TERMINOLOGY and LEXICOGRAPHY RESEARCH and PRACTICE

Rita Temmerman

Towards New Ways of Terminology Description

The sociocognitive approach

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Terminology and Lexicography Research and Practice aims to provide in-depth studies and background information pertaining to Lexicography and Terminology. General works will include philosophical, historical, theoretical, computational and cognitive approaches. Other works will focus on structures for purpose- and domain-specific compilation (LSP), dictionary design, and training. The series will include monographs, state-of-the-art volumes and course books in the English language.

Volume 3

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Towards New Ways of Terminology Description
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TOWARDS NEW WAYS OF TERMINOLOGY DESCRIPTION

THE SOCIOCOGNITIVE-APPROACH

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Introduction

Contemporary novelist Jeanette Winterson's artistic motto "Not words for things but words which are living things with the power to move." summarises the main thesis of this work. This may seem paradoxical since we are not concerned with literary language but rather with the study of recent terminology in the specialist language of the life sciences (e.g. biology, genetics, microbiology, molecular genetics, genetic engineering, biochemistry, recombinant DNA technology, biotechnology, etc.) with the intention of questioning the principles and methods of traditional Terminology.[1] Winterson expresses how language functions for her as a novelist. She wants to explore the power of words, words which can do more than just stand for things, words which can *"move"*. Words have the power to *move* in a more literal sense, i.e. to travel from here to there, from a speaker to one or many listeners, from a writer to one or many readers. But words also have the power to *move* figuratively. Firstly because the impact that words expressed by one language user can have on his audience slightly changes the world i.e. the *understanding* of the world is affected and as a consequence the world *is moving*, i.e. changing. Secondly, words can also *move* figuratively because of the role that words in language play in the understanding of the world by each individual. Language has a creative potential, in addition to its communicative and referential potential. Each individual can *move* from a state of inertia into a state of being, thanks to language. Thirdly, words can figuratively *move* a person emotionally. They do not only name objects or concepts objectively, they can also have connotations which may appeal to and have an impact on a person's subjective feelings. The power of words to move in these and other senses are self-evident for literary language which is general language. However, for special language, such as the language of the life sciences, the

1. The vocabulary of special language is *terminology* (lower case). The theory underlying and resulting from the study of *terminology* we refer to as *Terminology* (upper case).

expectation pattern tends to be that words should name well-defined concepts and that in scientific language the power of words to move is to be constrained. The expectation pattern concerning the strict and objective nature of the applied methods and the results obtained by science is supplemented by expectations about what scientific language should be like: concise, precise, to the point, with a specific *terminology*. Whereas a novelist like Winterson is expected to exploit the *power of words to move,* scientific language is expected to control it via terms. We attempt to explore some of the consequences of bringing the *power of words to move* to the discipline of Terminology.

Structure of this book

This work is structured as follows: in Chapter one the principles of traditional Terminology are discussed and a survey of new directions in the attempted scientific study of terminology is presented. In Chapter 2 we introduce aspects of the theoretical framework on whose basis we challenge the traditional credo of Terminology by doing an empirical study of terminology in the textual archives of the life sciences. In Chapters 3 to 5 the results of the empirical study are presented. In Chapter 3 we critically examine the concept of *'concept'* and the possibilities for meaning descriptions It is suggested that terminologists start from *unit of understanding* instead of *concept* and that they replace and/or supplement the traditional definition by *templates of meaning description*. We take a semasiological approach to the studies of categories in the life sciences by starting from the terms that designate units of understanding and investigating how these units of understanding and their designations are defined and explained in texts. We show that most units of understanding have prototype structure and that units of understanding are experiential rather than objective. In Chapter 4 we explore the link between the structure of the understanding of a category and the process of lexicalisation. We argue that two counterbalancing forces are at work when categorisation takes place within a language community: on the one hand the urge for univocity, on the other hand the urge for diversification when attempting a better and broader understanding. In the principles for standardisation of traditional Terminology, the emphasis has been on the urge for univocity. In sociocognitive descriptive Terminology the functionality of polysemy and synonymy in special language will need to be studied in more detail. In

Chapter 5 we investigate the mechanisms behind the urge for better and new understanding. Our hypothesis is that these are in many cases related to and inspired by metaphorical reasoning. The metaphorical model is an underlying schema which is not fully expressed propositionally and lexically. We challenge the principle of traditional Terminology which claims that because unambiguous communication is the ideal for special language it is preferable to replace a metaphorical term by its literal equivalent. We show how in the life sciences the gestalt-like metaphorical model which is at the basis of better understanding and new discovery plays an important role in texts which treat the same and related subjects. Therefore, instead of promoting the curtailing of metaphorical language in scientific discourse, as the principles of traditional Terminology suggest, one might even consider encouraging metaphor for the sake of progress of understanding. We show that in order to facilitate the understanding of terms, Terminology might want to establish guidelines for the description of metaphorical models. In the final chapter we show how the methods and principles of *sociocognitive Terminology* are applicable in terminography and how they can offer solutions for a number of problems in the traditional approach.

Chapter 1

From Principles of Standardisation to a Scientific Study of Terminology

> "Since it is semantically-based terminology can be studied from three different points of view, i.e. from the point of view of the referent, from the point of view of the designation given the referent, and finally from the point of view of the use the equation of referent and designation can be put to. Consequently we identify three dimensions of a theory of terminology: a cognitive one which relates the linguistic forms to conceptual content, i.e. the referents in the real world; a linguistic one which examines the existing and potential forms of the representation of terminologies; a communicative one which looks at the use of terminologies and has to justify the human activity of terminology compilation and processing" (Sager 1990: 13).

The scientific underpinnings of traditional Terminology have lately come under question. This chapter provides a survey of new directions in the attempted scientific study of terminology. These new directions are a result of reactions against the principles and methods for meaning description prescribed by the traditional schools of Terminology. The traditional schools believed in the need for standardisation in order to improve special language communication. Traditional Terminology was based on a few premises which were considered to be unquestionable: that concepts are clear-cut and can be defined on the basis of necessary and sufficient conditions, that univocity of terms is essential for unambiguous and therefore effective and efficient communication, and that figurative language and change of meaning are linguistic subjects which are of no concern to Terminology as Terminology restricts itself to the onomasiological perspective. Like Saussurian structuralist linguistics, the theoretical framework behind the methods and principles of traditional Terminology was strongly rooted in objectivism. If the belief in an objective world is replaced by the belief that the understanding of the world and of the words used to communicate about the world is based on human experience, and if this understanding is considered to be prototypically structured and embedded in a frame, the basic principles of the traditional Terminology schools will need re-evaluation.

1.1 Terminology, a scientific discipline?

The International Information Centre for Terminology (Infoterm) claims a separate status for "terminology science" (Felber 1984: 31), firstly, because there exist three so-called "schools of terminology", the Vienna, the Prague and the Soviet school; secondly, because "there are a number of universities which started to carry out basic research in terminology in the last two decades"; and thirdly, because "in 1979 a research centre for terminology […] was created at the Laval University in Quebec (Canada). At the same time the first chair for terminology was installed at this university" (31).

Two considerations are necessary here. (1) It is not the creation of schools of Terminology which turns Terminology into a scientific discipline. (2) Several definitions of "scientific discipline" are possible, or in other words the characteristics we are considering for determining whether Terminology can be accepted as a discipline could be criticised as insufficient or too vague.

Still, if we believe that a scientific discipline requires (a) a specific subject matter, (b) an objective of study which is reflected in its procedures and methods and (c) a theoretical framework which underpins its procedures and methods, then Terminology as traditionally defined, perceived and established by Wüster (1959) and his successors (e.g. Felber 1984) by means of a set of guiding principles (Laurén & Picht 1993: 498) does not fulfil all these requirements. It has a subject matter, namely the vocabulary of specialised (spoken and written) discourse. It has an objective, namely the identification, collection and description of terms which can then be applied to the purpose of qualitatively enhancing communication; however, this basic objective has, from the beginning, been subordinated to the demands of standardisation, so that procedures and methods were designed with this particular and limited application in mind. These objectives are based on a supposed theoretical foundation which is vitiated by an excessive concern with standardisation, to the extent that in recent years it has begun to be questioned.

The weakness of the theoretical basis is most evident in the guiding principles accepted by the traditional schools of Terminology in which linguistic facts are replaced by desiderata of term formation. The lateness of the critical re-assessment of the theory, principles and even some of the methods of traditional Terminology is largely due to the promotion activities by Infoterm, for the Vienna school of Terminology, the dominant voice of the older generation or traditionalists.

The first reason why traditional Terminology has claimed the status of a scientific discipline is that it has a specific subject matter: the vocabulary of LSP. LSP is defined by Hoffmann (1979: 16) as:

> a complete set of linguistic phenomena occurring within a definite sphere of communication and limited by specific subjects, intentions and conditions.

Terminology only takes an interest in the vocabulary of special language.[2]

> Nur die Benennungen der Begriffe, der Wortschatz, ist den Terminologen wichtig. Flexionslehre und Syntax sind es nicht. Die Regeln hierfür können aus der Gemeinsprache übernommen werden (Wüster 1991: 2).

In the view of traditionalists, the second reason why terminology can be called a scientific discipline is that it has a practical objective which is translated into a number of principles.

In Section 1.2 we will enumerate and briefly comment on five of the basic principles of the Vienna school of Terminology and point out how standardisation principles limit the possibilities for unprejudiced research in the field of Terminology. In Section 1.3, we will go on to compare the opinions of the different traditional Terminology schools on a number of parameters and point out the resemblance which these principles of the traditional schools bear to European structuralist linguistic principles. This point will allow us later on (Chapters 3 to 6) to reflect on whether the alternatives for meaning description that were studied and developed in cognitive semantics, in reaction to and following the structuralist era, can be further elaborated in terminological research. The Saussurian structuralist principles of language description are in line with **objectivism**, i.e. the belief that there is an objective world independent of and regardless of human observation and experience. In recent years this underlying principle for describing meaning has been questioned in the cognitive sciences. It has been replaced by the idea that conceptualisation is a direct

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2. We prefer *special language* or *specialised language* over *LSP* which is rather used in reference to special language teaching by some authors (Sager et al. 1980).

spin-off of **experience** and **understanding**. Meaning is studied in relation to *"embodied"* understanding (Johnson 1987). Categorisation is part of human experience and human understanding of the world. In Section 1.4 we will review some of the recent reactions against the traditional principles and indicate the direction present day terminological research is taking. Before we turn to the empirical study of the terminology of the life sciences in textual information (Chapters 3 to 6), we specifically want to assess in how far the general paradigmatic shift from objectivism to experientialism in contemporary thinking (Geeraerts 1995: Chapter 4) has influenced recent terminological research. In Section 1.5, we raise some questions concerning alternative methods for studying and understanding special language in general, as well as issues surrounding categorisation and lexicalisation in special language in particular. Finally, in Section 1.6, we discuss the need for Terminology's re-evaluation.

1.2 The principles of the Vienna school for Terminology

Traditional Terminology claims as its main basic tenets the following five principles: Terminology studies concepts before terms (the onomasiological perspective)(see Section 1.2.1); concepts are clear-cut and can be attributed a place in a concept system (see Section 1.2.2); concepts should be defined in a traditional definition (see Section 1.2.3); a term is assigned permanently to a concept (see Section 1.2.4); and terms and concepts are studied synchronically (see Section 1.2.5). What follows is a more detailed discussion of what the Vienna school has to say on these five principles.

1.2.1 *The first principle: the onomasiological perspective*

According to Wüster (1991: 1), Terminology begins with the concept and aims to clearly delineate each concept

> Jede Terminologiearbeit geht von den Begriffen aus. Sie zielt auf scharfe Abgrenzung zwischen den Begriffen.

In lexicology the distinction between semasiology and onomasiology identifies two different perspectives for studying the relationship between **words** and their semantic values. The semasiological perspective starts from the formal aspect, i.e. the words. The onomasiological perspective starts from the content aspect of the sign, i.e. the meaning. Words with shared semantic features are grouped together. (see Svensén 1993: 17–18).

But unlike the case in lexicology, when the Vienna school of Terminology claims an onomasiological approach, this does not refer to the content aspect of the sign but rather to the concept seen as part of the world outside language. Ideally, concepts are defined (see third principle) by being given a place in the concept system (see second principle) before they are designated by a term (see fourth principle).

Wüster (1991: 1–2) particularly stresses the differences between the linguistic approach and the Terminology approach.

> Das Reich der Begriffe wird in der Terminologie als unabhängig vom Reich der Benennungen (= Termini) angesehen. Daher sprechen die Terminologen von Begriffen, während die Sprachwissenschafter in bezug auf die Gemeinsprache von Wortinhalten sprechen. Für die Terminologen besteht eine Benennungseinheit aus einen Wort, dem ein Begriff als Bedeutung zugeordnet ist. Für die meisten heutigen Sprachwissenschafter dagegen ist das Wort eine untrennbare Einheit aus Wortgestalt und Wortinhalt. Es gibt einen Umstand, der es den Terminologen leichter macht, mit dem Ausdruck Begriff auszukommen: Für sie erschöpt sich die Bedeutung einer Benennung in der Sachbedeutung, auch Begriffsbedeutung genannt. Die Mitbedeutungen fallen in der Regel fort.

Felber (1984: 103) distinguishes the study of concepts, which he calls ‘conceptuology’, from semantics:

> Conceptuology is similar to semantics, which is a discipline of linguistics. It is, however, only similar. This has to be stressed. Conceptuology is based on the concept, which exists independently of the term, the meaning of which it is. A term is assigned deliberately to a concept after due consideration whether this term corresponds to the concept in question. The assignment precedes (sic) an evaluation of the linguistic symbol to be assigned. This symbol can be an existing term or a term to be created from the characteristics being integral constituents of the concept in question. Semantics investigate (sic) the meanings of a word, which do not exist independently of the word.

This quote is rather contradictory. If the concept is the meaning of the term how can it “exist independently of the term”? If the concept is the meaning of the term, then the term has a meaning which is the concept. The Vienna school ignores the fact that the naming of many concepts is part of their creation in the human mind. For some concepts (e.g. *DNA*) there is evidence that the phenomena existed before they were understood and named, but others are pure products of human activity and understanding (e.g. *biotechnology*) (Chapters

3 and 4). Lack of precision if not total confusion also occurs with the word *“corresponds”*. Felber does not specify the criteria for correspondence. He seems to imply that terms are somehow available and naming consists of choosing one from a range of existing possibilities. He does not make the fine distinction that meaning elements or even sound patterns only become terms when they are associated with a concept. Without the concept they have no meaning as terms, but may conceivably be words in general use.

The concept approach of the Vienna school of Terminology boils down to an attempt at reducing conceptualisation to a mental activity which can happen outside language. In order to be able to achieve the univocity ideal (fourth principle), i.e. one unique term for each concept, Vienna school adherents need to believe that ideally a term should be assigned to a concept in the final stage. The facts of special language communication are disregarded. In our case studies on the history of categories like *biotechnology* (see Chapter 3), *cloning* (see Chapter 4), *splicing* (see Chapter 6), we show that concepts cannot be communicated, and probably cannot even be conceived without language.

1.2.2 *The second principle: concepts are clear-cut*

The second principle states that concepts should not be studied in isolation, but rather as elements in a concept system that can be drawn up based on a close study of the characteristics of concepts, which bring out the existing relationships between the concepts.

> Due to the fact that concepts are composed of characteristics, they have direct relationships to other concepts, (sic) which have the same characteristics in their intensions (Felber 1984: 120).

In order to explain what Felber means by characteristics, we need to know first of all that for him “concepts are mental representations of individual objects” (115). Individual objects are specimens (examples, exemplars) exemplifying the concept. A characteristic is:

> an element of a concept which serves to describe or identify a certain quality of an individual object. The characteristic itself is also a concept (Felber 1984: 117).

Felber’s definition of characteristic conflicts with another of the same school. In the ISO standard 1087–1, a characteristic is “used for delimiting a concept”.

It is the “mental representation of a property of an object or a set of objects”, not just of one individual object.

Based on the insight that concepts have characteristics, direct relationships to other concepts which have some of the same characteristics in their intension[3] can be understood. Traditional Terminology is basically interested in the direct relationships, i.e. logical and ontological relationships.[4] It is recognised that concepts also have other relationships to other concepts as the objects they represent are contiguous (i.e., neighbouring in space or following each other in time). These relationships, however, are not considered to be essential for the meaning description of concepts by traditionalists.

Traditional Terminology asserts that a subject field or a subsection of a field is mentally accessible only if the concept field is structured. A structured concept field is referred to as a system of concepts. In such a system of concepts the individual concept reveals its direct relationships to other concepts. When comparing different concepts with each other Wüster and Felber distinguish the following types of relationships (Wüster 1993: 353–364; Wüster 1991: 9–15 ; Felber 1984: 120–129): logical relationships, ontological relationships (partitive relationships, relationships of succession and relationships of material-product), and relationships of effect (causality, tooling and descent).

In trying to assign each concept a place in a concept system one has to be able to clearly delineate the concept. Traditional Terminology believes this clear delineation can happen on the basis of comparison of characteristics.

Many concepts are not clear-cut. The traditional Terminology argument that concepts should be clearly delineated in order to ensure unambiguous and therefore efficient and effective communication is not convincing. If a concept needs to be clear-cut and unambiguous, then it is not easy to find examples of

---

3. A concept can be described by specifying its intension and/or extension. **Intension** denotes the *content* of the concept, which can be defined as the combination of the distinctive features which the concept comprises. For example, the intension of *motor vehicle* could be specified as ‘vehicle + engine-driven + steerable + mainly for use on roads or tracks’. **Extension** denotes the *range* of concepts, which can be defined as the combination of all the separate elements or classes which the concept comprises. The extension of **motor vehicle** could be specified as ‘engine + wheels + steering gear + etc.) (Svensén 1993: 120–21). (See also 1.2.3.)

4. A logical relationship can be expressed as ‘y is a type of x’, e.g. a *car* is a type of *motor vehicle*. Ontological relationships are: **a. partitive relationships** of the type ‘y is part of x’, e.g. an *engine* is a part of a *car*; **b. relationships of succession** of the type ‘y follows x’, e.g. *son* follows *father*; and **c. relationships of material product** of the type ‘y is made of x’, e.g. jewel is made of gold.

terms referring to real concepts in texts on e.g. the domain of the life sciences. What one does find can better be referred to as categories. As we shall see in Chapter 3, a category is more than the aggregate of its characteristics. Most categories are flexible. A definition of necessary and sufficient characteristics of a category cannot be given and there are no clear boundaries. The flexibility can be observed in the categories referred to by the terms *blotting*, *cloning*, *splicing, mapping, sequencing* (which are all techniques in molecular biology) *and biotechnology, molecular biology, molecular genetics, genetic* engineering (which are all names for disciplines in the life sciences). This flexibility is functional in categorisation and in communication, it allows for evolution of understanding, in other words for variation and progress in understanding. Moreover, we shall demonstrate in Chapter 3 that individual references we find for each category show degrees of representativeness and a clustering of overlapping senses. More often than not terms designating categories have a prototype structure (see Chapter 3).

1.2.3 *The third principle: concepts and terminological definitions*

For the Vienna school a terminological definition can be of three types: (a) intensional ,b) extensional or (c) part-whole . This is in line with ISO standard 704 (1995) *Terminology Work — Principles and Methods*. The principles for terminography worked out in this standard are parallel to Wüster's (1991) and Felber's (1984) model of meaning description. We quote the definitions for the three types of terminological definitions.

a. The intensional definition.

> The aggregate of the characteristics of a concept constitutes its intension (Felber 1984: 116).
>
> A definition by intension consists of a specification of the characteristics of the concept to be defined, i.e. the description of the intension of the concept. For this purpose first the nearest genus that has either been defined already or can be expected to be generally known — not a generic concept of a higher level of abstraction- is found. The genus is restricted to the correct extension by its linking to characteristics, which differentiate the concept to be defined from other concepts of the same level of abstraction. These characteristics are called restricting characteristics. The restricting characteristics belong to one type of characteristics (Felber 1984: 160–61).

> An intensional definition should state the superordinate concept and list the differentiating characteristics in order to position the concept being defined in its concept system and to delimit it from the other concepts in this system (ISO/TC 37/SC1/CD704.2 N 133 95 EN).

b. The extensional definition

> A definition by extension consists of the enumeration of all species, which are at the same level of abstraction, or of all individual objects belonging to the concept defined (Felber 1984: 163).
>
> Extensional definitions. A definition can list the extension of the concept (ISO/TC 37/SC1/CD704.2 N 133 95 EN).

c. The part-whole definition

> The description of the collocation of individual objects revealing their partitive relationships corresponds to the definition of concepts. Such a description may concern the composite. In this case the parts, of the composite are enumerated. It may, however, also concern a part. In this case the relationship of an individual object subordinate to the composite and the adjoining parts are indicated (Felber 1984: 164).
>
> A part-whole definition describes a superordinate concept in a partitive concept system by listing all the parts that make up the whole (ISO/TC 37/SC1/CD704.2 N 133 95 EN).

ISO/TC 37 expresses a preference for the intensional definition:

> For terminology work, part-whole definitions are less suitable than intensional definitions and are admissible only if the number of parts to be enumerated is limited and they can be clarified by an intensional definition or are generally known (ISO/TC 37/SC1/CD704.2 N 133 95 EN).
>
> …intensional definitions are preferable to any other form of concept description because they are more systematic (ISO/TC 37/SC1/CD704.2 N 133 95 EN).

Traditional Terminology strives for definitions which reflect the position of a concept in a concept system. The intensional definition is preferred as it is more systematic than any other type of definition. Traditional Terminology admits that not all terminology can be defined by a definition of one of the three types mentioned. Therefore they recognise the need for explanations, definitions which do not express the position of a concept in a concept system.

> An explanation is a description of a concept without considering its position in a system of concepts (Felber 1984: 160).

These explanations are not given any further elaboration, which creates the impression that the need for an explanation instead of a 'real' definition is exceptional.

For many (if not most) concepts it is impossible to create a meaningful intensional definition. A definition is meaningful if it provides the information necessary to understand the term which designates the concept being defined. Whether an intensional definition is possible and meaningful is partly linked to the type of concept (entity, activity, property, etc.) under consideration (see Chapter 2).

1.2.4 *The fourth principle: the univocity principle*

According to this principle, a term (a designation) is assigned permanently to a concept either by linguistic usage or by individuals or specialists of terminology commissions:

> While in linguistics word content and word form are regarded as a unit, in terminology concept and designation (=term, symbol, abbreviation) are separated. They form together a terminological unit. A permanent assignment concept-term, which is necessary for communication, is either given by linguistic usage or established deliberately by an act of will by individuals or specialists of terminology commissions (Felber 1984: 182).[5]

Univocity[6] means that each concept should be designed by only one term and one term should only refer to one concept. Following this principle, synonymy and polysemy are eliminated.

The permanent assignment concept-term, which can be a deliberate act, points to the strong interlacing of Terminology and standardisation. In Wüster's (1991: 2) Terminology frame the emphasis is on conscious deliberate language creation and shaping:

> Hervorstehend ist die bewußte Sprachgestaltung.

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5. This quotation is very confusing. One the one hand, Felber says that concept and designation are 'separated' , without saying by what or by whom, and on the other hand he says that they form a unit.

6. Univocity is a summary term for monosemy and mononymy at the same time. Felber (1984: 183–186) gives the following definitions: "monosemy: term-concept assignment, in which one concept only is assigned to a term" (183) and "mononymy: term-concept assignment, in which one term only is assigned to a concept" (186).

Wüster, the founder of the Vienna school of Terminology, was not a linguist but an engineer and a businessman. He was a specialist active in the field of standardisation. Standardisation organisations are concerned primarily with the standardisation of objects or products. This is a social and economic activity and its achievements must be the outcome of the collaboration of all interested parties. The standardisation of terms always occurs subsequent to the standardisation of objects (often products). The publication of a standard has little value in itself; its application is all-important. This principle applies to terminology with the same force. Application of commonly agreed terminology will oblige some parties to make changes in their linguistic practices in the interest of the common good (Johnson & Sager 1980: 81; Sager 1990: 118). Some product standards are legally enforced. In the world of Wüster (1984: 15) standardisation of terminology "has the purpose to unify concepts and systems of concepts, to define concepts, to reduce homonymy, to eliminate synonymy, and to create if necessary new terms in line with terminological principles".

The British Standardisation Institution (BSI), which is a national standardisation institution, defines *standard* as "a document, established by consensus and approved by a recognized body, that provides, for common and repeated use, rules, guidelines or characteristics for activities or their results, aimed at the achievement of the optimum degree of order in a given context" (BS O: A Standard for Standards. Part 1:1991).

ISO (International Organization for Standardization), is the world-wide federation of national standards bodies comprising 117 members in as many different countries (source: ISO/ PUBLICATIONS, March 1996). The results of ISO work are published in the form of *international* standards.

Trading partners throughout the world have grown to appreciate the importance of internationally agreed standards for a variety of things, including transport vehicles and cargo containers; for storage and handling requirements of perishable products; and for compatible world-wide facilities and administrative procedures to ease the movement of goods, people, and services internationally.

The technical work of ISO is carried out by technical committees (TC), one for each field. Examples of TCs are: TC 6 Paper, board and pulp; TC 20 Aircraft and space vehicles; TC 35 Paints and varnishes; TC 85 Nuclear energy; TC 147 Water quality; TC 202 Microbeam analyses.

Surprisingly TC 37 Terminology (principles and co-ordination) figures in this list of technical committees. One standard established by TC 37 is ISO/TC:37/SC 1/CD 704.2 N 133 95 EN Terminology work — principles and methods.

> This International Standard establishes basic principles and methods for preparing standardized terminologies. It describes links between objects, concepts, and their representations, and contains general principles governing the formation of definitions and terms (ISO/TC:37/SCI/CD704.2N13395EN:1).

Apparently, terminology, the "set of terms representing the concept system or concept systems of a particular subject field" is treated here as if it were a commodity. The "document,…, aimed at the achievement of the optimum degree of order in a given context" (see above) concerns the standardisation of language, and more specifically vocabulary. In other words, vocabulary, which is part of language, is treated as if it could be standardised in the same way as types of paint and varnish or parts of aircraft and space vehicles.

TC 37, however, treats concepts and terms as needing rules, guidelines or characteristics aimed at the achievement of the optimum degree of order in a given context. The activity for which the standards are needed is referred to as "terminology work: work concerned with the collection, description, processing and presentation of terms" or "terminography" which is defined as "terminology work that includes recording, processing and presentation of terminological data in printed form or machine-readable form" (ISO/CD 1087–1).

For TC 37,

> terminology work combines elements of many theoretical approaches involving the description and ordering of knowledge (at the cognitive level) and the transfer of knowledge (at the communicative level). Its central elements are concepts and terms (ISO/TC 37/SC 1/CD 704.2 N 133 95 EN:1).

We can therefore establish that terminology work embraces the following activities: identifying concepts and concept relations; establishing concept systems on the basis of identified concepts and concept relations; defining concepts on the basis of concept systems; assigning a preferred term to each concept; recording terms and their definitions in vocabularies and terminology databases.

For these activities, the ISO TC 37 norms claim scientific underpinning:

> the terminological principles and methods laid down in this standard are supported by the theory of science (epistemology), logic, linguistics, and cognitive psychology.

These so-called scientifically-founded claims are (ISO CD 704.2 N 133 95 EN):

> (1) Reality manifests itself as concrete objects, i.e., natural and artificial objects, e.g., a tree or a machine, or abstract objects, such as society, complex facts or processes. Concrete objects are often designated as perceived objects, whereas abstract objects are considered to be conceived objects.
>
> (2) If we discover or create a singular phenomenon (individual object, e.g., the planet Saturn, The Golden Gate Bridge, the society of a certain country), we form an individual concept in order to think about that object. For communication purposes we assign **names** to individual concepts so that we can talk or write about them.
>
> (3) As soon as we are confronted with several objects similar to each other (all the planets in the solar system, all the bridges or societies in the world), certain essential properties common to these objects can be identified as characteristics of the general concept. These characteristics are used to delimit concepts. On the communicative level, these concepts are described by definitions and represented by terms, graphic symbols, etc.
>
> (4) We distinguish among different kinds of individual objects. As noted above, most objects are instances of a class of similar objects. Concept relations and concept systems reflect their respective object relations and object systems
>
> (5) Concept formation plays a pivotal role in structuring human knowledge because it provides the means for recognizing objects as belonging to the same class. The cognitive process called abstraction leads to the formation of general concepts by categorizing similar objects into classes. A concept is a unit of thought made up of characteristics that are derived by categorizing objects having a number of identical properties.
>
> (6) Natural language expressions used for communication in special subject fields, such as law, science, technology, and medicine, are called terms. Terms must refer clearly and unequivocally to a particular concept. This precision is achieved by unambiguously defining the underlying concepts. The purpose of the definition is to describe the particular concept and to delimit it from other related concepts. This is achieved by analysing relations among concepts and developing concept systems.
>
> (7) On the basis of these definitions, each concept is assigned a preferred term. Terms, together with the definitions of their respective concepts, are recorded in vocabularies, terminology databases or in other types of terminological products.

According to these principles of traditional Terminology which are applied in standardisation practices ‘designation’, the assignment of a term to a concept is the final step. In the procedure for preparing terminology standards, terminologists are instructed to start from the concept which is part of the world outside language. Concepts are assigned a place in a concept system, on the basis of which they will be defined, before they will be named with a term.

This procedure can only be followed if firstly concepts exist as individual objects in the real world; secondly it is possible to define a concept by clearly delineating it from other related concepts; and thirdly univocity (isomorphism) is at the basis of unambiguous communication and the foremost function of special language is to avoid ambiguity.

The principles and methods of TC 37 claim scientific justification for terminology standardisation. The authoritative impact of the standardisation organisations and the activities of Infoterm Vienna had a discouraging impact on possible research initiatives concerning special subject communication and vocabulary. Language is treated like an object, a product, a commodity whereas linguistic reality tells us a different story. Traditional Terminology adheres to the underlying assumption that it is possible to achieve a one concept-one term situation by treating concepts as if they were language-independent.

In the corpus of life-science-related texts we studied we find evidence that polysemy and synonymy are necessary (functional) and inevitable aspects of terminology. In Chapter 4 we will furnish proof, firstly, of the functional advantages of the highly polysemous term *cloning* in communication about the life sciences; and secondly, of the fact that the existence of synonymous expressions e.g. *Southern blotting*, *Southern hybridisation* and *Southern transfer* is functional too, as the different terms allow for the expression of shifting perspectives and are not arbitrary.

1.2.5 *Fifth principle: the synchrony principle*

The fifth and final principle of the Vienna School of Terminology which we will discuss here is the synchrony principle. Traditional Terminology as defined by the Vienna school does not study language development and language evolution ("Sprachentwicklung") because the main emphasis is on the concept system, which they take to be the basis of special language. Therefore terminology is considered solely from its synchronic aspect:

> Der Vorrang der Begriffe hat zwangläufig dazu geführt, daß die terminologische Sprachbetrachtung synchronisch ist. Für die Terminologie ist das Wich-

> tigste an einer Sprache das Begriffssystem, das ihr zugrunde liegt (Wüster 1991: 2).

It is a fact that concepts evolve over time, as do their designations. The question of the extent to which the language system influences conceptualisation and categorisation has preoccupied language philosophy from time immemorial. An attempt at getting more insight into how the meaning of terms evolves alongside the world and human understanding, could be a major research topic for Terminology.

1.2.6 *Summary*

Terminology in its Vienna tradition has the vocabulary of special language as its field of study. It also has an objective, the standardisation of terminology, which is reflected in its principles and methods, of which we discussed five important ones. However, the third requirement for Terminology to be considered a scientific discipline, namely that it must define its basic concepts and create a theoretical framework which underpins its own principles and methods on the basis of empirical research (i.e., starting from facts instead of from utopia) has not been met by the Vienna school, nor by the other traditional Terminology schools (see 1.4). The reason is that the interest in terminological research was hindered by the interests of standardisation.

Traditional Terminology confuses principles, i.e. objectives to be aimed at, with facts which are the foundation of a science. By raising principles to the level of facts, it converts wishes into reality. It takes univocity to be desirable, but univocity is not a fact, rather polysemy and synonymy are facts. The one concept-one term situation is not a principle which is underpinned by scientific research. It is axiomatically taken to be the case. It is one of the principles of objectivism (see Sections 2.2.b and 2.5.2). Figure 1.1 gives a summary of the main principles of traditional Terminology and the evidence one is confronted with when studying terminology in special language.

Principles of traditional Terminology	**Our observations concerning the terminology of special language**
First principle: Terminology starts from the concept without considering language.	Language plays a role in the conception and communication of categories.
Second principle: a concepts is clear-cut and can be assigned a place in a logically or ontologically structured concept system.	Many categories are fuzzy and can not be absolutely classified by logical and ontological means.
Third principle: a concept is ideally defined in an intensional definition.	An intensional definition is often neither possible nor desirable.
Fourth principle: a concept is referred to by one term and one term only designates one concept.	Polysemy, synonymy and figurative language occur and are functional in special language.
Fifth principle: the assignment concept/ term is permanent.	Categories evolve, terms change in meaning, understanding develops.

Figure 1.1. *Contrast between the principles of traditional Terminology and the reality of the terminology we have been studying in the special language of the life sciences.*

1.3 The limits that are posed on unprejudiced research in Terminology

We would like to make three more observations about traditional Terminology. They concern traditional Terminology's relationship to objectivism, to dogma and to standardisation.

1.3.1 *Traditional Terminology and Objectivism*

Traditional Terminology applies the objectivist model which is at the basis of Western thinking. Objectivism, as defined by Johnson (1987:x), "takes the following general form: The world consists of objects that have properties and stand in various relationships independent of human understanding." For objectivists reality has a rational structure which is independent of human understanding. In order to describe this objective reality, language needs to express concepts "that can map onto the objects in a literal, univocal, context-independent fashion". To reason is to manipulate concepts according to the rules of logic. The human capacity to *understand* and to *imagine* is not discussed in objectivism. The human nature of understanding is believed to have no influence on the nature of meaning and rationality. Meaning is seen as objective because it is reduced to the relation between abstract symbols and things in 'reality' which have characteristics and relationships. The objectivist stance can only be upheld as long as one does not consider terminology in 'real' language (*parole)*, like in texts written by specialists. In other words, the objectivist stance does not give any attention to the communicative aspect of language.

1.3.2 *Traditional Terminology and Dogma*

In many cases Terminology has become a dogma. The model of what meaning is and how meaning can be described is not questioned even though there are many problems associated with the application of the terminological principles. For instance not all the terminology of a subject field can be captured in a description based on logical and/or ontological classifications. To take another example, specialised communication contains complex cases of polysemy, which cannot be 'solved' by terminological committees because polysemy is 'useful' and 'meaningful' in specialised communication. The univocity (monosemy and mononymy (Felber 1984: 183–186)) principle is untenable, but artificially maintained. Like polysemy, synonymy is also a fact whose function is apparent.

1.3.3 *Traditional Terminology and Standardisation*

Subject field communication as such is not studied. Instead, traditional terminologists only investigate ways of making terminology as efficient and unambiguous as possible. Wüster and his followers turned Terminology into a number of dogmatic principles for terminology description with language engineering, planning and standardisation, as a consequence of product standardisation, as the underlying socio-economic motivations. The double role of some of the Infoterm[7] staff as information providers for a UNESCO-spon-

7. "Recognizing the growing importance of terminology for the development of science and the humanities, for translation, and particularly for information and documentation activities, Unesco (sic) has been supporting terminological activities for the last twenty years. It was, however, only at the beginning of the seventies that the idea of an international co-ordinating body in the field of terminology, which had been discussed for some time within Unesco, came into being. It was in the framework of the UNISIST programme of Unesco, and on the basis of a contract between this organization and the Austrian Standards Institute, that the International Information Centre for Terminology, Infoterm, was established in 1971, in Vienna." (Felber 1984:I)

sored organisation and as collaborators in the Austrian Standards Institute and secretariats to an ISO committee resulted in the improper transfer of ideas that were useful for standardisation to theoretical considerations of terms, concepts and their role in language and knowledge generation and representation.

Wüster's principles as formulated in the first ISO 704 (1968) were quite suitable for documents which dealt with the standardisation of terms in the field of technology and engineering for objects which could themselves be standardised. Objects that can be standardised are industrial products or processes and hence their names are already fixed or can easily be fixed for the duration of the life of the standard.

The mistake was simply to generalise from this very practical and useful activity which was given its own justification in the ISO TC37 documents and then to proclaim that these guiding principles could form the basis of a more widely applicable theory of Terminology, let alone "The General Theory of Terminology" (Felber 1984: 96–97). The error started with Wüster who spoke of "allgemeine Terminologielehre" and was intensified by the inadequate translation of this expression into the General Theory of Terminology.

1.4 Different schools of Terminology

A history of the scientific foundation of the discipline of Terminology is given in Felber (1984) and in Laurén & Picht (1993). Laurén & Picht (1993: 495) give a survey of the 'scientific schools' in Terminology. They define a 'scientific school' as (a) having collective theoretical principles, (b) dealing with similar research subjects, (c) having fundamentally common research strategies (methodologies).

> Eine wissenschaftliche Schule ist gekennzeichnet durch einen gemeinsamen theoretischen Ansatz, die gleiche Einordnung des Forschungsgegenstandes, dessen Bearbeitung das Ziel der Schule ist, in das Gesamtbild der Wissenschaften und eine in den Grundzügen gemeinsame Forschungsstrategie.

They distinguish between the Vienna school, the Prague school and the Soviet School. The motivation for talking about schools is that a number of scholars start from common principles and beliefs. Apart from these three schools other research centres and other initiatives are acknowledged including the Canadian centre, the Nordic centre and UMIST[8] Manchester. Laurén and Picht (1993)

8. University of Manchester Institute of Science and Technology.

undertook a systematic comparison of principles which four of the identified schools and centres adhere to, based on the following parameters: the concept, the term, the relationship concept/term, the concept and term system, the relationship Terminology has with language planning and standardisation and the place Terminology claims for itself in the classification of sciences.

What strikes us is that these allegedly different schools of Terminology seem to coincide in most respects.

(a) For the three traditional schools of Terminology the concept is the starting point of terminological analysis. It is a unit or element of thought which expresses the intrinsic characteristics of an object. The Vienna school (Wüster) explicitly claims that the concept can exist without language. In the Canadian school the term is the starting point in terminological analysis.

(b) Whereas the Prague and the Soviet schools support the Saussurian view that the term is the totality of content (concept) and form (name), for Wüster the ‘sign’ has an abstract level and a number of possible realisations, a trivial observation which is not denied by others. For the Canadians the term is the starting point in terminological analysis.

(c) The Prague and the Soviet schools also follow Saussure in considering the term as a linguistic sign. Wüster wants a clear divide between concepts and terms. The Canadians combine the Saussurian and the Wüsterian approach.

(d) Following Saussure’s ideas, the concept and term system are the two sides of the theory of the linguistic sign. Wüster stresses that the concept system should come first. The ideal term should be assigned and needs to be transparent and as international as possible.

(e) It is significant that the underlying motivation for each of the schools seems to be language planning. For both the Prague and the Soviet schools there is a strong orientation towards standardisation. The Vienna school has the conviction that it is possible to influence the naming activities in special language, and the Canadians have the specific aim to secure the survival of the French language in Canada. One can imagine how difficult it is to examine the foundation of terminological meaning description objectively when the underlying motivation for the claimed scientific schools is language planning, which implies sponsorship by governmental bodies with language-related political objectives. The outcome is that the scientific study of terminology is confounded with the pragmatic activity of standardisation.

Saussurian structuralist semantics	**Traditional Terminology**
The belief that (words have) meanings (that) can be clearly delineated.	The European (as opposed to the Canadian) terminology model starts from the belief that concepts, which will be given the status of the 'meaning' of the term that will be assigned to them, can and should be clearly delineated.
The belief that the best way to describe meaning is to describe the mutual delimitation of concepts (semantic relations).	The belief that the best way to describe concepts is to determine their position in a concept system which visualises logical and ontological relationships.
The belief that the best way to describe meaning is to concentrate on denotational meaning (as opposed to connotational meaning) and on the literal meaning (and not the figurative meaning) of words.	The belief that the concept system is to be seen as independent from the term system, and that consequently, unlike words, terms are context independent: the meaning of the term is the concept.
The belief that meaning is to be described synchronically.	The belief that Terminology should choose not to study language development and language evolution as the emphasis is on the concept system. Therefore Terminology takes a synchronic approach.

Figure 1.2. *The similarity between Saussurian structuralist semantics and traditional Terminology.*

(f) The three schools and the Canadians are very much in line with Saussurian structuralist thinking. Even the Vienna school with its strong emphasis on wanting to cut Terminology loose from linguistics, shows parallels with structural linguistics (Figure 1.2).

The theoretical foundations listed by Laurén & Picht (1993) as being the features which characterise the traditional schools are not fully elaborated theories at all. If we consider the three elements relevant to Terminology : human thought, language and the world,[9] we realise that only some of the possibilities for treating the interdependence between these three factors are exploited. Traditional Terminology does not concentrate on the human dimen-

9. More details on the interplay between these three elements of the 'semantic triangle' (Gomperz 1908) are given in chapter two.

sion of conceptualisation. It does not want to consider that categories can be the result of conception in the mind and not solely of what can be perceived objectively. The role of language in thinking and understanding and representing the world is not exploited either. Moreover the linguistic study of terminology is deliberately left out. Traditional Terminology does not have a theory of cognition or concept formation and naming. (The simple definition of 'concept' is about all they have, and even then there is no complete consensus on this definition). Moreover they believe concepts exist or should exist in a definable way before they are designated with a term. The process by which concepts are formed and subsequently named is not properly explained at all. Traditional Terminology does not have a theory of communication. The way terms originate in texts and are discussed in texts is not given any consideration. Moreover the Vienna school's traditional Terminology denies that the observations it makes about terms is based on linguistics.

The origin of Wüster's thoughts may be relevant in trying to understand how the Vienna school of Terminology developed (Felber 1993: 15–16; Nedobity 1993: 293–299; Wüster 1993: 338–339). Not only was Wüster a strong proponent of Esperanto and other artificial or construct languages, he was also fully aware of:

(a) the problem of Swiss, Austrian and German language terminology which needed unification. Living in Austria but having studied in Berlin, he was very conscious of the linguistic and economic disadvantages of a smaller country; (b) the need for standardisation in order to have fair industrial competition especially for smaller firms which even in the thirties were threatened by industrial giants; (c) the wider ideal of international co-operation which has been vigorously pursued by many Central Europeans since the last century.

This is what drove Wüster to work on Terminology. He was a pragmatist who strongly believed in agreement through discussion; this drove him to urge ISO to set up a TC for Terminology. He also had an idealistic belief in people's acceptance of a harmonised technical language for the benefit of effective communication. From Austria, a small country, he saw the need to work through international bodies, rather than work simply inside the German-speaking communities. Since he wanted to achieve practical results he worked through the German and Austrian standards organisations and through ISO and all his efforts went into producing the basic documents finally published around 1968, virtually all of which were drafted by him.

The Soviet school and the Canadian school were motivated by very practical and immediate concerns as well. While Wüster was concerned with the harmonisation of the varieties of German on the one hand and the harmonisation of English, French and German on the other hand; the Russian and Canadian problems were also bi/multilingual on a slightly different plane, but the basic principles of transferring information from one language into another was common to all of them. The only difference from the German situation was that the Soviets could standardise the many languages of the Soviet Union internally and the Canadians had the problem of harmonising two national languages which could be done internally, but which were still influenced by the existence of US English on the one hand and European French on the other.

If Terminology allows for three activities: hypothesis (probability to be proven by experimentation or logical deduction or inference), description (of facts, what is proven) and prescription (the standardisation of terminology), the nature of most of the traditionalist publications fall into the last category. Prescription, however, presupposes certain assumptions about facts which have to be correct. If the facts cannot be supported by experiential evidence, the prescriptions lack a basis for their application.

1.5 Recent criticism on traditional Terminology

In the foregoing we have highlighted the main principles of traditional Terminology. We have indicated how these principles result from the underlying model of knowledge and language structure. The emphasis on the strong influence of the Vienna school, may have created the impression that all researchers and practitioners of Terminology have been accepting and applying these principles for meaning description without questioning them. This is definitely not the case. The wide influence and apparent authority of the Vienna school can partly be explained by the impact of the activities (e.g. congresses and publications) of Infoterm in Vienna, until recently a UNESCO sponsored organisation[10] which acted as the mouthpiece of the Vienna school.

10. "After a long period of financial uncertainty, the International Information Centre for Terminology (Infoterm) was reborn on 29 August, 1996 as an international association under Austrian law, … . The overall objective of the revamped association is to support specialist communication and knowledge transfer by promoting co-operation in the field of terminology in general, and by providing information on terminological activities and publications, promoting

Nevertheless, interesting critical reactions to the Vienna credo have been raised in several parts of the world.

1.5.1 *Juan C. Sager*

First of all there is the UMIST centre for terminological research from where Juan C. Sager and John McNaught (1986) have been critically evaluating Terminology as a potential discipline and as a practical activity. Juan C. Sager questions the 'disciplinary status' of Terminology in his book *A Practical Course in Terminology Processing* (1990: 1).

> There is no substantial body of literature which could support the proclamation of terminology as a separate discipline and there is not likely to be. Everything of importance that can be said about terminology is more appropriately said in the context of linguistics or information science or computational linguistics.

Sager sees Terminology as a number of practices. Terminology has developed methodologies, but these are only means to an end and do not constitute a discipline, which goes a step farther by establishing knowledge about things and is therefore justified in its own right. Sager denies Terminology the status of a discipline but he does not add — as we are doing here — that the discipline of Terminology might study the vocabulary of special language communication for the sake of contributing to the understanding of the nature of scientific thinking, creative thinking in science and the role language plays in this. If one manages to break away from the limiting context of standardisation practice and its reductionist approach, Terminology could contribute to the development of the cognitive sciences and to sociolinguistics.

Apart from questioning the status of Terminology as a discipline, Sager relativises and complements the principles of the traditional Terminology schools in a number of ways.

(a) He adds the *communicative dimension* to the other two dimensions traditionally considered in Terminology, i.e. the *cognitive dimension* and the *linguistic dimension*. The consequence of this is that terms are studied in **texts**, and not as context-independent labels for things. “The identification of a term

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and preparation (sic) of reliable terminologies by subject field specialists and institutions, and by initiating, organising and co-ordinating the development and application of harmonised methods and electronic tools in particular.” (Galinski, C. in *The ELRA Newsletter*, October 1996: 14) is made first contrastively in texts, by delimiting lexical units" (46). He points out that "the recognition that terms may occur in various linguistic contexts and that they have variants which are frequently context-conditioned shatters the idealised view that there can or should be only one designation for a concept and vice versa" (58–59). He shows how text-types and conventions can modify the intention of a text and influence the meaning of the terminology used (101). (b) He distinguishes between four types of concepts: entities, activities, characteristics and relations (25–26). (c) He acknowledges *complex relationships* "which cannot be conveniently captured by straightforward generic and partitive structures" (34). Examples of `type of relation' are *is caused by* (fallout-nuclear explosion), *is a product of* (paper-wood pulp), *is a property of* (compressibility-gas), *is a quantitative measure of* (temperature-heat), *is an instrument for* (computer-data processing), *is a counteragent of* (insecticide-insects), etc. (d) Sager incorporates aspects of multidimensionality (see also Section 1.5.5) in applying `a faceted classification' indicating the "kind of subdivision of a concept made on the basis of a particular characteristic"(35). (e) He recognises the relevance of levels of understanding when he claims that the non-specialist needs an encyclopaedic definition, and can not be satisfied with what he calls a "terminological definition" (48–49), which presupposes an understanding of the intension of the term and places the term in its position in the appropriate knowledge structure. (f) Sager sees "terminologisation" as a process in time. He sees the evolution of concepts as accompanied by stages of naming. "In the development of knowledge the concepts of science and technology like those of other disciplines undergo changes; accordingly their linguistic forms are flexible until a concept is fully formed and incorporated in the knowledge structure. The designation can, therefore, oscillate between the absolute fixation of reference of standards and the flexibilities of notions"(60). (g) He distinguishes between spontaneous term formation and designed and engineered term formation which he also refers to as "secondary term formation" (80).

In what Sager refers to as a "modern" terminological theory the purely onomasiological approach "i.e. a 'naming' approach , because in principle it starts from concepts and looks for the names of these concepts" (56) is left behind and replaced by "the increasing tendency to analyse terminology in its communicative, i.e. linguistic context" (58). Sager's modern terminological theory adopts a corpus-based approach to lexical data collection and terms are no longer seen as part of "a semi-artificial language deliberately devoid of any of the functions of other lexical items" (58). This new attitude opens up the investigation of special language vocabulary to the methods and approaches of present day lexical semantics, as we will show in our case studies (see Chapters 3 to 5).

1.5.2 *Peter Weissenhofer: relative definiteness and determinacy*

In his dissertation entitled *Conceptology in Terminology Theory, Semantics and Word Formation*, Peter Weissenhofer (1995), accepts the insights of present day lexical semantics, such as prototype theory (see Chapter 2). His general aim is:

> to integrate recent findings of research in the areas of semantics and word-formation, such as the prototype theory and modern morphological developments in psycholinguistics, into the theory of terminology and — on the basis of this integration — to develop a morpho-conceptually based classification system of the English baseball-terminology (193).

Weissenhofer points out the distinction which has to be made between the use of *concept* in terminology theory and in semantics and proposes an extension of Wüster's four-field concept model which is largely based on Ogden & Richards' semantic triangle (see 2.4.2) and which he feels does not meet all the requirements of a comprehensive terminological analysis.[11] In addition he also considers that in contradiction to "the assumption that (term-) meanings are relatively clear-cut and consist of a number of discrete features that make up a sign's semantic content" (194) linguists and psychologists have pointed out recently "that meanings are often quite vague and that many categories seem to be mentally represented in terms of prototypes rather than as sets of critical features" (194).

Weissenhofer believes that a theory of Terminology has to deal with problems of indeterminacy and prototype phenomena. The approach he favours

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11. "I have come to the conclusion that the four-field model in its original version does not meet all the requirements of a comprehensive terminological analysis. The main points of criticism are that it does not clearly distinguish between the levels of *langue* and *parole*, that it presupposes a one-to-one relationship between form and meaning and thus excludes the analysis of all those terms whose significata consist of more than one sememe, that, as a consequence, it does not account for phenomena such as polysemy and synonymy and , finally, that it does not allow for contextual and relational aspects of signs." (Weissenhofer 1995: 193–4).

in his dissertation is “to introduce a type of semantic feature which — as opposed to distinctive features — is optional, weighted, dependent upon the context and/or cotext and therefore suitable for expressing prototypicalty (sic) conditions.” (194). All these conditions he believes to be fulfilled by Lipka’s “inferential features” (1985).

For the Vienna school of Terminology the basis for efficient and unambiguous communication is monosemous, unambiguous terms. Unambiguous terms are assigned to clear-cut, clearly delineated concepts. Weissenhofer believes that, depending on the nature of the subject field, the requirements for unambiguous terminology may vary. He points out that some specialists in Terminology distinguish between fields “where an evaluative aspect plays an essential role” and fields “where definiteness and determinacy are often the main objective” (43). The evaluative aspect of Terminology is illustrated by the fact that subject-field specialists in the humanities and social sciences tend to hold different ideas about the concepts central to their subject fields (e.g. the contents of the concept denoted by ‘primitive’ in anthropology) (Weissenhofer 1995: 43). There can be no ultimate agreement on a single concept as the more fundamental feature of such concepts is “that any analysis and understanding of them must be based, at least in part, on the individual’s interpretation of some or all of their constituent characteristics” (Cole 1990: 13 in Weissenhofer 1995: 42).

Weissenhofer explains that those fields where definiteness and determinacy are often the main objective for their terminology are supposed to include many subject fields in the scientific and technological areas. The subject fields might be pictured on a scale varying from high requirements for definiteness and determinacy to low requirements for definiteness and determinacy. Sciences like mathematics and chemistry would have to be at the high requirements end. Subjects like these require and press for standardisation of terminology. For other subjects which score low on the scale this would be less the case.

Weissenhofer seems to imply that the requirements for definiteness and determinacy are determined by the subject field. Depending on the subject field he is describing, a terminologist has to adapt his principles for meaning description according to where the subject field occurs on the “urge for determinacy” scale.

It is understandable why Weissenhofer arrives at these claims if one considers his methodology for studying the terminology of baseball. The corpus he compiled is basically taken from official rule books on baseball and from specialised dictionaries and encyclopaediae. Weissenhofer is studying morpho-conceptual relationships in standardised terminology. He finds 16 types of relationships. Even though theoretically he seems to be aware of new trends in studying conceptualisation he remains very much in the tradition as far as his working method is concerned. Only the basis for lexicalisation is studied. The empirical adequacy of terminological concept theory is not really questioned as he starts from highly standardised terms.

In contrast, the subject field of the life sciences, the terminology of which we have been studying in texts, shows a diversity of types of concepts which by their nature may on the one hand require different principles for description and on the other hand may have a function in language development which is opposite to the univocity principle of standardisation. Some concepts appeal for functional polysemy, as polysemy is the transition towards the diversification of a concept.

1.5.3 *Britta Zawada and Piet Swanepoel*

Recently Britta Zawada and Piet Swanepoel (1994) have made some attempts to question the objectivist model for meaning description in Terminology and the empirical adequacy of terminological concept theories by pointing out the prototypical nature of concepts in the subject field of mineralogy. Examples of the classification and definition of minerals in the field of mineralogy are used to illustrate that the defining features of mineral species are typically the attributes of prototype categories.

