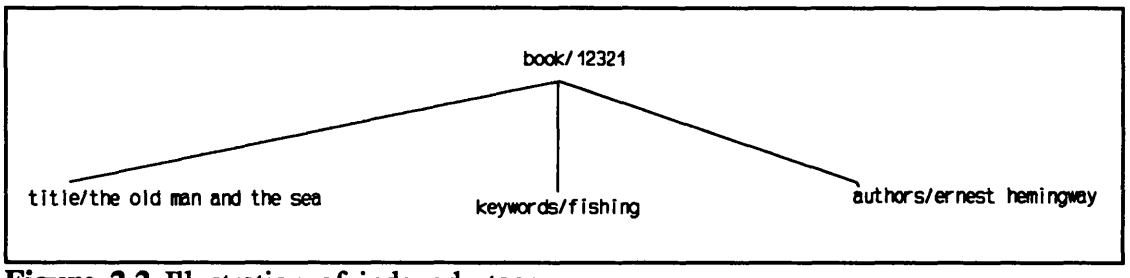


Figure 2.2 Illustration of indexed stages

In applying the SPA language, the first step is to describe the active legal entities and their responsibilities. The next step connects *actor-stages* to the responsibilities. Actions can only be taken from within specific actor-stages. The third step considers the passive legal entities or *props*. Instances of this type are held in a *prop-stage* which is connected to some of the actor-stages. Finally, detailed descriptions of the props, with information on their contents and on the authorities that are required to use them.

The SPA approach has a number of elements that compare favourably with other modelling methods. It attempts to address the question of developing a logic for social behaviour. Its exponents do not come to the problem with a ready-made solution but instead have constructed the logic from analysing the requirements of good representation languages, giving particular attention to the properties of conceptual and computational efficiency and of expressive adequacy. The emphasis is upon action—what actions may be performed by whom, under what conditions, and with what consequences: 'When legal entities are informed on the actions that are enforceable as consequences of their actions, they may choose more consciousl among the existing alternatives' (Goossenaerts 1988 p.2).

The notion of an actor upon a stage with certain props available may be compared in the LEGOL/NORMA approach to that of an agent in a given environment affording certain behaviourial opportunities. Stress is placed upon the authority and responsibility for each action. In the research post case that is developed by Goossenaerts (1988), for example, the rector of the university is found

to have responsibility for creating new posts, accepting an application and opening a vacancy.

In the SPA approach it is possible to define elements of what might be called ontological control, where at any point options of particular behaviour are limited by what has been done thus far. For example in the research post case the options of cancelling an application can only arise after the application has been made.

An important point in the favour of any formalism used for representation of social and physical systems must be the simplicity of expressions. The SPA approach has only three primitives: stage, prop and actor. This economy allows the encoding and reconstruction to be relatively straightforward, yet supplying plenty of scope for rich semantics to be addressed.

Against these advantages we must set what we feel to be a number of distinct weaknesses of the approach. There is the problem of how to map from the legal/physical system into the stage-prop-actor model. What guidelines do we have for deciding what is encoded from the real world into these categories. We are given citizens as examples of causers (actors) and people as objects (props), and we are told that a single physical entity may be in different roles at the same time. Our question is: who decides when a particular role prevails? In fact all the way through the analysis method the analyst constantly faces the problem of deciding how to map into the structures available when the only authority for a particular interpretation is that of the analyst. The classification index of books in the library example (ibid p.7), into book, title, author and keyword, whilst undoubtedly being an eminently reputable method of classification, is certainly not the only one. The SPA approach gives no support to the analyst in allocating responsibility for this classification, nor is clear how it would cope with a change in the method.

For the actor-stage model of public, the three distinct types of actor stage are identified by Goossenaerts et al: the *desk* where the decisions are taken, the *office* (or *off*) where actions that follow from decisions are executed, and the *public relations* (or *pub*) where information from the organisation is accessible to citizens. This typology appears to be reasonable and to concord with a common-sense understanding of the case. But by what criteria do we find the referents of these

three distinct types in the real world? Are these references to **physical** space—in other words do we look for a real desk in a real office?—or are these references to **social**, i.e. **legal** space, in which case we need the agents and the criteria for deciding when we have realised these entities.

A large number of the authorities given for the research post case, and almost certainly for the other cases referred to, comprise roles. A role in the sense used here is essentially a structural element in an organisation. The role will be occupied, when not vacant, by a person. The method does not appear to handle this question of roles well. In the final event the legal responsibility for decisions and actions taken is held not by a role, but by the incumbent of the role. How can the approach permit the role-holders to be identified, especially when these latter will be changing from time to time, with retirements, new appointments and the like, and also how can we trace the responsibility for the structure of roles itself?

The approach appears to include a number of procedural elements in the representation, running the risk by so doing of having a specification which cannot cope with new ways of operating. Current organisational rules, such as those governing the time of expiry of the application period in the research post example, are incorporated willy-nilly into the specification, and exemplified in the research post case. However there is nothing to stop a person sending an application in for a post which currently does not exist. In fact many organisations hire personnel on such a basis. The head of a department or the rector of a university will often have someone in mind before the post is advertised. The real problem here is the inability to distinguish between the substantive behaviour: creating posts, advising on applicants, doing research and so on, and behaviour which concerns the messages processed in support of the substantive: for example, sending notifications to applicants, completing administrative documents and application forms and sending accepted applications to the involved departments. The logic governing the substantive behaviour is unlikely to change quickly over time, whereas the logic of the communication system is subject to the impact of technical, organisational and legal change.

Perhaps most critical of all the weaknesses we might identify in the model is the question of how time is to be handled. The model makes no explicit

reference to this aspect of modelling legal and social affairs, and yet the research post case is riven with time considerations. If we look for example at the position of the existence of an instance of a person and the existence of an instance of an incumbency of say, a research post, then clearly if the person filling the role ceases to exist, the incumbency of the research post ceases also. The 'informal description of the situation' states only that a contract ends when the researcher is fired, resigns or retires.

Schank: Conceptual Dependency

Schank's (1973, 1975a, 1975b, 1977, 1986) long investigations into natural language have led him to the belief that: 'Natural language processing must be studied in terms of how meaning is communicated by language' (Schank 1986). In the effort to understand the concepts conveyed through natural language Schank found it necessary to develop the theory of 'Conceptual Dependency'. Put simply this was a device to respond to the need to be able to infer likely consequences from a piece of information. To make sense of a phrase such as 'John gave Mary an aspirin', Schank's language MARGIE generated the inferences 'John believes that Mary wants an aspirin', 'Mary is sick', 'Mary wants to feel better', 'Mary will ingest the aspirin'. The representation of meaning must be unambiguous or else little would be gained: the problem is that it must represent similar meanings in similar ways or else the system needs families of inference rules to deal with each representational variant. Thus the number of rules needed grows exponentially.

In order to facilitate inference, Conceptual Dependency attempted to draw together the elements needed to represent actions, causal relations, states and state changes. This theory defined initially eleven basic acts which ranged across human behaviour. Examples of such acts (ibid p.336) are:

PTRANS: to change the location of an object
PROPEL: to apply a force to an object, in a given direction
MTRANS: to transfer information, either within memory or between people
INGEST: to take something to the inside of an animate object

With each act are associated conceptual cases which modify the actions described, so that for example PTRANS, modelling the verb 'to go', possesses five cases: Objective (the object whose location is changed), two Directive cases, TO and FROM (marking the change in location), the Actor (who effects the change), and the Instrumental case (for how the change is effected, eg. by PROPELling the object. By parsing natural language expressions in terms of mappings onto these conceptualisations, the features associated with each case may be fully predicted once a mapping has been achieved. The action of 'eats' maps onto INGEST and the expectation will be that the object is food of some kind.

These conceptual cases provide the system with the expectations about the elements associated with any action. In a sense they are developments of the grammatical cases that exist in natural language; nominative (for the actor), accusative (for the object) and so forth. The difference here is that different acts (cf. verbs) have different cases. Thus the benefit of a uniform syntax for the semantics is not achieved. For each new action added to the basic list, there will be a new list of cases to learn; making the task of analysts using the representation language inordinately difficult.

MARGIE was able to use previous text to generate context to disambiguate potentially equivocal terms. 'He fired it' could refer to shooting a gun or finishing a clay pot. If the gun were mentioned in the previous sentence then that would be sufficient to create the right context. The problem here is that there are aspects of the living situation which are not apparent to the program analysing text. Schank uses the example of taking off one's shoes in a restaurant—unless you know it is a Japanese restaurant then the program will not understand. Associated to this is that without this knowledge the search for the correct inference leads to a combinatorial explosion of possibilities to consider.

As a solution to this problem the theory of scripts (Schank 1977) was developed. A script is a series of events that describes a particular context. As a stereotyped sequence it guides our expectations in familiar situations. So that going to the Japanese restaurant will include amongst the events such as entering the restaurants, announcing who you are to the host/maître, also those of taking off your shoes, sitting on a mat, and so on. Schank claims further that scripts provide, in

addition to detailed expectations when processing, also a basic structure for the series of events but separate the 'normative features from those which are unlikely to vary'. Ordering and serving, according to Schank, will be invariants but the particular items ordered and served will vary in particular instantiations, and in many restaurants one does not order: there is a fixed menu. These items are identified as *script variables*, and their values are filled in as the script is applied to understanding a story.

Both these notions of conceptual dependency and scripts are useful testing out new approaches to natural language processing. Schank declares that they have proved successful in performance and as tools for psychological investigations. They go some way in the search for a formalism for representing knowledge, and they do so because they attempt to replicate the structures of behaviour within their own structures.

The work of the researchers referred to in this chapter has had an important bearing on this thesis. Each made a special contribution to the understanding needed to grapple with the problem of semantics in our field. Fodor underlines the need for a semantic theory, a theory of meaning which may be used to predict the significance of expressions when they are employed in a specification language. Without such a theory we cannot explain and understand how organisations can use communication to direct the activities of its members in a predictable and stable manner. Winograd's contribution raises the notion of situated action, that semantics must reflect the situation in which the language is utilised, and that in any given situation only a certain number of actions are possible.

Closely allied to this is Schank's notion of Conceptual Dependency, whereby present behaviour possibilities rest upon previously realised actions. These two latter themes are reflected later in the notion of ontological dependency which underlies the philosophical assumptions of NORMA (see Chapter 4). Gibson introduces the idea of the world constructed by the agent who acts in it, and so the twin epistemological assumptions of action prevailing over being, and knowing deriving from action begin to emerge in his work; they are also incorporated by Stamper into the philosophy of NORMA. Morris's contribution is to introduce the role of the sign and the interpreter and in so doing moves us clearly away from

mentalistic theories of meaning. It becomes possible then to envisage the interpreters as also the responsible agents who shape the world they inhabit. Goossenaerts takes this process a little further by constructing a language with explicit metaphysics which are based upon the legal domain, and includes many of the elements outlined above: situated action with responsible agents acting in a world which they construct but where the options for behaviour are constrained by what has been realised.

Each of these themes is woven into the fabric of the specification language that we demonstrate with the applications in Chapters 5, 6 and 7.

Conclusion

This chapter has reviewed briefly some of the approaches used to handle the problems of meaning in representation formalisms. It does not pretend to offer a detailed survey of the whole field. What it has done is to draw attention to the problem of semantics for investigators coming from a wide range of disciplines. That they should have a great deal to teach us in the information systems area is not surprising: our discipline owes its existence to collateral disciplines such as linguistics and philosophy, and has a particular debt with regard to such theory as we can presume to possess. However it has emerged that the nature of the representation language, to be successful, must reflect the richness of the domain it seeks to capture in its formalism. Knowledge cannot be modelled properly unless the metasystem incorporates and mimics adequately the metaphysics of the object system: the world of business and social activities. In stating this we wish to draw attention to the purpose of this work, that is, to investigate the feasibility of using semantic analysis to develop information systems. In the next chapter the notion of meaning in the database field is examined, again with the same spirit of caution.

Chapter 3
Meaning in the database community

When switching attention away from the problem of meaning in the wider field of information systems generally, to the more narrow sphere of interest of databases, the essential task still remains: how consistently to relate signs, or in this case data, to reality. In this arena also there is little accepted explicit theory of meaning to which the many researchers subscribe.

What are widely accepted and incorporated into database theory are the metaphysical notions that pervade the fields of science and engineering. The world is seen to be composed of objects, which can be grouped together into sets. These in their turn may also be grouped into sets, and so set theory is being used as basis for semantic structuring and to develop ever more baroque assemblies. The relational model uses the concept of the mathematical relation and Chen (1976) developed the concept of entity set, relationship set and mappings amongst these latter and the relational model. These ideas are accepted in the database field unhesitatingly, where the main concern is with character-strings which can be grouped into tuples, which in turn may be grouped into relations. Stamper et al. (1990) point out that this artificial machine world cannot reflect the semantics of a social context. The subject of databases is intrinsically machine-oriented, saying nothing about the world to which the character strings refer. Whilst confined to the world of the machine, such a semantic theory is sufficient in understanding the problems of character storage and manipulation. However once the data needs to be related to reality this naive theory is inadequate, and in practice it is those who create the interface of the machine system to its social context that bear the burden of maintaining consistently the links:

> When an explicit theory of meaning is introduced, it is almost invariably a naive interpretation of set theory. This assumes a world, exactly analogous to a database, composed of objects (which are the meanings of names) grouped into sets (the meanings of predicates) ordered in n-tuples which are grouped into sets (the meanings of relations). The structures generated by the designers of schemas, typically use concepts of entity, attribute, and relation corresponding

to these structures, but what constitutes an entity, attribute or relation is arbitrary (Stamper 1990).

The fundamental question of relating the outside, or user's world to the symbols stored and manipulated in a computer database has been tackled by no less an organisation than the American National Standards Institute. They have determined three database modelling levels that reflect the user's conceptual model, the machine's physical model, and the mapping from one to the other. These levels are described as follows in the ANSI/SPARC proposal (Burns et al 1986; Jardine 1977) for the standardisation of database architecture:

1) External level. The user's logical view of the enterprise without consideration for performance of storage issues.
2) Conceptual level: The information model, providing the mapping from the logical to the physical, or internal level, describing the semantics of the entities and relationships, including descriptions of connections and consistency constraints.
3) Internal level. An abstract model of the physical database concerned with access paths and the storage of data.

In this categorisation the relational model (Codd 1970) and its various manifestations would be viewed as conceptual models. The tables or relations in the relational model provide the means for mapping to level 3. Models such as the Entity-Relationship Model (Chen 1976) can be seen as both levels 1 and 2.

It is noticeable that the description of level 2 incorporates the notions of entities and relationships into the baseline definition: we are effectively being forced to approach the world of data modelling with this terminology which embodies the world view outlined by Stamper and referred to above. It should come as no surprise that the database community shares these metaphysical notions and this 'theory of meaning'. Consider for a moment this line in an introduction to ADS (Kimura et al. 1985 p.298), a data model in which the notions of symbol and abstraction play an important part: 'Symbols are used to name real world entities and to described the relationships among them'. The new model is being constructed upon the metaphysics subscribed to by Chen. The semantics of set theory are incorporated almost unbidden into the nascent formalism.

In the knowledge base/database product GENERIS (1989) we are told for example that knowledge is represented in the form of 'facts' and 'rules' and that facts are of the form

> <subject> <relationship> <property>
> where "subject" can be the name of any *entity*. An entity is any object, concrete or abstract, or class of objects. "Property" can be the name of any other entity, or an *attribute*. "Relationship" is a named relationship between the subject and its property (GENERIS 1989 p.3).

So that what we have are role names for entities: subject and property are roles in ordered pairs of relationships. A fact such as "John Smith manages the accounts department" would translate into "John Smith" as the subject, "manages" as the relationship, and "the accounts department" as the property. But in the fact "The accounts department is located in London" the property becomes the subject. We are told that a particular property may be either an entity or an attribute, and an example of a fact with an attribute as its property would be "John Smith has age 32". Whilst not stooping to explicate the fundamental distinction between entity and attribute we are vouchsafed the vital information that attributes in GENERIS are of five types: integer, decimal, date, time and text; none of which are semantic properties but instead concern the way that the computer handles the symbols.

The underlying semantics of set theory become even clearer when we continue:

> Every entity will in general be a member of one or more classes. For example, John Smith may be an employee and a sportsman. The class membership relationship, or "generic association" is of particular importance in GENERIS. It is represented by any of the names:
> *is a* *are a* *are*
> *is an* *are an* *is*
>
> Examples would be:
> *John Smith is an employee*
> *Accounts is a department*
> *Employees are people*
>
> Using this relationship, one entity is made a member of another, ie. the latter becomes a class or set containing the former. No distinction is made by the System between entities and classes, and

> the class membership links can therefore be built up into a network of arbitrary complexity (GENERIS 1989 p.3)[1].

What is interesting is how ingenuously this section of a technical introduction to a marketed product discloses the widespread and largely sub-conscious preconceptions of what are inadequate semantics even to the admission of the arbitrariness of it all. Surely a better self condemnation could not be found. It is quite evident that the consistent linking of these symbols to their referents in the world of action must be done *informally* by those who use the system. No support at all is given for meaning in the operational sense.

Another point to notice in the ANSI/SPARC framework is the implicit assumption that the different external views at level 1 are somehow all compatible with an underlying conceptual view at level 2. In other words there is the unstated assumption that there is a unique (and objective) conceptual level with which all individual views are reconcilable. Work by Marche (1990) suggests that in the case of deciding, in a large North American telecommunications company, the criteria by which an edifice may merit the term 'building', there were at least three different views of the meaning of this word: the views of the accountants, the maintenance staff and the property management teams. In practice the ideal situation of ultimate reconcilability may only prevail by extensive policing of the data model by the data administrators.

The relational model

A key aspect of the database concept is the integration of data. Robinson (1989) rightly holds that a business organisation cannot be properly modelled by 'islands' of data. In the real world any organisation functions at the social level as an interrelated, if often complex, whole. In the common textbook example of suppliers and parts (eg. in Date 1986a), orders are related to suppliers and therefore they should be linked in the company's record system. A simple list of orders without

[1] Emphasis added

the information needed to connect them adequately does not provide an appropriate model of the world in which the company operates.

In view of this the early database systems concentrated upon linking records together, usually by adding pointers to the records. When the number of pointers became too difficult to handle, systems were developed to make life easier for the programmer.

While these systems aided the programmer in reflecting some relationships between data items and even in addressing questions such as simple integrity constraints and existence dependency, (eg. CODASYL from DBTG 1971), what they failed to do was to remove the inflexible structuring of the data. It was this aspect of the pointer based system that Codd (1970) addressed in his paper introducing the relational database system and emphasised three ways in which the pointer based system led to a loss of data independence: ordering dependence, index dependence and access path dependence. The most serious of these was perhaps the latter, where to retrieve items from a pointer based system, a program must follow a chain of pointers or access path, with the corollary that only queries for which access paths exist can be answered. In effect the range of queries is limited by the skill and capacity of the programmer in identifying possible future query profiles, or as we shall see later in this work, by the system specification language used in specifying the requirements.

Codd's data model in answer to these storage dependency weaknesses, he claimed in a later paper (Codd 1971), was: 'the simplest possible structure consistent with semantic considerations'. Whilst the relational model is attractively simple, his claim for the semantic power of the relational model is highly debatable, and the following section considers these defects.

Semantic defects in the relational model

A relation is an organised collection of data, usually presented as a table, where the structure consists of a heading and a body. The heading consists of a number of attributes of an entity, and the values for the attributes are drawn from a domain. For example the data values might be drawn from a domain of numbers, of days of the week and so on. The body of the table consists of sets of tuples where each

tuple is a set of attribute-value pairs. A relational database is a collection of (base) relations. Each database entity type is represented by a base relation. Facts about the entity type are represented by the attributes of the relation. An entity is represented by a tuple of the relation.

In a relational system there is only one concept available to the data modeller: the relation. Even in the simple and widely used Chen conceptual model there are two 'primitives' available for conceptual models, the entity and the relationship. For the relational model both these two concepts must be encapsulated in the relation. Furthermore the existence of a tuple implies the existence of both an entity and of its properties, as attributes. Take the case of the Employee database (Date 1986a): a tuple for an employee presupposes that not only that there is an employee, but that employee is attached to a department, has a salary, a manager, and so on. Moreover many relational database schemas make use of 'link' relations to overcome the 'many to many' problem. In the textbook Student database (Hawryszkiewycz 1984) the relation combining students and subjects, called unimaginatively "STUD-SUBJ" defines subject groups, joining together students and subjects. Thus the relation may represent many things and the user must navigate informally a large number of semantic questions, with very little help from the relational model itself. In contrast to the claim of 'making data more meaningful to users', the truth is that users must grapple with the wicked problem of semantics often unaided.

The relational model and the notion of a key

The relational model rests upon one central concept: the notion of a key. An instance of any entity recorded in the relation is distinguished by the key. So that a student in the university database will be recognised in the internal world of the computer solely by the student registration number. In many databases the person's name will be used as the key. Using a label as the internal identifier can work well up to the point where the connection can be made by the user to the entity that label refers to in the real world. But in the real world of social and business affairs we do not necessarily need to rely upon labels to identify persons and things. By doing so we run the risk of instabilities caused by coping with changes in

names. The amount of junk mail that arrives through the letter-box, often from the same source, but addressed to one person, albeit with slightly misspelt names, testifies to this glaring inadequacy. By the same token, assuming a new name in a database creates for the person a new identity wiping past glories and misdeeds in one fell swoop.

Relations between entities have to be expressed by including within the attributes of an entity the key, known as the "foreign" key, of the partner entity. When manipulating the database users have to specify joins between two or more relations, permitting users to create relationships within the data which may be completely nonsensical, and certainly not envisaged by the database designer.

The relational model and redundancy

Closely related to this matter of retrieval by unique key in the relational model is the aim of reducing redundancy[2]. The reason for this being to remove insertion, update and deletion anomalies, achieved when each data item which is not a determinant appears in one and only one relation. In the Employee database, EMPNO (employee number) will be included in the relation:

WORKS-IN (EMPNO DEPTNO)

rather than the employees actual name, because the name of the employee is functionally dependent upon the number. Thus even though many of the queries will be looking for the names of employees, the relations queried directly will not contain their names, and more complex queries will be needed to obtain them. The storage and processing requirements of the relational data model in effect impose an arbitrary view of the user's world upon the schema. From the standpoint of maintaining the stability and integrity of the database, within the limits of the relational model, this may be a price that database users are prepared to pay, but do we really need to put users into such a straitjacket?

[2] There is extensive literature on this subject see for example Codd (1972) and Bernstein (1976).

The relational model and atomic data

The relational model requires that all data in the model be 'atomic'; in other words that it cannot be split into smaller parts. A common example taken for illustrating this weakness is the question of the 'name' attribute. If we take as an attribute the notion of 'name', how do we handle first names and surnames? It is possible to take the two fields FIRST-NAME and SURNAME collectively as NAME, but then queries requiring the full name of persons would need a query based upon the two attributes and a logical connector; quite complex for a simple retrieval. In a sense the problem here is rather different from that posed by Jackson (1989) - can the model support part/whole distinctions? The ability to be able to divide things into parts, whether they be oranges, houses, organisations or orders, is something that most users will have as part of their normal range of competence.

The relational model demands that the entities stored in the relations be 'atomic', but just as in nuclear physics so in the world of social and business affairs, deciding what cannot be divided any further is no simple question. Any data model should support our ability to divide things into parts and to record the authority for each such division. The notion of being able to arrive by analysis at an indivisible unit of social reality for representation in a database is comforting, but unrealistic.

The relational model and many-to-many relationships

A classic problem of data analysis and design is the question of many-to-many relationships. The relational model does not support such relationships and consequently database designers take refuge in a 'link' relation. In the PARTS and SUPPLIERS case, we have the relation:

SP(S#,P#,QTY)

modelling the relation between PART and SUPPLIER, so that a PART is supplied by many suppliers and a SUPPLIER supplies many PARTS. In this case the SP can be deemed to refer to shipment, and we can delude ourselves that this is an entity in the real world, and set about convincing the user of the same. But when we have to stretch the imagination even further, say with the relation

ST-L(ST#,L#)

from the STUDENT and LECTURER case, where many STUDENTS have many LECTURERS and LECTURERS teach many STUDENTS. The creation of the link file STUDENT-LECTURER resolves the problem as far as the storage and processing of data goes, but the meaning of the data held in this link file may not be clear to the user. In addition to this uncertainty of the significance, there is the more general criticism of the inability of the model to represent faithfully the user's world. Such a device permits the designer to present a schema that reflects more the technical limitations of the eventual software than the requirements of the user.

The relational model and handling time

On the question of how databases handle time, the relational model has no facility for dealing with time. Using Chang's concept of 'time-varying relations of assorted degrees', Clifford (1983 p.214) argues that 'the model itself incorporates neither the concept of time nor any theory of temporal semantics'. The concept of time is crucial to many databases which need to reflect the changing flux of events in the real world. Unfortunately where the relational model should deal with time in a uniform and consistent manner, instead it is left to the analyst to decide when it is appropriate to use time attributes.

This work will return to the subject of the handling of time repeatedly since it is such a fundamental notion. The loss of valuable data through destructive updates is a serious criticism of the relational model and one which has had a good deal of attention from researchers.

The relational model and aggregation

Users often desire to treat different elements in their social and business affairs as aggregates, subsets or groups. The relational model cannot support this requirement without resorting to the creation of a new relation. A relational database with entities such as CAR and TANK modelled as relations would not be able to use the notion of 'vehicle', a natural enough way of economically referring to a large class of similar entities without having to add the new relation VEHICLE to the schema. Such a modification can only be done by threatening the integrity of the rule of

"one entity, one relation", and the attendant dangers of redundancy, duplication and inaccuracy.

Many of the latest 'semantic data models', a term widely in currency, eg. Balfour (1988) and Peckham (1988), attempt to correct this defect, together with other related ones, and these are reviewed below.

The relational model and type/occurrence confusion

Another defect of the relational model pointed out by Jackson (1989) is the inability to distinguish between types and occurrences. A company which keeps details about a range of cars that it offers to employees to choose from, might well have a relational database with two relations: CAR which would contain an entry for each car in the car park and CAR-TYPE containing a list of the available car-types. By doing this the data about generic features of types, such as engine size and service interval, can be separated from the details about particular cars, such as petrol consumed, tyres replaced, and so on. The relation CAR-TYPE contains data about universals, type abstractions, whereas CAR contains data about actual extant particular cars. This distinction is not clear to the user of the database and altering the entries in one relation has very different implications from doing so in the other.

When referring to types we want to stress the similarities between instances of say a Ford Fiesta, and the attributes of the Ford Fiesta will describe a model car, model in every sense of the term. When we come to refer to a particular car, we are interested in the differences between that car and others like it and we may find that the actual values for the attributes, say of engine size or actual service interval vary somewhat from those described at the type level. As we have seen, the relational model has little to offer in support at this level of abstraction.

Codd's extended relational model

In light of the many criticisms of the semantics of the relational model, the extended relational model (also known as the RM/T model) introduced in 1979 (Codd 1979), was developed as an answer. Although some of the defects are addressed, some remain valid.

The extended model still models the world in terms of entities, defined as 'any distinguishable object' where the object may be abstract or concrete. Of course the question of who does the distinguishing is still left unanswered. No place is given to the knower of the knowledge, it is simply assumed that these objects form part of an objective reality. Relationships are represented as entities also, but explicitly in this model, as opposed to the implicit treatment via foreign keys, in the earlier model. Any entity will fit into any entity type, so that a publication is an instance of the PUBLICATION entity type. Entities of the same type have the same attributes and entities can have sub-types and super-types, hence PUBLICATION is a super-type of BOOK, but DATABASE-BOOK is a sub-type of BOOK.

Three types of entities are discussed by Date (1986b): characteristic entities, associative entities and kernel entities. The syntax of RM/T allows the class of an entity to be identified and can support the integrity of the database by restricting manipulations to entities of that class, providing more flexibility and 'richness'.

RM/T has one very important advantage over the earlier model: it does not identify internally an instance of an entity by use of a key, but instead uses an internal surrogate number to perform that task. The unique surrogate number is generated internally and although can be addressed by users it cannot be modified by them. Surrogates permit the database to address uniquely the record for every instance of every entity in the system, without the problem of having artificially to impose a unique key value for each particular, where a ready-to-hand set of unique key values is not available. One is reminded of the problem of allocating unique numbers to members of the public, who in any case often fail to remember them, just in order to accommodate the social reality to the requirements of the technical system[3].

Relations in RM/T describe entities. Two types of relations are maintained by the system, E-relations and P-relations. E-relations indicate the existence of an entity, but no more, whilst P-relations record the values for the properties of an entity. Hence even when no other details are known, the mere existence of an

[3] This criticism is just as valid for manual systems such as the DHSS and Inland Revenue that rely(ed) on unique artificial numbers

entity may be recorded. Take for example the case of a person travelling to work each day on the same train. That person will almost certainly be able to recall the same individuals who use the train, and yet not know the names, addresses or any of the usual details that a database will store. In a standard relational model it would be difficult to record the existence of such fellow travellers without having these details. The E-relations concern the recording of the existence of the entities alone, while the P-relations address the matter of the properties of these entities. The RM/T model obviates the need to know *a priori* identifying particulars of entities since it does not rely upon them to manipulate the data.

In the E-relations therefore there is only the single attribute to contain the surrogate number for an entity instance. The E-relation device is used to permit the definition of entity subtypes:

CREATE E-RELATION PUBLICATION;

CREATE E-RELATION BOOK SUBTYPE OF PUBLICATION;

When the system adds to the E-relation 'BOOK' a surrogate value, it will do likewise in the publication E-relation.

Values for instances of entities are held in the P-relations. All such relations must have a surrogate attribute, in order to identify it as a tuple that belongs to a particular entity instance. In Figure 3.1 the surrogate number '5678' is the identifier

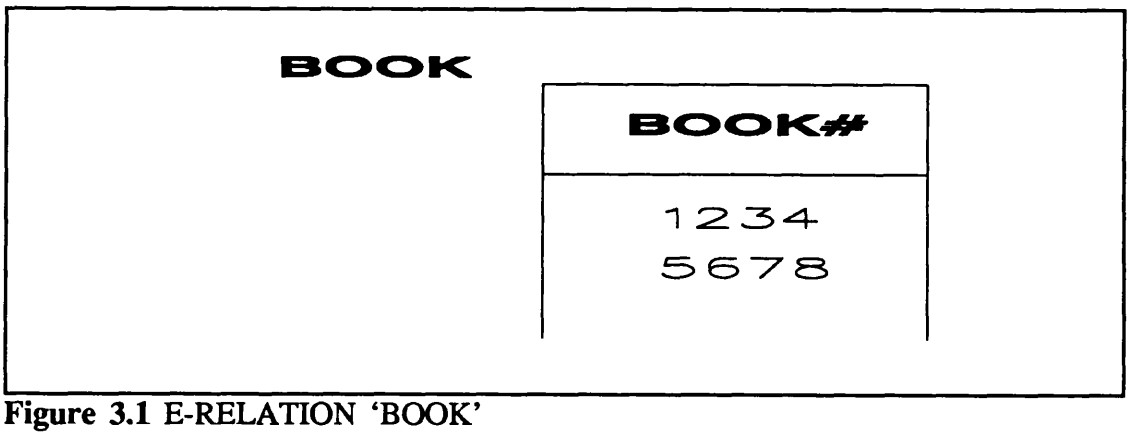


Figure 3.1 E-RELATION 'BOOK'

to the system for the work by Balzac 'La Cousine Bette', but by using the surrogate number this name is not needed to manipulate the record. Any one entity may be modelled by more than one P-relation. Take for example the entity BOOK

with attributes TITLE, AUTHOR, PUBLISHER, ISBN. This could be created in the following manner.

CREATE E-RELATION BOOK (see Figure 3.1);

CREATE P-RELATION BKT FOR E-RELATION BOOK (see Figure 3.2 for this relation with two entries);

PROPERTIES(TITLE DOMAIN(TITLE),
AUTHOR DOMAIN(AUTHOR),
PUBLISHER DOMAIN(PUBLISHER));

BKT

BOOK#	AUTHOR	PUBLISHER	TITLE
1234	Jane Austen	Penguin	Emma
5678	Balzac	Le Monnier	La Cousine Bette

Figure 3.2 P-RELATION 'BKT' (book title)

CREATE P-RELATION BKNO FOR E-RELATION BOOK (see Figure 3.3)

PROPERTIES(ISBN DOMAIN(ISBN));

BKNO

BOOK#	ISBN
1234	0-14-043010-5

Figure 3.3 P-RELATION 'BKNO' (book number)

Data abstractions and the Semantic Data Models

After years of focusing upon the benefits of the relational model, compared to the preceding hierarchical and network models, the attention of the database community seems to be shifting towards what the literature refers to as 'semantic data models' (Peckham 1988), and the RM/T model figures amongst these. As a better way of storing data, the relational model has begun to overshadow its competitors and yet concern exists that it does not allow users to incorporate a richer set of semantics into the database.

Schema

Much of the difficulty encountered with databases at the semantic level derive from the problems of the schema (or metadata) and the metaschema. Schemas in databases have the function of reflecting the world of the user in such a way as to allow him to report the changing facts about the world within its framework, because enterprises change continuously and need constantly to be able to record the new states of affairs. Unfortunately the mismatch between the structure of the database model required by the computer for efficient performance and storage and the way in which the user of the system may in fact envisage his reality gives rise to problems.

At the underlying metaschema level there is the problem of what kind of structures can be represented with any given model. Schemas that are constructed on the basis of entity-relationship primitives are wedded, like it or not, to the strengths and limitations of that meta-level.

As a way of overcoming the rigidity and inflexibility of the relational model, conceptual models such as SDM (Hammer 1981), TAXIS (Mylopoulos 1980), Functional Data Model (Shipman 1981), the Event Model (King 1984), and the Format Model (Hull 1988) seek to offer greater diversity and richness, over and above the basic concepts used to model elements of entity and relationship (Chen 1976), which seem to have become the 'sine qua non' of database modelling. These additional constructs, usually referred to as abstractions, include: generalisation, aggregation, association and classification. Also the requirement of

time-handling has become a vital question which many models do not consider at all, and those that do (Clifford 1983) provide partial solutions.

On examination these 'richer models,' whilst undoubtedly offering the analyst and database designer more structures to reflect the world of the user inside the machine system, still suffer from the inadequacies of the paradigm (the lack of an explicit common commitment to this notion prevents the use of the word 'theory') as the basis for these models, and as we have seen, for the relational model itself.

Thus a pervasive consensus appears to underlie all these models proffered in the field of database semantics, a consensus which has its provenance in the domain of classical logics, where particular metaphysical assumptions about the nature of reality prevail. Amongst these assumptions are the notions that:

everyone inhabits a common world ...
comprising discrete objects ...
with definite identity ...
classifiable into distinct sets ...
employing truth-functional semantics.

Whereas for the platonic mathematician the world conjectured from these premises will suffice for his purpose, for those of us working in a world made up of people drawn from very different backgrounds, faiths, cultures and traditions, starting from such *a priori* principles is proving an inappropriate basis for the construction of database systems.

The semantic models (and others) referred to have a common aim of providing a richer structure for modelling and each of them offers extra support from these abstractions, but always from within the limitations of the current orthodoxy of beliefs and assumptions.

Generalisation

Probably the first abstraction to extend the basic range of entity and relationship offered by the widely used Chen model, and one which has been emphasised by the TAXIS model, is that of generalisation referring to: 'the means by which differences among similar objects are ignored to form a higher order type in which the similarities can be emphasised' (Peckham 1988). Peckham uses the example of PUBLICATION as the generalisation and BOOK, JOURNAL_PAPER and

CONFERENCE_PAPER as specialisations. The use of such an abstraction greatly adds to the economy and power of expression, reflecting as it does linguistic practice in human affairs. In this particular example we could imagine many features, such as 'author' for instance, common to all these.

Insofar as we want to treat a group of such entities as a generalisation/specialisation unit, this facility will aid us in our work. However once we begin to examine carefully the differences between the members of this unit, or rather once we need to emphasise the differences, we find ourselves encumbered with that structure. What was apparently convenient now becomes a liability. Notice in Figure 3.4 that the relationship between the several entities PUBLICATION, BOOK, CONFERENCE_PAPER and JOURNAL_PAPER prevailing here and now, could present a threat to the future stability of the schema should the business (or in this case the library) decide to recast the mould. How, for example, would an unpublished work be recorded in this schema?

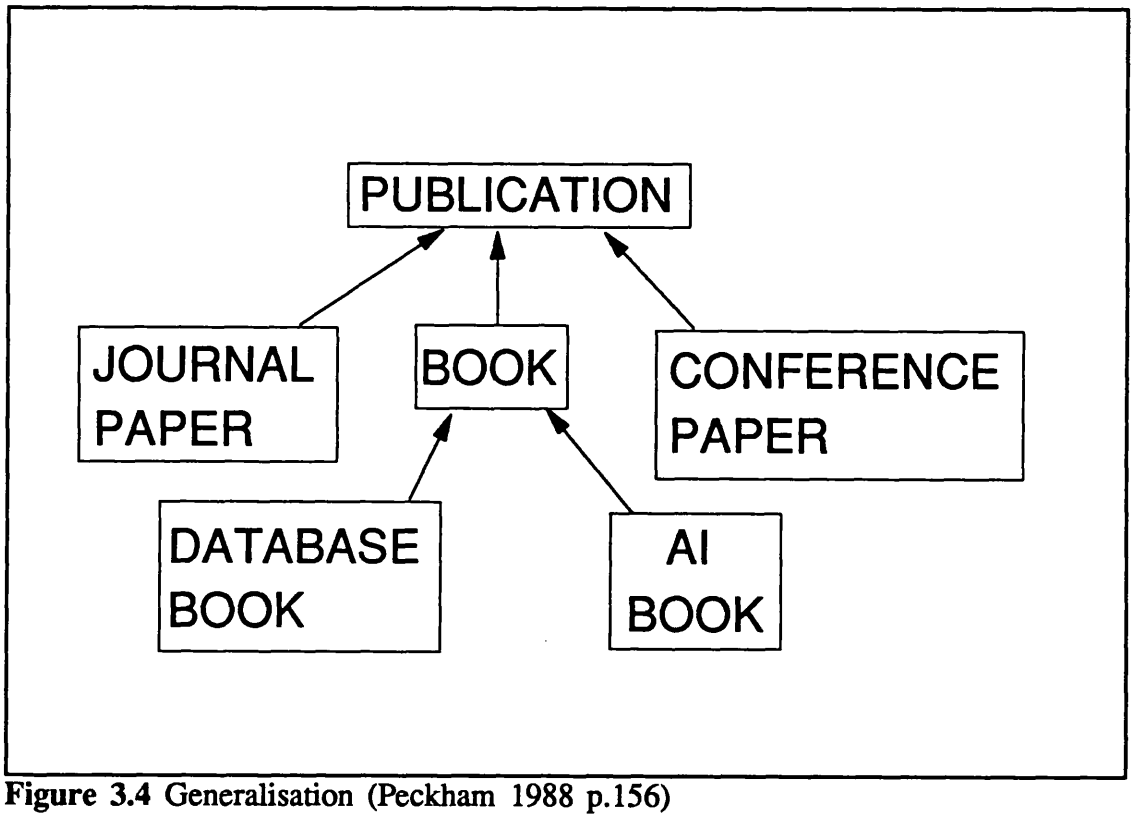


Figure 3.4 Generalisation (Peckham 1988 p.156)

Aggregation

Aggregation permits viewing relationships formed between lower-level types as higher-level types. In the relational data model such aggregation comes about through aggregating attributes to form relations. Models such as SDM and TAXIS may aggregate entity types or relations to form higher order entity types. Peckham (1988 p.156), pursuing the library case, illustrates aggregating two entities such as TITLE and AUTHOR to produce the higher order entity PUBLICATION.

The notion of aggregating a title with an author to form publication transgresses fundamentally the ontology of this domain: a publication could not come into existence without an author, and if published will have a title also. The failure to handle roles well underlies the problem. In many of the schemas we find in the textbooks PERSON has no place, whilst of course there exists a large number of roles filled by persons. It scarcely makes sense to suggest the aggregation of title and author to permit publication when for these first two terms to have any significance we should already be able to point to the existence of a publishable work (such as book or journal paper). A person will achieve the role of an author when he has completed a piece of work which qualifies him in the eyes of the body concerned as worthy of the ascription. For a library, in contrast to a body which organises conferences, would be handling material not yet published, publications would form the bulk of the items and so the authors in question will have published works in any case. In passing, we may note that writers must first produce the material, and then the work itself enters into a role of its own, once a publisher decides to make it a publication.

Classification

Many semantic models treat classification as a form of abstraction considering a collection of objects as a class of higher level objects, often of the type *is instance of* relationship (Mylopoulos 1980). In the library sample database Peckham (1988) give the example of the object class BEST_SELLING_BOOK which consists of all BOOK objects with sales greater that 10,000. But how will the database look if for some reason the library decides to change the definition and threshold of bestseller sales to 15,000 perhaps because of sudden increases in overall book sales?

Will all those books originally entered as bestsellers suddenly lose this status if their sales lay between the 10,000 and 14,999 mark? Will the database treat equally records from the two different criteria?

In this case we might present the criterion for this classification as a rule, possibly superseded in the course of time. An agent can choose to treat a subset of entities according to a particular rule or norm as a separate class, but the conceptual model should contain mechanisms which can handle the dynamics of any system of rules. Different users of the system might have differing standards for what constitutes a bestseller and the conceptual level would admit of only one.

Association

Association refers to the form of abstraction which treats relationships between member objects as higher level set objects, often manifested in the *is a member of* relationship, and supported by many semantic models including RM/T. For example (Clifford 1988 p.173) the set of DATABASE_BOOKS of AI_BOOKS as an association of BOOK objects. Some predicate such as TOPIC=DATABASE will usually determine the membership of the set, or the user could equally specify some other criterion.

The universal BOOK comprises two different sets of books. It would appear that books first belong to their set of database or AI books and only secondly to the BOOK set. Surely this again transgresses the ontology: first a book then a member of a set of books. This membership, as with classification above, could be handled simply by a rule.

Neither may we feel certain that all users of the library will necessarily divide the books into the same groupings. One department may treat a book as a database book, another may decide to place it in the knowledge base category. Instead of having to decide arbitrarily for all users of the library the denomination of a particular acquisition, a better approach would permit the library to define categories. Not only should we make available the criteria laying behind them, users and user groups should maintain their own definitions perfectly well. Each book could then fall into different groupings simultaneously.

Inheritance

Repeated information within the database schema arises from the derivation of one entity type from another. In the above case, conflict can occur where a specialised object inherits the same property from two higher level objects. For example

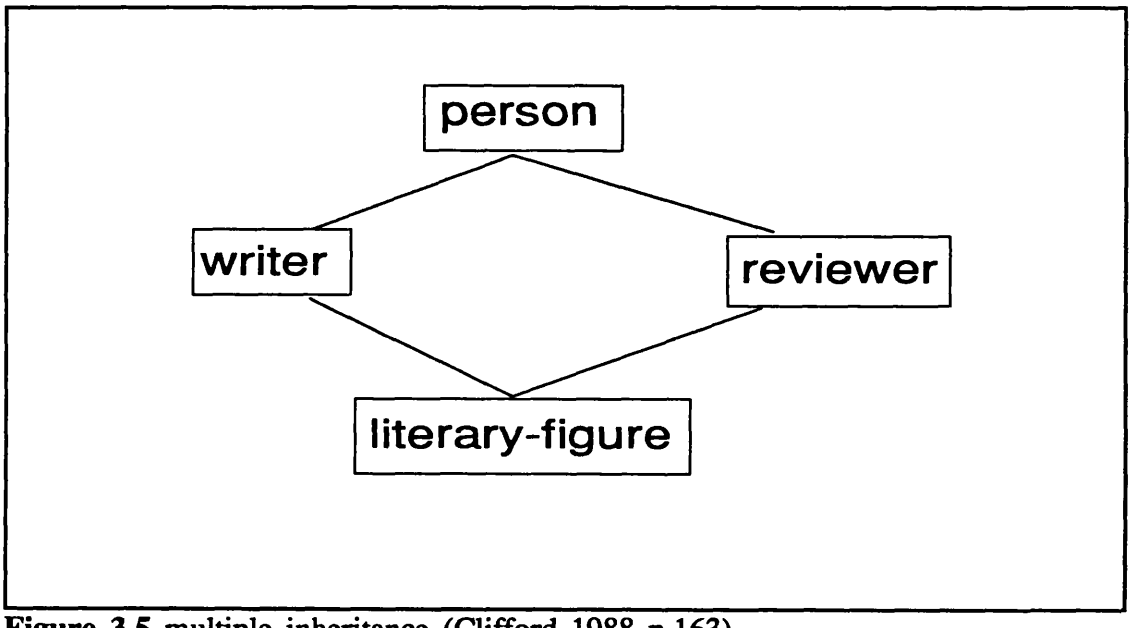


Figure 3.5 multiple inheritance (Clifford 1988 p.163)

Figure 3.5 shows the LITERARY_FIGURE which includes both writers and reviewers. LITERARY_FIGURE acts as a specialisation of both WRITER and REVIEWER and therefore inherits properties from both. Since both writer and reviewer will have a stipend attribute a problem occurs because the reviewer's stipend would refer to the remuneration for reviewing a book, whereas the writer's stipend would refer to the sum advanced by the publisher. Put simply the term stipend would have two different meanings, which the model has to handle by prohibiting the use of multiple inheritance or in some way providing resolution of the conflict.

Dynamic Modelling and the Handling of Time

Increasing dissatisfaction with the inability of data models to handle time has led to more emphasis upon this feature. Dynamic elements refer to those aspects of the database which undergo changes: as we have seen this includes both the data held and the schema in which they reside. In short a data model must have an

underlying assumption about time and reality. Clifford and Warren (Clifford 1988 p.215) rightly state:

> Most conventional databases are static, representing a snapshot view of the world at a given moment in time: changes in the real world generally are reflected in the database by changes to its data, thereby "forgetting" as it were, the old data.

Underlying this "destructive updating", as it has been called, we find the metaphysical assumptions of a timeless and unchanging Platonic reality, a world entirely relevant to many fields of academic endeavour such as mathematics. If we counterpose this 'world view' with one that suggests that existence provides a key notion for understanding what we choose to call reality, then we may begin to consider every object as having a 'lifespan'. This quintessential idea of existence pervades all the objects we might include in a semantic schema.

The perniciousness of 'destructive updating' reveals itself in high focus in the field of the law. So often a piece of legislation has the effect of altering or reforming legislation passed previously. However these reforms rarely have the effect of removing retrospectively the rights (or duties) set out before. In paying tax on capital gains, one calculates the amounts chargeable to tax for particular years in the past according to the regulations prevailing in those years. A database system which were to update destructively the basis in law for performing such calculations would prove of little value to taxpayers and their advisers.

Several temporal query languages have been developed already but most, such as TQUEL (Snodgrass 1987) and TSQL (Navathe 1987) are just extensions of conventional query languages. In addition there are attempts to develop models for temporal databases, such as RUBIS (Rolland 1987). Clifford and Warren (1983) suggest an approach based upon the work of Richard Montague (1973). Their solution rests upon the incorporation of time into the database as though it were an individual itself. The first step is to incorporate a method for time-stamping the tuples ("facts") in the database. To do this we add a new attribute, STATE, to the relation schema. Each of the records receives a timestamp so that a time-series remains of snapshots which allow the user to obtain the values for any given data

item for any of the time intervals (say years), but we do not know the existences of any of the objects. In the case of John's salary (Clifford 1988 p.219) we know that in 1980 it amounted to $27,000 and that in 1981 it had risen to $30,000. However we cannot derive the date of the change, i.e. when the value of $27,000 for John's salary finished its existence and the new figure came into force. This applies equally to John's career profile: whilst we can track his movements from department to department and from manager to manager over the years, we still do not know at what time one state of affairs replaced another. We cannot present a series of snapshots snapped at arbitrary intervals (weeks, years etc) as a totally satisfactory method of "handling time".

Conclusions

This chapter has not attempted to perform an exhaustive review of all the literature on the subject of database semantics—that would be a pointless task, in that practically all of it remains firmly within the paradigm outlined at the outset. Our intention in this section was to spell out the elements of this paradigm and to show how they permeate the entire field of databases. Nor is there much comfort from the advanced semantic data models, which only build upon the same metaphysical ground, and suffer thereby from the same limitations. In the next chapter an alternative approach to modelling knowledge is introduced, one which has been attentive to the defects of the old paradigm and which suggests a different one. Embodied in the tools employed in this old paradigm, for example in set theory and relational theory, there is a theory of meaning which is implicit (since it is only rarely explicitly referred to in the literature) appropriate for the disciplines of physics and engineering. Instead of tackling the problem of knowledge representation with the preconceptions of data representation, this new approach uses those of the social sciences.

Chapter 4

NORMA: knowledge representation language

The LEGOL/NORMA project was started in 1973 at the London School of Economics[1] with the express aim of tackling some of the issues raised in the preceding two chapters. Three fundamental questions were set on the agenda for the project to address (Stamper 1989):

> 1. How do we describe a social system as an information system with the maximum formal precision compatible with the intrinsically informal nature of social interactions?
> 2. How do we deal analytically with the problems of semantics that must be solved by the systems analysts and designers with the user whenever a computer-based system is developed?
> 3. How can we improve the methodologies for analysing and specifying business requirements before the software engineering task is undertaken?

