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Classical and New Means for Terminological Communication

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1. Introduction

Today, terminology activities are recognized as a fruitful field of study and research in which various professionals of specialist communication operate with advanced linguistic skills. Current terminology work is often carried out within the framework of specific cooperation structures and, in particular, within networks formed according to different criteria (common language, linguistic kinship, geographical proximity, commercial or political exchanges and needs, ideological affinities, etc.). Among these international networks, the most active and important are Réseau panlatin de terminologie-REALITER, Nordterm (Nordic co-operation forum for organizations engaged in terminology work), the European Association for Terminology-EAFT, and the International network for terminology-TermNet[2].

Terminology has also entered academia as an independent discipline and is taught up to Bachelor, Master and PhD levels in many countries. In terms of terminology education, Canada, where terminology was initially related to translation studies, was a pioneer country. It has proven useful in the development of linguistic engineering and natural language processing tools, as well as for the marketing of goods and services in today's global society.

In this contribution we outline the development of terminological communication in a timeframe going from the XVIIIth-XIXth centuries to the present. In particular, we identify three main periods in the history of terminology: the first one precedes Wüster's General Theory of Terminology, the second one corresponds to the birth and the development of this theory[3] and the third one follows it. More specifically, we focus on the link between the terminological 'mainstream' and its dissemination among the general public.

[1] Paolo Frassi is the author of paragraph 4. and of the Conclusions. Claudio Grimaldi is the author of the Introduction and of paragraphs 1., 2. and 3.

[2] See M.T. Zanola, *Che cos'è la terminologia*, Roma, Carocci, 2018.

[3] See M.T. Cabré, *La Terminologie. Théorie, méthode et applications*, Ottawa/Paris, Les Presses Universitaires d'Ottawa/Armand Colin, 1992 (1998); W. Forner, B. Thörle (éds.), *Manuel des langues de spécialité*, Berlin/

2. Classical Needs for Terminology Activity

The word "terminology" refers to a set of technical words belonging to a science, an art, an author or a social group, such as, for example, the terminology of medicine or that of computer science, in contrast with the common language that language speakers use every day. In a specialized context, "terminology" refers to a linguistic discipline that is devoted to the scientific study of concepts and terms in use in specialized languages, and it is the language of unambiguous communication in a particular area of knowledge or practice, based on its own specific vocabulary and linguistic uses[4]. In fact, terminology research aims primarily at identifying terms conveying specialized knowledge[5]. Its main function is to transmit specialized knowledge and the authenticity of its terminological use.

As far as related professional profiles are concerned, a lexicographer is a specialist who works on the creation of a dictionary within the discipline of lexicography, which is devoted to the study of words in a given language and the analysis of their forms and meanings. In contrast, a terminologist is specialized in the terminology of a given discipline approach. Terminology practice falls under the field of applied linguistics, which includes works in specialized lexicography, translation, writing and language teaching. In fact, these four areas of professional linguistics are closely related in the following ways:

– specialized translation requires mastery of specialized bilingual or multilingual terminologies;
– technical writing involves the use of terminology in specialized unilingual discourse;
– the aim of teaching specialized languages is the learner's acquisition of professional terminology.

The main terminological activities require the ability to identify terms designating concepts that are specific to a field to attest their use with precise references, describe them briefly by discerning the correct use from wrong one, and to recommend or advise against certain uses in order to facilitate unambiguous communication. A terminological unit is the label of a concept within a concept tree and may consist of a word or a phrase, a symbol, a chemical or mathematical formula, a scientific name in Latin, an acronym, an abbreviation or the official name of a job, an organization or an administrative entity.

From this point of view, a terminologist works differently in comparative and unilingual terminology activities: in comparative terminology, the differences caused by the inter-language transfers of specialized knowledge are highlighted by the absence of specific designations in one of the languages in contact. In this case, the role of the terminologist is to describe the observed gaps and propose designations to fill them. The proposal of a new term must be based on solid knowledge of the lexical formation rules of the host language. In unilingual terminology, the appearance of a new concept – whether it is

Boston, De Gruyter, 2016; R. Temmerman, *Towards New Ways of Terminology Description. The Sociocognitive approach*, Amsterdam-Philadelphia, John Benjamins Publishing Company, 2000.