> they are, amongst others, culturally, perceptually, and bodily based, idealized and essentially interactional and functional in nature (253).

They argue furthermore, that classification in mineralogy is founded on an experientialist rather than an objectivist epistemology.

> These factors strengthen the argument for a prototype approach to concept analysis not only in the humanities and the social sciences but also in the so-called natural and pure sciences (253).

In their paper they demonstrate that even though the natural and the pure sciences may be more precise than the humanities and the social sciences, classical concept theory is inadequate to account for the conceptual structure of these domains. They show that specialists themselves do not conceptualise their categories according to the classical concept theory which imposes the requirement that definitions have to take the form of binary, necessary and sufficient conditions for membership. The problem of scalar/graded characteristics, as opposed to the binary characteristics imposed by the classical concept theory, has long been acknowledged (258). In this paper they show that the gradedness of some categories is only one aspect of prototype theory and that several other aspects of the nature of the defining features of concepts are not adequately dealt with in classical concept theory.

Most structuralist frameworks within the classical concept model are embedded in a number of objectivist epistemological postulates. For example (258) (a) concepts (and the conceptual features of which they are made up) are no more than replicas or mirror representations of the objective structure of the world; and (b) concepts reflect the "essence" of the entities, relations, processes, etc., that make up this world.

Zawada and Swanepoel argue (260) that the existence of some classical categories does not necessarily constitute evidence for classical concept theories and against prototype theories. On the contrary, the existence of some classical categories illustrates the prototypicality of prototype categories. Geeraerts (1989) discusses the prototypical nature of 'prototype category' itself. What he means is that the prototypical prototype categories have all characteristics of prototype categories and that peripheral prototype categories only show some (or even none) of these characteristics.

Zawada and Swanepoel believe classical categories to have an "inherently prototypical nature" even if they can be defined in terms of necessary and sufficient conditions and have clear-cut boundaries.

> They are embedded in an experientialist epistemology in which even necessary and sufficient conditions for membership are dependent on the physical, cultural, and social experience of the observer (261).

Moreover the nature of classical categories "depends crucially on a functional aspect (such as a need in a specific domain to impose fixed boundaries to a category)" (260). So they are not in essence true classical categories.

What Zawada and Swanepoel (271) find is that even for the category of natural kinds (entities), such as minerals, definitions in keeping with an objectivist epistemology are simplifications with a functional purpose. This functional purpose can be that a group of specialists decide to follow the objectivist epistemology which believes that (a) fixed entities, properties, and relations exist in the world; (b) entities in the world are divided into natural kinds that are definable by essential properties; (c) complex properties are logical combinations of primitive properties; (d) meaning is based on reference and truth; (e) truth consists of the correspondence between symbols and states of affairs in the world; (f) there is an "objectively correct" way to associate symbols with things in the world.

In defining features of mineralogical concepts they found support for an experiential epistemology: (a) mineralogical entities and properties are real world phenomena, but the mental constructs we use to understand them are not only perceptually and culturally based, but are embedded in rich cognitive models; (b) natural kinds such as minerals are not always simplistically definable in terms of necessary and sufficient conditions; (c) complex properties operate as holistic gestalts which are "more" than the sum of the primitive properties; (d) the objective values of defining features are only meaningful in terms of generally accepted standards or norms; (e) the "truth" of the values of defining features can only be verified in terms of generally accepted standards or norms; (f) defining features and categories are dependent on functional and contextual constraints.

In the textual material we studied for getting insight in the categories of the life sciences, we did not limit our observations to entities (as Zawada and Swanepoel did in their study of mineralogy), but rather we extended it to include other ontological categories such as properties, activities, general categories, structures, sets and facts (Grossmann 1992). In concentrating on activities and general or umbrella categories we were confronted with the impossibility of treating these categories within the classical framework. What we found is that not only is it impossible to abstract the prototype structure of these categories but there is also functional exploitation of the prototypical nature of the categories in language.

1.5.4 *M. Teresa Cabré*

In an article entitled 'On Diversity and Terminology' (1995) M. Teresa Cabré "aims to show the link of the concept of diversity with terminology"(1). She claims that "without diversity in things and their names and without the need to overcome this diversity through unification, terminology would be bereft of its raison d'être." (1). The aim of her article is " to show how the field of terminology is dominated by the notion of linguistic diversity in all its aspects, although, paradoxically, its purpose is to overcome diversity both by invoking theoretical principles which defy the test of falsification and by proclaiming unifying objectives which hide a large range of goals” (2).

She points out that “the reality of specialised subjects is a multifaceted configuration of many concepts which can be studied from many different points of view” (2–3). She refers to the fact that “the world of technical and scientific concepts to which the specialised terms refer are in constant evolution and thus permanently dynamic”(3). “Only by idealising the objects at the root of a theory is it possible to account for this diverse complexity”(3).

Most importantly she questions the validity of the traditional theory of Terminology: “The aim at absolute uniformity of scientific terms would be an artificial and utopian process unlikely to achieve its goal (i.e. that of unification)”(14).

She adds that she does not believe that there are many terminologists really pursuing this goal.

> However, and despite this view, there are still those who maintain that the **idealised theory of terms** is the reality, and there are those who defend the principles of traditional terminology of rigid separation of special subject fields, uniform structures for all subjects, the relation of univocity between denomination and concept, etc. These principles are today being critically re-examined by some groups whose work is as yet not properly recognised (14).

In concentrating on categorisation and naming in the life sciences we do not want to give most of the attention to the unification goal of Terminology (that aspect has been given all the attention in traditional Terminology). We are going to concentrate on the role language plays in both diversification and in unification in the discourse process of specialised language. Categorisation and naming are permanently dynamic (see Chapters 3 and 4).

1.5.5 *Ingrid Meyer*

Ingrid Meyer and her collaborators at the University of Ottawa also question some aspects of traditional Terminology.

In the first place Meyer concentrates on the importance of encyclopaedic as well as lexical-semantic knowledge in the development of technology for managing knowledge in terminology-intensive environments (Meyer 1992). She believes the intensional definition gives only the necessary and sufficient characteristics that would enable a specialist (i.e. someone who already “understands the term”) to identify the object in question as an example of a category.

Other users of terminology who consult a bank to find out about the meaning — as they do not understand the term used — need encyclopaedic information.

She highlights that Terminology has both a linguistic and a conceptual dimension and the general goal of Meyer's research is to develop a computer aid (Cogniterm) to facilitate the latter (1993).

Secondly, she deals with the problem of multidimensionality:

> a phenomenon of classification that arises when a concept type can be subclassified in more than one way (i.e. in more than one dimension), depending on the conceptual characteristic that is used as a basis for the subclassification (Bowker & Meyer 1993: 1).

> Conceptual categories can overlap in many ways, since any partitioning of reality is arbitrary to some degree (Skuce & Meyer 1990: 188).

Thirdly, she questions whether Terminology can optimise special language communication by promoting unambiguous communication and points out that alternatively the diversity and the possibilities for creativity and imagination in scientific research and thinking might become the object of study.

In this work we also explore some of Meyer's topics: the importance of encyclopaedic information in descriptions of categories (Chapter 3), the problems of multidimensionality of categories (see 2.2 and Chapter 3), and the exploration of the diversity of and the possibilities for creative thinking in scientific research and how and to what extend creative thinking is made possible because of language and how this is reflected in scientific terminology (see Chapter 5).

1.5.6 *Socioterminology*

In France and French-speaking Canada several researchers have been moving from structuralist, Wüsterian, prescriptive types of terminological activities to questioning some of the traditional terminological principles in a new trend which took the name *socioterminology* (Gaudin 1993).

Socioterminology, as its name implies, tries to get the study of terminology back to the study of real language usage. A descriptive approach to terminology is promoted, to replace the prescriptive objective of the traditional Terminology schools' approach.

> Son objet [de la socioterminologie] est l'améliorisation des connaissances sur les discours spécialisés, scientifiques et techniques, sur les aménagements de ces discours, sur les circonstances de leur élaboration (le codage et l'encodage)

> et sur celles de leur saisie (le décodage) et de leur reformulation (Boulanger 1995: 198).

First of all, the descriptive approach incorporates the study of synonymy and polysemy which goes against the traditional schools' ideal of monosemy. As a consequence Terminology becomes part of general semantics as it studies "les pratiques langagières non départagées entre la langue générale et la langue de spécialité" (Boulanger 1995: 197).

Boulanger summarises the traditional approach as follows:

> Plutôt que de reconnaître la polysémie naturelle et la pertinence de la synonymie, on cherchait à retirer au terme son droit à la variation, à la fois en ce qui regarde les aspect sémantiques (la polysémie) et en ce qui a trait à la variation lexicale (la synonymie). Bien entendu, ce réductionnisme lexical était recherché; il était évident que l'effort d'"univocisation" avait pour objectif de ramener la multiplicité des situations et des variations de communication à une situation singularisée et simplifiée au possible (Boulanger 1995: 196).

Secondly, socioterminology questions the existence of clear-cut fields or domains. "La pureté sectorielle n'existe pas." (Boulanger 1995: 198). Gambier (1991: 37) as mentioned in Boulanger (1995: 198) thinks it would be preferable to consider sciences and technologies as "noeuds de connaissances". Terminologists and linguists no longer want to cut up knowledge into homogenous parts which are clear-cut and well-protected from all exogenous influences. For Gambier (1991: 37) "Un 'domaine' est constamment le résultat de la dialectique entre l'intégration (interdisciplinaire) et la parcellisation (hyperspécialisation)".

Thirdly, socioterminology wants to get away from the synchronic structuralist and Wüsterian approach to the vocabulary of special language. If sciences are networks of inherited nodes ("des noeuds hérités du passé") instead of monolithic blocks, then the diachronic study of the history of conceptualisation and naming should be taken up. (Gaudin 1995).

In line with the socioterminologists we have been studying terminology in texts, which implies that we study *parole*, i.e. real language usage. We equally found examples of the functional advantages of polysemy and synonymy (see Chapter 4). We studied the impossibility of splitting up the life sciences into clear-cut subdisciplines (see Chapter 3). In the texts we investigated we equally found information about the diachronic development of terms and their understanding. Moreover we were able to assess the impact of cognitive models on metaphorical thinking (see Chapter 5).

1.5.7 *Kyo Kageura*

Kageura takes issue with the claim of traditional Terminology that it is a discipline separate from linguistics. He concedes that "the emphasis on 'concepts' repeated by those who claim the independence of terminology seems inherently right, because meaning is frequently understood as a property of the language system" (Kageura 1995: 253). He argues that, if one agrees to replace 'concept' by 'meaning' in the term-concept relation, there is no reason for the independence of Terminology from linguistics. Linguistics has known interdisciplinary developments and is more than the theoretical, system-oriented, synchronic micro-linguistics which it was at one time for the structuralist school. The emphasis of traditional Terminology is on the language system (*langue*). However, because of its special language orientation, it needs to shift to the study of linguistic realities (*parole*). Kageura believes that Terminology should be placed within the broader framework of linguistics, instead of being a separate discipline. Empirical studies of the terminology of different special languagess could contribute to a better understanding of semantic principles in language. Instead of insisting on the fact that *conceptology* (a better (?) term for the polysemous *terminology*) is an independent discipline which wants to distinguish itself, Kageura (1995) believes that "the relative status of terms, concepts and their relationships in conceptual descriptions of terminological phenomena is exactly the same as that of words, meanings and their relationships in semantic descriptions of words"(255). The reasons are (a) that semantics does not only study words semasiologically (i.e. from word to meaning), but also onomasiologically (i.e. from meaning to word(s)) (see also Geeraerts 1989: 81–82); (b) that the discipline of Terminology which claims to be able to study concepts as they exist in a world independent of language, needs language (i.e. the definitions to delimit a concept and the lexicalisations of new concepts by designating the concepts with a term). In the context of a scientific community meaning is negotiated. A concept is not really recognised as such nor taken seriously unless it is named by a term. Grasping a concept, or understanding it, is close to naming it.

In line with what Kageura suggests, in this work we are studying the *parole* of the *life sciences*. We will adopt both the semasiological (how is a term understood?) and the onomasiological (how is a category understood and named?) perspective. We will furnish proof for the fact that the strict delimitation of concepts may be successful for unambiguous and efficient communication in some situations but should by no means be taken as a general principle. The theoretical distinction proclaimed by Terminology between the conceptual aspect and the linguistic aspect of the communication frame in which terminology functions is artificial. If Terminology is not an aim in itself but wants to study how concepts develop and are referred to in special language communication, then a re-evaluation of its principles is essential.

1.6 Conclusion: Terminology needs to widen its scope

Broadly speaking we can say that in the totality of the above seven critical reactions against traditional Terminology, each of the five terminological principles discussed in Section 1.2 is questioned, as is shown in Figure 1.3. The criticism which has been formulated against the principles and descriptive methods of traditional Terminology are a first indication of the validity of our claim that the discipline of Terminology needs alternative principles and methods for the study and description of terminology.

1.7 Towards Sociocognitive Terminology

In the previous section we discussed some of the critical reactions which were formulated by a number of terminologists concerning the five principles of traditional Terminology we dealt with so far. In this final section of Chapter 1 we will summarise the critical issues which will be treated in our case studies on categorisation and naming in the life sciences.

In line with the suggestions of, for instance, Sager (1990) and the socio-terminologists (Figure 1.13) we have been studying the terminology of the life sciences in linguistic contexts, i.e. in textual information (see also 2.3). This means that we deviate from the first principle of traditional Terminology (see 1.2.1) which says that Terminology should study concepts independently before deciding on the ideal terms to name the concepts.

Many concepts are increasingly seen as being prototypically structured instead of being clear-cut and definable by a set of necessary and sufficient conditions. More complex means of identifying concepts have to be found. We replace the meaning approach by an understanding approach (see 2.1). Prototype structure is a viable method for structuring the understanding of a category

	principle 1 the concept is central	principle 2 concepts are clear-cut	principle 3 intensional definition	principle 4 monosemy	principle 5 synchrony
Sager	naming approach replaced by analysis of t. in a ling. context	complex relationships/ multi-dimensionality	non-specialists need ency-clopaedic information	monosemy is rare	term-formation is a process in time
Weissen-hofer	category approach instead of concept approach	categories have prototype str./ inferential features/ subject fields on a scale from high to low requirements of definiteness		depending on the nature of the subject field the requirements for unambiguous t. may vary	
Zawada & Swanepoel	classical concept theory is inadequate to account for the conceptual structure of the natural and pure sciences		defining features of mineral spe-cies are typi-cally attribu-tes of proto-type catego-ries/def: scalar cha-racteristics		
Cabré		the reality of special subjects: a multifaceted configuration of many concepts: it can be studied from different perspectives		aim of absolute uniformity of scientific terms is artificial process unlikely to achieve its goal	the world of technical and scientific concepts to which specialised terms refer are permanently dynamic
Meyer		multi-dimensionality arises when a concept type can be subclassified in more than one way/any partitioning of reality is arbitrary	intensional definition only enables specialists to object as an example of a category/ importance of encyclop. and lexical semantic information	dilemma: T. can optimise and promote unambiguous communica-tion, or T. can concentrate on diversity, creativity and imagination in scientific research	

socio-terminology	real language usage should be studied	clear-cut fields or domains do not exist		polysemy and synonymy should be studied	diachronic study of concep-tualisation and naming
Kageura	replaces 'concept' by 'meaning' and studies *parole* instead of *langue*	strict delimitations successful for unambiguous communica-tion in some fields			

Figure 1.3. *How five principles of traditional Terminology have been criticised by several terminologists.*

(see 2.3.2.2). We will consider how categories get defined in texts and analyse the information which is found in texts which aim at making categories understood. The fact that these definitions are very different from intensional definitions is evidence for Sager and Meyer's claim that intensional definitions are aimed at specialists who already understand a term and know the category, but that non-specialists need encyclopaedic information in order to understand. To understand a category is part of understanding the frames or idealised cognitive models the category belongs to (Chapters 4 and 5).

Encyclopaedic information and semantic information cannot always be clearly distinguished. Understanding does not usually happen via essential characteristics and relationships, but via 'nodes of knowledge', which can have varying levels of complexity, depending on how detailed the understanding is or needs to be in a specific situation. Traditional definitions have to be diversified and other means of representing the content of concepts have to be developed.

In our corpus of texts from the life sciences we have been looking for monosemous and polysemous terms. For the traditionalists a polysemous term is a contradiction as — by definition — a term should be monosemous. We have found that monosemy is rare and have tried to find explanations for this fact. Weissenhofer has suggested that depending on the nature of the subject field the requirement for unambiguous terminology may vary. We will demonstrate that different types of categories have different requirements in this respect. We have been trying to find answers to the question formulated by Meyer whether Terminology can optimise understanding by promoting unambiguous communication or whether Terminology should investigate and find models to describe diversity and possibilities for creativity and imagination in scientific research and thinking. The case studies we have been concentrating on give us evidence for the second alternative. The functionality of polysemy and synonymy should not only be recognised but Terminology should also provide models for the description of frameworks of understanding, apart from the logical and ontological ones which are so much part of the objectivist tradition in which traditional Terminology has to be situated.

From the texts we studied it is possible to furnish proof of how figurative language is part of creative thinking and understanding. There is no point in claiming that everything which can be expressed figuratively can be expressed literally as well. It is essential to study the role of metaphorical frames (Fillmore 1976 & 1985) or metaphorical Idealised Cognitive Models (ICMs) (Lakoff 1987) in term creation.

To study terminology in *parole*, i.e. in the communicative environment of textual information, opens up the possibility for keeping track of the evolution of a term's meaning. It provides information on polysemy and synonymy and may yield data on the functionality of these phenomena in the history of conceptualisation, naming and understanding.

If the foremost functions of language are knowledge representation and communication, the technical and sociological conditions which permit and encourage or restrict particular acts of knowledge generation and communicative situations should be studied. Phenomena like power and sponsorship have an impact on lexicalisation in special language. Standardisation is only one example of this. All relevant factors, should be studied systematically. Terminology should not blindly accept standardisation, it should question and examine the phenomenon both sociologically and historically.

1.8 Summary

In Chapter 1 we have pointed out that the principles and methods of traditional Terminology coincide with the principles and methods for the standardisation of terminology. We have claimed that traditional standardisation-oriented Terminology should widen its scope. Terminology has a field of study: the vocabulary of special language. It aims at providing a theoretical framework which can be translated into principles and methods for the description of this special language vocabulary. This theoretical framework needs constant revaluation. We believe that some of the insights of the cognitive sciences (prototypicality, cognitive models, analogical understanding and diachronic analysis) should be incorporated into the principles and methods for terminology description. We aim at proving the relevance of these theoretical concepts to the description of terminology by studying categorisation and naming in a corpus of texts on the life sciences.

CHAPTER 2

New Propositions for Terminology

> Not words for things, but words which are living things with the power to move (Jeanette Winterson, *Art and Lies*).

The five principles of traditional Terminology schools that we discussed in Chapter 1 can be reduced to four key issues: *conceptualisation/ categorisation, naming or lexicalisation*, *metaphorical models,* and *the diachronic study of categories.* For each of these we found evidence in the special language of the life sciences. They are dealt with in Chapters 3, 4 and 5.

In this chapter we present aspects of the theoretical framework within which we have been working. We formulate alternative principles for a descriptive sociocognitive Terminology and we explain about the methodologies we applied when studying the terminology of the life sciences.

Before formulating alternative principles and methods for a theory of Terminology we should make it clear that we want to avoid a 'meaning' approach in the sense given to this by traditional Terminology. Traditional Terminology takes the *concept*, which is said to be the *meaning* of the *term* as its starting point. We prefer to replace it by an 'understanding' approach which implies that the *term* is considered the starting point for discovering categorial attribution.

Meaning is a confusing polysemous term in general language, but also in the special language of *semantics*, which is "generally defined as the study of meaning" (Lyons 1977: 1). Lyons distinguishes between three types of meaning, which correlate with three functions of language: the descriptive, the social and the expressive. For the descriptive meaning of utterances other terms have been used like *referential*, *cognitive*, *propositional*, *ideational* and *designative*. The social and the expressive meaning have been subsumed under a single term by many authors: *emotive*, *attitudinal*, *interpersonal*, *expressive* (Lyons 1977: 51). In traditional lexical semantics words and other expressions were held to be signs which signify or stand for other things. The distinction is made between (a) the sign (the word, the *signifiant*), (b) the concept (the *signifié*) and (c) the referent (Ogden and Richards) or significatum, the individual object in the world. The problem, which is solved differently by different authors, then becomes: is the meaning of a word (a lexeme) the concept or the individual object in the world. Distinctions are made between, on the one hand, *meaning* and *sense* (for Lyons *sense* is cognitive or descriptive meaning), and on the other hand, *sense* and *reference*. (Lyons (1977: 197) gives Frege's example of *The Morning Star is the Evening Star* which have the same referent but not the same sense).

In traditional Terminology the *concept* and not the *term* or the *word* is taken as the starting point for meaning description. The concept is considered the meaning of the term (see Section 1.2). Traditional terminologists believe one can know the concept, which exists objectively, define it, and name it with a term. It is on that basis that the meaning of a term can be said to be the concept.

We shall study the *understanding* of both some extra-linguistic conceivable reality and of lexical elements. Testimony of how *the world* is understood and of how *words* are understood is to be found in texts (*parole*), which are produced by one or more individuals and are therefore subjective. In concentrating on understanding, the (artificial) distinction between the cognitive or ideational and other aspects of traditionally defined *meaning* in textual communication will prove to be irrelevant. Texts provide data on how particular authors understand elements of the world, how they understand the existing lexical items which serve to communicate about these elements of the world and how they may be brought to the creation of new lexical elements.

Geeraerts (1993a) suggests that in contrast with what is traditionally believed *meanings* do not exist. His critical evaluation of the operational tests for distinguishing between vagueness and polysemy which results in the conclusion that no stable operational test exists, makes him suggest that the criteria which were considered to be criteria for deciding that polysemy exists are actually criteria of distinctness of meaning. He suggests that we change our metaphorical, pre-theoretical image of what *meanings* are. He points out that *meanings* are generally seen as entities or entity-like things, "presumably stored somewhere in the big storage room that we conceive the mental lexicon to be, to be carried by word forms to an interpreter who unpacks and understands them." (Geeraerts 1993a: 259). The metaphorical image schema behind this is that of reification: “meanings are things, pre-packaged chunks of information that are contained in and carried about by word bags” (259). Geeraerts suggests that we replace the reification picture by the image of a **floodlight,** i.e. replace “meaning as things” by “meaning as a process of sense creation”: “words are searchlights that highlight upon each application, a particular subfield of their domain of application” (260).

Geeraerts also raises the question of whether meanings are phenomena which are objectively out there, so that they can be discovered, or whether meanings are subjectively construed by the interpreters? “Are meanings found or are they made?” he asks (260). He suggests that if we “abandon the vestiges of objectivism in our methodological self-conception, the presupposition that there is a unique meaning itself can be rejected”.

Firstly we have been interpreting the *meaning* of the terminology in texts written by specialists in the life sciences. Whatever conclusions we draw, whatever inferences we make, will be based on our own understanding of the terminology. Secondly we have been interpreting the testimonies of specialists about their interpretation of terms and their motivation for naming categories with a particular term. Both types of information, our own inferences concerning meaning, i.e. our own understanding, and the information concerning the specialists’ understanding of terminology and of naming, have been drawn from textual material.

If, as Geeraerts suggests, the *prototype* (see 2.4.2.2) would have to be thought of as an interpretative perspective that helps us to interpret the uses of a word, then the link with the tradition of hermeneutics, which stresses that the methodological characterisation of the human sciences (explicitly including linguistics) is based on processes of interpretation rather than on the objectivist methodology of the natural sciences, is clear. It is one of our aims to show that even though the methodology of (in our case) the biological sciences may be objectivist,[12] there is no objectivist model to be discerned in the way their language develops.

The set of problems touched upon here also extends towards ideas of philosophy of science found in e.g. Kuhn and Feyerabend which state that all scientific thinking starts from perspectivist assumptions (see Section 2.3).

In Section 2.1 we first formulate three propositions for an alternative

12. Even though this was not the objective of our research we came across examples of subjective motivations for research in the field of the life sciences. (see Myers, G. 1990)

Terminology. Then, in Section 2.2 we explain and justify our research methods. First we explain our method of data gathering (2.2.1), then we explain how our research is to be situated in the research tradition on special language (2.2.2). In Section 2.2.3 we explain about document types and textual archives and in Section 2.2.4 we distinguish between archives and corpora. In Section 2.3 we concentrate on the basic theoretical insights for our research: hermeneutics and the structuralist and the cognitivist interpretation of the semantic triangle. Finally Section 2.4 explains the essence of four key issues of Terminology. These four key issues allow for perspectives which are familiar in semantics. The first issue (definitions of units of understanding) is addressed from a semasiological perspective. The question is: how is term x understood? In order to assess the understanding of particular terms by specialists we particularly consider their *reflective text fragments* in publications in which they attempt to describe or define what their understanding of the term involves. The second issue (univocity or polysemy) is first approached from an onomasiological perspective. The *naming* of units of understanding is investigated by looking for implicit and explicit motivations given by specialists for their naming of a particular unit of understanding by a particular term. The naming approach is supplemented by analysing the history of a particular term (cloning) and reconstructing the circumstances in the history of biology when this particular term was assigned to different but related categories. Onomasiologically, this sheds light on possible origins of polysemy. Semasiologically considered, the *cloning* case (Chapter 5) yields information on the evolution of meanings of words (*signifiants*). The third and fourth key issues (metaphorical understanding related to naming and the diachronic perspective) link the semasiological approach to the onomasiological approach in trying to understand the motivations for the assignment of existing terms to new or modified units of understanding and exploring the potentials and limitations of a particular *signifiant* in an incessantly changing world.

2.1 New propositions for an alternative Terminology

Our propositions for an alternative theory of Terminology start from the insight that words can not ‘mean’ objectively, but rather that they can be understood in a linguistic communication process about a reality outside language which has to be understood as well.

2.1.1 *Conceptualisation and Categorisation*

Our propositions on conceptualisation/categorisation refute the second and third principles of traditional Terminology (see 1.2.2 & 2.1.2.3).

From definitions in texts it is possible to find support for *proposition one: the prototype structure hypothesis is viable for the structuring and understanding of a category*.

Many units of understanding in the life sciences have prototype structure (see 2.3.2.2). Some categories do not show prototype structure. They are understood in a logical or ontological structure and could therefore be considered *concepts* as defined by traditional Terminology. All the other units of understanding which show prototype structure are *categories*. Not all categories show the same degree of prototypicality.

The characteristics underlying prototypicality are contained in what is traditionally called the encyclopaedic information, i.e. non-definitional information. Traditional encyclopaedic information appears to be essential information in the definition of categories. Instead of distinguishing between definitional and encyclopaedic information, we therefore propose to discern levels of essential information ranging from most essential to least essential. The order of 'essentialness' is relative. Encyclopaedic information is structured in several elements of the cognitive model: in the core definition, in the historical information, in facets of the content of a unit of understanding and in the perspective from where the unit of understanding is seen. There appears to be a convergence between the type of category and the degree of prototypicality, which may be applicable for practical use in terminography. This whole issue is treated in more detail in Chapter 3.

2.1.2 *Naming*

Our proposition on naming refutes the fourth and fifth principle of traditional Terminology (see 1.2.4 & 1.2.5). In traditional Terminology the ideal of monosemous vocabulary is taken to be the prerequisite for unambiguous (which implies allegedly scientifically proven efficient) communication. Polysemy and synonymy are believed to be obstacles for unambivalent communication and therefore restraints should be imposed on their uncontrolled proliferation in special language communication.

From factual information in texts it is possible to find support for *propo-*

sition two: monosemy is sometimes functional in special language but so are polysemy and synonymy.

Concepts lacking prototype structure have a natural tendency towards univocity. Categories which are prototypically structured are often polysemous and show synonymy. Polysemy is the result of meaning change over time. Why words grow into polysemy can be explained from prototype structure. For prototypically structured categories polysemy and synonymy are *functional* in the process of understanding. This is treated in more detail in Chapter 4.

2.1.3 *Metaphorical models*

Our proposition on metaphorical models[13] refutes the first principle (see 1.2.1) which separates language from conceptualisation. In the words of Wüster (1991: 1–2):

> Fur sie die Terminologie erschöpt sich die Bedeutung einer Benennung in der Sachbedeutung, auch Begriffsbedeutung genannt. Die Mitbedeutungen fallen in der Regel fort.

From factual information in texts it is possible to find support for *proposition three: metaphorical models link the language system to the world of experience and to the functioning of the mind.*

One of the functions of metaphorical models is to facilitate thought and expand the understanding of the world which can be expressed through language. This is treated in more detail in Chapter 5.

2.2 Methodology

In this paragraph we explain why and how we looked for information on categorisation and naming in texts on the life sciences. In Section 2.2.1 we

13. The use of figurative language like metaphorisation is one way of arriving at motivated naming. The following quote shows how traditional Terminology is phobic about this phenomenon. “Motivation. Voilà une qualité désirable, mais qu’il faut éviter de rechercher à tout prix. Au contraire, quand la motivation s’appuie sur des rapports sémantiques dérivés de la langue commune, elle peut être nuisible, car elle aura tendance à encombrer le néonyme de connotations qui n’ont rien à voir avec la notion à exprimer” (Rondeau 1984: 135).

show how our approach to gathering data differs from other approaches. The traditional ways of studying special language are dealt with in Section 2.2.2. What the impact is of different document-types on terminology and how this can be studied in textual archives is the subject of Section 2.2.3. Finally, in Section 2.2.4 the distinction between archives and corpora is discussed.

2.2.1 *Data gathering*

The empirical data we came across when studying special language texts concerning the life sciences will serve to validate the criticism of the principles of the traditional Terminology schools. There are at least two reasons why we chose to study the vocabulary of the life sciences: it is a recent and quickly progressing domain in science and its results are the consequence of interdisciplinary approaches. Because most of the results in the life sciences are recent it is relatively easy to trace the origin of a new development and to see how it quickly progresses. It is possible to find the very first publication in which a new development is discussed and the publications which followed the very first one can be traced back as well. Whereas in general language one often finds it impossible to trace back the first attestation of a category, this proves to be easier to do for the new categories in the life sciences. The interdisciplinary character of the life sciences make their vocabulary an interesting test field for studying categorisation and naming. Categories are approached from several perspectives and one can observe the effect of this fact on lexicalisation.

This method of looking for evidence on categorisation and naming in texts differs from most existing research on the subject of categorisation and naming. Traditionally, issues of categorisation and naming were studied via introspection (e.g. Lyons 1977) or through elicitation of data via tests and surveys (e.g. Rosch 1978; Gentner 1988) or by studying a corpus of categories in context from which the meaning is then derived (e.g. Geeraerts et al. 1994). Our method is a modification of the third approach. The limiting aspects of introspection as the basis for linguistic studies have been discussed by Geeraerts (1989a:41–42). For our objectives of studying the language of the life sciences the method of introspection was not realistic, since we are not trained molecular biologists or genetic engineers and we have never been actively involved in these disciplines. A trained life science specialist might be in a positions to take his own insights and judgements on the understanding of terminology as the source of inspiration, but even then the value of the information gathered as such for the purpose of this research may be seriously questioned. Elicitation of data via tests and surveys becomes interesting if one needs to find out about detail questions. For a discussion of the fact that the conscious reflection about language in data elicitation may yield unreliable results we refer to Geeraerts (1989a: 41–42).

We needed a modification of the third approach: the study of categories in a corpus of texts, appropriate for our objectives: to study the definability of units of understanding, their naming, their development in time, and the role of metaphorical models in the growth of knowledge. We have been looking for the history of conceptualisation/categorisation and of naming of particular concepts/categories in texts. In the texts our case studies rely on, subject specialists explain how new categories come into existence and comment on the naming of new categories, i.e. they explain the lexicalisations and in doing so spontaneously reflect on categorisation and naming.

The fundamental question we are trying to find an answer to is: do the new categories as they are being created, indicate a conceptualisation model of feature comparison in order to give the emerging category a place in a concept system as the structuralist model of meaning suggests, or can other scenarios be observed?

2.2.2 *The special language of the life sciences*

A special language can be defined as the collection of spoken and written discourse on a subject related to a discipline (Hoffmann 1984; Ahmad & Rodgers 1992, 1994; Kocourek 1982; Sager et al. 1980). The discourse we have been studying was restricted to written sources. We have limited the study material for the language of the life sciences to written texts produced by subject specialists. The senders of the message are subject specialists, the potential readers are either specialists or a wider audience such as students, interested laymen, etc. This means that apart from hard-core scientific publications, such as articles found in *Nature* or *Science*, popularised literature was considered as well. The complete list of publications that make up our corpus is contained in the bibliography. We are not concerned with the possibility that individuals may categorise or understand things in their minds without making use of language but with what understanding means with regard to terms and categories in the special language of the life sciences. In order to communicate about the categories one understands, one needs language. What one can understand for oneself needs to be rendered in language in order to communicate it and find out whether others understand it in the same way. Communication is a constant process of trying to make explicit what one understands about the world in order to make this clear to others. This can happen in a number of communicative situations. We can distinguish between these communicative situations depending on the categories the sender and the receiver of the message belong to.

In the literature, special language is classified according to a horizontal and according to a vertical principle (Hoffmann 1984: 58; Kocourek 1982: 30). The **horizontal classification** is about the domain of activity. Classification systems like the UDC system, attempt to divide knowledge into domains. There are delimitation problems between subdomains and the number of subdomains can be very high. If each domain is supposed to be discussed in a sublanguage, an additional problem is coming up with a possible hierarchy as not all sublanguages are on the same level and a further classification of sublanguages can be envisaged according to rather arbitrary criteria.

For Hoffmann (1984: 65) a **vertical classification** is based on four principles: (a) the level of abstraction, (b) the 'type' of language, i.e. the natural or artificial way of expressing syntax elements, (c) the environment i.e. the requirements imposed by e.g. the type of publication, and (d) the participants in the communication.

In line with the horizontal classification of special language we prefer to keep the indication of the subject we want to study rather vague. The classification of the subdisciplines of the life sciences is very problematic. There is a lot of overlap between biotechnology, microbiology, biochemistry, molecular biology, genetics, biochemical genetics, molecular genetics, genetic engineering, recombinant DNA technology, genetic science, etc. As much as the labelling of subdisciplines is sometimes clarifying and to the point, it is also limiting as most phenomena and activities undertaken within the life sciences are multifaceted (Meyer 1992 & 1993; Sager 1990). In order to illustrate this point we shall give the example of how a specialist classifies *microbiology*.

> The biological sciences are subdivided by the kind of organisms being studied (bacteriology, botany, mycology, zoology, virology), the scientific approach (ecology, genetics, immunology, molecular biology, physiology, systematics), or the applications (agriculture, industry, medicine). Microbiology is an "artificial" classification based on the microscopic size of the life forms, which include bacteria, microfungi, protozoa, unicellular algae, and viruses.

> However, even more than by the size of the subject matter, the study of this diverse group is distinguished by the methods used to study them, techniques first developed by Louis Pasteur and Robert Koch in the nineteenth century. […]
>
> The tools and techniques of microbiology form the foundation for much of modern biology and medicine. Contemporary biologists classify their disciplines with a bewildering array of hybrid rubrics such as fungal genetics, protozoan systematics, clinical microbiology, industrial mycology, and bacterial ecology (to name only a few), which reflects the diversity of specialties which rely on microbiological expertise. Nowadays, many scientists who work with microbial systems do not call themselves microbiologists at all but choose a name like biotechnologist, biochemist, molecular biologist, infectious disease specialist, public health worker, or chemical engineer. […]
>
> The widespread use of either microbial systems or microbial techniques means that the exact circumscription of microbiology as a science is difficult. Simultaneously, the wide scope ensures that the study of the smallest living things is one of the greatest of the biological sciences (Joan W. Bennett. Academic Press Dictionary of Science and Technology 1992: 1372).

Bennett is trapped in confusion because of the distinction between how she really understands *microbiology* and her culturally inflicted belief about how one *should* understand in order to define. This tradition is reflected in conventional dictionary definitions: meaning relationships are described primarily on the linguistic level. In trying to define her discipline she believes she should be able to classify it as a type of (logically) or as a part of (ontologically) a superordinate category. The obvious superordinate category is *biology* but the facet on which the subclassification is based is impossible to bring into line with the other subfields of biology.

There are several possibilities for dividing *biology* into subdisciplines (Figure 2.1). Bennett points out that biological sciences are divided by: **the kind of organisms being studied** (bacteriology, botany, mycology, zoology, virology) **the scientific approach** (ecology, genetics, immunology, molecular biology, physiology, systematics) and **the applications** (agriculture, industry, medicine). She does not know how to classify *microbiology*, defined in the alphabetical part of the dictionary (i.e. not in her window essay) as

> the scientific study of organisms too small to be seen by the naked eye, including protozoans, algae, fungi, bacteria, viruses, and rickettsiae. (1372).

In Bennett's description *microbiology* is an

> 'artificial' classification based on the microscopic size of the life forms, which include bacteria, microfungi, protozoa, unicellular algae, and viruses (1372).

Their *size* brings this diverse group of life forms together to be studied under the heading of the *discipline* of *microbiology*. The size of what is being studied yielded the motivation for lexicalisation. But, according to Bennett, even more than the size of the life forms, it is the methods for studying them which brings them together in the discipline of microbiology.

> However, even more than by the size of the subject matter, the study of this diverse group is distinguished by the **methods** used to study them, techniques first developed by Louis Pasteur and Robert Koch in the nineteenth century (1372).

She then goes on to claim that:

> The **tools** and **techniques** of microbiology form the foundation for much of modern biology and medicine.

Bennett is attempting to foreground and define *microbiology*. She therefore makes an inventory of the facets (aspects, attributes) on the basis of which subclassifications of the science of biology are made and lexicalised. She finds three: the **kind of organisms** being studied, the **scientific approach** and the **applications**. These three attributes, which can each have several values are of no use for the classification of *microbiology*. The problem is twofold: *microbiology* does not fall under the three attributes mentioned, and *microbiology* is **enmeshed with** several, if not all of the disciplines given as values of the three attributes.

It is highlighted that a subclass based on a different facet, which in this case gave rise to lexicalisation (to study the very small is the motivation for the lexicalisation *microbiology*), can not be placed next to other subclasses based on facets like *the kind of organism being studied, the scientific approach, the application* in a logical classification.

Of course one could imagine an extra category under the attribute: 'by the size of the organism being studied', of which *microbiology* would be the only value, as *the study of large organisms* is not a category which is recognised as a discipline at present and is therefore not lexicalised.

Two phenomena are striking: hybrid rubrics for disciplines which appear to merge in pairs (Figure 2.2) and names for professions which do not have a one to one relationship with the discipline (Figure 2.3).

Bennett feels the hybrid rubrics for disciplines to be factors which further complicate her attempt at logical classification.

This leaves Bennett with the perplexing reality that the subdiscipline of *biology* which she is trying to define (*microbiology*) can not be classified either logically or ontologically in a concept system in which the other subdisciplines figure. What makes matters even more complex is that contemporary biologists classify their discipline "with a bewildering array of hybrid rubrics such as fungal genetics, protozoan systematics, clinical microbiology, industrial mycology, bacterial ecology" (Figure 2.2).

Moreover "many scientists who work with microbial systems do not call themselves microbiologists, but choose names like: biotechnologist, biochemist, molecular biologist, infectious disease specialist, public health worker, chemical engineer" (Figure 2.3).

All this proves that as a consequence of the different perspectives for categories, there is overlap between categories and the choice for one

How Biological Sciences are Divided	by the kind of organisms being studied	bacteriology botany mycology zoology virology
	by the scientific approach	ecology genetics immunology molecular biology physiology systematics
	by the applications	agriculture industry medicine

Figure 2.1. *Bennett's taxonomy of biological sciences based on three different facets.*

Examples of hybrid rubrics for disciplines in biology reflecting the diversity of specialties relying on microbiological expertise	**fungal genetics** **protozoan systematics** **clinical microbiology** **industrial mycology** **bacterial ecology**

Figure 2.2. *Hybrid rubrics relying on microbiology (Bennett).*

lexicalised category over another in a particular experiential environment is inspired by other factors than those which might allow for logical and/or ontological classification of the category.

microbiologists choose names like	**biotechnologist** **biochemist** **molecular biologist** **infectious disease specialist** **public health worker** **chemical engineer**

Figure 2.3. *Professional names for microbiologists (Bennett).*

The analysis of Bennett's reflective text fragment leads to four observations.

(a) The conceptual category *biology* can be subdivided in many ways. The reason why is that any partitioning of reality is arbitrary to some degree. The complex, multidimensional "layerings" of concept relations that result are "virtually impossible to represent" (Skuce and Meyer 1990: 188).

Yet, these multidimensional layerings of concept relations are a reality terminographers and specialised dictionary makers are confronted with. Traditional Terminology offers only one reductionist approach for describing or representing this multidimensional reality: logical or ontological structuring.[14]

(b) Defining texts are self-centred. The vantage point for seeing other categories is the category under definition itself. The putative influence of microbiology on other disciplines is made clear in the following quote:

> Basic research by microbiologists has led to enormous advances in *immunology* and *genetic engineering*. Microbes can be genetically altered and used as hosts for the production of a wide range of hormones and proteins of medicinal and industrial value. *Diagnostic medicine* has been revolutionarized. Cloning techniques developed in bacteria are used for applications as broad as the dissection of the human genome and the analysis of DNA from long dead species. (1372)

It is noteworthy that the reflective text fragments defining other disciplines show this same self-centredness. This leads to apparent contradictions, e.g.

14. Bowker (1995) develops and tests a multidimensional approach to terminological classification that can be applied within a computational framework. She explores the phenomenon of multidimensionality, investigating some of its potential causes.

recombinant DNA technology is claimed as **their** invention by geneticists, molecular biologists, and biochemists. A considerable degree of subjectivity has to be recognised.

(c) Bennett explicitly recognises fuzziness in categorisation when she writes:

> The widespread use of either microbial systems or microbial techniques means that *the exact circumscription of microbiology as a science is difficult.* (1372)

This is a good reason for looking into the possible prototype structure of the category (see Section 2.3.2.2).

(d) It is clear that logical classification or taxonomy (x is a type of y) just like ontological classification or meronymy (x is part of y) are pervasive cognitive models in science according to which categories are structured. But, even though logical and ontological classification are pervasive in attempted objectivist classifications, it is a simplification to reduce the conceptual analysis of scientific fields to taxonomic and meronymic classifications as traditional Terminology does. Not only do we rarely find examples of clear-cut 'type of' or 'part of' relationships, the lexicalisation of a new discipline in the life sciences can be based on more complex or different relationships than logically or ontologically inspired ones.

As problems of exact delimitation are precisely the problems we are dealing with here, we do not want to specify the subject of the terminology that we have been studying any further. We shall, however, further limit our object of study, based on the vertical classification principles.

2.2.3 *Document types and textual archives*

As we previously explained, we have limited the authors of the documents under consideration to specialists dealing with their subject in written discourse. The document types we shall be concerned with are: specialised articles, specialised books, papers at specialist conferences, specialised encyclopaediae, dictionaries, and popularising books written by field specialists. This implies that not only are the texts written by field specialists, but that the potential readers of the text are mostly specialists as well.

Whether a text will be considered special or not will depend on the content of the text. Specialised communication, like communication in general, presupposes a sender, a receiver and a message. This message can have a multitude of forms (reports, articles, speeches, laboratory conversations, books, etc.), the style and the format of which will differ depending on the characteristics of the sender and the receiver of the message.

This medium (e.g. a learned journal, an academic textbook, a paper presented at a conference, etc.) will impose formal and content-related restrictions. The language used by the members of these various discourse communities is recorded in what Ahmad and Rogers (1994: 2) call the "textual archives of their [i.e. the discourse community's] common interest". In many ways such archives provide evidence about the occurrence and use of specialised vocabulary .

The type of information that we have been looking for in textual archives in the first place is related to the four key issues we have been concerned with: conceptualisation/categorisation (Chapters 3 and 4), naming (Chapters 4 and 5) metaphorical models (Chapter 5), diachronic development (Chapters 4 and 5).

We shall also look for the history of conceptualisation in textual archives. One aspect of this is how specialists communicate about their concepts, disagree, argue, distort and misuse language and beat it into next patterns in trying to come to understanding (Feyerabend 1993) (see 2.3.1.2).

2.2.4 *Archives and corpora*

Depending on the nature of the problem one is trying to solve, a strategy will have to be developed for extracting relevant information from the texts available in the archive. The textual archive of the life sciences (as of any other domain) is a virtual concept as it is not only impossible nowadays to collect everything which has been recorded on the subject. Even if one were able to accomplish this, the processing of all the information for the purpose of studying categorisation and understanding would be an impossible task to accomplish. Therefore we will introduce the concept of *situational archive* here. Our *situational archive* is the totality of all the textual material that we came across in our attempt to familiarise ourselves with life sciences-related subjects in trying to find evidence for our propositions on categorisation and naming in special language. Details of the texts contained in our archive can be found in the bibliography. When documents or fragments of texts are selected with a particular criterion in mind, and when they are evaluated, selected and organised in a systematic way according to explicit criteria, we end up with a situational corpus, a body of texts. Our situational archive is rather diversified, but for each case study we have narrowed it down to a manageable size determined by the nature of the argumentation we were developing.

2.3 Theoretical Foundations

The paradigms upon which we have been expanding are hermeneutics (2.3.1) and the cognitivist approach in semantics (2.3.2).

2.3.1 *Hermeneutics*

We have already indicated that our method links up with hermeneutics. We see hermeneutics as a theory underlying the methods for studying texts.[15] In our case this method provides the understanding of what conceptualisation or categorisation involves, what role lexicalisation plays in this and what the role of language is in new understanding. All this information is in the texts. For example, in order to study how specialists explain how they understand their concepts, define and name them, and how they categorise we decided to select what we call reflective text fragments (see Section 2.2.2) from our situational archive. We ended up with text fragments which we believe to be representative for the clarification of the problem at stake. In the tradition of hermeneutics *Verstehen* was a consequence of text interpretations.[16]

The reason why we claim that our first line of thought links up with hermeneutics is that we concentrate on textual information in order to find out about categorisation and its intricate relation with language. The testimony of how language exists (*parole*) is in the textual archives.

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15. Ricoeur (1981: 43) adopts the following working definition for *hermeneutics*: “hermeneutics is the theory of the operations of understanding in their relation to the interpretation of texts”.

16. Geeraerts (1995: 184) refers to the origin of hermeneutics as a theoretical enterprise in the course of the 19th century: “…hermeneutics is a philosophical tradition, inaugurated by Wilhelm Dilthey at the end of the previous century, that takes interpretation to be the basic methodological concept of the human sciences (Geisteswissenschaften).”

2.3.1.1 *Postmodernism and hermeneutics*

Reacting against rationalism, the postmodernist era goes back to hermeneutics. Postmodernist philosophers and theorists of science have reacted against structuralism, which they see as a last consecration of rationalism. In doing so the tradition of hermeneutics is brought to the fore. An example is Derrida's reaction to structuralism: deconstruction, which returns to the old tradition of text analysis. Deconstruction, an offshoot of post-structuralism, has often been accused of "relativising everything".

The post-modern philosopher Jacques Derrida has waged a one-man "deconstructionist" war against the entire Western tradition of rationalist thought. He says reason has been shaped by a dishonest pursuit of certainty which he diagnosed as logocentricism: "the word by which the inward thought is expressed" (1976) or "reason itself". Logocentricism desires a perfectly rational language that perfectly represents the real world. Such a language of reason would absolutely guarantee that the presence of the world — the essence of everything in the world — would be transparently (re)present(ed) to an observing subject who could speak it with complete certainty. Words would literally be the Truth of things. Pure communion with the world is the seduction of logocentric Reason. Derrida warns that it is a nightmare. The certainty of reason is a tyranny which can only be sustained by the evil of repression or by excluding what is uncertain, what does not fit in, what is different. Reason is indifferent to the other. Derrida is outraged by the totalitarian arrogance implicit in the claims of Reason. Against the essentialist notion of certainty of meaning, Derrida mobilises the central insight of structuralism — that meaning is not inherent in signs, nor in what they refer to, but results purely from the relationships between them. He draws out the radical 'post-structuralist' implications of this point — that structures of meaning (without which nothing exists for us) include and implicate any observers of them. To observe is to interact, so the 'scientific' detachment of structuralists or of any other rationalist position is untenable.

Derrida says there is nothing outside the text. He means text in the semiological sense of extended discourses, i.e. all practices of interpretation which include, but are not limited to, language.

Structuralism was incorrect in supposing that anything reasoned is ever universal, timeless and stable. Any meaning or identity (including our own) is provisional and relative, because it is never exhaustive, it can always be traced further back to a prior network of differences, and further back again, almost to infinity or the "zero degree" of sense. This is deconstruction — to peel away like an onion the layers of constructed meanings.

Deconstruction is a strategy for revealing the underlayers of meanings 'in' a text that were suppressed or assumed in order for it to take its actual form — in particular the assumptions of 'presence' (the hidden representations of guaranteed certainty). Texts are never simply unitary but include resources that run counter to their assertions and/or their authors' intentions.

Meaning includes identity (what it is) and difference (what it is not) and it is therefore continuously being "deferred". Derrida invented a word for this process, combining *difference* and *deferral* (to make conform, to subject) — "différance".

> … différance, an economic concept designating the production of differing/deferring. (Derrida, (1967)1976: 23)

Derrida has tried to extract a positive benefit from the disillusioning failure of a structuralist metalanguage. In so doing, he has left himself open to accusations of relativism and irrationalism. He has been accused of rejecting reason whereas he only rejected its dogmatic representation of itself as a timeless certainty. He has been accused of saying that nothing is real because everything is only a cultural, linguistic, or historical construct. What he is actually saying is that nothing is any less real for being cultural, linguistic or historical, especially if there is no universal or timeless reality to which it can be compared. He has been accused of saying that there are an infinite number of meanings whereas what he really said is that there is never just one. He has been accused of saying that everything is of equal value, whereas he only says that the question must remain open (Derrida 1976: preface).

Geeraerts (1993b) has pointed out what the convergence and divergence is between the Cognitive Semantics epistemology and Derrida's view. In his analysis Cognitive Semantics diverges from Derrida because it rehabilitates (a) the epistemological function of individual entities within a structure in prototype theory, (b) the epistemological role of the individual subject in experientialism, and (c) the notion of *preferred interpretation* as a result of the dynamic flexibility of prototypical categories which constrains the set of possible interpretations (see also 2.3.2.2).

2.3.1.2 *Relevance for the methodology of Terminology*

Considering that in present-day epistemology it is no longer taken for granted that categories exist before they get named,[17] Terminology might want to study, i.e. to question the intricate relationship between language and categorisation. As Feyerabend writes:

> theories become clear and reasonable only after incoherent parts of them have been used for a long time. […] When we attempt to describe and to understand developments of this kind in a general way, we are, of course, obliged to appeal to the existing forms of speech which do not take them into account and which must be distorted, misused, beaten into next patterns in order to fit unforeseen situations (without a constant misuse of language there cannot be any discovery, any progress) (Feyerabend 1993: 17–18).

Whereas many important 20-century thinkers (Russell, Wittgenstein, Heidegger) shifted their focus of analysis away from ideas in the mind to the language in which thinking is expressed, traditional Terminology did the opposite.

In a framework of structuralism[18] in which it is believed that the *structure* of language permits meaningful thinking, standardisation tries to break the link between thinking and language. In structuralism, signification is the process which binds together the signifier and the signified to produce the sign. In traditional Terminology it is not this binding process which is given priority but the separation of the two is forced. It is believed that — ideally — there is not a natural process of binding together the signifier and the signified, but a conscious intervention of a specialist or a terminologist who is going to assign the ideal name to the concept. Man is interfering, and he uses the insight that

17. "It is often taken for granted that a clear and distinct understanding of new ideas precedes, and should precede, their formulation and their institutional expression. First we have an idea, or a problem, then we act, i.e. either speak, or build or destroy. Yet, this is certainly not the way in which small children develop. They use words, they combine them, they play with them, until they grasp a meaning that has so far been beyond their reach. And the initial playful activity is an essential prerequisite of the final act of understanding. There is no reason why this mechanism should cease to function in the adult" Feyerabend 1993: 17.

18. For Saussure the meaning of language is in its **function** as a **system**. He wanted to find a way to isolate a coherent object of linguistics from a confusing swamp of language usages. The way he suggested was to separate language as a system (*langue*) from its manifestations in speech and writing (*parole*). To study *langue* was to look for the underlying rules and conventions that enable language to operate; to analyse the collective dimension of language rather than the individual speech, i.e. grammar rather than usage, rules rather than expressions, models rather than data. The ultimate aim was to find the infrastructure of language common to all speakers on an unconscious level. This is the **deep structure** which need not refer to historical evolution (structuralism examines the synchronic rather than the diachronic).

language is a structure which might reflect the structure of reality to his hypothetical advantage, thereby deciding that concepts should be named consciously in accordance with and isomorphic with the understanding of reality.

Yet, Saussure said the relation between signifier and signified is arbitrary. By this he basically meant that using the sound of a word to indicate an object (one exemplar exemplifying the concept) does not have an isomorphic relationship to the meaning of the word (for a structuralist the meaning of a word is the concept). Wittgenstein pointed out that the connection is in its use in social practice. For Wittgenstein, signification, i.e. the association of a sound and what it represents, is the outcome of collective learning (use in social practice of what Wittgenstein calls "language games"). Meaning is therefore the product of a system of representation which is itself meaningless, or if it is not, i.e. if there are underlying mechanisms, we have been unable to discover them.