This agenda led to a series of languages (LEGOL 1, 2.0, 2.1, 2.2, NORMA) to represent norms and norm systems, after having studied systems of legal, social and business norms. What became clear to the researchers was the inadequacy of formalisms based upon classical logics: predicate logic, propositional logic, deontic logic and so on, for analysing and representing systems of norms (Jacob 1985 and Stamper 1985c). Classical logics serve those domains well where there is already a good deal of agreement about what constitutes the nature of reality. In fields such as law, business and the social sciences, an independent reality cannot be assumed (Cook 1981, Crooks 1981). Indeed much of the work in these fields is concerned with determining the individuality and identity of the various legal, social and business entities, and with articulating and comparing the different 'world views', perhaps to obtain a consensus around one in particular. For classical logics,

[1] Since 1988 the project has been based at the University of Twente, Enschede, The Netherlands

these problems have already been resolved. They begin where the semantic problems have been settled.

Whilst such a departure from the usual axioms may be particularly difficult to accomplish for scientists and mathematicians, brought up on a diet of platonic principles and steeped in the values of objectivism, for those from other disciplines, law and the social science for example, this alternative paradigm is not so problematic. Since their work involves the comparison and analysis of differing customs, practices and interpretations, their readiness to accept a subjectivist stance is not surprising.

The language used in this research for specifying systems is a logic of norms and affordances, called NORMA (Stamper 1988b). It differs fundamentally from the formalisms reviewed in the preceding chapters in one major respect: it does not subscribe to the prevailing objectivist paradigm. Its assumptions about the world are different:

> 'NORMA is based upon two simple philosophical assumptions:
> there is no knowledge without a knower, and
> his knowledge depends upon what he does.
>
> Perhaps more radically but more simply, this position may be stated:
> there is no reality without an agent, and
> the agent constructs his reality through his actions' (Stamper 1988b p.75).

In this way a place is being given to the knowing agent, and furthermore the object world is seen as a world of action and not of being. The world does not exist for itself but is a reality constructed by knowing agents whose actions define this world. Such constructs are radically different from those that underpin most of science and mathematics, and have been developed over years in the course of the work of the LEGOL/NORMA project.

As a direct result these premises provide a firm platform from which to develop a formalism designed for the purpose. From a root and branch subjectivist epistemology, the premises direct us to a syntax for a language suited to the task of representing knowledge for business and social affairs. Thus instead of constructing a formalism for the specification of behaviour and the representation

of knowledge which takes for granted a ready-made world which is the same for all, Stamper has begun to build upon the basis of a subjectivist platform. And the syntax reflects that view. The well-formed formula in NORMA always has the structure of

AGENTbehavior or AGENTaction

and the effect of this is to demand from the person writing the representation that he specify who it is who is responsible for the knowledge. In place of an absolute truth notion, vital for classical logic, there is a notion of *responsibility*. NORMA requires that there be a subject for every action or behaviour.

A second effect is equally instructive. Each piece of knowledge reported in the logic refers to actions or behaviour by the knowing and responsible agent in the here-and-now. The past or future worlds, or those distant in space, must be explained in terms of semiological constructs which serve to bind the here-and-now to these other realities. In a sense this requirement necessitates the use of semiotics in understanding organised communication and it is here where the theoretical contribution of Morris (1955), for example, is most felt.

The Agent-in-his-environment

The world of a knowing agent is by definition complex, dynamic and interactive. The agent: a person, a team, a company or a whole jurisdiction, acts in and is acted upon by the environment. In this dialectic of flux, to be able to communicate agents must use invariants, so that in performing any action the familiarity with what is biologically and socially significant to those who share that reality permits predictable and stable behaviour. These invariants are informally established and then ultimately, where necessary, constructed by the law. We can see how these invariants persist, when analysed at a high level of abstraction, so that the notion of a 'chair' viewed over centuries concerns the support for a person who sits, and does not involve the number of legs, the material employed, or whether there are armrests or not. This concept of behavioural invariance provides one of the central cores of the theory behind NORMA. Agents in any environment have a number

of these invariant behaviours: ways of behaving or acting. For a single agent these are referred to as *affordances*, whereas for a group of agents the invariant behaviour is a *norm*.

In addition to NORMA is the language LEGOL (Stamper et al. 1982). Whereas NORMA is used for knowledge representation, LEGOL is used as a manipulation language. Its main operators are time based. When forming expressions to describe a fragment of some reality, we can combine affordances by the operators *while*, *orwhile*, *whilenot* and *whenever*. Notice that there is no negation operator, for the philosophical basis is a world of action; a person acts and cannot "un"act. The concept of negating can only be handled through the intentions behind the behaviour[2]. Given any affordance then others are presupposed, particularly the ability to perform the action and the capacity to begin and end its realisation. Using the special affordance of partition the agent can begin to explore notions of individuation: picking out one individual from a group of them. From these structures by using metonymy and metaphor[3], signs can be evolved. By using one affordance to stand for a realisation sophisticated concepts of individuation, of time and of space can emerge.

The agent-in-his-environment has experience of a limited range of behaviour which may be treated as invariants. These invariants could be 'feelings, activities, postures, relationships and even the objects in his world. They depend for their existence upon the combination of his own structure and that of his environment' (Stamper 1988 p.75). So an agent *A* could realise some invariant *x*, that is, in the here-and-now recognise the existence of an instance of *x*. We would write

Ax eg. John water (John experiences water)

to represent a *realisation*, that is, in the world of the agent A, A is experiencing x. Having acquired the ability to find and recognise x, the ability remains with A

[2] you may act now with the intention of negating the effects of past or possible future actions

[3] Metonymy refers to a change of name. We often call things instead of by their name by something connected with them: eg. the crown for royalty, the mitre for the office of bishop, red tape for the routine of office. In these cases the substituted word is a symbol. Another type of metonymy is using the instrument for the agent: eg. the pen is mightier that the sword, ie. writers have more influence than soldiers. A metaphor is an implied comparison, as opposed to the explicit comparison of the simile: his answer cut her to the bone, ie. the comparison is with the effect of the knife-cut. The importance for information systems of these two parts of speech is their contribution to our understanding of how one thing may stand for another: how semiological affordances are derived.

as an underlying realisation, even when there is no x. A person who has learnt to swim retains the ability to swim even when there is no suitable water. In NORMA one would say that the agent-in-environment has the *affordance* of x, or A can x, or:

Ax* eg. John water *ability* (John can recognise water)

Realising an invariant must be the responsibility of an agent who has the authority to determine whether it exists or not. In the simplest of cases this is when the agent uses his judgment to decide: a pasta cook deciding when the spaghetti is cooked *al dente* for instance. In the less simple case the authority may be given to a number of individuals and groups in a complex norm: as when a company is deciding to relocate its head office from London to some provincial spot. In either case we know that every affordance must have an authority as a component. This is shown as

Ax@ eg. John water@*John* (John decides what is water—for him)

which is an integral part of the affordance.

Ontological dependency

The notion of including ontology in the understanding an analysis of social affairs is certainly not a new phenomenon. Philosophers from Hegel to Lukacs (1980), and more recently Bunge (1989) have employed it as a central concept in their world view. Many fewer have been the researchers in the field of information systems who have incorporated it in their methods, but the case for doing so is forcefully made by Lee (1984). To maintain coherence a database schema, a representation of knowledge must reflect the ontological dimension of existence—we must know what has to exist in order for other entities to exist. This notion of ontology is a linchpin for NORMA.

Once an agent is realising some behaviour, some invariant, he can then proceed to experience other kinds of behaviour. Once he has realised water he can

swim. The realisation of water opens up new behavioural possibilities such as y*: swimming, drinking, splashing, washing, drowning. And this is written as

Axy eg. John water swim (John, experiencing water, swims)

The behaviour *y* cannot be realised, that is exist, unless *x* is realised also. We refer to *x* as the ontological antecedent of *y*, and this may be seen as a consistency constraint whereby the period of existence of *y* is circumscribed by the existence of *x*. Every realisation achieved by an agent has a period of existence delimited by a start and a finish, shown as

Ax+ and Ax- eg. John water start and John water finish
(John starts and finishes experiencing water)

These existence constraints form a powerful way of enforcing consistency on the resulting specification.

Parts

Instead of assuming that the world is composed of ready-made individuals (which must be atomic for the relational database model), NORMA supports the further partitioning of any affordance. A part may be an agent as part of a larger complex agent, such as a committee of the House of Commons, or it may simply be a component, as with a wheel of a bicycle, or a part of a body such as a leg. In addition, we can add that the part/whole relationship is also an ontological relationship: a part cannot exist without the whole. We may recall from the previous discussion about atomic data in the relational model how useful it is to be able to distinguish elements that arise out of others. They should be recognised as parts of their ontological antecedents, but there may be a temptation to assert that parts can exist independently of the whole, as when a wheel is detached from its bicycle. The part however is conceived as a functional element within the whole and outside of the bicycle the wheel is not capable of functioning as it does normally. It has to be occupying the role prescribed for it in order to work as normal. Parts may be seen as role-components and the particular element which

fills the role may change. A particular wheel may be capable of filling other roles: on a wheelbarrow for instance. The part is shown in the syntax (using the '.' to represent 'part of') as

Ax.y eg. John orange slice

and *y* is a part of and dependent upon *x* for its existence, and just as for ontological dependency the same time constraints apply.

Joint realisations

Agents will be capable of performing various actions simultaneously and we can represent this by using the *while* operator. So doing *x* while doing *y* is symbolised as

A(x,y) eg. John reading *while* sitting

and these are two behaviours which are coterminous. Alternatively our agent may be indifferent to either, and we can conflate the two behaviours

A(x:y) eg. John reading *orwhile* sitting

and lastly the agent may be able to recognise the behaviour that maintains the existence of *x* while *y* does not exist, and this is shown as

A(x;y) eg. John reading *while not* sitting

Each of these operators is evidently dyadic. This is because the operators are used to express conjunction, disjunction and restriction of patterns of behaviour. There is no monadic negation operator which can be used to refute the truth of something, because NORMA is used to express patterns of behaviour and action and not propositions which may be negated.

A restriction (the *while* operator) has special importance, for the realisation of two affordances simultaneously can provide the agent with behaviours that would not be possible otherwise. This is a case of joint ontological antecedents *x* and *y* for an affordance *z*, shown as

A(x,y)z eg. John cup *while* water drinks

where drinking in this case requires the prior existence of both the cup and water. In NORMA only two antecedents are allowed and experience has shown[4] that there is no need for more.

Related affordances

Once an agent can recognise the invariant *x*, he may also learn to recognise two related patterns of behaviour: those of the *beginning* and the *ending* of x. These affordances are expressed as:

Ax< and Ax > eg. John flu beginning and John flu ending

These structures permit us to reflect the intentional behaviour of an agent. We are able to relate other behaviour to the beginnings and endings. If John is able to recognise the symptoms of infection before it takes hold then maybe he can take steps to prevent it growing. This preventative behaviour, perhaps taking some antibiotics, really only has meaning in the context of such recognition. Notice that beginning and ending are not the same as start and finish, which are only known after the event.

Signs are affordances that stand for realisations, and provide other derived affordances. If our agents wish to overcome the limitations of time and distance, then a mechanism is needed which can transcend the here-and-now. When an agent is able to carry forward memories from the past to the present, this is similar to a

[4] In LEGOL 2.0 more than two antecedents were allowed but this was found to be unnecessary in later versions.

semiological ability. Linguistic affordances (or sign types) can be used to bind together events at different times.

Semiological affordances

Using signs enables us to use the notion of time. We need one to achieve the other. Whereas classical logics assume the existence of time as part of the objective reality, NORMA permits only the representation of the here-and-now. All other reality, whether past, future, distant or just possible, has to be constructed from parts of the agent's present reality. By using signs to stand for realisations, agents can overcome these limitations. For NORMA there are two kinds of signs: sign tokens and sign types. A realised instance of a sign is a sign token, such as a particular letter of application, whereas the pattern of the tokens are types and are realised as abilities to make or interpret the token. In general for information systems analysis we are interested in sign types, the tokens are of interest at the empirics and engineering level. We are concerned with the meaning of the signs. The term:

A"Ax" eg. John "John hungry"

implies that John realises a sign type that means John is hungry. John may wish to use this sign type to communicate about himself. If we wish to we may analyse in detail the method of communicating: speech, writing or body language, but

A"Ax"asserts eg. John "John hungry" asserts
(John asserts that he is hungry)

This can also be handled by use of the mood for propositional attitudes, dealt with below. We can also use a notation that captures the idea of 'meaning' in the sense of 'semantic value'. Given an affordance, it may be used as a sign-type, so that it can be regarded as the equivalent of some other sign-type which we represent as a function of its meaning:("[affordance]" -> "realisation")

where we call the realisation the 'meaning' of the affordance. The most common kind of affordance for which we are likely to introduce such 'semantic norms' will have a literal-type as its affordance. A sign "John is hungry" may be used to refer to the realisation of John when he is hungry. Another important use for this will be found when the affordance is a rule (ie: a sign representing a norm), and the realisation is an interpretation. The semantic norm, in this case, is what we usually call an 'interpretation'. "The Fifth Amendment" is the name of a rule in the United States of America whose interpretation permits a person to remain silent when otherwise he may incriminate himself.

Time

As has been stated above, time depends upon our ability to use signs. NORMA assumes that we have access to nothing other than the here-and-now, and therefore the start and finish of all realisations is always either in the past or the future. Thus :

Ax+ and Ax- eg.John hungry start and John hungry finish

is the start and finish of the realisation *Ax* (John being hungry) and therefore are sign types. Sign types can coexist with what they stand for and can continue to exist when their referent has ceased. It is this property that permits the binding together of events taking place at different times.

> 'In the physical world, causal chains involve a sequence of here-and-now interactions of material objects. In the social world (eg: tax liabilities today for last year's income) semiological linkages are basic. Time is a key semiological construct' (Stamper 1988b p.79).

In addition to the signs Ax+ and Ax-, NORMA provides constructs for before and after the existence of a realisation:

Ax\ and Ax/ eg.before John hungry and after John hungry

John does not experience either directly and they can only be known through the use of signs. These extra constructs provide a range of expressive power which can support the writing of the norms of any type of system. We often wish to refer to the before and after when specifying organisational behaviour, and the language provides this power in its syntax.

Norms and mechanisms

As we have seen, single agents have affordances, or behavioural invariants, in any given context; complex agents and groups of agents have norms as their invariants. If we wish to describe the behaviour of a social group in terms of NORMA, we need to link together the various affordances to show how they interrelate. For a social group a norm is a kind of mechanism, a piece of behavioural repertoire which is constantly repeated. In the sense of an organisation the norms are in a way the knowledge of the organisation: how it deals with the situations it encounters.

The mechanisms relating one affordance to another are specified using the notion of x *whenever* or y *then* x:

A(x ← y) or A(y → x)	eg. John resting whenever sitting and John sitting then resting

which is similar to a logical implication, but the existence of the norm is not related to the existence of the elements that comprise it, as with the truth-functionality of an implication. Instead the norm has its own existence, its own ontological antecedents, its own authority, just as with any other affordance.

Knowing about the start and finish of the norm is useful to help to reconstruct past situations, when perhaps different norms applied, and so we have extra facts about any norm:

A(x ← y)+ and A(y → x)-	eg. John's (normal) sitting and resting behaviour may have given way to an inability to rest while sitting. The start and finish times delimit the period when the normal behaviour prevails.

One may view the norm in its physical existence as a kind of mechanism internal to the agent. Our concern in this work is generally with the mechanisms that control the behaviour of social agents (companies, learned societies, welfare bodies, educational authorities, and the use of the term 'norm' therefore is highly appropriate. Social norms can be fairly complicated as a glance at any piece of legislation will show, but so are physical mechanisms such as talking and dancing. In practice the distinction between norm and affordance is not as great as might as first appear.

Determiners, measurement, individuality and identity

A very important additional notion for the specification of systems is that of determiners. These are the affordances of quantity and quality that permit us to compare one instance of a realisation with others. Determiners may be seen as a general form of measurement, in that they function to partition instances of realisations along various criteria. The two basic forms of measurement employed are *fundamental* and *pointer* measurement. With fundamental measurement two elements are involved: a system of norms for performing the measurements, involving comparisons with a standard measure, and the encoding of the results into a system of labels, often numerically interpreted algebra. Whereas for pointer measurement there is solely a mechanism which will assign numerical values to the realisation. Weight and height are examples of the fundamental measurements, whereas intelligence quotients and prioritisation are typical of the latter.

Most important of all are determiners of individuality, discreteness and identity. So often when writing norms we need to refer to individuals in a variety of different contexts and we want to maintain the reference to those individuals selected from one context to another. When recording facts about particular individuals, we use the notion of individuality which presupposes that we are able to recognise the uniqueness of each discrete individual. This is essential when we want to represent examples of ontological relationships where the antecedents are individuals. In a marriage, for instance, the two antecedents will be individual

persons. This individuality must be represented, and in NORMA it is achieved by use of the hash sign (#). Symbolically:

Ax#y eg. John cup weight (John can distinguish cups by weight)

indicates that x has a determinant y. Because such frequent use is made of identity, it is symbolised simply by the hash sign. The expression *Ax#* implies that an agent can realise individuals of the genus *x*. Similarly

A person# eg.John person#
(John can recognise individual persons)

says that the agent can identify persons. Weight and height however do not discriminate individuals—there will be many persons who have a given height or weight. The weight of 82 kgs would discriminate from the totality of actual persons the subset who weigh that amount.

Determiners and measurements are treated in a uniform way. Both afford values to joint antecedents: the standard and what is being determined, according to a system of norms, such as a measuring procedure. The validity of the values rests on the actual measuring process conforming with the rule. At the highest level of abstraction there is:

affordance#determiner eg. person#weight

where the determiner gives the name of the measuring procedure: height, weight, length, density and so on. In NORMA time constraints apply to manipulations of determiners. The expression for adding together the weight of two persons would be evaluated by checking that the two coexisted. NORMA would not add together the weights of Newton and Plato, for instance, since their existence periods do not overlap. What could be done is to add together the values of their weights. Another use of determiner is:

affordance# eg.person# (individuation: a determining mechanism)

where the determiner is an identity.

For affordances that require individuals as antecedents NORMA expresses them in this way:

A(person#1, person#2)marriage ie. two persons needed as antecedents

and the two persons are discrete individuals. Here *A*, the knowing agent would be an entity capable of recognising a marriage, such as a state. Notice here that one to one marriage relationships are implicit in this example. In ontological structures of this nature we can use role names:

A (person#husband, person#wife) marriage

and the role names indicate the discrete members of the relationship. Role names are useful during the process of performing semantic analysis because they draw our attention to the relationships from which they are derived.

Generic/specific relationships

From our review of the semantic data models in Chapter 3, it is evident that the ability within a semantic model to exploit the economy of expression from hierarchical groupings and inheritance of properties is valued. In NORMA this is accomplished by use of the generic/specific structure, which is specified by a norm:

A ((a:b:c:d:e) → f) eg. John (apple:orange:pear:plum:grape) → fruit

Since this is a norm it has an authority, a start and a finish. Should there be different interpretations, perhaps different schools of botanical thought, then this can be easily represented without ambiguity. Changes in definition can be reflected in the time values for the starts and finishes for each norm. At a more fundamental

level, the metaphysics of common structures can be defined for the generic affordance and then implied through the norm for all the specifics indicated.

A marvellous economy of expression is possible here. All the determiners that single out physical objects from other abstract affordances can be introduced at the generic level. Having declared that a physical object has determiners of mass, volume, surface area, height, colour, hardness and so forth, every different kind of specific physical object can inherit these characteristics by using the simple norm:

A ((person, apple, bridge) -> physical_object)

In this way the qualities of various affordances can be specified simply without prejudicing the possibility of changing them in the future.

Representation of data in the NORMA surrogate tables

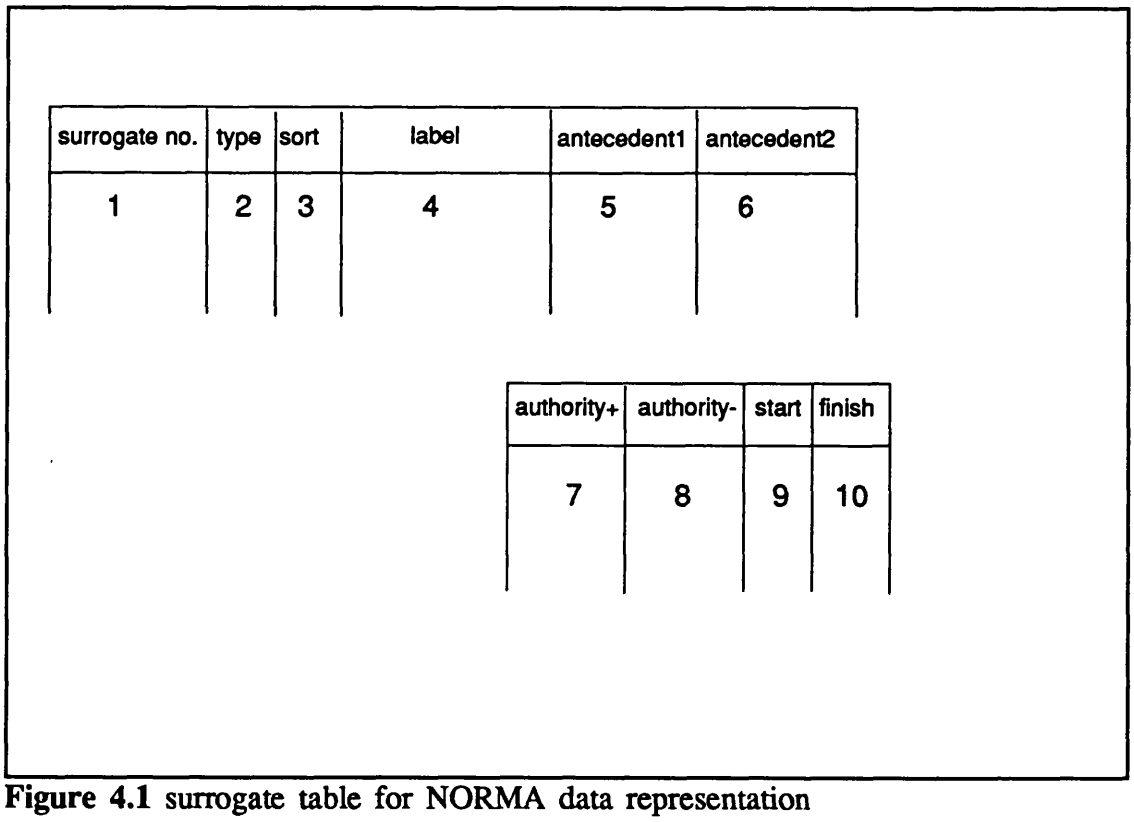


Figure 4.1 surrogate table for NORMA data representation

The radically different nature of the theory of meaning employed in NORMA is proclaimed in the idiosyncrasy of its representation of data. Its metaphysical assumptions apply to everything dealt with on the level of realised or potential action or behaviour. Every single realisation has common features: a start and finish; some authority which determines it, whether a judgment of a person or a complex norm; an ontological antecedent. Therefore in the database, or table of surrogates, a list of uniform elements may be used to represent any realisation. The same structure of table supports the recording of all data whether affordances or norms[5]. In the table in Figure 4.1, only the label or name of the realisation is a literal. Each tuple is a surrogate for some realisation and is given a surrogate number, or internal code, held in column 1. This internal code is then used in references to that surrogate from elsewhere in the table.

Column 2 holds the value for the type of affordance: whether a universal, a particular, determiner, determinant (the particular value for a determiner), role or norm. These are represented by **u** for universal, **p** for particular, **dr** for determiner and **dt** for determinant. This information provides the basis for semantic consistency checks; given we know the type of affordance, we can ensure that the affordances that it possesses conform with what is permitted. For instance particulars must have particulars as their antecedents. This matter touches on the meta-level of the schema and is referred to in Chapters 8 and 10.

Column 3 is for the sort of affordance: for instance, John is a sort of person. The surrogate number for 'person' should be placed in this slot in the surrogate for John.

Column 4 contains the name or label of the person, if known. This is often the identifier, such as the name John, in the outside world. In the surrogate table, the surrogate number is used as the identifier within the machine. Given that the literal is not used in internal operations, changes in name cause no consistency problems and no destructive update. The new value for the name can be recorded in a new tuple without deleting the previous. Different labels for the same affordance in different languages could easily be made available. Notice also that

[5] for a full illustration of this see the case data in Appendix A for the CRIS case.

the label is not needed to be able to record important details about the realisation. For the purposes of internal manipulation the surrogate number suffices.

Column 5 is for the surrogate number of the antecedent. In the case of John's hunger, John will be the antecedent of 'hungry' and the surrogate number given for John will be entered.

Column 6 provides a slot for the second antecedent surrogate number. If John has a membership of a club, then the first antecedent would be John and the second would be the particular club.

Column 7 requires the surrogate number for the authority which determines the start of the realisation. Where John joins a club this might be the membership committee.

Column 8 adds the surrogate number of the authority which determines the finish of the realisation. Usually this will be the same as for Column 7, but not always.

Columns 9 and 10 are for the time/date values marking the starts and finishes. Any surrogate that has a start value but no finish value is still currently in existence. When the finish value is entered then the realisation no longer exists, and any dependents it may have must cease also. If John dies, his membership at the club ceases and so does his peckishness!

A further extension is in progress (Liu 1990) adding Column 11 for mood_start and Column 12 for mood_finish. Here a range of propositional attitudes relating to each realisation may be recorded: assertion, hypothesis, forecast, question, permission, prohibition, obligation, retraction, prescription. If John is predicting that he will be hungry then this may be recorded, in much the same fashion as the assertion that he is so, and the mood_start column would read A for assertion. In the surrogate table in Figure 4.2 the figures for the heights of the four people (surrogates 18-21) have been entered in a hypothetical mood for the mood_start. They are simply values which have been hypothesised and are not intended as fact. The agent responsible in each case is the person himself. Mistakes in data entry may be recognised as such by declaring them retracted once the error has been noticed, and *R* for retraction would be entered in the mood_finish column. Here too is an element of consistency and integrity checking. A genuine error can be

Col 1 surrogate	Col 2 type	Col 3 sort	Col 4 label	Col 5 ant1	Col 6 ant2	Col 7 @+	Col 8 @-	Col 9 start	Col 10 finish	Col 11 mood+	Col 12 mood-
1	u	0	SOCIETY	0	0						
2	u	0	person	1	0	3	3			A	
3	u	0	nation	1	0	2	2	16000000		A	
4	u	0	territory	1	0	2	2	16500000		A	
5	u	0	height	2	0	2	2	17000000		A	
6	dr	0	citizenship	2	1	2	2			A	
7	u	0	possession	3	4	1	1			A	
8	u	2	Dalen, Jan v.	1	0	1	1	19400315	19851112	A	
9	p	2	Luning, Pim	1	0	1	1	19411120		A	
10	p	2	James, Peter	1	0	1	1	19501230	19900101	A	
11	p	2	Smith, Dick	1	0	1	1	19511225		A	
12	p	3	NL	1	0	1	1	6001212		A	
13	p	3	UK	1	0	1	1	6001212		A	
14	p	4	Netherlands	1	0	1	1			A	
15	p	4	Surinam	1	0	1	1			A	
16	p	4	England	1	0	1	1			A	
17	p	4	Wales	1	0	1	1			A	
18	p	5	1.87	8	0	8	8	19891220		H	
19	dt	5	1.80	9	0	9	9	19891220		H	
20	dt	5	1.77	10	0	10	10	19891220		H	
21	dt	5	1.78	11	0	11	11	19891220		H	
22	p	6	citizenship	12	8	12	12	19400315		A	
23	p	6	citizenship	12	9	12	12	19411230		A	
24	p	6	citizenship	13	10	13	13	19501230		A	

Figure 4.2 surrogate table example

declared as such, and the mistake is consigned to the limbo of retractions —but not destroyed. Analysis of errors can provide valuable information for the organisation.

No destructive updating

A very important by-product of the data representation is that it obviates the destructive update problem. No record is destroyed. When a realisation has ceased to exist its finish value is entered and the surrogate remains on record. Critics might reproach with the observation that any system built on this basis would soon run out of secondary storage. The riposte would be that the decision to take records off-line (nb. not destroy) is something that an organisation should shoulder in a pro-active manner, instead of allowing the technical limitations of computer systems to destroy important data. In fact evidence coming from the University of Qatar, where the administration system has been built on this NORMA data model, suggests that this can work to the advantage of the users. They are able to reconstruct the position as it stood at any time, say in regard to a person's

application, because the data model captures all the dynamics and conserves the records for use later.

The substantive business problem

This standard structure remains always in the background and provides a platform of formidable power from which to specify systems. All these structures: antecedents, authorities, existence constraints and so on, are automatically incorporated into any expression we write in NORMA. This structure is the model for the knowledge base expressed in NORMA, and in the foreground are the norms of the system that we write in LEGOL, which acts as knowledge manipulation language. Since the two languages have a common genesis there is massive expressive power in using the two together, yet great economy. The tight semantic control ensures that it is difficult to produce meaningless output when manipulating the knowledge base. Consistency and integrity are offered, not just syntactically but at the highest level—that of meaning and intention.

When specifying a system the semantic schema has to be produced using NORMA, and this is the main focus of attention for this work. Once that schema is in place, the business norms can be written which deal with how the affordances in the schema start and finish. These together amount to a specification, which can be animated and checked when implemented on an interpreter for the manipulation language. Concern with the message system may be suspended entirely for the language forces the analyst to home in on behaviour in the here-and-now. Building up a semantic schema enables the specification to demonstrate the precedence network of behaviours in the organisation. The schema, especially when portrayed in its graphical form, the ontology chart, allows one to know what behaviours are necessary to arrive at a particular realisation. We know what operations have to be performed to realise any behaviour. This is the manifestation of an operational theory of meaning, a theory of meaning far superior to those that underpin the formalisms reviewed in Chapters 1 and 2.

Graphical notation

To make the semantic schema more readily available and understandable, there is a form of graphical notation which expresses most of these structures. These basic symbols show the relationships between the affordances. Working from left to right, we have a time constraint which exercises extraordinary control over the specification. What is on the right can only exist if its antecedents to the left exist. If a nation goes out of existence, then the persons holding citizenship can no longer be its citizens. At each node the same structure of metaphysical categories heading the columns in the surrogate table applies. The ontology chart, or graphical version of the semantic schema, functions as powerful shorthand for specification in NORMA. Care must be taken not to confuse the ontology chart with the Data Flow Diagrams (DFDs) which are so popular as a specification technique. The ontology chart shows a map of existence dependent behaviour and does not concern the flow of messages and data. DFDs, on the other hand, map the flow of data in the organisation and effectively seek to present it as a message system.

The surrogate table may appear as a flat table not dissimilar to those found in the relational database systems. However there is a depth which is given to the

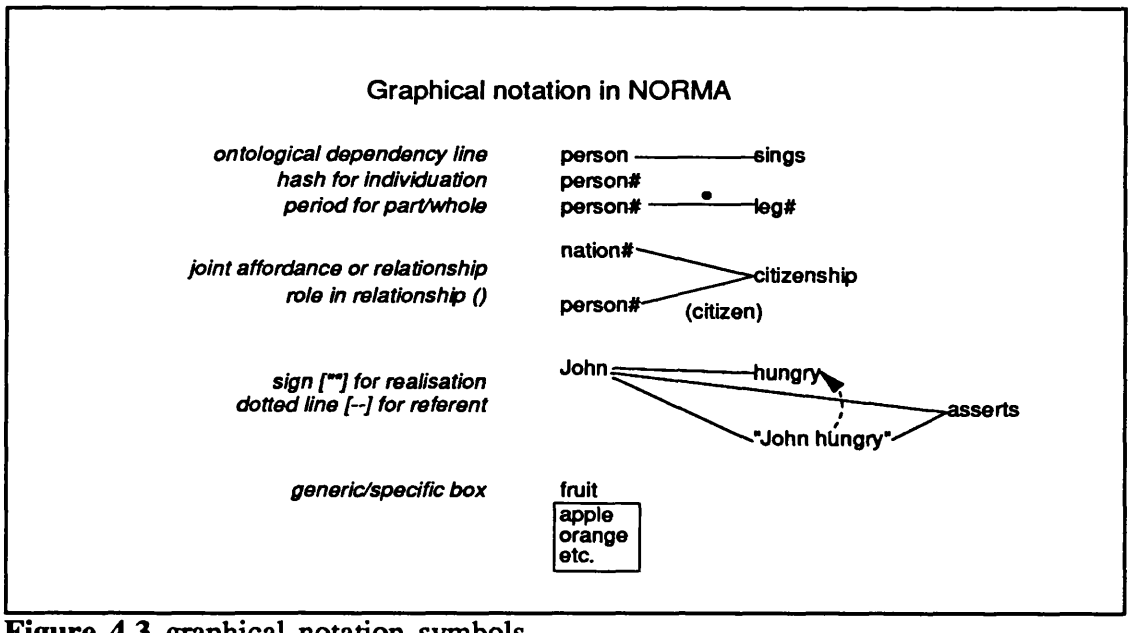


Figure 4.3 graphical notation symbols

representation by the ontological dimension. As we traverse the table we discover

the profound network of antecedence which indicates precisely what has to be realised in the world of responsible agents before any given affordance may be realised. Using the tool of NORMA when specifying a domain requires us to supply as many as possible of the cell entries, and then with the schema firmly in place we can begin to write the business norms.

NORMA and the applications

In the next three chapters of this work we set out three applications of semantic analysis, where NORMA has been applied to three different information systems problem domains. The Comparative Review of Information Systems Methodology (CRIS) case study was occasioned by the need to develop software to support the great number of conferences and meetings held by the International Federation of Information Systems (IFIP). Given IFIP's status as a large international organisation there were necessarily going to be elements of considerable complexity involved. The intricacy of the ontology chart in Appendix A bears testimony to this observation. For the Italian welfare organisation the question was one of developing a specific office automation system to support an existing, highly efficient, clerical and paper based system. In the school support system the matter concerned not the developing of a computer data system, but of unravelling difficult concepts in a difficult problem area.

Our concern here is to present these applications as very different in character in order to show how NORMA could be used to tackle problems of a distinct nature. In this sense what the language is being used for is the drawing of a conceptual map for each case. The conceptual terrain of each problem is examined in an exhaustive and thorough manner and with the ontology charts and surrogate tables (often shortened for simplicity) we are able to elicit knowledge in a consistent way.

We can compare the applications by a variety of criteria, and just three are indicated:

Formality: The school support application is the most informal of the three and was regulated by few written rules and much professional practice. The Italian welfare office, on the other hand, was bureaucratic in the extreme. In the CRIS application

the picture was mixed: the systems for handling conferences had been mostly informal and the intention was to formalise much of it to obtain benefits from a computer based system.

Strategic/Tactical: The school support application was largely strategic in nature, given that the professionals had a very free hand about how they organised themselves and what use they made of their resources. On the other hand the Italian office system was at a tactical level, concerned with fielding better the administrative trivia of matters whose substance lay with more august bodies to decide. The CRIS application might be said to lay somewhere between these two extremes.

Level of Articulation: The Italian office application was an example of a problem which was well articulated. The persons involved knew the system, as a system, intimately. Overriding bureaucratic requirements had ensured that the problem topology was reasonably transparent. In the school support application there was less evidence of a 'system' as such. Instead the professionals concerned seemed to view what they were responsible for as primary, and were not always aware of a way of looking at their combined activities as a system.

Therefore, in the following three chapters we indicate how NORMA has been applied to three applications. Each one is rather different from the others, and yet NORMA proved to be entirely appropriate for the task. The superficial dissimilarities of the presentation belie the underlying common thread; in each application the same full range of syntax for the language was directed at the case. Only with the development of a method for applying the syntax will the results from different applications resemble one another, and this is the objective addressed in Chapter 8.

Chapter 5
The Schools Support Unit

The system under investigation in this chapter deals with disruptive and behavioural problems in the London Borough of Barking and Dagenham (shortened here to Barking). In contrast to the typical data processing example that is often used to illustrate specification methods, we deal in this case with high level strategic issues about the use of scarce teaching and financial resources in a hard pressed authority. This case is presented expressly to show that NORMA may be applied to matters well beyond the usual boundaries of information systems analysis and design methods. Of particular interest is the informality which, with only a slight dusting of formal rules, characterises the domain.

The Barking education authority has, like most educational authorities, an educational psychology service, here known as the Schools Psychological Service (SPS), and we are interested in the work of part of that structure: the Schools Support Unit (SSU). There are some interesting questions about what constitutes a behavioural problem and how an identification of the problem at the level of the school proceeds to the acceptance as a case by the Service. Merely referring a problem to the Service does not of itself ensure this acceptance, only the consideration of the question. Hence we find a rich vein of issues concerning communication acts, as well as individuation and identification of phenomena, in this study. It is important to underline that the established practices of the Service have not been formalised and exist as conventions or norms which the staff have developed over a relatively short time. While the number of staff involved remains quite small, say a dozen in all, and the turnover is low, there is no reason why a complete formal system need be developed. Analysing the information requirements in this case meant having good access to staff members who know the procedures of working sufficiently well to be able to answer the questions we were prompted to ask when applying the language NORMA.

Setting the scene

To set the scene we begin by outlining the steps involved in this process, each step requiring a decision to be made by a responsible agent in the domain. Again we stress that this taxonomic presentation belies the much less formal day to day *modus operandi* of the SPS and the SSU. Only after relentlessly pursuing the underlying logic of the workings of these two bodies were we able to devise this schedule.

1. What is a problem of behaviour?

The first step in the chain is where the referring agency, usually a school, identifies a behavioural problem in a student. Various semantic problems need defining and resolving, and we analyse these matters below. Particularly relevant to our approach is the vexing question of how different institutions take different positions upon what constitutes unacceptable behaviour. What is considered acceptable behaviour in one school may be beyond the pale in another: not completing a homework assignment in Art may be a mortal sin in St. Angela's Convent School but a mere peccadillo in Dagenham High!

2. How to invoke the help of the support services?

The act of identifying does not amount to informing the body responsible. The referring agency refers the problem to the Schools Psychological Service (SPS) and this communication act does not bind the SPS to accept the case, merely to consider it. There will be questions concerning the nature of the problem and whether it is one that lies within the jurisdiction of the SPS. Important also is the referring to the SPS and not the Schools Support Unit (SSU), for the SPS is the body with overall responsibility and in fact a psychologist must be made responsible for each case. Only then may the SSU be involved if necessary.

3. Whether to accept the case?

The SPS decides to accept, or reject, the case, usually involving the SSU in the decision. At this point the SPS accepts responsibility for the attempt at resolving the problem and signals its intention to increase or decrease the relevant behaviours.

4. What level of resources to throw at the problem?

Unless the responsible psychologist requires only the allocation of a remedial reading teacher, in which case the SSU will not be involved, the SSU and the SPS decide a strategy together. In general however, the Head of the SSU will be notified and be requested to participate.

5. What will be the nature of the control programme?

The SSU develops a behavioural management programme suitable for the particular problem on the basis of the information gathered and of the judgment of the professionals participating.

6. How to get the programme implemented?

After developing an appropriate programme the SSU has the delicate task of negotiating with schools, parents, students and other agencies to ensure its implementation.

7. How to fine-tune the programme?

After implementation of the programme, monitoring produces the feedback necessary to facilitate any adjustments that may be required.

8. When to withdraw support?

After a period the SSU will reach a point where it feels that it can no longer improve the behaviours either because the required improvement has been realised, or because other types of professional help may be needed.

9. How to get approval for the closure decision?

The decision to withdraw support and close the case rests with the SPS, that is with the psychologist originally allocated the case, and ultimately with the Principal Psychologist.

In effect the semantic schema for this domain must provide generic answers to these questions, and in particular point to the decision makers responsible in each case.

Organisational structure and responsible agents

We put as our root agent the particular state of the United Kingdom. This is because the affordance of local education authority (LEA) is peculiar to the UK. We cannot expect other countries necessarily to have the same administrative structures.

The UK, therefore, has an education authority as an affordance, and Barking and Dagenham is a particular realisation of an LEA, set up after the reorganisation of the London Boroughs in 1964 (see also Appendix D):

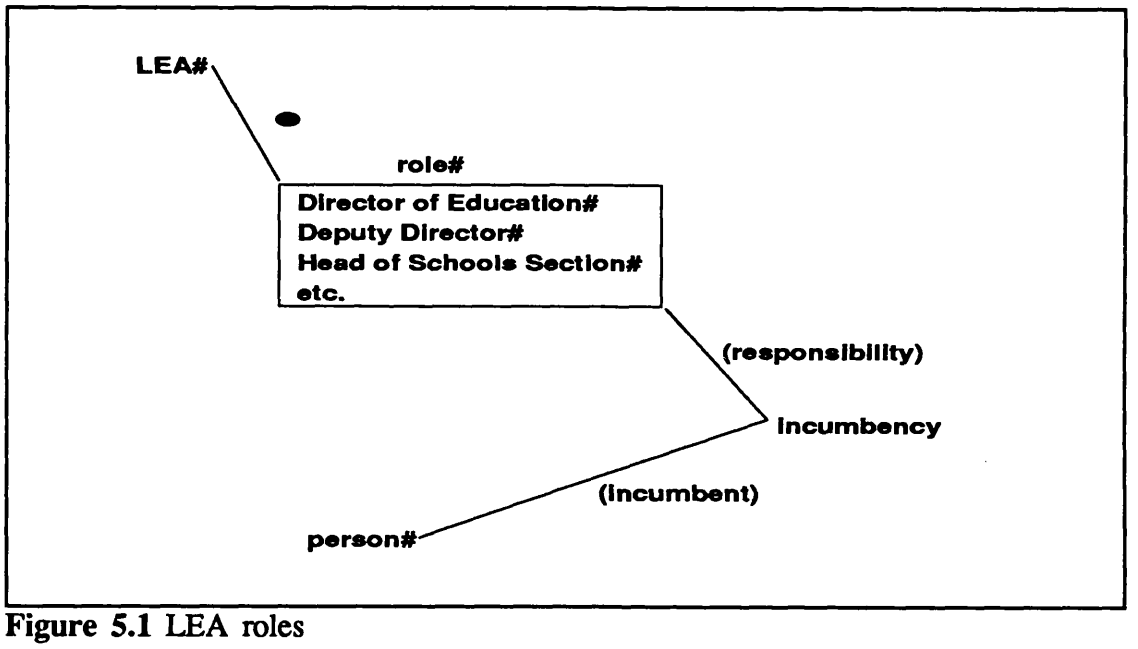


Figure 5.1 LEA roles

Affordance	**Antecedent1**	**Antecedent2**
Barking and Dagenham	United Kingdom	

The parts of the educational authority consists of subordinate organisational structures, which in turn comprise further layers of subordinate bodies. The building bricks of these constituent elements are offices, roles, parts of the organisational structure, which are filled by incumbents appointed to these posts for determinate periods. The Education Authority operates by means of the offices such as Chief Education Officer, Deputy Chief Education Officer, Chief of Schools Section and so on. Part of the Education Authority of Barking, another particular,

is the Schools Psychological Service. We would prefer to use a generic title to this affordance, reserving the name 'SPS' solely as the identifier for the particular structure in Barking. However different education authorities discharge their duties in this area in a different manner, and with different organisations, thus we have to refer to the SPS as a particular realisation of Barking education authority.

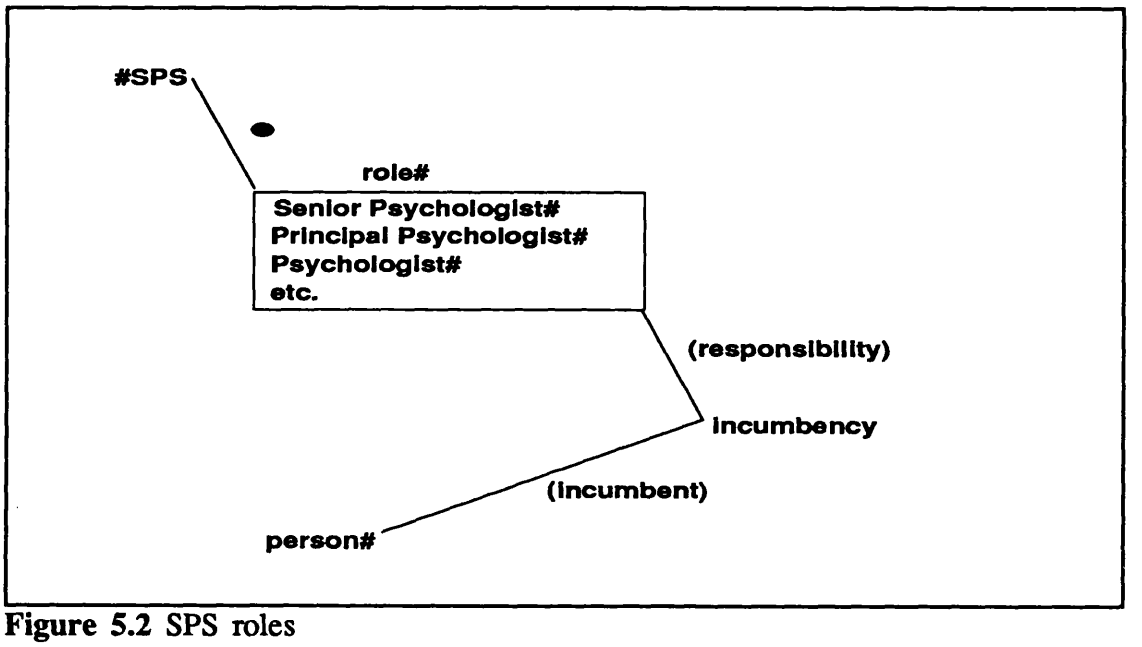


Figure 5.2 SPS roles

The SPS is part of the Barking authority and is comprised of a number of offices: Senior Psychologist, Principal Psychologist, Psychologist, and Secretary, which we present specifics of 'role'. At a level of jurisdiction below that of the SPS we have the SSU which is in its turn part of the SPS and comprises the following posts: Head of Unit, Senior Psychologist attached to SSU, Support Teacher and Secretary. The authority in the records for all these offices will in each case be the Barking education authority itself, and the contracts issued will cover the performance required of the incumbent, although the post holders will be engaged in a whole sphere of activities whose jurisdiction is less formalised. For example a teacher is responsible for teaching the classes he has been allocated by the Head Teacher, but he is not responsible for lending a hand to supervise lunch-time activities, such as chess clubs. It may be that informal norms are so strong in the school that he feels obliged to undertake this duty regardless of the contractual position.

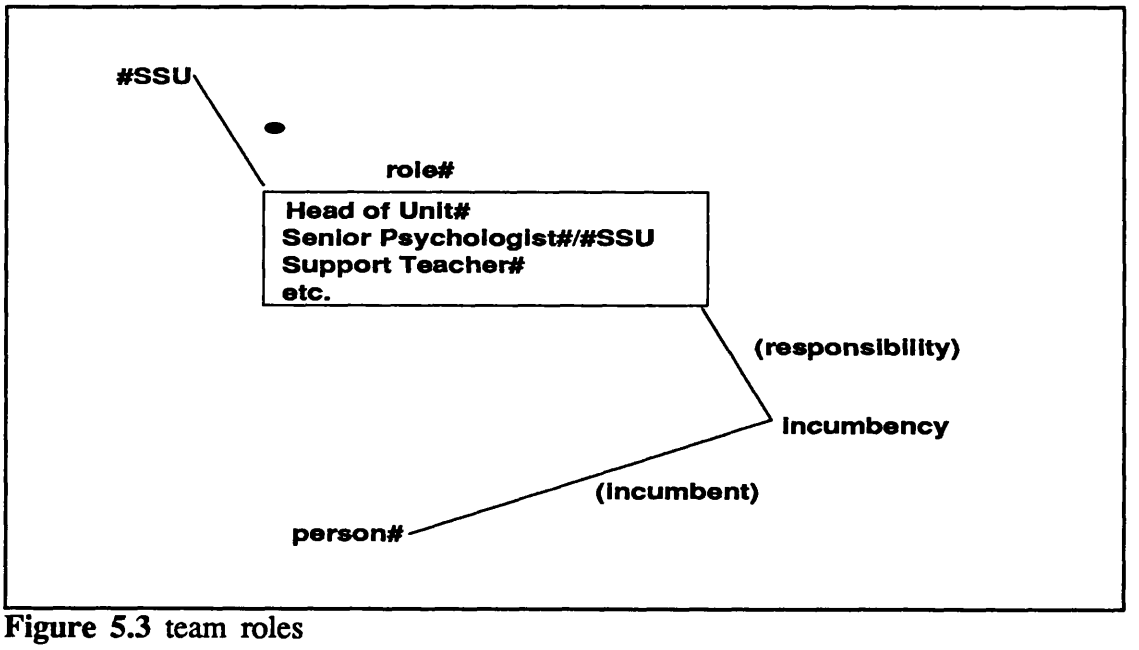


Figure 5.3 team roles

Another example of the preeminence of informality is the team structure which the SPS has evolved to deal with the handling of problems referred to it. Teams are responsible for an 'area', another construct of the SPS, which has no currency outside its jurisdiction. An 'area' is a notional concept which only loosely refers to geography and more closely reflects the catchment patterns of the various schools. 'Area' then is an affordance of the SPS whilst by contrast 'team' is part of the SPS, a functional and indispensable element in its operation. The team is a basic unit for the SPS in handling its cases and is comprised of various roles which make up the whole (the team) and include Psychologist(s), Remedial Reading Teacher, School Support Teacher and Secretary. In September 1985 the fifth team had two psychologists—the senior ones—to allow them a reduced caseload so as to discharge their other duties. The present team organisation dates from September 1983 when some organisational changes were introduced by the then Principal Psychologist. The composition of the teams is prescribed by a norm or rule which effectively provides the criteria in the authority field of the (NORMA) record for that team. In September 1985 there were five teams, one responsible for each area, and so the record for the universal 'responsible for' would be as follows:

Affordance	**Antecedent1**	**Antecedent2**
responsible for	team#	area#

For the purpose of everyday organisation, Barking schools are deemed by the SPS to be 'in' an area. But what about the schools? Do they depend upon the education authority or are they ontological dependent upon the state. The 1944 Education Act vests the authority for opening and closing schools in the hands of the Department of Education and Science, although unlike many other countries, in the United Kingdom the local education authorities take on much of the responsibilities that would be, if say on the Continent, held by the Ministry of Education, and indeed the Head Teacher has had significant powers over what is taught. Schools then are not dependent upon the educational authorities in which they are found, and for example the demise of the Inner London Education Authority will not imply the finish of the schools that it managed for forty or so years. 'School' and 'LEA' are ontologically independent insofar as instances of either do not require the existence of each other in order to exist themselves. Instead we have portrayed the relationship between them as one of 'maintains' {maintains (LEA, school)}, since the term derives directly from the usage that prevails in the domain. Schools which are not maintained by the local authority might be voluntary aided, as many Church of England schools are, or independent, as say Summerhill School in Suffolk. In addition there will be a wide range of other institutions going by the name of 'school' —evening school, free school, summer school etc.— which will conform to the criteria set by the different authorities that see fit to recognise them as such.

