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# The Different Forms of Concept Representation in Terminology: A Study of Documents Addressed to Fighter Aircraft Mechanics[1]

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## ABSTRACT

In this article I present research on different forms of concept representation in specialized aeronautical documents. I have isolated a sample of concepts in Spanish documents addressed to fighter aircraft mechanics in the area of fighter aircraft fuel systems. I have created a terminological database comprising these concepts and their representations, i.e., terms, explanations and illustrations. The analysis of this terminographic work allows us to determine the degree of importance to the expert of the different forms of concept representation and the relationships between them.

*Key words*: *terminology, terminography, concept representation, concept relationship, aeronautics.*

## RESUMEN

En este artículo presentamos una investigación sobre distintas formas de representación conceptual en documentos especializados en el campo de la aeronáutica. Hemos aislado una muestra de conceptos en documentos sobre sistemas de

1 This paper has been translated by Ms. Heather Adams, Professor of Technical Translation at the University of Las Palmas de Gran Canaria.

combustible escritos en español y dirigidos a mecánicos de aviones de combate. Con estos conceptos, hemos generado una base de datos terminológicos que incluye distintas representaciones conceptuales: términos, explicaciones e ilustraciones. El análisis de este trabajo terminográfico nos permite determinar el grado de importancia que estas formas de representación suponen para el mecánico especialista y la relación entre las diferentes formas.

*Palabras clave: terminología, terminografía, representación conceptual, relaciones conceptuales, aeronáutica.*

## 1. Introduction

The subject of forms of concept representation (FCR) has always been intriguing, and over recent years it has gained even more importance (Thornton 1996: 152). This growing relevance has reached the field of terminology. As Picht states (1994: 932), terminology has long been concerned with the description of the concept, and, in recent years, terminologists have revaluated how the concept can be represented.

However, little has been written in the field of terminology about FCR as a whole as corroborated by various experts (i.e., Kalverkämper 1993: 218; Laurén 1998: 186; Picht 2002: 3003).

Picht (*Ibid.*) states that non linguistic forms of concept representation (NLFCR) have not attracted the attention they deserve from terminology researchers, and that they are therefore the least studied and documented forms. They have even been classified in the classic literature on terminology as 'aids to definition' (Picht 1992: 234), rather than real ways of representing a concept.

Galinski & Budin (1998: 16) also refer to this situation. They state that the semiotic theory posited by Wüster (1985) has not yet been sufficiently evaluated despite the growing use and importance of non linguistic elements —pictograms, graphics, symbols, etc.— in specialized communication.

According to Ghenghea (1998: 783) "extralinguistic means [...] belong to other classes of signs than the natural language and have been scarcely studied as components of LSP texts".

Johns (1998: 183) tries to explain this lack of interest shown by linguistics in visual forms, as opposed to written language:

> There are at least two reasons for this concentration upon written word. One certainly is that applied linguists and compositionists are more interested in, and comfortable with, written language. Most of us are trained in the humanities, where words are central to disciplinary values and argumentation. A second, related reason is that in some academic classrooms and disciplines, such as literature, graphs, charts and other visual representations are not central to disciplinary values.

Very little attention has been paid to the relationship between linguistic forms of concept representation (LFCR) and NLFCR either. Thus, Picht (2002: 303) maintains that there are still many gaps to be filled in our knowledge regarding the relationship between LFCR and NLFCR in professional communication.

In order to fill some of these gaps, I have undertaken research into the importance and the relationship of LFCR and NLFCR in written aeronautical communication. This study has been performed on a sample of 372 concepts related to fuel systems extracted from Spanish documents addressed to fighter aircraft mechanics. The results of this research will lead us to a better understanding of how concepts are represented.

## 2. Different forms of concept representation

Before starting with the description of the research, it is necessary to delimit what I understand by concept and CR, together with what FCR are in technical texts.

Numerous definitions have been offered for concept, to the extent that they have even been classified. I shall not, however, give an exhaustive list of them here, nor evaluate them, as both these tasks have been carried out by others (i.e., Arntz and Picht 1995: 64 69; Picht 2002: 278) and, in any case, the formal requisites of length for this article prevent us from going into this point in any depth. I shall take the definitions given by the ISO standards, which are the commonly accepted definitions in terminology.

According to ISO 1087 1 (2000: 1), a concept is a "unit of thought constituted through abstraction on the basis of properties common to a set of objects". An object is "any part of the perceivable or conceivable world".