[4] See J. Altmanova, M. Centrella, K.E. Russo (eds./éds.), *Terminology & Discours/Terminologie et discours*, Bern, Peter Lang, 2018.

[5] See M.C. Conceição, *Concepts, termes et reformulations*, Lyon, Presses Universitaires de Lyon, 2005.

borrowed from another specialty or created as a new term – can lead to the absence of a designation or the presence of multiple designations that are synonyms. In this case, the role of the terminologist is to identify such synonyms and compile uninotional terminological lists, dealing with a single concept, in order to standardize their use.

From a historical perspective, terminology has a long tradition as an applied discipline. It has always existed because man has always felt the need to name the reality that surrounds him, classify the elements of nature, establish links between different concepts, and understand the equivalences among names that each community, and therefore each language, has chosen for the same concepts for various reasons (to be able to exchange and trade, among others).

A more structured conception of terminology may be traced back to the natural sciences in the 18th century thanks, in particular, to the work of Carl von Linné, a Swedish naturalist who created the first classification of living beings, first in botany, and then in zoology. He established a binary nomenclature where each individual is classified by its genus and its species. Other scientists, such as Lavoisier or Berthollet, also carried out work in this direction, in particular in chemistry.

In fact, for scientists in the 18th century who were concerned with accuracy, working towards a perfect language and issues of nomenclature, was no longer a secondary problem when faced with a world rich in new plant, animal and mineral genera. Language was seen as a communication tool representing both a new methodological approach of an experimental nature and a very precise way of structuring the analyzed reality[6]. This is why their work aspires at a purification of scientific language aimed at rejecting the terms and expressions of theories that do not correspond precisely enough to scientific reality: the main goal was "simply the truth, clearly and precisely said[7]".

This linguistic need, which was felt increasingly vigorously by the learned community of the natural sciences, for a univocal scientific language also stemmed from a precise epistemological turning point in which speculative, theoretical and gratuitous interest in the plant, animal and mineral kingdom developed. Such interest, however, was not motivated by the practical use that could be made of the knowledge thus obtained. Indeed, as Brunot indicates, "as this language is constituted, we realize that nomenclature is not only an expression of science, but that it is a part of science itself, and that clarity, exactitude, convenience of form are indispensable conditions for progress[8]".

A demand for linguistic standardization was also present in the field of chemistry, the language of which was steeped in a time of great chaos, and a solution to which was proposed by Lavoisier's reform at the end of the 18th century[9]. At a linguistic level,

[6] See C. Grimaldi, *Discours et terminologie dans la presse scientifique française (1699-1740). La construction des lexiques de la botanique et de la chimie*, Oxford, Peter Lang, 2017.

[7] F. Brunot, *Histoire de la langue française. De l'origine à nos jours*, Paris, Armand Colin, tome VI/2, 1966, p. 563 (translation from French "la vérité, simplement, clairement, précisément dite").

[8] Ivi, p. 524 (translation from French "au fur et à mesure que cette langue se constitue, on s'aperçoit que la nomenclature n'est pas seulement une expression de la science, mais qu'elle est une partie de la science même et que la clarté, l'exactitude, la commodité de la forme sont des conditions indispensables au progrès").

[9] See M.T. Zanola, *Arts et métiers au XVIII^e siècle. Études de terminologie diachronique*, Paris, L'Harmattan, 2014.

several instances of confusion of denomination could be identified, especially in relation to chemical substances which were known by different names referring to their color ("Spanish green", "red precipitate of mercury", in French *vert d'Espagne*, *précipité rouge de mercure*), physical properties ("antimony butter", in French *beurre d'antimoine*), taste ("bitter salt", "lead sugar", in French *sel amer*, *sucre de plomb*) or even alchemical association with celestial bodies ("Epsom salt", "Glauber salt" in French *sel d'Epsom* and *sel de Glauber*). It is precisely because of this confusion that chemists used long descriptive sentences that were supposed to contain useful information on the substances without falling into the terminological confusion resulting from the existence of multiple names.