Structuralism wanted to develop a metalanguage, which is a technical language, to describe the properties of the ordinary language. Traditional Terminology (inspired by structuralism and objectivism) wanted to develop a metalanguage to describe the properties of the vocabulary of special language. A metalanguage is a technical language devised to describe the properties of ordinary language. Wittgenstein had already come up against the limits of logic as a metalanguage in the 1920s. A privileged or "meta"-linguistic position is a mirage created by language itself. Structuralism, semiology and other forms of metalinguistics which promoted liberation from the enigma of meaning, only lead back to language, a non exit, and the consequent dangers of a relativist or even nihilistic view of human reason itself.

2.3.2 *The semantic triangle*

The second line of thought this work is guided by requires a familiarity with the traditional interpretation of the semantic triangle. The semantic triangle which was introduced by Gomperz (1908) (Felber 1984: 100) was referred to by Wüster in 1956[19] ("Dreiteiliges Wortmodell" (Wüster 1991: 165; in English translation: "Wüster's term model" Felber 1984: 100)), the founder of the

19. Other authors who made reference to the semantic triangle are Ogden (1923), Ullmann (1952), Knobloch (1956), Baldinger (1959).

Vienna school of Terminology. What this triangular model basically explores are the relationships between (a) some kind of reality (the world), (b) a means to communicate about and to create this reality (language), and (c) the centre of reasoning about and of understanding both the world and language (the human mind) (Figure 2.4).

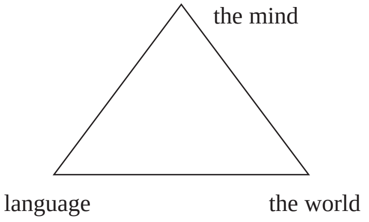

Figure 2.4. *The semantic triangle*

Wüster's interpretation of the elements at the three vertices are: "Gegenstand (Sachverhalt)", "Lautkörper" and "Wortinhalt" translated by Felber into *individual object*, *symbol* and *concept* (Figure 2.5).

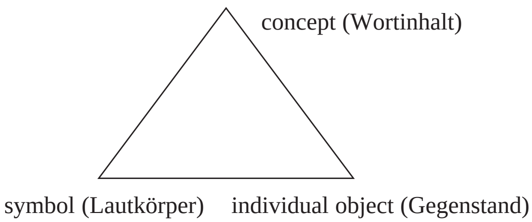

Figure 2.5. *Wüster's "Dreiteiliges Wortmodell".*

In the following sections, we will compare the elements on the vertices of this triangle in the traditional theory of Terminology with those in a new theory, which, because it is inspired by insights in cognitive semantics and functional linguistics opts for a different theoretical framework. This new sociocognitive theory of Terminology reacts against the theoretical framework which underpins the procedures and methods of Terminology as traditionally defined, perceived and established by Wüster and his successors (Laurén & Picht 1993).

2.3.2.1 *The objectivist model of traditional Terminology in view of the semantic triangle*

In traditional Terminology the full potential of the three elements of the semantic triangle was deliberately neither explored nor exploited. The world was reduced to what could be objectified, **language** was only considered in its naming function, and the human mind was only given credit for its capacity to classify individual objects on the basis of recognising characteristics which were common to all the members of the class representing a concept. The relationship between the world and language was limited to the acceptance that the world is objectively given and has to be named. The relationship between the world and the **mind** was reduced to the fact that the world can be understood by the human mind thanks to the classificatory capacity of the mind. As far as the relationship between language and the mind is concerned, the fact that language may have a role to play in the mental activity of understanding the world, in other words the creative potential of language, is not ignored, but is disregarded, brushed aside as irrelevant.

Underlying all this is the belief of logical positivism that for clear thinking, natural language is an obstacle. A calculus, i.e. a formal axiomatic system, would be ideal. In formalising an existing axiomatic system, variables are replaced by meaningless symbols. In doing so one obtains a logical system without meaning which allows for the objectification of several purely formal deductions. A calculus allows for a summing up of existing theoretical systems in short symbolic representations which permits more insight into the purely logical relations between diverse statements. Natural language is treated as a necessary evil which needs to be constricted. One example of such attempts at constriction is the standardisation of terminology. Standardisation equals a strife for univocity. One concept is referred to by one term (no synonymy) and one term can only refer to one concept (no polysemy). Polysemy, which is a characteristic of natural language is treated as uneconomical and therefore steps need to be taken to curtail this phenomenon. Language is reduced to the conscious literal level. Figurative language and connotative language are disregarded. Language is not to be seen as evolving in time. What is aimed at in traditional Terminology is to develop principles and methods for synchronic language description.

2.3.2.2 *The integrated model of modern Terminology*

What we refer to as *modern sociocognitive Terminology* can benefit from the findings of cognitive semantics, which elaborates on the full potential of the interaction between the world, language, and the human mind; and from the insight that the elements of the semantic triangle function in a social setting (the communicative function of language).

Sociocognitive Terminology considers our knowledge about the world of science and technology as **experiential** (Lakoff 1987). Much of what we know and understand about the world is **embodied** (Johnson 1987), is the result of our sensory perceptions. It should be added that the other part is the result of our reasoning, which is interactive with the input via on the one hand sensory perception and on the other hand the transfer of other language users' ideas which we take in via discourse (written and spoken) for which language is the medium.

Language has a cognitive function (ideational), as well as a textual and a communicative (interpersonal) function. (Halliday 1985). Language is a means for categorisation.[20] Modern Terminology could incorporate the idea that humans do not just perceive the objective world but have the faculty to create categories in the mind. Many of these categories of the mind have a prototype structure.

Prototype-theory finds its origin in the work of cognitive psychologist Eleanor Rosch. She was trying to understand the internal structure of categories. Categories and categorisation were studied, rather than concepts. To study 'meaning' in psycholinguistics is specific in that 'meaning' is not taken to exist as such. Nor does it exist as linguistic meaning, i.e. what is part of the language system. Rather it exists as experiential meaning. Her hypothesis is that the human being has a prototype, a best example for each category, in his mind and that classification happens on that basis. In *Women, Fire and Dangerous Things*, Lakoff (1987) proves that the categorisation of things does not happen exclusively on the basis of common features. His hypothesis is that human observation is determined by the possibilities and restrictions of the human body and is culturally determined. Rosch studied prototypes via configurations of features, which helped her to study the structure of the categories in the mind. Exemplars of the category 'bird' can have features like 'is able to fly', 'has feathers', 'has a beak', 'is not a pet', 'lays eggs', etc. There is

20. Note the distinction between on the one hand logical and ontological *classification*, which in traditional Terminology is supposed to be possible in the mind without considering or using language and before the naming of the concepts takes place, and on the other hand *categorisation* which is a result of the interaction between language and the mind.

no need for one or more features which are shared by all the exemplars of a category. Exemplars belong to a category because they show resemblance and share different sets of features. The exemplars can be seen as members of one family.[21] The exemplars of the category have family resemblance, i.e. share an overlap of features.

As far as the relationship between the world and language is concerned, language is the medium for expressing human world perception and human world conception. Language plays a role in the human understanding of the world.

Looking at the relationship between the world and the mind sociocognitive Terminology considers the world to be (partly) in the human mind. When considering language and mind, sociocognitive Terminology is ready to accept that the understanding of language cannot be separated from the understanding of the world (Figure 2.6).

	traditional Terminology	**sociocognitive Terminology**
the world and language	the world exists objectively and can be named	language plays a part in the understanding of the world
the world and the mind	the world can be understood by the human mind thanks to the classificatory capacity of the mind	the world is (partly) in the human mind
language and the mind	the creative potential of language is disregarded	the understanding of language cannot be separated from the understanding of the world

Figure 2.6. The interpretation of the relationships between the world, language and the mind in traditional Terminology and in sociocognitive terminology.

This same point has been made by Lakoff (see Taylor 1995: 19) who maintains that it is unrealistic to speak of a language faculty independent of sensory-motor and cognitive development, perception, memory, attention, social interaction, personality and other aspects of experience. Much of Lakoff's research concentrates on human experience: how do people categorise and understand?

> There is nothing more basic than categorization to our thought, perception, action and speech (Lakoff 1987: 5).

21. This is an extension of one of Wittgenstein's ideas.

In this view:

> a clear division between linguistic and non-linguistic faculties, between linguistic facts and non-linguistic facts, between a speaker's linguistic knowledge proper and his non-linguistic knowledge, between competence and performance, may ultimately prove to be both unrealistic and misleading (Taylor 1995: 18).

The classical view, adopted by the discipline of Terminology and by TC 37 standards like ISO CD 704.2, is that categorisation of 'things' is based on shared properties.

> From the time of Aristotle to the later work of Wittgenstein, categories were thought to be well understood and unproblematic. They were assumed to be abstract containers, with things either inside or outside the category. Things were assumed to be in the same category if and only if they had certain properties in common. And the properties they had in common were taken as defining the category (Lakoff 1987: 6).

A lot of classification happens according to that principle, which also in sociocognitive Terminology remains one of the basic methods for the analysis of categorisation, but that is not the whole story. In recent years the new theory of categorisation, called *prototype theory*, has supplemented the traditional analysis. In prototype theory categorisation happens around good, clear examples.

> These 'prototypes' serve as reference points for the categorization of non-so-clear instances (Taylor 1995: 42).

The starting point of the prototypical conception of categorial structure is summarised in Rosch and Mervis (1975: 573–74) (quoted in Geeraerts 1989: 567).

> when describing categories analytically, most traditions of thought have treated category membership as a digital, all-or-none phenomenon. That is, much work in philosophy, psychology, linguistics, and antrophology assumes that categories are logical bounded entities, membership in which is defined by an item's possession of a simple set of critical features, in which all instances possessing the critical attributes have a full and equal degree of membership. In contrast, it has recently been argued [...] that some natural categories are analog and must be represented logically in a manner which reflects their analog structure [...].

Firstly, prototypical categories cannot be defined by means of a single set of critical (necessary and sufficient) attributes. This implies that the critical or defining characteristics of the traditional (terminological) approach cannot be used to define all categories. Categorisation is based on similarity in terms of a holistic *gestalt*, which can imply perceptual but also interactional and functional attributes.

Secondly, prototypical categories exhibit a family-resemblance structure, or more generally, their semantic structure takes the form of a radial set of clustered and overlapping meanings. Members of the category therefore share some but not all properties. Peripheral members of a category may have no features in common at all.

Thirdly, prototypical categories exhibit degrees of category membership; not every member is equally representative for a category. Categories are structured around central members which are better examples of the category than the peripheral ones.

Fourthly, prototypical categories are blurred at the edges, which implies that some categories have fuzzy boundaries, i.e. there is no clear division between what belongs to the category and what does not, some exemplars are ambivalent (Geeraerts 1989).

The epistemological position of cognitive semantics can be defined in terms of *experientialism* (Lakoff 1987) supplemented by *paradigmatism* (Geeraerts 1985 & 1993b). Experientialism deals with the embodiment of language while paradigmatism "takes care of the expectational nature of natural language categories that is reflected in their prototypical characteristics (Geeraerts 1993b: 74). Cognitive semantics is able to transcend the dichotomy between empiricism and rationalism: "On the one hand, experientialism demonstrates how experiential factors shape the structure of cognition; on the other hand, paradigmatism points out how existing conceptualizations may influence the interpretation of new experiences" (Geeraerts 1993a: 74). The differences between the classical approach to categorisation (which in classical theories is most of the time referred to as *conceptualisation* but which amounts to logical or ontological classification) and the cognitivist approach are illustrated in Figure 2.7.

As we previously mentioned, the major difference between prototype theory and the traditional theory (of which structuralist ideas on meaning and language are part) is not just the recognition of the prototypical nature of categorisation but the rejection of an objectivist epistemology in favour of experientialism. Lakoff (1987) discusses the epistemological thesis of 'experiential realism'. Concepts do not result from passively registering objectively structured impressions from the outside world or from structuring input data according to innate concepts. Understanding is an embodied experience. Concepts and their features grow out of bodily experience and are understood in terms of it.

> The core of our conceptual system is directly grounded in perception, body movement, and experience of a physical and social character (Lakoff 1987:

The classical approach to classification. (Taylor 1995: 24)	**The cognitivist approach to categorisation (paradigmatism, prototypicality and experientialism)** (Geeraerts 1985, 1989, 1993b)
1. Categories are defined in terms of a conjunction of necessary and sufficient features.	1. Prototypical categories cannot be defined by means of a set of necessary and sufficient features.
2. Features are binary.	2. Features are scalar and prototype categories exhibit a family-resemblance structure.
3. All members have equal status.	3. Prototypical categories exhibit degrees of category membership
4. Categories have clear boundaries.	4. Some exemplars are ambivalent which implies that some categories have fuzzy boundaries.

Figure 2.7. *The classical approach of classification compared to the cognitivist approach to categorisation.*

> xiv).

We want to show that the structure of a category in the special language of the life sciences reflects its ontological function. We shall give examples of some terminological units which are more fit for a description in line with the traditional objectivist Terminology *concept approach*, and others which are better considered in terms of the experiential *category approach***.**

As the definition of *concept* is part of what is being questioned we shall provisionally use the denomination ***unit of understanding***. Ultimately, we shall distinguish between *concepts* which can be defined in the traditional way, and *categories* which show prototype structure and need to be defined differently.

Taking examples from the life sciences it is possible to show that some units of understanding are more objective than others. Some units of understanding can be more easily defined in terms of a clear-cut intension and extension than others and some can better be defined not on the basis of the traditional intension/extension model (see Section 1.2.3), but rather on the basis of what is traditionally known as encyclopaedic information.

2.3.2.3 *Conclusion*

In conclusion we can say that for sociocognitive Terminology the explanatory power of the full potential of how all three elements of the semantic triangle interact is of importance in studying terminology (Figure 2.6). Traditional Terminology in line with the Saussurian structuralist principles of language, starts from objectivism, i.e. the belief that there is an objective world independent of and regardless of human observation and experience. This objective world has to be discussed in the most clear-cut and unambiguous fashion for the sake of efficiency. On the basis of that hypothesis, principles for terminological prescription which materialised in standardisation have been developed, as well as principles for terminological description. In recent years the belief underlying meaning description that conceptual-knowledge-determines-experience has been questioned in the cognitive sciences. It has been replaced by the idea that conceptualisation is a direct spin-off of experience and understanding of the world. This has immediate consequences for Terminology and terminography. Four of the main issues are introduced in the next section.

2.4 Four issues at stake

If we replace the objectivist hypothesis by the cognitivist hypothesis (experientialism and paradigmatism and prototypicality) at least the following four issues will have to be tackled in Terminology: the definition of units of understanding, the univocity principle which is a consequence of the belief in isomorphism, the role of language in creative thinking and the development of categories in time

2.4.1 *Questioning the traditional definition*

As it is not difficult to prove that a number of units of understanding in the life sciences have prototype structure, the importance of what was traditionally referred to as encyclopaedic information (by which was meant less relevant information) for definitions will have to be reconsidered. Depending on the type of unit of understanding under consideration specific facets (aspects, attributes) appear to be of importance for the most effective definition, i.e. the most efficient way to make understood.

What defines a category (in cognitivism) is our structured understanding of it (Lakoff 1987: 21).[22] We need to look into other ways of structured understanding beyond the ones deemed to be of importance for definitions according to traditional Terminology, which were reduced to structured understandings of taxonomic and meronymic cognitive models. We shall point out that there are more types of structured understanding than just logical (taxonomic) or ontological (partitive or meronymic) structuring.

The objectivist paradigm bases cognition on a metaphysical account of a reality which is made up of objectively existing entities with properties[23] and relations among them. The cognitivist paradigm believes understanding implies imposing structures, i.e. Idealised Cognitive Models (ICMs) (Lakoff 1987) or frames (Fillmore 1985) in order to be able to categorise. Clearly this involves different structured ways of understanding depending on different vantage points and perspectives which depend on different experiential situations.

Both the information on different types of intracategorial structured understanding (facets) and on intercategorial understanding will have to be found in what is traditionally referred to as the encyclopaedic information concerning a concept (as opposed to the essential information or the "definitional knowledge" (Lakoff 1987: 172)).

We shall illustrate how defining in terms of explaining the structured understanding of a category is effectuated in texts and indicate the principles for terminological definitions that may be derived from these observations for

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22. Lakoff is referring to Austin's treatment of the holistic structure — a gestalt — governing our understanding of activities like cricket. "Such activities are structured by what we call a cognitive model, an overall model which is more than merely a composite of its parts. … The entities characterised by the cognitive model of cricket are those that are in the category. What defines the category is our structured understanding of the activities" (Lakoff 1987: 21).

23. We are using *features, attributes, characteristics* and *properties* interchangeably. Different authors use different terms, sometimes attributing slightly different senses to these terms. We believe the core meaning of these (near-)synonyms is the same.

cognitive Terminology (Chapter 3).

2.4.2 *Questioning the isomorphism principle*

Structuralist Terminology realised that the vocabulary of scientific and technical communication is not always isomorphic. But it believed its vocation consisted of prescribing rules for constraining the non-isomorphic aspects of natural language vocabulary. That the presence of polysemy in several different and communicative situations might be functional in language as a medium for communication and thinking was not considered.

In structuralist thinking the principle of isomorphism at large has been an issue. Examples of how isomorphism was studied in historical or diachronic linguistics are given by Geeraerts (1992 1995), such as the detailed studies of the principle of isomorphism in dialectology (Guilléron and Goossens) where cases of homonymophobia and of polysemiophobia were shown to be solved by the language system as it functions not in one individual but in a language society as a whole. The self-regulating language system is shown to include the mechanisms of homonymiphobia and polysemiophobia, which are considered to be an indication for the isomorphic tendency of natural language. Traditional Terminology did no more than reinforce and take in hand the allegedly scientifically proven *natural* regulating mechanism of language, which had been shown to exist by structuralists, by imposing monosemy.

If the isomorphic vocabulary principle holds in language in general, it seemed to stand to logic that in the language of science and technology, where precision is essential and where misunderstanding is to be avoided even more than in general situations, isomorphy is going to be of the utmost prominence. Therefore it was believed that standardisation should intervene and direct the vocabulary of science towards monosemy and mononymy.

Indeed, in general language, a structuring tendency towards isomorphic vocabulary cannot be denied. The mistakes which were made, however, involved the following:

(a) The isomorphism principle in language applies in a number of cases. We shall show that it makes sense to study the isomorphism principle alongside the process of polysemisation. We shall point out that the prototype structure of most categories can explain the varying opportunities for polysemisation in a diachronic setting.

(b) Structuralism-inspired traditional Terminology treats the supposed need for isomorphic vocabulary as a general and undifferentiated principle. It does not distinguish between different types of categories nor does it consider the relation between types of categories and levels of polysemy potential or isomorphism urge. We shall illustrate both points with the case-studies we present in Chapter 4.

2.4.3 *Category extension and metaphorical models*

The objectivist structuralist credo of traditional Terminology offered no tools for dealing with metaphor and metonymy, which were treated as unwanted and belonging to figurative language and had to be replaced by literal equivalents. Figurative language was avoided as it was an impediment for scientific i.e. logical thinking. Experientialism attempts to study the particular influence of metaphorical models on categorisation and understanding, whereas paradigmatism studies the influences of existing categories on new ones.

In contrast with objectivism in which reality and the understanding thereof is seen as objective, language independent and disembodied, cognitive semantics sees understanding and categorisation as *experiential*, i.e. embodied and based on human interpretation, and as *paradigmatic*, i.e. influenced by previously acquired knowledge. As Johnson (1987) shows, experientialism opens up perspectives for imagination and creative thinking in which language as a medium for cognition and for communication about this cognition has a position. Imaginative and creative thinking is often reflected in the use of metaphors. Metaphor is not primarily studied as a language phenomenon, “a deviant form of expression or a nonessential figure of speech” (Johnson 1987: 66), but as a fundamental process at the cognitive level, the non-propositional level at which metaphorical projections can be experientially creative. This non-propositional level we have referred to elsewhere as the metaphorical environment (Temmerman 1995)

Metaphorical thinking in the life sciences is demonstrated in the metaphorical models which appear to exist as non-propositional gestalts in the heads of the specialists. The tangible results of the metaphorical understanding of an environment are the metaphorical lexicalisations for many (new) categories in the discipline.

Lakoff and Johnson (1980) and Lakoff (1987), showed how metaphor is pervasive in everyday life, not just in language but in thought and action. Their thesis is that metaphor in language is possible because there are metaphors in the human conceptual system: "most of our normal conceptual system is metaphorically structured" (Johnson and Lakoff 1980: 4). Metaphors are grounded in our physical and cultural experience. Experiential 'gestalts' are multidimensional structured wholes which are the basic dimensions of our experience. We classify particular experiences in terms of experiential gestalts (Lakoff & Johnson 1980: 82). Understanding takes place in terms of entire domains of experience and not in terms of isolated concepts.

A theory of human conceptual systems has to account for how concepts are (a) grounded, (b) structured, (c) related and (d) defined (106). Unclearly structured concepts get structured in metaphor.

> Metaphor is one of our most important tools for trying to comprehend partially what cannot be comprehended totally. (193).

They argue that our experience is structured holistically in terms of experiential gestalts. These gestalts have a structure that is not arbitrary. Instead, the dimensions that characterise the structure of the gestalts emerge naturally from our experience. (224)

> Within the experientialist myth, understanding emerges from interaction, from constant negotiation with the environment and other people. It emerges in the following way: the nature of our bodies and our physical and cultural environment imposes a structure on our experience, in terms of natural dimensions of the sort we have discussed. Recurrent experience leads to the formation of categories, which are experiential gestalts with those natural dimensions. Such gestalts define coherence in our experience. We understand our experience directly when we see it as being structured coherently in terms of gestalts that have emerged directly from interaction with and in our environment. We understand experience metaphorically when we use a gestalt from one domain of experience to structure experience in another domain (230).

In studying the language of the life sciences we found evidence of gestalts of domains of experience which served to structure experience in the domain of the life sciences. In other words these source gestalts of domains of experience provided the underlying metaphorical environments in which progress was made in understanding and creating more and new aspects of the life sciences. There is growth of understanding and knowledge through metaphorical reasoning. This metaphorical reasoning amounts to the understanding of a new fact, situation, process, or whatever type of category based on the imagined analogy between what one is trying to come to grips with, to understand, and something one knows and understands already. This inventive or creative capacity is made tangible in neo-lexicalisations. These neo-lexicalisations are functional in the process of understanding, which is reflected in language.

To replace the denominations based on metaphor by literal language can only be defended by a Terminology which has its roots in objectivism. As soon as Terminology incorporates cognitivism it will show an interest in the function of figurative language (like metaphor) in the interaction between the world, language and the human mind, an interaction which aims at improved understanding, i.e. progress. The analogical reasoning from which the metaphorical naming of new categories with existing lexemes results, is rooted in human experience. The way in which metaphorical environments as non-propositional gestalts give rise to neo-lexicalisations is shown in Chapter 5.

2.4.4 *A diachronic study of a prototype-structured category*

In Temmerman (1998, Chapter 6) we described the complicated nature of the category *splicing*. We dealt with the prototype structure of *splicing*, with how the flexibility of this prototype-structured lexical item is to a large extend the result of polysemisation mechanisms and what the role of metaphorical models has been in the development of the category. We also described what the impact can be of loan words crossing linguistic borders on categorisation.

2.5 Summary

Having examined specialised texts of the life sciences we could not satisfactorily describe the terminological data according to the principles of traditional Terminology. We found facts which can more easily be handled by the descriptive and explanatory framework of cognitivism. Based on these findings we shall attempt to formulate alternatives for Terminology and terminography in Chapter 6.

CHAPTER 3

From Traditional Definitions of Concepts to Templates of Units of Understanding

> The traditional rules of lexical definition, based on Aristotle's analysis demand that the word defined (called in Latin the *definiendum*) be identified by *genus* and *differentia*. That is, the word must first be defined according to the class of things to which it belongs, and then distinguished from all other things within the class (Landau 1989: 120).

Traditional Terminology provides principles and a method for defining all concepts in a similar way. In this chapter we critically examine the concept of 'concept' and the possibilities for definitions and descriptions. Our first point is that Terminology might consider taking 'units of understanding' instead of 'concepts' as items which need definitions. Our second point is that the traditional definition needs to be replaced and/or supplemented by **templates** which can serve in the description of flexible and fuzzy units of understanding.

When formulating principles and methods for the description of units of understanding one can distinguish between concepts and categories. A concept could be defined according to the principles of traditional Terminology as it is the result of logically or ontologically structured understanding. It can be useful to make an abstraction of encyclopaedic information when defining a unit of understanding. In that case the description can be limited to indicating the logical or ontological position of this unit of understanding in a concept system by referring to a superordinate unit and mentioning the necessary and sufficient characteristics required to delimit it from related units in the same structure, the way it is prescribed by traditional Terminology.

Categories are all the units of understanding which are impossible to describe according to the principles of traditional Terminology. There is prototype structure, both within and between categories (intracategorially and intercategorially). We investigate a possible convergence between the type of category and the degree of prototypicality. Reasons for prototypicality can be found in what is traditionally called the encyclopaedic information. In 'cognitive' Terminology, units of understanding are considered to be understood encyclopaedically as well as logically and/or ontologically. For categories, other cognitive structuring principles apart from the logical and the ontological ones have to be taken into consideration such as the genesis of the understanding (a), facets of understanding (b), perspectives of understanding (c) and the intention of the sender of the message (d).

(a) Understanding is a process in time. It evolves with growing sophistication to better understanding. The explicitation of the periods in this process can be essential for the present understanding of some terms.

(b) Many units of understanding can be split up into several facets or aspects (of the intracategorial structure).

(c) Each unit of understanding can be looked at from a variety of vantage points. A unit of understanding is also determined by its intercategorial structure, i.e. how it relates to other units of understanding. When several other units of understanding can serve as a vantage point for looking at a particular unit, the perspective for the understanding of that particular unit will alter.

(d) The intention of the sender of a message is going to influence the information elements which will be included in the explicitation of the meaning of a category.

These structuring principles for the description of a category can be studied in relation to cognitive models, often referred to as frames. We concentrate on possibilities for representing the structuring of understanding of categories in templates related to types of units of understanding.

As we explained in Chapter 2 (2.5.1) we want to find out to what degree specialists in their texts define units of understanding in line with the principles of traditional Terminology, and, if they do not follow these principles, to see which alternatives they use. The question could be formulated as follows: in studying scientific writings do we find examples of the traditional Terminology ideal of clearly defining a concept based on the concept's clear-cut position in the concept system? Or do we rather find definitions of a different nature, definitions perhaps, which reflect the prototype nature of understanding as it is put forward in cognitivism (see Chapter 2). When reading texts with these questions in mind, it soon becomes clear, that (a) both types of definitions can be found in texts on the life sciences, and (b) that it makes sense to question the link between types of units of understanding and their definability. Ontology, as from old, distinguishes between types of categories such as entities (or individuals), properties (or features or characteristics), relations, structures, sets, quantifiers, facts.[24] Sager (1990: 27) distinguishes between four types of concept groups: entities ("which we derive by abstraction from material or abstract objects"), activities ("processes, operations and actions, here called activities, performed with, by or for entities"), characteristics ("properties, dispositions, grouped under the name of qualities, with which we differentiate among entities"), and relations ("that we wish to establish between any of the other three types of concepts"). In this chapter on units of understanding in the life sciences we focus on **entities**, **activities** and **collective categories** or umbrella categories, which could be seen as a type of entities. Characteristics and relations will be discussed indirectly as they appear in the definitions of entities and activities. We will concentrate on the definability[25] of an example of these three types of units of understanding in the vocabulary of the life sciences: *intron*, *blotting* and *biotechnology*.

The first unit of understanding, *intron*, refers to a sequence of DNA which is not coding for genetic information but which is found between sequences of genetic information. An *intron* is an entity which can be observed (perceived) by scientists in a laboratory. The second unit of understanding, *blotting*, is the name for a technique developed in laboratories to facilitate the reading of the order of the bases in DNA and RNA or of the amino acids in protein. This technique was first conceived in the mind, but in a second phase it materialised and in a process of trial and error, perception played a part in its coming into existence and further development. The third unit of understanding is *biotechnology*. It is an umbrella unit of understanding (referred to by a collective term) which indicates the totality of activities covered by a discipline. Such an umbrella unit of understanding is conceived in retrospect: when the name

24. "If our discussion of the categories is correct, then everything there is belongs to one of the seven categories: (i) (simple) individuals, (ii) properties, (iii) relations, (iv) structures, (v) sets, (vi) quantifiers, and (vii) facts" (Grossmann: 1992: 84).

25. We realise we have to be careful with the use of *definition, concept, term*, which in traditional Terminology have been given standardised meanings in an artificial way. When we use *'definition'* and *'definability'*, these terms have the sense of "description to make a category understood, as it can be found in texts".

biotechnology began to be used in the early 1970s it was recognised that the phenomenon of exploiting biological processes to our own advantage had been practised by humans for thousands of years.

For these three types of units of understanding we shall question the objectivity of their existence. We focus on how the units of understanding are defined in texts. This enables us to judge their fitness for terminological description in line with the principles of the traditional schools for Terminology.

According to traditional Terminology concepts need to be assigned a place in a logically or ontologically structured concept system in order to be defined. A definition indicates the superordinate term and the necessary and sufficient characteristics which delimit the concept from related concepts. We want to show that for some units of understanding in the language of the life sciences, such a definition is neither feasible, nor desirable because the impossibility of clearly delineating a unit is functional in science — we see defining as a never ending process having progress of both understanding and knowledge as its motive.[26]

Our evidence stems from textual material consisting of specialist publications, dictionaries and encyclopaedias in the field of the life sciences. We have been studying text fragments in which specialists make an attempt to define their concepts. The full list of publications consulted can be found in the bibliography.

This chapter is structured as follows: in Section 3.1 we introduce the three units of understanding we intend to discuss; in Section 3.2 we contrast the possibilities for a traditional (analytical) definition with the alternatives offered by prototype theory; in Section 3.3 we consider how a frame[27] or ICM[28] approach can offer alternatives for the intra- and intercategorial description of categories; in Section 3.4 this analysis will allow us to draw conclusions which may lead to new principles and methods for terminological definitions in cognitive Terminology.

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26. "Knowledge […] is not a series of self-consistent theories that converges towards an ideal view; it is not a gradual approach to the truth. It is rather an ever increasing *ocean of mutually incompatible alternatives*, each single theory, each fairy-tale, each myth that is part of the collection forcing the others into greater articulation and all of them contributing, via this process of competition, to the development of our consciousness" (Feyerabend 1993: 21).

27. Fillmore (1975, 1985, 1992), see Chapter 2 and 2.2. this chapter.

28. ICM stands for Idealised Cognitive Model. (Lakoff 1987), see Chapters 2 and 5 and Section 3.2.2.

3.1 Definitions of intron, blotting and biotechnology

By way of introducing the three units of understanding we shall first provisionally describe them and quote a definition from a specialist source. We use *definition* here as a vague indication for a speech act which can be a reply to 'what is x?' or 'what is an x?'.[29]

3.1.1 *First unit of understanding: the entity* intron

Gilbert discovered in 1978 that genes are split, i.e. that they have a structure in which the coding sequences and the non-coding sequences interlace (see Figure 3.1).

> By the late 1970s, it was clear that the protein-coding sequences in a eukaryotic gene do not necessarily consist of a single continuous stretch of DNA, as they do in a bacterial gene. Instead the coding region is often discontinuous, being interrupted by stretches of noncoding DNA; such noncoding DNA segments are called **intervening sequences** or **introns**, and the coding segments of genes — those that generally direct polypeptide synthesis — are referred to as **exons** (Berg & Singer 1992: 126).

exon	intron	exon	intron	exon

Figure 3.1. *The structure of eukaryotic DNA.*

3.1.2 *Second unit of understanding: the activity* blotting

For geneticists it is often useful to be able to identify a particular sequence in DNA fragments separated by gel electrophoresis. In 1975 E.M. Southern

29. If we apply this to 'definition' itself and ask 'what is a definition?', several answers are possible. In *Webster's Third New International Dictionary (1976)* we find (amongst others) the following three explanations: (1) 'a word or phrase expressing the essential nature of a person or class of persons or things'; (2) 'a statement of the meaning of a word or a word group <the -s in a dictionary>'; (3) 'in Aristotelianism: a determination of the real nature of a species by indicating both the genus that includes it and the specific differences or distinguishing marks'. The first and the third definitions of 'definition' are inspired by language-philosophical thinking about definitions as it has existed since antiquity. Ogden and Richards (1936) explain the distinction which is made between a *real definition* and a *verbal definition*. A real definition defines a thing. It enumerates the features which distinguish one thing from other things. A verbal definition defines a word and amounts to a type of substitution of symbols: a word is substituted by one or more other words (Temmerman, M. 1994: 84–87). Traditional Terminology's principles restrict the defining of terms to giving *real* definitions.

developed a method for doing so. Later, blotting of RNA and protein was carried out and named by (false) analogy *Northern blotting* and *Western blotting*. Methods for identifying both DNA and protein are called *South-Western blotting*, for both RNA and protein *North-Western blotting*.
The *Dictionary of Microbiology and Molecular Biology* (1987) has the following entry for *blotting*:

> Following ELECTROPHORESIS: the transfer of nucleic acids and/or proteins from a gel strip to a specialized, chemically reactive paper (or other matrix) on which the nucleic acids etc. may become covalently bound in a pattern similar to that present in the original gel. Transfer may be effected by capillary action — in which case paper (e.g. nitrocellulose, DEAE paper, APT paper) is sandwiched between the gel and a highly absorptive pad; alternatively, in electro-blotting, transfer is effected by electrophoresis. In the earliest (capillary) blotting, DNA was transferred to nitrocellulose (in the so-called 'Southern blot' or SOUTHERN HYBRIDIZATION procedure); subsequently, blotting of RNA (Northern blot) and protein (Western blot) was carried out. After blotting, a particular target molecule may be identified or assayed e.g. by fluorescence labelling or enzyme immunoassay techniques.

3.1.3 *Third unit of understanding: the collective category biotechnology*

Biotechnology is

> the *application* of advanced biological techniques in the manufacture of industrial products, including the production of antibiotics, insulin and interferon, or for environmental management, such as waste recycling (Academic Press Dictionary of Science and Technology, 1992).

> Biotechnology took on a new meaning and focus with this novel power to use DNA as a tool to make marketable materials. Modern biotechnology can be defined in its most general sense as the scientific manipulation of organisms, particularly at the molecular genetic level, to produce useful products. In a sense, biotechnology is one of the oldest industries in the world. The fermentation of wine or the preparation of bread, both brought about through the metabolic activities of yeast, come under its rubric, as do the centuries of cross-breeding and hybridization of crops and domesticated animals (Lee 1993: 16–17).

3.2 Definability in terms of intension and extension

We will submit the three units of understanding under consideration to a description in terms of the two models we discussed in Chapter 2: the concept approach based on an objectivist epistemology (see Section 3.2.1) and the category approach based on a cognitivist epistemology (see Section 3.2.2). Both models distinguish between the intension and the extension of a concept (in objectivism) or a category (in cognitivism). The question we need to ask in order to find out about the relevance of the objectivist epistemological model which is the tenet of traditional Terminology is: does information in texts indicate the concept's position in a logical or ontological concept system? (See Section 3.2.1). The question which we need to ask in order to understand the relevance of the cognitivist epistemology is: does information in texts reflect the prototype structure of some (most) units of understanding (3.2.2)?

3.2.1 The concept's position in a logical or ontological concept system

A definition in objectivist traditional Terminology is based on the position the concept has in a concept system. Based on that position an intensional definition can be given.

> An intensional definition should state the superordinate concept and list the differentiating characteristics in order to position the concept being defined in its concept system and to delimit it from the other concepts in this system (ISO/TC 37/SC1/CD704.2 N 133 95 EN).

An extensional definition can also be given:

> A definition by extension consists of the enumeration of all species, which are at the same level of abstraction, or of all individual objects belonging to the concept defined. (Felber 1984: 163)

We need to find out whether it is possible to define *intron*, *blotting* and *biotechnology* intensionally and/or extensionally in line with traditional Terminology.

3.2.1.1 *Intron*

For intron it is conceivable to refer to the superordinate concept *sequence in eukaryotic split genes*. There are two types of these: the *introns* and the *exons*, and it is also possible to clearly delineate these two concepts which are on the same horizontal level. One can list the differentiating characteristics in order to position the concept being defined in its concept system and to delimit it from the other concepts in the system (the **intension**) (Figure 3.2).

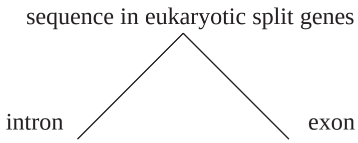

Figure 3.2. *The superordinate concept of intron and exon.*

The distinction between intron and exon is expressed in the following two definitions and represented in Figure 3.3.

> intron (Gilbert 1978) — any of those sequences (= intervening sequences) in eukaryotic (and archebacterial) mosaic or split genes that interrupt the coding sequence (exons) and are transcribed as part of a precursor RNA (pre-messenger RNA, pre-ribosomal RNA or pre-transfer RNA). Excision of introns and ligation of exons is accomplished by an RNA processing reaction called RNA splicing (Rieger 1991: 280).

> exon (Gilbert 1978) — any of those parts of eukaryotic split or mosaic genes that are expressed in the final protein or RNA product of these genes (RNA splicing). The exons of split genes are interrupted by introns (or intervening sequences). Each of the exons of a protein coding gene may represent a structural or functional domain of the encoded protein. E. modification, duplication and recombination may be a general mechanism for rapid evolution of eukaryotic structural genes (exon shuffling) (Rieger 1991: 177).

	intron	**exon**
characteristics	non-coding	coding
	not expressed in the final protein or RNA product of the genes	expressed in the final protein or RNA product of the genes

Figure 3.3. *The characteristics distinguishing intron and exon.*

The question we have to ask concerning the **extension** is whether it is possible to enumerate all species, which are at the same level of abstraction or all individual objects belonging to the concept defined. In principle this is possible. It would make a very long list, but if asked to do so scientists could launch a project with the objective of enumerate all the non-coding sequences in the DNA of all possible eukaryotic cells. As a matter of fact scientist all over the world are already decoding the genomes[30] of all possible species, also of human beings.

3.2.1.2 *Blotting*

For *blotting* it is not difficult to find a superordinate term. “Blotting” is “the technique used to detect the presence of specific molecules”(Segen 1992: 66), or a “technique of molecular biology” (Jones in *The Cambridge Encyclopedia of Human Evolution)*, or “a range of molecular biological techniques” (Bains 1993: 62). In other sources it is called a *method* (Nicholl 1994: 161; Drlica 1992: 152&234) or “a tool for analyzing gene structure” (Watson et al. 1992: 127) or a *procedure* (Chambers biology dictionary 1989). A superordinate term may not be mentioned at all as *blotting* can simply be defined as “widely used to detect the presence of a particular DNA segment in a sample of DNA” (Cooper 1994: 63).

The intension

Not only the superordinate term (technique, tool, method, procedure,…)can vary, but more significantly we find different perspectives from which different categorisations result, which may or may not be referred to by *blotting* (see Section 2.2.2.). It is impossible to come up with one clear-cut unambiguous concept structure which allows for a definition involving the necessary and sufficient characteristics to delineate *blotting* from other concepts. If *blotting* is defined as a “technique in molecular biology”, then we should be able to delineate it from other techniques in molecular biology, which can be placed on the same horizontal level in the concept structure. But which are those techniques that should be delineated from blotting? There are many molecular techniques or methods or tools or procedures which can be categorised in different ways depending on the perspective taken by the author (see Sec-

30. The **genome** is “the totality of the DNA contained within the single chromosome of a bacterial species (or an individual bacterium) or within the diploid chromosome set of a eukaryotic species (or an individual eukaryote). The human genome, for example, consists of approximately 6 (sic) billion base pairs of DNA distributed among forty-six chromosomes” (Cooper 1994: 333). Note the misprint in this definition. The human genome consists of approximately 3 billion (not 6 billion) base pairs. (Bains 1993: 156)

tion 3.2.2.2) but their relationship to *blotting* can not be presented in a simple logical structure.

The extension

The extension gives several types of blotting (Figure 3.5).

	identifies **DNA** molecules	identifies **mRNA** molecules	identifies **protein** molecules
Southern blotting	yes	no	no
Northern blotting	no	yes	no
Western blotting	no	no	yes
South-western blotting	yes	no	yes
North-western blotting	no	yes	yes

Figure 3.5. *Part of the extension of blotting. The three characteristics indicated are sufficient to differentiate between the five types of blotting.*

The applications of blotting or the reasons for blotting or the steps which need to be executed when blotting, which in traditional terminology are considered to belong to the encyclopaedic information, appear to be more essential for the definition of *blotting* than the intension and the extension of the concept as will be clear from the following quotes:

> Southern blotting, developed by E.M. Southern, is an extremely powerful tool for analyzing gene structure (Watson et al. 1992: 127).

In this quote the overall *aim* of the first type of blotting is expressed, whereas in the following quote the *applications* of Southern blotting are enumerated (bold) and the different applications of Northern blotting are expressed.

> Southern blotting is useful **for detecting major gene rearrangements and deletions** found in a variety of human diseases. […] It can also be used **to identify structurally related genes** in the same species and homologous genes in other species. Southern blots to a panel of genomic DNAs from a collection of organisms, zoo blots, **reveal the degree of evolutionary conservation of a gene.** […]
>
> Recently, Southern blotting has been used in conjunction with electrophoretic separation of very large DNA molecules **to prepare restriction maps** over distances of hundreds of kilobases. […] In this way genes can be ordered along chromosomes, revealing the clustering of genes into functionally related groups. […] As we shall see the Southern blotting technique has been

> important for our **understanding of a variety of biological processes** such as RNA splicing[…] and genomic rearrangements to form antibodies and T cell receptors […] and in the detection of rearranged oncogenes[…].
>
> Northern blotting […] is used **to examine the size and expression patterns of specific mRNAs** (Watson *et al*. 1992: 129–30).

More applications (i.e. encyclopaedic information) are found in the following two quotes:

> Prenatal detection of inherited defects. […]
>
> The easiest form of gene defect to detect is where the loss of gene function is caused by a deletion of part or all of a gene sequence resulting in a reduction in size, or disappearance, of a particular DNA restriction fragment in the Southern blot (Primrose 1987: 30).
>
> **Molecular fingerprinting**. It has long been the ambition of the forensic scientist to be able to identify the origin of blood and blood-fluid stains with the same degree of certainty as fingerprints. By careful use of DNA probes and Southern blotting, Alec Jeffreys and his colleagues have provided the necessary method. The method can also be used to settle cases of doubtful paternity (Primrose 1987: 32).

What we are implying is that for *blotting* (unlike for *intron*), firstly, the traditional analytical intensional definition of superordinate term and the necessary and sufficient characteristics, plus the extension, i.e. the full enumeration of all the types or all the parts is not feasible; and secondly, that for a core definition, i.e. a definition giving the minimal, most essential information, necessary to explain the meaning of a lexicalised unit other than the traditional definitional information may be necessary. A non-specialist who needs a definition, say from a terminological database, because he does not understand the term *blotting*, will not be satisfied with the traditional standardised type of definition. The process of understanding will be triggered if he is provided with an encyclopaedic definition comprising e.g. the aims and applications of *blotting*. Understanding *blotting* is not a logically structured event but a search for linking up new elements of understanding to categories which already exist in the mind (see Section 3.2.2.2). These links or relations can be of a variety of types (see Section 3.4).

3.2.1.3. *Biotechnology*

For *biotechnology* it is practically impossible to find a superordinate term. In the defining fragments taken from specialist publications (Figure 3.7), *bio-*

technology is **not** defined in a taxonomic concept structure of the type *biotechnology* is a type of A having the following characteristics which distinguish it from other concepts (C and D and …) on the same horizontal level.
Only defining fragment 5 (Figure 3.7):

> "Activity which leads to the conversion of raw materials into final products."

has a superordinate term. However, this superordinate term is too vague and too general to be meaningful in a definition following the guidelines of the traditional school. In a real taxonomy the superordinate term should be of the same nature as *biotechnology* is itself, i.e. a term indicating the category which has an intension of a more general nature (fewer characteristics), and consequently an extension which is larger than the category *biotechnology* itself.
In some of the definitions (Figure 3.7) we get indications that the very general superordinate category *biotechnology* could be considered a sub-class of: *the life sciences* (DEF 1). *Technology* also, could be a superordinate category of biotechnology in its modern sense of 'gene transfer technology'. *Biotechnology* could possibly be classified under technology, next to other types of technologies (Figure 3.6). But, *technology* too, is too general to be meaningful in a definition of biotechnology.

Technology		
biotechnology	x-technology	y-technology etc.

Figure 3.6. *A possible but irrelevant superordinate term for biotechnology.*

Neither can *biotechnology* be meaningfully defined in a single meronomic concept structure of the type: B *is part of* A and it has the following characteristics to delineate it from the other parts of A which are on the same horizontal row (i.e. parts C, D, E, etc.). It appears to be very difficult if not impossible to define biotechnology either logically or ontologically.

The intension

As there are several possible superordinate terms (hyperonyms) the characteristics to delimit *biotechnology* from other terms on the same horizontal level are difficult to come up with. *Biotechnology* like *microbiology* (see Chapter 2) and many other disciplines in the life sciences (*molecular genetics*, *biochemis*-

DEF 1	Biotechnology can be defined as *the commercial application of* engineering and technological principles of the life sciences (Harford 1988: 149).
DEF 2	The traditional definition of biotechnology is that it is *the exploitation of the biochemical potential of* microorganisms for medical, agricultural and industrial purposes. […] but, the ability to transfer genes back into living organisms has dramatically extended the scope of biotechnology (Kingsman 1988: 414).
DEF 3	Biotechnology is a term that defies simple definition. Some people equate it with the field of genetic engineering, while others take a broader viewpoint, defining it as *any application of* biological knowledge. […] To reduce confusion we will limit our interpretation to the two areas most often equated with biotechnology […] the genetic engineering of organisms[…] the other area […] in the fields of tissue (and cell) culture […] (Brum & McKane 1989: 713–14).
DEF 4	the exploitation of microbes and other types of cells to produce useful materials and facilitate industrial processes (British Medical Association, 1992: 53).
DEF 5	*Activity* which leads to the conversion of raw materials into final products. Either the raw material and/or an entity involved in the transforming process has a biological origin (Spier 1988: 105).

Figure 3.7. *Possible definitions of biotechnology.*

try, *recombinant DNA technology*, etc.) are of an interdisciplinary nature. Their coming into existence was the result of gradual developments and new findings in several disciplines (Figure 3.8).

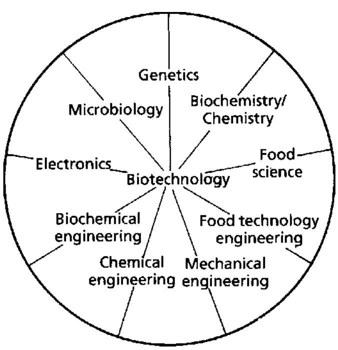

Figure 3.8. *The interdisciplinary nature of biotechnology* (Smith 1996: 3).

It is clear from Figure 3.8 that *biotechnology* has been a gradual development and that it results from the collaboration of scientists in several disciplines. It is a term which covers a wide spectrum of activities and their results. It is a category which is characterised by overlap and interaction with several other disciplines inside the life sciences (such as biochemistry and molecular genetics) and outside the life sciences (such as engineering, computing). Therefore biotechnology cannot be defined as part of a logical or ontological structure. It is the result of "interdisciplinary synthesis" (Smith 1996: 6).

The extension

We have already indicated that it is not possible to enumerate the full extension of biotechnology the way it was for *intron*, for which all the items which constitute the category i.e. which have the necessary and sufficient conditions could be enumerated, nor the way it was for *blotting* where a full list of different techniques could be given based on what molecules can be identified by the technique. (Figure 3.5). In a traditional analysis the extension for biotechnology would be everything which can be considered a type of or part of biotechnology. It is difficult to give an exhaustive list of all the types or parts of biotechnology as biotechnology is interdisciplinary by nature and can be approached in a multifaceted way. Structuring factors other than logical or ontological ones are encountered however (see 3.2.2.3).

By its nature, biotechnology is very complex. Intensionally this umbrella category cannot be defined on the basis of a superordinate term and simple characteristics. Extensionally, structuring principles such as complex relations come into play.

3.2.1.4 *Summary*

Figure 3.9 provides a summary of our findings regarding the possibilities for defining three different types of concepts according to the principles of traditional Terminology.

This section has provided us with the proof that definitions based on logical or ontological classifications are not feasible for all categories in the life sciences. We shall therefore turn to the prototypicality model provided by cognitivism for the description of understanding.

	Superordinate concept	**intension** can we enumerate the necessary and sufficient characteristics which delineate the concept from other concepts on the same horizontal level?	**extension** is it possible to enumerate all species or all individual objects?
intron (entity)	yes	yes	yes
blotting (activity)	yes, but several possible superordinate concepts	no	yes
biotechnology (collective category)	yes, but several possibilities — too vague	no	no

Figure 3.9. *The feasibility of defining three different types of concepts according to the principles and methods of traditional Terminology.*

3.2.2 *Prototype structure of units of understanding*

In the previous section (3.2.1) we observed that it is possible to provide a terminological description of the concept *intron* using the principles of traditional Terminology; however, it is very difficult (or even impossible) to do the same for *blotting* and *biotechnology*. In trying to understand why, we want to compare the traditional Terminology meaning model to the alternative understanding model offered by cognitivism. We shall first refer to the alternative understanding of the intension and the extension of categories as treated by Geeraerts (1989). Then, we shall try and look for a way to incorporate the information which was traditionally treated as encyclopaedic (i.e. non-definitional information), but which could be said to be essential for the understanding of a category in definitions.

To discover the referential extensional structure of a category the members of a category have to be considered. The extension of a category can be defined as the individual cases which belong to the category; in other words, the members of the category. If we are talking about a concrete unit of understanding such as the category *intron*, we can see the members or the individual cases which belong to the category as individual objects, which can be perceived. For more abstract categories like *biotechnology* each instance of where this category is being referred to in a communicative situation (like a text) could be seen as an exemplar of the category, i.e. an individual reference in a linguistic context which belongs to the conceived category. The members of a category show differences as there are degrees of representativeness (Figure 2.7, characteristic 3) (i.e. they are non-equal) and the denotational boundaries of a category are not always determinate (Figure 2.7, characteristic 4) (i.e. there is flexibility and vagueness).

On the intensional level the definitions of a category are considered. For prototypically structured categories there is flexibility and vagueness because there is no definition in terms of necessary and sufficient characteristics (Figure 2.7, characteristic 1). There are family resemblances (Figure 2.7, characteristic 2) which imply the overlappings of the subsets of a family.

> … if there is no definition adequately describing A,B,C,D, and E, each of the subsets AB, BC, CD, and DE can be defined separately, but obviously, the 'meanings' that are so designed overlap. Consequently, meanings exhibiting a greater degree of overlapping (in the example: the senses corresponding with BC and CD) will have more structural weight than meanings that cover peripheral members of the category only. In short, the clustering of meaning that is typical of family resemblances implies that not every meaning is structurally equally important (and a similar observation can be made with regard to the components into which those meanings may be analyzed) (Geeraerts 1989: 594).

We shall check for the prototype structure of the three concepts/categories. Then, in Section 3.3 we shall interpret each unit of understanding with reference to one or more frames (Fillmore 1976, 1985, 1992) or Idealised Cognitive Models (ICMs) (Lakoff 1987).

3.2.2.1 *Intron*

The intension

As we pointed out in Section 3.2.1.1, intensionally, *intron* is clear-cut because it is possible to define it in terms of a superordinate term and the necessary and sufficient characteristics that distinguish it from *exon*, which can be placed on the same horizontal level. There is no clustering of senses into family resemblance and radial sets.[31] Synonymy occurs in the denomination of the unit

31. Lakoff (1987: 84) definition of *radial structure of a category* is "A radial structure is one where there is a central case and conventionalized variations on it which cannot be predicted by general rule.".

(*intervening sequence*, *internal stretch*, *nonsense DNA*, *junk DNA*, *silent DNA*, *intragenic region*, *non-informational DNA*). Specialists agree on the clear-cut definition of the concept.

The extension

Extensionally there is no difference in salience among members of the category and there are no fluctuations at the edges of the family as one can clearly distinguish between what is an intron and what is not. Therefore we can conclude that intron is not a prototypically structured category. As we saw before it figures in a logical structure. This claim is reinforced by the fact that the textual information on which we based our analysis shows examples of traditional definitions.

Example one:

> […] the coding region is often discontinuous, being interrupted by stretches of noncoding DNA; such noncoding DNA segments are called **intervening sequences** or **introns**, and the coding segments of genes — those that generally direct polypeptide synthesis — are referred to as **exons** (Berg & Singer 1992: 126).

Example two:

> This led to the astounding discovery that in higher organisms the coding regions of many genes are interrupted by long stretches of nucleotides that do not code for amino acids found in the proteins. The organization of the human â-globin gene is shown in Figure […] as a gene containing three coding regions, called **exons**, interrupted by two noncoding regions, or **introns** (Drlica 1992: 166) .

Example three:

> **intron** a noncoding section of a gene that is removed from RNA before translation in cells from higher organisms. Bacterial messenger RNA does not contain introns (Drlica 1992: 228).