The various definitions given for CR are vague (Stockinger 1993: 5). I shall not here, once again for reasons of space, analyze these differing definitions. I will apply Greco's (1995: 372) and Montes Serrano's definitions (1992: 12 13), as I consider them to be the simplest and clearest. The representation of a concept is a linguistic or non linguistic expression, or combination of both, through which a concept is determined. I understand a non-linguistic expression to be one in which written or oral human language does not act as the main source of knowledge transmission.

As for FCR, we can also find a wide variety of classifications, though most authors agree that they can be divided into two categories: linguistic and non linguistic forms. The linguistic forms that appear in my corpus are terms, definitions and explanations. The non linguistic forms are illustrations. Let us define now these concepts. Once again, many definitions have been applied to these concepts, but I will simply highlight the definitions given by ISO.

A term is a "designation of a defined concept in a special language by a linguistic expression", and, a definition is said to be a "statement which describes a concept and permits its differentiation from other concepts within a system of concepts" (ISO 1087-1 2000: 4 5).

ISO does not define explanations. I have therefore selected another standard, the Austrian ÖNORM A 2704 (1990), according to which an explanation is "Inhaltsbeschreibung ohne hinreichende Bezugnahme auf ein Begriffssystem", which means "the description of a content without making sufficient reference to a system of concepts".

As the concept of *illustration* is not defined in any relevant standard, I define it myself. An illustration is a pictorial or photographic representation of a concept.

## 3. Documents analysed and sample

The field of fighter jets is largely inaccessible to the general public and, to our knowledge, no one has studied its different forms of conceptual representation with the exception of this paper's author, who investigated it in her thesis (Monterde Rey 2003a). As the field of fighter aircraft is very broad, we chose the specific area of fuel systems, because we could count on the specialized knowledge and assistance of a Spanish Air Force fighter mechanic, together with access to all the restricted documents (Maestranza Aérea de Albacete 1999 and 2002; Ministerio de Defensa 2000) he uses for F 18 fighter maintenance. These documents consist of a compendium of rules, specific repair instructions for each part of the aeroplane and a maintenance manual. They have been written by Spanish military aircraft mechanics and aeronautical engineers based on the original books written in English.

## 4. Methodology

The best approach to this type of research is to create a systematic terminological study, since it allows one to conceptually structure the field with which one is working, to delimit the number of concepts and to extract the different FCR of the selected concepts.

Many authors have proposed ways of carrying out systematic terminological study. The stages described by them are very similar, although the names of the processes and their order are different. Among all these methods, I have chosen the method developed by Arntz and Picht (1995: 252 264), since it includes the creation of systems of concepts that allow us to order the knowledge in an area conceptually, to establish the relationships between the concepts in that area and to isolate a sample within it.

I thus drew up a work plan including the objectives, the area to be studied, the choice of final format and the experts that could be consulted. The description of such conditions enables us to foresee possible problems, to evaluate the degree of difficulty of the task and, finally, to guarantee its success. Having drawn up this plan, I went on to read the documents described above and then manually to extract all the terms contained in them, to which end, I established a system in which all the concepts concerning the area of the fuel system of the F-18 fighter plane were related. This system of concepts was introduced into

GeneSis[2], a software application created by this paper's author (see Monterde Rey 2003b). Based on the superordinate concept represented by the Spanish term *sistema de combustible* (fuel system), three types of relationships were established: generic (type of), partitive (part of) and chronological (stage in) (see ISO 704 2000). In this way, I isolated 372 concepts.

In order to determine the minimum number of concepts we needed to include in order to ensure that our sample was representative of the area of aeroplane fuel systems, I used STATS™ [3], which automatically calculates the required number. In order to do so, we first had to establish the total number of concepts in the area. As I could not find a source for this information, I consulted three expert mechanics who specialise in this field, and they assured me that the total number (size of universe in STATS™) would not exceed 500. In order to ensure a maximum acceptable error of 5%, an estimated percentage level of 5% or 95.25% and a desired confidence level of 99%[4], the software application STATS™ informed us that the corpus should have a sample size of at least 101 concepts, confirming that my sample was representative.

Once it had been established that the sample was representative, I used an export function generated in GeneSis to export the terms of this system of concepts to MultiTerm, a software application created by Trados to manage terminological databases. The following step was to introduce in each terminological record generated in this way all the different forms of representation of the 372 isolated concepts, that is, definitions, explanations, illustrations and other terms. All these records constitute a terminological database that permitted the analysis of all the information related to CR.

2 You may download this software from my web page: www.webs.ulpgc.es/terminol/page3.html

3 Mr. Eduardo Acosta González, Doctor in Statistics and Professor at the University of Las Palmas de Gran Canaria, has recommended this software application made by Decision Analyst.