From this point of view, the creation and use of chemical nomenclature therefore responded to concrete pragmatic needs that the preceding botanical nomenclature successfully satisfied at the level of international communication. In this perspective, there were several points in common between botany and chemistry in the 18th century because, on the one hand, at the level of disciplinary organization, the two sciences had been linked to the medical and therapeutic field for a long time and had undergone their most important changes. On the other hand, at the linguistic level, there was a need to name realities or phenomena without superimposing ontologically different concepts. The consideration of this requirement spurred Lavoisier to create new names for simple chemical bodies, namely "oxygen" for *air vital*, "hydrogen" for *air inflammable* and "nitrogen" for *mofette*, from which facts and actions can be easily named (e.g., "oxygenate", "acidify", "acidification" and "acidifiable").

This principle of binary classification is still used in terminology, in particular for the drafting of definitions. At the end of the 19th century, this method began to be applied to techniques and no longer just to the sciences.

In the course of the 20th century, terminology involved multiple subjects (commerce, social and human sciences, sports...) beyond pure sciences and techniques[10]. To reach this universality, it was necessary to cross a century of great transformations, which began, in the first half of the 20th century, with the establishment of three classical schools of thought, i.e. the three great centers of terminological activity Vienna, Moscow and Prague. Each defended its own theoretical model. As far as this period is concerned, we highlight the work of Eugen Wüster, author of a book that became a classic in terminology studies, *The Machine Tool*, published in 1938[11].

3. Information Technology (IT) in Terminology Activities

Over the past forty years, information technology (IT) has become the main tool for accessing specialized knowledge and transmitting scientific, technical, literary and artistic

[10] See P. Faber, M.-C. L'Homme (eds.), *Theoretical Perspectives on Terminology. Explaining terms, concepts and specialized knowledge*, Amsterdam, John Benjamins, 2022.

[11] See E. Wüster, *L'étude scientifique générale de la terminologie, zone frontalière entre la linguistique, la logique, l'ontologie, l'informatique et la science des choses*, in G. Rondeau, H. Felber (éds.), *Textes choisis de terminologie I*, Québec, Université Laval, 1981, pp. 55-113.

information. These technological transformations have had significant consequences for all knowledge workers and language professionals, as well as for terminological activities. Any terminological activity, starting with the identification of terms, can be done manually. However, IT provides unprecedented gains in productivity, quality and accessibility. This is especially true for terminologists working in business, government agency or translation services where they need to create, maintain, and operate large computerized terminology files designed for many users.

The fundamental principle of any terminological approach is that the terms belong to fields of activity that are structured in systems of classification of specialized knowledge. Documentary classification systems, encyclopedias, manuals, and databases provide the terminologist with the necessary framework to establish or adopt such a classification system in the field in which his or her terminological research is carried out. For example, the TERMIUM database structures its terminology sets in major domains, each divided into other domains, which are in turn subdivided into sub-domains, for a total of approximately 1,600 classification nodes. This system continues to be adopted and adapted by many language professionals called upon to build terminology databases. Domain rankings evolve with the progress that is recorded in each area of activity. Such evolution may lead to the emergence of new disciplines, the interdisciplinary migration of concepts or the abandonment, fusion or differentiation of certain concepts and/or designations.

Another essential principle in the classification of domains consists in the distinction between proper domain and domain of application, and following the evolution of knowledge in a field of activity is one of the conditions of any terminological research required to reflect current events. A terminologist can acquire knowledge of an area by becoming familiar with its literature through in-depth reading. This knowledge will be useful in finding the fundamental terminology of a discipline.

Computer activities have been present in the field of terminography since the mid-1960s. However, for several decades it was only used to disseminate terminological data. Terminographers working for organizations such as the Commission of the European Economic Community, the Secretary of State (now called Translation Bureau) of Canada and the Office de la langue française in Québec (now called Office québécois de la langue française) quickly realized that it was impossible to distribute and manage hundreds of thousands of terms and the information accompanying them on paper. Terminology banks were from the result of this observation[12].

Nevertheless, although they stored the results of their research on computer, terminographers continued to collect data without any form of automation for a long time. Until the mid-1980s in fact, data collection and tracking was done manually. Manual analysis presupposes the careful reading and annotation of a series of documents selected after consulting with documentalists and specialists in a field in order to establish conceptual trees displaying the nomenclature of concepts to be defined. Manual processing

[12] See M.-C. L'Homme, *La terminologie : principes et techniques*, Montréal, Les Presses de l'Université de Montréal, 2020.

consists of transferring the terms and their contexts into uninotional terminology lists which will be used to select information relevant enough to be recorded on terminology files. When it comes to reviewing a very long document or a significant number of documents, the manual process quickly becomes tedious and quite demanding in terms of time and human resources.