Example four:

> Unlike prokaryotic genes, most eukaryotic genes are composed of stretches of protein-coding sequences (exons) interrupted by longer stretches of noncoding sequences (introns). (Cooper 1994: 45).

Example five:

> **intron** A region of a protein gene that separates one exon of the gene from another. The introns of a protein gene are transcribed but are excised from the RNA transcript before it is translated. Very few prokaryotic protein genes contain introns, whereas many eukaryotic protein genes contain at least one intron. (Cooper 1994: 334).

Example six:

> **exon** A protein-coding region of a gene, that is, a base sequence that is translated according to the genetic code into an amino-acid sequence of the gene's protein product. Most protein-coding genes in eukaryotes consist of a series of exons interrupted by introns (Cooper 1994: 332).

Yet, some reservations should be made. The units of understanding *intron* and *exon* did not have prototype structure when they were first conceived and perceived. However, recently, new facts were discovered on introns. Introns appear not to be meaningless after all (Wills 1991: 63 & 112), and contain genes of their own. Moreover the introns (the junk DNA) appear to function as glue (Wells 1996: 19).

> Only small parts of it code for the HTRP protein, and these coding regions are broken up by long stretches of seemingly meaningless DNA, called **introns**, that do not code for anything (although in a moment we will see that these are not so meaningless after all) (Wills 1991: 63).

> […] the introns […] make up 98 percent of the length of the gene we have been looking at. The other two percent consists of **exons,** the regions that actually carry the genetic information of the gene. […] **Some introns have recently been found to contain genes of their own**, though what the function of these genes might be and why there should be such genes within genes still remain to be discovered (Wills 1991: 112).

> Long, stuttering sequences of DNA, previously dismissed as junk, may be there to help glue chromosomes together before cell division. […] Duplicating a chromosome, and attaching the cellular cables that subsequently drag one chromosome copy to each end of the dividing cell takes time. If the junk DNA at the centromere did not act like glue, say the researchers, the chromosome copies could drift away randomly, resulting in daughter cells containing too few chromosomes, or too many (Wells 1996: 19).

Still, the ICM within which *intron* and *exon* are to be situated has only the two elements as such, which can be understood on the basis of their properties and the relations between them. The only possible perspective is *information encoded in DNA* and the distinction between those fragments of DNA which do and those which do not encode for information remains relevant. As the understanding of *intron* and *exon* originates in logical classification, these are concepts which are perfect for a description in traditional Terminology. When the concepts *intron* and *exon* were understood at first they did not show any of the characteristics of prototype structuring. Yet, these clear-cut concepts develop into categories which are beginning to show characteristics of prototypicality. The reason for this is that 'understanding' never stops but is an ongoing process. More and more aspects of information get associated with the category in its further development in time.

3.2.2.2 *Blotting*

The intension

We have to question the possibility of an analytical definition and of family resemblance amongst the exemplars of the category *blotting*. The core definition holds for all exemplars. In analogy with: "Southern blotting: a method for detecting the presence of and optimally manipulating specific DNA sequences previously separated by gel electrophoresis delineated by E.M. Southern" (Segen 1992); *Northern blotting* could be defined as a method for detecting the presence of and optimally manipulating specific RNA sequences previously separated by gel electrophoresis; and *Western blotting* could be defined as a method for detecting the presence of and optimally manipulating specific protein sequences separated by gel electrophoresis. As we showed in Section 3.2.1.2 this is not really an analytical definition in line with the principles of traditional Terminology, as there could be several superordinate terms.

Family resemblance

The exemplars of *blotting* show family resemblance. This family resemblance has resulted in several lexicalisations. Wills (1991) explains the analogy which was at the basis of the lexicalisation 'blot'.

> After the cosmids are digested with restriction enzymes, the resulting fragments are separated on gels. Since gels are too fragile to withstand the next steps, a permanent and much more robust copy of the gel is made. The fragments of DNA are transferred to a tough nylon membrane in a way that preserves their relative positions. This process, invented at Edinburgh University by E. M. Southern, is called a Southern blot, because the DNA is transferred from the gel to the membrane in exactly the same way that wet ink from a document can be absorbed onto a piece of blotting paper pressed down on it. After the transfer, the DNA fragments can then be attached permanently to the nylon membrane (Wills 1991: 139).

Apart from the lexicalisation *blotting* we also find the (near-) synonyms *hybridisation* and *transfer* which refer to the same technique but from a slightly different perspective. This points to family resemblance which results in synonymous lexicalisations.

The extension

Extensionally, there are several types of *blotting*, depending basically on what is being blotted (DNA, RNA, protein) and on the reasons for blotting. Some members of the category of blotting are more typical than others (e.g. Southern blotting is more typical than South-Western blotting is). Seen over a period of time, there have been fluctuations at the edges of the family as more and more types of blotting were developed. We can conclude that both intensionally and extensionally blotting has the characteristics of prototype structure.

3.2.2.3 *Biotechnology*

The intension.

Studying the definitions in Figure 3.7 (Section 3.2.1.3) we found the core meaning component comprises the following structure:

biotechnology is: the application of x in order to achieve y.

We find the following variants (see Figure 3.7):

(a) application is sometimes replaced by exploitation (DEF 2 and DEF 4), or by ‘activity’ (DEF 5),

(b) x can be: “engineering and technological principles of the life science” (DEF 1), “the biochemical potential of microorganisms” (DEF 2), “biological knowledge” (DEF 3), “microbes and other types of cells” (DEF 4)

(c) y can be: sellable products (the adjective defining ‘applications’, i.e. ‘commercial’ (DEF 1) points at sellable products or services), “medical, agricultural and industrial purposes” (DEF 2), “an enormous number of endeavours from agriculture to modern genetic engineering”(DEF 3), “to produce useful materials and facilitate industrial processes” (DEF 4), “final products” (DEF 5).

It is possible to capture the essence of meaning for x and for y: the common denominator for x is ‘biological techniques’, for y ‘commercial results’. The prototypical core of the category could be formulated as follows: **biotechnol-**

ogy is the application of biological techniques in order to achieve commercial results.

The question remains whether a definition can be given on the basis of necessary and sufficient conditions. If 'conditions' is interpreted as a list of characteristics or features, then our information does not indicate this possibility. Our material does show, however, that each reflective text fragment has the explicit or implicit prototypical core definition mentioned above.

A different question is whether the category of biotechnology can be presented as a cluster of overlapping senses. To begin with there is overlap in the core definitions as is shown, for instance, in the following examples: biotechnology is "the commercial application of engineering and technological principles of the life sciences." (DEF 1); "the exploitation of the biochemical potential of microorganisms for medical, agricultural and industrial purposes."(DEF 2); "any application of biological knowledge" (DEF 3).

The overlap could be split up into elements of overlap. How far do *commercial application* and *exploitation* and *application* overlap in meaning? 'Commercial' in 'commercial application' (DEF 1) overlaps in meaning with 'for medical, agricultural and industrial purposes' (DEF 2), as medical, agricultural and industrial purposes implies commercial purposes. Moreover, there is overlap between 'biological knowledge' and the 'biochemical potential of microorganisms' and 'engineering and technological principles of the life sciences'.

It will be clear from this section that if we go beyond the core definition and consider the understanding of biotechnology each time it is used in a particular context, the family resemblance can easily be observed.

The extension

The category does not have clear boundaries because: 1) different characteristics are highlighted in different contexts; and 2) several aspects of information are given, and depending on the varying perspective, the category seems to be modified.

Structuring factors (facets)

One structuring factor for the extension of biotechnology used in Zaitlin (1994) is that biotechnology is all about product making (Figure 3.10) and depending on the discipline (a facet or aspect) within which biotechnology is applied, different products are yielded.

Discipline	Products
genetics	transformed plants, animals, yeasts, bacterial genes
microbiology	enzymes,carbohydrates, proteins
immunology	hybrid antibodies
agriculture	herbicide resistant plants, insect resistant plants
plant science	tissue plasmogen activator
medicine	urokinase, cloned human growth hormone, epidermal growth factor, interferons, interleukins; restriction length polymorphisms, fingerprints
environment	microorganisms to degrade wastes

Figure 3.10. *Biotechnology products in several disciplines* (Zaitlin 1994)

Conclusions

Firstly, the analysis of defining texts leads to the conclusion that it is not possible to define *biotechnology* in the traditional terminological way, i.e. in terms of a superordinate term plus the necessary and sufficient conditions required to delimit the concept from other related concepts (i.e. disciplines in the life sciences). The type of definition obtained would be too restricted considering all the elements we discovered in definitions written by specialists. We were able to prove that the objectivist ideas about language and reality do not meet the requirements for a representation of the understanding of *biotechnology*.

Secondly, *biotechnology* is a flexible category. The perspective alters the selection of what is being expressed in different definitions.

3.2.2.4 *Results of our investigation*

The advantage and use of the traditional definition in terminography may be questioned for the following two reasons: 1) categories like blotting (an activity) and biotechnology (an umbrella category) are prototypically structured, and 2) a category like intron (an entity) which at its origin could easily be defined as a clear-cut category, gradually develops into prototypicality as well. To study categories in texts shows that many aspects of information which in the traditional opinion were considered less relevant may have to be reconsidered in a realistic description of categorisation and meaning in terminography. In Section 3.3 we show that Terminology may find methodological and theoretical support in frame and cognitive model analyses.

3.3 Cognitive models

The largest organisational unit of understanding in the mind is the *frame*. In 1976 Fillmore wrote “a frame is a conceptual prerequisite for understanding the meaning of a word”. In 1985 Fillmore proposed “frame semantics”. Within frame semantics a word’s meaning can be understood only “with reference to a structured background of experience, beliefs or practices constituting a kind of conceptual prerequisite for understanding the meaning” (Fillmore and Atkins 1992: 76–77). According to Fillmore (1985) knowledge structures (frames) are necessary “in describing the semantic contribution of individual lexical items and grammatical construction and in explaining the process of constructing the interpretation of a text out of the interpretation of its pieces” (232).

Lakoff was inspired by Fillmore’s frame semantics when he wrote *Women, Fire and Dangerous Things. What Categories Reveal about the Mind. (1987).* The main thesis of his book is “that we organize our knowledge by means of structures called *idealized cognitive models,* or ICMs, and that category structures and prototype effects are the by-products of that organization.” (68). Each ICM is a complex structured whole which uses four kinds of structuring principles: propositional structures (as in Fillmore’s frames), image schematic structures (as in Langacker’s cognitive grammar (1987)), metaphoric mappings (as described by Lakoff and Johnson (1980)) and metonymic mapping (as described in Lakoff and Johnson (1980)). In Chapter 5 we shall consider image schematic structuring and metaphorical mapping. In this chapter only the propositional structure is studied. Each propositional ICM has an ontology and a structure (Lakoff 1987: 285). The ontology is the set of elements used in the ICM. The structure consists of the properties of the elements and the relations obtained among them. These elements are mental representations, not real things. References to these elements, their properties and relations are in the texts we have been analysing.

If Terminology is to become the discipline dealing with the principles and methods underlying the description of units of understanding, the aim is to provide tools which can help describe units of understanding and their denominations. In line with its objectivist tradition, traditional Terminology believed concepts could be defined in order to clearly delineate them from other concepts. Nowadays so called *semantic networks* are the basis of most computational and psychological theories of meaning (see Johnson-Laird

1993: 328). Network theorists suppose that networks can represent the meanings of words. They have found a set of ubiquitous relational links like *superordinate*, *property*, *part*, which can function as labels on a link. The fact that most categories (words) are prototypically understood rather than as sets of properties and relations can be represented in the semantic network. Johnson-Laird and Miller introduced the idea of a *procedural semantics* (Johnson-Laird 1993: 331). They assume that the initial product of someone's understanding is a mental process. They confirmed what many theorists had argued before: that the mental dictionary is organised in fields of related words. Johnson-Laird claims that semantic networks perpetuate the 'symbolic fallacy' that meaning is merely a matter of relating one set of verbal symbols to another. It does not provide a model of the world. He argues that a theory that relates words to the world willy-nilly relates words to one another and renders superfluous those theories that carry out only the latter task. He shows how linguistic expressions relate to models and how models relate to the world. Johnson-Laird exploits the idea that the single mental model is provisional and can be revised in the light of subsequent information.

Depending on the ICM within which a unit of understanding has been conceived, its intracategorial or internal structure (aspects, facets) will vary as well as its intercategorial structure (the relationships the unit of understanding bears to what is conceived in the same frame of mind). The perspective will influence both the intracategorial and the intercategorial structure of the ICM to which the unit of understanding belongs. We shall describe ICMs for the two units of understanding *blotting* and *biotechnology*. In studying the intension and the extension of these two categories, we found that these cannot be defined as part of logical or ontological structures but have to be seen as part of ICMs, structured wholes of experience, beliefs or practices constituting a kind of conceptual prerequisite for understanding the meaning of a word. Defining a category will involve describing the relative position this category has in the conceptual structure. The types of information which we consider to be relevant in trying to define categories within ICMs concern the internal structure of the category (the intracategorial structure) and those concerning the relationships the category has with other categories in the ICM (the intercategorial structure).

In trying to describe units of understanding in terms of intracategorial and intercategorial structure we have to rely on information which comes to us in texts. Concerning the two examples for which we are about to show the intracategorial and the intercategorial structure (*blotting* and *biotechnology*), it will be easy to prove that there are no two concepts *blotting* and *biotechnology* which exist as independent units in the objective world, as traditional Terminology would have us believe. What do exist are texts in which authors give testimony of how they understand categories within an ICM which may differ from another author's ICM.

We can approach the problem of categorisation and meaning from the onomasiological and from the semasiological perspective. Onomasiologically considered, the question becomes: how are units of understanding named? We find functional synonymy in the case of *blotting* and we find texts in which the phenomenon *blotting* is described without reference to the lexicalisation. Semasiologically considered, we see that terms refer to prototypically structured categories and that there is polysemy.

Information, which — traditionally — was referred to as encyclopaedic information, i.e. inessential information for definitions, appears to be indispensable information for the understanding of units such as the activity *blotting* and the collective category *biotechnology*.

The examples which follow explore the role of ICMs in the understanding of blotting (Section 3.3.1) and of biotechnology (Section 3.3.2).

3.3.1 *Blotting*

We discuss the intracategorial (3.3.1.1) and the intercategorial (3.3.1.2) understanding of *blotting*.

3.3.1.1 *Variation in the intracategorial understanding*

Strictly speaking, and regardless of the situation in which it is relevant, *blotting* is a method, or a technique or a tool. (see 3.1 and 3.2.1.2). The methods, techniques and tools of the life sciences are used to achieve an *aim*. Depending on this aim, these methods or techniques (they are all processes built up of a number of successive steps) can be categorised differently. Intracategorially, *blotting* is a process consisting of several steps. The number of steps and the content of each step varies according to different sources.

Source 1: Segen's *Dictionary of Modern Medicine* (1992), splits up the Southern blotting method into six steps:

> 1. DNA is extracted from cells. 2. DNA is digested with a restriction endonuclease, cutting the DNA into fragments several hundred to thousands base

> pairs in length. 3. The fragmented DNA is separated by size with agar gel electrophoresis. 4. A nitro-cellulose or nylon membrane is placed on the gel ‘slab’ and bathed in an alkaline buffer solution, which denatures the DNA, separating it into single strands. 5. A layer of dry blotting material, often paper towels, is placed on top of the membrane, creating an osmotic pressure gradient sufficient to transfer the separated DNA fragments from the delicate gel ‘slab’ onto the membrane: this step is the ‘Southern transfer’ per se. Note: the transfer may also be effected by vacuum. 6. The presence of DNA fragments of interest is then determined by bathing the membrane in a ‘hybridisation’ fluid containing either a ^{35}S or ^{32}P-radiolabeled or biotinylated ‘probe’; if the DNA fragment of interest is present, the probe binds to the single strand of DNA and is detected by autoradiography, or by substrate digestion if the probe is biotinylated.

Source 2: *The Concise Encyclopaedia of Chemistry* (1988: 522) gives the following description with illustration (Figure 3.11).

> DNA fragments from restriction digests are separated according to their size by agarose gel electrophoresis
>
> The electrophoretogram is screened for the presence of specific nucleotide sequences by performing a Southern blot (see) followed by hybridization with ^{32}P-labelled specific RNA or DNA probes, then autoradiography.

From the text in combination with the diagram we can distinguish the following steps: 1. extraction of cellular DNA; 2. cleavage of cellular DNA with restriction enzyme; 3. agarose gel electrophoresis; 4. blotting onto nitrocellulose filter (Southern blot); 5. hybridisation with labelled probe; 6. autoradiography

Source 3: In *The Cambridge Encyclopedia of Human Evolution* (1992: 319) we find the following description plus illustration (Figure 3.12).

> Southern blotting involves cutting the DNA that is to be searched with a restriction enzyme to give a series of fragments. These are then separated by electrophoresis, to give lengths of DNA of different size. The fragments are washed through the gel on to a filter material. The probe is then applied to the filter, and binds on to any pieces that contain the appropriate sequence. Autoradiography of the filter detects radiation and hence the presence and location of lengths of DNA similar to those in the probe.

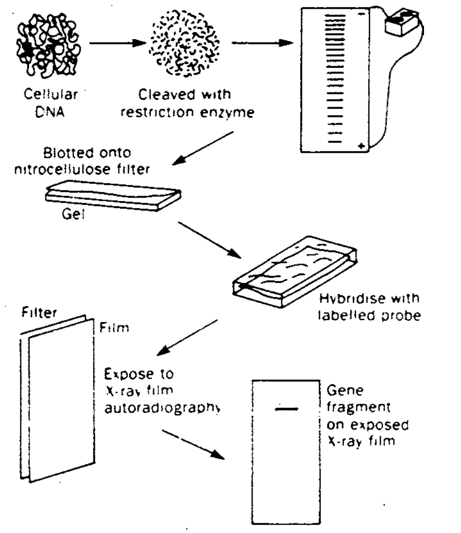

Figure 3.11. *The steps in blotting* (*Concise Encyclopaedia of Chemistry*, 1988: 522).

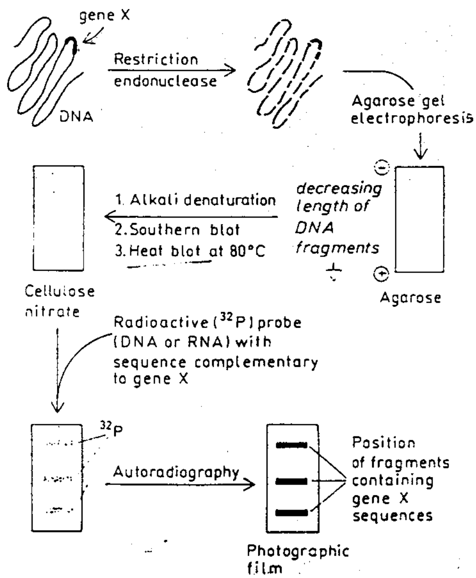

Figure 3.12. *The steps in blotting* (The Cambridge Encyclopaedia of Chemistry, 1992: 319).

From the text in combination with the diagram we can distinguish the following steps: 1. start from DNA which has to be searched for a gene X; 2 cut the DNA with a restriction enzyme to obtain fragments; 3 separate the fragments by electrophoresis; 4 wash the fragments through the gel on to filter material (= blotting); 5 apply the probe to the filter; 6. autoradiography. Each step in the process could be seen as a meaning component (which has its place in a process in time). The sources we are discussing split up the process of Southern blotting differently as shown in Figure 3.13.

source 1	sources 2 and 3
step 1	step 1
step 2	step 2
step 3	step 3
step 4	step 4
step 5	
step 6	step 5
	step 6

Figure 3.13. *The process of Southern blotting is split up into several steps. How the process is split up into steps may vary.*

When combining meaning elements differently, categorisation and lexicalisation can vary. This is the case both intracategorially and intercategorially. Intracategorially, the step in blotting which Segen describes as “a layer of dry blotting material, often paper towels, is placed on top of the membrane, creating an osmotic pressure gradient sufficient to transfer the separated DNA fragments from the delicate gel ‘slab’ onto the membrane: this step is the ‘Southern transfer’ per se”, is referred to in *The Concise Encyclopedia of Chemistry* as “a Southern blot”, and in *The Cambridge Encyclopedia of Human Evolution* it is described in the following way: “The fragments are washed through the gel and on to a filter material.” In other words the same step is referred to by the near-synonyms *Southern transfer*, *Southern blot*, and by a description.

3.3.1.2 *Variation in the intercategorial understanding*

What follows are two examples related to the intercategorial understanding of *blotting*. The examples prove the absence of a clear delineation of the category *blotting*. The methods, techniques or tools of molecular biology can be categorised differently depending on the *perspective* from which the techniques, methods or tools are understood. Even though scientists would agree that *blotting* is a laboratory technique in the life sciences the *term* is not necessarily mentioned when the extension of the techniques, tools or methods is being discussed. Similar techniques may be named otherwise because of a different perspective. The first example we are giving here is based on Green (1991), the second example is based on Coghlan (1994).

First example: tools for manipulating DNA in vitro.
Blotting is a tool for manipulating DNA in vitro seen from the perspective: ‘methods for studying the genome’. The elements which constitute the technique referred to by ‘blotting’ are part of the ICM a particular author (Green) is referring to, but the term is not mentioned. After having explained that “The genome contains the hereditary information necessary to specify the human organism.” Green subdivides his text into five parts:

I Genetic Information.
II Genome Organization
III Genome Variation: Polymorphism
IV Methods for Studying the Genome
V Human Genome Project.

It is the part on ‘Methods for Studying the Genome’(IV) which is of interest to us here, as it allows us to illustrate what perspective can contribute to the inclusion of elements in an ICM and their (possible) lexicalised expression. Green gives the following classification of ‘Methods for Studying the Genome’: (A) Tools for Manipulating DNA in Vitro, (B) Mapping, (C) How Genes are Found. ‘Methods for Studying the Genome’ is the perspective from which A, B and C are understood.

Under ‘Tools for Manipulating DNA in Vitro’ he enumerates

> methods (which) have been developed to *detect*, *amplify*, *synthesize*, *separate*, *alter*, and *determine the nucleotide sequence* of DNA molecules in the laboratory. Many of these rely on enzymes purified from bacteria, the byproducts of extensive biochemical studies of the mechanisms by which bacterial cells process DNA. Among the more important techniques are:[…] (875).

The seven methods he then discusses are understood from the perspective: ‘what tools for manipulating DNA in vitro are necessary for studying the genome, and more specifically the sequence of the nucleotides?’. ‘Tools for manipulating DNA in vitro' could also be understood seen from a different perspective such as 'how to cure genetic defects in human beings' (see second example), or 'how to manipulate plants genetically in order to make them herbicide resistant'. A different perspective would yield a different list of techniques under the heading 'tools for manipulating DNA in vitro', and possibly different lexicalisations.

Green discusses the 'tools for manipulating DNA in vitro' from the perspective of the *human genome project*. What follows are the seven tools as they are distinguished by Green. In each instance, we indicate whether the tool is necessary to **detect**, **amplify**, **synthesise**, **separate**, **ligate**, **alter**, or **determine,** the nucleotide sequence of DNA molecules in the laboratory. We underline the lexicalisations of the techniques which involve all these manipulations of the nucleotide sequences of DNA molecules in the laboratory. In later chapters some of the lexicalisations will be discussed in detail (*clone*, *PCR*, see Chapter 4, *splicing*, see Chapter 6).

(1) To **synthesise** a nucleotide sequence of DNA.
Chemical synthesis of oligonucleotides, short single-stranded DNA molecules…of any desired sequence (875).

(2) To **amplify** a nucleotide sequence of DNA.
The *polymerase chain reaction* (PCR), a method for amplifying a particular sequence from genomic DNA (875).

(3) To **separate** and to **ligate** a nucleotide sequence of DNA.
Cleavage of DNA molecules with restriction enzymes, which recognize specific nucleotide sequences within a DNA molecule and cut it (876).

In what follows *gene splicing* is described but for some reason (see Chapter 6 on splicing) the term is not mentioned :

> EcoRI "digestion" of DNA produces a set of double-stranded fragments with the single-stranded four-nucleotide overhang AATT at both ends. The overhang on one fragment is complementary to the overhang on any other fragment and can anneal to it; the enzyme DNA ligase can then be used to covalently *link two such restriction fragments* together or circularize a single linear fragment (876).

> (this is 'gene splicing'!) *Restriction digestion in conjunction* with ligation provides a powerful general method for making recombinant DNA molecules composed of pieces from several different sources (876).

(4) To **separate and determine** the order of nucleotides in a sequence of DNA.

> *Size fractionation of mixtures of DNA molecules* (e.g., restriction digestion fragments) *by gel electrophoresis*. […] Large DNA fragments are poorly resolved by ordinary electrophoresis, because they orient themselves for efficient passage through the gel such that retardation by the matrix is no longer proportional to length. *Pulsed field gel electrophoresis* circumvents this phenomenon by periodically changing the field direction to reorient the molecules and thereby restore proportional retardation of large fragments (876).

(5) To **amplify** a sequence of DNA.

> *Cloning*, a powerful method both for fractionating a complex DNA source into individual pieces and for making as many copies as desired of any particular piece (876).

The *cloning* which is discussed here is actually *gene cloning* (see Chapter 4). This specification is not made, as the perspective 'aim of the technique': 'to understand the human genome' implies that no other form of cloning could be at stake here. We can therefore say that the perspective influences the lexicalisation.

In line with this 'human genome' perspective, *cloning* is then described to be "usually a prerequisite to nucleotide sequence determination and to functional studies of a particular DNA segment".(876) There are of course many other reasons for gene cloning, but they are not relevant here considering the perspective. In Green's text an overview is given of the methods for gene cloning (more details on this will be discussed in Chapter 4 when *cloning* is discussed).

> The DNA molecules to be cloned are attached (typically by restriction digestion and ligation) to a vector DNA molecule, and the ligated molecules are introduced into microorganism host cells (876).

Very often the technique *to attach by cutting (restriction digestion) and joining (ligation) to a vector DNA molecule (often a plasmid in Escherichia coli)* is lexicalised in the literature by the term *gene splicing*. Yet, this term is not used here. An explanation might be that this article from a specialised encyclopedia is not written with just the fellow researcher in mind, but is written for a wider audience. To understand the essence of the message, no specialised term is needed, here. It is known by text writers that the use of too many technical terms may render a text less comprehensible. Still it remains remarkable that the information about a tool (splicing) in a text on *tools* is conveyed without using the term.

It is then explained how after *to attach by cutting and joining* the actual *cloning* (i.e. the making of identical copies) takes place:

> The vector includes sequences that permit replication of the ligated molecule within the host, and usually also a marker gene to permit selective growth or identification of only those cells which have successfully incorporated the DNA (876).

(6) To **detect** a sequence of DNA.

> Hybridization, a powerful method for detecting a sequence of interest within a complex mixture […] (876).

In what follows the principle of the method is described and the relationships between *hybridisation* and other tools (most of which have already been mentioned) are indicated:

> It is based on the tendency for single-stranded DNA molecules of complementary sequence to seek each other out and anneal, or hybridize. A cloned, or synthetic, DNA segment (the probe) is radioactively or fluorescently labelled, and its strands are separated and allowed to anneal with target DNA whose strands have also been separated. Usually, the target DNA has been fractionated (either electrophoretically or in the form of a clone library) and transferred to a solid support, typically a nylon membrane. (Transfers from electrophoretic gels are known as Southern blots).The location on the membrane at which the probe anneals indicates the fragment size or clone containing the probe sequence (876).

(7) To **determine** the nucleotide sequence of DNA.

> Determining the nucleotide sequence of a small cloned or PCR-amplified DNA segment (876).

As often in scientific texts the tool is first described by expressing what it involves, before the term is introduced to refer to the concept (here *sequencing*). Then the principle is explained and finally the two possible techniques (*Maxam-Gilbert sequencing* and *Sanger sequencing*) are mentioned:

> These fragments can be created either (1) by partial digestion with chemicals which cleave DNA strands at occurrences of the nucleotide (Maxam-Gilbert sequencing) or (2) by DNA polymerase-mediated synthesis of fragments complementary to one of the original segment strands, using a reaction mix which contains, in addition to the usual nucleotides, a modified form of one nucleotide that, when incorporated by the polymerase, terminates the nascent strand at that nucleotide (Sanger sequencing). (877).

The propositional ICM Green has in mind has an ontology and a structure. The ontology is the set of elements used in the ICM. Green distinguishes seven tools for manipulating DNA in vitro from the perspective of the Human Genome Project. His perspective influences which elements in his ICM are lexicalised. In 3 and 5 *gene splicing* is described but the term is not used. Another tool *blotting* is covered by this ICM as it amounts to the combinations of elements 4, 6 and 7 mentioned above, but the term is not used either. This could also be explained by the fact that the intention of the writer is not to overload his text by using too many technical terms.

Second example: Tools for gene therapy.

In other texts the perspective for a description of tools (methods, techniques) is **'how to cure genetic defects in human beings'**. Gene therapy aims at repairing or blocking faulty genes that cause disease. Different diseases require different types of therapy. Sometimes the fault can be corrected in the patient's body, by introducing a gene that will, for instance, produce a protein the patient cannot produce in large enough amounts. In other cases, faulty cells are removed from the body, 'corrected' by inserting new genes, and replaced. "The **tools** of the trade include *synthetic copies of the genes that produce essential proteins, 'antisense' DNA that switches off faulty genes*, and '*suicide genes*'" which could provide a means of reprogramming cancer cells so that they wither and die.

Other **tools** such as genetically engineered viruses and tiny capsules of fatty material called liposomes are among the "*vectors used to ferry genes into diseased cells*" (Coghlan 1994: 4) (Figure 3.14).

<table>
<tr><td rowspan="5">Tools in genetic engineering

Perspective: gene therapy</td><td colspan="2">Synthetic copies of the genes that produce essential proteins.</td></tr>
<tr><td colspan="2">'Antisense' DNA switching off faulty genes.</td></tr>
<tr><td colspan="2">'Suicide genes' which could reprogram cancer cells, so that they wither and die.</td></tr>
<tr><td rowspan="2">'Vectors' used to ferry genes into diseased cells</td><td>Genetically engineered viruses</td></tr>
<tr><td>Liposomes</td></tr>
</table>

Figure 3.14. Tools in genetic engineering understood from the 'gene therapy' perspective.

As the perspective here is 'gene therapy' (and not 'human genome project' as in (A), in this context two of the tools which are basically the same as the ones enumerated in Green's article on the human genome have different lexicalisations.

The first 'tool' is "synthetic copies of the genes that produce essential proteins". In principle this amounts to the first tool for manipulating DNA in vitro mentioned by Green: "chemical synthesis of oligonucleotides" (875). As the perspective in this article by Coghlan is 'gene therapy' it is specified that there exists a tool for making synthetic copies of genes *that produce essential proteins*. The same phenomenon as the one discussed by Green, is lexicalised differently because of the perspective.

The second example is "'vectors' used to ferry genes into diseased cells". The situation is looked upon from the perspective of the diseased cell which needs specific genes inserted into it in order to be cured. In Green's text the use of vectors was described from the point of view of the gene or the DNA fragment which had to be multiplied. We are showing the impact of perspective on categorisation and on lexicalisation. It is significant that *blotting* is discussed (mentioned implicitly) by Green but not named. In Coghlan's text, techniques are discussed, but as the perspective differs the blotting tool is not mentioned either explicitly or implicitly as this technique is not relevant here. These examples show how perspective taken by and the intention of the sender of the message play a role in understanding and what the consequences can be for categorisation and naming.

3.3.2 *Biotechnology*

In Section 3.3.1 we discussed aspects of the intracategorial and the intercategorial structuring of the unit of understanding which is often referred to by the term *blotting*. As blotting is an activity (procedure) it was predictable that in order to understand the category one would need to know of several steps which structure the intracategorial understanding. As biotechnology is an umbrella category, the understanding and naming of which is the result of retrospection, it is predictable that for its understanding, insight into its history is going to be essential. The propositional ICM *biotechnology* is part of is a complex structured whole which involves intracategorial and intercategorial structuring factors as well as historical periodicity as structuring factors.

We give three examples of how these three factors can structure the information in specific text fragments.

3.3.2.1 *Structuring factors in texts about biotechnology*

Example one. Harford's (1988: 149) categorisation expresses the relationship between *products and results* and *biotechnological techniques* (intracategorial aspects) and categorises these according to three periods in time (over the past 5000 years, in recent times and in the past few decades) (Figure 3.15).

> Biotechnology can be defined as the commercial application of engineering and technological principles of the life sciences. The history of biotechnology can be traced over many millennia and it has been described as the world's second oldest profession. For its first five thousand years, the food and drinks industries were the main province of biotechnology with the manufacture of bread, beer, wine, cheese, and many other fermentable products. Over more recent times the chemical and pharmaceutical industries have used biotechnological processes for the synthesis of many natural products, e.g. industrial alcohol, citric acid, a range of amino acids, antibiotics, vitamins, etc..
>
> During the past decades research successes in engineering, biochemistry and genetics have led to the major upsurge of interest in biotechnology. This has been largely brought about by the advent of recombinant DNA (rDNA) technology, otherwise known as gene cloning or genetic engineering. It was soon realized that the methods of genetic engineering greatly enhanced the potential of biotechnology, providing the prospect for the development of many new products and bioprocesses. […] (Harford 1988: 149).

Definition	"Biotechnology can be defined as the commercial application of engineering and technological principles of the life sciences."		
History		**Biotechnological techniques**	**Products and results**
	over the past 5000 years	fermentation	food and drinks, including: bread, beer, wine, cheese and many others
	in recent times	biotechnological processes used by chemical and pharmaceutical industries	synthesis of many natural products such as industrial alcohol, citric acid, a range of amino acids, antibiotics, vitamins, etc.
	in the past decades	recombinant DNA technology (= gene cloning, = genetic engineering)	new products bioprocesses

Figure 3.15. *The categorisation expresses the relationship between products and results and biotechnological techniques and categorises these according to three periods in time.* (Harford 1988: 149)

Example two. Kingsman's (1988: 414) categorisation expresses the distinction between traditional and new biotechnology, indicating the **organisms involved** and the **processes and results** (intracategorial aspects) depending on the **fields of application** (intercategorial perspective). He distinguishes between two periods in history, before and after the development of gene transfer technology (Figure 3.16).

> Biotechnology.
>
> The traditional definition of biotechnology is that it is the exploitation of the biochemical potential of microorganisms for medical, agricultural and industrial purposes. Brewing, bread making, cheese production, penicillin synthesis and sewage treatment are all examples but, the ability to transfer genes back into living organisms has dramatically extended the scope of biotechnology. This *new gene transfer technology* means that genes can be rapidly altered and they can be transferred between species, opening up completely new possibilities for increasing biochemical versatility. Biotechnology now involves plants, animal cells and animals in addition to microorganisms.
>
> One major impact of *the new technology* has been the ability to convert cells into 'factories' to synthesise compounds that were previously available only in limited quantities. Examples of such compounds are peptide hormones, antiviral and anti-tumour proteins and growth factors. The *technology* also provides new routes to the achievement of traditional goals, for example in the production of antigens as vaccines. The ability rapidly to manipulate the genotype also opens up possibilities for extending the traditional capabilities of an organism. For example, yeasts can be modified to produce low-carbohydrate beer and the yield of crops can be increased by producing herbicide and pest-resistant strains. Biotechnology can also be used to solve environmental problems, such as the disposal of waste products, and generation of alternative energy sources by the production of fuel alcohol (Kingsman 1988: 414).

Example three. Brum and McKane (1989: 725) give a sampler of **'additional' biotechnological applications** by which they mean methods apart from the standard ones (*cloning*, *splicing*, *blotting*); namely *liposome delivery systems, protoplast regeneration, in vitro fertilisation, automated DNA sequencing* (Figure 3.17). Depending on the perspective one wants to take this information can be seen as more essential or less essential. For a general definition of *biotechnology* it is less essential intracategorial information. For a definition putting recent developments in perspective this information would be essential.

Definition	Organisms involved	Fields of application	Processes and results
Traditional biotechnology: the exploitation of	micro-organisms	medicine	penicillin synthesis
the biochemical potential of micro-organisms for		agriculture	brewing bread making cheese production
medical, agricultural and industrial purposes.		industry	sewage treatment
New biotechnology: result of gene transfer technology.	micro-organisms, plants, animal cells, animals	medicine	-turn cells into factories to synthesise compounds, e.g. peptide hormones, antiviral proteins, antitumour proteins, growth factors -new routes to the achievement of traditional goals, e.g. production of antigens as vaccines
		agriculture	-ability to manipulate genotype, e.g. of yeast to produce low-carbohydrate beer.
		industry	-solve environmental problems: waste disposal -alternative energy: fuel alcohol

Figure 3.16. *Kingsman's (1988: 414) categorisation expresses the distinction between traditional and new biotechnology, indicating the organisms involved and the processes and results depending on the fields of application.*

A SAMPLER OF ADDITIONAL BIOTECHNOLOGICAL APPLICATIONS		
METHOD	***DESCRIPTION***	***VALUE***
LIPOSOME DELIVERY SYSTEM	Liposomes are artificial membrane vesicles that carry substances inside or on their surface	Vehicles for delivering DNA to cells; also safely deliver otherwise toxic drugs to target cells for treating infection or cancer. Substances stay entrapped in liposome until the artificial membrane fuses with the target cell's membrane and releases its cargo. Also used to boost immune responses against antigens in vaccines.
PROTO-PLAST REGENE-RATION	Each protoplast produced by enzymatic removal of plant cell walls can resynthesize its cell wall and regenerate an entire plant	An excellent technique for cloning commercial plants. Saves valuable land space-100 million potential plants can be evaluated in a single flask. This facilitates selection of plants that do well in poor growing conditions. Plants with increased resistance to cold, heat, drought, and disease can be selected by growing millions of protoplasts (in culture media) while exposed to these conditions. Only resistant variants will survive. Plants grown from these surviving protoplasts may be similarly resistant.
PROTO-PLAST FUSION	Two or more protoplasts are joined together, forming a single cell.	An application that brings together, in a single plant, genes of different species too unrelated to allow mixing by standard breeding techniques (pollination), thereby allowing creation of hardier hybrid plants
IN VITRO FERTILI-ZATION	Mature ova removed from a female animal are fertilized in a petri dish and implanted into the uterus of the same animal or another of the same species.	The mixing of sperm and eggs from the single pair of desirable animals, with the fertilized ova implanted into hundreds of females for development. The method also allows infertile human couples to have children of their own.
AUTOMA-TED DNA SEQUEN-CING	A machine is utilized that directly determines the base sequence of the DNA of a particular gene or a whole chromosome	An application that allows rapid and more accurate testing for transplant compatibility, determining paternity, diagnosing genetic disorders, even in the foetus months before birth; may speed the development of gene therapy to replace defective genes with functional substitutes, allows "DNA fingerprints", identifying a person suspected of a crime by determining the DNA sequence of cells left at the crime scene.

Figure 3.17. *Brum and McKane (1989: 725) give a sampler of 'additional' biotechnological applications by which they mean methods apart from the standard ones (cloning, splicing, blotting).*

We have seen how the perspective and the intention influence the way a category is understood. We have shown ways of visually representing the meaning structure of a particular category. In the following section we present the analysis of the meaning structure which is given to the category *biotechnology* by one particular author.

3.3.2.2 *The complex nature of understanding a category*

Using the 'definition' of *biotechnology* given by John Smith (1996), we can illustrate how extensive and complicated the understanding of a collective category can be, as well as show the complexity of an ICM. Smith takes a full chapter (Chapter 1 of his book) to introduce the category *biotechnology*.

We can distinguish between 1) the core definition (Section 3.3.2.2.1); 2) historical information (Section 3.3.2.2.2); 3) intracategorial information: aspects or facets (Section 3.3.2.2.3) and 4) intercategorial information (Section 3.3.2.2.4) in which the perspective from which the category is seen and the intention of the author influences the structuring of the ICM and the position the category takes up with regard to other categories (subdiscipline of modern biology, interdisciplinary nature, multidisciplinary nature).

3.3.2.2.1 *The core definition*

Smith formulates the core of what *biotechnology* means as follows:

> While biotechnology has been defined in many forms, **in essence** it implies the use of microbial, animal or plant cells or enzymes to synthesise, breakdown or transform materials. (Smith 1996: 2)

His definition is the "essence" (he actually uses the hedge[32] "in essence") of the many forms in which biotechnology has been defined, which we show in Figure 3.18.

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32. *Hedges* is the term introduced by Lakoff (Taylor 1989: 76) for the words and expressions which enable a speaker to express degree of category membership. "They include sentence adjuncts like *loosely speaking*, *strictly speaking*, conjunctions like *in that*, modifiers like *so-called*, and even *graphological devices like inverted commas*, as well as certain intonation patterns (as when one talks of a 'liberal' politician). Semantically, we can characterize hedges as linguistic expressions which speakers have at their disposal to comment on the language they are using" (Taylor 1989: 76).

a. The application of biological organisms, systems or processes to manufacturing and service industries.
b. The integrated use of biochemistry, microbiology and engineering sciences in order to achieve technological (industrial) application capabilities of microorganisms, cultured tissue cells and parts thereof.
c. A technology using biological phenomena for copying and manufacturing various kinds of useful substance.
d. The application of scientific and engineering principles to the processing of materials by biological agents to provide goods and services.
e. The science of the production processes based on the action of microorganisms and their active components and of production processes involving the use of cells and tissues from higher organisms. Medical technology, agriculture and traditional crop breeding are not generally regarded as biotechnology.
f. Biotechnology is really no more than a name given to a set of techniques and processes.
g. Biotechnology is the use of living organisms and their components in agriculture, food and other industrial processes.
h. Biotechnology-the deciphering and use of biological knowledge.

Figure 3.18. *Formulations in which **biotechnology** has been defined* (Smith 1996: 22).

Smith also discerns a three-component central core for *biotechnological processes*.

> Many biotechnological processes may be considered as having **a three-component central core**, in which **one** part is concerned with obtaining the best biological catalyst for a specific function or process, the **second** part creates (by construction and technical operation), the best possible environment for the catalyst to perform, and the **third** part (downstream processing) is concerned with the separation and purification of an essential product or products from a fermentation process (13).

Two observations can be made here which are relevant to the structuring of understanding. The first one is that Smith defines *biotechnology* partly by giving his readers examples of the flexibility of the category. *Biotechnology* has been defined in a variety of formulations. The second observation is that the author distinguishes between core components and less essential components in a definition.

3.3.2.2.2 *The history of biotechnology*

In order to understand biotechnology, the history of this category, which is in full development and which is the result of interdisciplinary efforts, is more important than for the categories *intron* (3.2.1.1 and 3.2.2.1) or *blotting*

(3.2.1.2 and 3.2.2.2 and 3.3.1). The vantage point of the writer of a text is the present. In order to define biotechnology in the present, periods of the past evolution are given, as are predictions for the future. We show that his historical information adds to the understanding of biotechnology and so do the speculations about the future.

The past

> …it should be recognised that biotechnology is not something new but represents a developing and expanding series of technologies dating back (in many cases) thousands of years, to when humans first began unwittingly to use microbes to produce foods and beverages such as bread and beer and to modify plants and animals through progressive selection for desired traits.
>
> The new biotechnology revolution began in the 1970s and early 1980s, when scientists learned to alter precisely the genetic constitution of living organisms by processes outwith traditional breeding practices. This 'genetic engineering' has had a profound impact on all areas of traditional biotechnology and further permitted breakthroughs in medicine and agriculture, in particular those that would be impossible by traditional breeding approaches (4–5).

Smith distinguishes between four periods in the development of biotechnology.

> **a**. Biotechnological production of food and beverages.
>
> Sumarians and Babylonians were drinking beer by 6000 BC; Egyptians were baking leavened bread by 4000 BC; wine was known in the Near East by the time the book of Genesis was written. Microorganisms first seen in seventeenth century by Antonie van Leeuwenhoek, who developed the simple microscope; fermentative ability of microorganisms demonstrated between 1857 and 1876 by Pasteur — the father of biotechnology, cheese production has ancient origins; so also has mushroom cultivation.
>
> **b.** Biotechnological processes initially developed under non-sterile conditions.
>
> Ethanol, acetic acid, butanol and aceton were produced by the end of the nineteenth century by open microbial fermentation processes; waste-water treatment and municipal composting of solid wastes were the largest fermentation capacity practised throughout the world.
>
> **c.** Introduction of sterility to biological processes.
>
> In the 1940s complicated engineering techniques were introduced to the mass cultivation of microorganisms to exclude contaminating microorganisms. Examples include antibiotics, amino acids, organic acids, enzymes, steroids,

> polysaccharides, vaccines and monoclonal antibodies.
>
> **d.** Applied genetics and recombinant DNA technology.
>
> Traditional strain improvement of important industrial organisms has long been practised; recombinant DNA techniques together with protoplast fusion allow new programming of the biological properties of organisms (4).
>
> Traditional biotechnology refers to the conventional techniques that have been used for many centuries to produce beer, wine, cheese and many other foods, while 'new' biotechnology embraces all methods of genetic modification by recombinant DNA and cell fusion techniques, together with the modern development of 'traditional' biotechnological processes (3).

How well can one understand the term and category *biotechnology* without this information? As we showed in Section 3.3.2.1, for the understanding of *biotechnology* the historical information is essential information.

The future.
To understand *biotechnology* is not only to know what it is now and what it was before, but also to be able to speculate about its future.

> Biotechnology will increasingly affect the efficiency of all fields involving the life sciences and it is now realistically accepted that by the early twenty-first century, it will be contributing many trillions of dollars to world markets (1).
>
> …it is a technology in search of new applications and the main benefits lie in the future. New biotechnological processes will, in many instances, function at low temperatures, will consume little energy and will rely mainly on inexpensive substrates for biosynthesis (4).
>
> Some of the most exciting advances will be in new pharmaceutical drugs and gene therapies to treat previously incurable diseases, to produce healthier foods, safer pesticides, innovative environmental technologies and new energy sources (5).
>
> 'New' aspects of biotechnology founded in recent advances in molecular biology, genetic engineering and fermentation process technology are now increasingly finding wide industrial application. A breadth of relevant biological and engineering knowledge and expertise is ready to be put to productive use; but the rate that it will be applied will depend less on scientific or technical considerations and more on such factors as adequate investment by the relevant industries, improved systems of biological patenting, marketing skills, the economics of the new methods I relation to current technologies and, possibly of most importance, public perception and acceptance (5).

> The industrial activities to be affected will include human and animal food production, provision of chemical feedstocks to replace petrochemical sources, alternative energy sources, waste recycling, pollution control, agriculture and forestry. The new techniques will also revolutionise many aspects of medicine, veterinary sciences, and pharmaceutics (5).
>
> Looking to the future, the Economist, *when reporting on this new technology, stated that it may launch 'an industry as characteristic of the twenty-first century as those based on physics and chemistry have been of the twentieth century* (7).

3.3.2.2.3 *Intracategorial aspects or facets of biotechnology*

Apart from a core definition (3.3.2.2.1) and historical information (3.3.2.2.2), different aspects or facets of *biotechnology* are introduced. Areas of application is an aspect of the category biotechnology. Smith introduces the main areas of application: *enzyme technology*, *waste technology*, *environmental technology* and *renewable resources technology*.

> Bioprocess technology. Historically, the most important area of biotechnology, namely brewing, antibiotics, mammalian cell culture, etc.; extensive development in progress with new products envisaged, namely polysaccharides, medically important drugs, solvents, protein-enhanced foods. Novel fermenter designs to optimise production.
>
> Enzyme technology. Used for the catalysis of extremely specific chemical reactions; immobilisation of enzymes; to create specific molecular converters (bioreactors). Products formed include L-amino acids, high fructose syrup, semi-synthetic penicillins, starch and cellulose hydrolysis, etc. Enzyme probes for bioassays.
>
> Waste technology. Long historical importance but more emphasis now being made to couple these processes with the conservation and recycling of resources; foods and fertilisers, biological fuels.
>
> Environmental technology. Great scope exists for the application of biotechnological concepts for solving many environmental problems — pollution control, removing toxic wastes; recovery of metals from mining wastes and low-grade ores.
>
> Renewable resources technology. The use of renewable energy sources, in particular, lignocellulose to generate new sources of chemical raw materials and energy ethanol, methane and hydrogen. Total utilisation of plant and animal material.
>
> Plant and animal agriculture. Genetically engineered plants to improve nutrition, disease resistance, keeping quality, improved yields and stress tolerance

> will become increasingly commercially available. Improved productivity, etc., for animal farming. Improved food quality, flavour, taste and microbial safety.
>
> Healthcare. New drugs and better treatment for delivering medicines to diseased parts. Improved disease diagnosis, understanding of the human genome (16).

A different intracategorial aspect of *biotechnology* is that it is applied in several types of companies. "The main types of company involved with biotechnology can be placed in seven categories" (7).

> Therapeutics. Pharmaceutical products for the cure or control of human diseases including antibiotics, vaccines, gene therapy.
>
> Diagnostics. Clinical testing and diagnosis, food, environment, agriculture.
>
> Agriculture/forestry/horticulture. Novel crops or animal varieties, pesticides.
>
> Food. Wide range of food products, fertilisers, beverages, ingredients.
>
> Environment. Waste treatment, bioremediation, energy production.
>
> Chemical intermediates. Reagents including enzymes, DNA/RNA, speciality chemicals.
>
> Equipment. Hardware, bioreactors, software and consumables supporting biotechnology (7).

3.3.2.2.4 *Intercategorial structuring*

Not only the core definition (3.3.2.2.1), the historical evolution (3.3.2.2.1) and the intracategorial structuring (aspects) (3.3.2.2.3) are of importance for the understanding of *biotechnology*. Aspects of the intercategorial structuring are the perspective taken by the sender of the message and the intention of the sender of the message.

The understanding of the intercategorial structuring is related to different perspectives that can be taken like: another discipline (e.g. *biology*), the interdisciplinary pursuit, public awareness, economic growth, the developing world.

> …modern biology is the most diversified of all the natural sciences, exhibiting a bewildering array of subdisciplines: microbiology, plant and animal anatomy, biochemistry, immunology, cell biology, molecular biology, plant and animal physiology, morphogenesis, systematics, ecology, genetics and many others (1).

The perspective can be the interdisciplinary pursuit.

> The term 'multidisciplinary' describes a quantitative extension of approaches to problems that commonly occur within a given area; It involves the marshalling of concepts and methodologies from a number of separate disciplines and applying them to a specific problem in another area. In contrast, interdisciplinary application occurs when the blending of ideas that occur during multidisciplinary cooperation leads to the crystallisation of a new disciplinary area with its own concepts and methodologies. In practice, multidisciplinary enterprises are almost invariably mission oriented. However, when true interdisciplinary synthesis occurs the new area will open up a novel spectrum of investigations. Many aspects of biotechnology have arisen through the interaction between various parts of biology and engineering (6).

The perspective can be public awareness (9) which implies optimism or pessimism concerning the future of biotechnology.

> As stated in the advisory Committee on Science and Technology report 'Public perception of biotechnology will have a major influence on the rate and direction of development and there is growing concern about genetically modified products. Associated with genetic manipulation are diverse questions of safety, ethics and welfare'(17).

The perspective can be economic growth (9–10).

> New biotechnology will have a considerable impact across all industrial uses of the life sciences. In each case the relative merits of competing means of production will influence the economics of a biotechnological route. Biotechnology will undoubtedly have great benefits in the long term of all sectors (9).

> Another contributory factor to the growing interest in biotechnology has been the current recession in the Western world, in particular the depression of the chemical and engineering sections, in part due to the increased energy costs. Biotechnology has been considered as one important means of restimulating the economy, whether on a local, regional, national or even global basis, using new biotechnological methods and new raw materials. In part, the industrial boom of the 1950s and 1960s was due to cheap oil, whereas the information technology advances in the 1970s and 1980s resulted from developments in microelectronics. It is quite feasible that the 1990s will increasingly be seen as the era of biotechnology. There is undoubtedly a world-wide increase in molecular biotechnology research, the formation of new biotechnological companies, large investments by nations, companies and individuals and the rapid expansion of data bases, information sucrose and above all, extensive media coverage (9–10).

The perspective can be the developing world (18).

> While many developing nations have successfully collaborated in the past with Western biotechnology companies, it is salutary to note that between 1986 and 1991 the percentage of arrangements implemented by US biotechnology companies with developing countries dropped from 20% to 3%! The ability of developing nations to avail themselves of the many promises of new biotechnology will to a large extent depend on their capacity to integrate modern developments of biotechnology within their own research and innovation systems, in accordance with their own needs and priorities.

Biotechnology is also intercategorially structured with respect to other disciplines and social activities: biotechnology and law (patents) (12), biotechnology and education (12).

> For biotechnology to be commercially successful and exploited there is need both to recruit a specialist workforce and also for the technology to be understood and applied by practitioners in a wide range of other areas including law, patents, medicine, agriculture, engineering, etc. Higher education will supply the range of specialist disciplines encompassing biotechnology, while some courses will endeavour to produce 'biotechnology' graduates who have covered many of the specialist areas at a less rigorous level than the pure degree specialisation. Also many already employed in biotechnology-based industries must regularly have means of updating or even retraining. To this end, there are now many books on specific aspects of biotechnology together with software programs. The European-based BIOTOL (Biotechnology by Open Learning) has now produced a wide range of learning programs..

The intention of Smith is to give as complete a definition of biotechnology as possible.

3.4 Conclusion

We distinguished between three types of units of understanding in the life sciences: entities, activities and umbrella categories.