For the universal 'school' in this domain we can specify:

Affordance	**Antecedent1**	**Antecedent2**
school	United Kingdom	-

whereas for a particular school, a realisation, we would enter the following.

Affordance	**Antecedent1**	**Antecedent2**
Erkenwald School	United Kingdom	-

The areas as we have seen have no such legal status, being the creation of the SPS for expediting its operation, and so area1 is a particular realisation of the SPS:

Affordance	**Antecedent1**	**Antecedent2**
area 1	SPS	

Allocating a school to an area lies in the powers of the SPS and the ultimate authority would be the Principal Psychologist:

Affordance	Antecedent1	Antecedent2
in	area	school
in	area 1	Erkenwald School

Notice here how the first entry is for the universal for a school in an area, whereas the second entry is for a particular instance of an actual school deemed to be in an

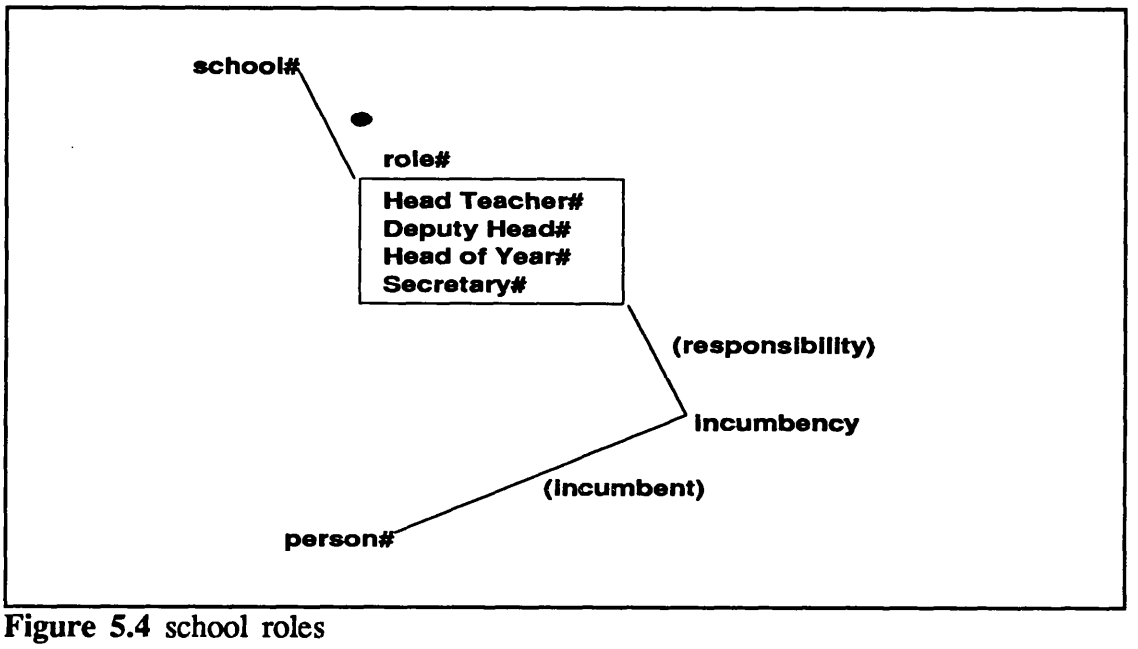


Figure 5.4 school roles

actual area. In this way we can place the various schools into areas, with a team responsible for the referrals from those schools. Hence in area 1 we found in 1985, alongside Erkenwald also Barking Abbey and Castle Secondary Schools, together with all their feeder primary schools.

The schools also have a structure of posts established by the education authority and these include roles such as: Head, Deputy Head, Senior Teacher, Head of Year, Assistant Teacher and so on. Each of these offices is filled by the education authority when it appoints persons to the posts. As a post is filled, an incumbency is realised and its existence starts:

Affordance	Antecedent1	Antecedent2
incumbency	role(school)	person
incumbency	Head (Parsloes Manor)	Peter Haydon

While the incumbents change from time to time, the office remains. However the office can also change when the incumbent remains the same. This often gives rise to contract disputes when the particular duties of a teacher are altered by the Head Teacher of a school and the member of staff disagrees, feeling that these were not the duties for which he/she was appointed. For the conflicting jurisdictions to be resolved between the education authority and the school level, the question may be referred to a higher jurisdiction, that of the courts.

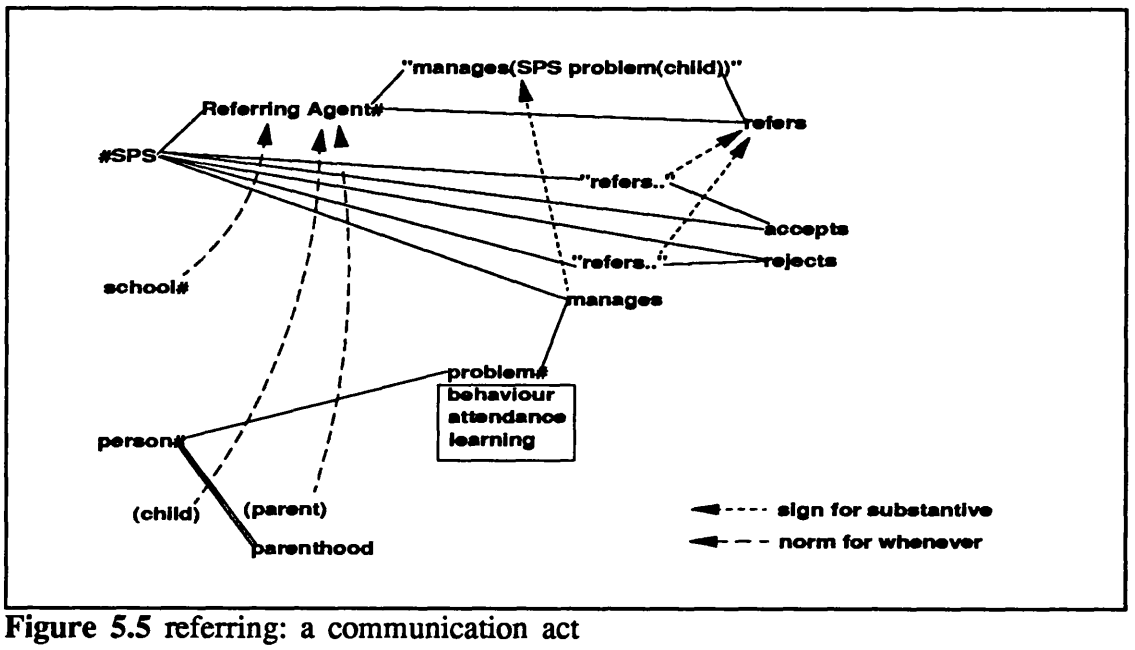


Figure 5.5 referring: a communication act

Despite the many times that 'role' is used there is no ambiguity in the NORMA formalism because the particularity of each realisation is guaranteed by the antecedents. For Peter Haydon we know that the particular role he is appointed to is that of Head in Parsloes Manor School, because this is required information as the antecedent of 'incumbency'. Requesting the authority that determines each occurrence ensures that the particularities of each realisation conform with the criteria in the authority for start or finish. If the role is redefined then the contractual position may have to be resolved —or else a visit to the courts is likely.

Another term that occurs often in the SPS world is that of 'referring agency'. This latter is another construct of the SPS and the Service adopts a norm which prescribes who or what is a referring agency. In so doing it effectively defines the world it wishes to operate in. Referring agencies may refer behaviour

problems to the teams, and while generally they will be schools or parent/guardians, this is not always so.

'Parent' is handled as a person in the relationship of 'parenthood' and filling the role of 'parent'. The authority for realising parenthood would be the legislation regulating the field of births, deaths and marriages. The chart shows a line from the role of parent to referring agency and the arrowhead indicates that this is a normative and not an ontological relationship.

The key affordance of 'referring agency' has Barking as its antecedent and the SPS as its authority. The responsibility for determining what shall constitute a referring agency in principle and in practice belongs to the SPS, acting on behalf of the whole authority in this respect. The SPS has created this universal to facilitate the way it wants to handle the behavioural problems in the Borough. We might present this as an excellent example of one of the fundamental tenets of NORMA: that the world is composed of agents who define the world in the way that they are prepared to take responsibility for. In addition to schools and parents as referring agencies, we find also Further Education Colleges, Youth Training Schemes, Child and Family Centres and Officers of the Education Authority. The jurisdiction for referral decisions differs according to the referring agency, and could range from the team psychologist or the senior psychologist with responsibility for the SSU, to the principal psychologist.

Referring Agency	**Decision made by**
Schools Parents Child and Family Centres	Team Psychologist
Youth Training Schemes Further Education Colleges Social Services	Senior Psychologist for SSU
Education Officers	Principal Psychologist

These constitute a series of simple norms governing the individuation of the agent responsible for deciding on whether a referral should be accepted or not. Custom and practice have developed so that the more mundane the referral agency the more the agent responsible for making the decision will be found lower down the hierarchy of the SPS.

Referring agencies must denote to the SPS a 'key worker', or contact person, who will act as the representative to the SPS. For instance in a primary school with a dozen teachers this will often be the Headteacher, since there is little non-teaching time available for teachers to undertake this work. In secondary schools the key worker may be one of the pastoral team[1], a Head of Year or a Deputy Head. This person then becomes the main point of communication between the SPS and the school. Usually the referring agency has to give prior commitment to allow the key worker to take part in training courses run by the SPS. Given previous experiences of schools that waste resources by not adhering to the procedures established, and the key worker must notify the problem in the manner specified, or else the school runs the risk of not receiving help with troublesome pupils.

One final piece in the mosaic of the organisational structure is the student who attends the school. The relationship

attends(person# school#)

may be begging the question: can a non-attender be attending a school? Perhaps the term 'enrolled at' might be suggested but this tends to reflect the communication act of enrolling, which marks the start of the student attending a school. There are cases of students attending school without being enrolled there, and the bureaucratic aspects of the question remaining unresolved for some time. In practice the decision to refer a student will be taken by the same authority, that is the school, that decides whether the person normally attends, or should attend.

Identifying problems and seeking help

The SPS classifies the problems that it handles in three groups: learning, attendance and behaviour. Problems are identified in four ways: screening, complaint, Court Care Orders and attendance.

• **Screening** is a process of testing at set times in the life cycle of the student such skills as reading and writing. Often the transitions from primary to

[1] Those teachers appointed not to posts of academic responsibility but to posts concerning the overall welfare of students, normally in the larger schools.

secondary school occasions such procedures, however new legislation is introducing compulsory testing at set times in the student's school career. Screening generally reveals learning rather than behaviour problems.

• Another rich vein of problems is revealed in the form of **complaints** within the agency. These may originate from subject teachers, dinner ladies, parents neighbours, or shopkeepers in the vicinity, all of whom may lodge such complaints about students with the school.

• Delinquent behaviour may be revealed by incidents involving the police and court, or it may go as far as a **Court Care Order** and the school will be formally involved.

• Poor **attendance figures** often constitute a signal of a problem and may be brought to light through the work of the Education and Welfare Officers of the form teacher who takes the register.

Although the SPS attempts to separate these problem of learning, behaviour and attendance for the sake of administrative convenience, in practice these three interact with one another and it can be difficult to separate them. In theory the behaviour problems will eventually involve the SSU, whilst 'pure' learning problems could rest with the team psychologist and the remedial reading teacher. However the SSU will often be involved in these latter problems.

It is possible to specify the problem quantitatively, where an agent sets a standard measure and a value as determiner of the problem threshold. For example a figure of attendance of less than 75% might be so defined. However in all cases the view of the professionals has to be sought to assess whether this is a 'suitable case for treatment'. Given the history of the student of the proximity of leaving, it may be that what would normally constitute a referral case is in fact left alone. Many teachers in inner city schools will recall instances of older truants well ensconced in paid employment who are simply left alone. The sheer numbers of attendance problems in some schools necessitates this kind of selection, given the limited resources.

What is clear is that the nature of a 'problem' is highly contextual and determined only by the agents on the scene. Different schools in the same street will hold different views about what constitutes a problem. Ontologically the

problem is an affordance of the person (in the role as student, in the 'attends' relationship). The authority judging the existence of the problem will be the referring agency itself:

Affordance	**Antecedent1**	**Antecedent2**
person	state	-
P. Johnson	UK	
bvr.problem	person	-
bvr.problem	P.Johnson	-

Entries one and three are the universals and two and four are entries for realisations. In making the referral to the SPS the referring agency performs a communication act (Searle 1969). These acts for NORMA have two antecedents, the agent performing the act and a sign. For 'refers' in our schema we have as antecedents the referring agency and a sign that signifies the problem, giving:

refers(referring agency# "problem#(person#)")

or put as a record:

Affordance	**Antecedent1**	**Antecedent2**
refers	Parsloes Manor School	"behaviour problem# (Peter Johnson)"

NORMA's specification method permits the content of the communication act to be specified at the level of meaning and intention (pragmatics and semantics) without involving us in the detail of the language or syntax (syntactics), nor the codes or signals (empirics), nor yet the physical medium employed in the signalling of the communication.

Custom and practice has resulted in five different methods being used for executing the referral act: the Referral Enquiry Form, a telephone call, a meeting held at the school, a letter and a personal visit to Seabrook House where the SPS is based. The insistence by the SPS on using the Referral Enquiry Form as the complex sign used in performing the referral act is well founded. The Form contains questions which require the agency to approach parents and involve them in the problem. This ensures that the opinions of the parents emerge and are thus considered by the professionals involved. If other notification procedures are used,

the team psychologist will ensure that this stage has been reached before accepting the referral.

The Referral Enquiry Form constitutes part of the Borough of Barking's implementation of the 1981 Education Act. It forms part of a procedure specified in the Guide for Head Teachers on Special Education Provision, known informally as the "Little Red Book". One of the intentions of the Act was to move away from the labelling of problem children, with its attendant dangers of 'giving a dog a bad name ...' and work towards a more fluid definition of the variety of problems encountered and towards special provisions that might be arranged. The procedure also aims at giving parents details of professional views about their children's problems and at giving them the opportunity to express an opinion on the appropriateness of the provision made for their children. For these reasons the Referral Enquiry Form requires that the school set out in some detail what its view of the problem is and what actions to date they have taken. The Form provides the school with its method of notification. The person responsible in the school will already know who is the team psychologist for the area in which the school is sited, as this jurisdiction is specified by the SPS. The completion and dispatching of the Form amounts to a formal 'referral'.

A telephone call is an informal approach which is more often employed by Social Services, or the Child and Family Centre, whilst the bulk of referrals will come from schools using the Referral Enquiry Form. There may be problems which are outside those for which the Form was designed. Occasionally a school may experience a crisis in a behavioural problem and resort to this method. The call may be received by any member of the staff at Seabrook House (where the offices of the SPS are sited), but the team psychologist is the only person to commit the SPS to a referral. In most cases this mean further information needs to be obtained and will result in the completion of the Form or a face-to-face meeting.

In some of the teams, the psychologists have adopted a procedure of a meeting as a method of notifying problems. Meetings are held in school, on a regular basis, of staff responsible for behavioural or pastoral problems. At these meetings formal referrals can be made and the necessary information gleaned.

Sufficient information may be contained in a simple letter to obviate the need for further formalities: this is also considered as sufficient for a referral. Very occasionally the parents might present themselves in person, with or without the child, at the offices of the SPS. Such actions are usually symptomatic of tense relationships and the case is generally viewed sympathetically.

The SPS can respond in two ways, to refuse or accept. Both these are communication acts and make use of signs in the same way. Take 'accepts' for example:

accepts(SPS "refers(referring agency# "problem#(person#)")")

In this case the second antecedent of 'accepts' is a complex sign that signifies the original referral, itself incorporating a sign.

Tackling the problem

In deciding to accept a problem referred to the SPS from a school, the psychologist will weigh a number of factors: has the proper referral procedure been complied with? has the school cooperated before with the SPS? has the family had dealings with the SPS before? how severe is the problem? To find the answers to these questions the psychologist will consult the Referral Enquiry Form, the past records of the SPS and the referring agency directly. If we consider the record for the 'accepts' affordance:

Affordance	**Antecedent1**	**Antecedent2**
accepts	SPS	"referral"

then the criteria for accepting a referral, located at the 'Authority for Start' field, are embodied in the often complex norms developed over the years and exemplified in the questions above that the team psychologist will be considering. For the referral from an Education Officer, the Principal Psychologist will be examining other factors, some of which will concern the strategic and political matters undoubtedly exercising his/her mind.

Accepting the referral triggers off the start of an instance of 'case'. The term 'case', common in professional circles, should not be confused with the

problem of the disruptive student, but rather refers to a entity which is handled by the organisation, and reflects the organisation's commitment to resolve the substantive problem. A case is not coterminous with the problem it concerns, and this fact is recognised when the SPS considers whether to continue the case (see below). For Peter Johnson's behavioural problem the school involved, Parsloes Manor, referred the case to their team psychologist,

Affordance	**Antecedent1**	**Antecedent2**
accepts	SPS	"referral" (Peter Johnson)

and once the team psychologist has accepted the case, the SPS will seek the cooperation of the SSU, generally where the problem is behavioural rather than learning, giving the affordance 'cooperates on':

Affordance	**Antecedent1**	**Antecedent2**
cooperates on	SSU	case#

The cooperation of the SSU is not automatic and the Head of the SSU has the options of accepting and beginning the cooperation on the lines suggested by the psychologist, accepting but postponing commencement, accepting but requesting a different approach, or refusing altogether, subject to the final decision of the Principal Psychologist. In deciding which of the responses to choose, the Head of the Unit will first assess the problem and the embryonic strategy outlined to him/her by the psychologist. The factors for consideration are fivefold:

a. the present number of current cases (both quantitative and qualitative commitment);
b. the number of staff available;
c. whether the involvement is likely to be productive (eg. competence to deal with the problem, degree of support available);
d. whether the psychologist's strategy suits the SSU approach;
e. the long term implication of setting precedents, in particular implying future commitments.

We can see these elements as part of the decision making framework and in NORMA they provide the basic structure for the norms that govern the committing of resources to particular problems and hence to which institutions, or for the most part, which schools.

Once again we draw attention to the role of the authority concerned in determining the existence of phenomena: the cooperation of the SSU in resolving the substantive problems facing students and schools is something which the SSU controls. NORMA allows us gradually to unfold this complex interactive and subjective reality and directs us to ask key questions where information may not be available at first sight.

We now turn to look at the development of methods for tackling the substantive problems. It is important to avoid the notion of a cookbook of recipes capable of handling problems which arise. Instead we can distinguish broad philosophical approaches to the problems and more detailed techniques which professionals select to deal with particular cases. The general direction chosen derives from several influences such as: past cases handled by the SPS/SSU, informal and formal discussions between professional groups, courses, specialist literature, visits to other institutions and discussions with colleagues from other authorities. The Head of the SSU[2] must initiate a detailed programme to deal with the case, and the first step is to allocate operational responsibility to a member of staff:

Affordance	**Antecedent1**	**Antecedent2**
allocates	person#	case#

The Head of the SSU will base the decision about whom to allocate the case upon three elements: existing commitments of staff; existence of successful relations between referring agency and staff; level of staff expertise in relation to case. In the first case where the member of staff already has a burgeoning caseload then it may be unwise to add to the burden. In the second case where there has been successful interaction previously then it is advisable to maintain the relationship. Lastly some problems require particular expertise and experience and therefore certain members of staff are either more or less suited, as the case may be.

We do not make one of the antecedents of 'allocates' the role 'Support Teacher' since the offices may change form time to time but the 'person' and 'case' will endure. To include what amounts to an organisational rule into the

[2] The Head of the SSU will base the decision upon three elements: existing commitments of staff; existence of successful relations between referring agency and staff; level of staff expertise in relation to case.

structure of the schema would lay it open to instability when the business, or service, alters its method of organisation.

To deal with the behavioural problem, the SSU uses the technique of a 'Behaviour Management Programme' (BMP), which for NORMA amounts to a set of norms of behaviour, to which the various parties involved must follow whether they be students, schools parents or the SSU itself. In effect the agents involved agree to a 'contract' which specifies their behaviour for the coming period, with an eye on improving the problem. The SSU develops a BMP for each problem that it has accepted as a case, but we do not make the BMP ontologically dependent upon a problem; as a norm it can exist even when there is no problem at all. Using the structure:

developed for (BMP# problem#)

rather than

developed for (BMP# case#)

we underline that the BMP is aimed at changing the perceived behaviour and not the administrative entity that has been developed to expedite the amelioration.

The BMP might include the student attending the SSU centre for a period and undertaking to improve his behaviour/attendance at school etc, perhaps the parents undertake to reward good behaviour in some specified way (a reward in the estimation of the student), and maybe the school has to make some adjustment in the timetable of the student, such as offering another practical subject or simply changing the subject teacher. Critical to the success of the approach is the vigilance of parties involved in monitoring the outcome of the changes and making, as necessary, adjustments to the BMP.

To induce schools to follow programmes and procedures established, the SPS/SSU can offer certain 'carrots'. For example, as part of the programme the student is obliged to attend Seabrook House, thus freeing the teacher from dealing with a disruptive element for that time. The other side of this coin is that if the school does not follow procedures laid down, the student can be required to remain

at school. Given that the school has asked for help the SPS has a strong hand in obtaining compliance with monitoring.

Part of the control is exercised by the regular meetings of the teams to review the case. Each case has a six-week review meeting which in effect provides one parameter of measurement of the effectiveness of the BMP. The SPS/SSU is measuring the extent of the behaviour modification against this timescale. In addition the SSU Head, the Senior Psychologist with responsibility for the SSU and the teacher on the case will meet weekly to briefly review developments.

The decision to close a case, that is to withdraw further support is a delicate one. Limitations on resources do not permit open-ended commitment, neither can a school be encouraged to shirk its own responsibilities. The weekly or six-weekly meeting provides the setting for such decisions. Consultations between the psychologist and the referring agency will have taken place beforehand. Deciding to close a case provides the 'Finish' field in the NORMA record for a given case:

Affordance	**Antecedent1**	**Antecedent2**
case 543	SPS	-

and also for many of the other realisations in the schema, including 'allocated', 'concerns', 'cooperates on'. On deciding to close a case the team psychologist will write to the referring agency and to the parents to inform them, and the SSU will inform the student orally. These activities constitute part of the communication system and do not concern primarily this analysis, which is attempting to elicit the substantive system, but these messages and their specifying would be the main concern of a traditional specification method, concentrating as it would upon the dataflow and not what the data refer to. This is not out of 'wrongheadedness' but simply the logic that is dictated by the tools available for tackling the problem.

Summary of SPS case

This case is different from the other two dealt with in this work in one important way: its informality. Investigations into the organisation of work in the SPS and SSU revealed almost no written procedures to describe how the information system is structured. Ways of working had been carefully developed over some years by a small group of professionals, who were close to each other both in physical and

intellectual rapport. The nature of the accommodation allocated to the group accounted for the former and the methods used for recruitment explained the latter. Consequently the rules governing the Service were embodied in the informal norms that have been referred to in this report. The strong informal system ensured that new recruits were quickly initiated into the operational methods, with great stress being placed upon the responsibility of each member to undertake his duties in an appropriate manner.

It is difficult to envisage how traditional dataflow methods could have adequately specified this system in any other than a trivial fashion. The message passing and record keeping approach would not have disclosed the intricate network of responsibility which characterised the true fabric of this organisation.

Chapter 6
Italian welfare

The subject of this analysis is the Istituto Nazionale Confederazione Assistenza (INCA). INCA is an example of a 'patronato' of the Italian state which has the status of a protagonist in affairs of legal contestation, and is an affordance of 'state'. The concept of *patronato* is peculiar to Italy, being a kind of charitable organisation recognised and licensed by the state to act of behalf of citizens in the pursuit of their various claims upon the state and its departments. In general they are institutions sponsored by trade union and religious bodies and reflect the spectrum of political life in Italian public affairs. In the Rome province there were in July 1989 twenty recognised patronati operating.

Ontology of state

In our study of the CRIS case in Chapter 7 we also confront the question of how to handle the notions of 'state', 'nation' and 'Society', and these are dealt with in some detail there. INCA encounters a large number of different state bureaucracies in the course of helping its clients. In a formal legalistic system such as one dealing with pension rights, it is no surprise that the state as an institution underpins most of the realisations. To complete the schema entry for the state of Italy, we should include the start date. But this may not be simple.

Prior to 1860 there was no state of Italy as such, instead there had been a variety of political entities including the Kingdom of the two Sicilies, the Papal States and the Kingdom of Piedmont. Certainly we can point to the existence of an Italian nation, albeit divided amongst these different political structures, but the start of Italy as a state we might date formally to the stirring events surrounding the unification movement and Garibaldi's thousand heroes. For many emerging nation-states the business of when the start date can be authoritatively attributed depends upon such diplomatic matters as who is doing the recognition, that is, whose authority is being sought. However for the people involved in those events most certainly Italy was a reality long before the ink dried on Cavour's signature.

In the same way for nationalists fighting today, say in Palestine, the nation already exists, just as it did for their Zionist predecessors in the same part of the world, earlier in this century.

At this very fundamental level we find it difficult to discern and identify a single social agent as authority to which to attribute this subjective reality, and this reflects the problems experienced in the world of international law and politics when those same issues are addressed. What we experience is a conflict in meaning, rooted in the conflicting jurisdictions. When Lithuania states that it is a sovereign state and the Soviet Union disagrees we can only conclude that the ultimate resolution of the conflict is a singularly political matter. In general we would hope to avoid being drawn into this quagmire if possible, but at least we do have a method of attacking such a thorny problem, should it be necessary.

Ontology of person

In obtaining their pension and other welfare rights, persons who have contributed to state schemes will have to be recognised by those state departments. Part of the bureaucratic activity will be to ensure that the person for whom the department has received contributions is in fact the self-same person who has made a claim and to whom the funds will be paid. Much of this work consists in the presenting of state-recognised certificates: *certificato di residenza* (certificate of residence), *certificato di nascita* (birth certificate), *certificato di congedo* (demobilisation certificate), and so on. The department will generally recognise this person uniquely in its own formal system by means of an arbitrary number allocated to each person at the outset of the obligation undertaken. In the United Kingdom this is the 'National Insurance Number', and in Italy the 'numero di matricola'. In Figure 6.1 we illustrate a first cut at specifying the schema for this part of the problem. We see that both 'department' and 'patronato' have 'person' as affordances. How can that be? Surely we are dealing in any case with the same person. Once again we confront a problem of ontology. A department has to establish the identity of the person with whom it has an obligation, but the existence of that person is not dependent upon the department. We cannot specify a 'person' as an affordance of 'department' for this reason. Our principle of

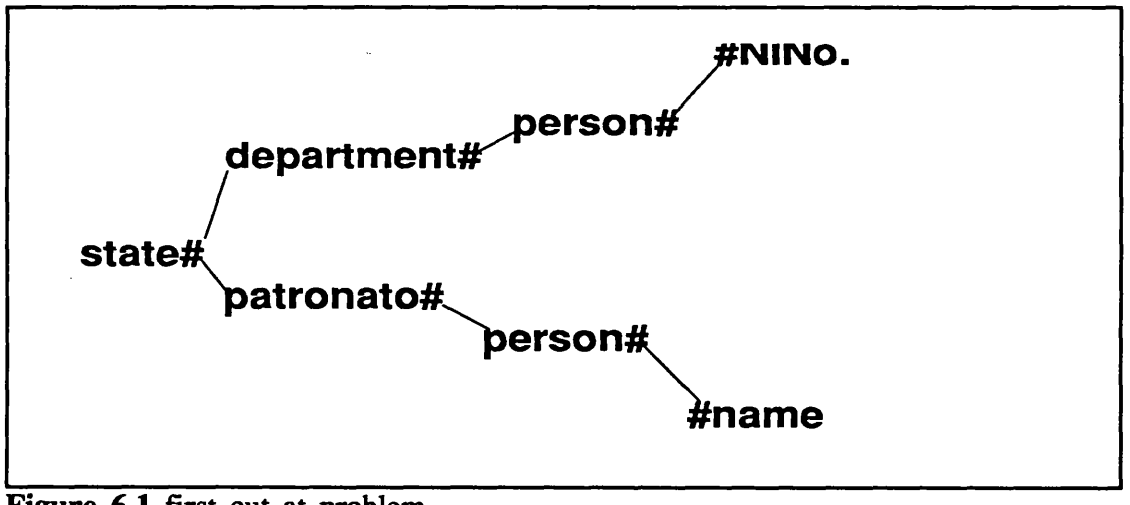


Figure 6.1 first cut at problem

ontological antecedence guides us to the representation in Figure 6.2.

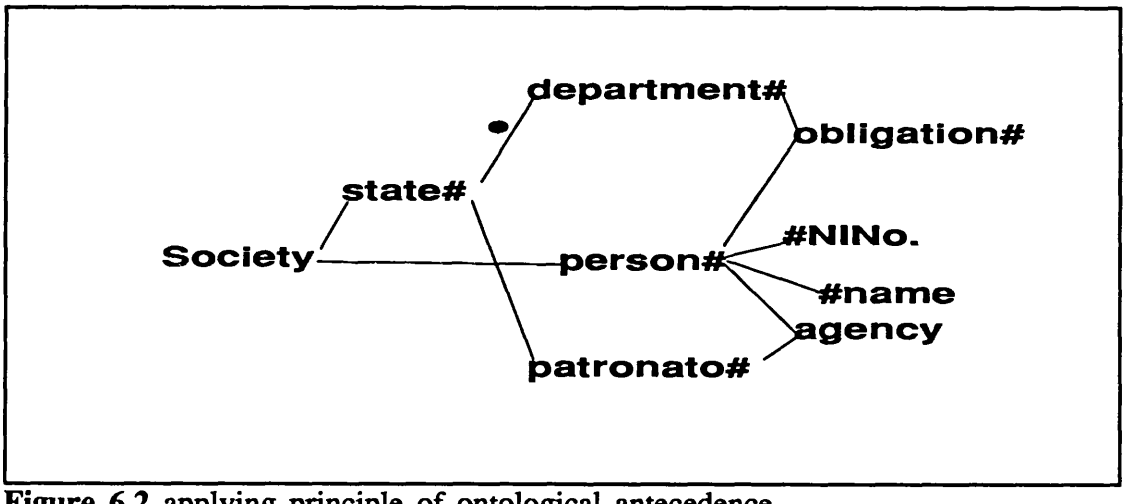


Figure 6.2 applying principle of ontological antecedence

The reason for making 'person' dependent on 'Society' is another tricky point, but we may note in passing the help provided by the application of the principle. If the state of Italy ceases to exist, it does not follow that instances of 'person' cease also. For 'Society' however this does hold.

Authority for 'person'

The antecedent of person may not give a clue to the authority for determining the existence of any particular person. We can take it that Society can recognise persons without much difficulty, however the departments of state need to establish

beyond reasonable doubt that the particular person making the claim for a pension, for example, is the actual person with whom the department has an obligation. The department will have a number of tests for the identity, mostly concerning the production of official documents. This matter concerns not ontology but authority: they should not be confused.

NORMA prompts us to search for the agents responsible for determination of existence. A number of complex administrative rules will regulate this process but ultimately the decision of whether to recognise a particular person as the one with the rights will fall to an individual or group of individuals. For instance in obtaining the certificate of residence from the Italian consulate, the person concerned will have to convince the member of staff responsible (*addetto ai passaporti*) that they in fact reside normally in the United Kingdom. Where people are continually coming and going between the UK and Italy, this may not be so simple as it might appear. Although appeals do occur, in practice the person responsible has almost total power of decision. In this manner it becomes evident the way that this formalism rests ultimately upon the informal system of human agents for the validation and integrity of what is recorded.

Establishing existence of realisations: Starts and Finishes

In much of the documentation of the casework surrounding the claim for pensions and other welfare rights, the various significant dates in the life of a person, such as birth and death, are very important in ascertaining eligibilities[1]. For NORMA these are can be referred to as the start and finish dates of the various affordances. Other terms have come into the language to denote such starts and finishes as in wedding:start of marriage; divorce, annulment (or death of spouse): finish of marriage; inauguration: start of term of office; registration: start of period of studentship, graduation: finish of term of (undergraduate) studentship; commencement: start of contract, expiry: finish of contract. For these cases we can

[1] DHSS Form CF(N)1278, for example, used for making the pension claim, has several questions on various dates: 1a. date of birth, 3(4) date of pension commencement, and 3(5) ceasing, and 4(2) date of marriage.

use the 'start' and 'finish' fields in our NORMA record to refer to these points in the existence of the realisations[2].

Causal and ontological dependency

The notion of 'married name' has to be handled somewhere in the schema and would be introduced as a further possible identifier. However, whereas in Italy a married woman retains her own surname, in the United Kingdom in general a woman assumes the surname of her husband.

Marriage, a relationship between two persons, is an affordance with two antecedents, a joint affordance, which as mentioned previously starts with a wedding and finishes with death, divorce or annulment. The married name does not necessarily depend upon the existence of the marriage, since it may be retained after the end of the marriage. A widow or divorcee does not have to relinquish her married name.

We have to distinguish the causal relationship from the ontological. While we may be sure that the acquisition of a married name is occasioned by marriage, the relationship is purely causal. Indeed there is no requirement for the woman to use the married name, even in the United Kingdom.

The role of 'spouse' is instantiated when there is an instance of a marriage and, ontologically, an instance of 'spouse' depends upon an instance of 'married' and an instance of 'person'. Referring to the number of antecedence (ie. whether antecedent1 or antecedent2), we may use the role name of 'spouse' when manipulating the knowledge base. Using the role names in this way, as they are used in natural language, we can access the power and economy of this device in common parlance. For example we can discover who is a spouse who lives in 14 Via Appia by directly manipulating the records of 'spouse' and those for 'dwelling'.

Nationality and residence ontological questions

Nationality is conferred upon a person by a state and it may not even be exclusive: it is possible to hold two nationalities at the same time. Once again we have two

[2] See Chapter 11 for discussion of research agenda in this particular area.

antecedents for an affordance: an instance of 'nationality' requires a 'person' and a 'state' to be in existence before it can exist.

Where a person is born is a piece of information requested frequently in this type of casework and the affordance 'in' with antecedents of 'person' and 'comune' seems to be the best way to present this relationship. We can contrast this with the notion of being resident in a particular place since this is a special concept with regard to taxation and voting rights. Italians who are working abroad but retain their residence for electoral purposes in their comune in Italy have the right to vote in the local municipal elections in Italy; if they transfer their residence to the UK, then they lose the right to vote in municipal elections, but can still vote for Italian national and European Community elections at polling stations organised in the UK by the Italian government.

For taxation purposes, an Italian (or foreign national) may be eligible to retain their domicile in Italy (or country of nationality) while being resident in the UK. This arrangement alters the tax liability considerably. The point here is that the term 'resident' or 'resident in' is extremely ambiguous and has no single meaning. The significance depends upon the context in which it used, and the authority or criteria which is being applied at that time. This must be spelt out in the 'Authority' fields, which for convenience are included only in the full Appendix C table. As far as the UK's Inland Revenue is concerned Mario Rossi is resident in 14 Via Appia Roma. Perhaps for other purposes he is considered to be resident at 114, Holloway Road, N7. The possible illegality of this arrangement is for Sig. Rossi and the relevant authority to discover.

State, department and scheme

Hitherto we have not introduced the notion of 'scheme', and here we do so. In differentiating between 'scheme' and 'department', we are stressing the distinction between the bureaucratic structure designed to carry out the instructions of Parliament, and the creation of complex legal abstractions under which citizens enjoy their rights. The welfare state has been responsible for the introduction of many such schemes, although INCA is principally concerned with pensions and social insurance. Departments that have administered such schemes have come and

gone but the obligations created have remained. In this way we may set out the ontology of this area as shown in Figure 6.3.

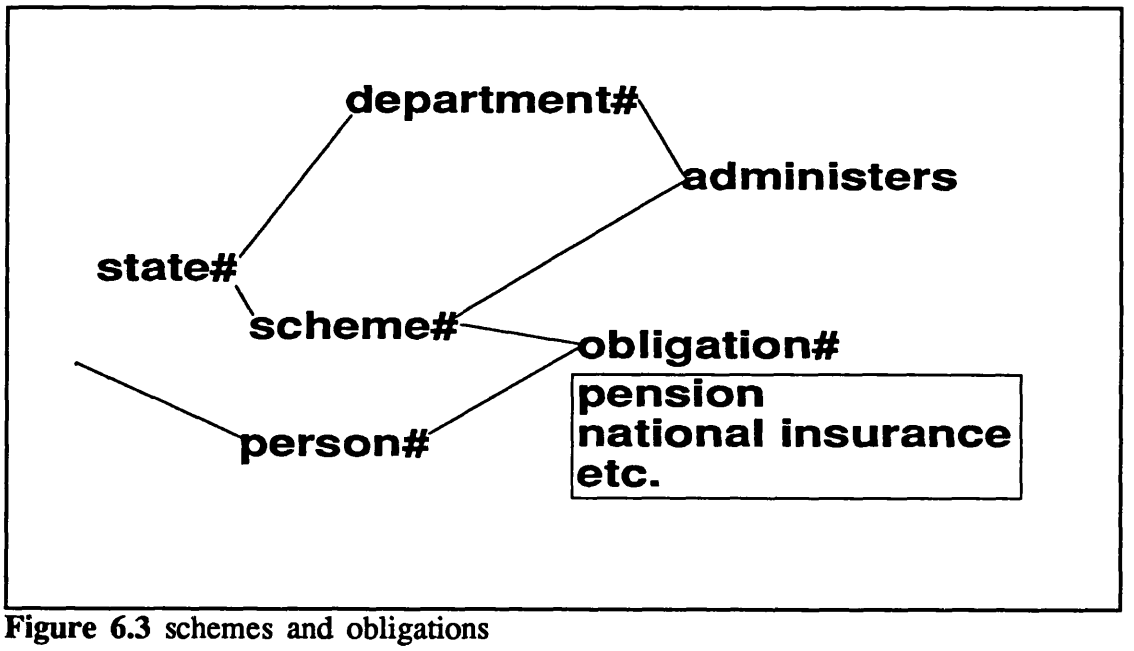


Figure 6.3 schemes and obligations

The question of who administers the scheme is not fixed in any ontological fashion. Conceivably the responsibility for administration could be shifted to other state departments or private businesses, as in the case of portable pensions.

Schema and data

The starts and finishes of departments are more easily determined than those of state, since they usually come into existence by means of legislation. In fact their substantive functions are often prescribed by specific pieces of legislation, which they exist to implement. In the case of the DHSS some 30 separate legislative acts circumscribe its work.

A problem may arise here for analysts in the understandable attempt to find a schematic basis for the data. We would like to define a schema from the terms used in describing the Italian welfare system that may also serve to record data from the British system. What is interesting here is that while we may view the Italian department, INPS, as parallel to the DHSS, there is one way in which the INPS is different: unlike the DHSS, the INPS does not handle industrial injuries, there is another state department for this work in Italy, the Istituto Nazionale

Assistenza Infortuni al Lavoro (INAIL). Given that we are able to separate the schemes administered by different departments (see Figure 6.3), we can comfortably handle these differences in administrative function. The correlations between the various bodies have been carefully established by joint agreements over the recent years under the ægis of the European Community.

From universal to particular

In general we want to produce a schema which contains only universals, so that in this way it may address the general requirements of a range of similar but individually different user problems. A schema for one airline should support the work of another airline also; and a schema for one country's social and welfare apparatus should support another. But occasionally there are universals whose antecedents are particulars. A particular reality produces universals which are peculiar to it alone. In nationality law, for example, perhaps the United Kingdom is the only state to have developed the notion of 'patriality', introduced in the 1981 Nationality Act, whereby rights to nationality are traced back through two generations.

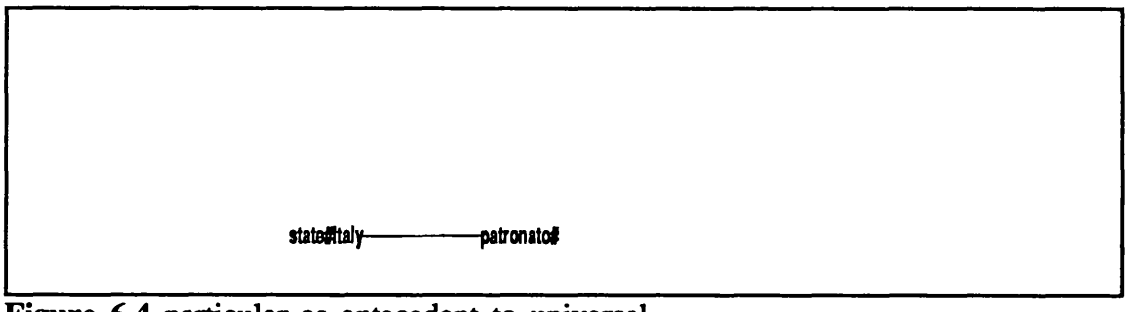


Figure 6.4 particular as antecedent to universal

In specifying 'patronato' as an affordance of 'state' we would be creating the idea that every state has such institutions, whereas from our British experience we know this to be false. Therefore we must show the particular state of Italy to be the antecedent of 'patronato', rather than the universal 'state'.

Postal and telephonic addresses: norms and names

In this section we turn to look at the problems raised in handling signs types, whether postal and telephonic addresses or the names used by different institutions to refer to schemes for national insurance in the two countries.

To expedite business by post and telephone we must handle the questions posed by addresses and telephone numbers. In all countries today we expect to find a postal authority, which may also be responsible for the telephone and telegraphic system, commonly referred to on the Continent as the PTT. These bodies were created by the states and their starts may be found in the particular legislation that gave them this legal status. Recently there have been reorganisations in many states which have separated the two functions and given them to different parastatal bodies. In the United Kingdom British Telecom was separate from the General Post Office in the Seventies, while in Italy the SIP was created from the Poste Italiane a little later.

Affordance	**Antecedent1**	**Antecedent2**
PTT	state	-
British Telecom	UK	-
SIP	Italy	-

These organisations control the sending of messages to their destination addresses. The addresses, whether postal or telephonic, are affordances of these bodies. A particular telephone number or postal address does not depend for its existence upon the addressee or subscriber —they are ontologically independent of each other. When telephone codes are rearranged or street numbers reassigned then the antecedence of the postal and telephonic authorities becomes apparent. For decades the telephone code 01 referred to the whole of Greater London area, but after the 6th of May 1990 the codes of 081 and 071 were used to refer to Inner London and Outer London respectively. What constitutes Inner and Outer London for this purpose is defined by British Telecom, and differs from how these terms are used in other contexts, say, in the salary allowances for the staff of the Midland Bank or the Metropolitan Police.

Affordance	**Antecedent1**	**Antecedent2**
tel. no.	PTT	-
076331192	SIP	-
014057686	British Telecom	-

Here we have the record for the affordance 'tel. no.' and it has as both its antecedent and agent responsible the PTT of the country. The other records indicate the existence of particular numbers, in the two countries. In the UK we could possible have Mercury instead of BT, but the structure in any case does not depend upon a rule of one telephone company only. However the relation between the addresses (and telephone numbers) and the person to be found at those addresses has to modeled and we can use for the telephone number the term 'contactable on', far less elegant that its equivalent in Italian of 'recapito'.

Affordance	**Antecedent1**	**Antecedent2**
contactable on	person	telephone number
contactable on	Mario Rossi	076331192
contactable on	Redvers Bulwer	014057686

We should analyse in a little more detail the relationship of 'telephone number' to 'person'. It is only by convention that a given telephone number permits contact with a given person. By the same convention a given person would be located in a given room or office and here would be found the telephone. The

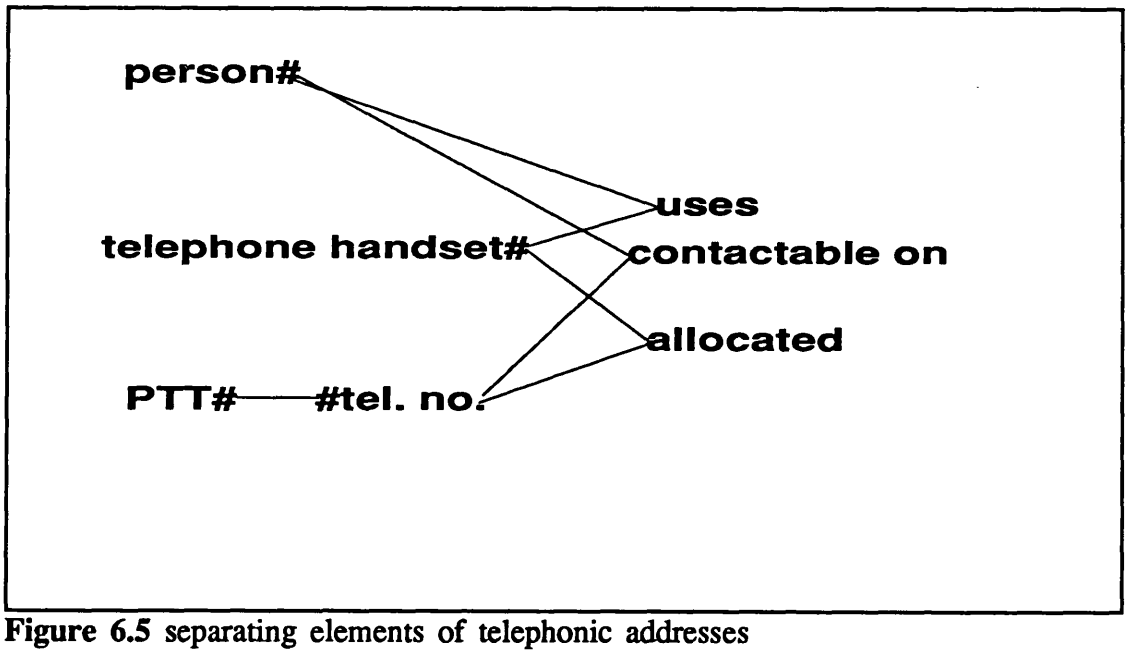


Figure 6.5 separating elements of telephonic addresses

advent of mobile telephones undermines this logic. A given number will be used to contact (a) particular telephone(s), and the proximity of the person to that handset will enable the call to be taken.

In Figure 6.5 the rule of ontology forces the different elements involved in a telephonic address to be separated out. The convention or norm referred to above would read something like:

contactable on (person# #tel.no.) ←
while (allocated (#tel.no. handset#)
while (uses (person# handset#)

This would translate into English roughly as: 'when a person uses (normally) a telephone with a particular number, then that person can be contacted on that number'. In the schema the occurrences of each of these universals would be recorded without losing any information should, for example, the person change their telephone number.

Provinces and codes

A similar kind of problem is encountered with postal and other similar codes. In each case we have a sign type, normally a mixture of letters and numbers, which in a given context refers to particular geographical locations and administrative entities. This is the classic case of relating a sign type to its referent. An agent uses a sign, in given circumstances, to reconstruct in semiological terms the world of experience. Instead of inventing codes one could use the full name to refer to the realisation, but codes are designed for their efficiency and, used in their intended context, are more efficient.

Italy has over twenty regions and each region is divided into between three to five provinces. Each has a code of two letters (except for Roma, which keeps its full name). The code and the province it refers to are not dependent upon each other, the connection between them is established by the state and is specified here as 'represents'. Conceivably the same code might be used to refer to other entities. The connection between them is strong because of consistent usage and reinforcement, much as we find with, say London postal districts. Thus there are provinces and codes:

Affordance	Antecedent1	Antecedent2
province	region	-
Rieti	Lazio	-
Milano	Lombardia	-

Affordance	Antecedent1	Antecedent2
code	state	-
RI	Italy	-
MI	Italy	

and tying them together we have the 'represents' affordance.