4 Dr. Acosta González has recommended these percentages as the most adequate for my research.

## 5. Results

With the database created, I analysed the different FCR one by one. Given the restrictions on space here, and considering that our objective in this article is to show the importance of these forms for experts in aeronautical mechanics, we shall confine ourselves to offering the percentage of each of the FCR that appear in the documents studied together with their degree of complexity to see the extent to which they adapt to the mechanics' level of specialist knowledge.

### 5.1. Terms

The term is, by its nature, the main LFCR. All concepts are represented by at least one term, unless a concept does not exist in a society or culture. This fact is proven in my sample, since there are 412 terms for 372 concepts, i.e. 10.75 % of the concepts (40 concepts) are represented by more than one term. Consequently, the ideal of univocity sought by terminology (Wüster 1985) is not accomplished. These terms are complex for the non-expert and are, in the main (93%), formed by the joining together of more than one word. This method of term formation is known as composition and is, together with suffixation, the most common way of coining new terms in Spanish (Almela 1999: 120). The formula followed by the terms in my sample is:

Nominal Syntagma = Noun + [(Prepositional Syntagma)$^n$ + (Adjective)]$^n$

Here we have some examples[5]:

| | |
|---|---|
| *llave cortafuegos general* | *NS = N + ADJ + ADJ* |
| *transmisor del destotalizador* | *NS = N + PS* |
| *interruptor de la llave cortafuegos general* | *NS = N + PS + ADJ* |
| *interruptor de la llave cortafuegos* | *NS = N + PS* |
| *manocontactores de presión* | *NS = N + PS* |
| *tablero de alarma* | *NS = N + PS* |
| *relés de alimentación de las bombas* | *NS = N + PS + PS* |

5 I use the following abbreviations: Nominal Syntagma (NS), Noun (N), Prepositional Syntagma (PS), Adjective (ADJ).

| | |
|---|---|
| *bomba de arranque* | *NS = N + PS* |
| *interruptor de la bomba de arranque* | *NS = N + PS + PS* |
| *relé de parada de la bomba de arranque* | *NS = N + PS + PS + PS* |

## 5.2. Definition

In my sample no concept is represented by a definition. This proves that this FCR lacks importance for the expert, who requires concepts to be represented by other means: terms, explanations and/ or illustrations.

## 5.3. Explanation

In my sample of 372 concepts, 363 of them (97.5 %) are represented by an explanation. This high percentage shows that the explanation is of considerable importance to the expert. These explanations complement the illustrations and refer to the concepts that appear in said illustrations. Within the explanations offered next to a term denominating an element in the illustration, the numerical code allocated to that element in the illustration is given. Let us read a typical example taken from one of the texts studied (Ministerio de Defensa 2000: 133):

> Conectado a la tubería de descarga de las bombas BP, el transmisor del destotalizador (130) manda por intermedio del relé (131), el indicador (132). Indicando, este último, al piloto la cantidad de combustible presente dentro del avión, su indicación coincide con la de los aforadores (122) cuando los depósitos pendulares (27) y los del ala (26) están agotados.

As we can see, the explanations are very highly specialized, and can therefore only be understood by an expert in the subject. Practically all the nouns found in the explanations represent specialized concepts (*tubería de descarga de las bombas BP, transmisor del destotalizador, relé, indicador, aforadores, depósitos pendulares, depósitos del ala*). To be more specific, in the 363 explanations I counted 350 different specialized concepts belonging to our corpus. However, we also found specialized concepts (99) which were totally unknown to any non-expert in the field, i.e. concepts for which no definition, explanation or illustration was offered in any of the documents used by the mechanics, and which must, by definition, be understood by them as a matter of course.

### 5.4. Illustration

In the sample isolated, all concepts are represented by at least one type of illustration. The illustration is so important to the expert that 70 % of the concepts (260 concepts) have more than one illustration. These complex abstract illustrations contain many symbols, and can thus only be understood by an expert trained in the interpretation of these forms of conceptual representation. We can classify the types of illustrations found in the following five groups: transparent views[6], cross-sectional views[7], exploded views[8], diagrams[9] and functional schemes[10]. I will not describe these illustrations and their characteristics in any depth here, as I have already done so in a previous publication (Monterde Rey 2004). However, the following example comprising a small part of a diagram (see figure 1) of the electrical circuit of the F 18's fuel installation taken from the maintenance manual of this fighter plane (Ministerio de Defensa 2000: 134) serves to give an idea of the complexity of the illustrations in question. It should be noted that the diagram is made up of a series of graphic symbols[11], the meaning of which must be clear to the reader if he/she is to identify which element of the circuit they represent.