3.4.1 *Results of our analysis*

We observed that one can differentiate between units of understanding which can be objectively perceived (e.g. intron), units of understanding which are conceived in the mind (e.g. biotechnology) and units of understanding which in a first phase are conceived in the mind but which materialise and develop further thanks to experience, i.e. the perceptions made when they are being tested. The first type is in line with what Geeraerts refers to as ontological categories (Geeraerts 1989a: 77–79), the second to Geeraerts' cognitive categories, and the third is a hybrid of the two.

		intensionally		**extensionally**	
		clustering of senses into family resemblance and radial sets	absence of definitions in terms of necessary and sufficient attributes	differences of salience among members of the category	fluctuations at the edges of the category
entity	**intron**	**no**	**no**	**no**	**no**
technique	**blotting**	**no**	**yes**	**yes**	**no**
umbrella term	**biotech-nology**	**yes**	**yes**	**yes**	**yes**

Figure 3.19. *The four characteristics of prototype structure in three types of categories.*

We discovered that a unit of understanding which at one point in history can be objectively perceived (intron) can initially be defined in line with the principles for definition of traditional Terminology. The first understanding of *intron* does not seem to be prototypically structured and the concept can therefore be defined traditionally. The other two units of understanding need alternative methods and principles for description. Two observations are relevant in this respect: one, these categories appear to show characteristics of prototypically structured understanding (Figure 3.19) and two, the essential information for the understanding of these categories is in what was traditionally referred to as encyclopaedic (as opposed to definitional information). The intensional and extensional definitions prescribed by traditional Terminology are relevant for units of understanding such as *intron*, whose understanding is based on logical or ontological classification. Units of understanding which are conceived in the mind on the basis of experience (such as biotechnology and blotting) show characteristics of prototype structure (family resemblance, fuzziness, best example). From our data it is clear that in order to make them understood, information is needed ranging from most essential to least essential, which is not structured logically nor partitively. For these categories a definition of necessary and sufficient characteristics is irrelevant. These categories can be described as prototypically structured and as part of frames or ICMs of understanding. Depending on the type of category different components of the frame will need to be highlighted (Figure 3.20).

	core definition	**historical information**	**intracategorial information: facets showing degrees of essence**	**intercategorial information: perspectives and intention**
intron	traditional definition	not essential	irrelevant	irrelevant
blotting	relevant	not essential	e.g. steps in the process, aim	e.g. the human genome
biotechnology	relevant	essential	e.g. field of application (bioprocess technology, enzyme t., waste t., environmental t., plant and animal agriculture, healthcare/types of companies involved/legal aspects/educational aspects	e.g. another discipline like biology/ the interdisciplinary pursuit/ public awareness/ economic growth/ the developing world

Figure 3.20. *Elements in the understanding of three units of understanding.*

The parallelism we suggested between the type of unit of understanding and the type of structure (logical or ontological structure or frame (ICM) structure) for understanding the category should be relativised in several respects.

We have simplified the situation in two ways: we chose to limit our description to three types of categories and we only discussed one example of each. The wrong impression may have been raised that we believe entities like *intron* are always understood as part of a logical or partitive structure and that activities and umbrella categories can never be understood as part of a logical or partitive structure. We do realise this is not the case. Firstly, many examples of entities can be found in the vocabulary of the life sciences which are not part of a logical or partitive structure. They are understood in a more complicated structuring and unlike *intron* they can be shown to have prototype structure. Secondly, not all categories which show little or no prototype structure are entities.

The parallelism we mentioned refers to the following elements:

1) If a unit of understanding is part of a logical or ontological structure it is more likely to be of the entity type than of any of the other types.
2) Historical information on the development of a discipline is essential information for the understanding of most umbrella categories. The text fragments on *microbiology*, *biochemistry*, *genetics*, *molecular biology*, *molecular genetics*, *genetic engineering* and *recombinant DNA technology* which occur in our corpus confirmed this conjecture**.** Historical information is predictably less essential information for the understanding of entities and activities.
3) The steps in how to perform an activity is predictably essential information for all the activities which are of specific relevance to the domain of the life sciences: *cloning*, *gene splicing*, *sequencing*, *blotting*, *mapping* and *PCR*. Steps in a sequence are of course not relevant for the understanding of entities and umbrella categories.

3.4.2 *Consequences for the principles of definitions in descriptive Terminology*

If terminology is to be studied and described in all its aspects the emphasis of the discipline of Terminology will have to shift away from establishing standardised methods and principles in order to achieve the optimal degree of logical and/or ontological order. We suggest taking optimisation of understanding as the key issue for Terminology. Terminology needs to study the elements of optimal understanding. Logical and ontological classification can lead to optimised understanding in some cases. In other cases the flexibility of a unit of understanding may be functional in the process of the coming into existence of a unit of understanding; therefore principles and methods are needed for describing this flexibility.

Examining categories which need to be defined as elements of propositional ICMs proved to be fruitful as it allows what was traditionally discarded as encyclopaedic information to be treated in a systematic but flexible way. We were able to show that for traditionally definable *concepts* the frame or propositional ICM is close to the concept representation of traditional Terminology (tree structure). For the definition of *categories*, ICMs allow for the incorporation of elements of understanding which evolved over time, for intracategorial structuring elements (aspects, facets) and for intercategorial elements of structuring such as perspective.

Additional principles are necessary to complement the principles of traditional Terminology. Terminographers should be aware of the following issues.

A first question which should be asked whenever a unit of understanding needs to be defined is whether the unit of understanding is part of a logically or ontologically structured frame or propositional ICM. If the answer is yes, a traditional terminological definition can be given on the basis of a superordinate term and the necessary and sufficient characteristics required to distinguish the unit of understanding from other units of understanding on the same horizontal level. If the answer is no, the unit of understanding is prototypically structured and needs to be defined differently. We suggest to start from a template for the description of units of understanding. Like in computer word and data processing a **template** is a blank document which contains formats of repeating elements. For the types of categories we studied (entities, activities, collective categories) the template could have the format and content as in Figure 3.21.

CATEGORY/TERM:

TYPE OF CATEGORY:
a) entity
b) activity
c) collective category
d) … etc.

CORE DEFINITION:

. . . .

INTRACATEGORIAL INFORMATION:
a) is a part of
b) consists of parts
c) is a type of
d) has the following types
e) aims
f) use
g) application
h) ….. etc.

INTERCATEGORIAL INFORMATION:
a) perspectives
b) domains
c) intentions

HISTORICAL INFORMATION:

. . . .

Figure 3.21. *Template for the description of units of understanding.*

A second issue is that the traditional distinction between definitional information and encyclopaedic information is less relevant than the variability of the distinction between more essential and less essential information. What is more essential information for the understanding in one situation or domain, or seen from one particular perspective or with a particular intention in mind is less essential information in other circumstances. Thirdly, depending on the type of category the essential information may vary. For activities successive steps can be essential information. For umbrella categories the history can be essential information. Fourthly, for the understanding of the structure of a category in a frame or propositional ICM both the intracategorial structuring principles (facets or aspects or attributes) and the intercategorial perspectives are important. Fifthly, the terminographer should be aware that the intention of the definer and the perspective taken are going to influence the type of information which is essential for the definition.

Summing up we could say that terminographers should be familiarised with the prototypicality principles of understanding as well as with the objectivist principles of meaning. Traditional definitions should be replaced by templates for meaning description which are based on the underlying insight that categories are understood within a frame or an ICM which is the largest structure within which both a lexicalised and a non-lexicalised category can be understood. The distinction should no longer be between definitional and encyclopaedic information but between more and less essential information which is structured within the frame and which can be highlighted or not depending on the situation in which a category is being referred to.

If optimal understanding and functional flexibility of categories become part of the concerns of the discipline of Terminology this opens up the road to studying some of the problems shunned by traditional Terminology, but encountered by terminographers in their daily practice, such as polysemy and meaning changes over time (see Chapters 4 and 5). The role of cognitive category building in the progress of knowledge and the importance of language therein (metaphor and metonymy) should be part of the list of problems with which the discipline of Terminology is concerned (see Chapter 5). So should the multidimensionality of a category which coincides with the multitude of perspectives (e.g. disciplines) from which a category can be viewed.

Most importantly we realised that the methods and principles of Terminology can no longer be satisfied with a scientific underpinning which is only based on the belief that there is an objective world out there which is waiting to be named. Our next chapter deals with some of the problems concerning naming.

CHAPTER 4

Univocity And Polysemy

> […] the cognitive system favours prototypical categories because they enable it to fulfil the functional requirements of *informational density, structural stability*, and *flexible adaptability* as a pattern of expectations (Geeraerts 1995: 111).

In studying a number of categories in texts concerning the life sciences we discovered that different types of categories predictably have different elements of essential information. Most importantly we found that the understanding of prototypically structured categories require types of information which can comprise e.g. historical information, steps in a procedure, intracategorial facets, and information on intercategorial perspective (Chapter 3). What traditional Terminology considered to be encyclopaedic information, i.e. non-definitional information, was found to be indispensable for the understanding of some categories. In Chapter 3 we discussed the possibility of representing the understanding of categories in frame structures or cognitive models. Chunks of knowledge (= fuzzy categories) can be better represented in networks of nodes and labelled arrows bringing out both their internal structure and their relations with other chunks of knowledge. In this chapter we explore the link between the structure of the understanding of a category and the process of (neo-) lexicalisation. Starting from the fact that most categories have prototype structure, we reconsider the traditional types of meaning extension (semasiologically considered) or neo-lexicalisations (onomasiologically considered) which have often been labelled generalisation, specialisation, metonymisation and metaphorisation. We describe the phenomenon we refer to as propensity to polysemy. We start from the hypothesis that it should be possible to find examples of categories which illustrate prototypically structured understanding and are therefore prone to polysemisation and other units of understanding which do not have a prototypical meaning structure and will therefore resist polysemisation.

We shall argue that two counterbalancing forces are at work when categorisation takes place within a language community: on the one hand the urge for univocity (which is sometimes referred to as polysemiophobia and homonymiphobia (Geeraerts 1995: 124) and on the other hand the urge for diversification when attempting a better and broader understanding. In the principles for standardisation of traditional Terminology, the emphasis has been on the urge for univocity. In sociocognitive descriptive Terminology the functionality of polysemy in special language will need to be studied in more detail.

Traditional structuralism-inspired Terminology hails the principle of one form for one meaning which is known as the isomorphism principle or the principle of univocity. In its principles, traditional Terminology disregards change. Change in meaning is left to the diachronic study of language and — like linguistic structuralism did for words — Terminology decided not to take the meaning evolution of terms as a central issue. The motivation for this was that traditional Terminology — unlike semantics — chose to limit its object of study to the link between concepts/objects and their denominations and does not study the possible impact language may have on "worldmaking" (Goodman).[33] This presupposes the understanding of the world based on pure perception without interpretation; as for the interpretation, language would be needed to make thought (reflection and analysis) possible. In traditional Terminology the denomination of concepts only becomes functional in particular communicative situations, where it is of the utmost importance for people to use the same term when they are referring to the same concept, in order to avoid ambiguity and misunderstanding.

In limiting itself threefold: 1) by only wanting to study the relationship between concepts and terms which name the concepts unidirectionally; 2) by not studying the terms as they actually function in language, i.e. in discourse, 3) by only wanting to study the relationship between the denominations (terms) and their concepts synchronically; traditional Terminology takes two

33. Goodman illustrates and comments on some of the processes that go into worldmaking: composition and decomposition, weighting, ordering, deletion and supplementation, and deformation (Goodman 1978: 7–17). Goodman sees all these processes in artistic worldmaking. Scientific creativity can be observed to function according to similar processes.

things for granted. Firstly, it starts from the idea that in the objective world a concept can come into being before a name is needed to refer to it; and secondly it accepts the principle of isomorphism which says that

> …similarity, firmly anchored in the nature of structures, is responsible for the fact that structures can be used to represent other structures. Language, for example, is a structure which, if it is to succeed, must have some sort of isomorphism to the world (Grossmann 1992: 50).

Instead of studying this precept by asking how language holds the secret to the structure of the world, or instead of questioning this precept altogether, standardisation oriented Terminology simply adheres to the principle of isomorphism. Moreover the principle of isomorphism is interpreted to take its ideal realisation 'simply' in one form one meaning. This reflects traditional Terminology's underlying objectivist ideology. If objectivism were not the ideal, if ideologically, the world were seen as subjective, as existing only in the mind of the observer, then the principle of isomorphism between the world and language would come to mean something totally different. Isomorphism would then allow for variation and flexibility, for a parallelism between the world as it is observed by several observers and a virtual cluster of possible ways of expressing the structure of the world in language. Convinced of the functionality of isomorphism in its objectivist understanding, traditional Terminology goes even further in prescribing that language should be made to reflect in the one and ideal way, the only possibly acceptable logical and/or ontological 'scientific' structure of the world. Terminology, the vocabulary of specialised subjects, is cut from the natural functionality of language (in discourse and in categorisation), and consequently it is detached from language's problem solving potential. Scientific terminology as it occurs in discourse is not given any attention from a perspective of 'understanding'. Terminology is condemned to be studied as a meta-language only, almost on a par with nomenclature.[34] Interpretation is unnecessary as there is only one term for one concept and vice versa.

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34. On nomenclature see Sager (1990: 90–97). In their approach to naming, the taxonomic sciences have evolved artificial languages which exploit the systematic nature and the classificatory use of language. They can construct systems for naming which can be understood and used correctly by their users. As Sager points out the taxonomic codes cannot claim absolute validity for a name but only aim at consistency in any one given classification. The rule systems of nomenclature overcome the unpredictability of word formation and the ambiguity inherent in popular names and general language naming processes. Examples of nomenclature are medical nomenclature, biological nomenclature and chemical nomenclature.

This is all the more surprising as for many scientific and technical fields the publications are not written in a metalanguage but in general language which follows the common linguistic rules (grammatical rules, word formation rules etc.) and has the same communicative and cognitive dimensions (Sager 1990). Specialists communicate in language which does not really differ from general language (see Section 2.3), but traditional Terminology wants to consider the choice of, e.g. a new term for a new concept, as happening according to a model which pretends language is outside the world of thought and investigation and is only needed the moment communication about a subject is wanted. The only motive which comes into play is that for clear and efficient communication unambiguous and univocal terminology is ideal. Natural language is treated as if it were an impediment to communication about the structure of the objective world. This is contrary to the claims of many linguists, philosophers of science, epistemologists and theoreticians.

As we are trying to find arguments against this principle of traditional Terminology, and as we believe that terminology develops out of the interplay of observation and reflection (for which language is the medium), we need to prove that the isomorphism between language and what it needs to describe is of a different nature. It is not the objective world as it is that needs to be named, but the world as it is being understood, interpreted and created by a member of a community of specialists. The members of this community are communicating with one another and with others, specialists and non-specialists. This isomorphism is of a different nature and can perhaps best be approached from a prototypically structured and frame-embedded understanding of categorisation.

The isomorphism exists between the way we process knowledge (this happens continually in time) in our brain and how categories are structured. In Chapter 3 we pointed out that most categories have prototype structure. Geeraerts sees three functional reasons for why "the conceptual development of lexical items exhibits characteristics that are typically prototypical" (Geeraerts 1985: 360), and "why the human brain should have a prototypical conceptual organisation at all": (360): the advantages of *informational density*, *structural stability* and *flexible adaptability* of the categorial system.

> […] once we have gained an insight into the basically dynamical character of prototypes, and once we have established the functional reasons for prototypical characterisation, we can explain the correspondence between the synchronic conceptions of prototype theory and the diachronic data […] (360).

Geeraerts gives two main reasons for this correspondence.

Firstly

> […] if the organization of knowledge is determined by functional reasons, it is no wonder that the actual functioning of the cognitive system reflects its organization. The *operation* of knowledge reflects the organization of knowledge precisely because the latter is determined by principles that are related to its efficient operation (360–61).

Secondly

> […] because dynamical flexibility is an essential aspect of prototypicality, the classical opposition between the static structure of a category and its dynamic change is overcome: flexible changeability is itself an essential aspect of the structure of a category (361).

The descriptions of the categories of the life sciences and of the process of lexicalisation appear in discourse. We can study some of the texts in order to reconstruct a process of formulation and reformulation. These texts furnish proof for flexibility and non-equality in categorisation. Flexibility and non-equality are aspects of the prototypicality principle of semantic structuring and its functionality in semantic change.

We observe that univocity is linked to clear-cut categories, that clear-cut categories are rare in the life sciences, and that even the term which names a category which is defined as a clear-cut category at one point is likely to evolve into polysemy. Polysemy is caused by changes at three levels: change in the understanding of the category (the conception), change in the category as such due to e.g. technological or sociological innovation (the perception), and change in the means for expression of what one perceives and understands, i.e. the result of the mechanisms of change in language. These three reasons for polysemisation act simultaneously and are interdependent (see Section 5.7). The mechanisms of change in language can be explained from the functionality of prototype structure in categories.

In this chapter we shall use our case studies to assess the relationship between categorisation and lexicalisation. We see two approaches to this: an onomasiological one and a semasiological one. Onomasiologically considered we want to know why a prototypically structured category A is lexicalised as x or as a cluster of variations on x (x1, x2 ….derivations, compounds, etc.) or as a cluster of near-synonyms (x, y, z..). We can show from empirical data that lexicalisation is not arbitrary, that polysemy has a role to play in the process of more and better understanding. Semasiologically considered we can observe how words change their meaning over time. We shall use our case studies to assess the role of prototype structure in meaning change. Can prototypicality put an end to the “unbridgeable cleavage” (Geeraerts 1985: 361) between diachrony and synchrony that it represented in structuralism and in traditional Terminology? In the functional view of semantic change offered by Geeraerts, synchrony and diachrony become closely linked because of the prototypical structure of categories which appears to be functional. Dynamism as well as stability become the topic of interest: “the tendency towards structural stability comes to be seen as merely one of the factors that functionally determine the dynamic operation of the conceptual system” (361).

The questions we need to ask are of the following nature. Firstly, in studying the (semantic) evolution of categories or the evolution of units of understanding in the life sciences can we observe anything which supports or refutes the structuralist conception of the lexicon: does language exhibit a tendency towards isomorphism in the sense of one form-one meaning? Secondly, in studying the (semantic) evolution of categories or the evolution of units of understanding in the life sciences what can we observe to support or refute the prototypical, cognitive-semantic conception of the lexicon. Does prototypicality imply a tendency to enhance the polysemy of a lexical item by increasing the informational density and ensuring flexible adaptability? Thirdly, in studying the (semantic) evolution of categories or the evolution of units of understanding in the life sciences can we find support for Geeraerts’ hypothesis that the conceptual efficiency principle (which stimulates prototypical clustering) carries more weight than the isomorphic efficiency principle (which is at the level of expressivity)? Geeraerts suggests one principle blocks the other from taking effect, or at least that before lexical differentiation occurs the possibility of a conceptual merger is checked. (Geeraerts 1989: 200 & 1995: 124–25).

> […] the prototypical principle precedes the isomorphic principle, and the latter only applies to prototypical categories as a whole, and not to the semantic nuances within these categories. The same point may be formulated in an alternative way. Prototype theory, one could say, specifies what is to be understood by “one form, one meaning”: according to the prototypical conception of categorisation, the isomorphism between form and content applies to conceptual categories as a whole, i. e. to prototypically organised bundles of nuances, and not to the nuances within these categories (Geeraerts 1995: 124–25).

Geeraerts distinguishes between trying to list the meaning changes which was basically done in the pre-structuralist historical philological tradition, and trying to discern the language mechanisms behind these classes of change, in other words the functional reasons for change. He thinks the traditional mechanisms of semantic change[35] should be analysed from the prototypicality angle (Geeraerts 1985: 362 & 1995: Chapter 2).

We should find out what implications the recognition of the functionality of polysemy in special language could have for the study and the description of terminology. In order to study diachronic meaning evolution, which can explain synchronic polysemy, a method is needed. To reconstruct the history of categories in the life sciences, we have been inspired by Geeraerts' method, which we have adapted to our own specific needs (Figure 4.1).

GEERAERTS APPROACH	**THIS WORK'S APPROACH**
G. studies the meaning evolution of words in general language.	We study the history of categorisation in the language of the life sciences and try to relate the data to the meaning evolution of terms.
G. looks for how the meaning of a lexeme changes over time by deriving the meaning of the word from a context (often a sentence from a corpus) (lexicographical method).	We study how categorisation evolves by reconstructing the extension of knowledge on a unit of understanding (e.g. *cloning*) from how it is explained in texts (articles or books written by specialists). This yields a history of the **facts**. The meaning extension of a term is considered, taking this background factual information into account.
A lot of guesswork and intuitive filling in of gaps is necessary.	Because the **facts of change** are known, it is possible to look for types of meaning extension and the possible functional mechanisms behind them, without first having to decide whether and how the change occurred.
In general language the rate of the mechanisms of change is variable and unpredictable;	Because we are studying a rapidly developing field which manifests a desire for more knowledge and better explanations, we can expect to find an accelerated semantic change mechanism.
G. splits up time in equally long periods of meaning evolution.	We split up the periods according to the attestation of a critical event: a moment of change in the **facts.**

Figure 4.1. *The difference between Geeraerts approach for the assessment of meaning evolution and this study's approach.*

35. These traditional mechanisms of semantic change are what Geeraerts refers to as "the basic foursome since Paul (1880)": generalisation, metaphor, metonymy, and specialisation (Geeraerts 1995: 70, 90–100).

In what follows we also want to elaborate on what we showed in Chapter 3: that in the language of the life sciences, the structure of concepts reflects their epistemological function and that this could have consequences for the principles and methods of terminological description. We have given examples of terminological units which can be suitably described in line with the traditional Terminology concept approach while others are better considered in line with the experiential category approach. In this chapter we want to show that for prototypically structured categories the traditionally claimed functional advantage of univocity is not valid.

Geeraerts' (1989a: 78) comparison between two types of prototypically structured categories (cognitive categories and ontological categories) in language may be of theoretical relevance in studying the vocabulary of specialised language as well (contrary to the convictions of traditional Terminology). In studying the epistemological function of categories in the domain of the life sciences, we found that it makes sense to first of all distinguish between units of understanding which do not have prototype structure and units of understanding which do.

Based on our insights gained in studying units of understanding in the life sciences we believe we can formulate the following propositions:

1) When a new phenomenon is discovered which can be clearly delineated and defined there is at first a natural development towards univocity (Section 4.1). The search for a better and more profound understanding of the unit of understanding and the possible meaning extension mechanisms of language (like metaphorising) are likely to lead to polysemisation of the term which was initially assigned to the unit of understanding.

2) Univocity as the ideal for unambiguous and therefore efficient reasoning and communication is unrealistic for prototypically structured categories (Section 4.2). This has at least two aspects to it. Firstly, polysemy is functional in specialised language. It is the consequence of a search for more and more profound knowledge and understanding. The discourse of a specialists community is the result of the constant discussion over what one needs to investigate, what the results are of the research, how to name what has been discovered and what the terms one uses in the discussion mean. This discourse contains data for the study of polysemy in language. What is univocal at one time may grow into polysemy depending on the type of unit of understanding and how it is understood (Section 4.2.1). Secondly, (near-)synonymy develops for reasons of accuracy in expression which is linked to the perspective

taken by the sender of the message (Section 4.2.2).

The two aspects of the non-desirability and impossibility of the univocity ideal are compared to the sociocognitivist view in Figure 4.2.

The univocity ideal in traditional Terminology	**The alternative view of socio-cognitive Terminology**
Univocity aspect 1: a term names one clear-cut, well-defined concept and is therefore not polysemous. Terminology takes a synchronic point of view. The dynamic nature of language is disregarded.	Polysemy is functional in specialised discourse. It is a consequence of changes over a period of time. The search for more profound understanding and the constant discussion over how to name what one knows and understands and what words mean is in the discourse of a community and is a process in time. Polysemy is the result. Even when there is univocity at one time, polysemy may develop depending on the type of category and how it is understood.
Univocity aspect 2: a concept should be referred to by one term only; a term should not have synonyms.	Synonymy is functional in specialised discourse; it reflects different perspectives.

Figure 4.2. *This table shows the contrastive stances of traditional Terminology and sociocognitive Terminology with regard to two aspects of univocity.*

In the case studies which follow we combine the onomasiological (the process of lexicalisation) with the semasiological (how word meaning changes) perspective.

4.1 A natural development towards univocity

A tendency towards univocity exists for clear-cut units of understanding such as *intron* (see Sections 3.1.1; 3.2.1.1; 3.2.2.1 and 3.3.1), which when they are named as such for the first time do not show characteristics of prototypicality. The specialists strive for univocity. It shows in the specialists' publications that once the definition is agreed upon, the naming is negotiated and there is a tendency to try and avoid synonymy. The order of events is parallel to standardisation procedures. We can prove this with the example of the birth of the units of understanding *intron-exon*, which is a case of naming negotiation.

When the phenomenon of the intron-exon structure of eukaryotic genes was discovered, three authors published articles on the subject: (a) Walter Gilbert, who was then American Cancer Society Professor of Molecular Biology at Harvard University, published a short article entitled: 'Why genes in pieces?' (*Nature*, 9 Feb. 1978: 501), (b) W. Ford Doolittle, was Associate Professor in the Department of Biochemistry, Dalhousie University, Halifax, Nova Scotia, when he published the article 'Genes in pieces: were they ever together?' (*Nature*, 13 April 1978: 581–82), (c) Francis Crick wrote the article 'Split Genes and RNA Splicing.' (*Science*, 20 April 1979: 264–71), when he was Kieckhefer Research Professor in La Jolla, California.

In their discussion of the terminology the authors agree that eukaryotic genes have alternating stretches of coding and non-coding DNA (see 3.2.1.1)[36] and suggest names for three units of understanding (*split genes*, *intron* and *exon*).

The core definition for each of these units of understanding is given in Figure 4.3.

We shall first pay attention to Gilbert's terminology.

> Our picture of the organisation of genes in higher organisms has recently undergone a revolution. Analyses of eukaryotic genes in many laboratories[1–10], studies of globin, ovalbumin, immunoglobulin, SV40 and polyoma, suggest that in general the coding sequences on DNA, the regions that will ultimately be translated into amino acid sequence, are not continuous but are interrupted by **'silent' DNA**. Even for genes with no protein product such as the tRNA genes of yeast and the rRNA genes in Drosophila, and also for viral messages from adenovirus, Rous sarcoma virus and murine leukaemia virus, the primary RNA transcript contains **internal regions** that are excised during maturation, the final tRNA or messenger being a spliced product.

36. The definitions of exon and intron are clear-cut in particular agreed upon contexts. Occasionally the definitions of intron and exon "*become blurred*" (Darnell *et al.* 288). "Walter Gilbert suggested the term INTRON to refer to a part of a primary transcript (or the DNA encoding it) that is not included in a finished mRNA, rRNA, or tRNA. An EXON is a primary transcript region (or, again, the DNA encoding it) that exits the nucleus and reaches the cytoplasm as part of an RNA molecule. The terms intron and exon are clear when they are applied to a primary transcript that gives rise to only one mRNA molecule. However, in the case of transcription units like that for the adenovirus genes, which can give rise to many different mRNAs, **the definitions of intron and exon become blurred**.[…] Nonetheless, the terms intron (or intervening sequence) and exon are commonly used." (Darnell et al. 1990: 287–88)(my emphasis).

> The notion of the cistron, the genetic unit of function that one thought corresponded to a polypeptide chain, now must be replaced by that of a transcription unit containing regions which will be lost from the mature messenger-**which I suggest we call introns** (for **intragenic regions**)-alternating with **regions which will be expressed-exons**. The gene is a mosaic: expressed sequences held in a matrix of silent DNA, an **intronic** matrix. The **introns** seen so far range from 100 to 10,000 bases in length; I expect the amount of DNA in **introns** will turn out to be five to ten times the amount in **exons**.

In this text-fragment a conclusion is drawn based on "analyses of eukaryotic genes in *many* laboratories". The author justifies the 'many' by enumerating 10 references to publications on the subject at the end of the article. The studies suggest that the coding sequences on DNA are not continuous but are interrupted by "'silent' DNA". Gilbert suggests calling the "regions which will be lost from the mature messenger" "**introns** (for intragenic regions)" and "the regions which will be expressed-**exons**". This is an example of an attempt at coining new terms in a scientific article. It is perfect for illustrating the

DEFINITION:	"any eukaryotic gene in which the coding sequences are interrupted by a number of usually noncoding regions" (Rieger 1991)	base sequences along the DNA of the gene which do not appear in the final mRNA	base sequences on the DNA which do end up in the mRNA
Gilbert's terminology, 9 Feb. 1978 *Nature*	genes in pieces	• introns • internal regions • intragenic regions	• exons • regions which will be expressed
Doolittle's terminology, 13 Apr. 1978 *Nature*	genes in pieces	• intronic DNA • redundant non-informational DNA /'intervening' DNA	• exonic DNA • coding DNA
Crick's terminology, 20 Apr. 1979 *Science*	split genes	• introns • intervening DNA • internal stretch • nonsense DNA	• exons • sense DNA

Figure 4.3. *Synonyms in specialist publications for three clearly delineated concepts.*

stimulus-response principle. Gilbert is making reference to 10 other publications, which he has taken into consideration before suggesting names for the newly discovered phenomena (‘silent’ DNA, ‘intron’, ‘exon’, ‘introgenic’ matrix). His suggested terminology is partly followed by colleagues, like Doolittle and Crick (see further) but what is most interesting is that it is also commented upon and criticised as the fragment from Crick’s article shows (see further this section).

We shall now consider Doolittle’s article. Doolittle refers to Gilbert’s terminology:

> The recent discovery that many eukaryotic structural genes are interrupted by stretches (sometimes very long) of **non-informational ‘intervening’ DNA**[1–7] is the latest and most dramatic demonstration of the striking difference between the organisation of prokaryotic and eukaryotic genomes. […]
>
> Gilbert has proposed that intervening DNA serves to speed evolution; the mature polypeptide chain is translated from a spliced mRNA derived from a primary transcript of both **intronic** (**non-informational DNA**) and **exonic** (**coding**) DNA. Occasional imprecise splicing can generate new proteins assembled from parts of old ones without sacrificing the original genes.
>
> […]
>
> In such cells a **genes-in-pieces** organisation (with RNA splicing) could not only have its current (evolutionary) role, but an additional role: to ensure that transcripts of **exons** ([sic!: this parenthesis is never closed] reiterated but often incorrectly replicated and transcribed were at least occasionally assembled so as to template functional proteins. As replication, transcription and translation became more faithful, such insurance became less necessary and the replication and transcription of **redundant and non-informational DNA** became increasingly irrelevant and burdensome.

In line with Gilbert, to whose point of view Doolittle reacts in this article, Doolittle uses “genes-in-pieces” here, for what in later literature is mostly referred to as “split genes”. He also uses “exons” and the adjectival derivations from *intron* and *exon*: “intronic *DNA”* and “exonic DNA”. For “intronic DNA” he uses the synonymous, motivated or self-explanatory terms “redundant and non-informational DNA” and “intervening DNA”.

In Crick’s article the most striking new term is “‘split’ genes” (264).

> In the last 2 years there has been a mini-revolution in molecular genetics. When I came to California, in September 1976, I had no idea that a typical gene might be **split** into several pieces and I doubt if anybody else had.

Crick refers to Gilbert's article, and then, he comments on the terminology:

> […] in this case there are two fairly long stretches of base sequences along the DNA of the gene which do not appear in the final mRNA. Such sequences are now known as **intervening sequences**. An alternative terminology, used by Gilbert and his colleagues refers to the **intervening sequences** as "**introns**"; those base sequences on the DNA which do end up in the mRNA are referred to as "**exons**" since they are the ones which are expressed. **At this stage, any terminology is likely to lead, before long, to difficulties and complications.(5) In this article I use the intron-exon terminology, if only for want of a better one.**

In his footnote (5) Crick explains why he finds this terminology confusing:

> There are two main difficulties. A stretch of nuclear RNA may be part of an intron if spliced one way but part of an exon if spliced in another way. In addition, one is tempted to use the two words to describe the parts of the DNA from which the stretches of RNA are transcribed. Nevertheless, used judiciously, the two words are undoubtedly useful. I imagine some committee will eventually decide on a wholly logical terminology.

Apart from introducing a more general term "split genes" for "genes having an intron-exon structure" or "genes in pieces" (Gilbert), Crick also offers alternative terminology: he talks about "intervening sequences" (like Doolittle) whereas Gilbert calls these "intragenic regions". Moreover, Crick uses the opposition *sense — nonsense (*"'nonsense' stretches of DNA" "interspersed within the 'sense' DNA").

Further down Crick introduces another synonym for "intron": "internal stretch" and he links up the concepts of "split genes" and "splicing":

> Thus splicing is defined as the mechanism by which a single functional RNA molecule is produced by the removal of one or more **internal stretches** of RNA during the processing of the primary transcript.
>
> Where are ***split*** genes found (265)?

What Crick presents as a problem of lexicalisation (terminology) causing ambiguity (which he suggests could be solved by a terminology committee) is actually not a terminology problem at all. The fact that the same stretch can be an "intron" in one context and an "exon" in another, does not make the terminology unclear as "intron" and "exon" are motivated terms because they express that in a specific situation particular stretches of DNA are either coding or not coding information.

What we see at work here, is a discussion between field specialists about the best term for a unit of understanding, the definition of which they agree upon. The order of things is similar to that in a standardisation procedure: first the concept in defined, then several possible names (synonyms) are suggested and finally a trend towards univocity is seen. We also find that Crick is explicitly imposing his authority, which points to the social factors which come into play when choosing the preferred term (see also Section 5.7). As the co-discoverer (together with Watson in 1953) of the double-helix structure of DNA he is likely to be taken seriously in academic circles.

All we are claiming at this point is that categories which can be defined as clear-cut, i.e. as lacking the characteristics of prototypicality are candidates for univocal naming. The fact that at the point in history when the intron-exon structure of eukaryotic DNA is discovered these two units of understanding are clear-cut does not mean that they are likely to stay clear-cut for ever. Further research on the structure of eukaryotic DNA may lead to more profound understanding and diversification or even refutation of the initial categories. New or more profound understanding (e.g. as a consequence of taking a different perspective) may be a reason for questioning the validity of the categories and turn the clear-cut categories into prototypically structured ones.

4.2 Polysemy and synonymy

If a tendency towards univocity (one term for one category) could be observed in the naming history of a clear-cut category, this is not the case for prototypically structured categories. We shall illustrate the functionality of polysemy (4.2.1) and of synonymy (4.2.2) for prototypically structured categories in what follows.

4.2.1 *Polysemy is functional*

Polysemy can be seen as the result of human reflection about the world, but from a purely semasiological point of view it is the result of meaning evolution. Prototype semantics seems to imply that language has a tendency to increase the polysemic character of lexical items. With the case of *cloning* we want to illustrate that:

(a) Prototypical categories exploit their own polysemic potential. A new variant can be incorporated into the category because of its resemblance to the prototype. This increases the polysemy of the term by raising the number of semantic variants grouped together around the prototypical core. The flexibility of prototypically organised lexical items is to a large extent the result of a mechanism of polysemisation (Geeraerts 1995: 123). The category *cloning* has exploited its polysemic potential several times in the course of its history.

(b) In Geeraerts' words "the conceptual organisation is not drastically altered any time a new concept crops up, but new facts are as much as possible integrated into the existing structure, which can thus remain largely unchanged" (Geeraerts 1995: 113). We shall illustrate the functionality of polysemy and the limits to the polysemisation of a prototypically structured category in the development of the language of the life sciences with the case of *cloning*. When and how the limits to the polysemisation process are reached can be illustrated with the case of *molecular cloning*.[37]

4.2.1.1 *The history of cloning*

The naming of the *methods for the amplification of a fragment of DNA* cannot be separated from the history of the lexeme *clone* in general nor from the history of the development of the life sciences (biology, medicine, biochemistry, genetics, molecular biology, biotechnology). Figure 4.4 is a schematic representation of the meaning extension of the lexeme *cloning* which entered the English language in 1903, both as a substantive *clone* and as its derived form *cloning*, indicating the technique. To understand the history of the lexeme one should know that people have been cloning plants since ancient times (Figure 4.4.A). A first technique consisted in taking one or several cuttings from a plant and having it (them) grow into full new plants.

> Clones have been commonplace in horticulture since ancient times. All individual MacIntosh apple trees, for example, are members of a clone, having been derived initially from a single mutated plant, and all share identical genes. A vast array of fruit and nut tree varieties and innumerable ornamental plants represent clones (Enc. Brit. 1974: 395).

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37. "**molecular cloning**–the multiplication of DNA sequences usually involving the isolation of appropriate DNA fragments and their in vitro joining (insertion into a restriction site) to a cloning vector capable of replication when introduced into an appropriate host. M.c. requires: (1) DNA of interest (foreign, passenger, or target DNA); (2) a cloning vector; (3) restriction endonucleases; (4) DNA ligase; (5) a prokaryotic or eukaryotic cell to serve as the biological host." (Rieger 1991: 333)

The principle of cell cloning is explained in the following quotation (Figure 4.4.B):

> The development of molecular biology represented a fusion of biochemistry and genetics. As has been discussed, most of the pioneer research in this field utilized microorganisms. The great strides made in genetic-biochemical analysis resulted basically from the ability to place an experimental organism on a culture dish containing agar (jellylike substance) and a nutrient medium supporting cell multiplication. The cells multiplied to produce discrete colonies. All the cells in a particular colony formed a *clone*; that is, they all had the same genetic constitution as the founding cell (Enc. Brit. 1990: 716).

In the late fifties scientists made it possible to clone plant cells (Figure 4.4.C). It allows plant biologists to produce a nearly infinite number of genetically identical plants from just a few cells.

> Cloning in plants is not new. Every time a gardener takes a cutting, he or she is producing a clone: a plant identical in every respect to its single parent. But some plants, palm trees for example, will not regenerate from cuttings. To clone them, cells are grown in a culture of nutrient material, multiplied, and encouraged to grow into thousands of new plants (Hawkes 1991: 14).

It will become clear that the cloning of animals asks for a different procedure altogether (Figure 4.4.D).

> During the second half of the 20th century, the possibility of producing identical animals by cloning generated popular interest in this biological phenomenon. Techniques for cloning animals were successfully demonstrated in amphibians. Using microsurgery, the nucleus from a body cell was transplanted into an egg cell (ovum) whose nucleus had previously been removed. The ovum was then induced to develop without fertilization; the resulting embryo was composed entirely of cells derived from the single implanted nucleus (Enc. Brit. 1974: 395).

It was the emergence of genetic engineering which made possible the cloning of genes (Figure 4.4.E). A wide range of technologies are involved in this, but most involve the recombinant DNA techniques. Thanks to a number of developments genetic manipulation became a reality.

> The cloning of a fragment of DNA allows indefinite amounts to be produced from even a single original molecule. (A clone is defined as a large number of cells or molecules, all identical with an original ancestral cell or molecule). The property that makes cloning of DNA possible is the ability of bacterial plasmids and phages to continue their usual life-style after additional sequences of DNA have been incorporated into their genomes (Lewin 1983: 300).

CLONING: 1. (A,B,C,D,G,H,I) the asexually produced progeny of an organism. 2. (E, F) a large number of identical copies of genetic material.

since when?	**what is cloned?**	**method?**	**number of copies?**
A. since the beginning of agriculture; named as such in English in 1903 (Rieger 1991).	plants	cutting grafting	one or a few or a large number of plants
B. 1929 (Barnhart 1988)	bacterial cells	cell cultivation	a colony of cells
C. 1939 (Smith 1988)	plant cells in order to achieve full plants	cell cloning and regeneration	ranging from one to thousands of plants
D. late 1940s (Levine and Suzuki	amphibians	enucleation	one or a few amphibians
E. 1973 (Cohen et al. 1973, Rieger 1991)	DNA	**molecular cloning**	a large number of DNA fragments
F. 1985 (by Saikai, according to Rieger 1991; by Karry Mullis according to Watson et al. 1992: 79)	DNA	PCR polymerase chain reaction	a large number of DNA fragments
G.1988 (Burton 1992: 15)	mammals	embryo splitting	two or more identical mammals
H.1988 (Hawkes 1991: 15)	mammals	nuclear transplantation. of embryo cell DNA into ovum	four or more identical mammals
I 1997 (by Wilmut, Nash 1997: 38)	mammals	nuclear transplantation. of body cell DNA into ovum	one or more identical mammals

Figure 4.4. *The development of cloning.*

The first principle to go by is the self-replicating capacity of the cell which is at the basis of gene cloning. The second essential new development was the ability to incorporate a fragment of DNA (a gene) of interest into the vector-DNA (e.g. a plasmid) of a bacterial cell and to introduce it into the bacterial host cell. This incorporated fragment would be reproduced with each cell division.

Polymerase chain reaction (PCR) (Figure 4.4.F) is the technique that first allowed a DNA fragment to be amplified without the help of a living organism.

> The polymerase chain reaction (PCR) is an in vitro method for selectively amplifying, or synthesizing millions of copies of a short region of a DNA molecule. The reaction is carried out enzymatically in a test tube and has been successfully applied to regions as small as 100 base pairs and as large as 6000 base pairs. In contrast, DNA cloning is a nonselective in vivo method for replicating DNA fragments within bacterial or yeast cells. Cloned fragments range in length from several hundred to a million base pairs (Cooper 1994: 128).

Animal cloning has three techniques: embryo splitting (Figure 4.4.G) and nuclear transplantation of the DNA of an embryo cell into an ovum (Figure 4.4.H) or of the DNA of a somatic cell into an ovum (Figure 4.4.I).

> One approach to cloning of mammals has proved to be very effective, however. **Embryo splitting** is a form of cloning in that individuals produced through use of this technique are genetically identical (Burton 1992: 32).

> Using miniature surgical tools, the nuclei from this cell cluster are removed and inserted into non-fertilised eggs of ordinary cows. These new embryos are then reimplanted into foster mothers, who give birth to identical calves. (Hawkes 1991: 15).

> From a cell in an adult ewe's mammary gland, embryologist Ian Wilmut and his colleagues managed to create a frisky lamb named Dolly, scoring an advance in reproductive technology as unsettling as it was startling (Nash 1997: 38)

Some meaning components relevant for distinguishing between several types of *cloning* are : (a) the *clone* resulting from the *cloning* activity can be **one** individual animal, plant (metaphorically also e.g. a computer (see 4.2.1.2.2)) OR the aggregate of asexually produced progeny, **a group** of individuals i.e. plants or organisms or DNA fragments produced asexually from one ancestor; (b) the *clone* can be produced naturally (twins) or artificially i.e. via human intervention (cuttings of plants) or in a laboratory for segments of DNA; (c) production happens asexually, there is only one ancestor; (d) the result is identical to the original; (e) living clones have the same genetic constitution. Figure 4.5 shows the two cores around which the understanding of *clone* is centred: clone **1**: the asexually produced progeny of an organism; clone **2**: a large number of identical copies of genetic material.

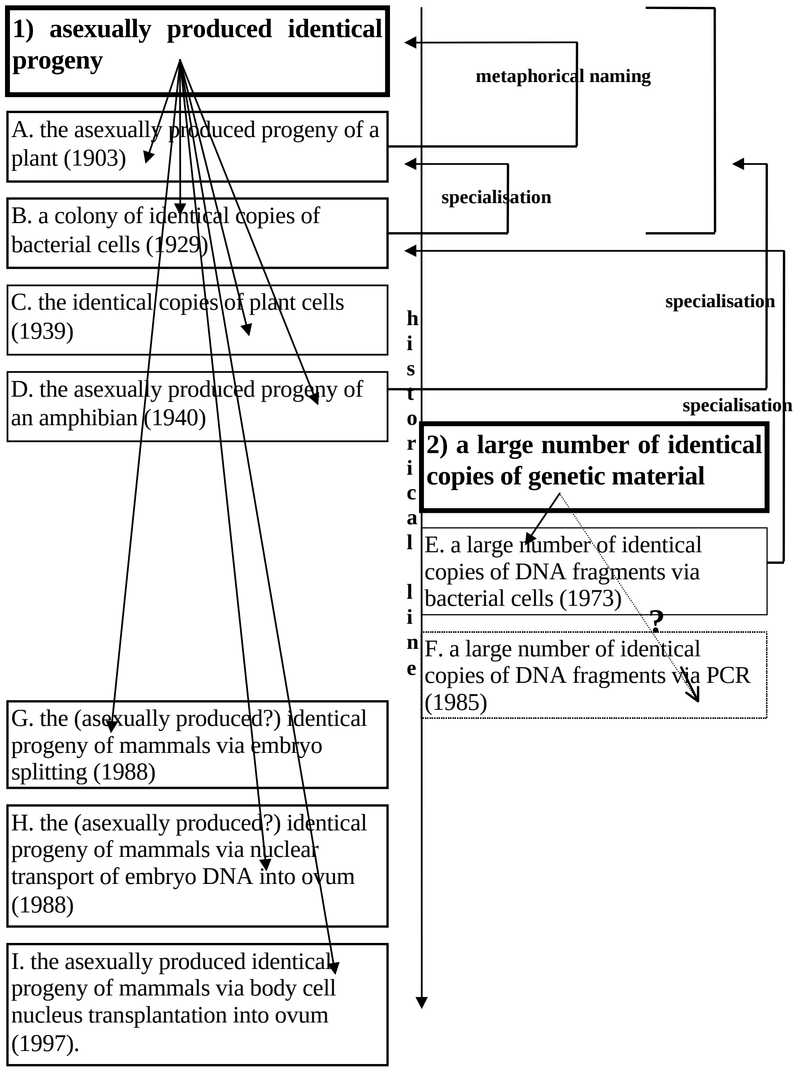

Figure 4.5. *Historical meaning evolution of clone.*

4.2.1.2 *The naming of molecular cloning*

The description of the history of *cloning* (4.2.1.1) has revealed the coming into existence of the category of *molecular cloning* to be a particular case. The two question we are trying to answer in this section are of an onomasiological nature. 1) Why are the methods developed in molecular biology for the amplification of a fragment of DNA named *cloning* or *molecular cloning* or *DNA cloning* or *gene cloning?* 2) Why has the term *cloning* recently been threatened to be replaced by its hyperonym *amplification*?

The reply to the first question i.e. why *molecular cloning* was named as such, has at least the following three aspects:

(1) Because *molecular cloning* related to the other types of *cloning* which had already existed for a long time when *molecular cloning* was developed.

(2) The relevant meaning element which *molecular cloning* had in common with all the other types of cloning which existed already was *'identical copy'*. The new element which was added to the meaning of *clone* because of *molecular cloning* was *'large number of identical copies'*.[38]

(3) *Molecular cloning* was named as such because it is a next step in the evolution of molecular genetics. This in contrast with PCR (polymerase chain reaction), the other new technique for obtaining a large number of identical copies, which was a development in enzymology.

The reply to the second question, i.e. why *cloning* is being threatened to be replaced by *amplification*, is twofold.

(1) A new method for making large numbers of exact copies — polymerase chain reaction (PCR) — is being developed, not in the molecular genetics line but in a different line of development, enzymology or biochemistry. Some writers refer to PCR as a special type of cloning whereas others would rather see it as a method for amplification, the hyperonym of both *cloning* and *PCR*.

(2) *Cloning* threatened to be replaced by *amplification* in the terminology of the life sciences as a consequence of the phenomenon of *generic posting*. The

38. "The cloning of a fragment of DNA allows indefinite amounts to be produced from even a single original molecule. (A clone is defined as **a large number of** identical cells or molecules, all identical with an original ancestral cell or molecule.) The property that makes cloning of DNA possible is the ability of bacterial plasmids and phages to continue their usual life-style after additional sequences of DNA have been incorporated into their genomes." (Lewin 1983: 300).

further development of language in other domains of life had its repercussions. On the one hand *cloning* was metaphorically borrowed by general language. The lexeme was used in more and more domains of life and may therefore have become overloaded.[39] As a consequence it is likely to become confusing (because of being too vague) in its scientific context and since synonyms and hyperonyms exist it will predictably be replaced by one of these. This is the case for *cloning* in its *molecular cloning* or *gene cloning* sense. The term we find it replaced by is mostly *amplification.*

Not only did the lexemes *clone* and *cloning* become overloaded as a consequence of polysemisation, they also started suffering from ambiguity. *Gene cloning*, which literally means the procedure of producing a large number of copies of a particular gene, also ends up being used as a synonym for *recombinant DNA technology* (which involves more and more new techniques under development as well) and for the aspect of gene cloning which made the procedure worthwhile: *gene splicing* (see Temmerman, 1998, Chapter 6)). So the term *gene cloning* is used at the same time in its literal sense, as a *pars pro toto* and as a *toto pro pars,* which obviously amounts to ambiguity.

We shall look at the twofold reply to question two (why *cloning* has been threatened to be replaced by a hyperonym) in more detail. First we describe the coming into existence of the new technique for making large numbers of exact copies: *polymerase chain reaction (PCR)* (Section 4.2.1.2.1) then we shall illustrate the generic posting phenomenon (Section 4.2.1.2.2).

4.2.1.2.1 *The invention of polymerase chain reaction*

PCR (polymerase chain reaction) is a technique developed in 1985 “which enables selective amplification of DNA sequences” (Nicholl 1994: 100) , but which is based on different principles and a very different process from molecular cloning.

> The polymerase chain reaction (PCR) is an in vitro method for selectively amplifying, or synthesizing millions of copies of a short region of a DNA molecule. The reaction is carried out enzymatically in a test tube (Cooper 1994: 128).

The categories *cloning* and *PCR* have the following two meaning elements in common: *amplification* and *identical copies*.

Before the development of PCR there was only one technique (though it

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39. Overloaded terms or words are used in too many different senses (Meyer 1992: 31).

had many different procedures or methods) for the amplification of DNA sequences, i.e. *cloning* with vectors in host cells; therefore the terms *amplification* and *cloning* were synonymous in most contexts. Because of the development of a new means for amplification this is no longer the case, and therefore we see a possible shift from the (near-) synonymy of *amplification* and *cloning* to superordination/subordination.

The question is whether *cloning* is still going to be used as a synonym of *amplification* after the invention of *PCR*. We found that for some authors this is clearly the case as they interpret the new technique (PCR) as a type of cloning or amplification (a). For others there are two types of amplification: *cloning* and *PCR* (b). Two possible interpretations of how PCR relates to other categories in the domain seem to be competing in the discourse of specialists.

(a) *Cloning* is sometimes found as a synonym of *amplifying* or *amplification* (Nicholl 1994: 102; Starr 1991: 165 & 169; Hodson 1992: 207; Watson et al. 1992: 79; Cooper 1994: 128). These authors interpret PCR as an alternative way of amplification next to cloning and reverse transcription (Figure 4.6). In the glossary at the end of Cooper's book it is made clear that the term cloning is only valid for "the production of many identical copies of a DNA fragment" by means of a cloning vector and a host cell. In the polymerase chain reaction a different process is involved:

> **molecular cloning**: The production of many identical copies of a DNA fragment by inserting the fragment into a cloning vector and propagating the resulting recombinant vector in a host cell (Cooper 1994: 334).
>
> **polymerase chain reaction** (PCR): An in-vitro process for producing many millions of copies of a DNA fragment. The process involves successive repetitions of a series of reactions and, when applied to a sample containing many different DNA fragments, can amplify one selected fragment (Cooper 1994: 335).

Techniques (methods) for the amplification of DNA fragments:

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a. methods for molecular cloning:
1. plasmid cloning
2. phage cloning
3. cosmid cloning
4. YAC cloning

b. reverse transcription

c. PCR

Figure 4.6. *The first of the two competing interpretations of the meaning relationship between molecular cloning and PCR.*

(b) But for other authors *(molecular) cloning* is a **hyponym (**Green 1991: 876; Bains 1993: 242) They consider PCR to be one possible cloning method (Figure 4.7).

Techniques (methods) for the amplification of DNA fragments
a. methods for molecular cloning:
1. plasmid cloning
2. phage cloning
3. cosmid cloning
4. YAC cloning
5. PCR
b. reverse transcription

Figure 4.7. *The second of the two competing interpretations of the meaning relationship between molecular cloning and PCR.*

In conclusion, we have given an example of a term which might or might not extend its meaning when new inventions or developments occur. *Cloning* might extend its meaning and the new technique (PCR) might be classified under *cloning*, referring to a new method (technique) for cloning. But an alternative scenario can be envisaged, as we have seen. The question is why *cloning* could go on polysemising several times in its meaning development before the occurrence of PCR and what makes PCR different from other techniques for amplification?

In specialised language *cloning* became so overloaded that in its sense of *molecular cloning* it shifted into the generic class and was replaced by amplification. This happened because new methods were being developed (such as PCR), as a result of which the emphasis was more and more on the 'large number of copies'-meaning component instead of on the 'identical copy'-meaning component. The 'identical copy'-core was not lost but was shifted in general language usage.

Our data show that the semantic overloading is part of a more general situation: generic shifting of *clone* from a special language term to a general word and generic posting in special language *(amplification)*. But other simultaneous developments could be observed in language which had their impact on the meaning and understanding of *cloning* as well as we show in the next section.

4.2.1.2.2 *Shifts in the semantic structure*

We can observe two types of shifts in the semantic structure of *cloning*. The first shift involves a metaphorical transfer of *cloning* from a term to a word. The second shift concerns generic posting. The metaphorical transfer of cloning is described in the following fragment:

> The word 'clone' has entered the vernacular; it can be found in newspaper articles, in novels and in poems, and it is heard on radio and television. Often it denotes a single, *perfect copy* of something — a person, an animal, an idea — but, this is not the way in which biologists generally use the word (Berg & Singer 1992: 89).

