HOW TO APPROACH THE DISCOURSE OF SCIENCE AND TECHNOLOGY

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Abstract

This paper focuses on some aspects that must be taken into consideration when approaching technical discourse. It presents an account of how to think about the functions of language in general and how these can be applied in use of specialised forms of discourse, with a focus on the discourse of engineering. The paper attempts to create a functional perspective towards a definition of the discourse of science and engineering.

Keywords: technical discourse, English, science and engineering, E.S.T.

1. Introductory remarks

Language in general functions based on a set of universal principles realized in different languages, depending to the environment human beings are exposed to. According to Chomsky, these principles define a number of general parameters of language which are given different settings the result of varying environmental conditions – by particular languages. Thus, language, mind and social life are closely linked together as, in one sense, language is essentially of cognitive nature. At the same time, it functions as a means of communication and social control. It is in the mind as abstract knowledge and must be experienced as behaviour. From this point of view, language is a system of signs designed to meet the needs of human groups and societies. Thus, this system of signs is socially motivated. Better said, it serves to express social meanings.

Technical vocabulary is often coined by adapting or extending meanings of existing words and word patterns, or building new words using known roots, suffixes or prefixes and that this can provide clues to meanings of unknown words. e.g. computer memory, astronaut, micro-surgery. Meaning is what makes a set of words different, and it cannot be fully determined by lexis or grammar. The words provide the main semantic content, which is to be selected from and shaped.

2. What is Technical English ?

The need to analyse the features of E.S.T. raises a set of fundamental problems such as the relationship between E.S.T. and general language, the specific characteristics of E.S.T. Dermot McElholm goes deeper into this question, specifically asking whether it is the use, the language structures, grammatical constructions that give E.S.T. its specificity. (McElholm: 2002) What is textuality in E.S.T.? And can Technical English be analyzed as a distinct but integral part of E.S.T.?

Text linguistics has dealt with the construction and coherence of sentences and types of texts, according to their functionality. This latter classification has imposed a

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term called textualisation strategies, which help make different text types more colourful by mixing the basic functional types – argumentative, narrative, descriptive, expository (used to inform, to explain, to describe, to present information or to persuade), instructive.

In the broad sense, then, we can think of technical English in terms of a language that shows how things are made, what lies beyond the process of making it, the purpose that it serves as well as the general laws that govern the making, purpose and use of those particular instances referred to as things.

In the late 1960's and the early 1970's there were many attempts to describe English for Science and Technology (E.S.T.).

The type of thought process involved in E.S.T. is a logical and sequential one, typical to Maths and Science, as highlighted by Kirkman and Kapp (Britton:1965). Furthermore, for Kirkman it is the purpose that defines technical discourse, whereas Kinneavy calls it the aim of discourse. Kinneavy wrote:

> *"I am concerned with complete discourse, not individual sentences or even paragraphs. It is often impossible to determine the aim of an individual sentence or paragraph without its full context. The same sentence or even paragraph in another context may have a very different aim. 'Discourse' here means the full text, oral or written, delivered at a specific time and place or delivered at several instances … By aim of discourse is meant the effect that the discourse is oriented to achieve in the average listener or reader for whom it is intended. It is the intent as embodied in the discourse, the intent of the work … Is the work intended to delight or to persuade or to inform or to demonstrate the logical proof of a position? These would be typical aims."* (Kinneavy, 1969 on http://www.jstor.org/pss/355033)

In the book entitled *How to Analyse Talk in Institutional Settings* edited by McHoul and Rapley, discourse is analysed with a focus on the setting, namely institutional setting, in models and case studies in the field of conversation analysis (CA), discursive psychology (DP) and critical discourse analysis (CDA). This approach emphasises the importance of context in the interpretation of discourse. Narrowing down the field, Mary LaRoche wrote of technical discourse, seeing it as a structure created by the writer out of the elements of the given writing situation. Her focus on the writer is not singular, as other researchers have noted that the author is of major importance. Robert Boltwood remarked that technical writing "provides information for people who will use it", implying a twofold perspective on discourse. From the point of view of an author, the writer must be an authority in the field, and the audience will necessarily derive one and the same meaning from the given piece of discourse. In the same line of thought, W.E. Britton asserted that the distinctive feature of technical and scientific writing lies in the effort of the author to convey only one meaning what he says. (Britton: 1965)