The implementation of IT began with the computerization of catalogs from libraries and major publishing houses. The digitization involves the transfer of texts, images, sounds and films on electronic media and their consultation on a local network. These technological transformations have palpable consequences for all knowledge workers. In particular, language professionals, including librarians, terminologists, writers, translators, among others, deal with these transformations in the course of their professional activities.

The technological evolutions of the last decades have involved various tools of terminographic work and many new means of support have been developed to facilitate the work of the terminologist[13]: documentary databases (DIALOG), computerized catalogs of large libraries, on-line references with automated search services in commercial databases (GEAC), electronic textual corpora and optical readers analysis assistance software (YVANHOÉ, Bureau de la traduction), automatic term-extraction tools (Nomino), phraseological concordancers (WordCruncher), terminology databases (TERMIUM, Grand Dictionnaire Terminologique, IATE), terminology search engines (Google engine), terminology data storage software (DicoMaker), multilingual database management systems (Termbase), multibase management systems (TermStar, MultiTerm and EdiBase).

The most important analysis tools provided by IT include:

– electronic textual corpora and optical readers. The web pages of government agencies, research institutes, universities and the private sector are distributing an increasing number of electronic documents and allowing them to be downloaded;
– analysis assistance software. Terminologists can use a program such as YVANHOÉ, designed at the Bureau de la traduction by a terminologist for terminologists who must manage large databases;
– automatic term-extraction tools. One of the best-known tools in this category is the Nomino software package, which performs a machine analysis of unilingual English or unilingual French texts;
– phraseological concordancers. These software programs, such as WordCruncher, are widely used in the analysis of literary texts to identify the particularities of a writer's vocabulary and preferred phrase structure. Adopted in terminology, it can count and list the occurrences of a requested term.

Once the terminological nomenclature of a thematic research has been determined, the terminologist locates information in the listed documentation explaining the concepts to be defined and the use of the terms that designate them. This identification makes it possible to group together the terms and textual justifications relating to each

[13] See S. Pavel, D. Nolet, *Précis de terminologie/The Handbook of Terminology*, translated into English by Christine Leonhardt, Ottawa, Translation Bureau, Terminologie and Standardization Directorate, 2011.

of these concepts. Both the identification and the grouping are done manually or using computerized tools. One convenient way is to query documentary databases.

– Terminology databases. Consulting terminology databases and databases such as TERMIUM, Grand Dictionnaire Terminologique (GDT), and Interactive Terminology for Europe (IATE) allows terminologists to better understand the concepts to be defined and to assess the quality and timeliness of the terms that designate them.
– Terminology search engines. The Google engine locates web pages that contain a particular term, lists them in order of importance, and highlights the searched term in each of the selected pages. This makes it easier for the terminologist to choose the most relevant information about the concept and its designations.
– Terminology data storage software. Personal storage tools like DicoMaker are generally easy to use when it comes to creating and updating records in multiple languages, viewing the file and printing in dictionary format, but their memory capacities are relatively limited.
– Multilingual database management systems. The Termbase system, for example, manages multilingual terminology data for the use of translators. It accepts files in English, French, Spanish, German and Italian, and allows the extraction and exchange of files, their updating, the statistical management of their content. It gives some users access to certain parts of the content of the database.
– Multibase management systems. Tools like TermStar, MultiTerm, and EdiBase maintain user-configurable databases, and define and aggregate numerous databases for consultation. They enable search restriction filters to be defined and saved. They are also used to protect certain parts of the content of databases.

Starting from a research topic, the terminologist can use the tools described above to:

– carry out document research and preliminary reading;
– build an initial textual corpus in the source language and the target language;
– define the field of his/her research;
– establish the concept tree to be studied and the related nomenclature;
– consult terminology databases;
– analyze the terms identified in context;
– group synonyms, variants and abbreviations in single terminological entries;
– select the textual criteria that is necessary for the description of concepts and the certification of uses;
– write definitions and observations.

Beyond an almost automated work chain, the profession is undergoing a process of modernization through the networking of terminology databases, the creation of websites for information and terminology products exchange, and consultation with the terminology activity sectors of major international organizations and the national organizations of member countries. From this point of view, terminology activity is currently a major component of the language industry. Effective communication presupposes the exchange of information across linguistic and cultural borders. Translation, terminology and interpretation play a decisive role in the multilingual management of

knowledge and in the production of documentary and language products facilitating the exchange of information.