The figurative extension "exact duplicate, carbon copy, replica" is first recorded about 1978 (Barnhart 1988: 181). According to *The Oxford Dictionary of New Words* (1991) the lexeme 'clone' got a new sense or meaning extension during the personal computer revolution: in the 1980s.

> **clone.** arose during the eighties, as a number of microcomputer manufacturers attempted to undercut the very successful IBM personal computer (and later its successor, the PS2) (The Oxford Dictionary of New Words 1991: 64).

> a computer which deliberately simulates the features and the facilities of a more expensive computer; especially, a copy of the IBM PC (The Oxford Dictionary of New Words 1991: 64).

The new sense of *clone* is described as:

> a *specialization* of the figurative sense of clone which originated in science fiction: from the early seventies, a clone was a person or animal that had developed from a single somatic cell of its parent and was therefore genetically an identical copy. The computer clones were designed to be identical in capability to the models that inspired them (and, in particular, to run the same software) (The Oxford Dictionary of New Words 1991: 64).

In the metaphorising process from the domain of biology to the domain of computer language the new 'value-added' meaning component is the *cut price* of the computer clones, which in turn makes a new shifted meaning extension possible, as the lexeme is now also

> widely used for other cut-price copies (for example, of cars and cameras as well as other computers) (The Oxford Dictionary of New Words 1991: 64).

The criminal activity of providing mobile phones with the stolen number of a paying customer is called *phone cloning*,[40] *and the offending apparatus is called a clone phone*. To *clone a phone* is the action of 're-chipping' a mobile

40. We are indebted to professor J.C. Sager for this example.

phone with another number which belongs to someone else. This can be done after a suitable mobile phone number has been ‘scanned’ by some sophisticated electronic device (Channel 4 News Bulletin 18 April 1995).

The second shift in the semantic structure of English is a case of generic posting. The unit of understanding *cloning* gradually applies to a wider range of organisms, then becomes generic for this kind of process while the more specific processes of duplicating plants, animals, etc. for the moment retain the word (but may eventually develop their own). The result is that we have at least temporarily, a broad common unit of understanding called ‘cloning’, which applies to all forms. Next to it we have separate more specific units of understanding, with their own features, but still called ‘cloning’. These units have their own partially common and partially distinct subunits, which will have some distinct names and some names in common. The result is homonomy which may eventually be eliminated when techniques develop sufficient distinctiveness as their own specialists are working on them. The unit of understanding ‘cloning’ and its parallel ‘clone’ is then likely to remain as a general abstraction, a superordinate term, becoming broader and more vague as more detailed units of understanding spring up under this umbrella. At the same time, for contexts where precision really matters a different sort of generic posting occurs: *amplification* can be a generic term for both cloning and PCR.

We suppose that diversification of terminology begins when groups of specialists see the need for clearer differentiation.

Eventually scientists discover that the generic unit ‘clone’ no longer serves a useful purpose and then rewrite history, telling us that certain terms were originally wrongly used or wrongly understood and that for the current state of knowledge a new terminology will make the differences clearer. Such work may then lead to further splits, this time between the popular name for a group of processes and the scientific names which signify that these processes have little in common, or not enough, at least, to be united by a superordinate concept.

4.2.1.3 *Conclusion*

We can conclude that there is ample evidence in this example of *molecular cloning* and *PCR* for the functionality of the development of polysemy. Because *understanding* is never a static situation but a constantly changing process in time which is aimed at progress, there is a constant development in what a term can be used to refer to. The three aspects of the semantic triangle (see 2.3.2) are subject to continuous change. The reality we experience in the world evolves, the way members of a language community understand the world may differ (slightly) from person to person, and the terms (words) which are used to denominate a chunk of knowledge and understanding cannot be said to have a clear-cut reference as their meaning (the way they are understood) varies and evolves.

We found that there are limits to the informational density of cloning. We discovered that the structural stability of language can be challenged when two different frames of understanding start hindering the comprehension. We also learned that the flexible adaptability of a lexeme appears to be restricted by competing frames of understanding.

4.2.2 *Synonymy is functional*

(Near-) synonymy exists because the mechanisms for naming can trigger several possible lexicalisations. Slightly different perspectives result in near-synonyms. The univocity ideal of traditional Terminology consists of trying to eliminate some of the near-synonyms and indicating a preferred term. The underlying idea is that to have several terms for the same concept/category is undesirable as it implies an impediment for unambiguous communication. The functional aspect of synonymy in a discourse community is overlooked.

Starting from the example of *Southern blotting* we can illustrate the functionality of synonymy and show that the reason why synonymy is functional may be that the different elements which are at the basis of synonymous lexicalisations were present in the initial situation when the technique was being developed. The question we should like to try to answer is: what is the functional advantage of having three near-synonymous terms, namely *(Southern) blotting*, *(Southern) transfer*, and *(Southern) hybridisation*.

Southern blotting is the commonly used term for the technique developed by E.M. Southern which involves the

> transfer of single-stranded, restricted DNA fragments (=Southern transfer), separated in an agarose gel, to the nitrocellulose filter (or other binding matrix) which is then analyzed by hybridization to radioactive or biotinylated single-stranded DNA or RNA probes. The hybrids are detected by autoradiography or a color change, respectively. S.b. reveals details of sequence organization (Rieger 1991: 454–5) (see also Chapter 3).

In a paragraph entitled “Probes to find cloned genes” we find the following description of *Nucleic Acid Hybridization*:

> Nucleic Acid Hybridization. Under the appropriate conditions two complementary single-stranded nucleic acids will spontaneously form base pairs and become double-stranded. If single-stranded, nonradioactive DNA *is fixed tightly to a filter* and then incubated in a solution containing single-stranded, radioactive DNA, double-stranded regions will form where the two types of DNA have complementary nucleotide sequences; the radioactive DNA will become indirectly bound to the filter through its attachment to a specific region of nonradioactive DNA. By measuring the amount of radioactivity bound to the filter, one can estimate the relatedness between two DNA’s (Drlica 1984: 68).

In this fragment from Drlica (1984), the process of what is commonly known as *Southern blotting* is described but the term is not introduced, instead the hyperonym *hybridization* is used.

As Grinsted and Bennett (1988: 150) write:

> **The general technique to determine homology is hybridization,** in which single-stranded DNA reanneals with complementary strands. […] it is simpler to do all of the hybridizations together. This is achieved by denaturing the fragments in the gel (i.e. making them single-stranded) and then transferring them to a filter to which they are irreversibly bound. *This is called a* ***Southern transfer****, after the inventor of the technique. (It is also called ‘****blotting****’, because of the details of the technique*.).

	motivation
Southern blotting	the **result** of the technique is a blot on a filter
Southern transfer	the **process** of transferring the denatured (single stranded) fragments from a gel to a filter
Southern hybridisation	the **principle** of the technique: single stranded DNA reanneals with complementary strands

Figure 4.8. The motivation for the synonymous naming of Southern’s technique.

The naming of Southern’s technique is motivated by (at least) three aspects of the (encyclopaedic) information concerning the technique (see Figure 4.8). Depending on which of the three elements a language user wants to stress in a particular context the use of one or another of the synonyms can be appropriate for more nuanced communication.

The reason why synonymy is functional is shown by the presence of the three elements for alternatively motivated names in the original texts on the method. E.M. Southern described his technique in two articles: 'Detection of Specific Sequences Among DNA Fragments Separated by Gel Electrophoresis.' (1975) *Journal of Molecular Biology*, 98, 503–17; and 'Gel Electrophoresis.' (1979) *Methods in Enzymology*, 68, 152–76. Southern does not refer to his own technique as '*Southern blotting'*. Modesty or 'good manners' must be the explanation. In the 1979-volume of *Methods in Enzymology,* in which Southern publishes his second well-known article, he does not use the term *Southern blotting* for his own method whereas other authors in the same volume consistently do, e.g. Szostak, J. et al. 'Hybridization with Synthetic Oligonucleotides.':

> In this chapter we describe procedures for the use of synthetic oligonucleotides for *Southern blot experiments* and gene bank screening, and demonstrate the effect of various mismatches on the efficiency of hybridization (420).

> DNA fragments were transferred to nitrocellulose paper (Schleicher and Schuell) by the *blotting procedure of Southern* (…) (421).

Southern likely feels that it would be inappropriate to refer eponymously to his own method. His modesty also shows in the section entitled 'Detection of Specific Sequences.' (157) in which he gives a survey of the methods available to identify a particular sequence in DNA fragments separated by gel electrophoresis; and mentions his own method last, even though his method (the Southern blotting technique) chronologically was the first one developed in time (1975) (protein: 1976; RNA: 1977). However, his summary description of his own method is very accurate and contains the three elements which served in naming the technique: *transfer*, *blotting* and *hybridization* (157–58).

> (…) DNA may be **transferred** from the gel to a sheet of cellulose nitrate, retaining the original patterns. The sheet of cellulose nitrate is laid against the gel, and solvent **blotted** through it by stacking absorbent paper on top. DNA is carried out of the gel by the flow of solvent and trapped in the cellulose nitrate paper, which is subsequently used for **hybridization** using well-established methods.

So all the elements for naming Southern's technique *Southern blotting*, *Southern transfer* or *Southern hybridization* were present in his own description of the technique.

4.3 Conclusion. The consequences for terminography

With the examples of *cloning* and *blotting* we showed the functionality of polysemy and synonymy. These facts conflict with the univocity ideal in traditional Terminology.

We propose, therefore, a diversification in the methodology of terminography. 1) A distinction has to be made between different units of understanding. In the case of a clear-cut concept the univocity principle may remain valid. For categories showing characteristics of a prototype structure, methods and principles have to be developed for acknowledging the existence of polysemy and synonymy in the description of meaning. In order to make this possible a re-evaluation of what is traditionally referred to as encyclopaedic information is essential, as we showed in Chapter 3.

Terminology as a scientific discipline needs to open up to methods for studying the role of language in the creative process of the growth of knowledge. From linguistics it could borrow precise methods for research such as the method explained and exemplified by Geeraerts for the description of diachronic change based on corpus analysis and partially applied here in the description of *molecular cloning* (for a second example see Temmerman 1998, Chapter 6 on *splicing*).

Polysemy appeared to be the synchronic result of diachronically increased informational density as a consequence of the evolution of a unit of understanding, of the flexible adaptability of categories which have prototype structure and of the dynamics of structural stability in language. The development of PCR (polymerase chain reaction), a method for amplification of nucleic acids, provided us with evidence for these three functional factors in the evolution of understanding.

The informational density of ***cloning*** appeared to reach its limits of efficiency and effectiveness for two reasons — an intracategorial and an intercategorial one. The intracategorial reason may be that the lexemes *clone* (as a noun and as a verb) and *cloning* became overloaded as a result of metaphorical extension in many different general language contexts (e. g. *He is an Elvis Presley clone. My computer is a clone. You can clone a phone.*). The intercategorial reason is that in the molecular biologist's laboratory a new method for making large numbers of identical copies was introduced which was created outside the existing molecular biologist's frame of understanding. This new method (PCR) was developed by biochemists, more specifically by enzymologists who were working in a different frame of understanding, as they are specialists with a background in biochemistry rather than in molecular biology and genetics. It is the confrontation of this same unit of understanding, named from the vantage point of two different frames of understanding which challenges the structural stability of the language system. The fact that by some PCR is considered to be a type of cloning while for others it is a different method of amplification, next to cloning, is evidence for Geeraerts' hypothesis that before lexical differentiation occurs, the possibility of a conceptual merger is checked. The flexible adaptability of *cloning* and *clone* appears to be restricted within a particular frame of understanding (the biology one) and can only be extended metaphorically, like in *computer clone*.

The functional advantage of univocity was taken for granted by traditional Terminology. The reasons for polysemy in some categories of the life sciences show that functional advantage is a dynamic and ongoing process, which is linked to progress of understanding. Progress of understanding forces words into flexible adaptation. The flexible adaptability of a lexeme is restricted by the structural stability of conflicting frames of understanding.

CHAPTER 5

The Impact of Metaphorical Models on Categorisation and Naming

> Indeed, the utility of theory-constitutive metaphor seems to lie largely in the fact that they provide a way to introduce terminology for features of the world whose existence seems probable, but many of whose fundamental properties have yet to be discovered. Theory constitutive metaphors, in other words, represent one strategy for the accommodation of language to as yet undiscovered causal features of the world. (Boyd 1979: 364)

> The interest of theoretical semanticians working within the framework of Cognitive Semantics for the study of meaning changes derives from their interest in polysemy, if only because the synchronic links that exist between the various senses of an item coincide with diachronic mechanisms of semantic extension such as metaphor and metonymy. (Geeraerts 1995: 7).

> Genetics is itself a language, a set of inherited instructions passed from generation to generation. It has a vocabulary — the genes themselves — a grammar, the way in which the inherited information is arranged, and a literature, the thousands of instructions needed to make a human being. The language is based on the DNA molecule, the famous double helix, which has become the icon of the twentieth century. Both languages and genes evolve. Each generation there are mistakes in transmission and, in time, enough differences accumulate to produce a new language — or a new form of life. Just as the living tongues of the world and their literary relics reveal a great deal about their extinct ancestors, genes and fossils provide an insight into the biological past. We are beginning to learn to read the language of the genes and it is saying some startling things about our history, our present condition and even our future. (Jones 1993:xi)

In Chapter 3 we took a semasiological approach to the study of categories in the life sciences by starting from the terms that designate units of understanding and investigating how these units of understanding and their designations get defined and explained in texts. In texts, concepts do not often appear as clear-cut entities (of an objective world) which can be clearly delineated from one another and defined by indicating a superordinate concept and giving the characteristics which distinguish the concept from related concepts in a concept system. We showed that most units of understanding have prototype structure, both intensionally and extensionally and that units of understanding are experiential rather than objective.

In Chapter 4 we adopted a combined semasiological and onomasiological approach in trying to determine the functionality of univocity (monosemy and mononymy) and polysemy. Our hypothesis was that the desire for univocity and that for diversity are two opposing but counterbalancing forces which both have a functionality in language. In the 'cloning' example we also studied a complex case of extension of reference and its limiting factors.

In this chapter we investigate the mechanisms behind the urge for better and new understanding. Our hypothesis is that these are generally related to and inspired by metaphorical reasoning. The existing frame (Fillmore) or Idealised Cognitive Model (ICM) (Lakoff) of a source domain of understanding is used to structure and categorise a target domain. The metaphorical model is an underlying schema which is not fully expressed propositionally and lexically. The proof and results of metaphorical thinking are in the metaphorical lexicalisations. We challenge the principle of traditional Terminology which claims that because unambiguous communication is the ideal for special language communication, it is preferable to replace a metaphorical term by its literal equivalent. We show how in the life sciences the gestalt-like metaphorical ICM (m-ICM) which was at the basis of better understanding and new discovery continues to have an important role in didactic as well as in scientific texts which treat the same or related subjects. Therefore, instead of promoting the curtailing of metaphorical language in scientific discourse, as the principles of traditional Terminology suggest, one might even consider encouraging metaphor for the sake of progress in understanding. More research on the process of metaphorical understanding and its relevance to language is needed. The discipline of Terminology could work out guidelines for the description of metaphorical models starting from the metaphorical lexicalisations which are the traces which metaphorical thinking leaves in a language.

In this chapter we intend to give an example of how the source and target domains of analogical thinking — which are at the basis of metaphorisation —

can be traced in the domain of the life sciences. The traces of this analogical thinking are in the textual archives of the domain. The analogical thinking can be traced from the metaphorical lexicalisations present in the lexicon of a language and it can be brought to a conscious level and explicitly explained. Attempts have been made to get more insight in the inter-relatedness of metaphorisations occurring in the language of a particular domain of experience, i.e. to trace metaphorical cognitive models (Lakoff & Johnson 1980; Lakoff 1987; Johnson 1987; Liebert 1992, 1995a, 1995b, 1996).

In what follows we shall first define what we mean by metaphor and then give an overview of how metaphor has been studied from different perspectives so far (Section 5.1). We claim that in contrast to what the traditional schools of Terminology believe, metaphor research in special language has relevance for Terminology (Section 5.2). In Section 5.3 we discuss different approaches to metaphor in linguistics. We distinguish between the pre-structuralist era (Section 5.3.1), the structuralist tradition (Section 5.3.2) and cognitivist-experientialist semantics (Section 5.3.3). In Section 5.4 we contrast an example of the description of metaphor in special language in a structuralist framework (Assal 1992) to two studies of metaphor in special language in a cognitive semantics framework: Liebert (1995a, 1995b, 1996, 1997 (forthcoming)) and what we are doing in this work. In Section 5.5 we show how the underlying metaphorical ICM concerning the understanding of genetics is **information.** This m-ICM has several sub-m-ICMs like DNA IS A LANGUAGE (Section 5.5.1), DNA IS INFORMATION IN AN ATLAS OF MAPS (Section 5.5.2), DNA IS SOFTWARE (Section 5.5.3) and DNA IS A TAPE OF FILM (Section 5.5.4).

Apart from providing us with evidence showing the existence of an m-ICM and providing us with the data for the description of a systematic analysis of metaphorical neolexicalisations, the case study will also furnish evidence supporting the following two issues.

One, the lexicalisations which can be interpreted as resulting from sub-m-ICMs help to distinguish between creative and educational metaphor (5.6).

In studying the vocabulary of a new discipline like the life sciences, it makes sense to look for the m-ICMs and to see how the underlying m-ICMs leave their traces in a number of lexicalisations. These m-ICMs have prototype structure in the sense that they have more and less typical lexicalisations: some lexicalisations will occur regularly and be shared by most of the specialists, and other lexicalisations are ideolectical, which means that they occur in the lexicalisation practice of only one or a few language users who are trying to explain something by elaborating on the m-ICMs and making them more explicit. Whereas the first class of lexicalisations will become part of the specialised language of the domain under consideration and will consequently turn up in dictionaries and encyclopaedia, the ideolectical lexicalisations do not normally become part of the lexicon of the language. This is essential in the distinction between creative and didactic metaphor. Another point is that many educational metaphors can only work in as far as they are further or analogue explicitations of the underlying m-ICMs.

Metaphorical naming is the first proof for the existence of an underlying m-ICM. New units of understanding occur and are named in accordance with it. Didactic metaphors offer a second proof of the existence of ICMs when they show further or alternative elaborations on the same m-ICM, which results in more neolexicalisations.

Two, the claim of traditional Terminology that it is better for the linguistic sign to be arbitrary[41] instead of motivated in order to assure univocity and to avoid polysemy, has to be refuted (5.7.). If cognition and language are seen as intertwined faculties, then a large number of linguistic signs that are structured in an m-ICM show systematicity and hence are motivated. This does not imply, however, that the development is predictable. Terminological theory might want to get more insight in how m-ICMs influence the process of categorisation. We also claim that progress in understanding via analogical thinking cannot be cut loose from the history of the interaction of social circumstances and science and from the history of technological development which can help research progress.

The objectivist structuralist credo of traditional Terminology offered no tools for dealing with metaphor, which was treated as unwanted and belonging to figurative language which had to be replaced by literal equivalents, as it was an impediment for scientific thinking. Experientialism ventures to study the influence of metaphorical models on categorisation and understanding in science.

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41. The Saussurian principle of the arbitrary character of linguistic signs concerned the absence of motivated links between sound and concept. Yet, “The arbitrariness of the linguistic sign and the systematic character of phonology notwithstanding, the meaning of linguistic utterances still derives from the meaning of their components, the words.” (Pavel 1989: 29). Experientialism tries to find new explanations for motivated naming.

We want to show that sociocognitive Terminology, in replacing the objectivist paradigm by the experientialist paradigm, can come to a better understanding of metaphorisation as a process. This may have consequences for terminological description (Section 5.8).

5.1 A definition and an overview of the theories of metaphor

Metaphor can be considered a multidimensional phenomenon. Whereas before, metaphor was thought to be either a deviant form of expression or a nonessential literary figure of speech, in the last decades metaphor has achieved a remarkable prominence as an important problem of philosophy, psychology, linguistics and other cognitive sciences. Metaphor in language and in thought has been studied in an interdisciplinary way for a few decades now (Ortony (1979); Lakoff and Johnson (1980); Paprotté and Dirven (1985); Johnson (1987); Lakoff (1987); Kittay (1987), Gentner (1988), Way (1991); Indurkhya (1992), Liebert (1992)).

The term ‘metaphor’ “is often used to refer to nonliteral comparisons that are novel and vivid and that convey ideas that are otherwise difficult to express”(Ortony 1975; in Gentner et al. 1988: 171). As Lakoff and Johnson (1980) have shown, metaphor is not a matter of language alone but “The essence of metaphor is understanding and experiencing one kind of thing in terms of another”(5). For our purpose of studying the role of metaphor in Terminology we distinguish between *lexeme metaphor*, *category metaphor* and *domain metaphor* (Liebert 1995a).

By *lexeme metaphor* we mean that there is a pair of lexemes, a: the source lexeme, and b: the target lexeme. Lexeme b is the projection of lexeme a. An example is b: *source of income* which is the projection of a: *source of a waterway*.

By *category metaphor* we mean that there is a pair of categories, a: the source category and b: the target category. Category b is the projection of category a. A category is understood within a frame or ICM. This means that for a *category metaphor* the source ICM may have its impact on the target ICM. A category is the set of a (number of) lexeme(s) and an intercategorial and intracategorial structured frame or cognitive model. Liebert calls this a ‘concept metaphor’ but because in Chapter 3 we distinguished between *concept* and *category* we prefer to talk about *category metaphor*. The example

Liebert gives of what we call a category metaphor is the following. If the frame or cognitive model for a linear waterway is <beginning, *>,<trajectory, *>, <end, *>, and we have a set of lexemes [source, river, sea, rain, clouds], then the slots which have been indicated by * can be filled in the following way: <<beginning, “source”>, <trajectory, “river”>, <end, “sea”>>. This category is then projected onto the category *circulation of money:* <<<beginning, “source”>, <trajectory>, “river”, <end, “sea”>>, <<beginning, “source of money”>, <trajectory>, “flow of money”>, <end, *>>>.

By *domain metaphor* we mean that there is a pair of domains a and b and the categories which belong to domain a are projected onto the categories which belong to domain b. Domain a and domain b consist of a set of categories. The example Liebert (1995a) gives is of the domain *water* having the categories *linear waterway* and *water circulation* and the domain *money* with its category *circulation of money*. The domain metaphor <water, money> implies a projection of the categories *linear waterway* and *water circulation* onto the category *circulation of money*. <<{linear waterway, water circulation}>, <{circulation of money}>>. In these definitions metaphor is seen as a phenomenon in which categorisation, analogical thinking, creativity and linguistic expression meet. Metaphor has not always been understood in that fashion. In the following we try to highlight some of the important ideas in the understanding of metaphor.

No matter how brief our overview is meant to be, we must start with Aristotle’s legacy to the present-day student of metaphor. He defines metaphor as a name given to something but properly belonging to something else (Way 1991: 7). He believes metaphor is implicit comparison, based on the principles of analogy. In modern terms this view is called the **comparison theory** (Ortony 1979: 3). Aristotle also sees metaphor as a kind of deviance from normal usage, its role being only ornamental. Therefore it should be possible to replace a metaphor by its equivalent literal expression. This brings Aristotle also close to the **substitution theory** which is defined by Way (1991: 23) as “any view which holds that a metaphorical expression is used in place of an equivalent literal expression and is, therefore, completely replaceable by its literal counterpart”.

The third type of theory which is mentioned in a number of publications (Ortony (1979), Way (1991), Indurkhya (1992)) on the history of theories for metaphor is the **interaction theory**. This theory was first proposed by Black

(1962)[42] and then developed by himself and by many other authors. The basic idea is that metaphors can create similarities that previously were not known to exist. Black believes that some metaphors can function as "cognitive instruments" (Ortony 1979: 5).

The theory developed by Lakoff and Johnson (1980) and further developed by Johnson (1987) and Lakoff (1987) is also interactionist. It goes beyond the language level by considering an extra dimension: the non-propositional image-schematic dimension. Lakoff and Johnson react against *objectivism* and want to replace it by *experientialist.* The objectivist view of metaphor holds that

> the objective world has its structure, and our concepts and propositions, to be correct, must correspond to that structure. Only literal concepts and propositions can do that, since metaphors assert cross-categorial identities that do not exist objectively in reality. Metaphors may exist as cognitive processes of our understanding, but their meaning must be reducible to some set of literal concepts and propositions (Johnson 1987: 67).

This objectivist view of metaphor has to be seen in the framework of "realism" (Ortony 1979: 1) as opposed to "relativism". Realism was dominant in logical positivism.

> A basic notion of positivism was that reality could be precisely described through the medium of language in a manner that was clear, unambiguous, and, in principle, testable — reality could, and should be literally describable. (Ortony 1979: 1)

However, an alternative approach is possible (relativism) in which "any truly veridical epistemological access to reality is denied" (Ortony 1979: 1). This relativist approach is also known as *constructivism* (Ortony 1979: 1) or *experientialism* (Johnson 1987). The central idea is that cognition is the result of mental construction based on experience. The framework of Lakoff and Johnson's research has come to be known as *cognitive linguistics*, i.e.

> an approach to linguistics and the humanities which does not separate the categories set up by any human language from those set up by our general cognitive faculties for abstraction and imagistic representation, but rather sees the integration of both in a specific socio-cultural environment (Dirven and Paprotté 1985:viii).

42. The distinction between comparison, substitution and interaction theories of metaphor was first proposed by Black (1962).

Johnson distinguishes between three standard theories of metaphor: literal-core theories, metaphorical proposition theories, and nonpropositional theories. In literal-core theory, metaphors are believed to be cognitively reducible to literal propositions. Metaphor is treated as a literary device. Comparison or similarity theories fall into this category (A is like B in certain definite respects). Metaphors in this view have no role in the generation of experiential structure. Metaphors are "devices for indirectly reporting on pre-existing objective states of affairs." (Johnson 1987: 68).

Metaphorical proposition theories defend the creativity thesis of metaphor which says that metaphors actually structure our perceived world or as Max Black formulated it: "metaphor creates the similarity" (Johnson 1987: 69). As Johnson points out, Black did not provide a sufficiently detailed account of how it is that metaphor can be creative. Johnson argues that one must treat metaphors as operating in a non-propositional image-schematic dimension where structures emerge from our experience. "That would constitute genuine creativity, in that metaphor would be taken as a mode of activity in the structuring of experience" (Johnson 1987: 70).

In the non-propositional or image-schematic dimension, metaphor has a distinctive cognitive force which we cannot explain merely by reference to lists of propositions. Metaphor is not in the first place studied as a language phenomenon, "a deviant form of expression or a nonessential figure of speech" (Johnson 1987: 66), but as a fundamental process at the *cognitive level*, the nonpropositional level at which metaphorical projections can be experientially creative. The example of "balance" is used by Johnson (1987: 73–99) to show that metaphor is a matter of structuring our experience, not just our reflection of already existing structures. Johnson finds out about preconceptual schemata via figurative expressions in language. He shows that the several different senses of the term *balance* are connected by metaphorical extension of balance schemata, and that we cannot understand the various meanings of *balance* without focusing on preconceptual gestalt structures within our network of meanings. The view of metaphor that emerges goes beyond the view of traditional theories. Metaphor is treated as a matter of projections and mappings across different domains in the actual structuring of our experience (and not just in our reflection on already existing structures). Johnson developed the notion of "preconceptual gestalt (or schematic) structures that operate in our bodily movements, perceptual acts, and orientational awareness. […], the image schema is not an image. It is, instead, a means of structuring particular experiences schematically, so as to give order and connectedness to our perceptions and conceptions" (Johnson 1987: 75). Lakoff refers to this non-propositional level as the **metaphorical ICM** (m-ICM).

In studying the *parole* of the life sciences in texts written by field specialists we have been looking for linguistic expressions and lexicalisations which furnish proof of the image-schematic dimension of metaphor. We want to investigate the possible impact of the m-ICMs hypothesis on the theory of Terminology. Therefore we need to start from what traditional Terminology had to say on metaphor.

5.2 Metaphor in traditional Terminology

In their first chapter of *Metaphors we live by* (1980) Lakoff and Johnson formulate the two elements which are of relevance for our criticism against how metaphor is dealt with in traditional Terminology: firstly,

> metaphor is for most people a device of the poetic imagination and the rhetorical flourish — a matter of extraordinary rather than ordinary language (3).

and secondly,

> metaphor is typically viewed as characteristic of language alone, a matter of words rather than thought or action (3).

We have not found explicit rejection of metaphor as a device of the poetic imagination in the formulation of the principles and methods of traditional Terminology. However, we have found traces of the implicit (Felber) and the explicit (ISO TC 37) belief that for traditional Terminology, metaphor is only relevant as an aspect of language's **naming capacity**.

Felber (1984) does not use the term metaphor but does mention "borrowings from the same language" (175) when discussing "terms".

> Sometimes it proves to be useful to attribute a modified meaning to a term current in another subject field provided this field is sufficiently remote to avoid ambiguity. Such a term is called transferred term (sic) (175).

One of Felber's examples is: "the terms "information" and "code" were introduced in genetics with modified meanings"(175). Felber does not comment on the role the interpretation or understanding of genetics in terms of "information" and "code" played in the creative aspect of scientific thinking. In his analysis the thinking and understanding had been accomplished before a term was allocated. The reason why — according to Felber — this *term based on transfer* is assigned to the concept and not a different *literal term* is that "a skilfully chosen transferred term may be more concise than a specially constructed complex term" (175). The word *metaphor* is not even mentioned by Felber. For him the transferred term is only of importance for the naming of a concept which ideally happens independently of the understanding of the concept (for the sake of avoidance of polysemy (see Chapter 3)). The concept itself — traditional Terminologists like Felber believe — comes about independently of language. He believes this is the case because the concept should exist in a clear-cut, objective way, being part of the one and only real world. At the same time the transfer element is considered to be only part of language in its naming capacity. In this chapter we will show how the *information m-ICM* was at the basis of a new understanding of genetics. A list of lexicalisations were the result of understanding via this m-ICM.

In contrast, the term "metaphor" does occur in ISO/TC 37/SC1/cd 704.2 N 133 95 EN. It is defined as a term formation method in interdisciplinary borrowing.

> In interdisciplinary borrowing, a word from general language or a term from another subject field is borrowed and assigned a new concept (26).

The examples given are: "memory (capacity of the human brain); memory (temporary storage capacity of a computer)" and "mouse (small rodent); mouse (computer/operator interface device)." Even though the ISO/TC37 standard points out that "Interdisciplinary borrowing utilizes individual characteristics of the original concept (or meaning) in a **metaphorical manner**, which is a source of polysemy in both general and special language" (26), it does not offer principles for a systematic description of metaphor in a particular domain. Suggestions on how to study and describe metaphor in a systematic way are given by Lakoff and Johnson (1980) and Lakoff (1987). Unlike adherents of objectivist traditional Terminology, who believe that special language communication can benefit from ruling out metaphor, these linguists claim that metaphor is pervasive in every aspect of understanding, not just in language but also in thought and action. "Our ordinary conceptual system, in terms of which we both think and act, is fundamentally metaphorical in nature." (3). Based on their suggestions for analysis and description of metaphor, we offer an alternative interpretation for the occurrence of the terms information and code (see Section 5.5.1) in genetics. These terms were not just "introduced in genetics with modified meanings" (Felber 1984: 175). They are the result of understanding and naming on the basis of a "Metaphoric Idealised Cognitive Model" (m-ICM) (Lakoff 1987) which played in the new understanding of genetics as information. Lakoff's (1987) main thesis is "that we organize our knowledge by means of structures called idealized cognitive models or ICMs, and that category structures and prototype effects are by-products of that organization." (68). According to Lakoff's experientialist approach to cognition, there are two types of directly meaningful concepts: basic level concepts and image-schematic concepts. They are directly meaningful because our bodies are structured in such a way that we are capable of perceiving certain objects, actions and properties directly as gestalts, i.e. conceptual units. It is important to note that the image-schematic concepts themselves structure the basic-level concepts. Therefore we can look at the cognitive models as consisting of elements structured by image schemas. The cognitive models can be subdivided into ICMs using non-imaginative devices and ICMs using imaginative devices.

The following belong to the cognitive models using non-imaginative devices: a. Kinesthetic Image Schemas (container, part-whole, link, centre-periphery, source-path-whole, up-down, front-back, etc.); and b. Propositional Idealized Cognitive Models (simple propositions, scenarios, feature bundles, taxonomies, and radial categories (282–304).

The following belong to the cognitive models using imaginative devices: a. Metaphoric Idealised Cognitive Models and b. Metonymic Idealized Cognitive Models.

According to the experientialist theory metaphorisation is achieved by partial mapping of some ICM structure in a source domain onto a corresponding structure in a target domain. For easy reference we shall distinguish between on the one hand the primary (or source) domain (which can be literal or metaphorical) and on the other hand the secondary (or target) metaphoric domain.

The **information** m-ICM has (at least) four sub-m-ICMs which show in several metaphorical namings: sub-m-ICM one: GENETIC MATERIAL (DNA) IS A LANGUAGE, sub-m-ICM two: THE TOTALITY OF THE GENETIC MATERIAL (THE GENOME) OF AN ORGANISM IS AN

ATLAS OF MAPS, sub-m-ICM three: GENETIC MATERIAL (DNA) IS THE SOFTWARE OF THE CELL, sub-m-ICM four: GENETIC MATERIAL IS A FILM-TAPE.

As our conceptual system is not something we are constantly consciously aware of, one way to find the m-ICMs which structure part of our understanding is to look for their traces in language (parole). We have been searching textual material concerning the life sciences for *lexeme metaphors*. Yet, the analysis which will be offered in Section 5.5 only takes lexeme metaphors as a starting point. We made use of three types of information to get from these lexeme metaphors to category metaphors and domain metaphors. Firstly, we made inferences from the set of lexeme metaphors we could observe in our text corpus. Secondly, we used the explanations of and comments on the metaphors they live by which specialists give in their texts. We have paid special attention to what we have called reflective text fragments. Thirdly, we consulted texts on the history of the life sciences. These three sources of information allow for the postulation of category metaphor models and domain metaphor models which must have played in the process of understanding.

Before presenting the analysis of the data encountered in our corpus we give an overview of the interpretation of metaphor by a number of linguists.

5.3 Metaphor in linguistics

Whereas in Section 5.1 we discussed the interdisciplinary approach to metaphor, in this section we consider how metaphor has been treated in linguistics. We distinguish between three periods: the period before Saussurian structuralism, the structuralist era and the cognitivist-experientialist era, which has known a dramatic upsurge thanks to the works of Lakoff and Johnson (1980), Lakoff (1987) and Johnson (1987), even though some of the ideas promoted by these authors had been uttered by e.g. the German linguists Trier and Weinrich in their ‘semantic field’ approach and in Dornseiff’s onomasiology approach (Liebert 1995a).

5.3.1 *The pre-structuralist era*

In the historical-philological tradition metaphor was basically studied as one class in the classification of lexical meaning change. The emphasis was on the search for the causes of these meaning changes (Geeraerts 1986: 13–66). Metaphor was described as implying conceptual transfer based on resemblance. The nature of the resemblance allowed for a classification of types of metaphors like the distinction that is made between material metaphors (the leg of the table), functional metaphors (the source of my worries) and experiential metaphors (a heavy voice) (Geeraerts 1986: 47). Of course many different classifications based on different criteria were possible. Moreover some metaphors could be classified in more than one category.

It was the aim of historical semantics to gain insight into the mechanisms which enable human beings to think in terms of resemblances. They recognised that this capacity to think by comparison is at the base of human knowledge. As Geeraerts indicates (49), an essential premise is that these metaphors cannot be reduced to simple types as a crucial aspect of the metaphorical capacity of human thinking is that metaphor yields unexpected results in stimulating the thought process by associating things which at first sight are beyond comparison. This perspective will remerge in cognitive semantics.

5.3.2 *Structuralism*

In the structuralist approach, metaphor is often described in the context of classifications of neologisms.[43] Language is studied as a system in its own right. Therefore the emphasis is no longer on the creative aspect of metaphor at the level of human thinking. A distinction is made between neologisms which are a result of changes of the *signifiant*, those which result from changes at the level of the *signifié* and those which result from changes at both the *signifiant* and the *signifié* level. Metaphors are a result of changes at the level of the *signifié*. A good example of a structuralist study of neologisms in the English language, is Tournier (1985). He set up a typology of word

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43. Alain Rey’s (1995: 77) definition of “neologism” reads as follows:“… neologisms are a unit of the lexicon, a word, a word element or a phrase whose meaning, or whose signifier-signified relationship, presupposing an effective function in a specific model of communication, was not previously materialised as a linguistic form in the immediately preceding stage of the lexicon of the language. This novelty, which is observed in relation to a precise and empirical definition of the lexicon, corresponds normally to a specific feeling in speakers. According to the model of the lexicon chosen, the neologism will be perceived as belonging to the language in general or only to one of its special usages; or as belonging to a subject-specific usage which may be specialised or general.”

formation, word alteration and borrowing which was based on dictionary information. Unlike Tournier, we studied the language of the life sciences in a text corpus. Because of that we have access to information on the process of understanding which was not available to Tournier (1985). For Tournier the emphasis is on finding out about how the English language as a system changes.

In what follows we first summarise the typology arrived at by Tournier. Then, we comment on the limits of his results and conclusions concerning the category "metaphor".

Tournier manages to build a coherent and comprehensive framework for the description and understanding of word-formation and neology in the English language. For him the description of "le lexique" ("l'ensemble des lexies") implies the description of the mechanisms on which its dynamics are based. He distinguishes four categories in the lexicon (33–34). The first three correspond to Chomsky's tripartite distinction between *occurring*, *possible but non-occurring*, and *impossible* lexical entries (see Figure 5.1). Category four consists of the foreign lexicon.

For Tournier lexical dynamics is based on the transfer of elements from the last three categories into the first A neologism of a different type is created for each of the three kinds of transfer. Tournier arrives at lexicogenetic matrices. He first separates what happens within the framework of one language (in this case the English language) and refers to this aspect as the internal matrix. The external matrix accounts for the influence from other languages on the English language.

If the new lexeme (the neologism) implies both the *signifiant* and the *signifié* we have a morphosemantic neologism or morphosemantic loan In case the neologism only concerns the *signifié* he talks about semantic neologism and semantic loans or loan translations and when the *signifiant* only is at stake he refers to the new lexeme as a morphological neologism and morphological loan. Semantic neologisms consist of conversion and "métasémie", Tournier's term for both metaphor and metonymy.

	construction:		
morpho-semantic neologism	affixation	prefixation suffixation inverse derivation	internal matrices
	composition	juxtaposition amalgam	
	phonological motivation	onomatopoeia and ideophonic elements	
semantic neologism	transfer of class	conversion	
	"métasémie"	metaphor metonymy	
morphological neologism	reduction of the *signifiant*	aphaeresis apocope acronyms	
loan words		morpho-semantic loan/ semantic loan and loan translation/ morphological loan	external matrices

Figure 5.1. *Table of lexicogenetic matrices according to Tournier (1985).*

Limits of his results.
Tournier is interested in the lexicogenetic mechanisms of the English language. At the same time he is aware of the function of the lexicon which is to reflect human experience. The link between human experience and language, the testimony of which is to be found in texts, is not studied by Tournier. He restricts his research to dictionary information on neologisms. He does not study the propositional and the image schematic ICMs — information on which can be found in textual archives — which give rise to the coming into existence of "métasémie", his term for meaning change. On the one hand it is surprising that Tournier does not look for explanations for métasémie, on the other hand it was difficult to find these explanations as his 'corpus', which basically consisted of (16 in his bibliography) general language dictionaries, did not provide for this information.

The restrictiveness of this type of research is due to the underlying belief that neology is basically interesting for studying the language **system**. This results in distinguishing classes of new lexemes in a typology. Metaphorical lexicalisation is only studied as a mechanism for naming new elements in the putatively objective reality.

In Section 5.4 we describe how Assal (1992) used this type of descriptive framework for the French terminology of biotechnology.

There is one more point we would like to make concerning Tournier's approach which is relevant for our discussion. Tournier states that "métasémie" is very prominent in the lexicogenesis of the English language.

> Nous n'avons pas travaillé sur la totalité des cas de métasémie de notre corpus général: ils se comptent en effet par dizaines de milliers, puisque les lexies qui echappent à ce processus sont une infime minorité, [...] (Tournier 1985: 221).

If *métasémie* is so prominent, one can be expected to wonder why this is. Tournier only provides a limited answer to this question. He does not investigate the underlying mechanisms which could explain the phenomenon. His analysis is that a "signifié en attente" (227) is waiting to be named. The mechanism of transfer of an existing *signifiant* to a new *signifié* is subdivided by him in three types: shift in usage, metonymy and metaphor. He believes that metaphor can be defined on the basis of analogy in the following way:

> c'est l'analogie entre deux signifiés qui permet d'utiliser un signifiant attaché à un signifié donné pour exprimer l'autre signifié dans lequel l'usage perçoit (ou du moins a perçu à l'origine) un point commun (au moins) avec le premier (222).

Tournier defines *metaphor* in terms of a componential analysis. The mechanism at the basis of metaphor he presents in a diagram (Figure 5.2). S1, s2, s3, etc. are the semantic features ("sèmes") of the categories ("sémème") Σ and S.

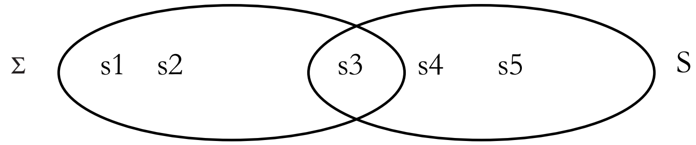

Figure 5.2. *Tournier's diagram of the mechanism at the basis of metaphorisation.*

The necessary and sufficient condition for metaphor to be possible is — according to this analysis — that Σ and S have at least one *sème* in common. This type of description of metaphor does not surpass the lexeme metaphor level. In line with the objectives of structuralist linguistic research language is studied as a system on its own. No interdisciplinary interest is taken in meaning, understanding and communication.

5.3.3 *Metaphor in cognitivist-experientialist semantics*

Cognitivists consider language as directly linked to thinking and understanding. Metaphorical thinking is a possible technique when attempting to understand. One associates what one is trying to come to grips with to something one understands already, to which the new unit of understanding has similarities. The associations involve a mental element, a language element and a creative element in which new units of reality may be brought to the awareness.

Whereas in structuralism words were often studied out of context (Tournier) for reasons we explained, recently, due to the impact of text linguistics and pragmatics, metaphor research has taken a new turn. The impact of co- and context on the meaning of words has been fully recognised in cognition.

> The notion of fixed, schematic meanings, still treated as complexes of universal primitives, has lost its attractiveness and with it, explanations of metaphors in terms of feature transfer, verbal displacement and the like (Dirven & Paprotté 1985:ix).

Metaphor is considered an instrument of thought, and a transaction between the constructive effects of context, imagistic and conceptual representation, and general encyclopaedic knowledge as we showed in our discussion of Lakoff and Johnson (1980), Lakoff (1987) and Johnson (1987) (see Section 5.1).

Metaphor had been studied on the concept level by the German linguists Trier, Weinrich and Dornseiff before (Liebert 1995: 147–51). Trier (1934) did not study the isolated metaphor as a rhetorical stylistic embellishment, but he studied groups of words in an *existential domain* (Seinbereich). In his understanding a field in one *sense domain* (Sinnbereich) gets structured by a different field of another sense domain. He introduced the concept of *image providing field*. The concept of *image field* was further elaborated by Weinrich (1976) who coined the term *image receiving field*. Both Trier and Weinrich believe an image field is a cognitive model.

Dornseiff (1954) adhered to onomasiology which took it as a principle that groups of entities serve as image sources for meaning changes. He is the first one to actually describe specific metaphorical domains. He studies domain metaphors in relation to their corresponding lexeme metaphors the way Lakoff and Johnson (1980) do.

5.4 A structuralist and a cognitivist approach to metaphor in the special language of the life sciences

Before presenting the results of our interpretation of the role of analogical thinking which left its traces in metaphorical lexicalisation in the life sciences, we shall draw attention to two linguistic research projects which have concentrated on life science related vocabulary. The first project concerns a descriptive approach of the vocabulary of biotechnology in a structuralist theoretical framework by Assal (1992) (see Section 5.4.1). The second project deals with the analysis and reconstruction of metaphorical structures of social groups by using the example of virological AIDS research. Based on the theoretical framework of cognitive linguistics, Liebert (1995a) gives a description of a network of metaphor models which could be observed in the communications of a research team of virologists (see Section 5.4.2).

5.4.1 *Metaphor in the language of biotechnology: a structuralist descriptive approach*

Metaphor has been studied and described in the language of biotechnology by Assal (1992) in the framework of his dissertation in which he tries to find an answer to the question "comment une sphère d'activité qui est née du croisement de diverses disciplines et technologies du vivant, mais qui s'en distingue par la spécificité de son objet, forme sa terminologie"(Assal 1992: 283). Metaphorisation is treated as one of eight[44] procedures of terminology creation

44. The other procedures are: formation par dérivation, formation par composition, formation par composition syntagmatique, formation par siglaison, formation par téléscopage, formation par calque, formation par emprunt terminologique.

in the domain of biotechnology. Assal studies and describes terminological metaphorisation starting from lexeme metaphors (see Section 5.1). Even though he selected his examples from a text corpus, the cognitive models which may be learned from the information in the texts are not considered. He adheres to the comparison theory of metaphor (see Section 5.1) and to Tournier's analysis of metaphor being based on the transfer of at least one "sème".

> […] les métaphores terminologiques que compte notre corpus obéissent dans leur ensemble au méchanisme fondamental de la métaphorisation terminologique: la métaphorisation ne peut se réaliser que quand il est possible d'établir un rapport analogique symbolique entre la réalité à nommer et la réalité préexistante désignée par le lexème à transférer. L'aspect symbolique de l'analogie permet de saisir et d'isoler dans le lexème à transférer le sème adéquat qui, en fonction de sa valeur allusive, va évoquer plus ou moins parfaitement la réalité à nommer (Assal 1992: 183).

One of the examples he gives illustrates what he means by "méchanisme de formation". The term *carte génétique* is defined as follows: "réprésentation figurative de la position des gènes, les uns par rapports aux autres, sur une molécule d'ADN". According to Assal this term was formed by analogy with the term *carte géographique*. He analyses the term formation procedure as having the following three aspects:

> Le processus de formation a consisté: (a) en une mise entre parenthèse du déterminant *"géographique"*, (b) en un transfer du lexème "carte" comme expression du trait sémantique *"être la représentation de la localisation de,"* (c) en la détermination du lexème carte par l'adjectif *"génétique"*.

We could represent his analysis of the metaphorisation process (Figure 5.3) in line with Tournier's diagram (see Section 5.3.2).

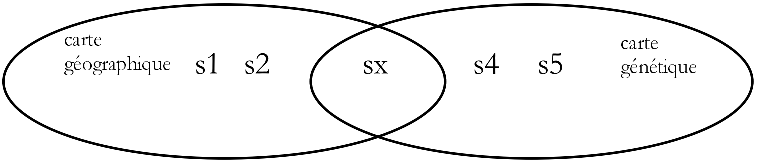

Figure 5.3. *Analysis of the term formation procure of "carte génétique"* (Assal 1992). *sx = "être la représentation de la localisation de"*.

Even though Assal realises that terminological metaphorisation is not a procedure of stylistic ornament, nor just a linguistic strategy for expressing an analogy, but a way of thinking and understanding,[45] he does not get beyond a description on the lexeme level. He does not really go into the question: what are metaphors in biotechnology for? Nor does he wonder if and how metaphorical lexicalisations in the domain of the life sciences are related as we shall do in Section 5.5.

5.4.2 *A network of metaphor models*

Alternative ways of describing metaphor have been worked out by for instance Liebert who proposes possibilities for metaphor coding in cognitive lexicography Liebert (1992) first studied metaphor in general language ("Metaphernbereiche der deutsche Alltagssprache") and tried to answer the question whether linguistics can contribute to the description of the metaphors we live by as an essential element of our cultural coherence. He investigated the possibilities for coding m-ICMs to make them accessible in computer format. Later he tried to use the ICM theory for the reconstruction of discoveries in science (1995a, 1995b, 1996 and 1997). Liebert (1995a) gives a detailed description of the corpus acquisition and corpus analysis of spoken texts, interviews and discussions of a selected group of virologists in the field of AIDS-research. As a result a network of metaphor models of this research group is presented and discussed. According to Liebert, the metaphorical system of virologists in AIDS-research is based on the central source domains TRANSPORT, PRODUCTION, COMPUTER and COMMUNICATION. Liebert's objectives involved three aspects: one, to investigate how metaphor is part and parcel of cognitive processes in the life sciences; two, to investigate how scientists can be made aware of their own metaphor systems and how they can adapt these in a playful way; and three, to develop a hypermedia-lexicon which represents the metaphor system of a specific expert group and to experiment with this hypermedia-lexicon in collaboration with the expert team. Liebert (1995b)

45. Assal does point out that terminological metaphorisation is a necessity inherent to scientific thinking. He makes reference to the epistemological and heuristic value of terminological metaphor. "La dimension épistémologique de la métaphorisation terminologique ne fait pas de doute quand on sait qu'une métaphore peut aller jusqu'au remaniement de tout un système de pensée, de toute une théorie"(Assal 1992: 179). But this insight does not have consequences for his analysis.

“works with virologists in the field of AIDS-research detecting established metaphor models in their thinking, accumulating them in a hypertext-lexicon, and finally letting the virologists reflect their own models in a game-like manner in order to gain new perspectives for their current research” (435). The general idea of Liebert’s project can be formulated in two theses. The first thesis is that “the reflection of one’s own cognitive models is an effective problem solving method for research teams” (435). The second thesis is that “the lexicon of metaphor models is an appropriate tool for the reflection of cognitive models” (435).

We have some criticism concerning Liebert’s example for proving his first hypothesis. He wants to understand how *reverse transcriptase* was discovered by a molecular biologist. Howard Temin came up with an explanation for the viral RNA which was found transcribed into its equivalent DNA in the cells which had been infected by the viruses. According to the so-called central dogma of molecular biology: “the genetic information is always transcribed from the DNA to the RNA, which produces the proteins” (434); this was just impossible. Liebert suggests that the discovery of reverse transcriptase by Temin was a result of a further reflection on existing metaphor models. “Howard Temin, postulated a new enzyme: if the DNA of the cell doesn’t understand the viral RNA, he argued, there must be an enzyme that transcribes RNA reverse in DNA, which can be understood by the human cell and then integrated” (435).

Liebert then reconstructs the discovery of reverse transcriptase with the ICM-theory (Lakoff 1987; Johnson 1987) (Figure 5.4).

We agree with Liebert that the reflection of their own cognitive models might be an effective problem solving method for research teams, but we have three reservations. The first reservation concerns the impression created by Liebert that when discovering *reverse transcriptase*, Temin had been reflecting the metaphorical models consciously. We see little proof for this hypothesis apart from the fact that the enzyme which was believed to be responsible for the transcription from RNA to DNA (the reverse of what was believed to be valid in the so-called dogma of molecular biology: from DNA to RNA to protein) was named *reverse transcriptase*. So the naming of the newly understood category — Liebert believes — was based on an extension of the metaphorical model underlying the understanding of the functioning of cells, but the only evidence for this seems to be the naming of the enzyme *reverse transcriptase* itself. Liebert might find evidence for his assumption if he were

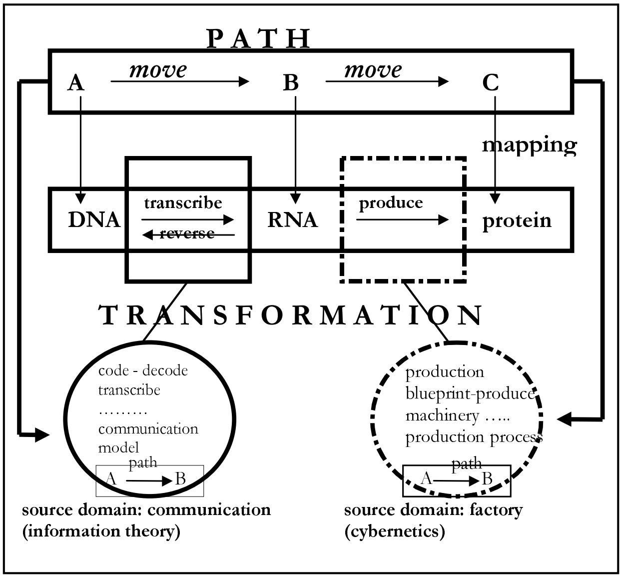

Figure 5.4. *The discovery of the reverse transcriptase as part of a complex, metaphorically structured model of the* ***Genetic Transformation Process*** *according to Liebert* (1995b).

to examine Temin's original publications on the issue. As the references to Temin's original publications are not mentioned in Liebert's bibliography, this step has apparently not been taken.