Considering all the examples above, when defining technical writing, the following distinctions should be made. Firstly, technical and scientific writing is a broad field in which it is highly recommended that a division into subject areas be made, so that the reader is indeed focused on one interpretation. Technical writing, engineering writing, engineering English, scientific English, scientific communication are important

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subdivisions, yet not completely adequate to define our field of research. In a broad sense, technical discourse could be seen as discourse with subject matter in science, engineering and business. More specifically, technical discourse is one that focuses on subjects that fall within science and engineering. The characteristics would be – concern with scientific and technical matters, use of scientific vocabulary (with a special focus on adjectives and nouns) and conventional report forms, commitment to objectivity and accuracy, a wide range of task.

Science has not been able to escape rhetoric, argument, and advocacy, because each scientific paper, when first written, is not immediately an unquestioned truth. In a scientific paper an author attempts to convince colleagues of some claim or set of related claims. At issue may be the identification of a phenomenon, the accuracy and veracity of data, the appropriateness of method, the general usefulness of a set of methods, the interpretation of data, or a new theoretical position. Scientific claims and methods must present themselves in competition with other claims, so an article must present good reasons why its claims should be taken as more accurate and more important than other claims in other articles. Although standards of scientific argument have been refined over the centuries, they are always directed at making claims persuasive. Standards of argument are often identified as methodological rather than rhetorical, because they have to do with finding and producing the most relevant and precise data or making the connection between data and ideas, but these nonetheless are issues of persuasiveness. The current standards have emerged because they have proven to be the most persuasive, trumping weaker arguments resting on less powerful data and reasoning.

This enclosure of science required substantial rhetorical work to define and maintain the social boundaries of science that allowed science to be internally regulated, to gain public authority over its areas of interest, and to garner public and commercial support for its endeavours. To convey the esoteric work of science to popular audiences, new journals emerged. As science and technology also become more important for other social, economic, and governmental institutions, many other new genres and pathways of communication have developed. To assist technologists in communicating with their peers, their corporate co-workers, and the public, technical writing instruction emerged as a university field in the twentieth century, and the technical writer became a major employment title in many organizations. As newspapers increased reporting on science and technology in the latter twentieth century, scientific journalism also became a recognized specialty.

3. Approaches to Technical Discourse (English for Science and Technology)

Among the prominent authors concerned with the notions of text and discourse, a few names must be mentioned. Their definitions and approaches to the study of language are relevant in an account of the tradition of text analysis. Brown and Yule dealt with discourse analysis in the early '80's, in the same period de Beaugrande and Dressler developed a text linguistic approach. Austin's speech act theory as well as van Dijk's

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theory of macrostructures are typical examples of approaches to text analysis, in the general sense.

Some approaches, which have been specifically developed within the E.S.T. setting, are mentioned by McElholm:

- Gopnik's study of the linguistic structure of scientific texts (1972) – concentrating on the structure of scientific texts rather than their vocabulary, paying attention to syntactic structures and transformations in articles in experimental biology and biochemistry;
- the text typology approach of Glaeser (1990) and the Leipzig school - counting elements in a corpus of texts on different subjects and from different fields and statistically analysing them;
- Trimble's "rhetorical analysis" of EST (1985) – basically oriented towards teaching EST, primarily intended for pedagogical purposes, with a focus on teaching procedures. McElholm suggests that Trimble's approach is the better known attempts to analyse EST texts, with some critical remarks regarding this discourse approach. Firstly, Trimble's analytical tools are confusing, secondly, argumentation is absent from his theory; rhetorical functions and patterns are not linked to grammatical phenomena, which are not systematically dealt with. Finally, Trimble never contrasted structures from EST texts with those found in ordinary discourse. (McElholm, 2002)
- Swales' genre analysis of 1990, which proposes a division of texts into different types within an overall linguistic frame, but it is limited to introductions to research articles.