4. New Needs for Terminology Activities

Terminographic activities essentially deal with terminological data, which include lexical entities and their properties. So, for example, if we consider the terminological entity *sale*, it has some syntagmatic and paradigmatic properties. In particular, as far as paradigmatic properties are concerned, *sale* has a semantic link with *seller, buyer, price, goods* etc. but also with *commerce, purchase* etc.

Terminological data, like lexical data, can traditionally be found in dictionaries. With the introduction of IT in lexicographic and terminographic work, traditional dictionaries have turned into databases. In the case of dictionaries concerning general language, the *Dictionnaire de Trévoux*, dating back to the 18th century, is now available online on the website of the Centre National de Ressources Textuelles et Lexicales (CNRTL), along with other dictionaries. Therefore, consulting a page of the *Trévoux* Dictionary on the web is not very different from consulting it in the traditional paper version, where the properties of the lexical entry are displayed in a linear way:

Figure 1 - Page of *Trévoux* Dictionary

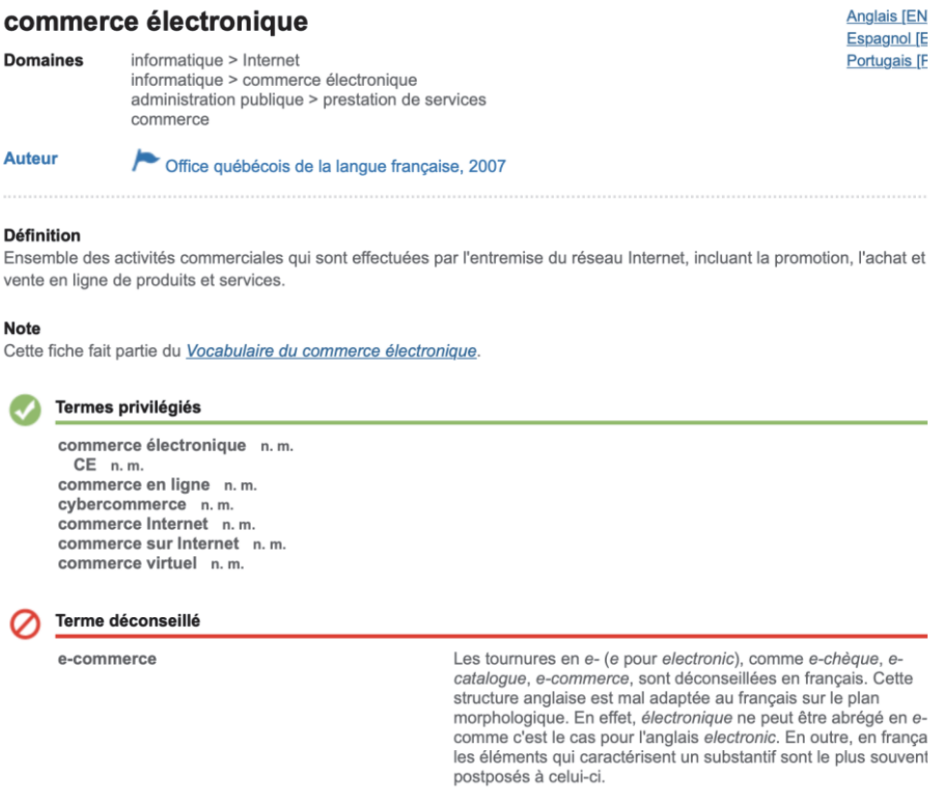
COMMENDEUR, eſt auſſi un Prélat, un Eccleſiaſtique qui eſt aggrégé par honneur dans les Ordres des Chevaliers, comme dans l'Ordre des Chevaliers du S. Eſprit. *Ordinis Sancti Spiritûs commendator.* Il y a pluſieurs Prélats *Commendeurs.*

Les *Commendeurs* de l'Ordre du S. Eſprit, ſont de purs titres auſquels n'eſt attachée aucune Commenderie. Henri III. ayant inſtitué cet Ordre fit ce qu'il put pour obtenir du Pape que les revenus des plus riches bénéfices du Royaume fuſſent attribuez à ces Commenderies, qui n'étoient que de nom. Mais il n'obtint rien de la Cour de Rome, enſorte que les *Commendeurs* de l'Ordre du S. Eſprit ne ſont que des *Commendeurs* titulaires.