Our second reservation concerns the fact that some of the terminology Liebert introduces is the terminology of his own analysis rather than of the analysis of specialists. What he calls the *genetic transformation process* is not once named that way in the corpus we have been examining. What we find instead is: *protein synthesis* (Lewin 1983: 85; Bains 1987: 29; Hodson 1992: 214; Bains 1993: 149; Alberts et al. 1994: 108; Cooper 1994: 45), *the transfer of information from DNA to protein* (Lewin 1983: 75; Alberts et al. 1994: 105), *the flow of genetic information from DNA to RNA to protein* (Berg & Singer 1992: 121), *gene expression* (Drlica 1992: 41).
(Genetic) transformation is an existing term in *genetics* but with a different meaning.[46] According to Liebert, the understanding of what he calls the

46. According to Hodson (1992) transformation "has two meanings in genetics. (1) A permanent change in the genetic characteristics of one bacterium by exposure to DNA of a different origin. […] (2) A change in an animal cell in tissue culture so that it grows and divides in the

Genetic Transformation Process involves two metaphorical domains. The first domain is the INFORMATION domain which provides an analogy for the understanding of the move from DNA to RNA. The second domain is the CYBERNETICS domain which provides an analogy for the understanding of the move from RNA to protein. In our corpus, we do not find any attestation of the formulation that RNA "produces" protein. Instead we find that RNA is *translated* into protein. (Lewin 1983: 125; Hodson 1992: 78; Drlica 1992: 43; Bains 1993: 151; Rieger 1993: 223; Alberts et al 1994: 105; Cooper 1994: 45). This is essential in the interpretation of the putative source domains in Liebert's analysis (see Figure 5.4). It implies that the "move" from B to C can be understood within the same ICM as the "move" from A to B. The source domain for the analogical understanding of both moves is the LANGUAGE ICM (see Section 5.5).[47] The CYBERNETICS source domain is not necessary to explain the metaphorical understanding, as the source domain for both moves can be INFORMATION (see Figure 5.5). CYBERNETICS could be a source domain for both moves if the cell is seen as a FACTORY. We do find a few text fragments showing this understanding of how a cell functions,[48] but few traces of this analogy are left in the terminology of the life sciences (few lexeme metaphors), and the ones which exist are not relevant in the m-ICM.

The third reservation concerns the analysis of the metaphorically structured model as it is presented in Figure 5.4. Liebert believes there are three metaphor models (439) which played in the understanding of reverse transcriptase:

– **metaphor model 1**: THE GENETIC TRANSFORMATION PROCESS IS AN OBJECT MOVING ALONG A PATH
– **metaphor model 2**: THE GENETIC TRANSFORMATION PROCESS IS TRANSCRIBING INFORMATION

---

same way as a cancer cell, possibly due to activation of a viral gene (256).

Rieger (1993: 222) explains genetic transformation as "the unidirectional transfer and incorporation of foreign DNA by prokaryotic or eukaryotic cells and the subsequent recombination of part or all of that DNA into the cell's genome."

47. In Section 5.5. we see LANGUAGE as a sub-ICM of the INFORMATION ICM, of which Liebert's COMMUNICATION model is part.

48. Our *plan* is stored in letters (Shapiro 1991); genes control the *production* of a single protein (Hodson 1992); translation takes place on the ribosomes, which act as a sort of *assembly frame* for building proteins (Berg & Singer 1992))

– **metaphor model 3**: THE GENETIC TRANSFORMATION PROCESS FROM RNA TO THE PROTEINS IS PRODUCTION ACCORDING TO A BLUEPRINT.

As far as the first model is concerned, we see no reason for believing that the "process" is understood as an "object" moving along a path. It is the "informa-

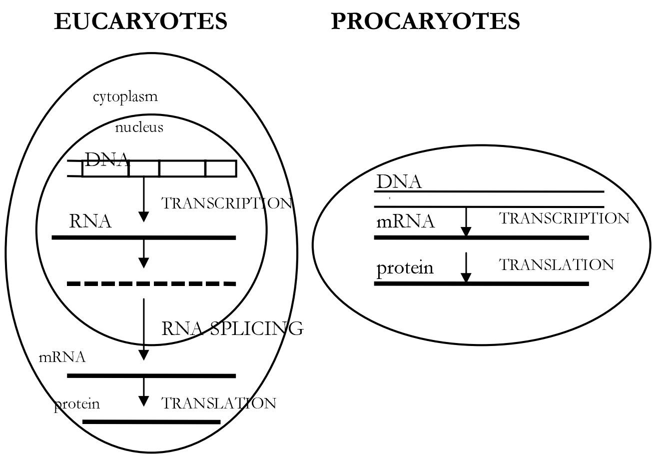

Figure 5.5. *The transfer of information from DNA to protein* (Alberts et al. 1994: 105).

tion" which flows along a path causing the two transformation steps to happen. "Information" can hardly be seen as an "object".[49] Liebert's second model only concerns the first step in what he refers to as the genetic transformation process, therefore he should add THE GENETIC TRANSFORMATION PROCESS <u>FROM DNA TO RNA</u> IS TRANSCRIBING INFORMATION to his **meta-**

49. In Elliott & Elliott (1997: 273) we find: "The flow of information in gene expression is DNA (transcription) — → mRNA translation) — → protein. (Please be careful to note that the broken arrows represent information flow, not chemical conversions. DNA cannot be converted into RNA nor RNA into protein.) The 'language' in DNA and RNA is the same — it consists of the base sequences. In copying DNA into RNA there is transcription of the information. Hence mRNA production is called gene transcription, or more often, simply transcription, and the DNA is said to be transcribed. The RNA molecules produced are called transcripts. The 'language' of the protein is different — it consists of the amino acid sequence whose structures and chemistry are quite different from those of nucleic acid. The synthesis of protein, directed by mRNA, is therefore called translation. If you copy this page in English you are transcribing it. If you are copying it into Greek you are translating it".

phor model 2. Concerning Liebert's third model we do not understand why only "the genetic transformation process from RNA to the proteins" is produced according to a blueprint. In our corpus we find the "blueprint" metaphor with reference to the two-steps-process. The lexicalisation *blueprint* is as much part of the INFORMATION metaphor model as of the CYBERNETICS metaphor model.[50] We suggest the following formulation for the first metaphor model:

– THE PROCESS OF PROTEIN SYNTHESIS IS A FLOW OF INFORMATION ALONG A PATH IN TWO MOVES

Because we believe the second and the third of Liebert's models can be interpreted within one model (Figure 5.6), we suggest the following reformulations:

– THE FIRST MOVE IN THE PROCESS IS THE TRANSCRIPTION OF THE INFORMATION FROM DNA ONTO RNA.

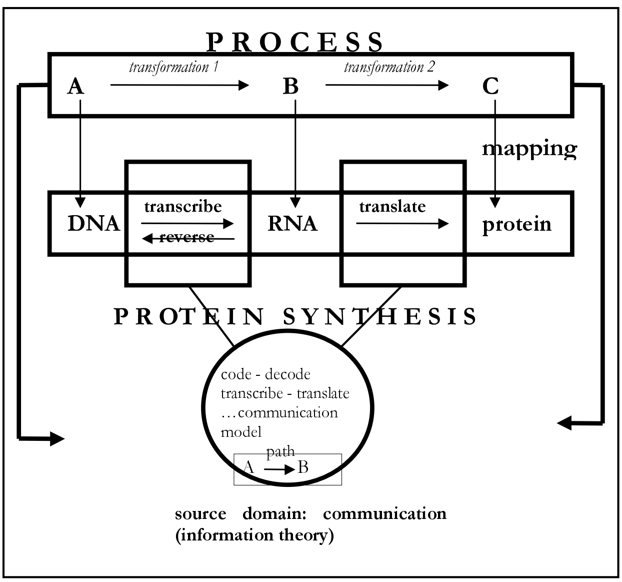

Figure 5.6. *The discovery of* ***reverse transcriptase*** *as part of the metaphorically structured model of* ***protein synthesis****.*

50. "The Human Blueprint. The race to unlock the secrets of our genetic script." is the full title of Shapiro's book (1991).

– THE SECOND MOVE IN THE PROCES IS THE TRANSLATION OF THE INFORMATION FROM RNA INTO PROTEIN.

Liebert's analysis as well as the one we have been presenting take the lexeme metaphor as a starting point to find out about the domain metaphorical models underlying understanding. It is presumed that life science specialists understand by means of metaphorical domains and that these metaphorical domains have left their traces in language as lexeme metaphors. The student of metaphor needs to (re-)construct the m-ICM the scientists are living by. This implies an interpretation of data by the student of metaphor, i.e. some kind of understanding as well. Two different understanding scenarios have to be distinguished. The first concerns one or several scientist(s) who understand (aspect of) their field metaphorically. The second concerns the student of metaphor who is interested in understanding how and why scientists understand aspects of their field metaphorically but who needs to understand the metaphors the scientists live by as well. Just like scientist may come up with several parallel or related understandings of their subject field, students of metaphor will come up with several understandings of the structure of metaphorical domains life science specialists live by. This shows in the different understandings of the m-ICMs of *protein synthesis* by Liebert and by ourselves. We indicate two reasons why our analysis of the understanding of *protein synthesis* differs from Liebert's analysis of the *Genetic Transformation Process*. The first one is that we used different corpus material (moreover in a different language: we studied English and Liebert studied German). The second one is that not exactly the same method for analysis has been followed. For example, we avoid abstractions or lexicalisations which are rather the result of our own understanding than that of the specialist's. Therefore we do not refer to *protein synthesis* as *transformation* because we do not find any attestation of *transformation* in our corpus. The term *transformation* is a lexicalisation resulting from the metaphor student's understanding of the subject of *protein synthesis*, rather than of the life science specialist's understanding. This proves that not only the m-ICMs life science specialists live by have prototype structure (see Liebert 1995a: 176 on *protometaphor*) but also that the flexible understanding of the m-ICM by the student of metaphor is possible because of the prototype structure of the m-ICM.

5.4.3 *The study of metaphor in a text corpus on the life sciences*

So far we have been discussing the description of metaphorical neo-lexicalisation by Assal (1992) and the study and description of lexeme, category and domain metaphors in HIV-virology research by Liebert (see Section 5.4.2). Before we introduce the results of our own research, we present a table comparing our own approach to Assal's and Liebert's on the following aspects: theoretical background, definition of the problem, type of corpus, language studied, aim of the project and results of the investigations.

	Assal (1992)	**Liebert (1995a&b)**	**this study**
*Theoretic*al backgro*und*	structuralist linguistics and Terminology	cognitive linguistics and speech analysis	cognitivist linguistics, Terminology and hermeneutics
Problems studied	neologisms in the language of biotechnology	metaphors in the cognitive processes of the life sciences: the case of virologists on an HIV project	prototypically structured categories in the special language of the life sciences; polysemy and univocity in the special language of the life sciences; metaphorical lexicalisations as part of m-ICMs in the language of the life sciences
Corpus	specialised and popularising articles, student manuals and dictionaries	lectures interviews written discourse	a corpus of texts written by specialists for a variety of readers; special attention to the role of m-ICMs in the development and naming of entities, activities and general categories
Language	French	German	English
Aim	to describe the types of neolexicalisations in the language of biotechnology	to investigate how metaphor is part and parcel of cognitive processes in the life sciences to investigate how scientists can be made aware of their own metaphor systems to develop a hypermedia-lexicon	to prove the non-arbitrariness of the sign in the life sciences, in the sense that metaphoric models result in lexicalisations; to prove how analogical thinking, sociological circumstances and new technological inventions are working simultaneously in the advancement of the life sciences; to show the distinction between creative and didactic metaphorisation in Terminology.

Result	a description of metaphorical lexicalisation at the word and concept level	a description of metaphorical models which explain the phenomenon of metaphor at the lexeme, concept and domain levels the concept of protometaphor	a description of metaphorical models which explain the phenomenon of metaphor at the lexeme, category and domain levels. directives for the description of metaphorical models in terminography

Figure 5.7. *The differences between the approach of Assal, Liebert and Temmerman in the study of metaphor in the life sciences.*

Traditional Terminology believed metaphor was an impediment for unambiguous "scientific" naming and communication. We believe that Terminology can no longer ignore that the importance of metaphor in categorisation and naming has become a central issue in the cognitive sciences. Having its past in the objectivist paradigm and being confronted with the experientialist paradigm of cognition, terminologists are forced to consider the impact of metaphorical reasoning on categorisation and naming. This should result in an elaboration and adaptation of the guidelines and methods for terminography. Before formulating suggestions for guidelines and methods for terminography, we present an example of the description of a network of metaphorical models based on an analysis of a corpus of texts from the life sciences archives.

5.5 Metaphorical naming: the traces in language of m-ICMs

In this section we want to concentrate on the **growth** of understanding and knowledge through metaphorical reasoning (the mapping of a source domain onto a target domain). Metaphorical reasoning results in the understanding of a new fact, situation, process, or whatever type of category based on the imagined analogy between what one is trying to come to grips with, to understand, with something one knows and understands already. This inventive or creative capacity is made tangible and leaves its traces in neolexicalisations. The imaginative reasoning of which the metaphorical naming of new categories with existing lexemes is the result, is rooted in human experience.

The disciplines of the life sciences develop in cognitive frames or cognitive image schemata which can be seen as *'Gestalts'*. In order to develop new ideas practitioners of the discipline of the life sciences take over existing cognitive frames or cognitive image schemata from domains of experience outside the life sciences. This opens up possibilities for m-ICMs. Metaphorical cognitive models leave their traces in neolexicalisations.

The metaphorical cognitive model functions as a gestalt. This can be seen when we compare the part of the metaphorical gestalt that is actually lexicalised to the part that could possibly be propositionally and lexically expressed if more explicitness was required.

Underlying the progress in the understanding of the mechanisms of life are a number of analogies which have left their traces in metaphorical lexicalisations. One can witness the development of a new lexical field based on specific metaphorical gestalt structures or analogy image schemata. When studying the mapping not just at the lexeme level but also at the structural level of categories and domains (see Section 5.1) the mechanisms of metaphorical reasoning are revealed.

The domain metaphor underlying the understanding of molecular genetics is that heredity is based on **information** stored in our genes (DNA). We quote three text fragments which state this explicitly.[51]

> the flow of **genetic information** is unidirectional, from DNA to protein with messenger RNA (mRNA) as an intermediate. The copying of DNA-encoded genetic information into RNA is known as transcription with the further conversion into protein being termed translation. This concept of **information flow** is known as the **Central Dogma**. (Nicholl 1994: 8).

> One of the goals of this book is to explain how **information** is stored in DNA, how it is used, and how it is reproduced (Drlica 1992: 4).

> The ability of cells to maintain a high degree of order in a chaotic universe depends on the genetic **information** that is expressed, maintained, replicated, and occasionally improved by the basic genetic processes — RNA and protein synthesis, DNA repair, DNA replication, and genetic recombination (Alberts et al. 1994: 223).

Several sub-domains of the domain m-ICM around **information** are expanded upon and are the explanation for a number of metaphorical lexicalisations (see Figure 5.8) like:

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51. We could quote scores of texts in which the information analogy is explicitly stated. The basic analogy is very much alive and still actively serving as a source for new lexicalisations in the course of further discoveries and better understanding as we shall see.

- DNA IS A LANGUAGE. Genes are messages written in a language. This is a first sub-m-ICM based on the experience that **information** is often expressed in a **language** (see Section 5.5.1).
- DNA IS AN ATLAS OF MAPS. The totality of the localisation of genetic information of an organism (the genome) can be depicted on maps. Just like explorers of the globe depicted **information** on the localisation of geographical phenomena that they had been able to observe on maps, geneticists mark the position of genes on genetic maps. (see Section 5.5.2).
- DNA IS SOFTWARE. DNA is software which can be run by the cell. This is a third sub-m-ICM based on the experience that **information** is often stored and made available in an **electronic format** (see Section 5.5.3).
- DNA IS A FILM. DNA is a film which can be 'read' by a projector. This is a fourth sub-m-ICM based on the experience that **information** can be stored and made available on **film-tapes** (see Section 5.5.4).

***Source domain** which provides the analogy.*	*Sub-domains of the information ICM.*
	Genetic material (DNA) can be understood as a language (Section 5.5.1).
The **information** ICM.	The totality of an organism's genetic material (the genome) can be understood as an atlas of maps (Section 5.5.2).
	Genetic material (DNA) can be understood as the software of an information processing system (the cell) (Section 5.5.3).
	Genetic material (DNA) can be understood as a film-tape (Section 5.5.4).

Figure 5.8. *Representation of the sub-domains which are part of the* ***source domain*** *(information) which can be used in the understanding of molecular genetics.*

5.5.1 *DNA IS A LANGUAGE*

A first sub-ICM is based on the experience that information is often expressed in language. In this case the genetic material (the DNA) can be understood as if it was a language. Shapiro (1991: 4) describes how the idea that our plan is stored in letters has been around for a little more than a generation. Before that, our ancestors were inspired by other imagined analogies which left their traces in language. Remnants of a much older idea are still preserved in language as a type of verbal fossils: that heredity is preserved and transmitted by our blood. The thought has become so familiar that we do not even pause when we see such phrases as *royal blood*, *bad blood*, *blood relative*, *blue blood*, and *mixed blood*. The blood theory was first devised by Aristotle (384–322 BC) and others of that era. For those who believed this idea, inheritance involved a blending of parental qualities, as in the mixture of two different liquids.

Linear text is different. It can be *spliced* but not blended. The child receives a selection of components from both parents. Some remain intact, while other traits from a parent may be lost entirely.

We summarise the story of inheritance and indicate **in bold face** the **lexicalisations which bear on the underlying language analogy**. The summary is based on Hodson (1992) and Berg & Singer (1992).

The mechanisms of inheritance were discovered in 1866 by Gregor Mendel. For Mendel the ‘factors’ of inheritance (we now call them genes) were entirely abstract entities. Microscopes were by that time operating at magnifications of 1000x or more. In the cell nucleus structures that looked like coloured threads were seen; they were named chromosomes (from the Greek for ‘coloured bodies’). It was immediately realised that here was the reality behind Mendel’s ‘factors’. Chromosome research became the focus of genetics. It was obvious that the chromosomes provided the physical basis for Mendel’s mechanisms of inheritance; they could not be the same as Mendel’s factors (genes) for the simple reason that there were not enough of them.

Although the behaviour of genes was becoming better and better understood, there was no information about their physical behaviour beyond the fact that they were located in a row along the chromosomes. It was clear that the genes were in some way carrying **messages**, and that in order to be self-perpetuating through cell divisions, the genes must be able to **duplicate** themselves accurately. But there was no theory about what chromosomes could be made of to give them these remarkable properties. Later experiments pointed out that the secret was in the DNA (deoxyribonucleic acid). Francis Crick and James Watson tackled the problem of DNA’s double helical structure by building a scale model of wire and pieces of cardboard. The molecule was like a spiral staircase, with the steps made of pairs of bases (A (adenine) always joined to T (thymine), C (cytosine) always joined to G (guanine)) and the banisters made of sugar-phosphate chains.

What Crick and Watson had discovered was that DNA had a structure which allowed it **to copy itself**. Since A must be paired with T, and C with G, it follows that, if a DNA molecule is split down the middle lengthwise, all the **information** is there to reconstitute the whole molecule again.

Crick and Watson's proposed structure for DNA also provided the explanation for how a gene works, in chemical terms. It was already known that a gene controls the production of a single protein. What the Crick-Watson model showed was how the gene could contain **a message encoded in the sequence of letters** which was the specification of which protein is to be made. The coding structure of DNA does two things:

- It ensures that DNA is **replicated** to produce more DNA.
- It ensures that DNA is **transcribed** into RNA, which is then **translated** into protein.

Transcription and translation

When DNA makes a protein, it does so via an intermediate molecule called ribonucleic acid (RNA) which is very similar to DNA. RNA is usually in the form of a single strand. A molecule of RNA can be made to an exact and repeatable pattern by **reading off** the base sequence of a stretch of DNA; this process is called **transcription**. The strand of RNA produced in this way is known as **messenger RNA**, or mRNA, since it **carries the message telling** that protein is to be made from the particular stretch of DNA that was **copied**.

Sydney Brenner worked with Crick on **deciphering the DNA code**, and they discovered that it is **written in 'words' of three letters**. As there are four possible bases occurring in groups of three there are 64 (i.e. 4^3) possible combinations, but only 20 amino acids **to be coded for**. It turned out that most amino acids are **coded for** by more than one **codon**, and that there are three **codons** which do not represent any amino acid but are 'stop' signals where the **protein-coding message** ends (see Figure 5.12).

The **code sequence** of the DNA gene is used to build a molecule of **messenger RNA**; this is assembled by an enzyme called RNA polymerase, and this part of the process is called **transcription**.

There are also many molecules of a different kind of RNA known as transfer RNA (tRNA). Each tRNA molecule consists of only three bases. These three bases form an anticodon, and each of these matches on to the codon in the mRNA. This part of the process, known as **translation**, takes place on the ribosomes, which act as a sort of assembly frame for building proteins. The tRNA molecules form a line, and the amino acids join up in the specified order to form the protein chain.

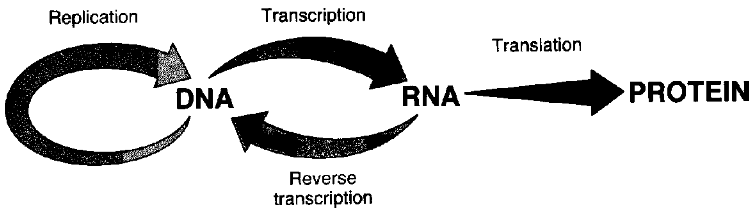

Figure 5.9. *The arrows indicate the processes and directions that pass genetic information from DNA to RNA, from RNA to protein, and from RNA to DNA* (Berg & Singer 1992: 35).

It is difficult to figure out whether the cognitive frame or gestalt of '**language**' is activated once the analogy between genes and language is understood; or whether one detail of the analogy: the visualisation of bases on the DNA strands, which are abbreviated to the first letters of the bases' names (A, T, C, G), triggered off the understanding of genetic processes via the language analogy. Metaphorical transfer of the understanding of information coded in language to the new understanding and naming of the scientific field of genetics is possible. The language metaphorical model begins to show its impact on thinking about genetics and naming the units of understanding. When dealing with the message in DNA, writers rely on the existing vocabulary of everything which has to do with *language* and *language processing*. The analogy is going to give rise to explicit lexicalisations.

We have to distinguish between (a) borrowings of terms from the language source domain model which provides the analogy (e.g. **letter**); (b) creations of terms based on the language source domain model which provides the analogy but using a word which existed already in a different domain (e.g. **to sequence**); and (c) new creations inspired by the language source domain model which provides the analogy but named differently (e.g. **codon**) (see Figure 5.10.) (see also Section 5.6).

	elements of the language source domain model which serve in the analogy	*lexicalisations concerning language-inspired information in genes*
type a (existing term or word is borrowed)	letter	**letter** (representing a base (nucleotide))
type b (existing word is assigned new sense)	letters occur in a particular order or sequence in a text	the order of the letters can be determined with a method called **sequencing**
type c (new term is created)	words represent units of information	**codons** are three letter words

Figure 5.10. *Three types of terms finding their origin in the language analogy of genetics.*

What follows are text fragments in which the analogy model is explained. A number of terms in these fragments are lexicalisations which find their origin in the metaphorical model. In brackets we indicate for each term whether it belongs to type a, b or c, as explained above and in Figure 5.10.

Genes are carrying information**.** The information in the gene is determined by the **sequence of letters**. The letters (A, T, C, G) are the abbreviations of the chemical names for the four bases involved (adenine, thymine, cytosine and guanine). This results in derived lexicalisations: to determine the sequence of the letters is a technique called **'to sequence'** and '**sequencing**' (type b).

> The bases come in four varieties, popularly abbreviated A, T, G and C. The **letters** stand for adenine, thymine, guanine, and cytosine, the chemical names of the bases. Since each nucleotide contains only one base, the nucleotides can also be identified by the same four letters. These four letters are precisely **ordered** in DNA, and it is through this arrangement of nucleotides that cells store information. The principle is similar to the Morse Code, where information is transmitted in combinations of two symbols, dots and dashes (Drlica 1992: 29).

> Sanger knew that cracking the code required two things: learning how **to sequence** DNA, and then finding a piece of DNA that coded for a known protein. If he were then to sequence that piece of DNA, the code should become clear. Still it was not obvious how to begin **sequencing** the complicated DNA molecule, with its two strands running in opposite directions and its impervious molecular structure (Wills 1991: 38).

The DNA **code is deciphered and written in words of three letters** : **'codons'** (type c) that code for amino acids.

> […], the information in a gene is arranged as **words** rather than as individual letters. This is because proteins, which are also linear chains, are composed of subunits (amino acids) of 20 kinds, which are chemically different from the 4 subunits (nucleotides used to sore information in DNA. […]. Many experiments have confirmed the prediction that the genetic code is read as triplets of nucleotides. Triplets in DNA that correspond to amino acids are called **codons** (Drlica 1992: 34).
>
> There is no punctuation between the **codons**. Thus it is important that the **reading frame** of the nucleotide code be established correctly — the start signal must be in the right place. This principle can be illustrated by the following sentence read as 3-letter words.
>
> Joe saw you win the bet.
>
> oes awy ouw int heb et (Drlica 1992: 34).
>
> […] an organism's characteristics are encoded by a four-letter alphabet, defining a language of **three-letter words**. The letters of this alphabet are the bases adenine (A), guanine (G), cytosine (C) and thymine (T), with triplet combinations of these bases making up the 'dictionary' that is the genetic code (Nicholl 1994: 8).
>
> Some brilliant genetic experiments by Crick, Brenner, and others had already demonstrated that the bases must be read in groups of three. Nirenberg was able to use artificial groups of three to work out the **code words** or **codons** for all twenty amino acids (Wills 1991: 39).

The equivalent of a *codon* in the cognitive frame of 'language' is *word,* which raises the question: why was the new term *codon* coined?

Apparently, *word* was too vague and too general and imprecise to become a term. A codon is a *word* or a *code* consisting of 3 letters only. In order to be more precise *word* would have had to be specified like in 'three-letter word'. Moreover, *codon* sounds more scientific in analogy with lots of other scientific words (also in the physical sciences) ending in '-on': *electron*, *transposon*, *exon*, *intron*, *replicon, cistron, operon, duplicon, conjugon, amplicon*, etc. Furthermore, *codon* is reminiscent of *code* (*DNA code, amino acids to be coded for*, etc.) and therefore self-explanatory.

According to Rieger (1991: 98) *codon* goes back to Crick (1963). Rieger defines *codon* as

> any triplet of nucleotides (coding unit) in DNA or RNA (if RNA is the carrier of primary genetic information as in some viruses) that codes for a particular

> amino acid or signals the beginning or end of the **message** (anticodon) (…) Of the 64 possible codons in the genetic code, the mRNA triplets UAA (ochre), UAG (amber), and UGA (opal), serve a terminator codons, AUG and GUG are initiator codons.
>
> **Synonymous** (=degenerate) codons are different codons for the same amino acid (…)
>
> There are indications that **reading** of a given **context** may be influenced by mRNA sequences external to this codon (effect of the **reading context** on **translation**).
>
> Any base triplet which can encode any of two or more amino acids is called an **ambiguou**s codon (Rieger 1991: 98).

In this fragment the metaphorical gestalt is worked out further, so that whatever can be ascribed to *word* is transferred to *codon*: a word can be *synonymous*, so can a codon, a word can be *ambiguous*, so can a codon, there may be an effect of the "reading context" on the "translation" of a word, the same is true for a codon.

In other sources (*The New Penguin Dictionary of Biology*, 1990) the terminator codons are named *nonsense codons*, a denomination which can also be explained from the metaphorical gestalt of the analogy: DNA IS A LANGUAGE.

We want to claim that this presents strong evidence for the proposition we are trying to prove which is that the metaphorical model is an underlying image schema which is not necessarily fully expressed propositionally and lexically. The proof is that if one lexicalisation (codon) is not in line with the image schema which provides the analogy (language), this does not really disturb the analogy. The word *codon* is further expanded on as if it were a synonym of *word*, which can be modified by adjectives often associated with *word* as is shown in *synonymous codons* and *ambiguous codons*.

DNA is **transcribed** (type a) into RNA, which results in the lexicalisation: **'transcription'** (type a).

> RNA is synthesized on a DNA template by a process known as DNA **transcription**. Transcription generates the mRNAs that carry the information for protein synthesis, as well as the transfer, ribosomal, and other RNA molecules that have structural or catalytic functions (Alberts et al. 1994: 224).
>
> Gene expression is the process whereby information stored in DNA directs the construction of RNA and proteins. In this process information is first **transcribed** into RNA, a single-stranded DNA-like molecule (Drlica 1992: 42).

In the process called **'transcription'** (type a) the base sequence of a stretch of DNA is **read off** (type b). The strand of RNA is lexicalised as **'messenger RNA'** (type b) since it carries the **message** (type a) telling that protein is to be made from the particular stretch of DNA that was to be **copied** (type a).

> **Transcription** is the synthesis of an RNA molecule using a DNA molecule as a template; genetic information is converted from a DNA form into an RNA form. […]The new chain is called **messenger RNA** because it carries information from DNA to sites where the information is used to specify the order of the amino acids in proteins (Drlica 1992: 43).

RNA is **translated** (type a) into protein, which results in the lexicalisation: '**translation**' (type a).

> Messenger RNA transports the information from DNA to subcellular structures called ribosomes. […] It is on them that the information in the messenger RNA is **translated** from the nucleotide language into the amino acid language (Drlica 1992: 44).

> The **translation machinery** works in the following way. A ribosome attaches to the messenger RNA near a site on the messenger called the start codon, a three-base triplet that indicates where to start reading the message (Drlica 1992: 44).

Genes must be able **to duplicate** (type a). *To duplicate* is part of the cognitive model of *language*, in its aspect of writing. The synonyms we find for *to duplicate* are *to replicate* and *to make copies*. **Replisomes** (type c) are clusters of enzymes which make the replication happen.

> […] he [Sanger] began to look into an enzyme called DNA polymerase. This enzyme is the most prominent of the many different enzymes that are required to duplicate or replicate DNA. DNA cannot **make copies** of itself unassisted; that would be like asking a book to make copies of itself without the help of a printing press, or a copy machine, or at the very least a typewriter. The genome is like a book that contains among many other things, detailed instructions on how to build a machine that can make copies of it — and also instructions on how to build the tools to make the machine! Thus, genes in the DNA itself code for both the enzymes that perform the **replication** and the enzymes that build those enzymes (Wills 1991: 41).

> For DNA **to duplicate**, the double helix must be unwound into two separate chains. These separate chains can then be used as templates to construct two new chains complementary to them. Through this process, […], the information in the old molecule is accurately transferred to its two daughter molecules. A whole cluster of enzymes, together called a **replisome**, is required to unwind the DNA, position the DNA polymerase molecules correctly, and

> break and join the growing DNA chains in a variety of ways. The discovery of how the **replisome** works took lifetimes of effort and has been one of the triumphs of molecular biology (Wills 1991: 41).

Cells have evolved **proofreading mechanisms** to reduce the number of errors in protein synthesis (**proofreading** (type a), **proofreading mechanism** (type b)).

> The fidelity of protein synthesis depends on the accuracy of the two adapter mechanisms […]: the linking of each amino acid to its corresponding tRNA molecule and the base-pairing of the codons in mRNA to the anticodons in tRNA. […] Two fundamentally different **proofreading mechanisms** are used […]. A relatively simple mechanism is used to improve the accuracy of amino acid attachment to tRNA. […]. A more subtle "kinetic **proofreading**" mechanism is used to improve the fidelity of codon-anticodon pairing (Alberts et al. 1994: 239).

> It is likely that if an incorrect base were accidentally incorporated during DNA synthesis, the polymerase would pause, excise it, and then recopy the region, most likely correctly. This activity, called **proofreading**, is a property of almost all bacterial DNA polymerases (Darnell et al. 1990: 472).

The limitations of the language analogy model

The metaphorical model does not provide a 100% analogy. We found two limitations: (a) there is lack of full parallelism between units of understanding indicated by the same term in the source and target domains of the metaphorical model, and (b) more lexicalisations based on the language analogy were feasible but did not materialise for reasons of competition with other types of lexicalisations. Sometimes the competition stems from other sub-m-ICMs of the information model.

a. Lack of full parallelism

The synthesis of proteins which is based on gene expression is understood via a limited interpretation of the language analogy. In a language like the English language words can be composed of a number of letters varying from one to upwards of ten. In the language of the genes all words are three letter words. In a language like the English language the letters which make up words occur in the 26 letter alphabet necessary to spell out the English language. In the language of the genes the alphabet is made up of four letters A, T(U)[52], G, and

52. Uracil (U) is one of the four nitrogenous bases which form the core of RNA (but not of DNA, where its place is taken by thymine (T)). It pairs with adenine (A)(Hodson 1992: 261).

C, which are abbreviations for the bases adenine, thymine (uracil), guanine and cytosine.

In a language like the English language the letters represent sounds and they are arbitrary in that they do not have meaning in themselves.[53] In the language of the genes words are not build up of meaningless letters but of letters representing bases. The order of the bases (or nucleotides) is meaningful "to specify the 20 amino acids as well as the necessary punctuation, such as start and stop signals. Many experiments have confirmed the predictions that the genetic code is read as triplets of nucleotides" (Drlica 1992: 34)(Figure 5.11).

Natural language (e.g. English)	***The language of genes***
has an alphabet (English: 26 letters)	has an alphabet (4 letters)
letters of alphabet combine to form words	letters of alphabet combine to form words
letters represent sounds	letters represent bases

Figure 5.11. *The lack of full parallelism between the source and target domains of the metaphorical model: DNA IS A LANGUAGE.*

The four nucleotides of DNA, taken three at a time, can form the sixty-four combinations shown in Figure 5.12. Sixty-one correspond to amino acids in protein; the other three are stop (termination) codons. The amino acids are listed by the customary three-letter abbreviations (Phe = phenylalanine; Ala = alanine; Cys = cysteine; Lys = lysine; etc.). Notice that all amino acids except tryptophan and methionine have more than one codon (we could say that 'synonymy' occurs). Where multiple codons for amino acids exist, the base in the third position seems to have the least meaning (Drlica 1992: 35).

53. There are of course a few exceptions to this rule like onomatopoeia.

		second base							
		U		C		A		G	
f	U	UUU	Phe	UCU	Ser	UAU	Tyr	UGU	Cys
i		UUC	Phe	UCC	Ser	UAC	Tyr	UGC	Cys
r		UUA	Leu	UCA	Ser	UAA	TERM	UGA	TERM
s		UUG	Leu	UCG	Ser	UAG	TERM	UGG	Trp
t									
b	C	CUU	Leu	CCU	Pro	CAU	His	CGU	Arg
a		CUC	Leu	CCC	Pro	CAC	His	CGC	Arg
s		CUA	Leu	CCA	Pro	CAA	Gln	CGA	Arg
e		CUG	Leu	CCG	Pro	CAG	Gln	CGG	Arg
	A	AUU	Ile	ACU	Thr	AAU	Asn	AGU	Ser
		AUC	lle	ACC	Thr	AAC	Asn	AGC	Ser
		AUA	lle	ACA	Thr	AAA	Lys	AGA	Arg
		AUG	Met	ACG	Thr	AAG	Lys	AGG	Arg
	G	GUU	Val	GCU	Ala	GAU	Asp	GGU	Gly
		GUC	Val	GCC	Ala	GAC	Asp	GGC	Gly
		GUA	Val	GCA	Ala	GAA	Glu	GGA	Gly
		GUG	Val	GCG	Ala	GAG	Glu	GGG	Gly

Figure 5.12. *How "to convert three letter words written in the four letter alphabet of RNA into the 20 letter alphabet of proteins"* (Drlica 1992: 35).

b. Restrictions to the possible lexicalisations based on the analogy

Not all new lexicalisations in the newly developing cognitive model are necessarily taken over from the source ICM which provides the analogy. We already discussed the case of *codon* (which parallels *word* in the source domain). In the following text fragment (Shapiro 1991) it is explained how possible lexicalisations which might have been based on the metaphorical model did not take shape. Geneticists do not talk about *spelling differences*, but about *polymorphisms*, they do not refer to *text differences* but to *restriction fragment length polymorphisms*, abbreviated as RFLPs and pronounced 'rifflips'. For didactic reasons Shapiro makes the underlying analogy totally explicit by using more metaphorical lexicalisations to clarify his point. This is only possible because the analogical model as a gestalt is essential in the understanding of DNA as a language. These metaphorical lexicalisations are not part of the scientific terminology which one would expect to be explained in a terminological dictionary.

As Shapiro remarks in the following fragment this “slangy phrase” gives no clue at all of its meaning to an outsider, whereas a new metaphorisation leading to a term related to the other metaphorisations would!

> (on the occurrence of CAC and CAT)
>
> Both forms exist abundantly in the human population with CAC in the majority. You or I may have either. In fact, it is possible to have both, as each of us normally has two different **copies** of chromosome 11 (and all the other numbered ones). I will call small variations of this type **spelling differences** (polymorphisms), including cases where the two forms differ by the loss or gain of a few **letters**, as well as simple substitutions of one **letter** for another. Larger changes will be called **text differences**. […]
>
> (for **text length differences**) Geneticists have selected the much less comprehensible jawbreaker: restriction fragment length polymorphism. As this phrase is unwieldy, they abbreviate it RFLP, then pronounce it “rifflips” at meetings. We finally get a slangy phrase that rolls readily off the lips, but gives no clue at all of its meaning to an outsider. I will stick to the phrase I chose above (which is **text differences**) (Shapiro:1991: 124–5).

So far for the evidence we came across when trying to find details on the language sub-m-ICM. We shall now switch to the second sub-m-ICM concerning **information** we distinguished in the textual material on the life sciences.

5.5.2 *DNA IS INFORMATION IN AN ATLAS OF MAPS*

We first present the information on the analogy between **genetic mapping** and geographical mapping (Jones uses the term “genetic geography” (1993: 46)) and indicate the lexicalisations which can be understood as resulting from this analogy. Then we show how the analogy permits further elaboration without this necessarily giving rise to more terminology. In didactic texts the analogy is further exploited in order to help the reader understand the subject and neolexicalisations are created. These neologisms, however, can not be considered real terms.

5.5.2.1 *Genetic and geographical mapping*

The analogy between the representation of **locations** and their mutual distances and genes helped to understand the importance of the position of genes in the genome of organisms. In higher organisms like in human beings the information needed is of a double nature: scientists will want to know on the one hand ***on which chromosome*** a particular gene is to be found and on the other hand ***where in the sequence of genetic information on the DNA strand*** the particular gene is to be found. Based on the experience that information on previously unknown territory can be obtained and stored by exploring and carefully mapping what one discovers, the way explorers did when they were discovering new previously unknown continents, geneticists set out **mapping the genomes** of different organisms. The *human genome* is "the blueprint for the development of a single fertilized egg into a complex organism of more than 10^{13} cells. The blueprint is written in a coded message given by the sequence of nucleotide bases — the As, Cs, Gs and Ts that are strung along the DNA molecules in the genome" (Cooper 1994: 71). Anyone who has basic biology knows that DNA contains genes, that genes are the coded messages for making proteins and that proteins carry out all of the functions of an organism. It was considered a good idea to start reading the entire sequence of bases from one end to the other and to draw a complete **genetic map** of man, defined by RFLPs (restriction fragment length polymorphisms) which are used as **marker genes**. This resulted in the Human Genome Project, one of the most ambitious scientific programmes of the 20^{th} century. It is an international effort that seeks to create a detailed **map of human DNA.**

Since the project started (officially in October 1990), several teams from all over the world have been busily mapping the 50,000 to 100,000 human genes and sequencing the base pairs (6 billion bases) they consist of (Cooper 1994: 71). By 2005 the maps should be completed. They will be of inestimable value in the development of biotechnology, biological research and clinical medicine, because they will allow the scientists to localise the genes, causing certain hereditary diseases, on the human chromosomes.

A distinction is made between *genetic-linkage maps* and *physical maps*. The difference between those two can be summarised as follows: genetic-linkage maps show the position of each gene in relation to another gene; on physical maps one can read the exact number of base pairs between two genes. It is the combination of the genetic-linkage maps and the physical maps that will reveal the human genome.

The construction of genetic-linkage maps

The genes are arranged in a linear order on the chromosomes. Normally, the genes on a certain chromosome should be transmitted together from parents to children. Such genes, which are always inherited together, are said to be linked. However, sometimes, crossing-over occurs. This means that two genes which are normally on the same chromosome, are transmitted separately. The children receiving such a modified chromosome of one of their parents are called recombinants. Scientists trying to establish **genetic linkage maps** compare the number of recombinants among the offspring in certain families to the total number of children in those families. This comparison yields the recombination fraction. The main rule is the following: the fewer genes are linked, the higher the number of recombinants, and thus the recombination fraction, will be. In a final stage, the recombination fractions are turned into **'genetic distances'** (expressed in centimorgans), which are the relative distances between the genes of a chromosome. These **genetic distances** allow geneticists to determine the order of the genes.

Initially, the genes the linkage of which was being tested, were chosen arbitrarily (classical linkage mapping). This was a very time-consuming method, and therefore scientists soon started to use so-called DNA-polymorphisms as **markers (modern linkage mapping).** An example of such a **DNA-marker** are the RFLPs (restriction fragment length polymorphisms). Those are small sequences of DNA resulting from the cutting of the DNA on a certain chromosome by a restriction-enzyme, which is capable of finding that particular sequence autonomously. Those sequences are present in any human being but they can be inherited in several forms. Therefore, we call them 'polymorphisms'. Once **localised**, the RFLPs are radioactively labelled, so that they can be made visible under a sophisticated microscope. Finally, the co-inheritance of the RFLPs with other genes is studied. This allows scientists again to determine the position of the other genes in relation to the RFLPs and to each other.

The construction of physical maps

Physical maps show **physical distances** (in base pairs) between **landmarks** along a chromosomal DNA molecule. At present a **physical map** is being constructed for each of the 23 human chromosome pairs.

The first technique used to construct **physical maps** is in-situ hybridisation. Just as in the construction of **genetic-linkage maps** by means of RFLPs this technique is based on the use of radioactively labelled DNA-probes. First, the double helix of DNA of a certain chromosome is being separated into two single strands. Then, a number of sequences of base pairs on one of the strands is stained. Those fluorescent strands will be serving as probes. They are put together with another single strand of DNA, on which geneticists try **to localise** the base sequences of the probes. The probes automatically join those particular sequences if they occur on the strand examined (hybridisation). This technique yields **maps** with a low resolution, which means that fluorescent labels that lie too short to each other seem to run into one another.

Another kind of physical maps are the so-called **'contig maps'** or 'contigs'. "A contig map is a set of contiguous overlapping cloned fragments that have been positioned relative to one another" (Cooper 1994: 113). Those **maps** are far more detailed than the maps constructed by means of **in-situ** hybridisation. The technique to obtain them is the following: each human chromosome is being cut into fragments (digested) by restriction-enzymes. Those fragments are being cloned several times. Then, each of those fragments is separated further by another restriction-enzyme. On each clone, this second process of digestion is being interrupted at different times. As a result, the scientists involved have overlapping clones at their disposal. DNA-probes (obtained by hybridisation) are used to determine the order of the overlapping base sequences in the fragments. The final goal of the Human Genome Project is to obtain **contig maps** of the entire genome.

source domain: **geographical map**	**target domain:** **genetic map**
continents	chromosomes
to localise places	to localise genes
markers or landmarks	RFLPs as markers
relative position of places in relation to other places (in kilometres or miles)	***genetic-linkage map***: the position of each gene in relation to another gene (genetic distance in centimorgans) ***physical map***: the number of base pairs between two genes (distance in base pairs between landmarks
region	region
site	site

Figure 5.13. *Aspects of the analogy between geography maps and genetic maps.*

5.5.2.2 *Lexicalisations based on the analogy*

In the following fragments (1 to 8) from four books written for non-specialists (Jones (1993), Levine and Suzuki (1993), Cooper (1994) and Shapiro (1991)), the aspects of this analogy shown in Figure 5.13 are worked out in more detail.

FRAGMENT 1

Genetics, like geography, is about **maps**; in this case the **inherited map** of ourselves. Not until the invention of accurate clocks and compasses two thousand years after Herodotus was it possible to measure real distances on the earth's surface. Once these had been perfected, good **maps** soon appeared and Herodotus was made to look somewhat foolish. Now the same thing is happening in biology. Geneticists, it appears, were until only a few years ago making the same mistakes as the ancient Greeks. Just as in **mapping** the world, progress in **mapping genes** had to wait for technology. Now that it has arrived the shape of the **biological atlas** is changing very quickly. What, two decades ago seemed a simple and reliable **chart of the genome** (based, as it was, on the inheritance of **landmarks**, such as the colour of peas or of inborn disease) now looks very deformed (Jones 1993: 41–42).

FRAGMENT 2

To look at an ancient **chart**–even one as faulty as that of Herodotus- is to realise that **maps** contain within themselves a great deal about the lives of those who drew them. They show the size and position of cities, the path of human migration, and the records of peoples long gone. The **genetic map of humanity** is no exception; and it may also hold the secret to many of the diseases which afflict us. When those students now entering medical school begin their careers — careers in which genetics will play a crucial role — a copy of the complete **map** should be in their hands (Jones 1993: 56).

FRAGMENT 3

Discoveries like the neurofibromatosis gene are both common and visible these days. At least once a week, headlines trumpet accounts of researchers who have tracked down yet one more gene that either leads directly to a specific disease or predisposes its bearers towards illness. Words like "discovery" and "tracking down" are appropriately used in this context, for **gene hunters** are very much like **explorers** prospecting in uncharted territory. If anything, gene hunters' work is harder because it requires two different types of inquiry.

First, like any explorer, **gene hunters** survey as they go, compiling **"maps"** of chromosomes on which they record easily identifiable **landmarks** and the locations of specific genes. That work is important, because in many ways, finding a gene in the human genome is like trying to track down an individual person with no information other than the fact that the target is **located** somewhere on earth. At first, researchers hunting for genes had only one choice: to chop all our DNA into tiny, gene-size bits and randomly test each piece to see if it was the right one. Given the size of the human genome (3 billion base pairs, remember), that's roughly akin to mounting a manhunt by wandering randomly through the world and reading the names on all the mailboxes.

Second, after **locating** genes, researchers want to “read” them, […] (Levine & Suzuki 1993: 28).

FRAGMENT 4

The Human Genome Project is the first large coordinated effort in the history of biological research. The aim is to make a detailed **map** of human DNA — the hereditary instructions inscribed in DNA that guide the development of a human being from a fertilized egg cell.

Like sixteenth-century **maps** of the new world, present **maps** of the human genome contain few **landmarks** and many parts unknown. And like the explorers of the new world, the **genome explorers** are pushing forward into vast **uncharted territory** in the face of great uncertainties — both political and technological (Cooper 1994: 70).

FRAGMENT 5

The idea is based on a very old method for inferring the order of and relative distances between genes that lie along a single chromosome, what we call **genetic-linkage mapping**. […] traits are almost always co-inherited […] linkage between two different gene pairs.

How often do two alleles get separated by crossing over? It depends on how far apart they are. And that’s the key to estimate the distance separating the two alleles. That distance is called the **genetic distance**. People have done many such linkage studies and constructed **linkage maps** giving the order of and **genetic distances** between genes that specify Mendelian traits and that lie on the same chromosome. The problem is that linkage analysis provides no way of **locating** genes on the chromosomes itself. […]

Variations in spelling are called polymorphisms. […]

the first priority of the Genome Project, as outlined in the joint DOE/NIH five-year plan, is to construct **linkage maps** of polymorphic markers and furthermore to include enough **markers** on the linkage maps so that no two are very far apart. At the same time we will build **physical maps** consisting of cloned DNA fragments that cover the genome in a more or less continuous way, so we can locate the markers from the linkage maps on the DNA itself.

[…] Once we have the linkage maps of highly polymorphic markers and the physical map of ordered, cloned DNA fragments, the search for disease genes will become routine (Cooper 1994: 70–75).

FRAGMENT 6

Mapping and sequencing the human genome is going to be expensive, and it's going to take a long time. In the last five years, however, we've had some technological breakthroughs that make the Genome Project feasible, especially the first step of constructing **physical maps** for the whole genome . When people first started talking about this project, most of them were unaware that Maynard was working on a method to clone very large pieces of DNA in YACs (yeast artificial chromosomes). That new cloning method has now become the mainstay of a **physical-mapping** effort. Without YACs, we would have been stuck with little pieces of the physical map and no way to put them together. To use an analogy, we would have had an interstate highway that was interrupted every mile or so by a stretch of dirt road or no road at all. That's better than nothing, but it's not as useful or efficient as a continuous highway. […]

The difficulty in making a physical map is that often you get a few pieces hooked together to form a little island of the puzzle — that **island** is called a **contig** because it contains pieces of DNA that are contiguous in the genome — but then you get stuck because you can't find the overlapping pieces that would extend the **island** on each end (Cooper 1994: 103).

FRAGMENT 7

But **maps** are not merely navigational tools. They also provide a means of correlating many types of data. For example, we use maps to locate mountains, rivers, and city and state boundaries, but we also use maps to plot population density, average rainfall, climate changes, earthquake activity, and so on. And once we plot those data on a map we start to see relationships.

Cytogeneticists, doctors, and molecular biologists are all making observations on the genomes of individuals on a daily basis, but without a map we have no way of correlating those data with other information about the genome. Once we have a continuous **contig map**, those date will become important. We'll be able to locate the exact **site** of, say, a chromosomal **translocation**, insertion or deletion or a new DNA marker and to correlate that information with other facts about that **region** of the genome. A number of labs have already constructed YAC contigs spanning several million bases, and we can expect that kind of success to continue (Cooper 1994: 104–5).

FRAGMENT 8

In historical exploration, a certain type of person would be the one who first ventured into known territory, noted the dangers and safe places, and make a rough map of the terrain. He would then move on to the next adventure, while others moved in to settle the land. The same pattern may well be followed in the human genome.

The **first explorers** will simply decipher the text, recording the DNA sequence on one human cell sample. They or others may also probe its division into different languages, noting protein-coding, control, and structure areas;

> interruptions; LINEs and Alus; and any unusual features of interest. A group of specialists will then move in for a longer stay. They will prepare and test the **newly discovered** proteins, **explore** their role, and learn how they fit into the complicated network of interactions that makes up human biochemistry.
>
> (Shapiro 1991: 139).

We can observe the following phenomena:
a) The analogy has given rise to generally accepted vocabulary : **map** (all fragments), **mapping** (fr. 5,6), **landmarks** (fr. 4), **sites** (fr. 7) (what we called **type a** naming in Section 5.5.1).
b) The analogy has given rise to lexicalisations which are adapted to the specificity of the new field under development (what we called **type b** naming in Section 5.5.1). Examples are **genetic mapping** ("any method used in the measurement of positions and relative distances between genes of a linkage group or **sites** within a gene" (Rieger 1991: 213)) like **genetic linkage mapping** and **physical mapping**
c) The analogy gives rise to didactic metaphorisations (**discovery,** ***tracking down, gene hunters, explorers*** (fr.3) .

"Words like "**discovery**" and "**tracking down**" are appropriately used in this context, for **gene hunters** are very much like **explorers** prospecting in uncharted territory."

d) We also find examples of how authors elaborate aspects of the analogy to make the information pass, but without further lexicalisations resulting from this; e.g.
(fr. 3) "That work is important, because in many ways, finding a gene in the human genome is like trying **to track down** an individual person with no information other than the fact that the target is located somewhere on earth."
(fr. 6) "Without YACs, we would have been stuck with little pieces of the **physical map** and no way to put them together. **To use an analogy**, we would have had an interstate highway that was interrupted every mile or so by a stretch of dirt road or no road at all. That's better than nothing, but it's not as useful or efficient as a continuous highway".
(fr. 7). "But maps are not merely **navigational tools**. They also provide **a means of correlating many types of data**. For example, we use **maps to locate** mountains, rivers, and city and state boundaries, but we also use **maps** to plot population density, average rainfall, climate changes, earthquake activity, and so on. And once we plot those data on a map we start to see relationships.

Cytogeneticists, doctors, and molecular biologists are all making observations on the genomes of individuals on a daily basis, but without a map we have no way of correlating those data with other information about the genome. Once we have a continuous **contig map**, those date will become important."
(fr. 8) "In historical exploration, a certain type of person would be the one who first ventured into known territory, noted the dangers and safe places, and make a rough map of the terrain. He would then move on to the next adventure, while others moved in to settle the land. The same pattern may well be followed in the human genome.

The **first explorers** will simply decipher the text, recording the DNA sequence on one human cell sample. They or others may also probe its division into different languages, noting protein-coding, control, and structure **areas**; interruptions; LINEs and Alus; and any unusual features of interest. A group of specialists will then move in for a longer stay".
e) We find extra information which is loosely linked to the analogy by implication.
(fr. 3) "finding a gene in the human genome is like trying to **track down** an individual person with no information other than the fact that the target is **located** somewhere on earth."
(fr. 4) the analogy between explorers who are drawers of maps in territories where they have to live with uncertainties and "gene explorers are pushing forward into vast **uncharted territory** in the face of great uncertainties — both political and technological."

5.5.3 *DNA IS SOFTWARE*

The third information sub-m-ICM involves that genetic material (DNA) can be understood as the software in an information processing system (the cell). This is explicitly pointed out in:

> There's another appropriate analogy here, one that emphasizes why the unity of life has been so important to molecular biology. You can think of DNA's coded instructions as molecular **"software"** that runs the **"hardware"** of life. Just as[54] a **word-processing program** tells computer hardware what to do, DNA's instructions control life's machinery. Why is that comparison useful?

54. The underlining is ours.

> Because if you work with computers the way most of us do, you know enough about your favorite word processor or spreadsheet to use it, but you could hardly write the program yourself. In much the same manner, molecular biologists know enough about certain DNA-based "programs" to use them without fully understanding how they work.
>
> So it's handy that much of the **life's software**–regardless of the organism it comes from — will run on the hardware of nearly any other living cell. That's why, for example, researchers who discover and learn to control the molecular word processor used by one organism can harness that tool to manipulate genetic text in different organisms without having to learn precisely why or how that particular **molecular program** works as it does (Levine & Suzuki 1993: 23).
>
> As pointed out above, the subunits of the DNA strands, the nucleotides, are the chemical basis for **storage of information** in DNA (Drlica 1992: 33).