Affordance	Antecedent1	Antecedent2
represents	code	province
represents	RI	Rieti
represents	MI	Milano

Coordinating different schemes

Strangely enough similar questions dog the analysis for the schema for the various norms governing the various social welfare rights in the two countries. In discharging its responsibilities under obligations to contributors to pension schemes and the like, each state department has a series of norms or regulations which govern the accepting of the claims and the eventual payments. Each norm is a complex sign for the behaviours required in the handling of pension schemes, so that 'retirement pension' is the name of norm governing the discharging of the DHSS obligations in that specific area. In determining each instance of an obligation the authority which is used is the norm or piece of legislation governing that particular claim.

To simplify the problems of handling the joint jurisdictions, whereby a person has pension rights under Italian and UK schemes and so avoid any overpayments, the two states have agreed a schedule known as Tabella A/B/C which places into categories the various obligations in the two jurisdictions. International agreement between the two administrations establishes the matching of one country's norms to the other's. In this way the notion of 'subsumes' has been created, whereby one norm can be said to subsume another (see Figure 6.6).

Let us take the particular example of the *pensione di invalidità* —the name of the norm under which the Italian state, through its department of INPS, controls the fulfilling of obligations entered into in the area of invalidity pensions. Roughly

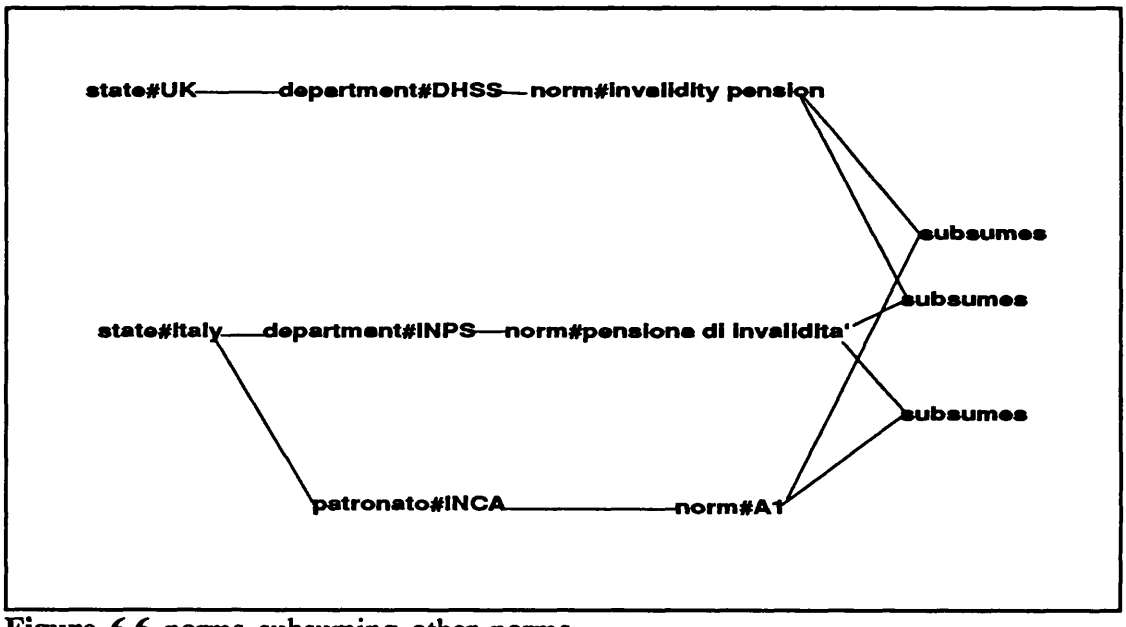


Figure 6.6 norms subsuming other norms

speaking the British counterpart would be the *invalidity pension*, although great caution is urged since the norms are very different, and cases that pass as suitable for the pension in Italy are often viewed with more scepticism in the UK. For the INCA organisation these two different norms have to be reconciled, at least in the language used to expedite the cases that they give rise to, and the norm A1 subsumes both.

INCA has taken these categories and used them to refer to the various obligations contained therein. INCA in its turn has norms that govern the way their organisation processes the handling of the claims for the rights referred to in the departments's norms. These norms are the affordances of INCA —they do not depend upon the departments' rules for examining claims. They relate directly to them, and participate with them in a 'subsumes' affordance.

The INCA norms, labelled A, B or C plus a number as in A1 above, are drawn from the categories agreed by the Italian and British Departments in 1978, and for INCA they have the function of establishing degrees of difficulty associated with the obtaining of the pension or right. The INCA norm associated with A5 equates the British 'old person's pension' with the Italian 'pensione sociale'.

By separating the norms according to their ontological antecedence, we can specify them as functionally independent of each other. Where the agents

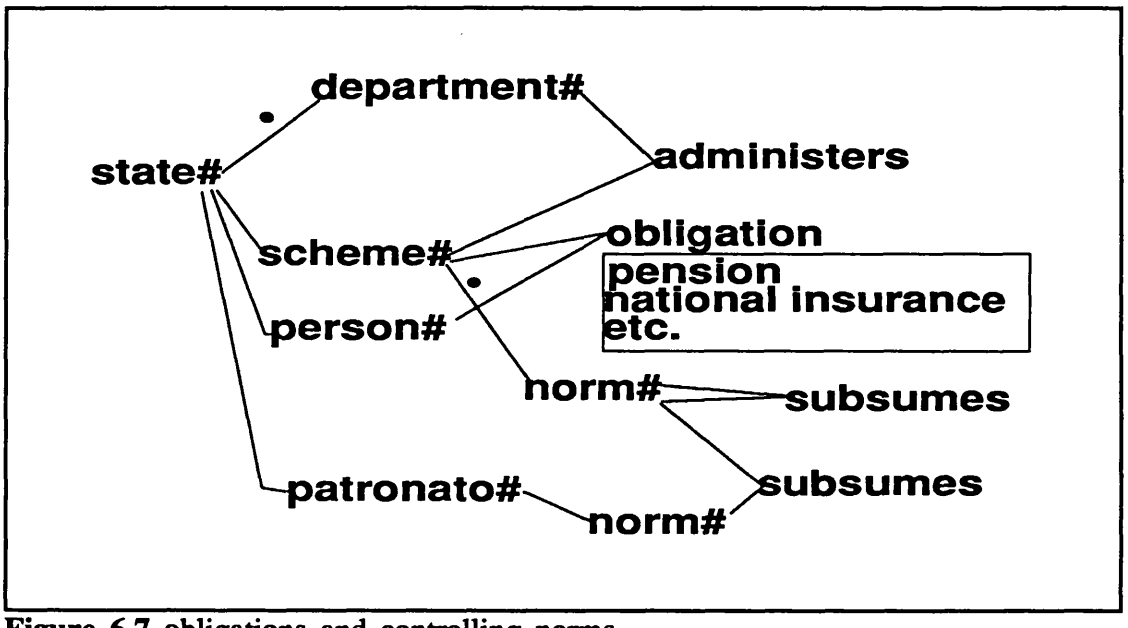


Figure 6.7 obligations and controlling norms

responsible decide that one norm subsumes another then this can be reflected in the schema. Even when this is no longer the case, the underlying structure of the schema is not jeopardised in any way. It remains stable and able to cope with the dynamics of international agreements that govern this domain.

Wholes, parts and affordances

Italy is divided, historically, culturally and administratively, into regions and provinces, currently 20 and 96 respectively. We make the regions ontologically dependent upon the state, given that we are referring to the administrative topography of the country, and that the state retains the right to create and abolish these entities. Take for example the creation of the region of Basilicata and the abolition of Lucania. In the United Kingdom we have more recent experience of the abolition of such entities as the county of Huntingdon and the Soke of Peterborough, Rutland and the Ridings of Yorkshire, and the creation of Humberside, Avon and Cleveland. This is a problematic question matter however, if we consider the history of the state of Italy, regions such as Lazio (Latium) go back considerably further in time.

Affordance	Antecedent1	Antecedent2
region	state	-
Lazio	Italy	-
Lombardia	Italy	-

When we reach the level of the smallest administrative unit, i.e. town or 'comune', we confront the same dilemma as for the region. Is the town, ontologically dependent upon the structures superior to it administratively? If the region for some reason finishes, does the existence of the town finish? History suggests that some of the towns in Italy have considerably greater longevity as cultural entities than the province or region, yet as part of the administrative structure they do not have an independent existence. For example the town of Poggio Mirteto, now in the province of Rieti in the region of Lazio was, prior to Fascism, in the province of Perugia in the region of Umbria, not a physical change but an administrative one.

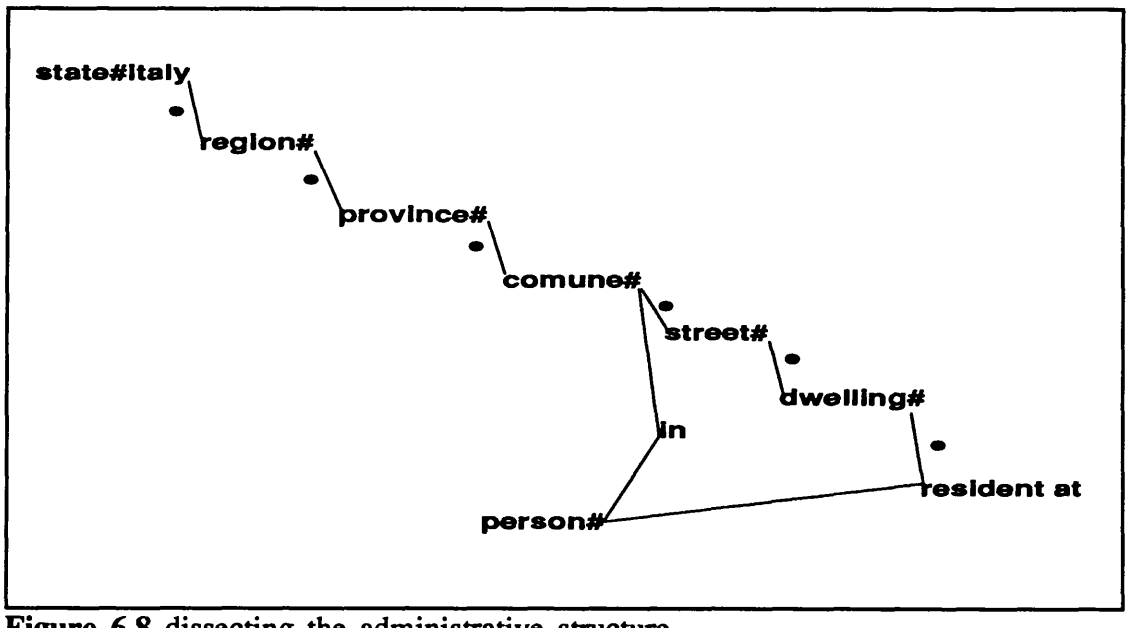


Figure 6.8 dissecting the administrative structure

In deciding whether we are dealing with a part or an affordance, we must determine whether the antecedent is constituted of parts of the candidate affordance or whether the candidate affordance is something that may or may not be realised by the antecedent. Viewed from the point of administrative structures a town, a region, a county, are all parts of the overarching whole. Viewed as cultural, social

and economic entities, they may well survive the demise of the state of which that they form part.

Finding the right terms

In general we want to adhere to the terms used in the normal discourse when developing a semantic schema. However a certain amount of additional terms is usually required to flesh out the full schema. In the case of where people live for example. Particular houses themselves form part of a street, and besides houses there may be apartments, bungalows, villas, cottages, terraces, prefabs, inhabited abandoned buses and so on. For the universal that encompasses all these the term 'dwelling' seems to provide the best solution. Here we suggest 'dwelling' because it covers the widest possible number of terms for the particulars of where people live. The PTT would be the authority for determining the existence of a particular dwelling. Experience has shown that the Post Office is willing to deliver letters even to gentlemen of the road who reside regularly at bus shelters. In so doing the Post Office is demonstrating its authority over what shall be considered an address.

Given that the structures of 'region' and 'province' as realised in Italy do not exist in the state of the United Kingdom, we must present these as parts of the particular state. However we would expect to find other states which are administrated in a similar fashion. The chart showing a section of the schema allows us also to record where a person was born:

in (person# comune#)

Where the start of a realisation of 'in' was also the start of the realisation of that person then this would be the record of their birth in that comune.

INCA is a structure which exists to provide support mainly to Italian citizens engaged in claiming or protecting their rights. The bulk of the work in the British section concerns the obtaining of pensions. In addition to pensions there are many other benefits which assisted persons seek help and advice about. What universal terms can we use to refer to these rights and benefits? Using the notion of a claim suggests that the persons claiming feel that the state (or its department) has some

commitments to them which they have to redeem. So that the notion for which we are searching has at any rate two antecedents: 'person' and 'scheme'. Perhaps a suitable generic term might be 'obligation', covering pensions, re-entry grants and the like. Many of the assisted persons using the European INCA offices may well have worked in more than one other country, depending upon the pattern and history of emigration, and it is not unusual for an Italian worker living in London who is approaching retirement to have worked and paid contributions in: as a coal miner in Tournai, Belgium; as a carworker in Stuttgart, Germany; and as a waiter in Soho, London. Therefore there will be several different obligations to obtain information upon.

Individuality and identity

In this section we find the question revolving around how to maintain the link between a realisation and its surrogate in the database, especially when its name, identifier or label has changed. Take a case of a particular dwelling: Flat 4, 100 Via Roma, Viterbo. This example allows us to examine the problem of using the usual label or name as the identifier in any formal system. The record above for a realisation of a particular dwelling has the label Flat 4, 100 (Via Roma, Viterbo). What happens if the label alters because of a renumbering of the dwellings in a street? We will be unable to use this same record if we are also manipulating the records in our formal system, using the label or name as an identifier. The identity of any realisation does not reside in the label or name used to refer to it, but rests in the ability of the agent in the environment to recognise that realisation. We use identifiers in our world of signs, in a database perhaps, to recall the surrogate or record of that realisation, not the actual entity itself. What we require is a surrogate number which every affordance and realisation is given when it is entered into our knowledge base, then instead of writing the label or name of the entities we are manipulating, we would use this number. We saw how in Chapter 3 how the extended relational model (RM/T) uses the device of a surrogate number to obviate the difficulty of tracking occurrences by using their external 'real world' identifiers.

In practice the surrogate number is the internal identifier to the formal system. So the effect of a renumbering would be

Surr#	Label	Ant1	Ant2	Auth+	Auth-	Start	Finish
87654	flat #	Via Roma	-	Italy	Italy	1-5-1987	
87655	#4,100	87654	-	Poste It.	Poste It.	1-5-1987	31-8-1988
87656	#4,110	87654	-	Poste It.	Poste It.	1-9-1988	

The realisation has not altered, merely its label. To be meticulous we should add the name or identifier as another affordance of any affordance that is capable of individuation and identification, thus for 'street', but not for 'represents' above. These three tuples above record the fact that a particular flat in Via Roma, recognised by the surrogate of 87654, had its house/building number for the street altered to 100 from 110 on the 1st of September 1988.

It is entirely possible for the same realisation to have different names (cf. identifiers) even in an informal system, and at the same time. An example of this is the small Dorset village of Shroton (shortened from Sheriffstown), which is also known officially as Iwerne Courtney. This usage of two names dates from the period after the Norman Conquest of Britain, where the Norman-French speaking community used the name of the local lord, whilst the Saxon community continued in their traditional usage. This dichotomy has survived to today. Two linguistic communities will usually employ different signs to refer to the same entity, but even so, a single community may use two signs to refer to one concept. A merging of the linguistic communities does not always mean the elimination of the 'redundant' term.

Other identifiers

The INCA documentation distinguishes first names, surnames and married names[3]. We have already seen the problems associated with using the usual name or label to refer to, in this case, instances of persons realised. We have identified if our formal system an instance of a person, by the name of Mario Rossi. This person

[3] One example is Modulo V, the form that the assisted person completes and signs which provides basic personal details to INCA and also functions as proof of the individual's agreement to agency status. This latter is required by the state departments with whom correspondence will take place.

has a first name and a surname, which we can record as separate affordances of a person, who in our formal system is identified by the surrogate number of 53. To avoid ambiguities we can use surrogate numbers in the records. Universals also have surrogates, so that 58 below records the affordance of a first name for a person. Number 59 is the surrogate for an realised first name, the person who is represented in the antecedent.

Surr#	Label	Ant1	Ant2	Auth+	Auth-	Start	Finish
58	firstname	person	-	state	state		
59	Mario	53	-	Italy	Italy	13-6-1922	
61	Maria	55	-	UK	UK	31-2-1934	

The instances of these first names starts with the dates in the Start field. Should there be a discrepancy between these dates and the Start dates for the persons concerned (ie. their birthdates), then this reveals to us the period of time before they were christened.

For the surname exactly the same rules apply:

Surr#	Label	Ant1	Ant2	Auth+	Auth-	Start	Finish
64	surname	person	-	state	state		
65	Rossi	53	-	Italy	Italy	13-6-1922	
68	Potter	67	-	UK	UK	31-2-1934	

Should Maria Potter (surrogate number 67) decide to change her surname by deed poll to Garibaldi, then the formal system would handle it in the following way:

Surr#	Label	Ant1	Ant2	Auth+	Auth-	Start	Finish
68	Potter	67	-	UK	UK	31-2-1934	31-12-1987
1067	Garibaldi	67	-	UK	UK	1-1-1988	

Putting a date in the 'Finish' field says that this realisation no longer exists for the authority concerned, the state. Of course Maria will not expect other linguistic communities, such as her friends at the community centre to immediately cease using her former surname. Using this example we may see the ambiguity of using the usual name as the identifier for the formal system. If Maria's surname is no longer Potter then, the string 'Maria Potter' in the antecedent of the surname column does not make much sense any more. At a human level we use names to refer in discourse to other persons not present, but we have developed mechanisms

for recognising the identity of persons which do not depend upon the names they use. Put simply, humans can cope with changes in labels, more easily than any formal system.

Conclusion

This application was an example of a fairly typical office casework problem. The parameters of the problem were well defined, insofar as the scope of work is delimited by the exigencies of the statutory obligations binding the assisted persons and the various national states. Ambiguities, where they arise, are generally resolved by the state departments, either singly or collectively, as in the case of the Tabella A/B/C agreements which determined what shall be the counterparts in one country to those obligations recognised in another. The ontology chart in Appendix C documents the majority of terms required to specify the information system requirements.

Another moment when semantic ambiguities and discrepancies come to the fore is when the Italian and British administrations differ over how to interpret their obligations in the facts of a particular claim. INCA handles cases of invalidity benefits where an Italian tribunal will deem a given industrial injury to be equal to a fixed percentage of invalidity and this translates to a certain pension entitlement. For the same injury the British tribunal will often be less generous in its assessment, and the persons assisted will have recourse to INCA for the appeals procedure.

In one case which came to light the sitting British judge seemed bent upon deeming the person still capable of working, and cited the case of Douglas Bader, a famous fighter pilot in the Second World War, who continued flying despite having lost a leg in an aerial battle. The defending lawyer then asked if the judge would like to be flown in an aeroplane with his client at the controls, vouchsafing at the appropriate moment the knowledge that the malady of his client was a heart complaint. The appellant won his case.

It is in these instances where uncertainty in the operational meaning for the key terms used in the relevant legislation is resolved. NORMA can take such questions in its stride quite naturally. There is a place for the authority for each

term. Where the obligation to a person for invalidity is recognised by the Italian authorities, then we can insert them as the relevant authority. We are not faced with the impossible task of attempting to define only one permissible signification for the term 'invalid'. Our formalism caters for any responsible agent who determines a particular realisation. In general, the various bureaucracies involved are able to correspond and reach decisions about claims on the basis of the shared understanding of the terminology.

Chapter 7
The CRIS case

In the Comparative Review of Information Systems Methodology (CRIS) example the International Federation of Information Processing (IFIP) Working Group 8.1 undertook to produce for the 1988 Conference (Olle 1982, 1983) a detailed design specification for conference organisation, to be used as a model for testing various information systems design and analysis methods. In Appendix A is the preamble to this specification document. We have taken this, together with the knowledge acquired of the functioning of the organisation, as the basic material to be analysed.

The IFIP context

In working our way through the terms used in the problem definition we will also be adding in other terms that will be repeated often in this domain: copy, version, text, and the like. In so doing the scope of analysis is widened to address the larger question of running a conference.

'IFIP' is a particular instance of a society and was created as a legal entity of the state 'Switzerland'. Its existence was determined by the laws of that state and its legal persona rests upon the existence of that state. Should the state of Switzerland cease to exist then so would IFIP as it is presently constituted. At the universal level we would look for an antecedent universal (of which Switzerland is a particular), such as state or nation.

But what do we mean by nation or state? In the case of a legal person such as IFIP, the antecedent must have the power to grant such legal status to its affordances, so that the rights that the legal entity enjoys are confirmed and guaranteed by the antecedent. Similarly the history of France since 1871 has produced some five distinct republics, five states in all, but these states were arguably based upon the same French nation. Perhaps, then, 'nation' is the antecedent of 'state', although persons play roles in both. The role of 'citizenship' is appropriate for both. In strict legal terms the citizenship of a state is guaranteed

by its nationality laws. The citizenship of a nation is something more amorphous (are German speaking Rumanians citizens of the German nation?), but nevertheless substantive.

Behind the affordance of nation there is the most basic of all agents, the root agent of all behaviourial affordances, human society in its most general sense. Although this may be difficult for analysts to justify introducing into any schema, it is indisputably the *sine qua non* of our legal and social reality. Unfortunately we have the confusion of the term 'society' used for associations of the IFIP kind. We will distinguish between them by capitalising for the term for human society in general. If the society is organised in a particular manner then it may realise an instance of a 'federation'. Another most fundamental affordance is that of 'person', which is a ubiquitous term in any organisational specification, and here we make 'Society' in general its antecedent.

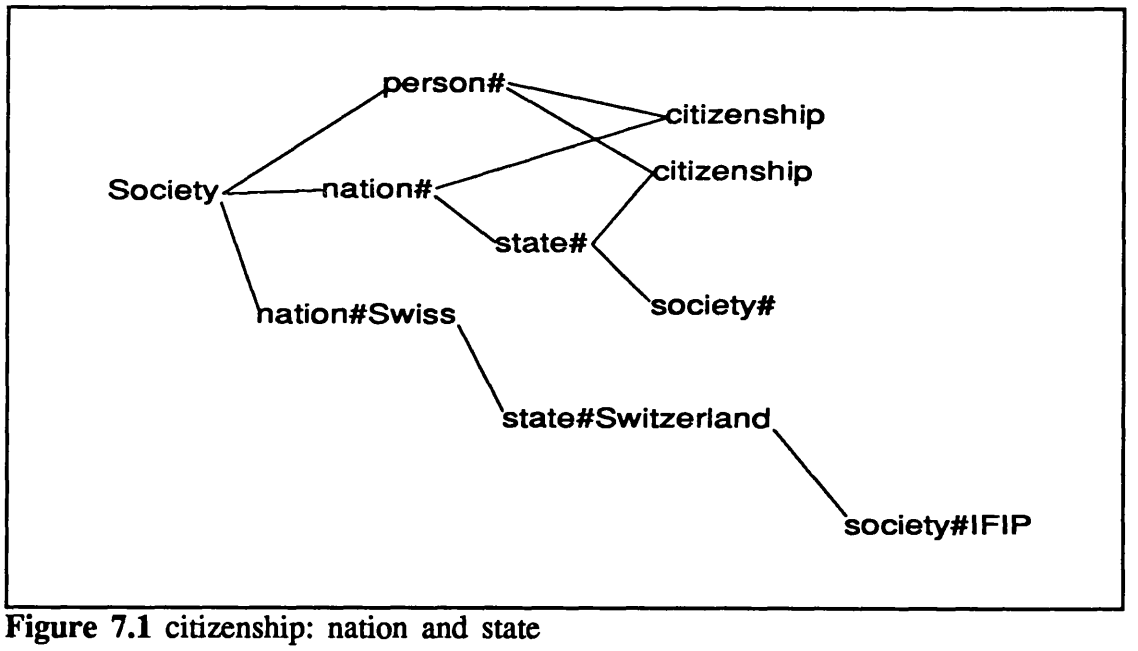


Figure 7.1 citizenship: nation and state

Affordance	**Antecedent1**	**Antecedent2**
nation	Society	-
state	nation	-
person	Society	-
IFIP	Switzerland	-
society	state	-
federation	state	-
citizenship	person	nation
citizenship	person	state

'Data processing' is the name of a specific type of learned society, which is at the generic level, whilst 'national' is a title bestowed upon any society but where the bestower remains, always, to be identified. In some cases it may be the state of provenance. If an instance of a society finishes, then so do the dependent instance of 'national'. At this juncture we might ponder the choice of the term 'society', since in the IFIP context it could seem very general. The term might be used to refer to associations of various kinds: dog lovers, Freemasons, lobby groups of all descriptions. For the sense used in the CRIS case, something more narrowly focused is required. When a body of academics and practitioners is formed to pursue the development of knowledge in their chosen field, perhaps the term 'learned society' might be more appropriate. It conveys more forcefully the nature of the work in which IFIP is engaged. A word of warning though: the introduction of new terms should be done with great circumspection and with the agreement of the users. The term 'learned society' could be seen as a possible alias for 'society' in the IFIP domain.

Affordance	**Antecedent1**	**Antecedent2**
learned society	state	-
national	learned society	-
data processing society	state	-

The text of the problem definition mentions that IFIP has members from "about 40 countries". 'About 40' is a determinant, where the determiner is individuality, that allows the discrimination of a number of countries. This instance of measurement will cease to exist if the countries themselves no longer do so. 'Country' however is rather ambiguous as when British people use the term loosely to refer Wales, Scotland, England or Northern Ireland, and sometimes to the United Kingdom. IFIP appears to adopt the latter connotation (as per 'state' above) but the International Rugby Board and the Federation of International Football Associations, for example, use the former!

IFIP organisation

All the 'organisational units' (a term introduced in the explanatory note "Example B, Design Specification for Conference Organization"), such as 'Technical Committee', are parts of the IFIP structure. Their ontology is the same as the

whole body, and they depend on the same realisations for their own existence, in this case the State of Switzerland. If for any reason this state were to cease to exist, IFIP and its parts would have to reconstitute themselves under another state's legislation. At the highest levels in the organisation there are the General Assembly, the Technical Assembly, the Council and the Working Conference. Each of these higher level bodies, as we saw in pass 4, breaks down into smaller ones that take care of day to day matters. To simplify much of the analysis and its representation, we will use the affordance of 'organisational unit' to be a generic to all the specifics of IFIP organisational structures.

Affordance	**Antecedent1**	**Antecedent2**
organisational units	IFIP	-
Technical Assembly	IFIP	-
Technical Committee	Technical Assembly	-
Working Group	Technical Committee	-
Task Group	Working Group	-
Special Interest Group	Working Group	-

This device allows us to simplify representing some of the structural features. Within each of the organisational units there will be found the usual offices for member, chair, secretary and treasurer. These latter are examples of an 'office', parts of the organisation, without whose existence the organisation would not exist. As with the 'member' part of, say, the Technical Committee the office persists even if the incumbent is for some reason not appointed. We could draw the analogy with the structure of a representative body such as the House of Commons: the demise of the sitting member for Chipping Sodbury does not imply the finish of that particular role of member, just the finish of that particular incumbency. A visit to the Chapter House of a great English cathedral supports this way of approaching organisations, for there we find that the representative canons for each parish in the diocese have their own seats in the polygonal chamber, each with the name of the parish inscribed in stone above. The certainty of a seat in a full meeting is something that some parliaments have still not yet managed to accomplish!

Persons who occupy the offices in an organisational structure can be seen as incumbents. This would be a general role name, instantiated when a person and an office jointly realise an 'incumbency'. Take away either one and the incumbency finishes. Churches often have long lists of past vicars going back into

the mists of time showing the starts and finishes of particular realisations of incumbencies. In those cases it was the death of the person which finished the existence. In other cases it could be the removal of the office itself, as happened during the time of the Reformation in England.

Roles in relationships always have two antecedent: the relationship and the agent involved in it. For 'member' the relationship will be 'membership' and the agents concerned will be the various data processing societies which are at any time currently members of IFIP. Should they, or the membership relationship itself, cease to exist then the instance of 'member' would do likewise. But who may become members of a learned society such as IFIP? As with many of these kinds of organisations membership is possible both on a personal level and on a corporate level. A corporate body such as a company may join as may a private individual. The affordances 'company' and 'corporate body' will be dependent on a particular state. It will be useful to be able to recall which persons are employed by which corporate bodies, perhaps when deciding from whom to seek out sponsorships, and so we can add 'employs' as jointly afforded by 'person' and 'corporate body'.

Corporate bodies can play an important part in funding and lending more status to Working Conferences by sponsoring them. In terms of sponsorship both Working Groups, from the IFIP side, and friendly businesses may act as sponsors. This gives rise to two affordances of sponsorship, both having 'Working Conference' as one antecedent: 'sponsorship' where 'corporate body' is the second antecedent, and 'sponsorship' where 'Working Group' is. A role of 'sponsor' arises when sponsorship takes place, with 'sponsorship' and whichever is the role occupier as the other antecedent.

'Appoint', as every communication act, has two antecedents of the agent performing the act and the sign or utterance that the agent uses in the execution. The sign always refers to legal and social relations that the agent wishes to influence in some way. In this case the sign would refer to the start of the membership of a person of a Technical Committee, that is: **"+membership(person# Technical Committee#)"**. Appointing the person will be a member society wanting representation on that committee. 'National Representative' is handled as a role in

the membership relationship, with membership and the member society as the antecedents.

Affordance	Antecedent1	Antecedent2
office	IFIP	-
incumbency	person	office
membership	learned society	learned society
membership	person	learned society
appoint	learned society	"+membership(person# Technical Committee#)"
"+membership(person# Technical Committee#)"	learned society	-
		-
corporate body	state	-
company	state	-
sponsorship(1)	corporate body	Working Conference
sponsorship(2)	Working Group	Working Conference

'Each' is a determiner of Technical Committee and therefore has this as its antecedent. Every affordance which may be individuated can have 'each' as an affordance. Each TC has a number of 'Working Groups' which tackle the detail of the work in the area of concern. Working Groups are part of the TC and have the same antecedent as it. Working Groups involve themselves in various 'activities' and these include the organising of the "small invited conferences", or 'Working Conferences'. The conferences are always clearly established as IFIP conferences, and not some affordance of the Working Group. Whereas the WG takes on the task of the bringing into existence of these conferences, the antecedent is IFIP itself. By using determiners such as 'small' and 'invited' for a conference the characteristics of the Working Conference start to become clear enough to allow us to discriminate it from other universals of conference.

Affordance	Antecedent1	Antecedent2
small	conference	-
invited	conference	-
conference	IFIP	-
Working Conference	IFIP	-

Inviting contributions to the Working Conference

Every Working Conference, as with any conference, has to have a declared subject as its theme in order to focus the attention of the participants. The 'subject' will generally be included in the label or title of that particular Working Conference, but it would be wrong to rely on this convention without analysis. The subject of the

conference is one more way in which its particularity is established. Subject is a part of the knowledge domain of IFIP and to relate the Working Conference to it we need to introduce the harmless term 'on'. We can therefore conceive of subject as participating in a relationship with conference in the realisation of 'on'.

To organise the Working Conference there are two types of structures: the Organizing Committee (IFIP uses American spelling) and the Program Committee. These are akin to the WGs and TCs as they relate to IFIP. They form part of the Working Conference, parts that have specific tasks to fulfil. Every Working Conference, and we would suppose all other conferences, need these bodies to prepare the ground. Their antecedents are once more IFIP. The text reveals the rule that the OC should be 'based in' the same country in which the Working Conference is to held (viz. 'held in'). The meaning of 'based in' needs to be established. It could refer to the normal residence of the committee members, that is, that the members should be drawn from those normally resident where the conference is to be held. It could be referring to their nationality as well. This signification is borne out by the stipulation that the PC should be 'international', implying that its members should be drawn from many nationalities. Or else it might refer to the location of the meetings of the committee: they should be convened in the country chosen to hold the Working Conference. Whatever the precise definition may be, the antecedents of 'based in' would be 'Committee' and 'state'. As for 'held in', the text specifies that conferences are held in countries, but on reflection the term 'hold' and its derivatives normally refers to assemblies of people, and so it would be the meeting of the conference that is indicated, rather than just the associated organisational activities, and this implies antecedents of 'meeting' and 'state'.

Affordance	**Antecedent1**	**Antecedent2**
subject	IFIP	-
on	Working Conference	subject
based in	Committee	state
held in	meeting	state

The year of 1982 saw a particular Working Conference held in a particular country, the Netherlands, and realised an instance of 'on' a particular subject, **'Information Systems Development Methodologies: a Comparative Review'**. As with all

particulars their antecedents are always particulars. Hence the antecedent of that Working Conference is IFIP.

Affordance	Antecedent1	Antecedent2
WC "ISDM: CR"	IFIP	-
on	ISDM: CR	WC "ISDM: CR"
WG 8.1	IFIP	-

Getting contributions from academics and practitioners requires the conference organisers to engage in a kind of conversation with such persons. As we saw in the fourth pass at the text, this means that communication acts are used. The structure of such an act gives us the dependency relations directly. The 'call for papers' is a sign type whose antecedent is the Working Conference, in practice the PC members, and the communication act is 'invites'. For the response to this invitation from the would-be contributer, the communication act is 'accepts', and the sign type is 'letter of intent', with the person as its antecedent.

Those who write papers, or at any rate are asked to write them, will usually have some expertise in some area of the chosen subject for the conference. Perhaps they have contributed papers before for conferences of IFIP or other organisations. This would be represented by the affordance 'expertise', where the antecedents are 'person' and 'topic'. We would not expect our members to have expertise in the whole of a conference subject. When people contribute papers for the Working Conference, or act as a referee, or perform other services such as committee work, then we ought to be able to employ the term 'participation'. Future IFIP conference organisers will be interested to know who has participated in the work of a Working Conference, and this does not imply that they have necessarily attended the conference. Participation may fall short of actually attending. Perhaps the paper has been accepted and even discussed, but the author could not be there in person. Persons can also realise 'participation' at the level of the meeting, and so here we would be making a distinction between the work of the conference in general, and the particular work of the meeting.

Each 'paper' treats a 'topic', and one 'version' of the paper will realise a 'revision' of a previous version. In terms of the scope of the individual papers, they will tend to address in more detail particular parts of the chosen subject of the conference. For the methodology subject, aspects of analysis, design and

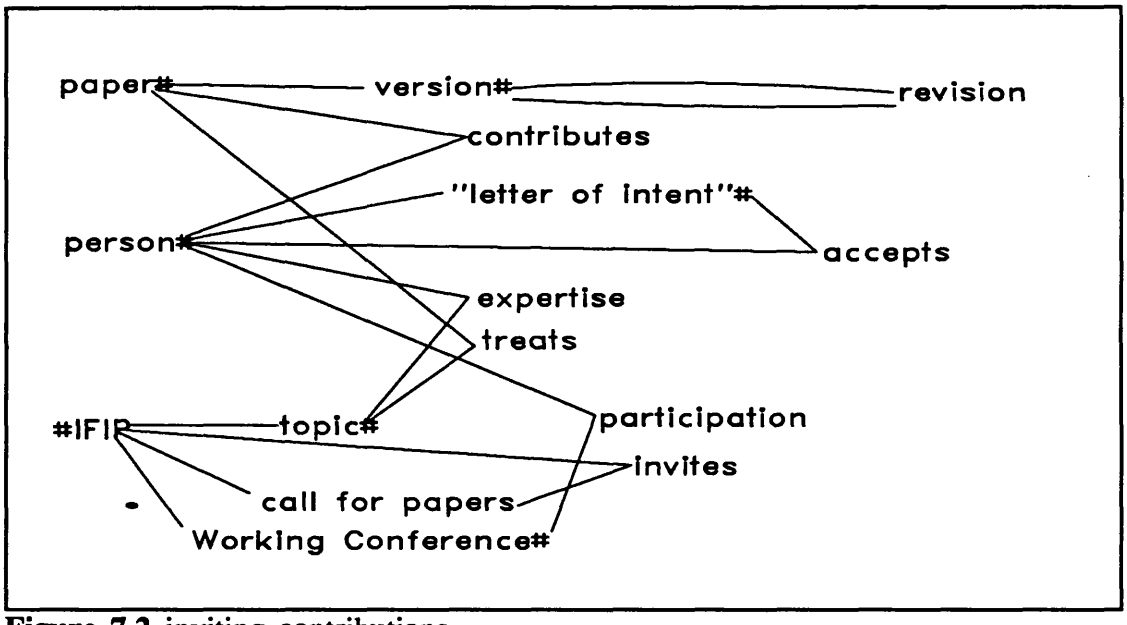


Figure 7.2 inviting contributions

implementation might be considered. Papers and topics are not dependent upon one another and might be related through a joint affordance of 'treats'. At the highest level of abstraction a particular paper might be referred to in discourse while still not written out. Think of how publishers refer to a book they have commissioned even though it still has no physical form. Such notions of literary artifacts have important matters of legal determination attached to them, and the final arbiter in any dispute regarding copyright, for example, will be the appropriate state. Following this line of logic we arrive, with 'state', as the antecedent of 'paper'. A general affordance of state to cover these kinds of creative output, and one we should use for economy, is that of 'work'. And one other example of a kind of work which is used in this context is 'abstract', still a piece of creative output but not a paper.

Some may think that the person who creates the paper should be the antecedent, but we cannot make the author the antecedent of paper, for the paper will survive the passing of the person. This would infringe the NORMA rule of ontology. A particular state recognises and protects such cultural phenomena, with the force of law, even after the demise of author, copyright holder or commissioning body.

Affordance	Antecedent1	Antecedent2
call for papers	IFIP	-
invites	IFIP	call for papers
letter of intent	person	-
accepts	person	letter of intent
paper	state	-
treats	paper	topic
revision	version (new)	$version^{-1}$ (old)
participation	person	Working Conference
expertise	person	topic

Discussing papers contributed

The paper contributed by a person does not consist in the physical form of written text sent to the Program Committee. It could conceivably be delivered by electronic mail, by telephone or by dint of some passing troubadour charged with the job of reciting the work faithfully to the Committee. As far as the law on copyright goes however the work must consist in some physical form or 'medium', such as a paper hard copy or a 3.5 inch diskette, for such rights to be established. Thus some copy must exist but copyright is established over the work itself: the conference paper. At this level we are dealing with the sign-type and not the sign-token which may assume many forms. To have a copyright we must have a work, in this case a paper, in existence. The ownership of that copyright, however, must belong to a legal person of some kind, and not necessarily the author. A 'copyright' has 'paper' and 'legal person' as its antecedents: legal person rather than just person because the owner might be a corporate body. What is recognised as a legal person will depend upon the state concerned.

The 'copy' has as an antecedent 'version (text)'. The version will have as its antecedent 'paper'. In an international organisation like IFIP there will be several working languages and so any papers will have to be expressed in one language or another, hence there may be English texts, French texts and so on. Once again the antecedent of 'text' will be 'Society' and a 'paper' will be normally 'in' a 'text'. If we were to make the antecedent of 'text' either 'state' or 'nation' then we could not cater for the eventuality of these languages outlasting these social and political entities, and yet still being interpreted correctly, as with Ancient Greek or Latin.

Affordance	Antecedent1	Antecedent2
medium	state	-
text	Society	-
in	paper	text
version	paper	
copy	version	medium
copyright	paper	-
ownership	copyright	legal person
legal person	state	-

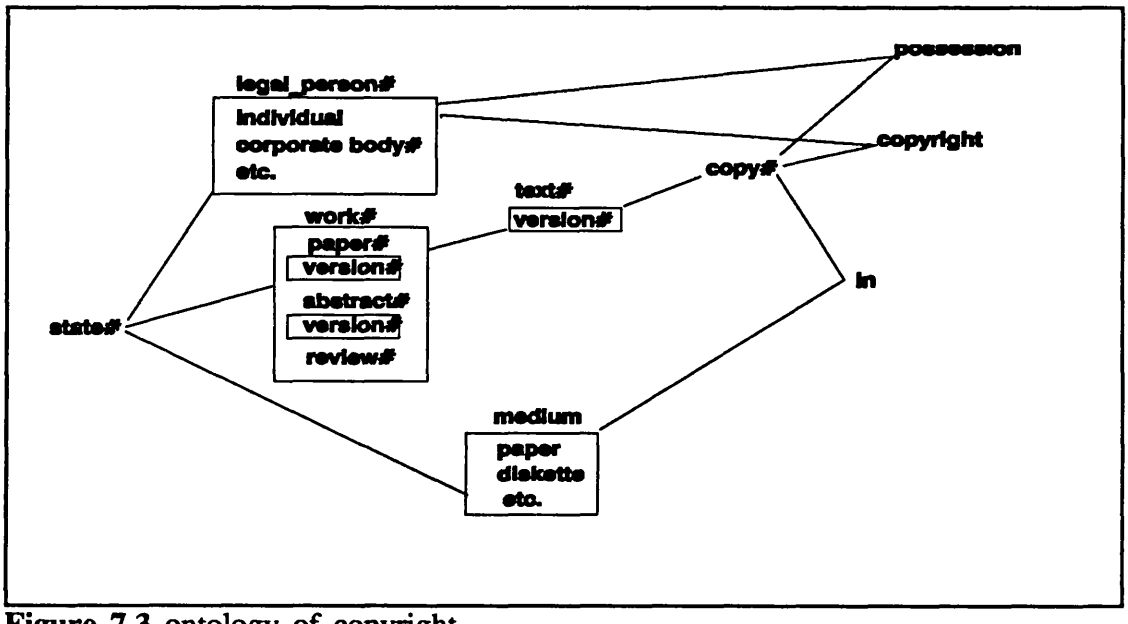


Figure 7.3 ontology of copyright

Usually we would expect the person who wrote the paper to be the person who holds its copyright. But complexities can arise. Take for example the occasion when the paper was contributed by a limited company, a systems house that adopts a successful methodology of its own for developing systems. This company might commission two of its employees to write the paper for the Working Conference. To make this distinction we need a term 'authorship' with antecedents of 'person' and 'paper', as well as 'contributes' with 'legal person' and 'paper'. Each paper submitted will be reviewed by members of a refereeing panel whose membership is drawn from persons known to have expertise on the subject of the conference. Therefore 'membership' will be part of the panel, itself part of the Working Conference, and such a membership will have to be jointly afforded by 'person' and 'refereeing panel'. Members of such a panel will enjoy the role name of 'referee' by virtue of their membership, although it could happen that a

person who reviews another paper is not a member of the panel, and would also earn the title 'referee'. In the light of favourable reviews, some papers will be accorded the status 'selected', while others will be marked as 'rejected'. Both these affordances have a single antecedent in 'paper'. Experts in the conference subject will require expertise, and 'expertise' needs a 'subject' and a 'person' to be instantiated.

A Working Conference typically will meet over a period of some three days, and will be broken up into sections to deal with the various topics covered by the contributions. A part/whole hierarchy may be discerned of 'meeting' and 'session', where the meetings are divided into sessions. Selected papers were 'grouped into' different sessions. IFIP's CRIS88 conference was divided into Session 1 on "Automatic aids for analysis and design", Session 2 on "Approaches to automated system generation" and Session 3 on "Integrated and automated analysis, design and construction". During each session a number of the selected papers were presented, and this represents a further partition into 'presentation'. During a 'presentation', the speaker usually would present his own paper to the conference, permitting a 'discussion' to be realised. In order to be able to present and discuss a paper the person concerned would have to attend the meeting, or at any rate the session. At this point we should include the affordance of 'attends', with antecedents of 'session' and 'person', although restrictions of space mean that some who would like to attend may not. IFIP has developed the notion of eligibility: a person may be eligible to attend if they have qualified in some way, for example, by writing a paper, working on a refereeing panel or Technical Committee. However, eligibility in itself does not suffice, and priority is awarded on a pre-determined scale. Therefore we have an affordance of 'eligibility', and the antecedents can be arrived at by asking the question "Of whom for what?" And the answers are: 'person' and 'Working Conference'. 'Priority' is then a determiner of this eligibility. Top priority would be indicated by the value '1' for example.

Affordance	Antecedent1	Antecedent2
authorship	person	paper
contributed	legal person	paper
refereeing panel	Working Conference	-
membership	refereeing panel	person
meeting	conference	-
session	meeting	session
grouped into	paper	person
presentation	session	meeting
included	paper	meeting
discussion	session	paper
eligibility	person	Working Conference
priority	eligibility	

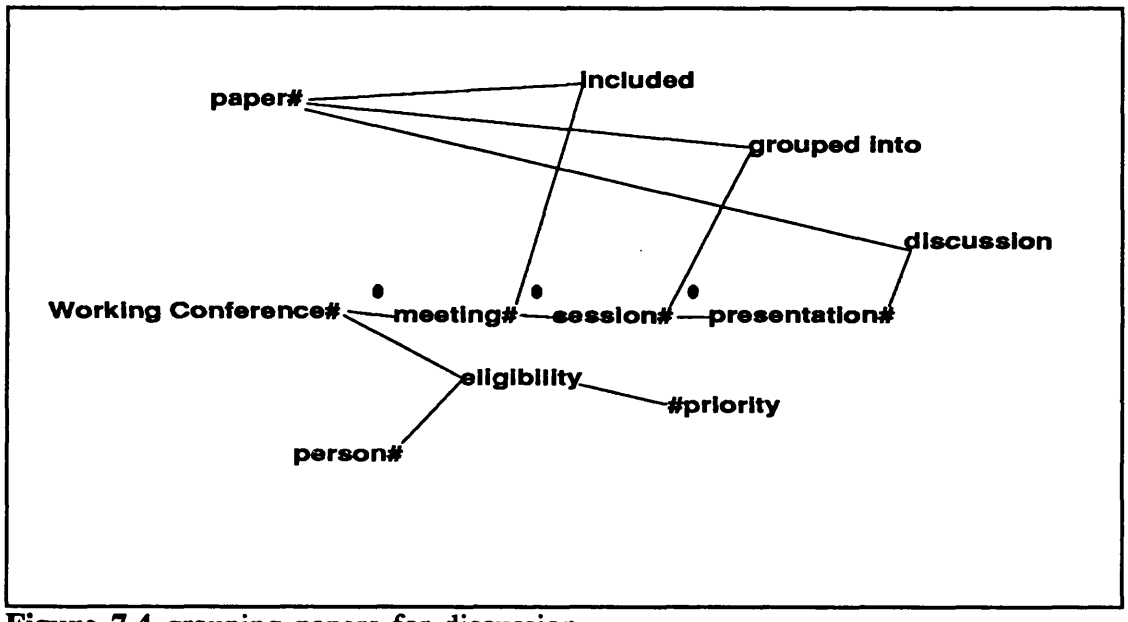


Figure 7.4 grouping papers for discussion

Tracking the movements of papers

During the period of reviewing and assessing the contributions people have made, there will be a need to send copies of papers around the members of the refereeing panel. Normally at least two referees will review a paper. To locate a person for the purpose of sending a paper we usually use the address we have for them. A person is located at an address. The person and the address are ontologically independent of one another. An address does not depend upon a person for its existence. So what does it depend upon? Postal addresses are affordances of the national postal authority, in its turn an affordance of the state. If for any reason

the name of the street changes, then that address ceases to exist. Therefore 'located at' and 'address' must be further affordances required. Addresses themselves are sign types used to represent physical locations. Changing the name of a place does not alter its geography but the terms we use to talk about that place. Rhodesia and Zimbabwe are simply different terms used to refer to the self-same physical location. An address and a physical place jointly afford 'represents'. To complete this section of the schema we need to add in two further affordances 'PTT' (Postal Authority) and 'place', the latter having 'state' as its antecedent.

A copy of a paper will be sent to a person, a referee for example. But sending the copy does not mean, unfortunately, that it will arrive. Only when a person has a copy can the success of the operation be secured. Here we would want to make sure that our schema does not assume too much. Perhaps in the halcyon days of the Royal Mail this assumption may have even been justified, but certainly not any more. Consequently we distinguish the affordances of 'sent to' and 'has', also in this section, for both person and Working Conference in relation to a copy of the work.