COMMENDEUR, chez les Hollandois, ne veut dire que Commandant. On appelle *Commendeur*, celui qui commande une petite armée navale, une eſcadre, le Capitaine d'un vaiſſeau, d'un brulot, d'une flute, &c.

In terminology, most terminographical work consists of databases that are not very different from traditional dictionaries. These databases (e.g., Termium and the Grand Dictionnaire Terminologique-GDT) have the same structure as traditional dictionaries because they present information concerning, for example, domain, variants, definition, example, phraseology and recommendations, following a linear format.

Figure 2 - Example of a Grand Dictionnaire Terminologique term entry



There are some limits to this kind of representation (and consequently communication) of terminological data, that we can list as follows:

– linearity: you are asked to read through the lines in order to find what you are looking for;
– loss of immediacy: when you look for a definition, you are asked to acquire other information you are not really interested in;
– arbitrariness in displaying data: each terminographic tradition chooses its own order of presentation of different categories of information (lexical entry, variants, definition, example);
– lack of intuitiveness.

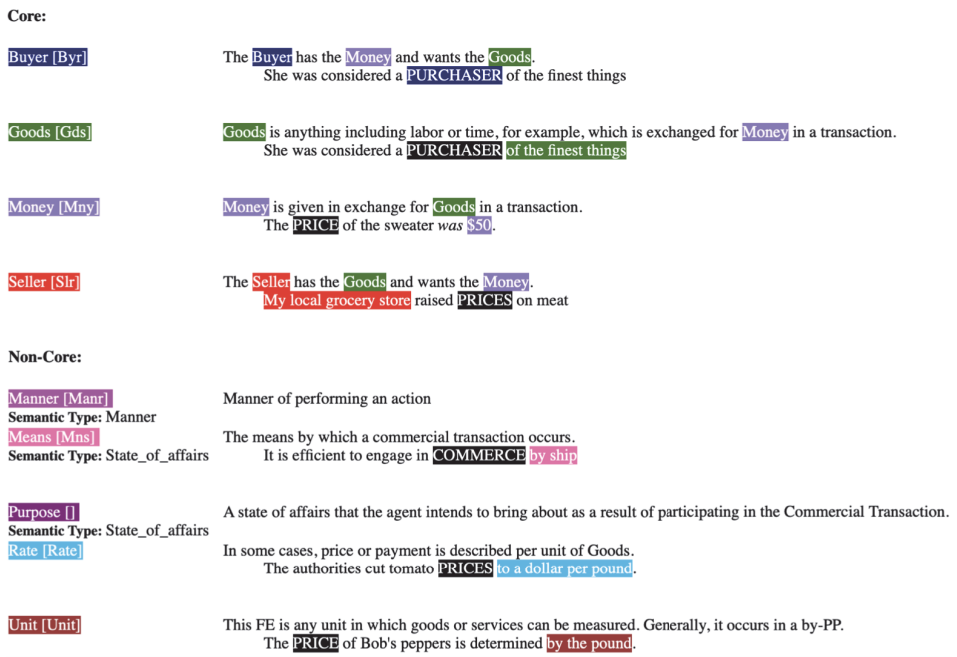
We think that in general lexicography, as well as in terminography, we can find models that may allow these limitations to be overcome.

For example, FrameNet[14], which concerns general language, presents the following advantages:

– while based on linearity, it relies much more on intuitiveness and logic;
– it displays the lexical entry and its lexical *entourage*;
– a user who wants to use *commerce* could also need lexical entries which are part of the *frame* of *commerce*, such as *buyer*, *seller*, *goods*, *money*;
– from a logical perspective, these lexical entries are properties (actants) of the lexical entry *commerce*.