"DNA's coded instructions" are thought of as "molecular **software** that runs the **hardware** of life". The comparison is relevant because just like computer users can use but not write a program, molecular biologists know enough about DNA to use it without fully understanding how it works. The 'software' (DNA) of a particular organism can be run on the hardware (cells) of nearly any other organism.

In our corpus we find mention of the analogy between the computer software and DNA but no examples of how this analogy has inspired term formation. A possible explanation for this observation is given in Section 5.6.

5.5.4 *DNA IS A TAPE OF FILM*

Potentially, the information model consists of more sub-models than the three we indicated so far (language, geography, computer software). In Drlica (1984 & 1992) we find that a fourth information sub-m-ICM, the film sub-m-ICM (Figure 5.14), is brought to the fore to explain the structure of genetic information.

> In some ways **DNA is similar to motion picture film**. Like film, DNA is subdivided into "frames" that make sense when seen in the correct order. In DNA the "frames" correspond to the letters in the genetic code, […]. When a number of frames or genetic letters are organized into a specific combination, they create a scene in the case of film and a gene in the case of DNA (Drlica 1992: 4).
>
> As pointed out above, the subunits of the DNA strands, the nucleotides, are the chemical basis for storage of information in DNA. Returning to the film

> analogy[…], the units we have now defined as nucleotide pairs, or base pairs, correspond to a scene in the motion picture film (Drlica 1992: 34).

motion picture film	***DNA***
frames	letters in the genetic code
scenes	genes

Figure 5.14. *The analogy between motion picture film and DNA*

The lexicalisations *frames* and *scenes* are ideolectical lexicalisations, which are used here for didactic purposes. These lexicalisations are transient. The lexemes do not become terms in the language of the biological sciences. In Drlica's book this analogy reinforces the understanding of *gene splicing*. Genes can be spliced in the laboratory the way film or tape can be spliced in a studio. For *splicing* we refer to Temmerman (1995, 1998, chapter 6).

5.6 Creative and didactic metaphor

The quotes in Section 5.5 from texts written for scientists and from popularising scientific texts, made it possible to prove that an m-ICM has an internal structure (sub-ICMs): some sub-ICMs serve the purpose of aiding understanding (like the film sub-ICM), others serve a creative purpose of new scientific understanding. One should distinguish between firstly, researchers' articles whose neolexicalisations are the result of conscious or subconscious analogical thinking; secondly, specialist manuals for users with a scientific background; and thirdly, popularising texts written by specialists for a large readership (see Figure 5.15).

text type 1: research articles	analogy is introduced
text type 2: specialists manuals	analogy is present
text type 3: popularising texts	analogy is made more explicit

Figure 5.15. *How analogies are worked out in different text types*

5.6.1 *Example of text type 2 and text type 3*

In texts for specialists (type 2) one finds explicitations of the m-ICMs, as in the following quote:

> Great advances in understanding the hereditary mechanisms used by fungi, bacteria, and viruses followed speedily and decisively because their biological characteristics simplified the analysis of their genetic structures. Implicit in these advances was the concept of the gene as **information**–that is, information that governs the characteristics, growth and behavior of living things. A consequence of this was that all living things must have **mechanisms that decipher or "read" the genetic information**. Genes also must permanently **store** such **information** for **transmission** from parents to offspring (Berg & Singer 1992: 10).

In this fragment we find indications of both the **DNA is a language analogy** ('decipher' or 'read'), and the **DNA is software analogy** ('information', 'store', 'transmission').

In popularising texts (type 3) like Jones (1993) attempts are made to render a complex subject accessible to non-specialists. This popularising text is more explicit about the metaphor than the more scientific text of Berg & Singer (1992) in which the metaphor is also made explicit but not explained in as much detail and with the same zeal for making matters easy to understand.

> This book is about what genetics can — and cannot — tell us about ourselves. Its title The Language of the Genes, points to the analogy upon which it turns, the parallels between biological evolution and **the evolution of language**.
>
> Genetics is itself a **language**, a set of inherited **instructions** passed from generation to generation. It has a **vocabulary**–the genes themselves — a **grammar**, the way in which the inherited information is arranged, and a **literature**, the thousands of instructions needed to make a human being.
>
> The language is based on the DNA molecule, the famous double helix, which has become the icon of the 20th century. Both languages and genes evolve. Each generation there are **mistakes in transmission** and, in time, enough differences accumulate to produce a new language — or a new form of life. Just as the living tongues of the world and their literary relics reveal a great deal about their extinct ancestors, genes and fossils provide an insight into the biological past. We are beginning to learn to read the languages of the genes and it is saying some startling things about our history, our present condition and even our future (Jones 1993: xi).

LANGUAGE	GENETICS AS A LANGUAGE:
has a vocabulary	the vocabulary are the genes
has a grammar	the grammar is the way in which the inherited information is arranged
has a literature	the literature constitutes the thousands of instructions needed to make a human being
language evolves	genes evolve: each generation knows mistakes in transmission
literature gives us insight in the past	genes give us insight in the past
we read language	we read the language of the genes

Figure 5.16. *Schematic representation of how the language gestalt provides a didactic metaphorical model for genetics.* (based on Jones 1993:xi).

In Jones (1993) the similarity-based metaphorical model is consciously used and expanded on as a didactic method which helps the understanding. Jones spells out the analogy between 'genetics' and 'language' (see Figure 5.16). In doing so he proves the gestalt structure of the m-ICM. The potential for similarity does not necessarily have to be expressed in lexicalisations. Yet, because the m-ICM provides the possibility of understanding, the gestalt structure of the m-ICM allows for a more detailed elaboration on the analogy between the source cognitive gestalt and the new or the target cognitive gestalt. If more explanations are needed, e.g. because the potential readers of the text are non-specialists, this will result in further borrowings of the vocabulary of the source domain.

In Jones' book more elements of the analogy language — genetics are used: genes are linked to history (3), each gene is a message from our forebears (3), all the genes together contain the whole story of evolution (3). Jones also reverses the analogy: Darwin described evolution as *descent with modification*. Language is also likely to be garbled during transmission.

The alphabets of both languages are compared: language has 26 letters arranged in words of x letters — the language of the genes has 4 letters arranged in words of three letters (3). Jones adds anecdotes to illustrate how easily language gets corrupted when passed on, which are superfluous from the point of view of adding more information, and observes how incredible it is that life can manage with only four letters, whereas human language needs 26 (4). Anecdotes often serve to make a point. They also do in Jones' text in which they serve to emphasise the underlying tone of amazement, of wanting to stress how interesting and important all this is. A paradox is pointed out: although the vocabulary is simple, its message is long. A scheme exists to read the 3000 million letters and to publish the most boring *book* ever written (4). A comparison is made to make the reader realise the size of the bulk of information: if it were printed out the equivalent of a dozen or so sets of the Encyclopedia Britannica would be needed (4).

This spelling out of the analogy is not necessarily going to result in a better understanding of genetics as a language. It seems that genes are being paired up with too many items in the **language** domain (Figure 5.16): genes evolve like the vocabulary of a language, genes evolve like a language evolves, genes are the literature of a language. If genes are at the same time the vocabulary, the language itself and the literature written in the language, this means that the analogy is rather in the gestalt than in the details.

The further elaboration on the language analogy by Jones is to be seen as serving a didactic purpose and not as scientifically creative. Jones is trying to explain the new phenomena to a wide audience and uses figurative language which is partly idiosyncratic and intermittent and does not lead to neologisms which become part of the terminology of the scientific community. Jones refers to anecdotes which are intended to make the text easier to read (e.g. the quotation from a book which does not contain the letter “e”; the Human Genome Text is the equivalent of a dozen or so copies of the Encyclopedia Britannica), but whose content is peripheral in the analogy model. This is different from the creative potential of language as an instrument for analogical thinking.

5.6.2 *Scientific and didactic metaphorisation*

Having distinguished between creative and didactic metaphorisations, in this section our hypothesis is that the metaphorical neologisms which constitute the terminology of a discipline are the ones related to the creative analogical thinking process which resulted in the further understanding by specialists of what had been understood before. Based on that insight it is possible to distinguish between the sub-m-ICMs which basically provide the analogy for creative metaphorisations (cognitive function) and the sub-m-ICMs which served for didactic metaphorisations (communicative function). Terminologists should distinguish between both types of (sub)m-ICMs. In other words we can say that some neo-lexicalisations refer to categories which were understood within an m-ICM and that these neo-lexicalisations are always linked up to creative analogical thinking. Other neo-lexicalisations are the results of further elaborations on analogies which before were used for creative understanding or they are the results of analogies used for didactic purposes.

When applying our insights to the information m-ICM we have been describing in Sections 5.5 and 5.6.1 we can distinguish between two groups of sub-m-ICMs. To the first group belong the sub-m-ICMs DNA IS A LANGUAGE and DNA IS AN ATLAS OF MAPS. Some terminology of the life sciences are neolexicalisations which can be explained from new analogical understanding based on these m-ICMs (see Figure 5.17). The same two sub-m-ICMs belong to the second group together with two others i.e. DNA IS SOFTWARE and DNA IS A FILM, which can be the base for further didactic explicitations and which are at the base of transient, didactic lexicalisations (see Figure 5.18).

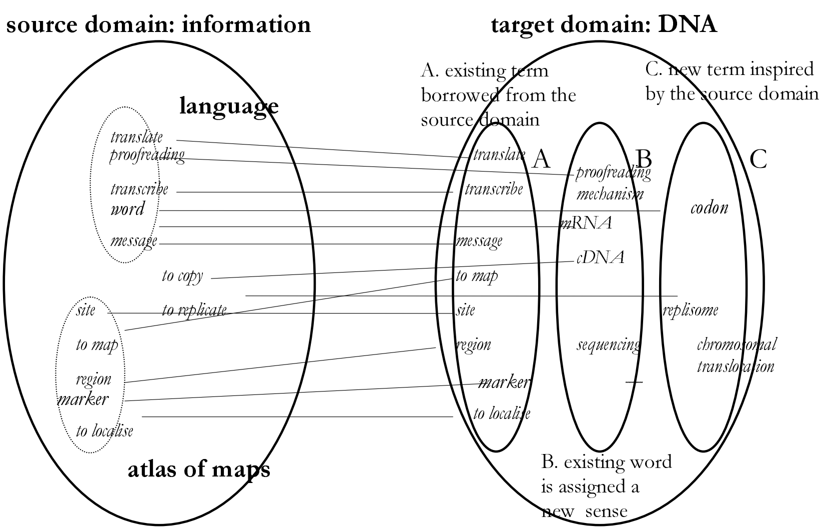

Figure 5.17. *The sub-m-ICMs of the information m-ICM which provides the analogy for new terminology.*

Figures 5.17 and 5.18 show the transfer of source domain vocabulary to the target domain. Three different categories of vocabulary transfer can be distinguished: category A: an existing term is transferred from the source domain, category B: an existing word is assigned a new sense, category C: a new term is coined inspired by the source domain. A comparison of Figure 5.17 with Figure 5.18 shows clearly that sub-m-ICMs which played in the process of creative understanding — unlike sub-m-ICMs which play a role in didactic understanding — give rise to new terms (category C) which are perhaps not directly recognisable as metaphorical lexicalisations but which can nevertheless be situated in the domain transfer. Figures 5.17 and 5.18 show the network structure of modular lexical fields of a source domain and how the transfer of this source domain as a gestalt can explain the metaphorical

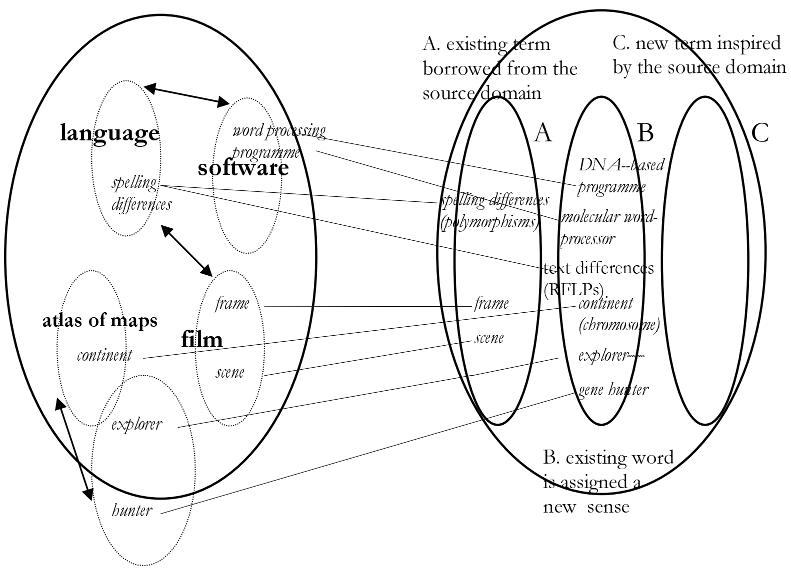

Figure 5.18. *How the sub-m-ICMs of the information m-ICM provide the analogy for didactic metaphorisations.*

lexicalisations in a target domain. LANGUAGE, ATLAS OF MAPS, SOFTWARE, FILM, are ad hoc modules, created in the mind (lit up by a flood light) for the sake of understanding the target domain: GENETIC INFORMATION. The intra- and interrelational structure of each module is never set nor stable but transient and reconsidered each time a module is activated, whenever the subject is being communicated about in language. Because each module is a gestalt rather than a fixed set of lexical items, we have used dotted lines to indicate that the delineation is not a clear-cut borderline. The m-ICM DNA IS INFORMATION has provided us with evidence for the fact that categorisation is experiential and not objective. On the basis of analogy with what is already understood human beings understand new experiences, via image schemata or cognitive frames they have in mind. One experiential gestalt serves as a source of inspiration for the creation and understanding of a new experiential gestalt. Understanding can take place in terms of entire domains of experience. Traces of this are the neo-lexicalisations, which are the result of understanding via a metaphorical model. A new domain of experience can be inspired by more than one experiential gestalt which can serve as a metaphorical ICM. Several metaphorical ICMs can interact and together make the understanding of new experience possible, leaving their traces in the names given to new categories in the making. If the new domain of experience proves to be more complex or not totally parallel to the source domain, some of the lexicalisations will reach beyond the domain of experience which made up the initial source of inspiration.

It appears that the difference between didactically employed and creatively employed metaphorical gestalts is that the first lead to lexicalisations which only serve in the particular context of the didactic situation, whereas the creative metaphorisations lead to neologisms which are likely to catch on and become generally accepted terms in special language and beyond. Didactic metaphors, however, give more (propositional and lexical) explicitness to the metaphorical ICM(s) which is (are) at the basis of understanding the new domain of experience.

5.7 The diachrony of understanding

It is important to realise that progress in the history of the life sciences results from the interplay of social, cognitive and technical developments (Keller 1995). In order to be able to estimate the role of analogical reasoning which offers the motivation for metaphorical naming we need to place it in the framework of the other factors which determine historical development of the life sciences: social circumstances and technical progress. Figure 5.19 shows how the language development of the life sciences which is tangible in neolexicalisations and in polysemisation can be considered as acting simultaneously with and being mutually influenced by the social, technical and cognitive developments of the life sciences.

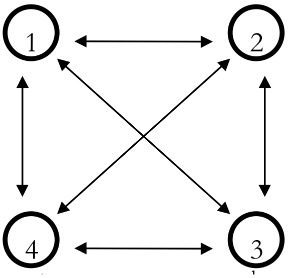

Figure 5.19. *How the social (1), technical (2), cognitive (3) and terminological (4) developments of the life sciences are interdependent. Therefore it is possible to present them in a network structure.*

In order to prove this we start off by giving a brief historical overview of the history of the life sciences (5.7.1), then we show which social (5.7.2), technical (5.7.3), and cognitive (5.7.4) factors influenced the development of the life sciences and indicate the possible impact of the social, technical and cognitive developmental factors on the terminology of the life sciences.

5.7.1 *Aspects of the history of the disciplines of the life sciences*

A terminologist who wants to understand the genesis of new terminology in a discipline will need to know the history of this discipline. For the understanding of the life sciences it is essential to have insight into the development of the following four phases.

Phase one: the study of heredity: transmission and development. In the 19th century heredity referred to both “**transmission** of potentialities during reproduction” and “**development** of these potentialities into specific adult traits” (Allen 1985: quoted in Keller 1995: 4). The question the scientists were trying to find an answer to was: how is a single germ cell capable of reproducing the entire body with all its details?

Phase two: the emergence of genetics and the coexistence of embryology and genetics. In 1902, a few years after Mendel's writings had been rediscovered, what he referred to as "factors" was related to chromosomal structure. The term *genetics* was coined in 1905 (by Bateson, see Rieger 1991: 218) and *gene* in 1909 (by Johannsen, see Rieger 1991: 189). With the emergence of **genetics** a redefinition of the term **heredity** coincided. It was now gradually narrowed down to refer exclusively to **transmission**. At first, however, genetics which emphasised the transmission aspect coincided with embryology which studied development. Whereas for embryologists the question remained "how does an egg develop into a complex many-celled organism?", for geneticists the question was "how do genes produce their effects?".

Phase three: the development of genetics. The study of gene activation which was the province of embryology was left behind in favour of the study of gene action. The attention was shifted from higher organisms to single-cell organisms. The one gene-one enzyme hypothesis was adopted, which gave rise to the study of the **biochemistry** of gene action and to the discipline of **bacterial genetics**. Experiments with bacteria established that deoxyribonucleic acid (DNA) is the chemical basis of the gene. James Watson and Francis Crick proposed the now-accepted structural basis of genetic information in DNA (1953). Later, the order of nucleotides along the DNA molecules was found to specify the linear arrangement of amino acids in proteins (*Academic Press Dictionary of Science and Technology* 1992: 918; Keller 1995: 17–19).

Phase four: developmental biology: back to gene activation. Keller (1995: 25–27) shows how since the 1960s a new interest was shown in gene activation but that the old name for the discipline of *embryology* got replaced by *developmental biology*.

A merging of the study of gene action and the study of gene activation is seen. "The point is that as we learn more about how genes actually work in complex organisms, talk about "gene action" subtly transmutes into talk about "gene activation", with the locus of control shifting from genes themselves to the complex biochemical dynamics of cells in constant communication with each other" (Keller 1995: 28).

5.7.2 *Social factors influence the development of the life sciences*

Keller (1995) gives the example of the power game between (basically)

German embryology and American genetics. She believes the shift in emphasis from embryology to genetics had reasons which can be explained sociologically. She is very convincing when she claims that the power struggle between the American and the German scientific world resulted in a favouring of genetics research projects, to the disadvantage of embryology research projects. Feminist Keller is less convincing when she claims that the study of the genes in action (the study of the nucleus) took precedence over the study of the cytoplasm and of gene activation as the active genes are more in line with male domination and therefore rather studied by the majority of male scientists than the activation of the genes by the interaction with the cytoplasm, which would give more importance to the female factor. This is not the place for discussing this point extensively. Let us formulate just one thought to express our reservations: if to study gene activity is more of a male scientist incentive than to study the cytoplasm and embryology, does that imply that the German pre-war scientists were less male dominant than the American scientists? What Keller does prove is that researchers — including herself — are influenced by social trends, like political correctness or feminism. Making abstraction of some details we believe that the point Keller is making about social factors having influenced the development of the life sciences is a good point. Social factors can furnish the explanation for the coming into existence and the disappearance of particular lexicalisations.

A striking example of the influence of social factors on the development of the life sciences is the disappearance of Greek and Latin from the school curriculum for the study of e.g. medicine in different countries at different times. When scientists were no longer influenced by classical languages, they started to use different word formation elements and with them different metaphors.

5.7.3 *Technological factors influence the development of the life sciences*

Like in practically all fields of research the computer has shown its merits in molecular biology. It has offered possibilities for easy storage, processing and transmission of the genetic text of life and other information. The Human Genome Project,[55] for instance, would have been inconceivable without pow-

55. The human genome is "the totality of DNA contained within the chromosomes. … The human genome … consists of approximately 6 billion base pairs of DNA distributed among forty-six chromosomes." (Cooper 1994: 333)

erful computing facilities. What made the genome project possible is that the 'text' of DNA is stored in a computer. This text is the result of the laboratory technique 'sequencing'. The sequencing technique is a second example of how technological innovations influence the development of the life sciences.

A. Computation and the Genome Project

The following quotes give evidence for the decision of the scientific community to make the text of life computer readable.

> The human genome may be considered a biological "program" written in a largely unknown programming language. Assembling a full description of this complex object and making the description available to all researchers via computer network will require innovation in software engineering. Understanding the structure and function of the genome will require scientific breakthroughs in which computation will play a major role (Cooper 1994: 250).

> Improvements in the DNA-sequencing technology in the mid-1970's enabled researchers around the world to determine the exact sequence of nucleotides in samples of DNA much more easily than before. Computers were the most convenient way to handle the large quantities of sequence data discovered using the new methods. Furthermore, since many people became interested in applying computer technology to interpreting those data, the data needed to be readable by computers. To meet those needs, Walter Goad created the Los Alamos Sequence Library in 1979, which in 1982 became GenBank (Cooper 1994: 270).

B. Sequencing

The sequencing technique is a second example of technological innovations and its consequences for new categorisations.

In order to didactically explain how sequencing can be done, Jones uses the analogy between electrophoresis (the first step in sequencing) and the possibilities of sorting sentences by length in a word processing programme. Then the analogy of putting sequences which have been cut by enzymes and how text fragments are pieced together after having been shredded by a paper shredding machine is given.

> The successes of the molecular explorers depend, like those of their geographical predecessors, on new surveying instruments which made the world a bigger and more complicated place. The tools used in molecular geography deserve a mention.

> The first device is electrophoresis, the separation of molecules in an electric field. […] The computer on which I am writing this book can do some fairly useless things. One of its talents is-if asked- to sort all sentences by length. This sentence, with its twenty words, would line up with many otherwise unrelated sentences from the rest of the book. Electrophoresis does this with molecules. The length of each DNA piece can be measured by seeing how far it has moved into the gel. Its position is defined with ultraviolet light (which DNA absorbs), chemical stains or a radioactive label. Each piece lines up with all the others which contain the same number of DNA letters (Jones 1993: 44–46).

The point is that technological innovations can be the explanation for new understanding and new terminology.

5.7.4 *Cognitive factors influence the development of the life sciences*

How cognitive factors like analogical reasoning have influenced the development of the life sciences and its terminology has been shown extensively in Section 5.5.

5.7.5 *Summary*

In Section 5.7 we have pointed out the impact of social, technological and cognitive developmental factors on the terminology of the life sciences, and we have emphasised that in the history of a discipline social, technological, cognitive and linguistic factors act together and mutually influence one another.

5.8 Towards guidelines for the description of metaphorical models and the resulting lexicalisations

Traditional Terminology adheres to an objectivist model of reality. At the basis is the belief that there is an objective world out there which has to be studied in an objective way. Traditional Terminology believes that language has to be regulated and controlled (i.e. standardised) in order to secure objectivity, clear-cut understanding, and efficiency and that for that reason literal lexicalisations are to be preferred over metaphorisations. We have pointed out non-objectivist models of understanding in which language and thought appear to be based on experience and more importantly in which language seemed to play a role in analogical thinking resulting in metaphorisations.

We have given examples of the fact that the naming of new units of understanding is not arbitrary but motivated. The role of metaphorical ICMs in the progress of knowledge is reflected in the naming of new units of understanding. New findings often appear to be the result of a deviant, alternative approach, which calls for imaginative creativity. Metaphorical thinking is part of the mechanisms which stimulate the imagination.

We have proved the existence of the **information** metaphorical ICM in the coherent and related naming of a number of new units of understanding. The ICMs can be made more explicit in didactic metaphor.

The question remains as to whether metaphorical models can be of use in terminography and if so how. We shall return to this question in Chapter 6.

CHAPTER 6

Towards New Ways of Terminology Description

> Le débat sur les dictionnaires spécialisés doit être replacé au sein du domaine général de la dictionnairique, pour plusieurs raisons […]. Dans tous les cas, l'objectif du dictionnaire est d' être utile (Slodzian 1997: 23).

> Many words of technical origin in current use have highly specific meanings which are not really accessible to anyone who does not know the subject. They are explained, so to speak, within a scientific or humanistic discipline. If we just wrote out the "official definition", our users would hardly be helped at all (Collins COBUILD English Language Dictionary, xix).

> I would be naive to demand the previous knowledge of concepts, because concepts can be accessed only via their names, except for their initial formation which is the exclusive prerogative of the discoverer, inventor and the theorist who forms hypotheses (Rey 1995: 97).

In this work we have questioned the principles of traditional Terminology and tested the potential relevance of some of the insights and methodologies of cognitive semantics for descriptive Terminology. In this final chapter we present the result of our search for a general theory of Terminology. We first formulate five alternative principles for Terminology which can replace the traditional ones that we have shown to be unrealistic as they only concentrate on terminological standardisation, and not on the realistic meaning description of terms occurring in textual archives (6.1). Then we speculate on the consequences that the alternative principles for Terminology could have for the terminographer's working methods and we propose a procedure for terminology description based on an analysis of textual information. The functional differentiation between types of descriptive terminologies is defined in terms of two parameters: (a) the content domains of specialised language and (b) the profile of potential users of the information provided by the terminology (6.2).

The methods for a terminography project should also be determined by these two parameters and not only by the traditional semasiological/onomasiological differentiation which distinguishes general and specialised lexicography from terminography. Finally we formulate some critical remarks and suggestions for further research (6.3).

In Chapter 1 we discussed five main principles of traditional Terminology and we indicated that we would try to prove that the terminological facts one is confronted with when reading texts in the field of the life sciences are difficult to describe in accordance with these five principles. We also indicated that the principles of traditional Terminology are the principles of standardisation and that standardisation is only one aspect of what should be the concern of the theory of Terminology. The main aim of standardisation is the unification of concepts and terms. It is a deliberate, conscious, socio-economically motivated activity with the object of rationalisation. Standardisation rationalises understanding and communication in order to make goods and information readily exchangeable. Standardisation committees of specialists in a field will meet and come to agreements on the precise definition of concepts. The definition indicates the position of a concept in a concept structure by mentioning the term referring to the superordinate concept and by giving the necessary and sufficient characteristics which distinguish the concept from other concepts in the concept system which are on the same horizontal level. It is only when the concept is defined, i.e. when its position in the — usually logically or ontologically — structured system is clearly described that the ideal term will be assigned. This ideal term is monosemous, i.e. it is used to refer to one concept only.

Of course standardisation is a valuable and necessary activity in society in one specific communicative situation: where specialists, those who already understand the subject field, consciously and willingly get together to come to an agreement on their concepts. This kind of terminology work is of a prescriptive nature. The mistake made by traditional Terminology was to proclaim the standardisation principles as the general theory of Terminology. However, terminology also plays a role in many other communicative and cognitive situations. The principles and methods of traditional Terminology do not take these into consideration. In the process of understanding the life sciences, language has played an active role. Examples of this were given in Chapter 5 where it was shown that analogical reasoning and metaphorisation appear to be intimately linked. Lexical metaphors can be seen as surface realisations of underlying concept metaphors which figure in more complex domain metaphors.

Terminology needs to find methods for studying and describing all the aspects that play a role in the process of special language understanding. Moreover, the terminology which is encountered in the textual archives of science should be described in a systematic way with a variety of potential user groups in mind. These potential user groups have one thing in common. They are likely to consult the terminology in the hope of finding help to understand a category which has been lexicalised in language as a term and therefore occurs in discourse. In other words, the potential users of descriptive terminologies need information which is the result of a combined semasiological and onomasiological approach in terminography. The onomasiological aspect resides in the treatment of a set of related terms. The semasiological aspect provides information on polysemy and diachronic changes in understanding. The data for a combined onomasiological and semasiological description are available in the textual archives of special language.

We see two main objectives for Terminology. One concerning the theoretical underpinning of the discipline and one regarding the search for the best methods and guidelines for terminography.

The theoretical underpinning of Terminology needs (a) a theory of 'understanding' of categories and (b) a theory of the interplay between lexicalisation and categorisation. Moreover, Terminology needs to provide methods and guidelines for terminography involving the description of (a) the understanding of categories, and (b) the process of lexicalisation (Figure 6.1).

Terminology	**understanding**	**lexicalisation**
theoretical issues (6.1)	search for a theory of **understanding** categories and terms by a variety of language users (principles 1, 2, 3)	search for a theory of the relationship of **lexicalisation** and categorisation (principles 4, 5)
terminography (6.2)	methods and guidelines for the description of **understanding** categories and terms aimed at a variety of user groups	methods and guidelines for the description of the process of **lexicalisation**

Figure 6.1. *The distinction between the objectives of the theory of Terminology and their applicability in terminography.*

Research on the variety of informational units in terminology is needed in order to provide guidelines, methods and principles for terminology description aimed at different user groups.

In a previous chapter we suggested that principles and methods of traditional Terminology should be supplemented by the principles of sociocognitive Terminology. In what follows we consider some of the theoretical issues of sociocognitive Terminology (6.1) and the consequences of working within a new paradigm for terminography (6.2).

6.1 Theoretical issues in sociocognitive Terminology

In this section we distinguish between principles (6.1.1) and methods (6.1.2). Principles are the basic beliefs on which a theory is founded, whereas methods are tools, techniques used to achieve insight or to analyse data in order to be able to formulate a reply to a theoretical question. Subsection 6.1.1 contrasts the principles of traditional Terminology with the new principles we have been proposing in this work. In Subsection 6.1.2 the three methodological techniques we made use of in our analysis of some of the terminology of the life sciences are recapitulated.

6.1.1 *New principles for Terminology*

Figure 6.2 contrasts the principles of traditional Terminology with the principles of sociocognitive Terminology. In the following subsections we explain how we replaced each of the traditional principles by one grounded in sociocognitive Terminology.

Traditional Terminology	Sociocognitive Terminology
Principle one: Terminology starts from concepts which can be clearly delineated.	**Principle one:** Sociocognitive Terminology starts from units of understanding which more often than not have prototype structure (6.1.1.1).
Principle two: Clear-cut concepts can be attributed a place in a logical or ontological concept structure.	**Principle two:** Understanding is a structured event. A unit of understanding has intracategorial and intercategorial structure and it functions in cognitive models (6.1.1.2).
Principle three A concept can be defined in an intensional definition (superordinate concept and differentiating characteristics) and/or extensional definition.	**Principle three** Depending on the type of unit of understanding and on the level and type of specialisation of sender and receiver in communication, what is more essential or less essential information for a definition will vary (6.1.1.3).
Principle four: A term is assigned permanently to a concept. It is believed that ideally one term only should be assigned to one concept.	**Principle four:** Synonymy and polysemy are functional in the progress of understanding and therefore need to be described (6.1.1.4).
Principle five: a) Concepts and terms are studied synchronically. b) The relationship between concept and term is arbitrary	**Principle five:** a) Units of understanding are constantly evolving. The historical periods in their evolution may be more or less essential for the understanding of a unit. b) Cognitive models (e.g. metaphorical ICMs) play a role in the development of new ideas which implies that terms are motivated. (6.1.1.5)

Figure 6.2. *Contrast between the principles of traditional Terminology and the principles of sociocognitive Terminology.*

6.1.1.1 *Principle one: units of understanding*

The main key word of traditional Terminology was *concept* (principle one, Figure 6.2). In sociocognitive Terminology it is to be replaced by *unit of understanding*. The **concept** in its traditional definition of “unit of thought constituted through abstraction on the basis of properties of a set of one or more objects” (ISO/CD 1087–1, 1995) (an *object* is a “phenomenon in the perceivable or conceivable world”) is too restrictive. As we showed (Chapter 3) few concepts exist objectively. People understand the world via cognitive frames or Idealised Cognitive Models (ICMs) in which prototype-structured units of understanding are related. We consider **units of understanding** instead of *concepts* when studying the terminology of the life sciences. Only few units of understanding in the domain of the life sciences do not have prototype structure (one could say that these are the only real concepts, because they can be defined in accordance with the principles of traditional Terminology), but most have prototype structure and are therefore better referred to as **categories**. The problem then becomes: how does one study and describe categories? Does one take a *term* as a starting point (semasiological approach) or the abstract idea of a "chunk of knowledge" (onomasiological approach)? We believe it is necessary to describe the information obtained by combining three perspectives: the nominalistic perspective (the unit of understanding is the sense of the word), the mentalistic perspective (the unit of understanding is an idea which exists in people's minds) and the realistic perspective (the unit of understanding is an external form which exists in the universe). Terminology should try and describe the intricate relationship between the three perspectives of understanding. Traditional Terminology theoretically stipulates that a specialist can describe the concept before giving any attention to the term. The concept is considered to exist in an abstract way, without acknowledging the role language plays in categorisation and communication. This position equals the one taken by specialists on standardisation committees. It reflects just one aspect of how special language vocabulary can be handled in communication. Artificially, the fact that terms already exist to communicate about the knowledge in the specialised domain under consideration is conveniently overlooked. With the aim of arriving at unambiguous communication the artificial model insists on first clearly delineating a concept and then naming it in order to obtain mononymy and monosemy.

As terminology can only be studied in discourse[56] it is better to accept that it is the **term** which is the starting point in terminological description rather than what was traditionally called the *concept*. What is named by the same term in different texts can be shown to have different referents. More often than not a category cannot be clearly delineated. It is like a *chunk of knowledge* which has a core and a structure but which exists in a process of continuing reformulation and is therefore in constant transition.

When considering the meaning of a particular term we notice that the

56. For our arguments against introspection and data elicitation see 2.2.

borderline between polysemy (the fact that one term can have different senses) and vagueness (the fact that a term is never used with exactly the same meaning) is fuzzy.

6.1.1.2 *Principle two: understanding is sorting cognitive models*

Traditional Terminology believes a clear-cut concept can be attributed a place in a concept structure. This concept structure is based on logical (e.g. x is a type of y) or ontological (e.g. x is part of y) classification. Sociocognitive Terminology believes understanding amounts to categorisation. Each category is understood as existing within cognitive models. Understanding is a structured event. There are two aspects to this: a unit of understanding has intracategorial and intercategorial structures (6.1.1.2.1) and a category has prototype structure (6.1.1.2.2).

6.1.1.2.1 *Intracategorial and intercategorial structures*

In traditional Terminology, only distinguishing characteristics were deemed intracategorially important, while logical and ontological relationships were considered intercategorially important. In sociocognitive Terminology, however, a category's existence is not considered to be independent of language. Intracategorially a distinction is made between different information modules (like features, core definition, historical information, procedural information). These information modules may have varying levels of prominence depending on the type of category (e.g. entity, activity, umbrella category) under consideration. Intercategorially perspective, domain and intention of the cognitive model need to be unveiled.

The intracategorial and intercategorial structure of a category can be observed in discourse and implies more modules of information than just the distinguishing characteristics and the position in a logical or ontological classification.

6.1.1.2.2 *Categories have prototype structure*

Categories have prototype structure. Intensionally, only few categories can be defined by means of necessary and sufficient characteristics and more are blurred at the edges. Extensionally, exemplars of categories more often than not exhibit family-resemblance structure and degrees of category membership. Getting insight into the prototype structure is part of the process of understanding a term. Descriptive terminology may want to work out more detailed methods for prototype structure analysis (see Section 6.1.2.1).

6.1.1.3 *Principle three: template representation*

Because concepts in traditional Terminology needed to have a place in a concept structure, it was believed that they could be defined on the basis of necessary and sufficient characteristics. In sociocognitive Terminology meaning descriptions can have more essential or less essential units of information. Depending on the type of unit of understanding, what is considered more essential or less essential information for a definition will vary.

We have shown in the preceding chapters that there are types of units of understanding. Very few units of understanding are concepts according to the definition of traditional Terminology. The others have prototype structure and are referred to here as categories. Depending on the type of category different information modules can vary in informational importance (Figure 6.3).

It is possible to imagine a **template of understanding** composed of different modules of information which can hold more or less essential information depending on the type of unit of understanding and on other factors such as the perspective from where the unit of understanding is understood (see Section 3.3.2.2.4).

	types of information modules				
type of unit of under-standing in the life sciences	e.g. historical information	e.g. steps in the process	e.g. attributes		
			e.g. aim	e.g. application	e.g. result
umbrella unit e.g. biotechnology	2	0	0, 1, 2.	0, 1, 2.	0, 1, 2.
entity e.g. intron	1	0	0, 1, 2.	0, 1, 2.	0, 1.
activity e.g. cloning	1	2	1, 2.	1, 2.	1, 2.

Figure 6.3. *Depending on the type of category different information modules can vary in informational importance on a scale from 0 to 2* (0=irrelevant, 1=relevant, 2=prominent).

6.1.1.4 *Principle four: functionality of synonymy and polysemy*

If, as has been claimed, science is an intertextual process, it should be possible to study the descriptions of the categories of the life sciences and of the process of lexicalisation in discourse. One needs to study texts in order to understand the flexibility and diversity in categorisation. If one leaves the self-inflicted limitations of studying language as a system on its own (traditional Terminology inspired by Saussurian structuralism), one finds that there is very little arbitrariness in categorisation and lexicalisation. Synonymy and polysemy appear to be functional in the process of progress of understanding.

Textual information contains the proof that it is possible to refer to prototypically structured categories in different ways, using (near-) synonymy. In many cases (near-)synonymy can be explained by acknowledging that there can be different perspectives as we showed in the case of *Southern blotting*, *Southern hybridisation* and *Southern transfer* (Sections 3.2.2.2 & 4.2.2).

Textual archives contain the factual information necessary to prove that the three reasons for polysemisation occur simultaneously. The first reason is a change in the world due to new technology or social change. The second reason can be found on the cognitive level: change in the understanding of the category. The third reason lies in the possibilities and constraints brought about by the totality of all the elements of change in language which accepts on the one hand that the prototype structure of categories provides for further meaning evolution and on the other hand that elements in language mutually influence and constrain one another.

6.1.1.5 *Principle five: cognitive models are constantly in transition*

The constant development of units of understanding can be explained as the result of several simultaneously active factors which influence the cognitive model sorting: (a) the urge for more and better understanding; (b) the interaction between different language users; (c) prototype structure in the understanding of categories which can be seen simultaneously as the result of and as one of the causes of meaning evolution. Cognitive models like metaphorical ICMs play an important role in the development of new ideas. This explains how lexicalisation can be motivated.

6.1.1.6 *Summary*

Figure 6.4 gives an overview of the different perspectives of traditional and sociocognitive Terminology on a number of key issues.

	Traditional Terminology	**Sociocognitive Terminology**
starting point	The concept A concept exists objectively.	The term designating a unit of understanding. Some units of understanding can be perceived (in reality), all units of understanding are conceived (in the mind).
terms	Terms name concepts.	Terms are motors in the process of understanding as they link new understanding to previous understanding.
structures	Concepts figure in concept systems which are logically or ontologically structured.	Units of understanding function in ICMs. A distinction is made between propositional ICMs and metaphorical ICMs.
definitions	The definition of a concept reflects the position of the concept in the logical or ontological concept system, i.e. a concept is delineated from the superordinate, the subordinate and the co-ordinate concepts by giving essential characteristics.	The definition of a unit of understanding x is a reply to 'what is x?'. What is essential information is dependent on the type of unit of understanding. Modules of understanding comprehend e.g. • historical information, • intracategorial information • intercategorial information • procedural information.
monosemy and polysemy	Univocity is believed to be ideal in order to cut out ambiguity. Ideally one concept only is assigned to a term (monosemy) and one term only is assigned to a concept (mononymy). Therefore standardisation is indicated.	Relative to the type of unit of understanding univocity (monosemy and mononymy) as well as polysemy can be functional. Therefore both possibilities can be exploited for better understanding. Synonymy can be functional.
imagination	Figurative language has to be curtailed and replaced by literal equivalents.	The power of the imagination is given credit and figurative expressions are part of the terminological description.

Figure 6.4. *The different perspective of traditional and sociocognitive Terminology on a number of key issues.*

6.1.2 *New methods for terminological analysis*

Sociocognitive Terminology is a paradigm involving a number of principles which differ from the paradigm of traditional Terminology. In order to be a fully-fledged discipline Terminology needs more than principles. It needs tools, i.e. methods and techniques for the analysis of terminological data which can serve a double purpose. On the one hand these methods and techniques allow the researchers to test the validity of the principles and on the other hand they provide the terminographer with data for his descriptive practice. Traditional Terminology used *componential analysis* as its most important tool, with the aim of drawing tree structures representing concept structures (taxonomies and meronomies). For the analysis of the terminological data we collected from the textual archives on the life sciences we resorted to three methods of data analysis: prototype structure analysis (6.1.2.1), cognitive model analysis (6.1.2.2), and diachronic analysis (6.1.2.3). These three methods are part and parcel of the tool kit of cognitive semantics.

6.1.2.1 *Prototype structure analysis*

In Chapter 3 we presented an analysis of the prototype structure of the categories *blotting* and *biotechnology*. *Blotting* is an example of an activity and *biotechnology* of an umbrella category. We found proof in the textual archives of the life sciences of the prototype structure of these categories. This explains why it is not possible to define these categories in terms of a conjunction of necessary and sufficient features. We also discussed an example of a ‘real’ concept, i.e. a concept definable in accordance with traditional Terminology practice (*intron)*. However, even this ‘concept’ seems to be in the process of developing prototype structure, i.e. of becoming a category (Chapter 3). Prototype structure analysis allows for the reformulation of principles one and two (see Figure 6.2).

6.1.2.2 *Cognitive model analysis*

Whereas the prototype structure analysis is relevant for the intracategorial structure, the intercategorial structure, i.e. the structural relationships a category can have with other categories in the same domain of experience, can be analysed by applying the methods of cognitive model analysis as we showed for *biotechnology* in Chapter 3. This results in visual representations (nodes and labelled arrows) which differ from traditional tree structures. Cognitive model analysis allows for a critical revision of principles two, three, four and five (see Figure 6.2).

6.1.2.3 *Diachronic analysis*

In order to understand categorisation and naming, an analysis of the history of categories is essential. It proves that naming in science is hardly ever arbitrary and that categorisation is a process in time. The evolution of categories is related to the prototype structure of categories. A visual representation of the meaning evolution of terms along historical lines allows for insight into categorisation and naming. We analysed cases of recurrent use of the same lexical item for naming distinct categories belonging to the same domain of experience (e.g. *cloning*, Chapter 5) or to different domains of experience (e.g. *splicing*, Temmerman 1995, 1998, Chapter 6). A historical analysis can not be seen in isolation from a cognitive model analysis (e.g. DNA IS INFORMATION, Chapter 5) and a prototype structure analysis (e.g. *biotechnology*, Chapter 3). A diachronic analysis questions principles two, four and five (see Figure 6.2).

6.1.2.4 *Conclusion*

Prototype structure analysis, cognitive model analysis and diachronic analysis can be applied to research in Terminology but also to data analysis with the aim of terminological description as we shall see in the next section.

6.2 Terminography

Sociocognitive Terminology has an impact on the methods of terminography. If Terminology is the discipline dealing with methodologies and principles for the study of terminology, terminography is the practice of systematically describing terminological data. Sociocognitive Terminology requires a complete rethinking of terminography.

Even though — in practice — terminographers have always started from *understanding* as they had to rely on textual material for their terminological analysis, one of the principles of traditional Terminology required them to (artifically) pretend that they were starting from concepts.

In sociocognitive Terminology the terminographer should be trained to start from *units of understanding*. Units of understanding have at least three aspects to them: one, they can only be discovered by terminographers and terminologists as soon as they exist in language, i.e. as soon as there is a term or description to communicate the unit of understanding in language; two, they refer to something which can be perceived or conceived of in some reality; and three, they are understood in the mind of specialists, terminologists and terminographers. This implies that the traditional Wüsterian analysis in which it is postulated that concepts should be treated as if they existed objectively and independent of human understanding and language is misleading and in need of modification.

As compared to traditional Terminology, sociocognitive Terminology has more and different theoretical underpinnings which go hand in hand with other methodological tools for the analysis of categories which occur in textual information. We have shown how the sociocognitive approach in Terminology can borrow methodologies from cognitive semantics for at least three types of analysis. A first method involves componential analysis in combination with the insight that understanding is experiential (implying the prototype structure of categories and the constraints of cognitive models on language). A second method is directed at the search for the cognitive models underlying categorisation. A third method implies the description along historical lines of the development of polysemy. The foregoing has an impact on the practice of the terminographer. The different theoretical basis will give him a different conception of what terminography should imply. A terminographer who works within the framework of these three methods for analysis will (a) have a panoply of possibilities for category description based on the insight that one can distinguish between types of units of understanding, (b) be capable of providing representations of cognitive models in e.g. network structures, and (c) be able to represent category development.

In this theoretically directed work we have been carrying out analyses in much more detail than can be expected of practising terminographers who need to reach a compromise between time and quality of analysis. Most importantly, a terminographer will have to tailor his methodology, depth of analysis and descriptive accuracy to the potential user of the terminological information.

6.2.1 *Procedure for terminographical analysis*

The objective of terminography is to describe a set of terms related to a subject field. The result should be a coherent collection of entries. Each entry has information modules which systematically provide information responding to requirements which may vary. The focus remains on the set of categories to which the terminological collection refers.

Before a terminographer can start compiling terminological records he needs to make a few preliminary decisions (domain, users groups, mono- or multilingual records) and to plan to provide information which can be categorised in four units: (a) the category unit, (b) the linguistic unit, (c) the reference unit, and (d) the identification unit (Figure 6.5).

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a) the category unit
type of category? relevant information modules
intracategorial analysis (prototype structure)
intercategorial analysis (cognitive models analysis)

b) the linguistic unit
morphosyntactical information (variants in spelling and pronunciation, morphological analysis on term formation, grammatical category)
information on synonymy and collocations
usage (sociolinguistic level, geographic level)

c) the reference unit
a terminographical record can contain contexts, bibliographical references, etc.

d) the identification unit
a terminological record is identified in several ways by e.g. name of author, date, reference number

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Figure 6.5. *Four units of information in terminographical records.*

6.2.2 *Three key issues of terminographical analysis*

A terminographical analysis will be based on the analysis of a textual corpus selected according to the needs of the potential user groups of the terminology. After reading and analysing the corpus, the terminographer will end up with a list of terms which need terminological description. The description will be based in the first place on the information provided by the texts at hand. The advice of domain specialists is essential when assessing the extent of the subject domain. The specialist(s) will be needed in the selection phase of representative texts but also for ad hoc consultation in case of difficulties with terminology interpretation in the course of text analysis and finally for the editing of terminological records.

Discourse analysis can yield three types of information for description (Figure 6.5): specifying information, terms and category descriptions.

specifying information	domain indication intention assessment perspective description	
terms	types of units of understanding synonymy and polysemy: prototype structure	
category descriptions	template:	core definition intracategorial description intercategorial description historical information procedural information

Figure 6.6. *The three types of information for terminological description extractable from discourse analysis.*

Texts provide the specifying information needed for the domain indications, the intention assessment and the perspectives taken (Figure 6.6).

The first step in the terminological analysis of a domain will be to list the domain specific terms which occur in the texts. The information provided by the texts should allow for the distinction between terminology which is more relevant and terminology which is less relevant to a particular domain.

Differentiation between types of units of understanding will constitute the next step. For different types of units of understanding it is predictable which modules will have informational prominence (see Figure 6.3). This has consequences for descriptive practice.

The initial distinction between entity, activity, umbrella category etc. could have consequences for the selection and prominence of the information modules which need to be provided.

In discourse one can find explicitations of the levels of (near-) synonymy and justifications for the functional need for synonymy as well as the descriptions of different senses that can correspond to a particular term (Figure 6.6).

Category description can take the form of templates composed of different information modules which will have different levels of importance depending on the type of category under consideration. Examples of modules are core definition, intracategorial description, intercategorial description, historical information, procedural information (Figure 6.6). All this information can be gathered from discourse analysis.

Suppose we want to provide a terminological description of *biotechnology*. The specifying information should have been our concern in the first phase, before starting the analysis of the category. As the case may be the domain indication could be e.g. *molecular biology, molecular genetics, microbiology, biochemistry, genetic engineering, recombinant DNA technology, etc*. The intention assessment implies an estimate of the potential users of the terminological information, e.g. *molecular biologists, medical doctors, laboratory workers, students in science.* The perspective description could be the commissioner's name e.g. *food industry company name, pharmaceutical company name, genetic engineering laboratory.*

In the second phase the prototype structure of the term *biotechnology* will be studied in the corpus and described in both its intensional and its extensional aspects (see Chapter 3). This prototype structure analysis is going to be the basis for the third phase which is the category description, for which we envisage the following procedure. The first question should concern the type of category under consideration. *Biotechnology* is an ***umbrella category***. The modules of information which are important for umbrella category description are: the core definition, intracategorial information which one obtains from prototype structure analysis, intercategorial information which one obtains from representing the cognitive models which are described in the texts of the corpus, and diachronic information which one obtains from doing an analysis on a historical line.

6.3 Concluding remarks

Having arrived at the end of this work we realise the limitations (6.3.1) and formulate a number of suggestions for further research (6.3.2).

6.3.1 *The limitations of this work*

A critical reader could argue that the life sciences terminology studied in this work is too limited as only a small segment of the set of terms related to the domains involved have been discussed extensively. In this section we explicitly identify those respects in which this work is constrained and suggest some ways in which it could be extended.

We decided to restrict our analysis to a number of categories of the types *entities*, *activities*, *umbrella categories* and to use only the results of our analysis to illustrate the points we have been trying to make regarding the principles and methods of Terminology. This means that a lot of the material we analysed has not been described extensively in this work. Moreover, the vantage point we took for a number of problems pushed other aspects into the background. One example of something that could strike the reader as an oversight is that we have not differentiated between simple terms and multiple element terms and phraseology when discussing categorisation and naming. A second lacuna is that we did not go into multilingual terminologies. In this work we have chosen to analyse categorisation from the English language perspective.

English is the language of science and technology, i.e. of most primary term formation (Sager 1990: 80). Conceptualisation and the naming of new categories happens in the first place in the English language. Life science terminology in other languages is strongly influenced by English. Many terms are simply borrowings or loan translations. This is the result of knowledge transfer to another linguistic community which is carried out by what Sager (1990: 80) refers to as *secondary term formation*. It is believed that all languages have the potential to fulfil all expressive needs. For multilingual terminologies considerable research is necessary with regard to intercultural categorisation and categorisation related to secondary term formation. Translation studies building on *stylistique comparée* (Vinay & Darbelnet (1968), Malblanc (1963)), have made a start with this kind of study (see Sager (1993)).

6.3.2 *Suggestions for further research*

Possibilities for the actual implementation of the principles and methods of sociocognitive Terminology in life science terminography projects should be tested extensively.

A start could be made by evaluating whether existing dictionaries and terminologies are already putting sociocognitive Terminology principles and methods into practice. It would be interesting to examine the degree to which these principles and methods are applied intuitively without ever having been explicitly stated as principles and methods.

Furthermore, a detailed analysis and description of requirements for each and every user group of dictionaries and terminologies is required as well as an in-depth study of the relationship between types of categories and their most relevant meaning description modules. Finally the principles and methods of sociocognitive Terminology should be tested in computerised terminology database management systems (e.g. Trados Multiterm for Windows) which are particularly helpful in creating, managing and presenting terminology. These systems are *concept oriented*. One entry always corresponds to one concept, i.e. one language-independent abstraction of an idea. This means that an entry contains all the terms that name the concept (in as many languages as required), together with additional information associated with the concept (e.g. a definition, a context, an example).

Reflection is needed on the possibilities for providing these terminology management systems with information about polysemy and diachronic development.

In traditional Terminology the emphasis was on the one hand on concepts as they exist in objective reality and on the other hand on terms which are needed to name concepts. Sociocognitive Terminology replaces *concept* by *category*, an experiential unit of understanding. To shift from the objectivist traditional Terminology paradigm to the experientialist sociocognitivist Terminology paradigm involves bringing *the power of words to move* to Terminology. We have shown how language facilitates experience, creativity and inventiveness as much as experience, creativity and inventiveness cause language changes. We have studied **terms** as part of natural language with several functions: the cognitive, the interpersonal, the intertextual and the referential.

We have introduced the idea of *the power of words to move* to the discipline of Terminology in several respects. Firstly, in many cases ideas are forced out of the words themselves. Words fuel the mind and enable its creative power and words move us towards better understanding. Words allow for worldmaking (Goodman 1978) e.g. via metaphorical cognitive models. Secondly, words have the power to move through time. To reconstruct their itinerary means to recount fragments of the history of experience and to prove the role language plays in creating this new experience. Thirdly, words have the power of moving understanding from one language user's mind to other language users' minds. Communication and exchange of experience via language are part of a sociological process. Fourthly, words have the power to move subtly when they reflect different facets and nuances of experience like scintillating diamonds. Because categories have prototype structure words have the power of moving into meaning development which partly explains polysemy. Lastly, words have the power to move in network structures, which implies that they guide and restrain our ways of thinking.

In the introduction we quoted Jeanette Winterson because her artistic credo coincides with the hypothesis we have been expressing in this study. As much as words in artistic writing, terms used in special language have the power to move our experience.

> How can I come close to the meaning of my days? I will lasso them to me with the whirling word. The word carried quietly at my side, the word spun out, vigorous, precise, the word that traps time before time traps me (Jeanette Winterson, *Art and Lies* 1994: 138).

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