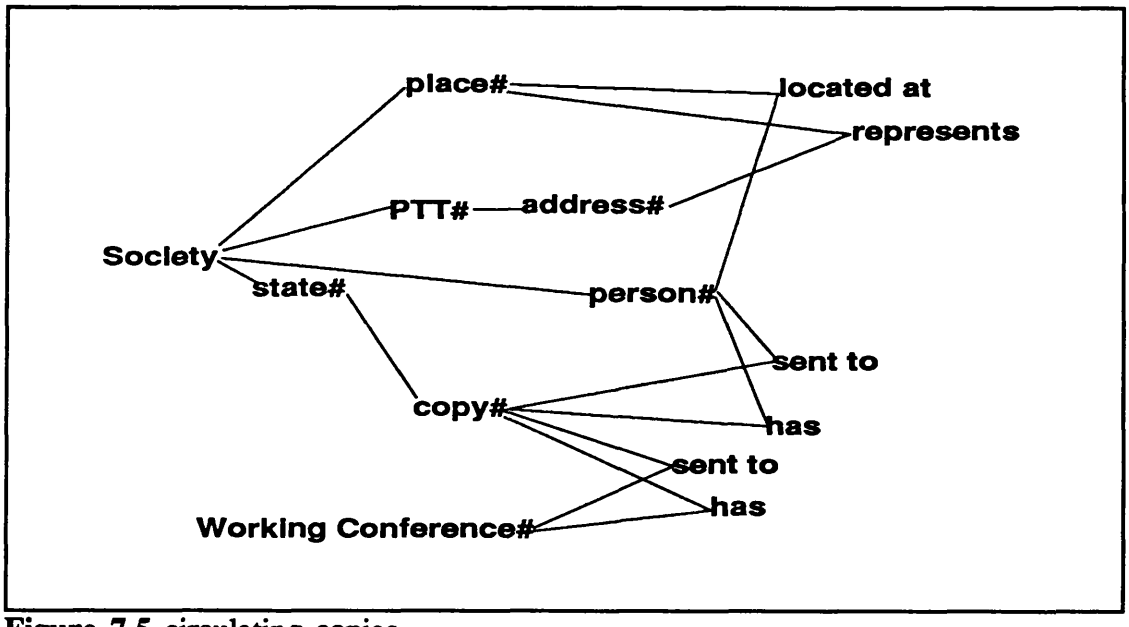


Figure 7.5 circulating copies

Affordance	Antecedent1	Antecedent2
place	state	-
Postal Authority	state	
address	Postal Authority	-
represents	address	place
sent to	copy	Working Conference
sent to	copy	person
has	person	copy
has	Working Conference	copy

Our root agent for problem domains of this large scale is 'Society'. All our sophisticated social reality depends ultimately on this base. As an affordance of 'Society' we have 'nation'. Who is the authority deciding whether a nation is in existence? Nations come and go, but over very long time periods. The notion of a Viking nation or a Celtic nation for most commentators no longer carries much weight but that of a Danish, a Welsh and a French nation, to name but a few, carries more conviction today.

The question of who decides upon the existence of 'state' is ticklish also. One has only to cast an eye on the diplomatic dilemmas concerning the recognition of such entities as Palestine, Biafra or Lithuania to obtain an inkling of the problem. Here is not the place to dwell upon such matters. However there are international bodies of various kinds: for instance, the IMF, the World Bank, the United Nations and Amnesty International, all of which accept responsibility for their own definition.

A third very basic affordance is that of 'person'. The questions surrounding the determination of the existence of a person —when he starts and finishes to exist— are vital for many business and social entities. To make a judgment about whether a person has ceased to exist, for example when they have been in a coma for years, is no simple matter.

In all these cases, 'nation', 'state' and 'person', the judgement which is most relevant and critical is the one taken by the overriding body itself, IFIP. Where there are controversial questions to be resolved, IFIP will have to stand by its own decisions. If it wishes to recognise a state, with the concomitant of having its National Representatives appointed to Technical Committees, then it is free to so decide. And also carry the consequences. This is the kind of decision which

international sporting bodies, such as the Olympic Committee, have to make regularly.

IFIP itself is a legal persona recognised by the state of Switzerland, and this is its authority. For the authority for 'society', 'federation' and 'learned society' we need only look for the 'state' (the universal of Switzerland) where the society, federation or learned society is constituted.

Many affordances have the IFIP Council for their authority. IFIP Council decides upon what constitutes a 'Working Conference', a 'conference', whether it is 'small' or 'invited'. It will also decide upon the division of the knowledge domain of the learned society into its constituent parts: 'field', 'subject', 'area' and 'topic'. As research advances new instances will arise of whole new subjects which may require new Technical Committees for them. The IFIP Council will reserve this decision to itself. Lower down that scale the Technical Committees will decide upon instances of 'areas'. For an individual Working Conference the Working Group which sponsors it will decide the existence of an instance of 'on': when a Working Conference is on a particular subject or not.

In the preliminary communication between the PC and the prospective contributors and attenders of the Working Conference, we find some interesting questions of authority. Initially the PC invites persons to contribute by sending out the 'call for papers', using some sign token to realise the communication act, usually a printed sheet of conference details. Although the receiver of the 'call' is the one to interpret the meaning of the signs thereon, the authority on whether the utterance exists or not must be the PC. Similarly in using that sign to realise the communication act of 'invites', once again the authority is the PC. For the person who 'accepts', a sign to embody the intention has to be in existence, in this case the 'letter of intent', and then the act of 'accepts' can be performed.

In Appendix A, the authority columns reveal the appropriate authority for the start and finish of each affordance. More often than not this is the first or second antecedent of the affordance.

Time is a central notion in information systems work and often the languages or logics that we use when analysing and specifying take little, if any, account of it. NORMA, however, takes time as one of its central notions, where

existence constraints are exercised upon all affordances. Every instance of an affordance has a start and a finish, and these are markers held in the record. English is full of terms that refer to these two extremes of a lifespan: birth and death for a person; kick-off and fulltime for a football match; commencement and completion for a contract.

In addition to the starts and finishes, which we come to know after they have occurred, there are the other concepts of beginning and ending. These relate to the intentions of agents who wish to bring things into existence and take them out. A beginning is rooted in the intention of an agent, a "twinkle in the eye" perhaps, which does not immediately give rise to the start of something. But without the beginning there would be no start.

The CRIS case does not offer many examples of this mechanism. When the problem definition states that "Working Groups are encouraged to organise conferences", we can construe this as referring to the beginning of a conference. Organising, in this sense, means doing the necessary to bring about the start, or finish, of something. A similar notion maintains in the use of preparing as in "preparing a list of attendees". Preparatory activities provide the necessary precursor to the realisation. Both preparing and organising point to the beginning of some realisation.

NORMA provides the analyst with an organic structure for all affordances and this structure includes the ability of agents to recognise the beginnings and endings of the realisations they afford. These constructs are inbuilt in each affordance in any semantic schema.

Corporate bodies

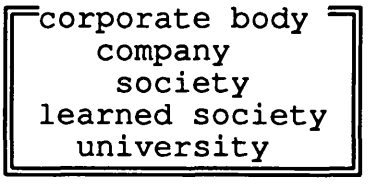
IFIP is stated to be a federation, a term usually reserved to describe constitutional systems. This federal structure indicates what IFIP is comprised of: large corporate entities, already constituted under their own local legislative frameworks. Therefore IFIP is a society, in its case a learned society, with a federal constitution. First a learned society and then a federation.

The generic of corporate body covers all the various types of incorporated organisations: company, society and learned society. It would also include parastatal

bodies such as some university or a nationalised industry. If we make this grouping we can say, for example, that a corporate body may employ a person and describe the organisation more succinctly. What we have in fact is a norm:

corporate body ← company, society, learned society, university, etc.

This norm says that whenever we have an instance of the affordances to the right of the arrow we have a corporate body. We can illustrate this in the ontology chart by drawing an arrow to connect the specifics to the generic, or by drawing a generic/specific box:



Treating universals as a set means we should search for what they have in common, knowing that on further inspection the particularities of any realised instances will emerge. The affordance in common to this group in the CRIS example is that of 'employs(corporate body, person)': they can all be employers of persons. Differentiating them are the affordances of the various organisational units of a learned society like IFIP, which has 'membership' jointly afforded from another learned society. When the question of copyright arises the legal question of the agents involved comes to the fore. Each of these bodies is answerable in law for its actions and can be sued in the courts. This is also true of the private individual. Hence we find another generic/specific categorisation of:

legal person ← person, corporate body

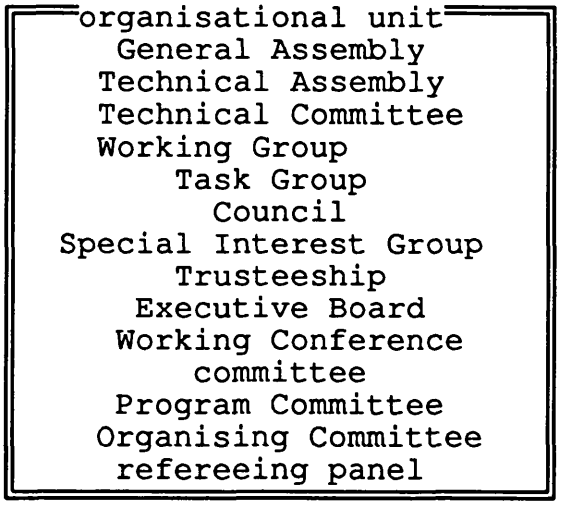
enabling us to group together these very different affordances that have similarity in one respect, at least in the CRIS case, they may both hold the copyright of a literary work.

Organisational units

Given the very large, complex and federal fabric of IFIP it comes as no surprise that there are so many organisational units, often nested one inside the other. For the purpose of clarification we do not box them together on the ontology chart but separate them so their functions are more obvious. This does not hide the underlying genericness of the structure:

organisational unit ←	General Assembly, Technical Assembly, Technical Committee, Working Group, Task Group, Council, Special Interest Group, Trusteeship, Executive Board, Working Conference, committee, Program Committee, Organising Committee, refereeing panel

All these affordances have in common that they are part of another organisational unit, and they are comprised of a generic element: 'office'. The various types of offices will be largely similar, but the particular duties will differ.



It must be clear with such a wide range of different organisational entities that there needs to be a wide variation in the affordances that each one has. The range and scope of the work of each within the IFIP world runs from concern with long

term strategic matters to the lowest level of organising a small meeting of a few committee members to discuss the agenda of the next business meeting. For convenience we group them together under this heading, in the full knowledge that on other counts we would treat them separately.

Office

Every organisation accomplishes the tasks in hand thanks to the holders of the various offices of which it is comprised. Each of the IFIP units is made up of lots of these offices, some more grandiose than others. By handling 'office' generically on one level we can avoid over-elaborating the chart with detail. Every office participates in a joint affordance of 'incumbency' with 'person'. The rule or norm on which this generic structure is based would take the following form:

office <==chair, president, secretary, etc.

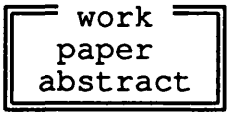
But the range of offices is wide. Just a few will suffice to give the flavour:

IFIP Council: president, past president, vice-president, secretary, treasurer, trustee
General Assembly: member,
Technical Committee: chair, secretary, national representative
Working Group: chair, vice-chairman, secretary, member
Special Interest Group: president.

Work

Conferences are primarily for discussion and exchange of opinions, centred around the ideas first expressed in the papers submitted and selected for inclusion, but as we have seen, other kinds of literary works are also to be found in this domain, such as referees' reports and abstracts. We have chosen to model the report as a paper which reviews another paper, and have then created a role for these kinds of papers. We would defend this since many papers themselves are reviews of literature.

Abstracts are short literary works. Comparison might be made with synopses for books, which although also short can still be used to create copyright for publishers. Some abstracts may not be developed into full conference papers, perhaps because they are rejected out of hand by the Program Committee, or for reasons concerning the author's ability to complete. Nevertheless the abstract has an existence of its own which needs to be recorded in the information system.



Papers can participate in a wide range of relationships which however preclude abstracts: inclusion in a session, being selected, being rejected. In this representation we figure them as specifics of the generic type work, and the economy of this specification technique, referred to in Chapter 4, means that we can allow 'paper' to inherit the generic affordances of 'work', while permitting particular characteristics to appertain solely to the former.

Conclusions

The CRIS case offers an example of a more amorphous domain to specify. It is not delimited by legislation, but nevertheless is most certainly under the control of overarching norms and internal IFIP rules. In practice many of the ambiguities and critical decisions will be settled at an informal level— who constitutes an expert in a field? what constitutes a valid acceptance to contribute? when is a conference session deemed to commence? did a person participate in the work of a conference?— are the kinds of questions handled on the spot by those with the responsibility to do so. Appendix A illustrates how vast the potential schema could be for this case, with something over 70 universals identified. Additionally a number of case data particulars have been provided to show what sort of surrogates might populate the surrogate tables. Although the complexity of the problem is somewhat daunting, this study shows that NORMA could take such a task in its stride, and the resulting specification ends as a very rich and complete blueprint for the ultimate development of a technical system for this case. At every point

the syntactic structures of the semantics of the language urge the analyst on to investigate the fundamental parameters in time and space of each term, and provide a clear framework in which to record the findings.

Chapter 8
The Process of Semantic Analysis

In this chapter we set out a method for applying semantic analysis, on the basis of the experience gained in the applications and other examples. Although analysts may have a sound grasp of the fundamental tenets of NORMA, this still leaves the question of how to begin tackling a problem.

Reflections on the applications

When addressing the question of how people can learn how to use an analytical technique, there are two possible answers: by osmosis, that is, by sitting next to someone who knows and learning on the job; or by following a route already mapped out through the tasks. This has the effect of creating an order in which things have to be done. In addition to applying the technique of semantic analysis to exemplary problems, another of the tasks of this work was to produce such a order. Although the substantive aim of the analysis is to insert as many values as possible into the surrogate table for each application, we could say that as long as many values as possible are entered into that table, there is no particular merit in addressing that generic task in one way or another. Indeed, glancing at the preceding three chapters could well produce the impression of three different techniques, because there is little resemblance between any of them in terms of the order in which particular tasks were carried out, nor is there anything unifying them in their content. However we accept that there is a need to identify the order in which the elements of the analysis should be tackled, particularly where beginners are concerned; we need to give some guidance on how to get started. This chapter indicates a path that can be taken through the analysis in order to answer this criticism. It is a method (not a methodology) and it does not profess to be the only one possible. It is offered as a distillation of experience the present author has acquired over four years of familiarity with using this technique.

It is possible simply to sift through all the terminology employed in the problem domain in order to gradually piece together a full schema, but this is the

approach that might be suitable for an experienced analyst. For the novice, pointing to the rich set of constraints is not sufficient. The need is to spell out a method, an order in which tasks should be carried out. In fact, having so many constraints makes it essential that there is a process laid out for carrying out the analysis.

NORMA is a tool with which we can begin to construct the schema from terms used in a discourse. These terms, or any non-linguistic signs, can be culled from the usual sources: rulebooks, regulations, documentatation and so forth. In addition, quite informal snippets of discourse may be taken and subjected to exactly the same analysis. In a number of passes at the text, illustrated in Figure 8.0, we apply all the rigour of the specification language to the material so that the ensuing schema is gradually shorn of all semantic anomalies, that is, semantically normalised. Each pass contains a number of operations to which we subject each term in the text.

In Pass 1, we want to know whether each term is worthy of further investigation or whether it should be dismissed for the time being. In Pass 2 we are concerned with universals, particulars, and individuals. Pass 3 continues with considering relationships and the roles of participating relations. In Pass 4 communication acts and their components are analysed, and states of agents. We examine determiners and determinants, and then we follow with considering parts and their wholes. Pass 5 is probably the most time-consuming and critical where we attempt to discover the antecedents for the affordances we have identified so far. Some of this work has already been accomplished in the previous passes. Having determined the ontological antecedents for affordances, in Pass 6 we seek to provide the authority which determines the existence, the start and finish times, for each affordance, and in Pass 7 we provide the start and finish dates for any affordance for which we have this information. Pass 8 considers the mood of each affordance: assertion, hypothesis, imperative, and interrogation. In Pass 9 we are interested in grouping together those affordances that are specifics of generics. Pass 10 sees the checking of ontological dependencies and the completing of the ontology chart. In the figure are set out the details to be entered on record for each pass, for each semantic unit, or elemental unit of meaning.

10 Passes at the text

Detail required	*To enter*
Pass 1	
Agent/Affordance	***Y or N***
Agent	***Y or N***
Substantive	***(S)ubstantive, (M)essage, (C)ontrol***
Alias of	***Name of affordance***
Pass 2	
Particular	***If Y then write P and name Universal***
Universal	***If Y then write U***
Particular Universal	***If Y then write PU and name Universal***
Individual	***If Y then write #***
Pass 3	
Relationship	***Write Label of affordance***
Relation 1	***Write label of first participating relation***
Role 2	***Write role name of above if any***
Relation 2	***Write label of second participating relation***
Role 2	***Write role name if any***
Pass 4	
State	***Y or N***
Communication Act	***Write name of Act***
Agent	***Give name of agent who performs Act***
Sign type (U)	***Name universal sign type***
Sign token (P)	***Name particular sign token***
Determiner (U)	***Y or N, if Y name scale***
Determinant (p)	***Name affordance determined***
Part of	***Y or N, if Y name whole***
Pass 5	
Antecedent 1	***Name one antecedent***
Antecedent 2	***If another antecedent name it***
Pass 6	
@+	***Name agent responsible for determining Start***
@-	***Name agent responsible for determining Finish***
Pass 7	
Start (+)	***Give start date***
Finish (F)	***Give finish date***
Pass 8	
Mood start	***Choose mood (A)ssertion, (H)ypothesis etc***

Pass 9
Group together generics and specifics

Pass 10
Check ontological dependencies and draw ontology chart

Figure 8.1 10 passes at the text in semantic analysis

Semantic units, agents and affordances: pass 1

In Pass 1 the text is scanned to identify 'semantic units', and we can begin by separating each term.

An	normally
IFIP	based in
working conference	the
is	country
required	in
by	which
IFIP	the
procedures	conference
to	is
have	to
an	be
Organizing Committee	held

Each word may not be a semantic unit but instead may be part of a term which is. Phrasal verbs such as 'based in' and 'held in' fall commonly into this category, but so does a term such as 'working conference'. Here the term has a precise reference which is more than simply the sum of its parts. A working conference is something more than a conference which is working, referring to a specific form of activity of IFIP. Where the terms begin with capital letters, such as with Organizing Committee, as a proper noun, this aids us with a rule of English orthography which indicates the reference to a particular entity.

These constitute the elemental linguistic building blocks with which those involved in the organisation construct meanings and hence get things done.

Eliminated terms

In seeking to derive a schema from text supplied in natural language, there will be many terms that we will have to set on one side. Most of these arise because they fulfil a purpose when using natural language as a specification language, but when using NORMA to specify systems, these terms have no place. Very often these are terms used in syntactical manipulations: and, which, they, has, whose, of, for. They function as logical connectives to maintain a continuous thread throughout the text. The term 'which' binds references together of the country where the conference is to be held to the country where the Organizing Committee is based. The pronoun

'they' refers to societies who have the power of appointing National Representatives. Employing 'of' is common for establishing relations between elements of discourse, for instance in the phrase, 'the federation of the national data processing societies', it serves to specify the particular type of federation. In NORMA these functions are handled by the logical structure of the language.

Most common of all is the redundancy of any part of the verb 'to be', for in NORMA instead of having states of affairs, we have responsible agents to determine that something exists. Being is handled by the existence parameters that apply to all affordances: there is a responsible agent who decides when an instance of anything is realised.

Existence possible: agent or affordance

As we complete the first pass at the text, we are trying to decide on what semantic units should be considered for later analysis. We never totally discard any piece of text that we have been given because it will always help to provide context for the terms we analyse. In addition to the reasoning provided above for not retaining certain terms, we may also approach the problem positively by asking whether each term can be realised by an agent, or in other words, can it have an existence? We can envisage the existences of 'working conferences', of 'Technical Committees', of 'members', of 'papers' and so on, but not of 'and', of 'whose' and of 'is'. Agents in NORMA have the capacity to realise by the affordances that depend upon them. Marking a term as capable of having an existence amounts to saying that it is a candidate affordance for the schema. Alternatively we may reject that term as a potential affordance. Here are some of the terms from the text that, at this point, we would not include in our schema:

> and; are; be; for; has; have; how; in; is; of; off; on; or; they; to; was; which; whose; would.

Agents who can take responsibility

Later in the analysis we will want to know who is to take responsibility for what exists. At an early stage it is convenient to mark down who are the agents in the

domain we are examining. Much of what is realised in this domain originates with these agents in any case. By agent, we might refer to a number of possibilities: an individual person; sets of individuals; corporate individuals, legal persons or groups; sets of corporate individuals, legal persons or groups. For the CRIS case the agents will include IFIP itself, Technical Committees, Working Groups, Working Conferences, Program and Organization Committees, authors, referees, data processing societies and so on. Each of these will be able to take responsibility for deciding when some affordance has started its existence. So for example, the Technical Committees decide when new Working Groups come into existence, whereas a Working Conference decides when the meeting has begun.

Substantive, message and control system

In this first pass we can also determine another vital piece of information about the affordances that we are analysing. We can distinguish between substantive affordances that concern the central tasks of the organisation, and those that concern the message passing and record keeping. A third category covers the affordances that relate to the control system. For the CRIS case most of the terms in the problem definition are substantive ones: federation, society, IFIP, committee and so on. However in the section dealing with 'Business Activities', there are a number of terms that refer to the message system: sending invitations, registering acceptances, generating lists. Such terms indicate the nature of their concern with procedure, rather than with the substantive tasks.

Similarly for control there are terms such as 'ensuring' which should be marked appropriately. When the design specification discusses the idea of member societies being allowed to appoint National Representatives, the ability of such bodies to realise these actions is not in question. The affordance of 'National Representative' is substantive, whilst that of 'allowed' refers to controlling norms.

The central affordance of 'paper' in this conference case highlights the problem of distinguishing between message and substance. At one level we can regard a paper as a work of an author, and here we are thinking about the intellectual contribution that has been made. We are not concerned with the form of the contribution. The use of the term 'paper' suggests a form that has been

common until now, but already the new methods are being used for recording and passing text for conferences. We must not confuse the two uses of the term 'paper' and in semantic analysis our prime concern is with the substantive notion.

Among the activities of the Committees of the Working Conference is the grouping of papers into sessions. Once more we have an affordance which is substantive. When the committee members decide which papers must be discussed together they are performing a task central to the work of the Working Conference. This grouping of papers serves to focus attention on certain key issues and is an expression of the priorities for the Working Group, as the committee members see them. Approached from another direction, it is conceivable that this grouping might be viewed as simply part of the routine procedures for dealing with the received papers.

Alias

Quite often there will be two or more labels that are used to refer to the same affordance. Usually there will be good historical reasons for this, as for instance when there have been distinct language communities, each with its own usage. Or it might be simply a matter of convenience, so that 'IFIP' is a shorthand form of 'International Federation of Information Processing'. One is simply an alias for the other. Another possible example is with 'submitter', which is in the problem definition text, and 'contributor', which is a term suggested as a role name by the term 'contributes'. Both terms connote the provision of some material to a third party. But are they labels for the same affordance? In this example we might agree that this is so, although the idea of contributing perhaps implies less constraints surrounding its execution than submitting. In the final analysis we would have to seek the opinions of those who operationalise the terms.

Here we have the result for the semantic unit 'IFIP'. That it is a possible agent or affordance and there can be no doubt that it exists, under the ægis of the state of Switzerland. Further consideration leads to the conclusion that IFIP is also a responsible agent, in the sense that it can and does take legal, and social, responsibility for its actions. IFIP is not merely part of a message or control system but is a substantive entity in itself. As an instance of a learned society it

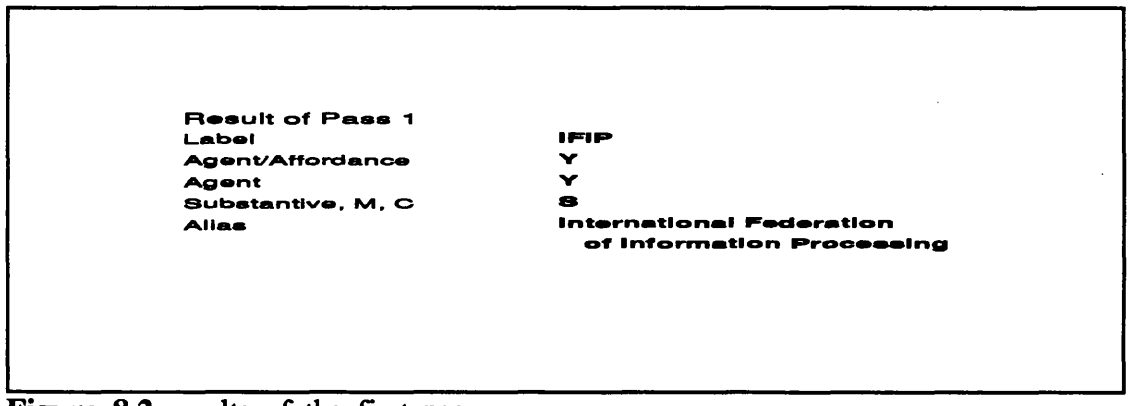


Figure 8.2 results of the first pass

is a particular example and not some universal case.

Universals, particulars and individuality: pass 2

In the second pass we examine each term to decide whether it is a universal or a particular universal, or a particular, an instance of a universal. Finally we note whether it is an individual or a continuum.

Universals

Universals represent the invariants that shape the domain, and for the CRIS case there will be very many of them. The problem definition defines in broad terms the structures of the conference organisation test case. Terms such as 'federation', 'societies', 'National Representative' indicate universal affordances and do not refer to any particular instance of one. Given that many problem definitions will articulated in such a general way, this is not surprising. Our schema will attempt to provide similar generality. A universal represents the ability to realise a particular instance of that behaviour. Consequently while the discourse centres on 'Working Groups', 'Working Conferences', 'federation' and 'countries' then we are dealing with universals, and we mark them with a 'U'.

Particulars

When considering particulars, we concern ourselves with an instantiation of a universal. So instead of talking about Working Groups in general, we might refer to one in particular. Hence Working Group 8.1 is a particular of the universal

'Working Group'. Similarly for federation there is the particular 'IFIP'; for country, 'Netherlands'; for working conference, the 1982 instance; for topic, 'Information Systems Design Methodologies: a Comparative Review'. Notice however that the particulars do not have to have been realised. We may talk about a particular paper that we want someone to write, or a particular conference that we would like to organise. Whether the particular has been realised or not depends upon whether we can find the agent responsible for its determination to confirm as much.

When marking the affordance with a 'P' we can also indicate, if known, the universal of which it is particular.

Particular Universals

Handling universals and particulars is not always straightforward. Occasionally there are cases where a further category of particular universals may exist. Take for example the case of carpentry. A carpenter will refer in discourse to universals such as nails, screws, bolts, and nuts. But each of these categories will be subdivided into subsets of sizes, such as one inch, inch and a half, and so forth, still not referring to any one instance of them. These subsets of the universals we classify as types of universals, or particular universals, and in this pass we would indicate what the universal is, when there is a particular universal. In the CRIS case, there are few examples of these, but the two committees that do the groundwork for the Working Conference arrangements can be modelled in this way. Working Conferences can have committees, and the Program and Organising Committees are cases of these. However the PC and the OC are not particulars, there may be many of these in existence at various times, when for example there are several conferences being arranged concurrently, for example the conference on the topic on 'Temporal Aspects of Information Systems' held in France and sponsored also by WG8.1 was being organised at the same time as the CRIS conference. Therefore OC and PC are the labels of particular universals, where the universal is 'committee'.

Individuation and Identity

Certain affordances we will be able to classify as individuals, that is pick them out singly from a collection of similar instances of the same universal. So that we can distinguish one conference from another, one person from another, but not one instance of 'priority' from another. Having established the individuality of an affordance we can perform measures to determine partially or completely its identity. Often a name will be sufficient to identify successfully a person in a given context, but knowing their sex, weight or height, will not fully do so. Notice that the particularity of some affordance is established by its antecedents, but not its identity. We know that a particular priority has been assigned to a particular person, but we cannot, as such, identify this priority. Our concern here is to decide whether we can individuate an instance of the affordance, and if so we use the hash sign '#'.

In the case of 'Working Conference' we can establish that unless we have a label that indicates to the contrary, such as Working Conference CRIS 88, then we are dealing with a universal, and not a particular. Where there are several subtypes of conference, as here, then this indicates to us a Particular Universal. IFIP will hold other sorts of conferences which are not small and invited, as with

Results of Pass 2

Label	**Working Conference**
Agent/Affordance	Y
Agent	Y
Substantive, M, C	S
Alias	
——Pass 2	
Particular	**No**
Universal	**conference**
Particular Universal	**PU**
Individual	**#**

Figure 8.3 the second pass

constitutional conferences. Because we can distinguish between one instance of a

Working Conference and another, for example 'Computerized Support during Systems Life Cycle', held in Great Britain, and 'Temporal Aspects of Information Systems', held in France, we can add the information that instances of it are individuals.

Roles and relationship: pass 3

Some terms indicate a relationship between two affordances, and where such a relationship exists there will often be role names for the two relations in the relationship. Where terms such as 'held in' and 'based in' are employed then we are prompted to search for the two relations of the suggested relationship, and possibly two role names. We are told that an OC should normally be based in the country in which the conference is to be held. Incidentally, the knowledge that we need in order to deal with the location of OC and PC members points to the requirement for more analysis to provide schema support for residential information. Given the basic structure of a relationship, we can sketch out for 'based in' a series of entries such as these.

Relationship	**Relation1**	**Relation2**
based in	OC	country
	Role name	**Role name**
	?	?

The relationship necessitates two affordances to realise it, that is, an instance of this 'based in' universal can only be realised when there are first instances of an OC and of a country. Often these relations in the relationship will have a role name that describes them while the relationship prevails, as in that of a husband and wife in marriage. But there may not always be role names. With 'held in' we might posit the role of host or host country, but in the end it will be the norms followed by the agents themselves which will determine the matter.

Relationship	**Relation1**	**Relation2**
held in	conference	country
	Role name	**Role name**
	?	host?

In examining these terms we notice that a problem arises over the precise meaning of 'country'. With the sense of holding something in a place we tend to imply a geographical location, a territory, but country also has a connotation of a political entity or nation state. The two may not overlap. It would be a rash person who ventured to say that the political entity of country always referred to a precise territory. We return to this question later.

How does NORMA model the relationship between a federation and a society? Using the term 'member society' indicates the existence of a membership relationship: society and federation are joined in a membership affordance. IFIP is a learned society whose members, instead of being individual persons, are themselves learned societies. The notion of federation is generally applied to organisations whose constituent elements are 'sovereign' bodies themselves: the United States of America; the National Union of Miners; the Confederation of British Industry. Essentially the federation is an organisational form which may or may not be appropriate to a given society.

Using a term that is a role name such as 'referee' raises the questions of how to supply the missing terms:

Relationship	**Relation1**	**Relation2**
?	?	?
	Role name	**Role name**
	referee	?

It is reasonable to assume that the holder of the role will be a person and hence we have the term for Relation1. Analysing the text further we discover that the referee is the person who writes the report on the work of a third person. And since we have tended to use the word 'contributes' rather than writes we ought to do so here also.

Relationship	**Relation1**	**Relation2**
contributes	person	report
	Role name	**Role name**
	referee	?

The way that the paper relates to a report can be characterised in the following manner.

Relationship	**Relation1**	**Relation2**
reviews	report	paper
	Role name	**Role name**
	review	subject

For the initial paper itself the idea of a person contributing a paper appears to reflect the underlying dependencies. Unless IFIP makes a distinction between the contribution of the work, perhaps where sent by a company or employer and the actual authorship of the paper, then the contributor is also the author, that is, they are aliases.

To provide schema support for tracking the whereabouts of authors, members of committees and so on, we need to know a little more than the country they are based in. A person is located at some place. The person and the place are ontologically independent of one another: a person ceasing to exist has no impact on the existence of the place. However the instance of being located at the place finishes. Consequently we can present this as a relationship in this manner:

Relationship	**Relation1**	**Relation2**
located at	person	place
	Role name	**Role name**
		location

and we may find role names, perhaps for Relation2 'location', that are appropriate.

Sponsor is another role name which we find in use in the IFIP domain. A sponsor is a role name in the relationship of sponsorship, although we find two senses of sponsor. One sponsor is always the Working Group which desires the conference (although there may be collaboration among WGs to act jointly): the other sponsor is an organisation putting either its money behind it, or its reputation. It is, however, an external body to IFIP. These two types of sponsorship represent two different meanings for the one term 'sponsorship', but there need be no confusion since the antecedents who will realise an instance of the affordance will differ. For the first kind of sponsorship the first relation will be Working Group, for the second it will be some legal person such as a company or parastatal body.

Using the term 'national' in referring to the data processing societies which are eligible for membership of IFIP could perhaps imply the existence of some relationship in which this term is a role name. There is often more than just one

society of this kind, and determining which one is the 'national' is a matter for IFIP. Rather than a relationship, this affordance is a role name which applies in the relationship between a society and a nation, when the former is said to represent the latter. We would, on the other hand, expect the term 'national' when applied to a person, to refer to the relationship of nationality realised jointly by nation and person. For a society, this concept of nationality does not apply.

'Author' is common form of role name, ending as it does in 'or', and we can place it in the slot for roles. To fill the role we need a person, and the other relations must be some kind of work or literary output. For the relationship itself 'contributes', as we have noted above is appropriate, although other possibilities might exist. For the second role 'contribution' would follow naturally.

Communication acts, determiners and parts: pass 4

In this fourth pass at the text, we are interested in a variety of NORMA structures that permit the representation of organisational knowledge. Part/whole relationships are simple enough to understand at the intuitive level: we expect to be able to divide anything into parts. But there can be problems distinguishing between when we an affordance is a part or an affordance of a realisation.

Part/whole distinction

IFIP has a large number of parts within parts of its whole. Many of these are not mentioned in the problem definition but they serve to illustrate this structural feature of NORMA. At its highest level IFIP has a General Assembly, a Technical Assembly, a Council and Working Conference. All these bodies are integral parts of IFIP. In turn these bodies have parts of their own, and each of these structures has parts which are the offices of chair, secretary and so on.

IFIP accomplishes much of its work through the committees, allowing the detailed work to be done. The outgoing President of IFIP spelled this out in November 1989: 'The technical committees are the engine room of IFIP. Without them, IFIP would be nothing' (Owen 1989). Once it has been agreed to run a Working Conference then the work or the OC and PC begins to become important. These bodies operate as a vital organism in the fabric of the Working Conference,

Results from Pass 3	
Label	**author**
Agent/Affordance	Y
Agent	Y
Substantive, M, C	S
Alias	
Particular	
Universal	U
Particular Universal	
Individual	#

Relationship	**contributes? writes?**
Relation 1	**person**
Role 1	**author**
Relation 2	**work? paper?**
Role 2	**contribution**

Figure 8.4 the third pass

and must be seen as parts of the whole.

Each of these organisations has a large number of offices, positions or roles, which make up its structure. In just the same way the roles are part of the organisational bodies. A committee has roles for chair, secretary, treasurer and so on, and would have no substance without them. At any moment a particular role may have no incumbent, but it still exists independently of the persons who occupy it. We need to relate the two affordances of role and person by some relationship which ties them together. In this case we are looking for a term preferably in use in the organisation which captures this notion: perhaps 'occupancy' or 'incumbency'. Incumbency suggests this commitment to fulfil the duties of the role, and so we add this to the list of affordances.

When learned societies such as IFIP constitute themselves, they do so with the aim of extending the boundaries of their particular knowledge area. Terms such as 'subject', 'topic', 'field' and 'area' allow the society to divide the knowledge into subsets of differing scope. A part/whole hierarchy of knowledge permits the organisation to focus on wider or narrower targets with its different activities. Possibly a hierarchy of knowledge/area/field/subject might provide the necessary parameters for such a 'map'. However the terms used by one learned society to mark out its 'map' of knowledge will be different from those used by another, and this hierarchical order could be changed around. In the problem definition itself 'subject' and 'topic' are used interchangeably in IFIP as aliases one for the other.

> 'Working Conferences which are small invited conferences on some subject'

and

> 'In 1982, Working Group 8.1 organized a Working Conference in the Netherlands on the Topic 'Information Systems Design Methodologies: a Comparative Review'. (Appendix A)'

This overlapping could cause problems when seeking to distinguish the scope of a particular contribution. Does a contributor write on a topic or a subject? Informally such ambiguity can be resolved, but moving to formalise the domain with a technical system requires that these possible anomalies be investigated thoroughly.

Communication act, agent, sign type/token.

Business is so often accomplished by intricate patterns of what we might refer to as conversations. Possibilities are sounded out by using hypothetical cases, offers are made and accepted and the status of mutual commitments, obligations and responsibilities alters. These changes are effected by means of communication acts, where responsible agents use sign types that can embody their intentions and purpose. With the sign realised as a token the communication act is then performed. Consequently we have three questions to answer when analysing

communication acts: who is the agent? what is the act? and what is the sign type used as the utterance? If we have just one of the three elements at the outset, then we are driven to find the other two.

Communication act	invites ...
Agent	
Sign type/token	

We know that we must have an agent to do the inviting and some sign type to embody the intention. Therefore we might continue

Communication act	invites ...
Agent	Working Conference#
Sign type/token	call for papers

where the call for papers, or the invitation, is a complex sign that refers to a person contributing a paper. We are not concerned directly with the form of the sign token used, whether a letter, a fax message or telex, as that would draw us into the message level of analysis, but instead we are interested in the utterance that permits the communication act to be realised. This 'call for papers' stands for the instance of a person contributing a paper. In effect the 'call for papers' amounts to a sign structured as *"contributes(person# paper#)"*; at the time of inviting the person has not yet written the paper, and the rule of ontological antecedence means that the performing of the communication act requires a sign that refers to this affordance. Quite naturally many of those invited will be happy to contribute and would respond by accepting.

Communication act	
Agent	
Sign type/token	acceptance

The 'acceptance' is one of the semantic units in our text, and we can recognise it as an element in the communication act of 'accepts', although this word as such is not used. We might now adjust this threesome as follows

Communication act	accepts
Agent	person#
Sign type/token	letter of intent (acceptance)

The letter of intent is the sign type which the person uses in effecting the communication act when accepting. Here the sign refers to the invitation. A person accepts an invitation, which itself contains a sign which refers to some future behaviour. In this case the letter of intent is a sign which refers to the contribution of a paper, in turn referred to in the invitation. The letter of intent might be reconstrued as:

"accepts(person1 "invites(Working Conference# "contributes(person1 paper#)"))

Another use of 'invitation', is the invitation to attend the conference. Here the distinction is clear since the sign type refers to the attendance of the person at the conference meeting.

Communication act	invites ...
Agent	Working Conference#
Sign type/token	"attends (person# Working Conference#)"

Accepting this invitation involves a person, a sign referring to the invitation and the communication act itself. The sign will be similar to the previous one, except that purpose of the invitation is different.

"accepts(person1 "invites(Working Conference# "attend (person1 Working Conference#)"))

A further example of a communication act is in 'appoints', where member societies of IFIP are able to appoint a National Representative to Technical Committees. When a person is appointed the mutual commitments of the role holders of appointer and appointee are altered. Responsibilities and duties change.

Results of Pass 4 (communication act)	
Label	of Intent
Agent/Affordance	Y
Agent	N
Substantive, M, C	S
Alias	
Particular	
Universal	U
Particular Universal	
Individual	#
Relationship	
Relation 1	
Role 1	
Relation 2	
Role 2	
------Pass 4	
State	
Communication act	accepts
Agent	person
Sign type (U)	Y
Sign Token (P)	
Determiner (U)	
Determinant (p)	
Part of	

Figure 8.5 results for a communication act in Pass 4

Realising the act required once more the agent concerned to employ a sign which refers to this commencement of the new legal and social *status quo*. Member societies will use a sign which refers to the start of the incumbency of a person in the role of National Representative. Quite probably different societies will use different forms of such sign tokens to perform this function. Its semantic content however is circumscribed by these dependencies.

Determiner, scale, determinant

When agents discriminate amongst instances of realisation, they perform certain operations, or measurements, which permit this individuation. In certain cases the measurements may be precise and exhaustive enough to allow identification of unique individuals. This process can be seen as the measurement

of the realisation on some kind of scale. For fundamental measurements, such as weight and height, the scale and the rules governing the measuring procedure are well known. For other sorts of measurement, these matters are less clear. We can lay down, however, the basic elements in each case of a determiner, norms for measuring along the scale, and a determinant, that is, the value for what is being determined.

In making these discriminations amongst instances of realisations the agent with the responsibility are applying formal rules or informal criteria. Our semantic analysis requires us to examine closely what such criteria are, and with the knowledge of who is to apply them we are able to construct a complete schema. For example, for the priority for each person in attending the conference there is a scale from 1 to 3. The procedures for making such discrimination or measurement will be decided by the Program Committee, and to interpret them in actual instances there will be identified responsible persons. The determiner is 'priority' and for each individual there is a determinant or value for his priority. Governing the measurement is the norm which regulates this evaluation.

The letter of intent acts as part of a communication act or accepting the invitation to contribute a work. It does not refer to any particular token used rather the sign type in general.

Antecedent: pass 5

As we move towards the later parts of the analysis, we require more details about the dependency/antecedent relationships between the affordances. Having determined what antecedents any instance of an affordance requires, we may turn our attention then to revealing the criteria, or authority responsible, for determining the existence of any instance. These should be found mostly among the responsible agents identified in the first pass.

Every affordance in a semantic schema has either one or two antecedents, and at this point in the analysis we want to pin these down. In each case the question is: what are the realisations that must exist to instantiate it? In some cases we have answered this already. For each relationship, for instance, the participant relations give us the antecedents which must exist if the relationship is to exist.

Results of Pass 4 (determiner)

Label	priority
Agent/Affordance	Y
Agent	N
Substantive, M, C	S
Alias	
Particular	
Universal	U
Particular Universal	
Individual	
Relationship	
Relation 1	
Role 1	
Relation 2	
Role 2	
-----Pass 4	
State	
Communication act	
Agent	
Sign type (U)	
Sign Token (P)	
Determiner (U)	priority
Determinant (p)	#1 to #3
Part of	

Figure 8.6 results for a determiner

For each determiner, in a similar manner, the antecedent is what is determined: the instance of the determiner depends on the existence of the determinant. With any affordance we have to find its ontological dependents. In the case of 'held in', any instance would depend upon an instance of a conference meeting and of a state. At the point when the meeting finishes, less plausibly the state, then that instance of 'held in' ceases to exist.

Authority: pass 6

Once we have elicited the affordances that populate the world of IFIP, we need to move on to the next stage of stating who takes responsibility for deciding the existence of each realisation. In some cases there will be rules which govern the process of deciding the start or finish of some instance. But even here the rule will

Results from Pass 5	
Label	held in
Agent/Affordance	Y
Agent	N
Substantive, M, C	S
Alias	
Particular	
Universal	U
Particular Universal	
Individual	
Relationship	held in
Relation 1	state
Role 1	host
Relation 2	meeting
Role 2	
------Pass 4	
State	
Communication act	
Agent	
Sign type (U)	
Sign Token (P)	
Determiner (U)	priority
Determinant (p)	#1 to #3
Part of	
-------Pass 5	
Antecedent 1	meeting
Antecedent 2	state

Figure 8.7 results for Pass 5

eventually be interpreted by some person or persons. For certain affordances the authority responsible is clear, while for others we may have some difficulty deciding. The tendency is for the affordances on the left hand side of the ontology chart to be more closely related to the day to day work of the organisation, and therefore less problematic. Above all is the consideration that the task of resolving who is responsible when this is not apparent, is one of the utmost importance to any organisation.

Start and finish dates: pass 7

In the surrogate table there are separate columns for the start date and the finish dates of each affordance. Part of the task of the semantic analysts is to attempt to complete the entries for these columns. For universals there will be great difficulty

in giving the start dates: the concept of 'state' goes back into the mists of time, the concept of 'person' even further. We would leave these blank—they are conundrums to be resolved by the philosophers. With new universals we might be luckier. For instance, the concept of 'patriality' as a criterion for the determination of British nationality can be pinned down to the 1981 British Nationality Act. Occasionally we may be able to place finish dates for universals. The universal of 'phlogiston', a substance believed for centuries to be behind the phenomenon of combustion, was finally laid to rest by the theories of Lavoisier and Priestley towards the end of the eighteenth century.

For particulars and especially for realisations our task is less problematic. Particular persons have their birthdates and these are their start dates. Where we do not know this information we are continually confronted by the blank entry that reminds what we must yet discover. When searching for this information we have the aid of knowing who is responsible for determining the start and finish of each affordance.

Mood: pass 8

For most computer based systems the general assumption is that the symbols stored therein refer to 'facts' about the world which the user deems necessary to record. But on the basis that the business and social affairs require the use of moods other than 'fact' (assertion), NORMA requires that the mood prevailing at the start and finish of the existence of the affordance be stated. In many cases this may be assertion, but not always. Take for instance the problem of limited allocating conference places to the many who wish to attend. Inviting a person to attend a conference, stating an intention to attend (ie. accepting the invitation), and actually attending the conference could result in three moods: hypothesis, prediction, assertion, to handle the evolution of the exchange leading up to the conference.

In this pass we should pay attention to the moods for the affordances registered in the semantic schema. Where there are 'conversations' of the kind referred to here there will be a set pattern of moods which characterise the changing status of responsibility and expectation. This pattern can be reflected by inserting universals enabling us to record the flux of events when invitations,

acceptances and attendances materialise in their hundreds. In Figure 8.8 the gradual evolution of the position regarding the attendance of John is tracked[1]. At the start of 1988 the invitation goes out, and an H for hypothetical attendance is registered; at the start of February John accepts the invitation and a P for a predicted

surrogate	type	sort	label	ant1	ant2	@+	@-	start	finish	mood+	mood-
	U		attends	person#	WC#						
	P		attends	John	CRIS88			19880101	19880201	H	P
	P		attends	John	CRIS88			19880201	19880919	P	A
	P		attends	John	CRIS88			19880919	19880922	A	A

Figure 8.8 changes of mood in handling conference attendances

attendance marks the end of the purely hypothetical state of affairs as the mutual responsibilities alter; at the start of the conference on the 19th of September the mood changes to A for assertion, marking the end of the prediction phase and the existence of an actual realised attendance. At each phase the surrogates reflect a manifest and intricate complex of interwoven duties and responsibilities.

Generic and specific: pass 9

Categorising and grouping into sets has been an important technique when attempting to discuss organisations in an economical way. For NORMA the generic/specific structure is a key feature of the specification. Analysts do not attempt to identify definitive generics and specifics, but instead the aim is to reveal the usages that are found in the organisation. What we have, in effect, when we discover such relationships are conventions or norms whereby a responsible agent consistently behaves in a manner that relates a specific to a generic. Other agents may do things differently.

[1] For the sake of clarity the surrogate numbers have not been employed in this example

In Chapter 7 examples found in the CRIS case study were considered in some detail.

Draw and check ontology pass 10

In the final pass the analyst is naturally enjoined to check the consistency of the analysis. For the most part this means ensuring that the elements traced in the semantic schema and recorded in the surrogate table follow the constraints set out in the syntax of the language NORMA.

It would be repetitious to return to the points covered in Chapter 4 where the syntactical controls over the semantics employed are itemised, but work is going ahead at the University of Twente on the production of the NORMA interpreter which will be able to do much of the checking of the semantic constraints in an automatic fashion. For example, the most critical question is that of ontological antecedence. Any affordance must have its ontological antecedents declared, and a module in the NORMA system will check that this has been done. Presently this work can be done 'manually' and when the semantic schema is given in a graphical fashion this kind of checking is fairly simple to perform: the branching of the lattice structure require the antecedents to be stated in any case. When the schema becomes unwieldy this 'manual' checking becomes more worrisome.

Conclusion

These series of passes at the text conduct the beginner analyst through the difficult array of overlapping considerations that must be made. Effectively this is a profound textual analysis, some might use the term hermeneutic process, which must be done if the terminology by which the actors in the domain refer to their behaviour is to be constrained into a formal schema. At each pass more and more detail is acquired and the analyst is able to complete the columns of the surrogate table. At the simplest level the analyst must ask whether each term is worthy of further consideration or whether it should be eliminated. Then the agents are distinguished from the affordances, and universals, particulars, and individuals are identified. Gradually the attention moves to relationships and roles and to the key notions of antecedents, taking in determiners, parts, states, communication acts and

their related notions of signs types and tokens. To complete the surrogate table columns starts and finishes, authorities and moods must be supplied. Before checking the ontology of the schema, the analyst should be in a position to write the norms of the generics and specifics.

These steps account for the bulk of any semantic analysis and when thoroughly completed they should furnish the analyst with a battery of specification detail for the information systems requirements of the problem domain. Setting out a series of steps to follow always lays one open to the risk of being accused of producing a 'cookbook', in the manner of those recipe books that seek to reduce into a number of simple stages the often complex culinary activities that go in to turning out a wholesome meal. The risk is of 'reductio ad absurdum' —that the simplification leads to absurdity, and the subtleties of the approach are lost in the bleak aridity of step-following. On the other hand there is naturally a need to digest the indigestible into some ready-to-hand method which can provide an entrée into a new analytical approach. A crutch for the needy, a platform for the confident. The steps reviewed in this chapter do not purport to be the final product; they need further testing and refinement. But they do represent a concrete basis from which to support this new form of analysis.

A method of this kind, with a large body of theoretical underpinning to be understood and assimilated, has an overriding need for a method for performing it. Over the years the present author has noticed how often students who were coming into contact with this new approach for the first time would bewail the lack of a clear and concrete starting point. There is in existence at the London School of Economics a large body of literature, in the form of student reports, dissertations and the LEGOL/NORMA working papers themselves, which is available for guiding those who want to use these methods. However this literature pales in comparison with the material available on many other specification methods, especially where these are tied in with software support. The complexity of specification methods so often necessitates a clear exposition of the steps that the analyst must take, if the beginner is not to be lost by the wayside. The expert in a particular technique has no such need, and more often than not, will soon be developing his own special order of performing the various tasks and be finding ways of cutting corners. However, when there is a good deal of theory which we cannot assume to be

automatically understood by someone at first encounter, then the principles of the analysis must be supported by a clear method for performing the work.