Although it maintains a linear form, FrameNet goes beyond tradition by proposing links between lexical entries[15], based on a network model:

Figure 3 - Example of a search on FrameNet



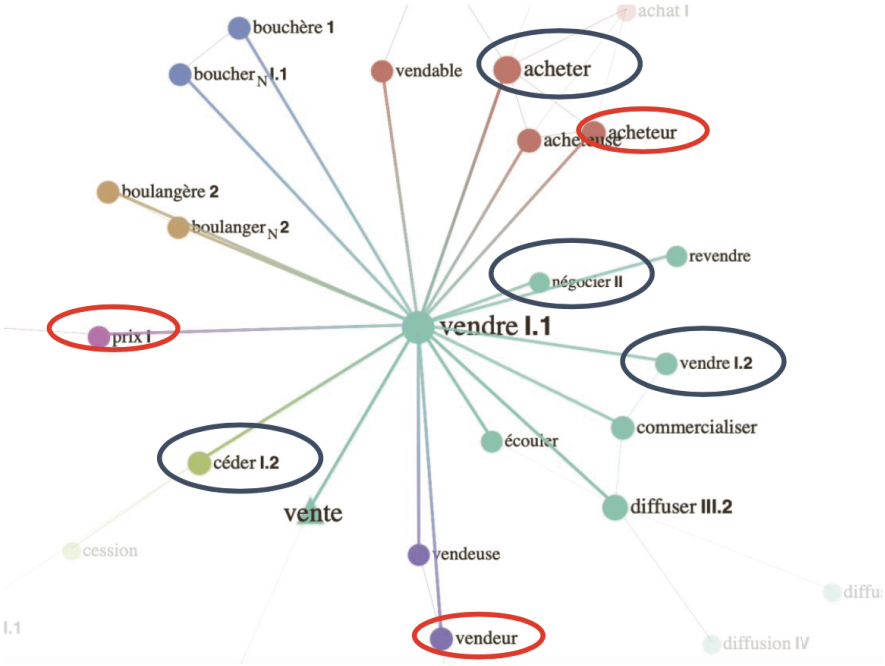
The idea is interesting and may be explored through a different display of linguistic data: this is a means to better communicate this knowledge.

[14] See J. Ruppenhofer *et al.*, *FrameNet II: Extended Theory and Practice*, Berkeley CA, International Computer Science Institute, 2010, available at: <https://framenet2.icsi.berkeley.edu/docs/r1.5/book.pdf> (accessed on 02-05-2023).

[15] See D. Spohr, *Towards a Multifunctional Lexical Resource. Design and Implementation of a Graph-based Lexicon Model*, Berlin-Boston, De Gruyter, 2012.

More recently, the idea of a lexical network was conceived and realized within the ATILF-CNRS Laboratory of Nancy: as a result, the RL-fr (Réseau Lexical du français[16]) project displays lexical entities in a graph, where each node corresponds to a lexical entity and the nodes are connected on the basis of the syntagmatic and paradigmatic relationships between lexical entities:

Figure 4 - Example of a search on a lexical network



We decided to base our approach on this model for the creation of a terminological database at the University of Verona. The database is called DIACOM-FR[17] and will concern the basic terminological units of the domain of International Trade within a diachronic perspective. Terminological entities will be displayed in a terminological network taking advantage not only of the lexicographic experience of RL-fr but also, more

[16] See V. Lux-Pogodalla, A. Polguère, *Construction of a French Lexical Network: Methodological Issues*, in *Proceedings of the International Workshop on Lexical Resources*, 2011, available at: <https://hal.archives-ouvertes.fr/hal-00686467/> (accessed on 02-05-2023); A. Polguère, *From Writing Dictionaires to Weaving Lexical Networks*, in "International Journal of Lexicography", 27, 4, 2014, pp. 396-418.

[17] See P. Frassi, *DIACOM-fr, une base de données terminologiques de type diachronique*, in « Cahiers de Lexicologie », 118, 1, 2021, pp. 23-50.