In 2006, in the book entitled "Trends in Specialized Discourse Analysis", in its third section, 'The Discourse of Science and Technology', Khurshid Ahmad demonstrates how corpus linguistics methodology can be applied in the study of metaphors in texts on particle and nuclear physics. Firstly, he points to a constructionist property of scientific discourse claiming that '*scientists literally and metaphorically (!) create a world of make-believe through a web of words – some borrowed, some invented, endorsing self-belief here and suppressing the beliefs of others there* (Ahmad, 2006: 198)'. The way researchers phrase their thoughts and which words they choose may influence our perception. This potential of specialised discourse to shape our understanding of specific phenomena requires further interdisciplinary analysis.

4. Communication in E.S.T. texts

The act of communication through language represents levels of cognitive and social activities. In terms of text in the field of EST there are clear differences that help us distinguish types of operations presented in them.

Expository texts are common in EST, since science and technology usually present general facts, rather than individual ones. The following are fragments from an expository text:

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"All matter is made from tiny particles called atoms. So far, scientists have discovered about 112 different types of atoms. A substance made up of atoms, which are all the same, is called a chemical element… " "For example, the gas oxygen is an element. So is the metal iron. A substance made up of different type of atoms joined together is called a compound. For example, water is a compound of the elements oxygen and hydrogen. The atoms of different elements can combine in so many different ways, to form many thousands of different compounds" (Pocket Science: 1999)

As we can see, the text presents objects, terms that have a clearly defined meaning in the field of chemistry. Furthermore, the text is concerned with the general properties of chemicals and not with one particular instance, they show the relationship between facts, the methods used to establish these facts. This is why in this kind of text one finds definitions, classifications.

"*The unit used to measure frequency is named Hertz, which is defined to be the number of cycles in one second. (This unit is named after Heinrich Hertz, a famous 19th century physicist.) If you increase the frequency of sound (there are more cycles in a second), you get a higher pitched sound. When you decrease the frequency, you get a lower pitched sound."* (http://www.dosits.org/science/whatis/frequency.htm) *"In acoustics, a sound is … quantified by its frequency of vibration. However, scientists refer to another quality of sound called pitch that is a subjective measure of the combination of the frequency and intensity of a sound."* (http://www.bartleby.com/64/C004/027.html)

Expository writing is a mode of writing in which the purpose of the author is to inform, explain, describe, or define a subject to the reader.

"A typical mechanical differential contains a housing (or carrier), two side gears, and several pinion gears. A rotating driveshaft of the vehicle engages a ring gear, which is mounted onto the differential housing. The driveshaft drives the ring gear, which in turn rotates the differential housing. Pinion shafts attach the pinion gears to the housing so that, as the housing rotates, the pinion gears are driven. The pinion gears drive the two side gears, which in turn drive the axle (or half shafts) attached thereto." (http://www.freepatentsonline.com/WO2007111915.html)

A well-written exposition is focused on its topic and listing events in chronological order. Examples of this type of writing are instructions, directions and instructions on performing a task. Key words such as first, after, next, then and last usually signal sequential writing. The language characteristics of expository texts are: the use of present simple and present perfect simple; articles and nouns combine in a generic way; connectors which express cause, effect, result, objectives, contrast and concession are used.

Prescriptive texts are typically contrasted with descriptive ones, which observe and record how language is used in practice, and which is the basis of all linguistic research. Serious scholarly descriptive work is usually based on text or corpus analysis, or on field studies, but the term "description" includes each individual's observations of their own language usage. Unlike prescription, descriptive linguistics eschews value judgements and makes no recommendations.

The main aims of linguistic prescription are to define standardized language forms either generally (what is Standard English?) or for specific purposes (what style and register is appropriate in, for example, a patent ?) and to formulate these in such a way as

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to make them easily accessible. Prescription can apply to most aspects of language: to spelling, grammar, semantics, pronunciation and register. Prescription aims to draw workable guidelines for language users seeking advice in such matters. E.S.T. being typically concerned with generic states of affairs, prescription that appear here are not specific. At the same time, prescriptive E.S.T texts are normative, saying how things should be done, as in the following example:

"… in at least one embodiment, the guide slots 70 may be produced inexpensively, for example, by die casting due to the guide slots 70 functioning only to aid in assembly. The apertures 60 may also be produced relatively inexpensively, for example, by use of a drill and milling machine. The size and the location of the apertures 60 can be precisely produce to support a pinion gear assembly, such as, the spider pinion gear assembly."
(http://www.freepatentsonline.com/WO2007111915.html)

Their language characteristics are: the use of the imperative, the conditional, the future and the present subjunctive mood; impersonal constructions of the form *it is necessary that;* modal verbs like *must, should, need to, may;* etc.