Chapter 9
Principles for Performing Semantic Analysis

This chapter aims to aid analysts in the application of NORMA as a systems specification language and seeks to provide guidance in performing semantic analysis. Given the hydra-headed nature of the problem of applying a semantic theory, outlining a set of principles perhaps offers more scope than seeking to lay out rules. Rules tell us how to behave in particular circumstances, whereas principles require observance at all times, and especially when there may not be any relevant rules to follow. However given the aim of developing an interpreter for NORMA which can check the semantic consistency of data held in its surrogate table, there is an overriding need to develop a set of such rules. These would have the form of any other system represented in NORMA: a semantic schema for the area of discourse, in this case the world of the metadata or schema itself, and rules written in LEGOL which prescribe the behaviour of the elements in the schema. What results is a prescription at the metaphysical level of any schema written in this form: a schema for schemas.

If the theory of behaviour that underlies NORMA is sufficiently rigorous to encompass any world we might choose to represent, then this 'super-schema' promises to be the alchemist's stone for information systems builders: a set of regulations that ensures that the systems built using such tools conform to a very precise and well tried body of semantic constraints that will guarantee to stand the test of time. Unfortunately we do not pretend to be able to deliver such a prize with this work but instead hope to demonstrate the feasibility of such a quest, and these rules have been gleaned from the understanding gained during the application of semantic analysis to the problems discussed in the case studies, as well as many others.

As with any other task of semantic analysis we endeavour to subject the terms used in the area of discourse to the rigours of NORMA as the specification language. In this case this means targeting the very terms that NORMA employs as primitives to specify information systems and seeking to develop an ontology

chart and a set of norms (or rules) which prescribe the way in which these elements of discourse may be used in the process of performing semantic analysis. Effectively this is a semantic analysis of semantic analysis. On the basis of the experience gained and using the outline of the specification language NORMA given in Chapter 4, it has been possible to provide in the following pages the ontology chart and twenty or more rules.

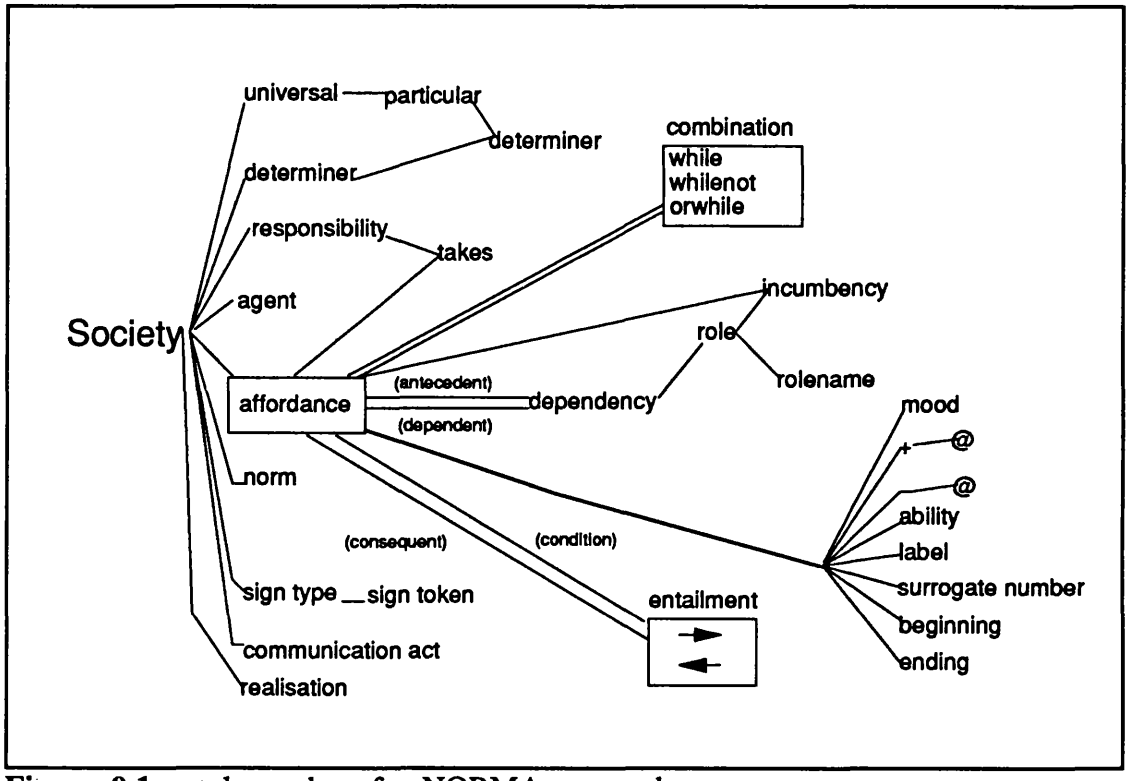


Figure 9.1 ontology chart for NORMA meta-schema

In Figure 9.1 we illustrate in the form of an ontology chart the semantic schema for this metaschema. Whilst not complete, it permits sufficient of the rules for this metalevel to be prescribed to show the path of future development. On the basis of this schema the rules for semantic schemas may be written.

As with legislation in general each individual rule does not apply exclusively of the other rules that exist. Instead the situation is that all the rules apply together. For the most part they are rules of definition which delineate the terms used, but in a way which permits the metaphysical assumptions of NORMA to be imposed upon the schema. Each constraint indicates a parameter for the analyst

when seeking to apply semantic analysis. More constraints imply less 'artistic' solutions but a greater likelihood of semantic normalisation: both the expert and the relative novice should come up with the same solution if the rules are applied in a consistent fashion. A further ambition is that partial solutions to a big problem should be capable of integration.

Further to this is the hope that the determination of rules in such a manner should allow the computer-based interpreter for NORMA to perform many of these checks on the data which is entered. In this way the burden of ensuring that the constraints of the specification language have been complied with falls less on the shoulders of the analyst and instead is taken up by the computer.

1 Affordances

At the most basic level we posit the root agent, Society in general, and Society has a vast range of behaviours available to it. At the most generic level these are affordances. This first rule is a generic/specific rule that relates all the various kinds of behaviour to the affordance.

Affordance ← ability; agent; beginning; communication act; combination (orwhile; while; whilenot); dependency; determiner; determiner; ending; entailment; incumbency; label; mood; norm; particular; realisation; responsibility; role; rolename; sign type; sign token; surrogate number; takes; -; +; @+;@-

Everything that applies in the schema to the affordance in general applies also to these specifics. Note that the reverse is not true: the characteristics of each of these specific kinds of affordances are peculiar to that kind.

2 Agent

agent ← affordance <u>while</u> takes(affordance responsibility)

[1] emphasis denotes operators in LEGOL

Agents are key to the whole basis of NORMA in that they are the hooks from which the formal system knits into the world of informal social intercourse. This simple rule spells out the requirement for taking responsibility in order for an affordance to be treated as an agent. In the metaschema it is appropriate to spell out who the agents are, to enable the further development of the specification.

In rejecting the view of the world as a ready-made objective reality and replacing it instead, following the approach of Gibson (1977), with one where there are many agents who have differing ways of perceiving and experiencing, we can use the notion of responsibility to anchor the representation. In practice what this means is that the agents will usually be found to the left of our ontology charts because it is they who realise the affordances to the right. Agents take responsibility for their particular way of dividing up the world, and for the affordances that they realise, and it is this capacity that separates an agent from any other affordance.

Any group of persons or team or collective body can be an agent, but the largest agents become whole jurisdictions covering complete classes of people, which under the jurisdiction perform their duties, carry their responsibilities and enjoy their rights. A group agent owes its coherence and capacity to carry collective responsibility to its internal norms for making its members (in that role) conform to collective/joint intentions.

3 Realisation

A realisation ← affordance while((antecedent while particular)
while (antecedent while agent))

B realisation ← affordance while (antecedent while realisation)

Realisations materialise when an agent determines the existence of a particular entity. The affordance must have for at least one antecedent an agent to realise the behaviour, since other types of affordances cannot "behave" as such. Equally the realisation of behaviours by agents means that particulars must be the

antecedents and not universals. The universal implies a pattern of behaviour but not actual behaviour. The while operator functions as a time constraint on the realisation: a realisation exists while the agent exists, and while the particularity of the antecedent maintains. Notice also in Figure 9.1 that the line of ontology is separate from the rest of the chart. This because we need to distinguish between what behaviour *may* exist (ie. the rest of the chart) and what *does* exist (what is realised). This rule shows how affordances may become realisations: it is the link between the possible and the here-and-now in any domain.

Rule 3B permits the antecedent to be a modified agent, hence John is an agent, but John with a cup is an agent (modified). Both are realisations: first under 3A and the second under rule 3B. John with a cup can go on to realise the affordance of drinking.

This category of rules guarantees that anything that is recorded as having existed has to have a clear lineage of realisation. Entities do not exist for themselves but have to be realised by responsible agents. This ensures that the validity of data can always be traced back to whoever has realised and taken responsibility for the manifestation.

4 Ability

ability(affordance) ← affordance

A simple rule which allows every affordance to be associated with the ability to realise the behaviour. If we attribute to John the affordance 'sings' then it implies that he has the ability to warble even when he is not so doing. If he should suffer some permanent damage to his vocal chords then we should have to remove the affordance from its association with him. The network of possibilities reflects directly that of the ontology chart.

5 Authority

A @+(affordance) ← agent or norm

B @-(affordance) ← agent or norm

C @+orwhile@-(realisation) ← agent while realisation

These rules restrict the range of types of affordances that may be given as authorities which determine the starts and finishes of realisations to just two: agents and norms. In the case of universals a norm is often specified. The person who judges whether a foul has been performed in a football match is the referee, and this is a norm which does not identify a particular person. In an actual Cup Final the identity of the referee is, and must be, apparent; the person or agent will be a realisation.

We always have a responsible agent to turn to whenever the formal system is used to record the start or finish of any actual behaviour in the informal system.

6 Antecedents

A maximum antecedents ←number antecedent whilenotgreater than 2

B particular ← affordance while (antecedent while particular)

C universal ←affordance
while (antecedent while(particular orwhile universal))

Ontological antecedence underpins all realisations. Affordances are realised by their antecedents of which there may not be more than two. There is no special virtue in the number two for the maximum number of antecedents, neither is there any deep metaphysical significance in the choice; except that experience has shown that it is perfectly adequate for this purpose. Rule 6A merely sets this maximum figure.

6B requires that the ontological antecedents of any particular must be particulars themselves. A particular is ontologically always invested with other

particulars that set it in its context. A particular Cup Final will be held in a particular stadium, played between particular teams and so forth.

This is not so for universals. A universal may have as antecedents other universals: as in the CRIS case where the affordance 'citizenship' and its two antecedents 'person' and 'state' were all universals. However the International Federation of Information Processing, a particular, had a number of universals—Working Groups, Technical Committees, Working Conferences—all of which were dependents of IFIP. 6C encapsulates this specification.

The ontology chart represents the semantic schema in a graphic manner, where the connecting lines between the affordances stand for ontological dependencies. This means that the affordance to the right can only exist whilst the one at the left hand end of the line(s) exists: instances of the realised affordances depend upon instances of their antecedents. Analysts must check carefully that this rule is adhered to when beginning to sketch out the schema in this way.

Perhaps it is appropriate at this point to introduce rules that link affordances to their fundamental roles in the ontological structure.

D antecedent ← affordance1 <u>while</u> dependency(affordance1 affordance2)

E dependent ← affordance2 <u>while</u> dependency(affordance1 affordance2)

In this way the semantics of two critical terms, antecedent and dependent, are demarcated, so that the validity of the considerable use that is made of them in the specification is secured.

F relation <u>or</u> relationship ← affordance <u>while</u> <u>number of</u> antecedent <u>while</u> 2

Where an affordance has two antecedents, as with 'citizenship(person state)', then this is defined as a relation or relationship, that is, the two antecedents must both be realisations for their joint affordance to be realised. We can distinguish

between the use we make of the term relationship and that of relation, in the sense that the former might be restricted to cases where the antecedents are persons, whereas the latter be used where other affordances are involved in a joint affordance. In which case the rule for the relationship would be:

G relationship ← affordance while (number of antecedent
(while person) while 2))

curtailing the use of the term 'relationship' only to those cases where 'person' is the antecedent.

7 Parts

Another very simple rule deals with the 'part' affordance. In one sense this is just an extension of the rule of ontology. A part of some realisation can only exist while the realisation of which it is part exists.

part(affordance) ← affordance

Whereas with relational data models the assumption that the data held is atomic, ie. indivisible, no such restriction is enforced here. How can we know in advance that the entities we allocate a place to in the schema when it is first constructed will not prove to be divisible later. Dividing and sub-dividing spaces is common practice for those engaged in property management; the schema produced with NORMA methods will easily cope with such demands. The relational database will not.

8 Joint affordance or combination

combination ←affordance1 while ((dependent while while orwhile
whilenot orwhile orwhile)
while (antedent1 while affordance) while (antecedent2 while
affordance))

When several behaviours (for an individual agent) are realised contemporaneously then we have a joint affordance or combination. Note the distinction between these and rules. Norms prescribe circumstances where the behaviour concerns several independent agents acting in concert, whereas with combinations we are still considering the individual agent alone, albeit where the agent is a complex one, such as large organisation or institution.

With combinations, or joint affordances, which are explained in more detail in Chapter 4, we use the LEGOL dyadic operators while, whilenot and orwhile, to combine individual affordances into more complex structures. The antecedents are merely affordances which are threaded together using the LEGOL syntax as operands in the expressions.

9 Signs

A sign type ← affordance1 while represents(affordance1 affordance2)
while (affordance1 while universal)

B signification ← affordance2
while represents(affordance1 affordance2)

C sign token ← affordance1
while ((represents(affordance1 affordance2))
while (represents while realisation)))

D communication act ← affordance while (antecedent1 while agent)
while (antecedent2 while signtype))

A sign type is a kind of affordance which is used to stand for another. At the level of the type we are concerned with universals only and this is a limiting clause in 9A. For realisations the sign type becomes a sign token, actually employed as a sign in an exchange between agents. The token must be a particular, by rule 3A. The counterpart of the sign is its signification, the 'meaning' of the sign. In rule

9B this is attributed to the other affordance in the 'represents' joint affordance: affordance2 is the signification of affordance1.

Rule 9C specifies that in any realisation involving signs, the sign token, or realised sign type, carries the 'meaning' of the other affordance.

Finally rule 9D restricts the performance of communication acts to cases where the antecedents are agents and sign types/tokens. Agents will need to communicate with each other in order to accomplish their tasks and this will be achieved by using communication (or 'speech' acts), such as order, request, acknowledge, inform, and so on. The existence of these communication acts provides another clue in seeking to identify the agents in any domain. If they can make use of speech acts and are thereby able to change the set of expectations, obligations and commitments that comprises our social reality, then we may be sure that they are agents in the sense of being able to take responsibility[2]. Here we are interested in the pragmatic level, in the use of these communication acts to convey intentions of our agents to each other. We do not concern ourselves with the messages by which this interchange is effected.

For signs, the ontological dependency functions also. A sign is created by an agent capable of acting semiologically, and this sign will be interpreted by another agent who will be disposed to act in response to the sign. However an agent can realise a sign when its signifier may not exist: a blueprint for a new piece of machinery exists before the machine it signifies has come into existence; a halt sign on a disused railway track may survive long after the railway system has ceased to disturb that neck of the woods.

10 Norms

A agent ← antecedent(norm)

B norm ← (entailment(affordance1 affordance2))

[2] We do not think of machines as agents in this sense: we cannot hold the computer responsible for having overcharged a customer, just as in the past we would not blame the telephone for a mistake in the ordering of goods by phone.

In NORMA the invariants of behaviour for groups of agents are referred to as norms, as opposed to affordances where only single agents are concerned. Given this understanding, 10A specifies that norms must have agents as antecedents: only agents can realise behavioural norms. 10B, however, prescribes the norm structure itself. We have chosen the term 'entailment' as a generic for the two specifics '←' (if... then) and '→'(whenever). These two operators are used to construct assemblies of behaviour and, in effect, denote where one affordance entails another.

This profile of a norm can be used to indicate how the norm might be entered into the surrogate table. The two antecedents, affordance1 and affordance2, are the antecedents of the operator. Whenever affordance1 and affordance2 are jointly realised then the particular norm has been realised also. The label of the norm affordance will be the name of the norm itself, say 9B. In the case of informal norms, such as greeting a person encountered in the corridor, then there may be no name as such. The uniqueness of the norm is guaranteed by the two antecedents, and the surrogate number will serve to enable the manipulation of the surrogate for the norm.

11 Determinant

determinant ← affordance while ((antecedent#1 while determiner)
while (antecedent#2 (while particular))

Where determiners are used to discriminate amongst affordances, the two antecedents must be determiners and the particular which is being determined. For example where the weight of a person is reckoned at 88 kilograms, then this determinant (88 kgs) has as its antecedents the particular person and the affordance/determiner of weight. There would have to be a norm that specifies the standard of weight in metric units. Rule 11 ensures that the accompanying information must be supplied when attributing determinants.

12 Roles

A role ← affordance while (antecedent while dependency)

B rolename ← affordance while (antecedent while role)

C incumbency ← affordance (while (antecedent1 while role)
while (antecedent2 while (antecedent while (dependency
while (antecedent while role)))))

One of the strongest aspects of NORMA is the way that roles are handled. Just as in the spoken language where the use of roles permits a delicacy, an accuracy and an economy of expression, so too with the specification language NORMA, but never in a way which prejudices the ontological structures and the resistance and durability over time of the schema.

Rule 12A begins by establishing the role as an affordance which depends ontologically on a dependency. For instance the role of 'spouse' in marriage depends upon the dependency between marriage and person. Should this dependency cease then so would the role.

The 'rolename' in rule 12B is the particular label given to the role. The semantic pattern does not alter just because the rolename changes, hence it is ontologically separate.

In rule 12C we desire to pin down the occupiers of the roles and restrict them in an appropriate fashion. Thus one antecedent of 'incumbency' is always the role itself, such as 'spouse'. The second antecedent is restricted to being an antecedent of the dependency on which the role depends. Therefore the dependency would be between 'marriage' and 'person', of which 'person' is the antecedent, and this dependency is the ontological antecedent of 'spouse'. In such a manner we can constrain the incumbents of roles to those affordances which participate in the role-generating dependencies. This would mean that we could not include in the surrogate table an entry which registered a robot as a spouse! This would be

excluded because it failed to conform to the prevailing specification at the level of the metaschema.

13 Individual

individual ← affordance1 (while particular)
while (determinant while (antecedent while affordance1))

An important metaphysical category is that of the individual. So often we need to be able to refer to individuals in our everyday affairs. The ability to discern individuals is not taken for granted by NORMA and instead is seen as an affordance of some realisations only. This rule states that an individual must be a particular (and not a universal) and must participate in a determinant affordance with some determiner. At this most fundamental level we are concerned with the ability of an affordance to be individuated. Having established that, say, persons are individuals then we can proceed to include individuals in relationships, and prescribe behaviour for them. Hence a rule could be written to deny the right of an individual to be an antecedent of two marriages concurrently (where the ontology is MARRIAGE (PERSON#1 PERSON#2). We can write that PERSON#1 may not be involved in two marriages, without needing to identify that person; the individuation is sufficient.

14 Agreement

agreement ← affordance1 while (((antecedent1 while agent#1)
while (antecedent2 while agent#2))
while (@+while@-affordance1 (while antecedent1 while
antcedent2)))

This rule illustrates how NORMA can mould quite generalised and even mundane concepts into underlying prescriptions for any schema. Agreement has a notion of two parties involved in some concordat in which each party has some degree of control. If either party withdraws then the agreement ceases to exist, or at least the

ending of the agreement is posited. The rule states economically this concept specifying that the antecedents must be agents, and not just any type of affordance, and that both of these agents have jointly the authority to determine the start and finish of the agreement. With a rule such as this, the NORMA interpreter could check the validity of any affordance deemed to be a type of agreement: contracts, arrangements, deals, treaties and the like, and ensure that the underlying requirements are being met in each case.

Rules and Principles

Although a complete set of such rules would furnish the analyst with the tools to complete a semantically normalised analysis for any information system, it may prove to be beyond the powers of researchers in this field. A distinction was made in the opening paragraph of this chapter between rules and principles, and unfortunately this distinction is necessary even within this analysis. There are aspects of the work of semantic analysis that are not easily transmutable into formal rules, or at any rate the utility of the result may be questionable. Our aim is to develop tools which can aid the analyst in performing this task. Rendering in a formal language that which may be better explained in natural language does not necessarily add to knowledge. However, where the rules that are expressed in the formal language can then be incorporated into an interpreter for NORMA, and will serve to perform consistency checks on all data entered, this job is more than justified.

In view of this position, we outline a few of these principles which serve to support the work of the analyst.

Principle 1

Analyse all terms used to represent phenomena in the user's world as candidate affordances for the schema, without changing the words. Alternatively:

Given A"x" and Ax
analyst must use "x" to refer to x

A principle crucial to NORMA is that the user community is central to the design process. This is made easier than in most methods because concern with the computer can be completely suppressed. The principle of user centrality leads us to insist on employing only the user's vocabulary instead of playing Humpty-Dumpty, where the analyst not the user decides the meaning of terms, as nearly all analysts and programmers do when forced to use current methods. Therefore the names of affordances are restricted to be semantically unitary words or expressions in the normal discourse of the business. It should be reasonably easy to develop a thesaurus containing information that will enable the computer to create a preliminary analysis of the vocabulary being studied in the form of default classifications that the analyst can amend as he thinks fit. As we accumulate reliable fragments of ontological structure through the analysis of many cases, the thesaurus will become enriched by their addition. The analyst will have the benefit, as he studies an expression, of the consolidated experience of his predecessors, and the gradual perfection of these analyses through criticism. We shall have less need to reinvent every wheel.

Principle 2

The object system can be decomposed into substantive, communication and control sub-systems, of which the substantive system is the most important. The primary classification is by semiological level (Stamper 1985):

> substantive items are the primary concern of the business,
>
> communication (or procedural) items convey information about the substantive ones,
>
> control items are information about the maintenance of the system, rewards and punishments.

How to distinguish substantive, communication and control? Our initial focal system is the substantive system and to concentrate upon it, for convenience, we may make two assumptions:

> a) that everybody in our substantive system knows what they have to do: they do not need supplying with information in order to carry out their functions;

b) that everybody in our substantive system does what they should do: they need neither rewards nor coercion to ensure that they conform with the requirements of the substantive system.

Before analysts despair at the naivety of these assumptions, permit a moment's reflection to consider how conveniently this stratagem allows us to concentrate upon the norms and affordances of the substantive system, free from the cluttering detail of the communication (or message) system and the control system. Both these latter play crucial roles in the functioning of any system but in this fashion they can be analysed separately from the substantive system.

Traditional analytical approaches emphasise the movements of messages and the storage and retrieval of records, as for example in dataflow analysis (de Marco 1979) and deal with an organisation as though it were a gigantic 'information plumbing' system. They work in terms of flows of data or data structures that will be held in storage devices. They rely upon an informal treatment of semantics and are unable to say very much about what the messages refer to. Insofar as they deal with the contents of messages they deal with them syntactically as arrangements of sub-messages and fields and data elements. To escape from the nightmare we have to go behind the information plumbing paradigm to deal with the business rather than with the bureaucracy overlaid upon it.

The substantive system gives the content of the messages, whereas the communication system concerns itself with the form and addressing of the message. Since the particular method employed in achieving the business goals may change from time to time, our prime aim is the specification of this substantive system. Having once specified this, we can build the specification for the communication and control sub-systems.

It is worthwhile in passing to note that the metaphysical assumptions that underpin NORMA secure attention to the substantive. The expressions that are written in the language are reflections of actual behaviour in the here-and-now, and the messages and records that refer to this behaviour are treated as signs. Having a plank of semiotics as part of the theoretical platform guarantees this distinction in a natural manner.

Principle 3

Specific members of a generic/specific hierarchy can realise affordances available to the generic members. Alternatively:

Afy while (a:b:c:d:e → f) → Aay:Aby:Acy:Ady:Aey

Because the generic/specific norm is so fundamental to the specification of any system, it is perhaps worthy of particular mention. While the norm exists that indicates the generic/specific hierarchy (a:b:c:d:e → f) , each affordance attributed to the generic affordance (f) is inherited by each of the specifics ((a:b:c:d:e)—anything that 'f' can do so can 'a', 'b', 'c', 'd' and 'e'. Strictly speaking there is no need to spell out this as a principle, since what it achieves is catered for by the use of norms. Here it is only a special case because so much emphasis is placed on 'inheritance' in the "semantic data models" developed in the 1980's, and outlined in Chapter 3. Affordances attributed to any specifics do not automatically apply to other specifics nor to the generic. If 'f' is 'fruit' and 'a' is 'apple' then the characteristics of fruit may be assigned to apples, but this does not imply that all fruit is green.

Principle 4.

All affordances which are realised (i.e. realisations) have a determinate existence during which they, as invariants, conform to the authority. When this invariance ceases, according to the judgment of the authority, then that existence ceases. Starts and finishes in the schema refer to the existence markers for realisations as far as the formal system (of signs) is concerned. For the agent themselves, existences of realisations is denoted by beginnings and endings.

We have expressed the notion of existence as a key principle for the NORMA specification language. As agents realise affordances, the existence of the realisation starts, and in the record we may enter a date/time for the START field. When a realisation exists, its the START field will have an entry but the FINISH field will not.

SURROGATE #.....
LABEL.....borrows
ANTECEDENT 1.....copy xyz123 (of Cider with Rosie)
ANTECEDENT 2.....A. Lender
AUTHORITY START..library assistant
AUTHORITY FINISH.
MOODSTART.....assertive
MOODSTART.....
START.....1/4/1989
FINISH.....

Here we have the record of the start of a 'borrows' realisation, which has two realisations as antecedents: a realised person, with the label (or in this case, name) of 'A. Lender' and a realised copy, with a label 'xyz123'. When A. Lender returns the book to the library the date/time for the FINISH field can be entered.

Starts and finishes represent the formal boundaries in time that agents recognise for the existences of realisations. Examples abound of special terms that are used to refer to these boundaries, for example for person we have birth and death, whereas for marriage we have wedding for start, but death, divorce or annulment as various ways of finishing a marriage.

The beginnings of the 'borrows' realisation will originate with the persons that decide to use the library at some stage in their intentional behaviour. These persons might place the ending with the point when they leave the library building, when the book is cancelled from their library record, or at some other stage. Starts and finishes concern the markers for the formal sign system that is used for recording and tracking the library behaviour.

One could draw an analogy with a downhill ski-race. The start and finish markers on the slope represent the formal definition of the race (still to be interpreted by the race officials). For the individual skiers, the race may begin when they are warming up, putting on their skis, and so on. The ending of the race for them may be at a considerable distance from the finishing poles and could be when they are finally back in the dressing room having a shower. Beginnings and endings relate to some mechanism inside the agent and reflect the intentional aspects of their actions.

Rules and stability of schema

In the opening chapter of this work it was stated that one main strand in the research was the quest for tools which could ensure stability of schemas in databases and computer systems. This endeavour has been undertaken in different ways by other researchers, in particular Marche (1990) and Ades (1987), who have been associated with the work of the LEGOL/NORMA project. Marche's work has been of particular interest in attempting to develop a tool for the measuring of database stability over time. One of his discoveries has been the extent to which the same terms come to have different meanings in different parts of large organisations, and to which the meaning changes with the passing of the years. An example of this, mentioned in Chapter 3, was that of the term 'building' when employed in a large Canadian telecommunications company. At least three major departments of the company used different meanings. These were the accounts department, the maintenance department and the real estate department. What is clear is that the usages developed in each case served the purpose for which it was intended. Problems arose only when the various departments needed to cooperate and in their cooperation this term was central.

Conclusions

A body of rules and principles is what is used to guide the behaviour of a very large number of business and social activities. Articulating the rules and principles which guide the activities of the experienced semantic analyst should be easier than trying to do the same for a data analyst. The former has an explicit body of semantic theory upon which he carries out his trade; the latter has little theory but usually a lot of practical experience. What has been presented in this chapter is an outline of guidelines for the performing of semantic analysis which should make explicit what is permissible in the construction of semantic schemas. It fall short in two ways: it is lamentably incomplete and lacks many rules yet to provide a full specification, and it is based upon the experience of semantic analysis of a very limited number of persons. There has been a hitherto gruesome logical short circuit: the lack of clear explicit rules for doing semantic analysis restricts the

number of possible exponents of the cult. This part of our work, inadequate though it may be, seeks to break this vicious circle.

In addition to explicating the rules, we have attempted to expound general principles which should be applicable at all times in the performing of the analysis. Occasionally analysts will need to refer to these principles, or to the philosophy on which they are based, to resolve the dilemmas that tend to recur when disentangling semantic ambiguities. Shifting the paradigm from that of an objective reality to one where the agents involved choose to structure the world they inhabit in the way that best suits their purpose appears to be the most difficult obstacle to overcome. Once achieved, experience has shown that analysts can quickly accumulate a reasonable corpus of skill in handling these semantic questions.

Chapter 10

Problems in performing semantic analysis

Continuous exposure to analysts seeking to acquire confidence with semantic analysis has enabled us to come to a good understanding of what errors are commonly made; such information will be vital for training in the method. In this chapter we examine the work of a few analysts with a view to highlighting some of these 'classic' deficiencies.

Role as affordance

Straub examines the problem of scholarship allocation in a university (Straub 1988) and there are a number of versions of the ontology chart which indicate the evolution of the analysis. In Chart 1 (Appendix H) we find a common error has been incorporated —that of the specification of a role as a separate affordance. An 'officer' affordance is presented as something jointly afforded by 'office' and

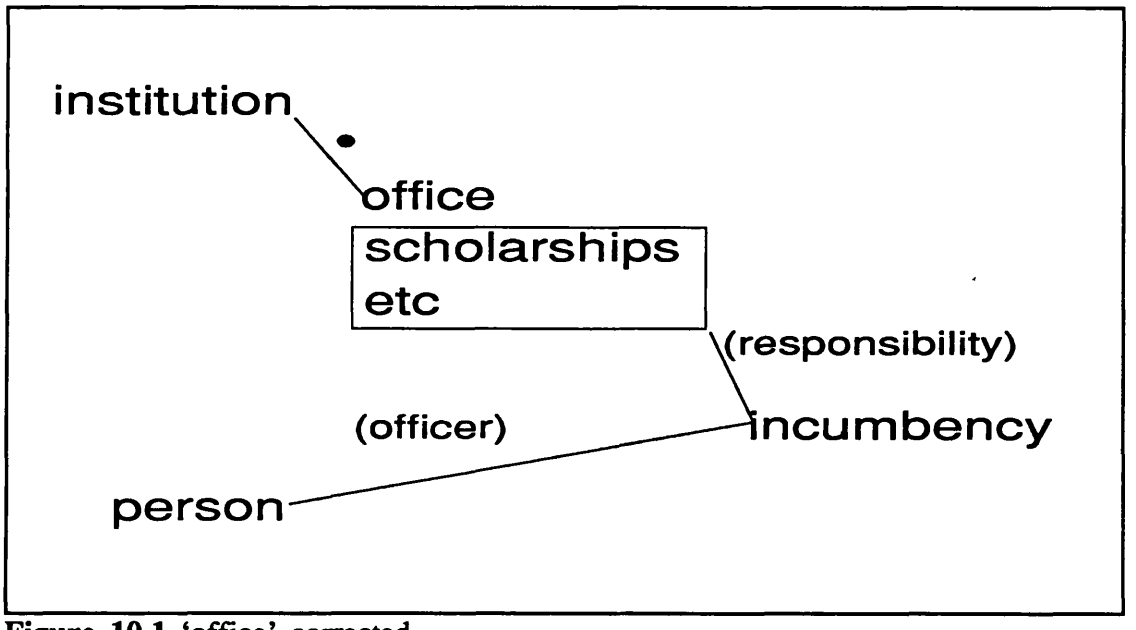


Figure 10.1 'office' corrected

'person'. When the person ceases the role of 'officer' ceases also, would run the logical consequence of this representation. This would suggest that the position in some administration ceases to exist if the person occupying it currently, or previously, should come to some untimely end. This runs counter to experience. The notion of an "establishment" in the British Civil Service includes the idea of a number of posts for particular parts of the service, regardless of whether the posts are currently filled. Similarly, in an army we speak of a regiment being "under strength" suggesting that there are fewer soldiers than there should be. In this sense the slot or post in the structure exists independently of the person filling it.

Instead the notion of 'office' for NORMA is a very general and fundamental one (see Figure 10.1). Here the term is exactly parallel to that of 'role', used in the SPS example in Chapter 5. An administrative structure is seen to be composed of parts, which are the building bricks of the organisation and these parts in the scholarship case are known as "offices". Each officer will have a particular set of tasks to perform and may be referred to in this way, i.e. the Scholarship Officer. An instance of a person filling the post is handled by 'incumbency' jointly afforded by person and office, as illustrated in the case studies.

Ontological dependence of personal states

As persons we are capable of a wide range of sensations and feelings, and we need

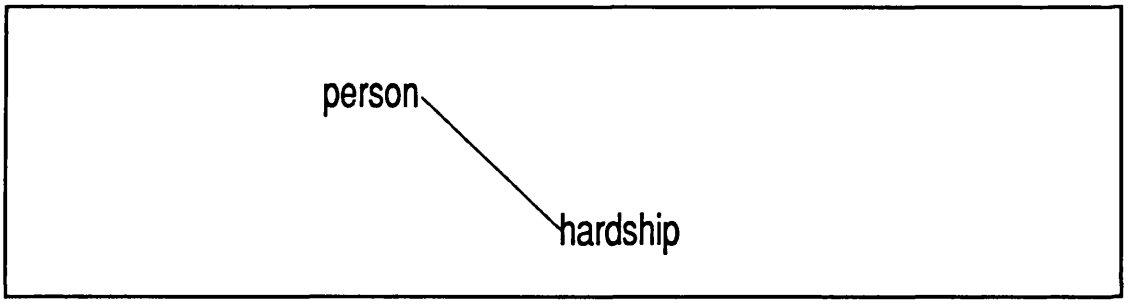


Figure 10.2 'hardship' corrected

to handle these from time to time in a schema. The scholarship case covers the question of students experiencing hardship financially. In Chart 1 (Appendix H) 'hardship' is shown as a joint antecedent of 'suffers' together with 'person', without

any antecedent of its own. What does this imply: that hardship is something that exists for itself outside of the person who experiences it. This is a curious conception, where feelings and human sensations are given identities and existences of their own, detached from the persons that give them life. The NORMA philosophy does not support this representation and requires that sensations and feelings depend upon persons for their existence. Therefore 'hardship' would be an affordance of 'person' (Figure 10.2). In experiencing hardship a person would realise, that is determine, the existence of an instance of it, on their own authority. The interesting question is how does an external agent, such as a university committee, establish the existence of hardship in a more 'objective' manner? On the basis of past cases, criteria would be used such as income, personal circumstances and so on, to permit comparison and evaluation of applications for funds. Such criteria do not impute that the applicants themselves are not undergoing hardship. Two sets of authorities will produce their own findings: the students involved and the committee.

Antecedents necessitated

In the same area of Chart 1 (Appendix H) we find the section that deals with 'assistance' (Figure 10.3).

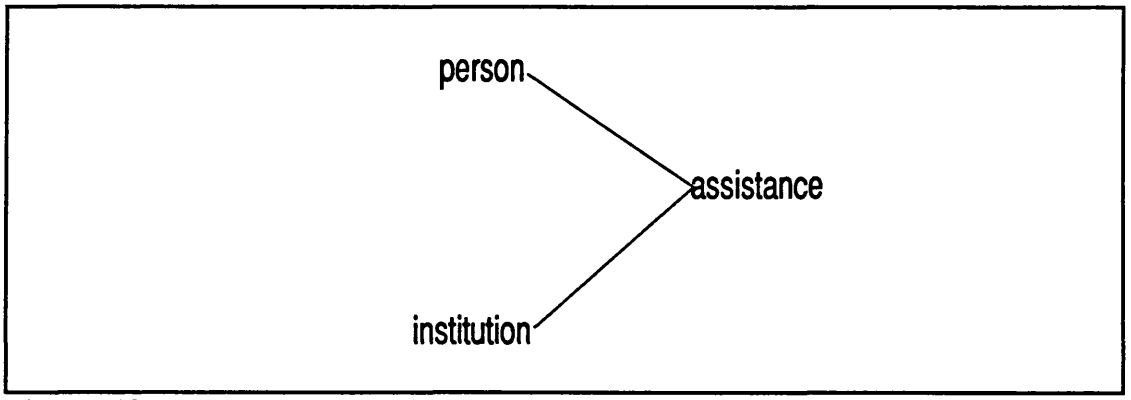


Figure 10.3 'assistance' corrected

Straub has presented 'assistance' as having no antecedent as such and presumably intends it to be viewed as ontologically independent of the affordances specified. This would imply that assistance is something that exists for itself, outside of the

agencies that may provide it. On the contrary, however, the notion of assistance generally carries with it the intervention of one party to the benefit of a second party who needs it. This would suggest two antecedents to 'assistance': one party being the person receiving and another party providing it. The second party would quite often be an agent, in the NORMA sense —capable of responsibility, although it is perfectly possible for an object to provide assistance.

Realising an instance of assistance would create two roles: that of 'assister' and that of 'assisted'. Putting together these two notions of hardship and assistance, Straub has correctly joined them in a relationship of 'relieves'. Thus relief can be realised only once the hardship and the assistance have been instantiated first. In this way the formulation is ontologically sound, since the notion of relief requires first the existence of some problem for the person concerned, and then secondly the alleviation of it.

Ontology of communication acts

In the second chart for the scholarship problem, certain changes have been made. 'Assistance' and 'person' jointly afford 'requires'. What does this imply? In order to realise an instance of requiring, the person and the assistance have to be in existence already. We must conclude that this is inaccurate, since the need for the assistance would have disappeared if this were so. The affordance of 'relieves' is then dependent upon requires. Here we have a confusion: relief is the effect of assistance upon hardship as shown in the preceding paragraph. This error is compounded by making the sign for relieves {'relieves'} dependent upon the affordance itself. In other words the sign for an affordance may only be instantiated when the referent, or actual behaviour, is realised. Since signs are crucial in conjecturing possible worlds, this is a grave error. For the most part these mistakes arise from an incomplete understanding of the ontology of communication acts.

Requesting and suggesting are examples of such acts. As seen in Chapter 4, communication acts involve agents using signs to effect changes in the world of social and legal expectations and obligations. To request assistance, a person must

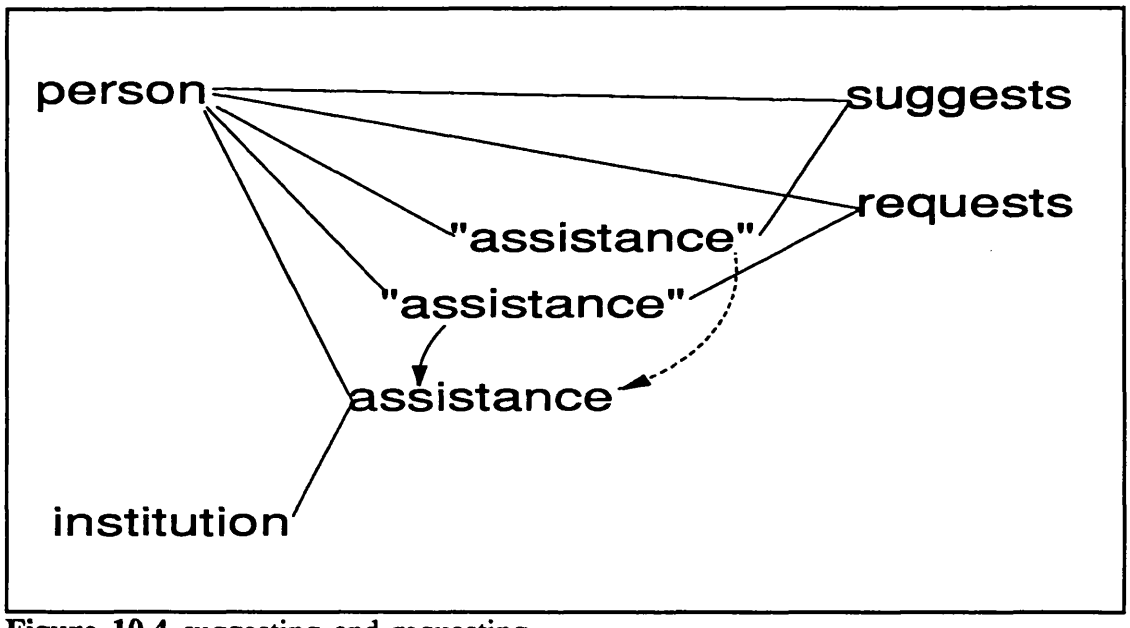


Figure 10.4 suggesting and requesting

employ a sign which refers to the assistance desired, in some act of requesting. The sign itself does not amount to the commission of the act. Quite strict rules exist which ensure that if the act is performed in the manner specified by social convention or legal ruling, then certain consequences follow. Both acts of suggesting and requesting assistance would use signs referring to this assistance in a semiological fashion. Neither act is dependent upon an instance of assistance, which may not occur, but upon an instance of a sign type which can always be reproduced.

Overlooking the clue of a role name

In Chart 3 (Appendix H) the affordance of 'legal_person' is introduced as the antecedent of 'assistance'. This seems to be missing the point of the scholarship arrangements. If the institution is spending so much effort in seeking out those students in need and attempting to resolve such problems, then surely the institution itself should be an antecedent of 'assistance'. Branching from this 'legal_person' is the affordance of 'provision', and here again the question must be posed: what is being provided? Provision suggests both a provider and something being provided, depending upon whether we refer to the act of provision or the role name

for what is provided. In either case there is a joint affordance. In the figure, A illustrates the version given in Chart 3, whereas B shows the correction. Notice the introduction of the very general term 'resources', which permits both the normal monetary form of assistance, and more miscellaneous possibilities: finding accommodation, passing on contacts, and other kinds of help. What is important is that such resources do not depend upon the provider to exist, they are there in any case. Solution A does not allow the specifying of the resources and implies that the demise of the legal person concerned would mean the finish of the resources. Role names permit the economic manipulation of the data held in such a schema: placing 'provider' in the context part of a query restricts the search to just those legal persons who hold (or held) this title.

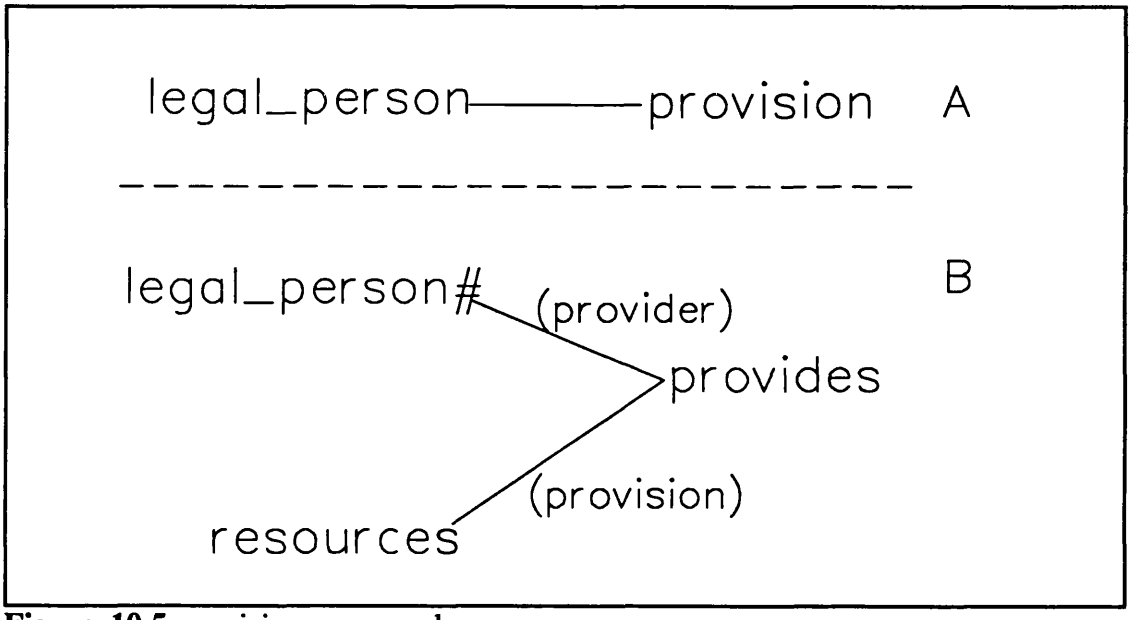


Figure 10.5 provision compared

Confusing procedure with substance

One of the most commonly recurring problems is found in 'applies', as in Chart 6 (Appendix H). Because it is such an everyday notion it is perhaps worth dwelling on it a moment. The difficulty comes from treating the term as some affordance of direct experience, rather than in a semiological fashion. In one sense the act of applying might appear to be substantive enough: obtaining the necessary forms,

completing them in accordance with the specifications (using block capitals, for example) and dispatching the letter to the correct address, assuming we are dealing with a postal application. Behind all this activity is the real point of the matter —making a request for some action from another party— perhaps to grant you some funds, a place at university, a job in an office. The form filling is simply part of the procedure, which could be altered if needed. When the form is used as part of the communication act, the expectations of those involved necessarily change. The applicant expects some consideration to be given to the request and the institution receiving the request expects certain things in return. If we treat 'applies' as a communication act, we can separate the sign type, the application form, from the action which is performed using the sign. Hence the sign refers to some state of affairs which does not (yet) exist but which the agent intends should.

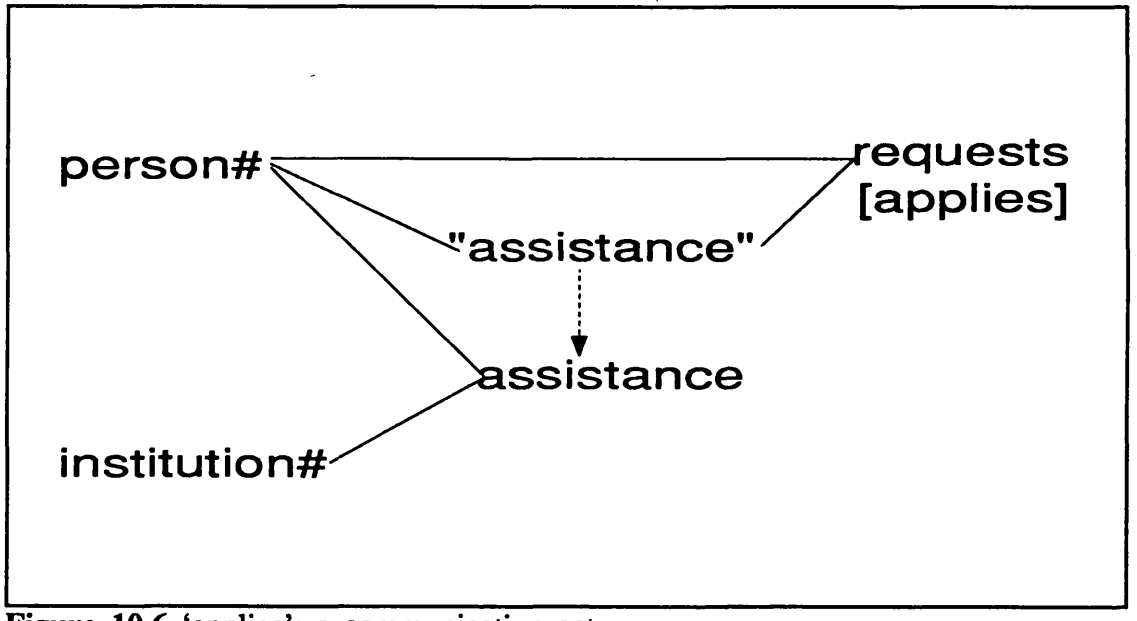


Figure 10.6 'applies': a communication act

Here the goal is the realisation of an instance of assistance. The person seeking assistance would employ a sign which refers to this possibility in the course of the act of requesting. Using the term 'applies' tends to lay the emphasis upon the procedural aspects instead of the substantive. Possibly we might use the term 'requests' to indicate more clearly the nature of this affordance.

Analysing the communication act of 'refuses' can be undertaken after the foregoing request or claim has been treated. Refusing, as a social act with meaning, can only have any significance if it is performed following a request of some kind. The parties to the refusal must be already related by this preceding act. Consequently the ontology of 'refuses' builds upon the structure of the foregoing act —rather as in the CRIS case in Chapter 7, accepting an offer to contribute can be analytically constructed over the schema for 'invites'. Once again the temptation is to relate the two affordances of direct experience, instead of incorporating a semiological antecedent into the ontology for the communication act.