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6 A transparent view is a drawing that reveals a structure's interior and identifies the exterior through the use of imaginary lines. (This definition and those in footnotes from 7 to 11 have been provided by Dr. Rafael Moreno, Senior Professor at the Aeronautic Engineering School of the Polytechnic University of Madrid. See Monterde Rey 2004: 264 265).

7 A cross-sectional view is a sequential representation of the different parts making up a whole composed of planar cuts showing each section.

8 A exploited view is drawing of a mechanism that shows the individual parts separately, usually indicating their relating positions.

9 A diagram is a schematic type of illustration that represents the behavior of a system, installation or any other object of this kind, where their different components are depicted with graphic symbols.

10 A functional scheme is a type of illustration that simplifies the representation of a whole by means of graphic symbols that allow to explain and understand its functions.

11 Symbolic drawings that represent an element in a diagram or a functional scheme. For example, in the manuals studied, a circle with the letter P in its center represents a pump (see figure 1).

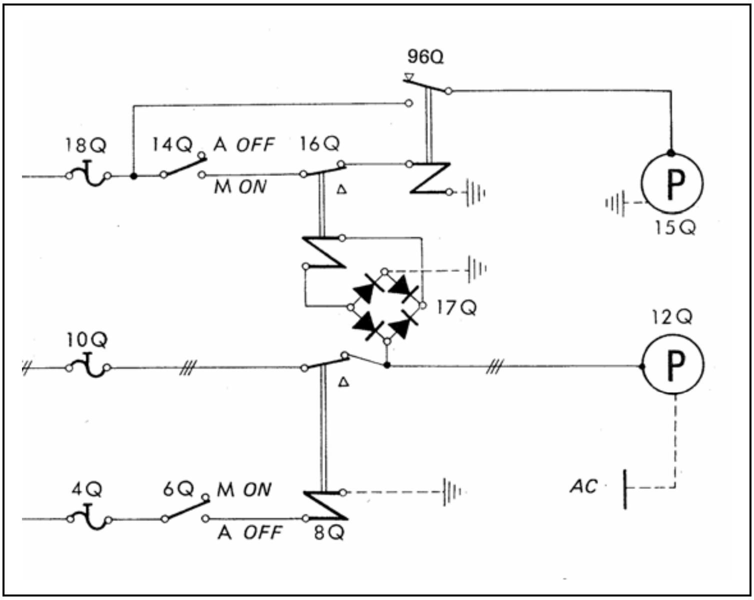


**Figure 1. Example of diagram**

Miller (1998: 30) offers an explanation for the high percentage of illustrations in manuals addressed to experts. A reader with specialist knowledge of a particular field will normally examine the illustrations first, and subsequently read the text. A specialised mechanic follows the illustrations when repairing mechanical faults, and it is therefore essential that each concept is represented by an illustration, and it can also be necessary to be able to consult different illustrations of the same concept. The reader's level of specialised knowledge allows him/her to interpret highly abstract illustrations replete with graphic symbols that transmit a large amount of information.

5.5. Statistical test

In order to prove that our distribution is significant, and therefore that the results are not merely due to a coincidence, I decided to apply a statistical test. Among all non parametric tests of statistical significance, I have selected chi square ($\chi 2$) since it allows us to prove if there is a relationship between several variables and to compare observed counts of particular cases to the expected counts. The hypothesis tested with chi square is whether or not two or more samples are different enough in some characteristic or aspect of their behaviour that we can generalize that the populations from which our samples are drawn are also different in the behaviour or characteristic. Let us analyze in the following table the observed and expected values for the different FCR studied.

| | CONCEPTS WITH $O_i$ | CONCEPTS WITHOUT $O_i$ | CONCEPTS WITH $E_i$ | CONCEPTS WITHOUT $E_i$ | $\Sigma\ O_i$ |
|---|---|---|---|---|---|
| TERM | 372 | 0 | (372 x 1107)/ 1488 = 276.75 | (372 x 381)/ 1488 = 95.25 | 372 |
| DEFINITION | 0 | 372 | (372 x 1107)/ 1488 = 276.75 | (372 x 381)/ 1488 = 95.25 | 372 |
| EXPLANATION | 363 | 9 | (372 x 1107)/ 1488 = 276.75 | (372 x 381)/ 1488 = 95.25 | 372 |
| ILLUSTRATION | 372 | 0 | (372 x 1107)/ 1488 = 276.75 | (372 x 381)/ 1488 = 95.25 | 372 |
| TOTAL | 1107 | 381 | 1107 | 381 | 1488 |