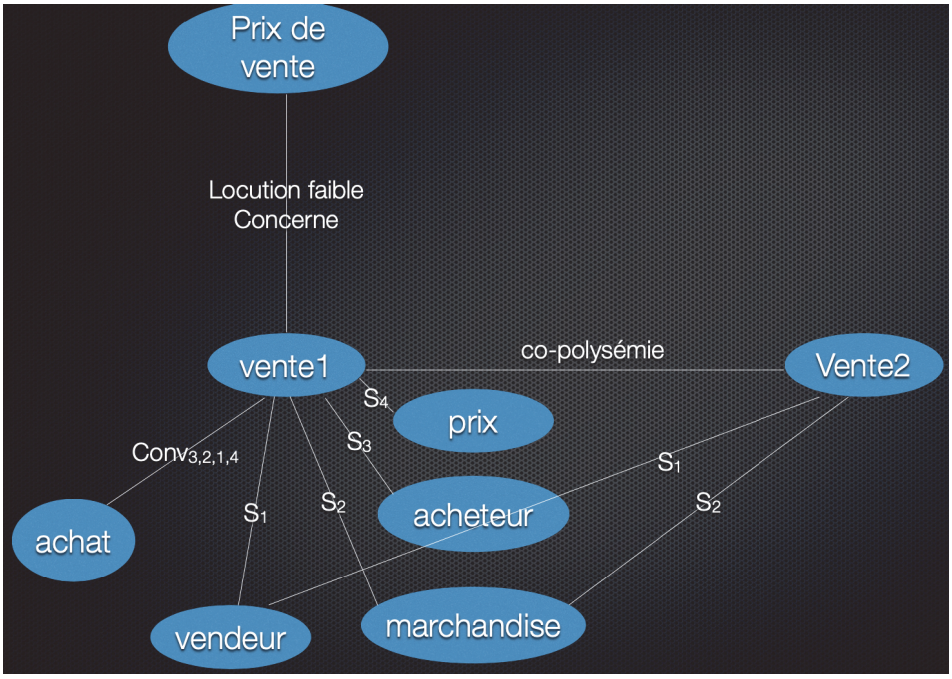
in general, of the modelization of paradigmatic and syntagmatic links that has been proposed by Explanatory and Combinatorial Lexicography[18].

More specifically, we will rely upon the following instruments that have been provided by IT in order to create this lexical network[19]:

– Lemon (Lexicon Model for Ontologies – W3C Ontolex) and LexInfo for the codification of terminological entities;
– Lexfom (A lexical functions ontology model[20]) for paradigmatic, sytagmatic and formal links.

We think that this model of displaying terminological data presents some advantages in terms of readability, since it is more based on intuitiveness and logic (which is closer to the model of mental lexicon) than traditional linear databases:

Figure 5 - Example of a search on DIACOM-FR database



[18] See I. Mel'čuk, A. Polguère, *Les fonctions lexicales dernier cri*, in S. Marengo (éd.), *La Théorie Sens-Texte et ses applications. Lexicologie, lexicographie, terminologie, didactique des langues*, Paris, L'Harmattan, 2021, pp. 75-155.

[19] See P. Frassi, M. Rospocher, *Ontologie, locuzioni deboli e legami fra entità terminologiche nell'ambito del progetto DIACOM-fr*, in E. Chiocchetti, N. Ralli (a cura di), *Risorse e strumenti per l'elaborazione e la diffusione della terminologia in Italia*, Bolzano, Eurac Research, 2022, pp. 138-151.

[20] See A. Fonseca, F. Sadat, F. Lareau, *Lexfom: a lexical functions ontology model*, Osaka, COLING., 2016, available at: <https://www.researchgate.net/publication/309763313_Lexfom_a_lexical_functions_ontology_model> (accessed on 02-05-2023).

These features make this model exploitable in the field of education, and more specifically in teaching and learning terminology, for second language and mother-tongue learners[21].

5. Conclusions

In this contribution, our goal was to retrace the main changes that have taken place in the field of terminology research and in the creation of terminographic products from a communicative perspective. The evolution of linguistic needs for work in terminology has led to the creation of new models of treatment and dissemination of terminological data in which IT plays a primary role, with unprecedented advantages in finding and sharing information.

From a historical point of view, terminology was structured as a discipline starting from a time in which the need for linguistic standardization was perceived in certain areas of scientific knowledge, mostly to avoid communicative confusion regarding the properties and characteristics of elements belonging to the botanical, chemical and mineral kingdoms. Over the centuries, terminology has become increasingly structured from a theoretical point of view, up to the current era in which the recognition of terminology as a field of research and work at an international level is unanimous.

The contribution of IT in terminology has been considerable, and currently is the semantic web and artificial intelligence that poses ever greater challenges to the work to be carried out in the field of terminology. New models of representing terminological entities represent the most important innovation in the terminology sector, as well as one of the most advanced research goals in response to the difficulties present in today's society, where the need to find the correct information and its correct transmission within an unambiguous communication perspective presents concrete challenges that still must be overcome.

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