Ontology of a status and its bestower

Chart 6 (Appendix H) poses another tricky problem in the guise of the notion 'graduate_of'. With antecedents of 'person' and 'educational institution' this might

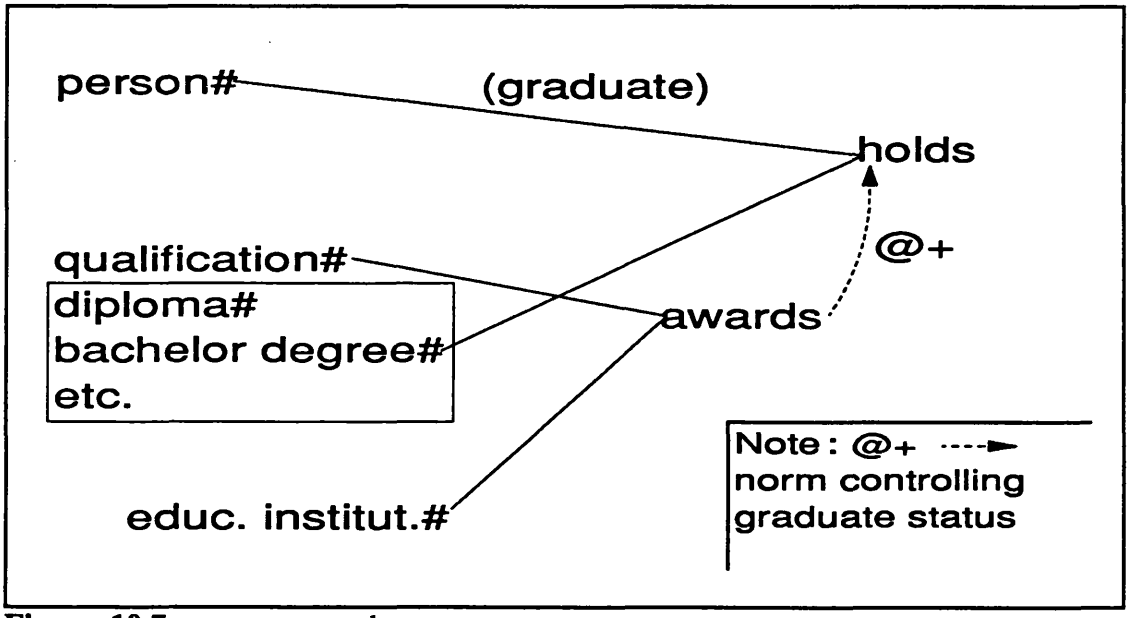


Figure 10.7 person as graduate

seem at first sight to be reasonable. Applying the rule of ontology to 'person' would result in the finish of the instance of 'graduate_of' should the person concerned cease to exist. This formulation might have the semblance of correctness, but are we suggesting that the closure of an educational institution means that its alumni are now orphans? Surely once you have graduated from a

university or college you remain a graduate of it for as long as you survive. What we have is the institution which is the agent which determines whether you are a graduate or not; neither is it necessary for you to be one of its students, since an institution may bestow degrees for honorary purposes to persons who have never entered its portals, except to receive the certificate. The holding of the degree depends not ontologically but normatively upon the awarding of the degree. This arrangement permits the case of stripping the holder of the degree, ie. when 'award' finishes, 'holds' finishes also.

Simplifying the complex

The difficult, but interesting, problem of complying with the stipulations of the 1986 Financial Services Act has occupied not only the minds of several major institutions in the City of London, but also at least two students from the LSE. Whereas Dhillon (1989) began the work of analysing the regulations of the Association of Futures Brokers and Dealers (those concerning compliance with this legislation) and worked on producing the first cut of a semantic schema, Shah (1990) was more interested in attempting to construct a working computer system from this analysis. Even Shah, however, was forced to investigate the semantic problems and adjust the schema.

In Shah's version there are a number of improvements which can be suggested and which would serve to produce a more concise and understandable ontology chart. This is particularly important when we consider that the chart is meant to be a device for communicating with other analysts and the user on the subject of the specification. As it stands (see Appendix E) Shah's chart is of impenetrable complexity and could be understood only by the initiated. With one or two small alterations it can be easily simplified.

Handling roles

In this case there are a very large number of roles which persons hold in a company structure. Each of these roles is of interest to the regulatory bodies, in that the incumbents are potential sources of 'insider information' and thus records

must be kept on who holds, or has held, a particular role. Shah has partly done the work of grouping the roles together having placed, for example, Director, Manager, Partner, Compliance Officer, Finance Officer, Secretary and Customer Interests Officer, all under one generic/specific group. His rationale for this appears to be that the rule by which changes in these incumbencies must be notified is the same one for all. Since each tuple in the surrogate table for each universal of role will in any case have to have the appropriate authority specified, we could arrange all the roles into one generic/specific relationship, thus reducing the number of complicating lines on the chart at a stroke. There will be simply one generic of 'role' with many specifics.

Grouping into a 'new' category

Another way of simplifying the chart is to take all the various events which trigger a notification and place them in a new generic/specific relationship: 'event'. While this might be criticised by the letter of our law (principle 2), in that we introduce a new term, the term 'event' is fairly natural for this purpose and does not appear to violate the domain terminology. For the most part such events include:

1 starts or finishes (changes) in the incumbency of any of the roles;
2 starts or finishes in the roles;
3 starts or finishes in ownership of the firm and its subsidiaries;
4 starts or finishes in the business carried on by the firm;
5 starts or finishes in the firm itself;
6 starts or finishes in petitions or resolutions leading either of the two foregoing;
7 starts or finishes in the location of the registered office of the firm.

In every case of these events occurring within a firm in the regulated financial service sector, there is an obligation upon the firm to notify the change to the market's regulatory body —in this particular case the Association of Futures Brokers and Dealers. Once again grouping these events together vastly reduces the clutter of detail on the ontology chart. In effect what we are doing is to raise the level

of abstraction just a shade higher than it was pitched in order to be able to see more clearly the relationships that prevail.

Explicit introduction of norms

Specific norms govern the existence delimiters of all the entities in an ontology chart. For the affordances mentioned above these norms are to be found in the Notification Regulations themselves. Each of the norms can be attributed the name of the subsection in which it appears, although informal norms never have names since they do not figure in any formal system where the name, taken typically as identification, would be used for manipulation. These rules govern the existences of the items listed in the previous section.

Inserting these norms on the ontology chart might be justified when the elements are few, but when there is a great deal of complexity, simplifying the representation should be our watchword. In the surrogate tables each norm will have its place in the authority start or authority finish column for the tuples for each universal.

Incorporating normative relationships into the ontology

The work of Thönissen (1990) is interesting in ranging widely over many issues in the LEGOL/NORMA methods. His treatment of the CRIS case builds on analyses performed by others and adds features of his own. One feature that should be noted is the use in the chart (see Appendix I) of the representation device of making the role an antecedent. For example,

—an antecedent of 'ownership' (copyright, author) is 'author'

—an antecedent of 'representation (learned society, member)' is 'member' of IFIP;

The effect of this on the ontology chart is to permit more information about the relationships to be represented economically, and more importantly reduces the spider's web somewhat. There has been little written in the research group about the consequences of incorporating this feature into the normal methods, but it seems to have been widely adopted.

Unfortunately there is no rose without a thorn.

What happens is that this practice enforces the embodiment of behavioural norms into the schema. Consider for a moment the copyright question. At a commonsense level we might accept the formulation provided, but surely we should progress beyond that. By specifying that one of the antecedents of the ownership of copyright must be 'author', we are effectively excluding other possibilities. Take the possibility of the author being commissioned to write a piece for a third party. Is not this what journalists do? Who owns the copyright of an article for *The Times*, Times Newspapers or the journalist concerned? And how could we represent the change of ownership of copyright, when the author decides to sell it? With one antecedent anchored to the affordance 'author' the market is rather restricted.

Similar problems arise from the 'representation' ontology. As it stands in Thönissen's chart, the National Representative (a role in 'representation') must be a member of the learned society. In general this would follow as a matter of course, to represent a body on a second, one should be at least a member of the first body. But the course of experience can weave strange patterns. Think of an instance, common in diplomatic circles, where for some reason normal representatives cannot carry out their usual duties, and their work is in part taken over by third parties. The Swedish diplomat in Iran who occasionally acted for British interests did not number among the subjects of Her Majesty.

In the work of Ades (1987) (see Appendix F), much is done to refine a schema for the administration of the University of Qatar. However in the sample extracted for illustration (p.20), albeit a small section, there are a number of problems. The 'studentship' relationship between a person and a university poses no problems, yet together with 'course' affords 'takes'. What does this mean? It could imply that only a person who is a student may take a course, in which case it would fall under the criticism levelled about role antecedents above. Less likely is the interpretation of the abstract notion itself of studentship entering into some relationship with a course, yet we are not to know. Equally obscure is the affordance of 'group offered' with its antecedents of 'course' and 'semester'. In this case there are the separate matters of 'offers' and 'group'. Offered is a term

we would normally employ as a communication act, which we cover elsewhere. Group is understandable enough but where it relates to either 'course' or 'semester' is not clear. How the two fit together is even more perplexing.

Firstly the ontology of 'group' needs to be established, and then membership of it by persons. Secondly, the offering of a course presumably should be handled in the usual fashion for communication acts, and thus the cancellation of the offer can be dealt with as a withdrawal of the offer. Interestingly enough, another student, Lupolo (1987), working upon the same problem at the same time does in fact make this separate. In her chart (Appendix G) the institution, through its schools, affords groups, of which persons can have membership, and offers courses.

Conclusion

This critical review of the work of other analysts is not intended as unfriendly criticism, but instead as a constructive attempt to build up not only a *modus operandi*, where the work of one analyst is open to scrutiny by another, but also, and as a direct result of this, as a way of accumulating a vast library of well tried and tested bits of analysis. Since we are aiming at specifying at the highest level —of behaviour— then wherever groups of people are doing the same things, then the ontology should be the same.

We are under no illusion that the application of semantic analysis in a rigorous fashion entails considerable effort and practice initially. The greater the number of constraints the more understanding required. But gradually the growth in the critical mass of material available and of analysts using the method should facilitate the initiation into the method. What we discovered is that, despite the apparent plethora of specification techniques in NORMA and their attendant notational questions, there are relatively few structures required for an economical representation of quite complicated scenarios.

Chapter 11
Thesis Conclusions

There are many methods currently used for analysing businesses for the purposes of information systems development: different ways of slicing through the organism in order to understand better how it functions. Semantic analysis, in espousing an explicit theory—a theory of meaning which is especially appropriate to social and business affairs—provides what is in effect a powerful knowledge elicitation technique. By basing the whole information edifice upon the responsibility of the various agents who are protagonists in the business, the analyst can always pinpoint those able to resolve any uncertainties and disputes over meaning.

The surrogate table and the norms formed with the terms defined therein together give a tangible form to this structure for the recording of the knowledge in the business. The method sets parameters of time, space, agents concerned in the realisation, agents responsible for determining its existence and the mood, for each and every item considered. These permit the analyst to operate with a high degree of sureness that uncovering the values for each parameter for every element in the analysis will guarantee a very deep understanding of the problem. Looking through the results of the CRIS case we can find who is responsible for each small item in the business of running conferences in that learned society.

Increasingly the cross-national and cross-cultural growth of information systems incurs problems of semantic ambiguity and understanding. Semantic analysis has the tools not only to ferret out these problems, but also to handle them quite naturally once discovered. The different understanding about who might have responsibility for referring students with behavioral problems to the psychological service soon comes to light when the analytical tool used is persistently posing that very question. And if more than one view is held, then this is naturally brought into the light for discussion. Different solutions (meanings) may co-exist, as long as there is an agreed norm for handling the questions of which prevails when.

The method does not rest upon a presupposition of an *a priori* assumption that there is only one correct view of the organisation. Nor is it necessary to have

just one view at the end of the process. More often than not different understandings can work together to produce a richer texture of organisational life. A conference whose papers are decided by just one referee will be a decidedly dull affair; a school psychological service that posits only one explanation for attendance problems at school will carry little weight with the workers at the 'chalk face'.

When using this method, difficulties in communication which lie submerged in the daily hurly-burly of organisational life can be forced to the surface. Once an organisation has a specification of the semantics of the terms it uses to do business, it has a blueprint which can be used for a whole variety of purposes: induction of new employees, high-level policy reviewing or for the development of new computer based systems.

In clarifying the understanding of what the business does, scope is still left for handling the different understandings that may prevail in different sections of the organisation, which only have to be reconciled when the two have to converse. Two different schools can happily survive with totally different definitions about what constitutes a student with a 'behaviour problem'. Only when the two need to interpret each other's signification of the term does it become necessary to negotiate the conflicting meanings: as when the transfer of students from the one to the other is being discussed, or more to the point, when a centralised formal system such as a bureaucratic or database system is being developed. At this point the capacity of the modelling language to portray these varied conceptions becomes critical, and it is generally here where the constrictions of what are viewed as the computer system straitjacket make themselves felt.

Performing semantic analysis: findings

Throughout this research there has been a firm commitment to the efficacy of the method and its superiority over its rivals. A great handicap for those seeking to use semantic analysis has been the lack of accessible material that describes how to do it. What little there is does not offer the novice a method, but sketches briefly how some principles might be applied. In seeking to remedy these defects, the present author has attempted to provide more fully worked examples of analysis.

Perhaps the greatest difficulty has been the lack of a method for carrying out the task. Chapter 8 demonstrates the sequence of passes at the target problem which appeared to provide the most natural evolution.

Undoubtedly the first practical problem is to obtain some text which describes the work of the organisation: just as the practitioner of the occult needs samples of the hair, nails and skin of the victim in order to commence his dastardly work, so the semantic analyst requires an equally representative body of material from his chosen target! Whilst in highly formalised organisations this material may be found in the rulebook, regulations, manuals and clerical code, in more informal work situations such material may be entirely absent. So it was with the Schools Psychological Service (Chapter 7). Almost every item of text had to be coaxed from the mouths of the protagonists: psychologists, support teachers, school head teachers and heads of year, even to the point of interviewing a student with behavioral problems. Once this material is in place then work can begin.

As the text is subjected to analysis the questions begin to arise, and some answers may be supplied from the knowledge of the analyst, but so often recourse is needed to those involved. To discover who is the authority that decides whether a paper is or is not a conference paper, and then at what point it commences so to be, one needs to solicit the opinions of main actors on that stage. Often it may be that the questions have never occurred to them before and so the answers are not ready to hand. Custom and practice carve a deep furrow for the members of a social grouping; to the point where interrogation of the kind suggested by the analytical framework is counter-productive.

Many of these matters are not new for those involved in information systems analysis and design. The problems of obtaining empirical data are common to all involved in research of any kind. Whether this analytical approach can obviate these inconveniences is unlikely.

Advantages are to be found in the standard format for the data expressed chiefly in the form of the surrogate table. With the constant requirement for the same blanks to be filled in for every single affordance the analysts at least has a clear perspective of the task in hand. Other analysis and design methods and other

data storage approaches have a multiplicity of recording formats to be addressed. This uniformity is a blessed relief, and is conducive to shortening the learning period. Associated with this is the benefit of the table as a vehicle for communication amongst analysts. A massive amount of analytical detail is available in a readable way, once, that is, the novice semantic analyst has learnt to read the table. For even greater economy of expression the ontology chart offers a simpler means of representation. Each node has implicit in it the information held in the surrogate table.

Combining data and schema

Undoubtedly a considerable bonus of the method is realised in the ability to combine schema and data. Whereas in the relational data model, for example, it is impossible to record items of data until the relational schema itself has been completed, in semantic analysis the structure of the surrogate table is already known in advance. As the analyst begins to enter the surrogates for the universals, the particulars of any of those universal may also be recorded. Once the surrogate for 'person' has been completed, including the antecedent, authorities and so on, details of particular persons can be added. For the analyst who has limited access to first hand sources such a facility is a great boon. The data entry does not have to be left until a later date, after the grand schema has been unfolded, and the scent of the quarry has gone cold. Using the mood fields, mistakes can be rectified by initially entering surrogates in the hypothetical mood and then, after further investigation, either retracting them or changing the mood to assertion.

In practice these facilities offer the analyst(s) an audit trail of analysis. Every essay at defining a fragment of a schema may be recorded, in precisely the same form as the polished, final version. The starts and finishes and mood changes allow the genesis of each section of analysis to be traced and scrutinised.

Plethora of rules

A major drawback, in one sense, is the complexity and extent of rules that govern the specification using NORMA. An infinity of rules seems to extend before the

analyst who ventures out for the first time on this task. And in one way this is certainly a drawback, entailing the analyst in no small a commitment to permeate the philosophical outlook and learn its plethora of rules (indicated in Chapter 8).

However, looked at from another perspective this weight of formality is a distinct blessing. In analytical methods that are short on constraints, too much is left to the informal side, to the analyst, who, with his wealth of experience can soon conjure up a working solution. The beginner analyst, however, has little support from the method itself and is left to flounder.

Parallels may be drawn between arguments over the relative difficulties of English, with its modest cumulus of grammar and syntax, compared with the likes of French or Italian (or for that matter other latinate languages), with their mountains of formal rules to be scaled by the novice linguist. Where formality reigns, diligent attention to the syntax can yield surprisingly good results: where the logic resides in informal structures the road to success may be even more arduous and in all probability less well signposted.

That is not to suggest that we are lacking in analytical methods which are suffused with rules of form and structure. What cuts out NORMA from the rest is the superiority of the philosophical stance that lies behind the formality.

Without any doubt at all, NORMA can be said to be a 'difficult' specification method. Difficult not primarily because of the number of rules which circumscribe it, but because of the shift in assumptions which it represents and embodies. For analysts used to traditional approaches to data and information, the ontology charts resemble so many dataflow diagrams. For them the terminology of affordance, realisation etc. is confusing and intimidatory. Rational argument on the necessity of new terms for new concepts does not remove the underlying paradigm that they have imbibed over the course of their educational and professional careers and on which they have built hitherto satisfactory working systems.

The most likely supporters of the NORMA approach will be found in the ranks of two main groups. One group will be novice analysts, those used to no particular approach as yet, and who may embrace new methods without feeling

committed "ideologically" to data analysis and its cousins. Often students who have taken up courses where these new methods have been exposed have not always been aware that they are many miles from the traditional approaches. The other group, whose ranks are growing by the day, consists of those who are disillusioned with the results gained from the use of orthodox methods, who are disappointed with the returns from the large sums invested in new technology and contemptuous of the meagre payoff. These people are less likely to include analysts and systems designers amongst their number, for the reason of emotional commitment to the intellectual investment they have made in standard approaches. They are more likely to be people who are concerned with the highest level of business, the managers and principals, as opposed to the technicians and systems people. It is to this group that the best appeal can be made with methods based on NORMA.

Directions for research

Undoubtedly the development of an interpreter which can take in statements expressed in NORMA and manipulate them using LEGOL will be a great step forward. It should be possible to move towards an animation, not just of the organisation's data as at present, but also of the organisation's norms. In effect the system should be able to represent in an interactive fashion the workings of the organisation so that a wide range of queries and scenarios can be investigated.

Such a system will permit the schemas and ontology charts produced by semantic analysts to be directly tested. What will be needed then is the speeding up of the process of analysis itself, and here we are working to develop computer based support. The need is for a tool that can check that the structures that the analyst defines conform with the underlying metaschema. In this way it should be impossible to extract results from the stored data which are nonsensical. For example the system should not add together the weights of two persons whose existences never overlapped, when the existence parameters would permit only the addition of the two numbers. Achieving this goal will enable the burden of consistency checking to be lifted from the shoulders of the analysts and handed over to the computer.

Further research might permit help to be provided to the analyst when seeking to specify a problem domain. Fong (1990) has developed a small system for her MSc project which gives help to the analyst when performing semantic analysis on text. The system provides facilities for text editing and parsing along the lines of the semantic grammar of NORMA. Its output is a semantic schema for the problem area. A separate graphics facility is needed to generate an ontology chart both during and after the analysis. The importance of the chart as a visual and graphical representation of the relatively abstract schema cannot be overestimated.

It would be useful to have recourse to sections of analysis previously tested, using a kind of thesaurus facility. When a given term is marked the system could offer the user to select from a variety of possible 'mini-schemas' which encompass the term. Given that the specification is of behaviour patterns, which tend to be fairly enduring, rather than of organisational procedure which changes from place to place and over time, the chances are that the mini-schemas will prove to be reusable. For example the section of an ontology chart that deals with posts, incumbents, and applications to fill the posts is likely to be very similar across many different businesses and organisations. What is needed is research into discovering whether there are considerable sections of reusable analysis and how they can be shared and developed. So often with existing database schemas, the possibilities for reusing schemas are limited, partly because organisations are 'cagey' about revealing their inner workings, and partly because with procedural based specification the chances of the analysis being reused is limited.

Given that there are, and will continue to be, many systems analysts and designers who will continue to use existing relational and other database models and who use orthodox specification methods rather than those outlined in this research, it is important to consider how semantic analysis and the semantic schemas can be married into the existing tools and techniques. Ades (1987) is researching into the possible relationship between semantic analysis and the relational model, and it would be an important step forward to develop a method for translating the semantic model into a relational one in a controlled manner, clearly indicating what

compromises have to be made. Similarly it would be useful while this new approach is being established to have a way of bridging the passage from established information systems analysis and design methods to these. This would mean that the break with what are becoming old-fashioned and inadequate tools would be less traumatic.

What this research has achieved

Here we set out what we believe to be a number of the achievements of this research work:

Clarification of method

This research has accomplished a clarification of what exactly constitutes semantic analysis. Such literature as was available in the LEGOL/NORMA papers concerned the application of the semantic grammars of the LEGOL languages which preceded NORMA. With regard to NORMA the only major contributions concerned the outlining of the syntax of the language without any systematic application of it. By setting out in a transparent fashion the key elements of the language, this research makes it possible and more likely that new cohorts of practitioners may be tempted to give it a try.

Exemplification of method

Having clarified the essential elements of the language this work has shown how the language can be put into practice. The technique has been exemplified on many case studies, of which only three have been illustrated. This process of indicating how the technique can be applied to a case is necessary if we are to show the practical usability. Unfortunately the overriding concern for pushing ahead the work of developing NORMA has in the past not permitted attention to be given to explaining just precisely what performing semantic analysis looks like in practice.

Development of more precise rules

Another important contribution has been the setting out of more precise rules for the constraints; the sketching out of a metaschema. Although more work is needed here to express the full range of metaphysical relationships that underlie any semantic schema in NORMA, a start has been made. This work will allow the building of a computer system to support the analyst.

Developing a way to perform the analysis

With the large range of constraints and fundamental assumptions associated with NORMA, the need for a method of applying them was paramount. In this work we have attempted to set out a rational agenda of work comprised in the performing of semantic analysis, and in an easily accessible manner. A simple set of ten stages in the work spans the range of tasks that are required. At no stage has there existed such a straightforward introduction, rather, the tendency has been to shy away from such an objective by pointing to the possibility of beginning the analysis in a number of ways. In the view of the present author a tangible and practical method to begin with is more valuable to the novice than the knowledge that there are a myriad possible ways of commencing.

Review of common errors

As a further contribution this work has examined a few of the examples of semantic analysis performed by students and others, and identified a few 'classic' errors. The importance of this is to focus on what are likely to be common mistakes that spring from an inadequate grasp of the language, and if corrected can lead to better results quite quickly. Matters of ontology and roles pervade almost every possible problem domain imaginable. If we can put users of the method on the right track early on in the process then we can avoid a significant part of the problems associated with the 'learning curve'.

APPENDIX A: Text of the CRIS Conference Design Specification Introduction

IFIP is the International Federation of Information Processing and is a federation of the national data processing societies of about 40 countries. IFIP has about 12 technical Committees and the member societies are allowed to appoint a so-called National Representative to each Technical Committee whose work they consider of interest.

Each Technical Committee has two or more Working Groups. One of the activities which these working groups are encouraged to organize is Working Conferences which are small invited conferences on some subject of relevance to the formally approved scope and aims of the Working Group.

An IFIP working conference is required by IFIP procedures to have an Organizing Committee normally based in the country in which the conference is to be held, and a Program Committee which should be international.

In 1982, Working Group 8.1 organized a Working Conference in the Netherlands on the topic "Information Systems Design Methodologies: a Comparative Review". Each submitter was invited to show how his methodology would handle a test case based on conference organization.

The requirement is for the design to support the Business Activities listed in Figure B.1.

1. Arrange technical program

    1.1 Sending out call for papers to prepared list
    1.2 Registering letters of intent received in response to call
    1.3 Registering contributed papers on receipt
    1.4 Distributing papers to referees
    1.5 Collecting referees reports and selecting papers for inclusion in program
    1.6 Grouping selected papers into sessions and selecting chairman for each session

2. Local arrangements

    2.1 Prepare list of invitees
    2.2 Issue priority invitations to National Representatives and to members of Technical Committee's Working Groups
    2.3 Ensuring authors of selected papers receive an invitation
    2.4 Ensuring authors of rejected papers receive an invitation
    2.5 Avoid sending duplicate invitations to any individual
    2.6 Registering acceptances of invitations
    2.7 Generating final list of attendees

The Constituent Elements of IFIP

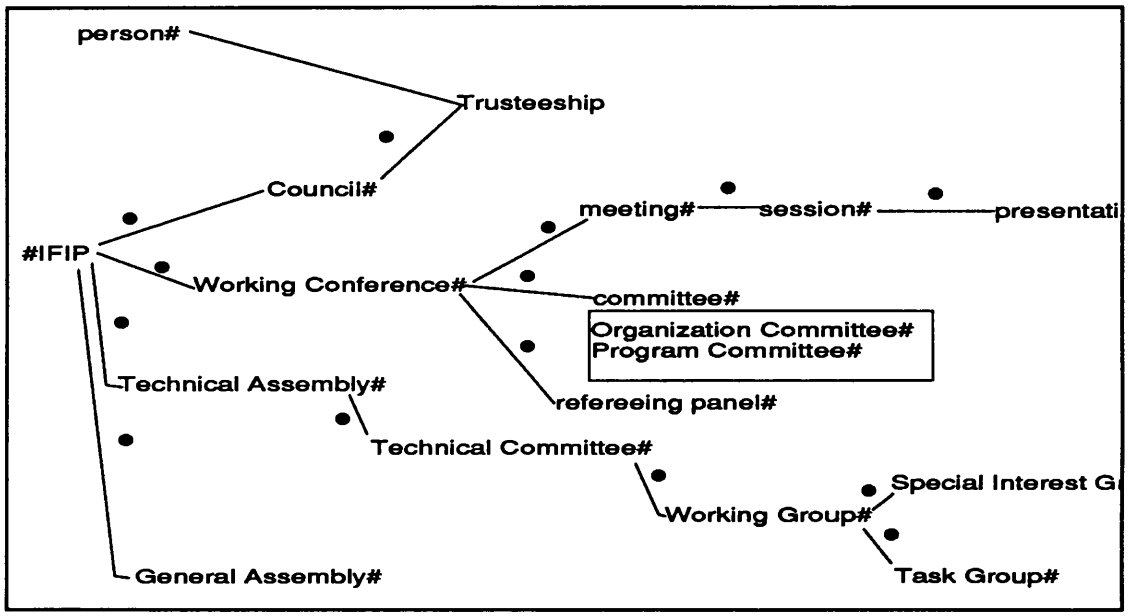


Figure I the parts of IFIP

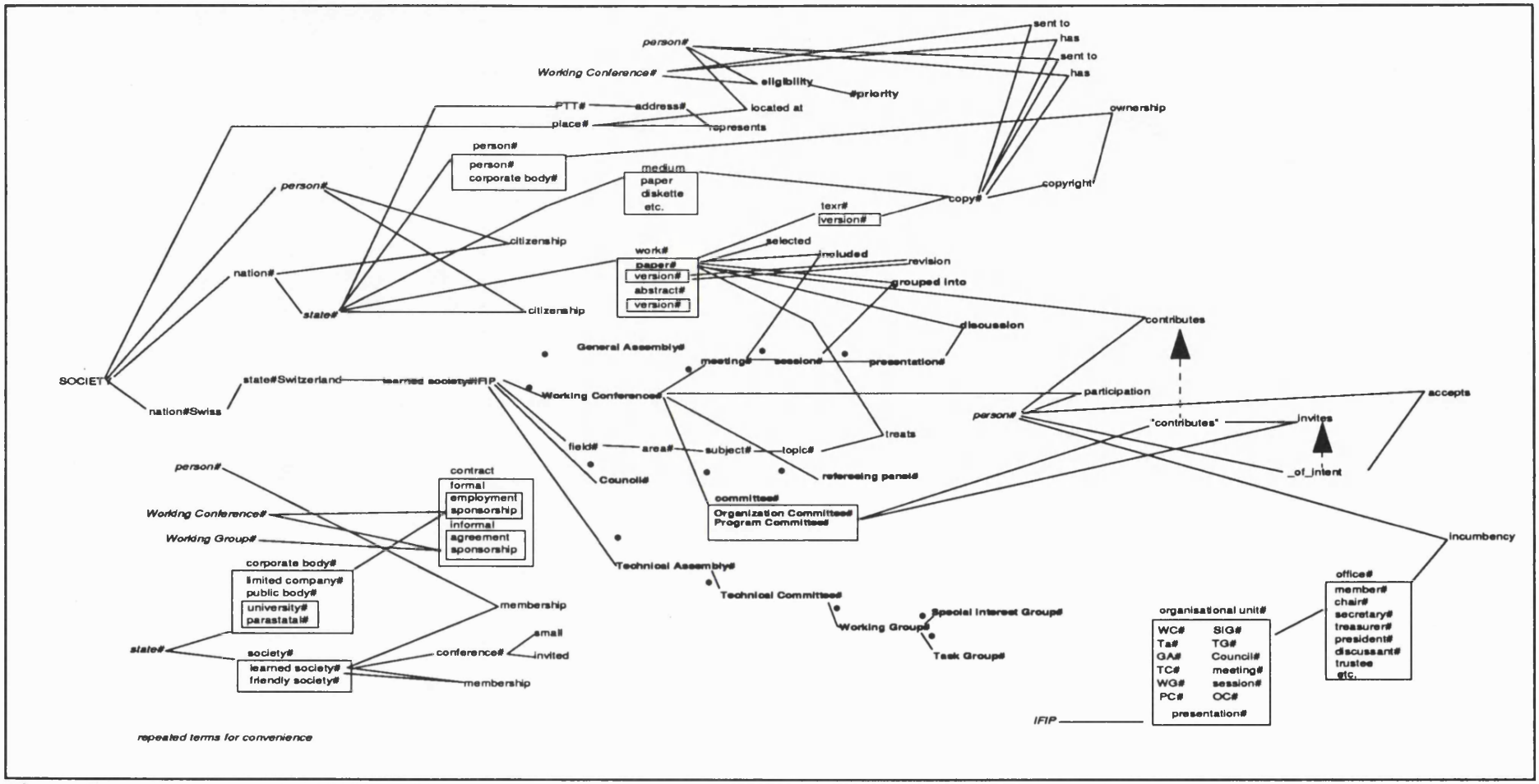


Figure I ontology chart for CRIS problem

APPENDIX B: Case Data for the CRIS Case

SURROGATE	TYPE	SORT	LABEL	ANT1	ANT2	@+	@-	START	FINISH
nation	u	a	nation	Society		Society	Society		
person	u	a	person	Society		Society	Society		
language	u	a	language	Society		Society	Society		
state	u	a	state	nation		Society	Society		
recognised	u	a	language	state		state	state		
Switzerland	p	state	Switzerland	Swiss		Swiss	Swiss		
Danish	p	nation	Danish	Society		Society	Society		
Dutch	p	nation	Dutch	Society		Society	Society		
English	p	nation	English	Society		Society	Society	1300/01/01	
French	p	nation	French	Society		Society	Society	1000/01/01	
German	p	nation	German	Society		Society	Society		
Welsh	p	nation	Welsh	Society		Society	Society	1000/01/01	
Italian	p	nation	Italian	Society		Society	Society	1860	
5 F Republic	p	state	5 F Republic	French nation		French	French	1958	
Norwegian	p	nation	Norwegian	Society		Society	Society		

Belgian	p	nation	Belgian	Society		Society	Society	
FDR	p	state	FDR	German		German	German	1946/01/01
Netherlands	p	state	Netherlands	Dutch		Dutch	Dutch	1596
Denmark	p	state	Denmark	Society		Danish	Danish	
Rep of Italy	p	state	Rep of Italy	Italian		Italian	Italian	1860
British	p	nation	British	Society		Society	Society	
Norway	p	state	Norway	Norwegian		Norwegian	Norwegian	
ctzshipS	u	a	ctzshipS	person	state	Ant2	Ant2	
learned soc.	u	a	learned soc.	state		Ant1	Ant1	
DP Society	u	a	DP Society	state		Ant1	Ant1	
org. unit	u	a	org. unit	IFIP		Ant1	Ant1	
GA	u	a	GA	IFIP		Ant1	Ant1	
TC	u	a	TC	Tech Assembly		GA	GA	
membership	u	a	membership	person	TC	Ant2	Ant2	
WG	u	a	WG	TC		GA	GA	
WC	u	a	WC	IFIP		GA,TC	GA,TC	
committee	u	a	committee	WC		WC	WC	
OC	u	a	OC	WC		WC	WC	

PC	u	a	PC	WC		WC	WC	
referees panel	u	a	referees panel	WC		WC	WC	
meeting	u	a	meeting	WC		OC(WC)	OC(WC)	
paper	u	a	paper	state		Ant1	Ant1	
membership	u	a	membership	person	referees panel	@Ant2	@Ant2	
Chair	u	office	Chair	org. unit		org. unit	org. unit	
presentation	u	a	presentation	session		Chair(session)	Chair(session)	
discussion	u	a	discussion	presentation	paper	PC(WC)	PC(WC)	
PTT	u	a	PTT	state		Ant1	Ant1	
place	u	a	place	Society		Society	Society	
address	u	a	address	PTT		PTT	PTT	
represents	u	a	represents	address	place	PTT	PTT	
work	u	a	work	state		Ant1	Ant1	
abstract	u	work	abstract	state		Ant1	Ant1	
versionT	u	a	versionT	versionP	language	@Ant1	@Ant1	
language	u	language	language	French		Society	Society	1200
language	u	language	language	English		Society	Society	1300
Council	u	a	Council	IFIP		IFIP	IFIP	

Trusteeship	u	office	Trusteeship	IFIP		IFIP	IFIP
tel. no.	u	a	tel. no.	PTT		PTT	PTT
Task Group	u	a	Task Group	WG		TC	TC
field	u	a	field	IFIP		learned soc.	learned soc.
area	u	a	area	subject		GA	GA
subject	u	a	subject	field		GA:WG	GA:WG
topic	u	a	topic	area		PC(WC)	PC(WC)
letter of int.	u	a	letter of int.	person		Ant1	Ant1
accepts	u	a	accepts	person	letter of intent	WC:Chair(PC)	WC:Chair(PC)
attends	u	a	attends	person	session	OC	OC
authorship	u	a	authorship	person	work	Ant1	Ant1
based in	u	a	based in	committee	state	WC	WC
call f. papers	u	a	call f. papers	WC		OC	OC
company	u	a	company	state		Ant1	Ant1
legal person	u	a	legal person	state		Ant1	Ant1
medium	u	a	medium	state		Ant1	Ant1
copy	u	a	copy	versionT	medium	PC	PC
contributes	u	a	contributes	legal person	work	PC	PC

diskette	u	a	diskette	state		Ant1	Ant1	1956
corporate body	u	a	corporate body	state		Ant1	Ant1	
expertise	u	a	expertise	person	topic	Ant1	Ant1	
has	u	a	has	person	copy	Ant1	Ant1	
incumbency	u	a	incumbency	person	office	@Ant2	@Ant2	
invites	u	a	invites	WC	call f. papers	WC	WC	
located at	u	a	located at	person	place	Ant1	Ant1	
membership	u	a	membership	learned soc.	learned soc.	Ant1,Ant2	Ant1,Ant2	
represents(state)	u	a	represents(state)	learned soc.	state	Ant2	Ant2	
national	u	a	national	learned soc.		state	state	
membership3	u	a	membership3	corporate body	person	Ant1,Ant2	Ant1,Ant2	
revision	u	a	revision	version#2	version#1	PC	PC	
on	u	a	on	WC	subject	GA	GA	
participation2	u	a	participation2	person	meeting	OC	OC	
reviews	u	a	reviews	paper#2	paper#1	PC	PC	
selected	u		selected	paper		PC	PC	
sent to	u	a	sent to	copy	person	OC	OC	
sent to	u	a	sent to	copy	WC	person	person	

treats	u	a	treats	paper	topic	PC	PC		
sponsorship1	u	a	sponsorship1	corporate body	WC	Ant1,Ant2	Ant1,Ant2		
sponsorship2	u	a	sponsorship2	WG	WC	Ant1,Ant2	Ant1,Ant2		
surr#	ty	sort	label	ant1	ant2	auth+	auth-	start	finish
A. Bertztiss	p	person	A. Bertztiss	Society		Society	Society		
A. Finkelstein	p	person	A.Finkelstein	Society		Society	Society		
AA Dorodnicyn	p	person	AA Dorodnicyn	Society		Society	Society		
Alex V Stuart	p	person	Alex V Stuart	Society		Society	Society		
B. Gunadi	p	person	B. Gunadi	Society		Society	Society		
Bill Ollie	p	person	Bill Ollie	Society		Society	Society		
BL Sendov	p	person	BL Sendov	Society		Society	Society		
E.Falkenberg	p	person	E.Falkenberg	Society		Society	Society		
F. Bodart	p	person	F. Bodart	Society		Society	Society		
G Glaser	p	person	G Glaser	Society		Society	Society		
HW Le Roux	p	person	HW Le Roux	Society		Society	Society		
J Fourot	p	person	J Fourot	Society		Society	Society		
J. Bubenko	p	person	J. Bubenko	Society		Society	Society		
J. Dietz	p	person	J. Dietz	Society		Society	Society		

J. Hagelstein	p	person	J. Hagelstein	Society		Society	Society	
L. Penedo	p	person	L. Penedo	Society		Society	Society	
L. Bhabuta	p	person	L. Bhabuta	Society		Society	Society	
M.Z. Hanani	p	person	M.Z. Hanani	Society		Society	Society	
O Longe	p	person	O Longe	Society		Society	Society	
OM Dalton	p	person	OM Dalton	Society		Society	Society	
P-X Guo	p	person	P-X Guo	Society		Society	Society	
PA Bobillier	p	person	PA Bobillier	Society		Society	Society	
R Piloty	p	person	R Piloty	Society		Society	Society	
R Stamper	p	person	R Stamper	Society		Society	Society	1934/05/09
G. Bracchi	p	person	G. Bracchi	Society		Society	Society	
ctzshipN	p	ctzshipN	ctzshipN	Italian	G. Bracchi	G. Bracchi	G. Bracchi	
ctzshipN	p	ctzshipN	ctzshipN	B. Gunadi		B. Gunadi	B. Gunadi	
ctzshipN	p	ctzshipN	ctzshipN	A.Finkelstein	UK	A. Finkelstein	A. Finkelstein	
ctzshipN	p	ctzshipN	ctzshipN	E.Falkenberg		E. Falkenberg	E. Falkenberg	
ctzshipN	p	ctzshipN	ctzshipN	J. Dietz		J. Dietz	J. Dietz	
ctzshipN	p	ctzshipN	ctzshipN	J. Bubenko		J Bubenko	J Bubenko	
ctzshipN	p	ctzshipN	ctzshipN	J. Hagelstein		J. Hagelstein	J. Hagelstein	

ctzshipN	p	ctzshipN	ctzshipN	L. Bhabuta		L. Bhabuta	L. Bhabuta	
ctzshipN	p	ctzshipN	ctzshipN	M.Z. Hanani		M.Z. Hanani	M.Z. Hanani	
ctzshipN	p	ctzshipN	ctzshipN	Peter Jones	Welsh	Peter Jones	Peter Jones	1944/12/12
ctzshipN	p	ctzshipN	ctzshipN	A. Bertztiss	American	A Bertiss	A. Bertiss	
ctzshipS	p	ctzshipS	ctzshipS	A Goldsworthy	Australia	A Goldsworthy	A Goldsworthy	
ctzshipS	p	ctzshipS	ctzshipS	A.Finkelstein	UK	UK	UK	
ctzshipS	p	ctzshipS	ctzshipS	Alex V Stuart	Netherlands	Netherlands	Netherlands	
ctzshipS	p	ctzshipS	ctzshipS	BL Sendov	Bulgaria	Bulgaria	Bulgaria	
ctzshipS	p	ctzshipS	ctzshipS	E.Falkenberg	Netherlands	Netherlands	Netherlands	
ctzshipS	p	ctzshipS	ctzshipS	F. Bodart	Belgium	Belgium	Belgium	
ctzshipS	p	ctzshipS	ctzshipS	G Glaser	USA	USA	USA	
ctzshipS	p	ctzshipS	ctzshipS	GJ Morris	UK	UK	UK	
ctzshipS	p	ctzshipS	ctzshipS	HW Le Roux	South Africa	South Africa	South Africa	
ctzshipS	p	ctzshipS	ctzshipS	J. Bubenko	Sweden	Sweden	Sweden	
ctzshipS	p	ctzshipS	ctzshipS	J. Dietz	Netherlands	Netherlands	Netherlands	
ctzshipS	p	ctzshipS	ctzshipS	J. Hagelstein	Belgium	Belgium	Belgium	
ctzshipS	p	ctzshipS	ctzshipS	L Penedo	Portugal	Portugal	Portugal	
ctzshipS	p	ctzshipS	ctzshipS	L. Bhabuta	UK	UK	UK	

ctzshipS	p	ctzshipS	ctzshipS	OM Dalton	Rep of Ireland	Rep of Ireland	Rep of Ireland	
ctzshipS	p	ctzshipS	ctzshipS	P-X Guo	China	Rep of China	Rep of China	
ctzshipS	p	ctzshipS	ctzshipS	PA Bobiliier	Switzerland	Switzerland	Switzerland	
ctzshipS	p	ctzshipS	ctzshipS	Peter Jones	UK	UK	UK	1944/12/12
ctzshipS	p	ctzshipS	ctzshipS	R Hirschheim	USA	USA	USA	
ctzshipS	p	ctzshipS	ctzshipS	R Piloty	FRG	FRG	FRG	
ctzshipS	p	ctzshipS	ctzshipS	R Stamper	UK	UK	UK	1934/09/05
A.F. Cyb Econ	p	learned soc.	A.F.Cyb Econ	France		Fr. Co. Law.	Fr. Co. Law	
BCS	p	DP Society	BCS	UK		Royal Charter	Royal Charter	1984
Genootschap In	p	DP Society	Genootschap In	Netherlands		Netherlands	Netherlands	
data processing	p	field	data processing	IFIP		IFIP	IFIP	
TC2	p	TC	TC2	Tech Assembly		GA	GA	
TC7	p	TC	TC7	Tech Assembly		GA	GA	1972
TC8	p	TC	TC8	Tech Assembly		GA	GA	1974/75
Soc.Comm/IS	p	TC	Soc.Comm/IS	IFIP		TC8/9	TC8/9	1987
WG2.1 (Algol)	p	WG	WG2.1 (Algol)	TC2		GA,TC2	GA prop by TC2	1983
WG2.2	p	WG	WG2.2	TC2		GA,TC2	GA,TC2	1965
WG2.3	p	WG	WG2.3	TC2		GA,TC2	GA,TC2	1969

WG2.4	p	WG	WG2.4	TC2		GA,TC2	GA,TC2	1973		
WG2.5	p	WG	WG2.5	TC2		GA,TC2	GA,TC2	1974		
WG2.6	p	WG	WG2.6	TC2		GA,TC2	GA,TC2	1974	1985	
WG7.1	p	WG	WG7.1	TC7		GA,TC7	GA,TC7	1972		
WG8.1	p	WG	WG8.1	TC8		GA,TC8	GA,TC7	1976		
WG8.3 (DSS)	p	WG	WG8.3 (DSS)	TC8		GA,TC8	GA prop by TC8	1981		
WG8.4	p	WG	WG8.4	TC8		GA,TC8	GA,TC8	1985		
CRIS82	p	WC	CRIS82	TC8		GA,TC8	GA,TC8	1981	1982	
CRIS88	p	WC	CRIS88	IFIP		GA,TC8	GA,TC8	1986	1989	
meeting	p	meeting	meeting	CRIS88		CRIS88	CRIS 88	1988/09/21/10:00	1988/09/21/17:00	
session1	p	session	session1	CRIS88		Chair(session1)	Chair(session1)	1988/09/20/10:00	1988/09/20/17:00	
session2	p	session	session2	CRIS88		Chair(session2)	Chair(session2)	1988/09/21/10:00	1988/09/21/17:00	
OC88	p	OC	OC88	CRIS88		CRIS88	CRIS88			
session3	p	session	session3	CRIS88		Chair(session3)	Chair(session3)	1988/09/22/10:00	1988/09/22/15:00	
discussion1	p	discussion	discussion1	presentation1	paper1	PC88	PC88	1988/09/21/14:00	1988/09/21/15:00	
BTelecom	p	PTT	BTelecom	UK		Ant1	Ant1	1976		
GPO	p	PTT	GPO	UK		UK	UK	1840		
NL PO	p	PTT	NL PO	Netherlands		Netherlands	Netherlands			

SIP	p	PTT	SIP	Italy		Rep of Italy	Rep of Italy	1970	
in Peckham	p	place	in Peckham	Society		Society	Society		
in Hengelo	p	place	in Hengelo	Society		Society	Society		
10, The Gardens	p	address	10, The Gardens, SE11	GPO		GPO	GPO	1888	
F.S.straat 6	p	address	F.S.straat 6	Netherlands Post		NL PO	NL PO	1976	
represents	p	represents	represents	F.S.straat 6	in Hengelo	NL PO	NL PO	1976	
represents	p	represents	represents	10, The Gardens, SE11	in Peckham	GPO	GPO	1888	
eligiblity	dt	eligibility	eligibility	R Stamper	CRIS88	PC88	PC88	1988/04/01	
priority	dr		priority	eligibility		PC	PC		
priority	dr	priority	priority	eligiblity	CRIS88	PC	PC	1988/04/01	
version	p	versionP	version	"MEASUR"		UK	UK	1988/02/01	
Council(1985)	p	Council	Council(1985)	IFIP		IFIP	IFIP	1985/01/01	1985/12/31
39(2)23993400	p	tel. no.	39(2)23993400	SIP		SIP	SIP	1985	
ISDM	p	topic	ISDM	methodology		IFIP	IFIP		
A&D	p	area	A&D	IFIP		GA	GA		
"MEASUR"	p	paper	"MEASUR"	UK		UK	UK	1988/02/01	

attends	p	attends	attends	J Backhouse	session2	OC88	OC88	1988/09/21/10:00	1988/09/21/17:00
attendee	r		attendee	attends	person	OC	OC		
authorship	p	authorship	authorship	J Backhouse	"MEASUR"	PC88	PC88	1988/02/01	
version3	p	versionT	version3	"MEASUR"	English	PC88	PC88	1988/09/01	
call f. papers1	p	call f. papers	call f. papers1	CRIS82		CRIS82	CRIS82	1981	1981
call f. papers2	p	call f. papers	call f. papers2	CRIS88		CRIS88	CRIS88	1987/03/01	1987/03/30
contacted on	p	contacted on	contacted on	G. Bracchi	39(2)2399400	G. Bracchi	G. Bracchi	1988	
contributes	p	contributes	contributes	R Stamper	"MEASUR"	R Stamper,PC88	R Stamper,PC88		
"MEASUR"1	p	versionT	"MEASUR"1	"MEASUR"				1988/04/01	
copy1	p	copy	copy1	version3	diskette1	PC88	PC88	1988/09/01	
employee	r		employee	employment	person	@Ant1	@Ant1		
employer	r		employer	employment	corporate body	@Ant2	@Ant2		
expertise	p	expertise	expertise	R Stamper	ISDM	R Stamper	R Stamper	1970/01/01	
held in	p	held in	held in	CRIS82	Netherlands	CRIS82	CRIS82	1982	1982
held in	p	held in	held in	CRIS88	UK	CRIS88	CRIS88	1988/09/19	1988/09/21
incumbency	p	incumbency	incumbency	AA Dorodnicyn	Trustee(Cncl)	IFIP	IFIP	1984	1987
incumbency	p	incumbency	incumbency	Alex V Stuart	Trustee(Cncl)	IFIP	IFIP	1985	1988
incumbency	p	incumbency	incumbency	AW Goldsworthy	Pres-Elect(Cncl)	IFIP	IFIP	1985	1986

incumbency	p	incumbency	incumbency	BL Sendov	Vice-Pres(Cncl)	IFIP	IFIP	1984	1987
incumbency	p	incumbency	incumbency	G Glaser	Vice Pres(Cncl)	IFIP	IFIP	1985	1988
incumbency	p	incumbency	incumbency	GJ Morris	Vice-Pres (Cncl)	IFIP	IFIP	1985	1986
incumbency	p	incumbency	incumbency	P-X Guo	Trustee (Cncl)	IFIP	IFIP	1985	1988
incumbent	r		incumbent	incumbency	person	IFIP	IFIP		
invites	p	invites	invites	CRIS82	call f. papers1	CRIS82	CRIS82	1981	1981
invites	p	invites	invites	CRIS88	call f. papers2	CRIS88	CRIS88	1981/03/01	1981/01/31
location	r		location	located at	place	PTT	PTT		
member	r		member	membership1	corporate body	@Ant1	@Ant1		
member	r		member	membership2	person	@Ant1	@Ant1		
methodology	p	area	methodology	analysis and design		GA,TC	GA,TC		
represents	p	represents	represents	BCS	UK	IFIP	IFIP		
Nat Rep	r		National Representative	membership5	person	@Ant1	@Ant1		
new version	r		new version	revision	version#2	@Ant1	@Ant1		
TC8 Chair	p	office	TC8 Chair	IFIP		TC8	TC8	1974	
old version	r		old version	revision	version#1	@Ant1	@Ant1		

on	p	on	on	CRIS82	ISDM	WG8.1	WG8.1	1982	1982
participant1	r		participant1	participation1	person	@Ant1	@Ant1		
participant2	r		participant2	participation2	person	@Ant1	@Ant1		
participation	p	participation1	participation	R Stamper	meeting	1988/09/19/10:00	1988/09/21/17:00	PC88	PC88
presentation	p	presentation	presentation	session2		Chair(session)	Chair(session)	1988/09/21/14:00	1988/21/09/15:00
PC88	p	PC	PC88	CRIS88		CRISS88	CRIS88	1986	1988
referee	r		referee	membership4	person	@Ant1	@Ant1		
rejected	dr		rejected	paper		PC	PC		
report	r		report	reviews	paper#2	@Ant1	@Ant1		
responsibility	r		responsibility	incumbency	office				
selected	p	selected	selected	"MEASUR"		PC88	PC88	1988/04/01	
sent to	p	sent to	sent to	copy1	CRIS88	J Backhouse	J Backhouse		
Temp Asp IS	p	WC	Temp Aspects IS	TC8		TC8	TC8	1986	1989
treats	p	treats	treats	"MEASUR"	ISDM	CRIS88	CRIS88	1988/05/01	
subject1	r		subject1	reviews	Ant2(reviews)	PC	PC		
subject	r		subject	treats	topic	PC	PC		
sponsor	r		sponsor	sponsorship1	corporate body	@Ant1	@Ant1		
sponsor	r		sponsor	sponsorship2	WG	Ant1	Ant1		