**Table 1. Observed and expected values for different forms of concept representation**

If we apply the formula of Chi square

$$\chi^2 = \Sigma (O_i-E_i)^2/ E_i = [(372-276.75)^2/ 276.75] + [(0-95.25)^2/ 95.25] + [(0-276.75)^2/ 276.75] + [(372-95.25)^2/ 95.25] + [(363-276.75)^2/ 276.75] + [(9-95.25)^2/ 95.25] + [(372-276.75)^2/ 276.75] + [(0-95.25)^2/ 95.25] = 1441.89590935279$$

Where $O_i$ is the observed value and $E_i$ is the expected value.

We apply the following formula to find out the degrees of freedom (d.f.):

d.f.= (n-1) (m-1) = (4-1) (2-1) = 3

where *n* is the number of rows and *m* the number of columns of the table above.

For a probability of error (*p*) less than or equal to 0.001, the critical value of chi square is less than the 437.85 (Walpole and Myers 1992: 362 366), which proves that the distribution is significant and, as a consequence, the results are not due to coincidence.

## 6. Relation between text and illustration

Let us now relate the LFCR (terms and explanations) with the NLFCR (illustrations) found in the sample.

All the explanations contain references to illustrations. These references take the form of the terms of the different items depicted followed by the number assigned to them in the illustrations. However, these explanations explain a concept by referring to the illustrations rather than describing said illustrations. As we have seen, the illustrations are very abstract and complex, and cannot therefore be interpreted by a layperson. For this reason, non-experts will not be able to understand either the illustrations or, as a consequence, the explanations.

At the bottom of each illustration, there is a caption introduced by the word *figura* (figure), followed by the number assigned to that the illustration in the manual and a term that represents the same concept as is depicted in the illustration. Here we have an example of two captions extracted from the F-18's maintenance manual (Ministerio de Defensa 2000: 155 156):

*Figura 15 – Transferencia de combustible – Circuito de combustible*

*Figura 16 – Alimentación del reactor Intercomunicación*

However, none of the explanations refer to these figures by means of sentences such as "see figure x". For this reason we can deduce that the expert must know which illustration corresponds to each explanation.

All the elements in the illustrations are numbered. In the case of two types of illustrations, functional schemes and diagrams, these numbers can be found in a list inside the manual. Next to each number, we can see the term of the part, a brief description of its function and another number that indicates the position of the part in the plane. Thanks to this information, the expert can quickly review facts related to any particular element.

Moreover, in the case of functional schemes, there is a legend displaying all the graphic symbols in the illustration. These symbols are not standardized, hence the need for a legend.

By contrast, although the diagrams have graphic symbols, they are not accompanied by a legend. Nevertheless, we can find a list of graphic symbols at the beginning of the manual.

In short, although the expert must be perfectly familiar with all the elements represented in each illustration, he has five kinds of textual resources to help him to understand them:

- captions (in all illustrations);
- explanations that cite the part numbers for each component depicted in the illustrations (in all illustrations);
- the number assigned to each component (=term) represented in the illustration, explanation of its function and position in a list (for functional schemes and diagrams);
- legend (in functional schemes);
- list of graphic symbols followed by the term of the component which they represent (for functional schemes and diagrams only).

In conclusion, in this technical text on fuel systems addressed to mechanics, explanations, terms and illustrations are related in the different ways described.

## 7. Conclusions

In the light of the results obtained, I can affirm that in specialized aeronautical literature on fuel systems all FCR are very specialized and cannot therefore be interpreted by someone who has no previous expert knowledge of this field.

All concepts are represented by means of terms and illustration and 97.5 % of them are also represented by explanations. However, definitions are not found in this kind of text.

The terms are very specialized and complex, 93 % of them being created by means of composition. There is no univocity since 10.75 % of the concepts are represented by more than one term.

All the forms of concept representation are related. Illustrations are very abstract, but they are clarified by means of textual forms: captions, explanations, numbers of the components, legends and list of graphic symbols followed by their denomination (=term).

These findings may be explained using Sperber and Wilson's theory of relevance (1995). These researchers deem that the reader of a text collaborates to a greater or lesser extent depending on his/her level of knowledge of the subject matter of the text in question. For this reason, the expert aeronautical mechanic, with his perfect knowledge of the subject matter, requires only illustrations together with explanations related to said NLFCR to guide him through the process of repairing aeroplanes.

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