Argumentative texts try to discover problems and respond to them using logical and argumentative structures. Popular science texts and media argue for or against a particular point of view, dealing with a problem and trying to persuade the audience of the correctness of the point of view or conclusion drawn, on basis of the arguments presented and the inferences made. Their language characteristics are: use of logical and argumentative linking words; use of qualifiers; they contain inductive and deductive inferences; they contain hypothesis.

Narrative texts relate events or sequences of events in the past and in EST they are generally historical accounts, such as the history of the windmill, etc. Typically, an E.S.T. narrative would belong to popular science magazines:

"Since ancient times, man has harnessed the power of the wind to provide motive power for transportation. Likewise, the technique of grinding grain between stones to produce flour is similarly ancient, and widespread. Quite where and when these two came together in the first windmill is unknown, but a likely scenario suggests a Persian origin, from where (tradition has it) the knowledge spread back into Northern Europe as a result of the Crusades. However, since the Persian mills were quite unlike the early European designs it seems just as likely that the adaptation of wind as a power source was independently discovered in Europe, albeit at a later date."
(http://www.windmillworld.com/windmills/history.htm)

Their language characteristics are: use of adverbs of time and space; use of past tenses; temporal connectors; anaphoric or cataphoric reference.

Owing to the way that knowledge is structured in science, to the nature of the phenomena it deals with, d*escriptive texts* are less frequently encountered. Descriptive elements are usually found in expository texts, presenting concrete individual phenomena; the use of numbers is a typical indicator of a descriptive text, referring to a concrete reality in real time and space:

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"In this diagram, the cross-head is connected to a drive rod that connects to one of three drive wheels for the train. The three wheels are connected via coupling rods so they turn in unison." (http://science.howstuffworks.com/steam1.htm)

Descriptive texts include references to concrete places, use deictic expressions and indexical expressions, deal with spatial relationships between objects and with concrete persons and their actions. Thus, the following language characteristics can be seen: use of stative verbs, use of articles and possessive adjectives, use of the present tense simple, use of adverbs of space and time, situational reference.

A text may contain a mixture of the aforementioned types and in each text one of them will be the predominant mode of communication. The various linguistic features cover a range of microstructural (linguistic) phenomena that define the dimension of argumentation of E.S.T. texts.

5. Conclusions

The importance of E.S.T. for international communication has meant increased interest in the analysis of E.S.T. and above all in the analysis of the structure of E.S.T. texts. To analyse such texts it is necessary to have: an ***overall theory of language and text*** that can deal with E.S.T. as part of its framework; a theory that can analyse grammatical and textual phenomena at all levels in an ***integrated way***; tools to discover the overall ***structures of E.S.T. texts;*** analysis of representative samples of all the different ***levels and genres;*** a framework to illustrate the ***functionality*** of texts belonging to different genres in the specialised contemporary contexts; an ***interdisciplinary approach*** to deal with the variety of sociolinguistic, grammatical, textual and cognitive phenomena encountered in E.S.T.

Among the questions to be answered are:

1. How do argumentation and rhetoric provide categories and structures for the analysis of EST?
2. How do the linguistic, ontological, cognitive and epistemological dimensions intertwine in the analysis of EST?
3. How does specialised discourse shape our understanding of specific phenomena?
4. What particular phenomena that have been explored less in E.S.T. research need closer examination? (analogy, metaphor, metonymy, synechdoche)?
5. How important are standards in text analysis?

In order to make plausible generalisations about the nature of E.S.T. texts, we need establish whether certain categories or genres have different structures (are popular science texts different from textbooks or specialised articles) and how specialised vocabulary reflects and shapes a type of understanding of the world around us. Much of the meaning of the word **specialised** actually refers to the specific content as well as the context, defined groups of language users and specialised vocabulary, and according to circumstances influenced by social, cultural, economic, and sometimes political factors. A

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theory of language alone cannot completely describe certain phenomena that involve language use. The question that remains to be answered is how we can analyse the relations within and without technical discourse, since "contexts control the way" linguistic performance occurs. (van Dijk 2008:221).

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