APPENDIX C: An INCA surrogate table

Label	Ant1	Ant2	Auth+	Auth-	Start	Finish
PTT	state	-	state	state	1972	
BTelecom	UK	-	UK	-	1980	
SIP	Italy	-	Italy	-		

Label	Ant1	Ant2	Auth+	Auth-	Start	Finish
tel. no.	PTT	-	PTT	PTT	1980	
076331192	SIP	-	SIP	SIP	1970	
014057686	BT	-	BT	BT		

Label	Ant1	Ant2	Auth+	Auth-	Start	Finish
contact. on	person	tel. no.	PTT	PTT	1987	
contact. on	Mario Rossi	076331192	SIP	SIP	1989	
contact. on	R. Bulwer	014057686	BT	BT		

Label	Ant1	Ant2	Auth+	Auth-	Start	Finish
province	region	-	state	state	1932	
Rieti	Lazio	-	Italy	Italy		
Milano	Lombardia	-	Italy	Italy		

Label	Ant1	Ant2	Auth+	Auth-	Start	Finish
code	state	-	state	state	1946	
RI	Italy	-	state	state	1946	
MI	Italy	-	state	state		

Label	Ant1	Ant2	Auth+	Auth-	Start	Finish
represents	code	province	state	state	1946	
represents	RI	Rieti	Italy	Italy	1946	
represents	MI	Milano	Italy	Italy		

Label	Ant1	Ant2	Auth+	Auth-	Start	Finish
region	state	-	state	state	1860	
Lazio	Italy	-	Italy	Italy	1860	
Lombardia	Italy	-	Italy	Italy		

Surr#	Label	Ant1	Ant2	Auth+	Auth-	Start	yFinish
87654	flat #	Via Roma	-	Italy	Italy	1-5-1987	
87655	#4,100	87654	-	Poste It.	Poste It.	1-5-1987	31-8-1988
87656	#4,110	87654	-	Poste It.	Poste It.	1-9-1988	

Surr#	Label	Ant1	Ant2	Auth+	Auth-	Start	Finish
58	firstname	person	-	state	state	13-6-1922	
59	Mario	53	-	Italy	Italy	31-2-1934	
61	Maria	55	-	UK	UK		

Surr #	Label	Ant1	Ant2	Auth+	Auth-	Start	Finish
64	surname	person		state	state	13-6-1922	
65	Rossi	53		Italy	Italy	31-2-1934	
67	Potter	67		UK	UK		

Surr #	Label	Ant1	Ant2	Auth+	Auth-	Start	Finish
67	Potter	67	-	UK	UK	31-2-1934	31-2-1987
1067	Garibaldi	67	-	UK	UK	1-1-1988	

APPENDIX D: An SPS surrogate table

Label	Ant1	Ant2	Auth+	Auth-	Start	Finish
Barking and Dagenham	United Kingdom	-	DES	DES	1964	

Label	Ant1	Ant2	Auth+	Auth-	Start	Finish
responsible for	team#	area#	SPS	SPS	1984	

Label	Ant1	Ant2	Auth+	Auth-	Start	Finish
school	United Kingdom	-	DES	DES		

Label	Ant1	Ant2	Auth+	Auth-	Start	Finish
Erkenwald School	United Kingdom	-	DES	DES	1-9-1974	

Label	Ant1	Ant2	Auth+	Auth-	Start	Finish
area 1	SPS	-	P.Psych	P.Psych	1-9-1985	

Label	Ant1	Ant2	Auth+	Auth-	Start	Finish
in	area	school	SPS	SPS	1-9-1985	
in	area 1	Erkenwald School	SPS	SPS	1-9-1985	

Label	Ant1	Ant2	Auth+	Auth-	Start	Finish
incumbency	role(school)	person	LEA	LEA		
incumbency	Head (Parsloes Manor)	Peter Haydon	Barking	Barking	1-9-1979	

Label	Ant1	Ant2	Auth+	Auth-	Start	Finish
person	state	-	?	?	birth	death
P. Johnson	UK		?	?	22-9-1970	

Label	Ant1	Ant2	Auth+	Auth-	Start	Finish
refers	Parsloes Manor School	"behaviour problem# (Peter Johnson)"	SPS	SPS	1-2-1985	
Label	**Ant1**	**Ant2**	**Auth+**	**Auth-**	**Start**	**Finish**
accepts	SPS	"referral"	SPS psych	SPS psych		
Label	**Ant1**	**Ant2**	**Auth+**	**Auth-**	**Start**	**Finish**
accepts	SPS	"referral" (Peter Johnson)	Alan Sigston	Alan Sigston	5-3-1985	
Label	**Ant1**	**Ant2**	**Auth+**	**Auth-**	**Start**	**Finish**
cooperates on	SSU	case#	Head SSU	Head SSU		
Label	**Ant1**	**Ant2**	**Auth+**	**Auth-**	**Start**	**Finish**
allocates	person#	case#	Head SSU	Head SSU		
Label	**Ant1**	**Ant2**	**Auth+**	**Auth-**	**Start**	**Finish**
case 543	SPS	-	Alan Sigston	Alan Sigston	5-3-1985	5-6-1985

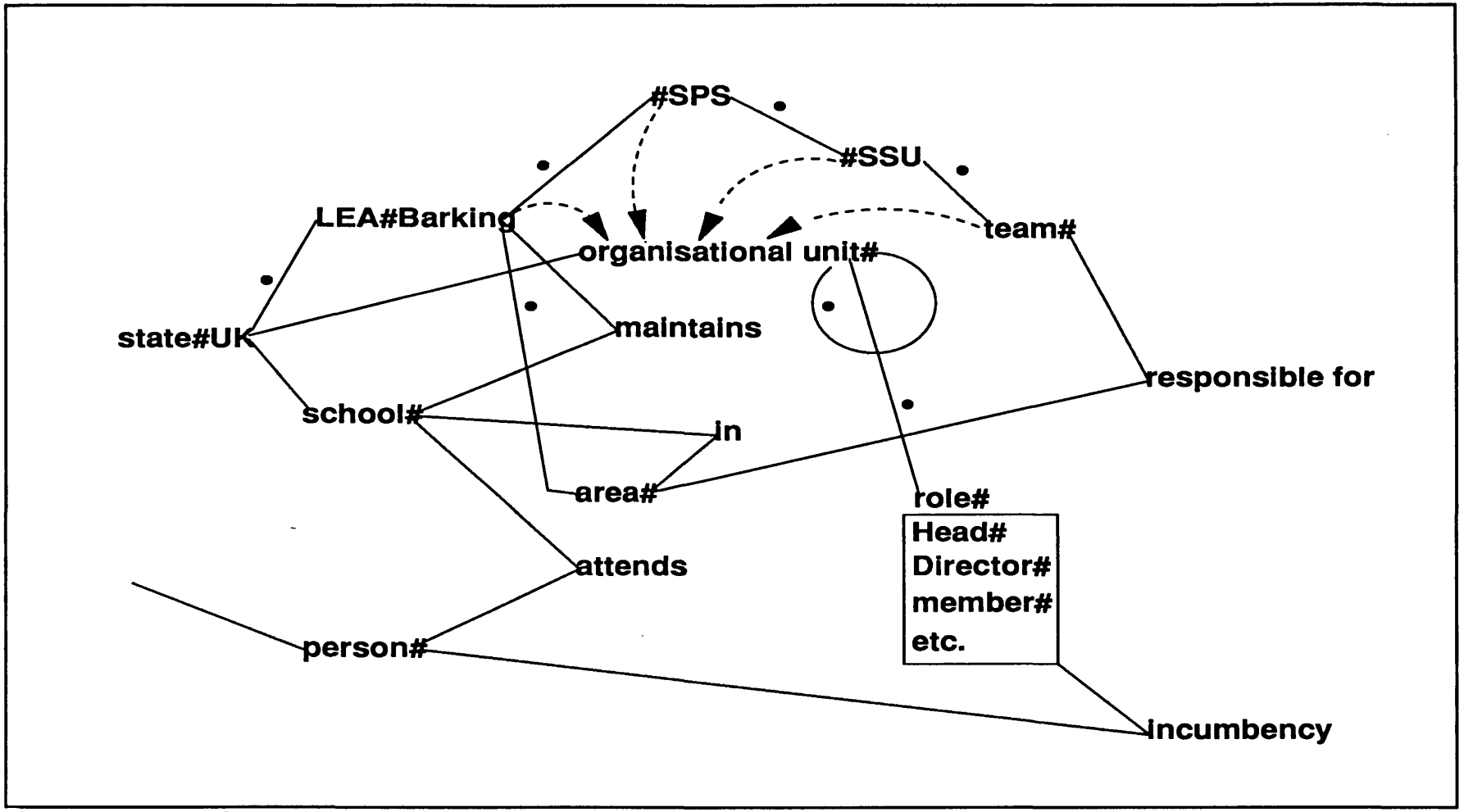
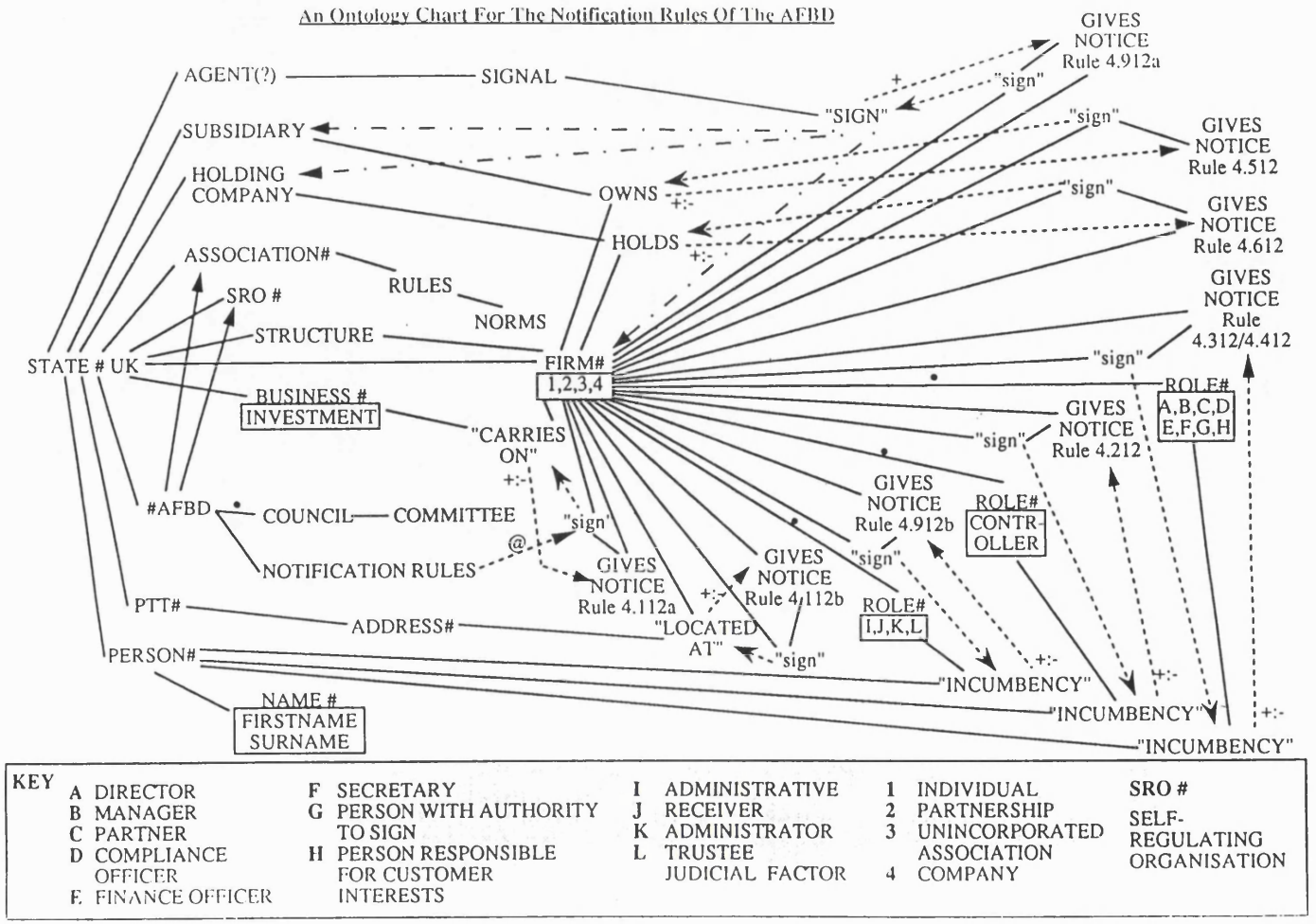


Figure II.1 economy of expression using a generic/specific norm

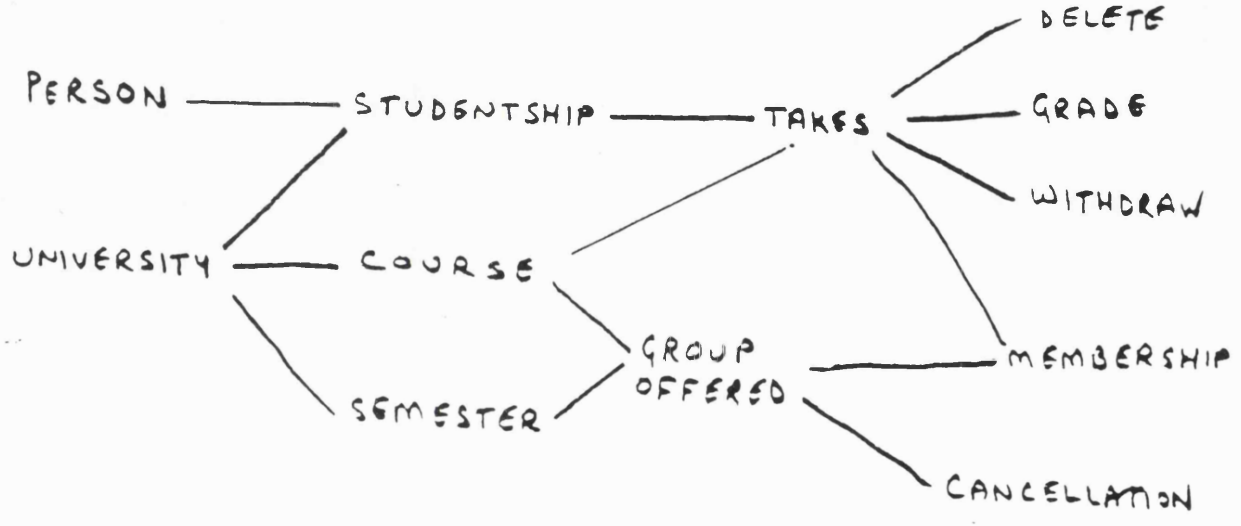
APPENDIX E: Notification rules Ontology Chart (Shah 1990)



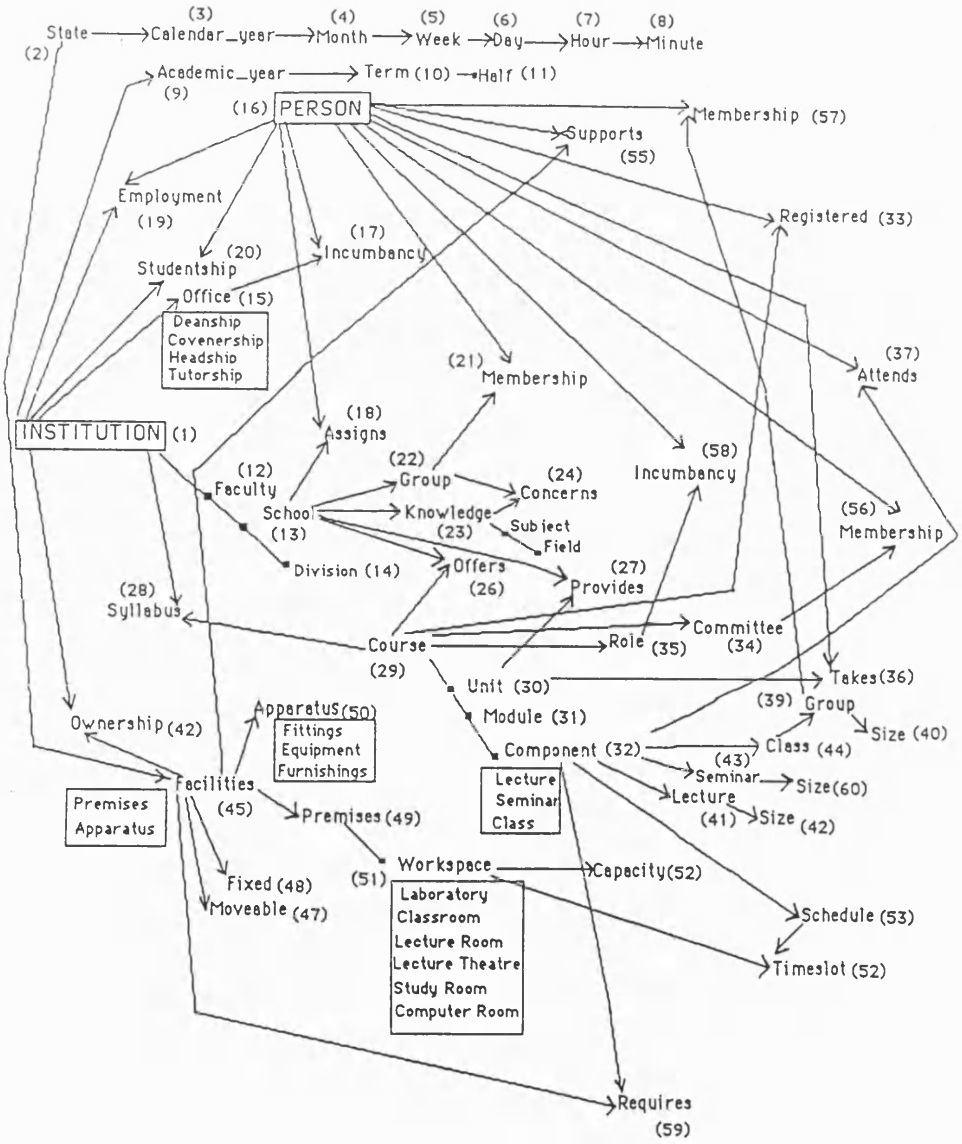
APPENDIX F: Student Course Data Model (Ades 1987)

3.4 Post-Semantic Analysis Data Model

This part outlines the Data Model as it emerged after the application of Semantic Analysis. We concentrate on two critical components: STUDENT COURSE and PERSON DIARY.

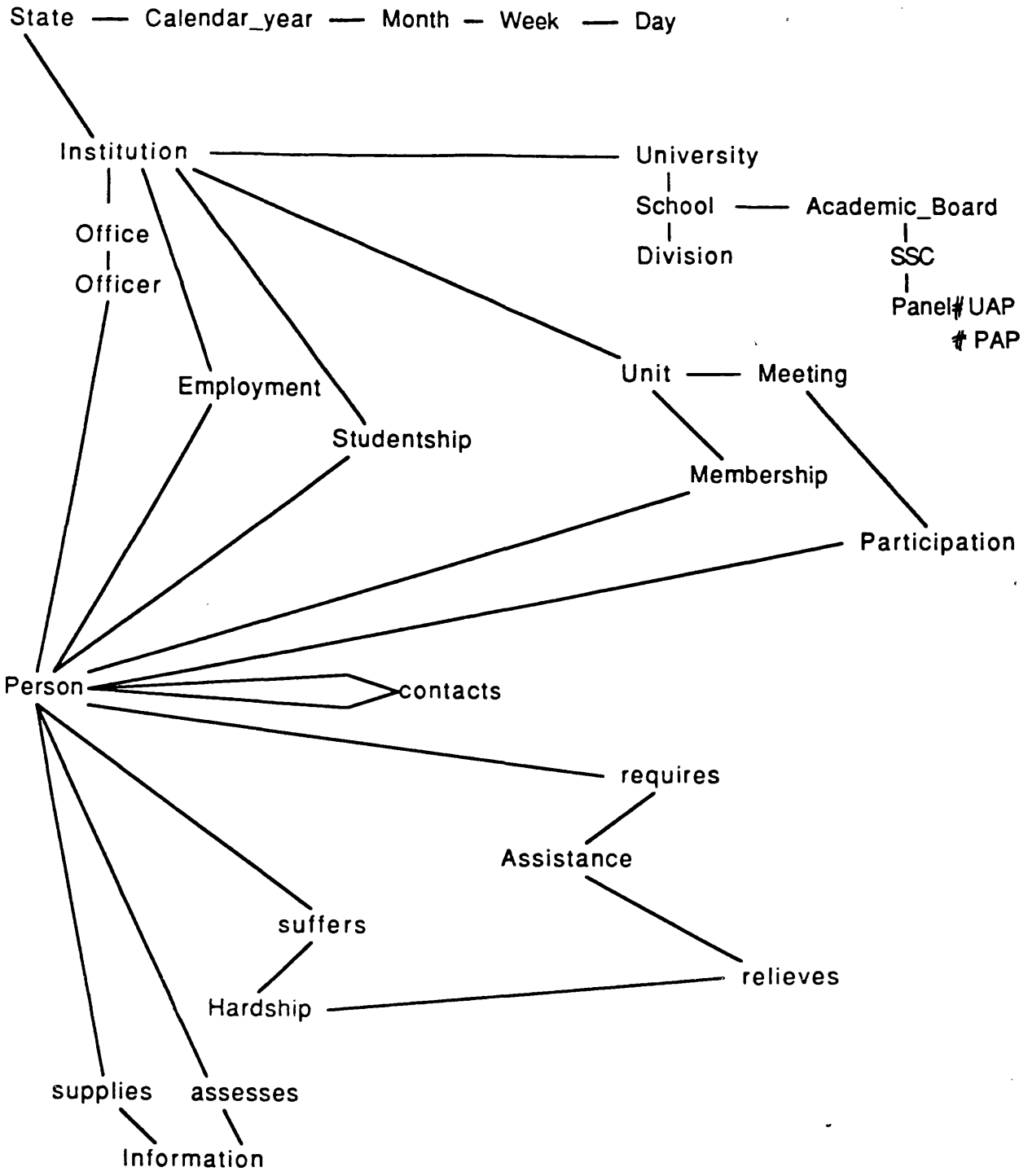


APPENDIX G: Ontology Chart for Course Database (Lupolo 1987)

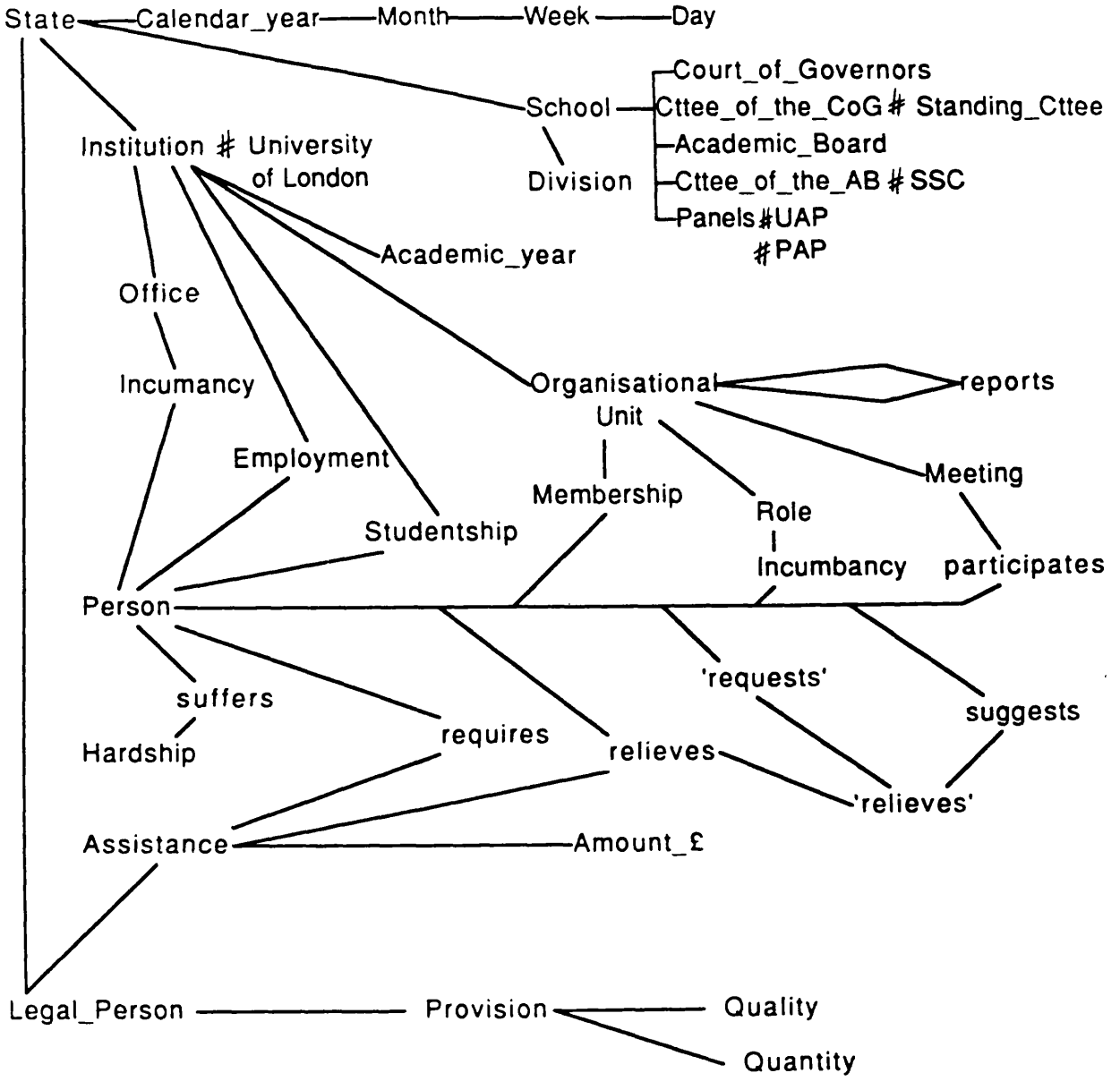


APPENDIX H: Ontology Charts (Straub 1988)

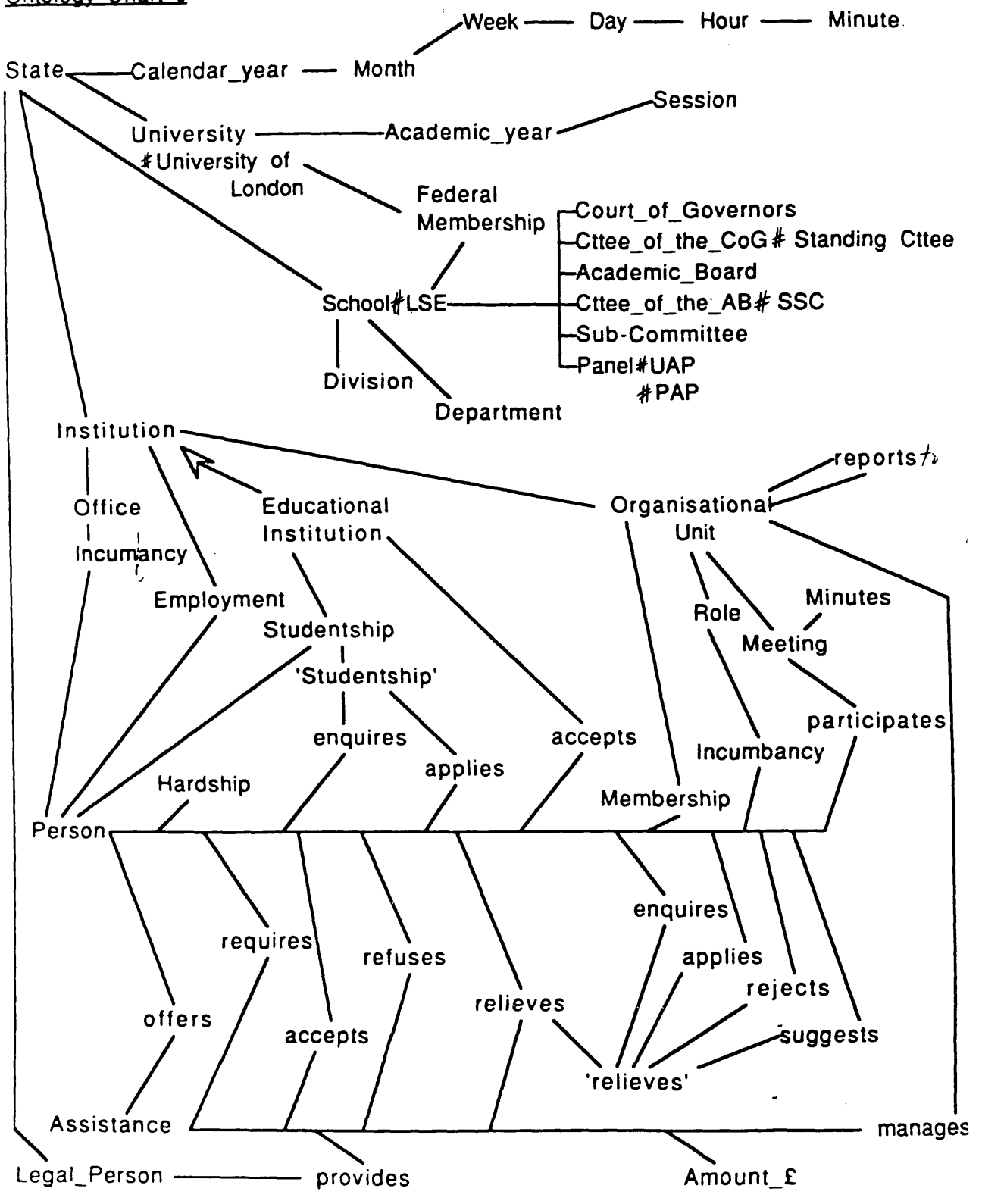
Ontology Chart 1



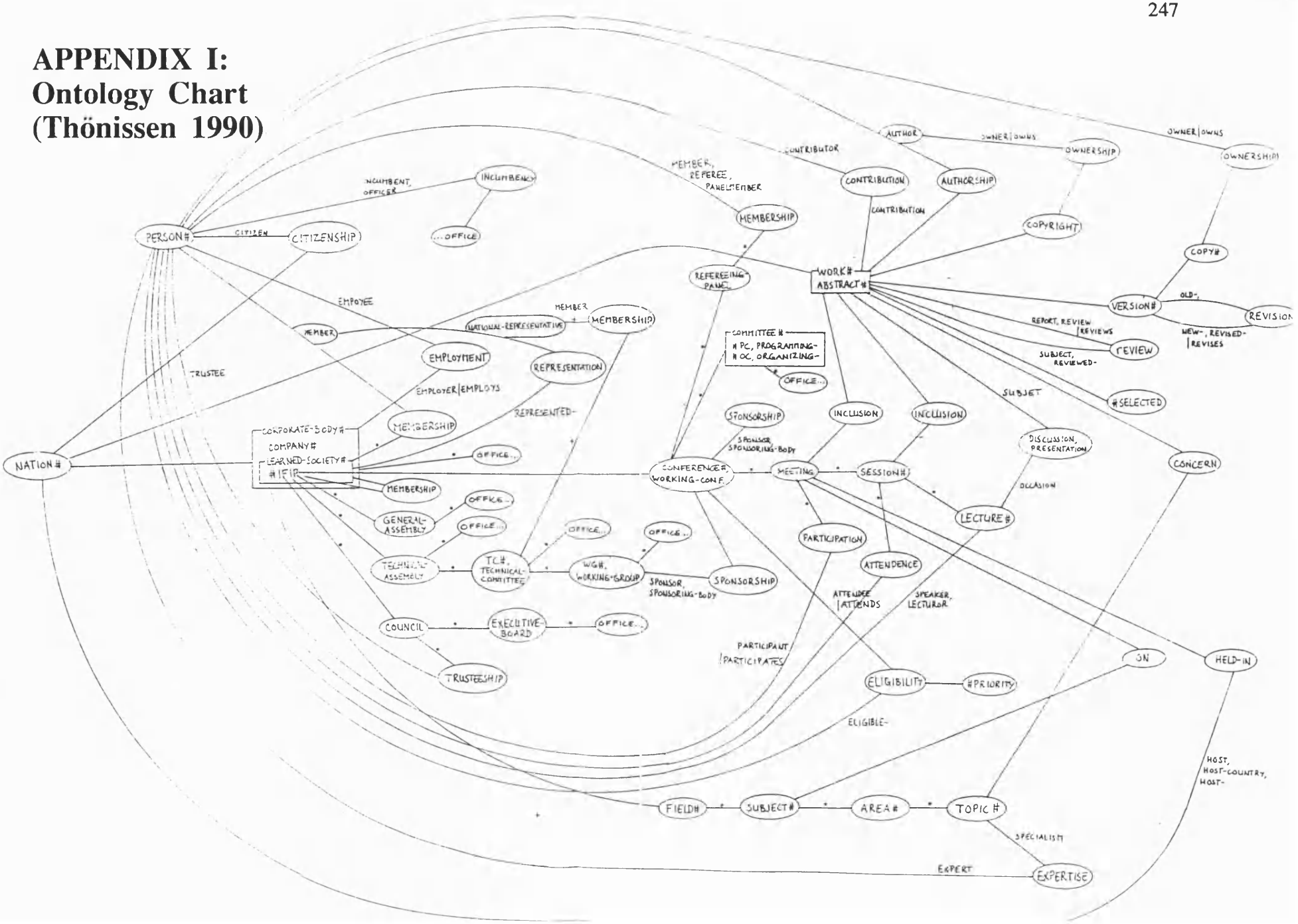
Ontology Chart 3



Ontology Chart 6



APPENDIX I:
Ontology Chart
(Thönissen 1990)



REFERENCES

Ades, Y. (1989) *Semantic Analysis for Enterprise Data Modelling*, MSc project report, London School of Economics and Political Science.

Austin, J.L. (1962) *How to do things with words: the William James lectures delivered in 1955* Oxford University Press. Oxford.

Aitchison, J. (1988) *Words in the Mind: an introduction to the mental lexicon*, Basil Blackwell. Oxford.

Atre, S. (1980) *Database, Structures, Techniques for Design, Performance and Measurement*, Wiley. New York.

Backhouse, J. (1988) 'Simpler and Richer Cognitive Models for Information Systems Analysis and Design', *Proceedings of the IFIP International Workshop on Human Factors in ISAD*, Imperial College.

Balfour, A. (1989) 'INFOEXEC: The first practical implementation of semantic database', in *Proceedings of the Seminar Series on New Directions in Software Development*, BCS & Polytechnic of Wolverhampton.

Bernstein P.A. 1976) 'Synthesising Third Normal Relations from Functional Dependencies', *ACM Transactions on Database Systems* 1:277-298.

Bloor, D. (1976) *Knowledge and Social Imagery*, Routledge & Kegan Paul. London.

Bloor, D. (1983) *Wittgenstein: A Social Theory of Knowledge*, Macmillan. Basingstoke.

Bunge, M. (1989), *Treatise on Basic Philosophy Volume & Ethics*, Reidel: Kluwer Academic. Boston.

Burns, T., Fong, E., Jefferson, E., Knox, R., Mark, L., Reedy, C., Reich, L., Roussopolos, N. and Truszowski, N., (1986) *Reference Model for DBMS Standardization.* Database Architecture Framework Task Group (DAFTG) of the ANSI/X3/SPARC Database System Study Group. ACM Sigmod Rec. 15,1,19-58.

Chamberlin, D. (1976) 'Relational database management systems' *ACM Computing Surveys*, Vol 8, No.1.

Chen, P. (1976) 'The entity-relationship model: Towards a unified view of data', *ACM Transactions on Database Systems* Vol.1, No.1 March.

Chomsky, N. (1980), *Rules and Representations*, Blackwell. Oxford.

Clifford, J. and Warren, D.S. (1983) 'Formal Semantics for time in Databases', *ACM Transactions on Database Systems* Vol. 8, June.

Codd, E.F. (1979) 'Extending the Relational Model to Capture More Meaning', *ACM Transactions on Database Systems* Vol.4:397-433.

Codd, E.F. (1972) 'Further Normalization of the Data Base Relational Model', in *Curant Courier Symposium 6: Data Base Systems*, Prentice Hall 65-98.

Codd, E.F. (1971) 'A Relational Data Base sub-language founded on Relational Calculus'. *Proceedings ACM SIGFIDET Workshop on Data Description Access and Control* 35-68.

Codd, E.F. (1970) 'A relational model for large shared databanks', *Communications of ACM* 13:377-387.

Cook, S. et al. (1981) 'The Application of Artificial Intelligence to Law: A Survey of Six Current Projects', AFIPS Conference Proceedings, Vol 50, National Computing Centre, AFIPS Press. Arlington. LEGOL/NORMA working paper L60.

Cory, H.T., Hammond, P., Kowalski, R.A., Kriwaczek, S., Sadri, F., Sergot, M. (1984) *British Nationality Act as Logic Programme*, Imperial College.

Crooks, R.M. (1981) *LEGOL as an Aid for the Drafting of Legislation* MSc Report LSE 1981; LEGOL/NORMA working paper L64.

Date, C. (1986a), *'Introduction to Database Systems'*, Vol 1, 4th Edition, Addison-Wesley. Reading, Mass.

Date, C. (1986b) *'Introduction to Database Systems'*, Vol 2, 4th Edition, Addison-Wesley. Reading, Mass.

DBTG 1971 DataBase Task Group of CODASYL Programming Language. *Committee Report.* BCS and ACM.

de Marco, T. (1979) *Structured Analysis and Systems Specification*, Yourdon Press, Prentice-Hall Inc., Englewood Cliffs. New Jersey.

Deen, S.M. (1985) *Principles and Practice of Database Systems*, Macmillan, Basingstoke.

Deen, S.M. (1977) *Fundamentals of Database design*, Macmillan.

Dhillon, G.S. (1990) *Semantic Analysis and Norm Specification - A Case of the Notification Rules* MSc project report. London School of Economics and Political Science.

Dittrich, R. (1986) 'Object-oriented database systems: The notions and the issues' in *Proceedings of the International Workshop on Object-Oriented Database Systems* (Pacific Grove, Calif.). IEEE New York, pp 153-163.

Dreyfus, H.L. and Dreyfus, S.E. (1986) *Mind over Machine: the Power of Human Intuition and Expertise in the Era of the Computer*, Blackwell. Oxford.

Fodor, J.A., Bever, T.G. and Garrett, M.F. (1974) *The Psycholinguistics of Language: An Introduction to Psycholinguistics and Generative Grammar*, McGraw-Hill. New York.

GENERIS (1989) *GENERIS: A technical introduction*, Deductive Systems Limited. Uxbridge.

Gibson, J.J. (1966) *The Senses Considered as Perceptual Systems*, Houghton Miflin, Boston.

Gibson, J.J. (1977) 'The Theory of Affordances' in RE Shaw and J Bransford (eds), Perceiving, Acting and Knowing, Hillsdake, N J, Lawrence Erlbaum Associates.

Goossenaerts, J., Lewi, J. and Dumortier, J. (1988) *A Stage-prop-actor Approach to Legal Representation*, Report CW 78, University of Leuven.

Gorman, M. (1984) *'Managing Database: Four critical factors'*, QED.

Hammer, M. and McLeod, D. (1981) 'Database description with SDM', *ACM Transactions on Database Systems* Vol.6 No.3 September.

Hawryszkiewycz, I. (1984) *Database Analysis and Design*, SRA, 1984, .

Hull, R. and Yap, Chee K. (1984) 'The Format Model: A Theory of Database Organization' *Journal of ACM Vol.31*, No.3 July.

Jackson M.S. (1989) 'Beyond Relational Databases', in *Proceedings of the Seminar Series on New Directions in Software Development*, BCS & Polytechnic of Wolverhampton.

Jardine, D.A. (1977) *The ANSI/SPARC DBMS Model*, North Holland. New York.

Katz, J.J. (1981) *Language and other abstract objects*, Basil Blackwell. Oxford.

Katz, J.J. (1972) *Semantic Theory*, Harper & Row. New York.

Katz, J.J. (1964) 'Analyticity and Contradiction in Natural Language' in *The Structure of Language: readings in the Philosophy of Language*, Fodor, J.A. and Katz J.J (eds.), Prentice-Hall. Englewood Cliffs, New Jersey.

Kent, W. (1978) *Data and reality: basic assumptions in data processing reconsidered*, North Holland. New York.

Kimura, T.D., Gillett, W.D. and Cox J.R. Jr. (1985) 'A Design of a Data Model Based on Abstraction of Symbols' in *The Computer Journal* Vol 28 No 3.

King, R. and McLeod, D. (1984) 'Semantic Database Models' in *Database Design* S B Tao (ed.), Academic Press.

Kowalski, R. (1978) *Logic for Problem Solving,* North Holland. New York.

Lee, R.M. and Stamper, *Doing Business with Words: Performative Aspects of Deontic Systems*, LEGOL/NORMA working paper L77.

Leith, P. (1988) 'The Application of AI to Law' *AI and Society*, vol 2(1).

Liu, K., Klarenburg, P. and von Slooten, F, (1990) Reference Manual for LEGOL-3.0, University of Twente, The Netherlands.

Lukacs, G. (1980) *The Ontology of Social Being,* Merlin Press.

Lupolo, T. (1987) *Semantic Analysis - Mapping from a Semantic Schema into a Relational Database Schema* MSc project report. London School of Economics and Political Science.

Marche, S. (1990) *Measuring Data Model Stability,* Unpublished Thesis. London School of Economics and Political Science.

Mason, P.J. and Jones, S. (1980) 'Programming the Law', in *Information Systems Environment* (eds) B C Lucas, F F Land, T J Lincoln, K Supper, North Holland 1980; LEGOL/NORMA working paper L30.

Minsky, M. (1975) 'A framework for representing knowledge' in *The Psychology of Computer Vision*, Winston P.H. (ed.), McGraw-Hill Computer Science series.

Montague, R. (1973) 'The proper treatment of quantification in ordinary English' in *Approaches to Natural Language*, KJJ Hintikka (Ed.), Dordrecht Germany.

Morris, C. (1964) *Signification and Significance*, MIT Press. Cambridge, Mass.

Morris, C. (1955) *International Encyclopedia of Unified Science*, eds Neurath, Morris and Carnap, The University of Chicago Press. Chicago.

Mylopoulos, J. and Bernstein, P.A. (1980) 'A Language Facility for Designing Database-Intensive Applications', *ACM Transactions on Database Systems* Vol.5 No. 2 June.

Navathe, S.B. and Ahmed, R. (1987) 'TSQL: A language interface for history database' *Proceedings of AFCET-IFIP WG8.1 TAIS Conference.* Sophia Antipolis, France.

Olle, T.W., Sol, H.G. and Verrijn-Stuart, A.A. (1982) *Information Systems Design Methodologies: A Comparative Review.* North Holland. Amsterdam and New York.

Olle, T.W., Sol, H.G. and Tully, C.J. (1983) *Information Systems Design Methodologies: A Feature Analysis*. North Holland. Amsterdam and New York.

Owen, K. (1989) 'Ashley Goldsworthy: IFIP activist' in *The Computer Bulletin*, Vol.1, November.

Page, E. and Wilson, L. (1978) *Information, Representation and Manipulation in a Computer*, 2nd edition, Cambridge Uuniversity Press. Cambridge.

Peckham, J. and Maryanski, F. (1988) 'Semantic Data Models', *ACM Computing Surveys* Vol 20 No.3 September.

Pratt, P. and Adamski, J. (1987) *Database Systems: management and design*, Boyd and Fraser.

Rolland, C., Nobecourt, P. and Lingat, J.Y. (1987) *Temporal Management in an Extended Database*, Université PARIS 1.

Schank, R.C. and Leake, D.B. (1986) 'Computer Understanding and Creativity', in *Information Processing* (ed.) H-J Kruger Elsevier Science Publishers B V, North Holland.

Schank, R.C. and Abelson R. (1977) *Scripts, Plans, Goals and Understanding*, Lawrence Erlbaum Associates. Hillsdake, New Jersey.

Schank, R.C. (1975a) *Conceptual Information Processing*, North Holland. New York.

Schank, R.C. (1975b) 'The Structure of Episodes in Memory' in D. Bobrow and A.Collins, (eds.) *Representation and Understanding*, Academic Press.

Schank, R.C. (1972) Conceptual Dependency: A Theory of Natural Language Understanding, *Cognitive Psychology* 3(4), pp 552-631.

Searle, J.R. (1984) *Minds, Brains and Science: the 1984 Reith Lectures* British Broadcasting Corporation. London.

Searle, J.R. (1969) *Speech Acts: An Essay in the Philosophy of Language*, Cambridge University Press. Cambridge.

Shah, K. (1990) *Association of Futures Brokers and Dealers Notification Rules - An Application of Semantic Analysis*, Project Report. London School of Economics and Political Science.

Shannon, C. and Weaver, W. (1963) *The Mathematical Theory of Communication*, Urbana: University of Illinois Press. Chicago.

Shipman, D.W. (1981) 'The Functional Data Model and the Data language DAPLEX', *ACM Transactions on Database Systems*, Vol.6, No.1 March.

Snodgrass, R. (1987) *'The temporal query language TQUEL' ACM Transactions On Database Systems*, Vol 12 No. 2, June.

Sowa, J. (1984) *Conceptual structures: information processing in mind and machine*, Addison-Wesley. Reading, Mass.

Stamper, R.K., Backhouse, J., Liu, K., Kolkman, M., Ades Y. and van Slooten, C. (1990) *From Database to Normbase*, CSCW'90 Conference 7-10 October, Los Angeles, California.

Stamper, R.K. (1989) *A Guide to the LEGOL/NORMA Project Papers* University of Twente.

Stamper, R.K., Backhouse J. and Althaus, K. (1988a) 'Expert Systems - Lawyers Beware', *Proceedings of 4th International Congress on Law and Computers*, Italian Supreme Court. Rome.

Stamper, R.K., Althaus, K. and Backhouse, J. (1989) 'MEASUR: Method for Eliciting, Analysing and Specifying User Requirements' in *Computerized Assistance during the Information Systems Life Cycle*, T.W. Olle, A A Verrijn-Stuart, L Bhabuta, (eds.), North Holland.

Stamper, R.K. (1985a) *A logic of social norms for the semantics of business information*, IFIP 2.6 Working Conference on Database Semantics, Hasselt, Belgium, January.

Stamper, R.K. (1985b) *A Non-Classical Logic for Law Based upon the Structures of Behaviour*, 2nd International Congress, Logica Informatica, Diritto, Florence, September 3 - 6; LEGOL/NORMA working paper L85.

Stamper, R.K. (1985c) *Nationality Act—A LEGOL case study and comparison with PROLOG*. LEGOL/NORMA working paper L84.

Stamper, R.K. (1985d) *General Sub-Systems*. LEGOL/NORMA working paper L73.

Stamper, R.K. and Tagg, C., Mason, P.J., Cook, S. and Marks, J.O. 'Developing the LEGOL Semantic Grammar' in Artificial Intelligence and Legal Information Systems, C. Ciampi (ed.). North Holland. LEGOL/NORMA working paper L48.

Stamper, R.K. (1980) 'LEGOL: Modelling Legal Rules by Computer', in B Niblett (ed.) *Computer Science and Law*, Cambridge University Press. Cambridge; LEGOL/NORMA paper L35.

Stamper, R.K. (1978) 'New Perspective for Computers in Law and Administration' *Uomini e Computer*; LEGOL/NORMA working paper L22.

Straub, B. (1988) *Semantic Analysis and Semantic Database* MSc project report, London School of Economics and Political Science.

Susskind, R.E. (1987) *Expert Systems in Law: A Jurisprudential Inquiry* Clarendon Press. Oxford.

Thönissen, K.(1990) *Semantic Analysis - A Study and Comparison* Graduation Report, University of Twente, School of Management Studies, January.

Winograd, T. (1986) *Understanding Computers and Cognition: a new foundation for design*, Addison-Wesley. Reading, Mass.

Winograd, T. (1972) *Understanding natural language* Edinburgh University Press. Edinburgh.