Scientific English (SE) has been one of the recurrent topics in
Contemporary Linguistics and its formal properties have been
defined in light of current language theories and related models
of language analysis. The elements of distinction have in fact
been established by:

a) quantifying grammar structures and language patterns occurring
in authentic scientific text (cf. BARBER, 1962);

b) explaining rhetorical acts "...used to give expression to
certain reasoning processes...", and then classifying formal
devices responsible for "...coherence of discourse and
cohesion of text." [ALLEN and WIDDOWSON, 1974, 58-59];

c) describing rhetorical techniques whereby "...the items of
information chosen are related to one another or to the main
subject of the given unit of discourse" [TRIMBLE, 1985, 12].

In exploring the language encountered and needed in scientific
communication, these studies have mustered valuable information
on factors of language content and organization. Hence, they have
provided insight into the essential constituents of the "...princi-
ples of economy, clarity, expressivity and processibility which
underlie Textual Rhetoric" [LEECH, 1983, 16].

With respect to characterizing scientific discourse, however, the
investigations carried out the conclusions drawn seem to consider
the phenomenon as governed mainly by grammar system mappings. In
fact, no appreciable attempt has been made at defining the mental
processes and norms which underlie the development of specific
arguments and at establishing their influence on language forms. Generally, the discussion focuses on the importance that cognitive abilities of users and conventional requirements have in this field of discourse. (cf. WIDDOWSON, 1979, 1983) But these elements are never explicitly analysed as determinants of linguistic manifestations.

As a result recognition of the qualitative factors of scientific argumentation which determine "...how utterances have meanings in situations." (LEECH, 1983, X), and condition linguistic functions, has remained peripheral in these descriptions. This has limited the information on important aspects of SE and has provided grounds for disputing the specificity claims.

The arguments against the proposition of a distinct speech and research area stem from considerations that grammar items, language patterns, speech and rhetorical acts defined as markers of scientific discourse neither abound in, nor are exclusive to scientific prose (cf. CORBLUTH, 1975; PORTER, 1976; HUTCHINSON and WATERS, 1987). But doubts also endure as to whether scientific communication can be considered the product of "...universal sets of concepts and methods of procedures which define disciplines or areas of enquiry independently of any particular language." (WIDDOWSON, 1979, 24).

Obviously, the uncertainty about the "universality of science" (cf. SWALES, 1985), and the dispute about the validity of SE studies arise not only from dependency on code analysis, but also from lack of familiarity with how the methods of science and field-related knowledge can influence linguistic manifestation and discourse processing. Yet a brief reflection on an episode with which we may all be familiar may show that these variables play a fundamental role in the making and understanding of rational speech.

In fact, the announcement made by FLEISCHMANN and PONS about their experiment and production of thermonuclear fusion and the debates it triggered opened up to us all the "forums of competition" through which science progresses. (cf. TOULMIN, 1972) We were thus given a glimpse of how the language of science is created through the "...schemas of perception, exchanges, techniques, values, and the hierarchy of practices which govern scientific discourse" (FOUCAULT, 1970, 191).

On this occasion, it may have occurred to us that independent of the language systems through which the information was received, the claim made by the two scientists gave rise to very different reactions. On the one hand, lay people were fascinated by the feat and accepted it at face value; on the other, the scientific communities were amazed and puzzled at the event and expressed doubts about the validity of the report.

Both the circumstances and the phenomenon described eluded accepted scientific theories and models while the results were beyond logical expectations. Hence, before accepting Electrochemically induced nuclear fusion of deuterium* as a fact, field
specialists throughout the world wanted to verify the event described.

Some of the questions about the 'clean energy' claim concerned pragmatic properties of scientific discourse directly related to GRICE's (1975) "Cooperative Principle" and its maxims. The experts found the account wanting in terms of "quantity", "quality", "manner" and "relevance". But the discussion drew on shared knowledge and experience related to the fields of physics, chemistry, mathematics and statistics. Thus, the language used in the debate was mediating content-in-context.

Technical vocabulary and structures such as 'heavy water', 'magnetic fields', 'neutron', 'proton', etc., recurrent in these debates, may have sounded familiar to most of us. But without specific knowledge and appropriate training, it was difficult to visualise analytically the concepts they conveyed in order to process and follow the argumentation. Code classification, according to any model, was of little help in this task as can be readily appreciated by analysing just one of the conceptual frames originated through this event, namely "cold fusion".

Following current models of language description, the structures of this compound may be classified as follows:

<table>
<thead>
<tr>
<th>Vocabulary</th>
<th>Structures</th>
<th>Function</th>
</tr>
</thead>
<tbody>
<tr>
<td>cold</td>
<td>every-day</td>
<td>adjective modifier</td>
</tr>
<tr>
<td>fusion</td>
<td>technical</td>
<td>noun head</td>
</tr>
</tbody>
</table>

By analogy with the compound 'cold weather', for example, an analytic and explicative extension of the language content of "cold fusion" will give 'The fusion is cold'. This sentence is correct, but it gives an absurd explanation of the 'oxymoron' in question.

Actually, "cold" here does not refer to the scalar temperature, condition or quality of the noun it seems to modify. While "fusion" is not a synonym of "melt", "join" or "change of state". The two grammar constituents represent a permanent transmutation of a chemical substance (Deuterium) into another (supposedly Helium 4) in set conditions. This phenomenon involves collision of particles (positive ions) brought about by heat energy and resulting in a discharge of chemical elements with release of radiation and heat energy.

Therefore, in this context, "cold fusion" has a Pickwickian sense. It refers to a nuclear reaction whose steps can be visualised, quantified and tested through a given mathematical formula. But its real significance can be appreciated only if one is aware of the huge amount of heat energy required to produce thermonuclear fusion by any other means compared to the quantity reportedly used in the Utah experiment.
It is obvious then, that this term was coined by scientists in the light of scientific information as a synthetic substitute for the analytic 'electrochemically induced nuclear fusion' and underlying qualitative and quantitative aspects. Nonetheless, the inclusion and use of this expression in the universe of science depends on further scientific verification of the phenomenon it presumes, as well as on community consensus.

Once this validation has taken place, the techniques and phenomenon signalled by the compound "cold fusion" will become a "constituent" of the disciplinary matrix or community-rooted conceptual webs, procedures and values by means of which scientists strive, in unison, for knowledge and understanding of reality (cf. KUHN, 1970). Independent of the language system used to codify this expression, within the specific universe of discourse, it will then be associated to the same conceptual frames. Hence, it will be able to function as both a topic and an instrument of research and discourse.

It seems evident then that, besides language content aspects, the SE issue involves factors of communication which determine "...how words work in discourse ...and how discourse works" (RICHARDS, 1936, 10), in relation to the mental processes, conventions, procedures and goals of the world of science.

The study of this problem has been a central topic for discussion in the epistemic branch of Modern Rhetoric. And I believe that this discussion has yielded an analytic description of the constituent factors of scientific discourse which may throw light on the phenomenon and add perspective to SE studies.

Specifically, E. GRASSI defines scientific argumentation as: "...rational speech which seeks universal meaning via the scientific classification system" (GRASSI, 1980,113). Thus, he focuses on the formal properties, procedures and purpuses of the language of science and relates them directly to the Galilean Method. This analyses and describes nature and its laws on the basis of factual observation, established theories, experiments and mathematical procedures. However, to warrant truth value and systematic public control of the claims made among other formalities, it demands objective linguistic accuracy.

GRASSI discusses these requirements but only to conclude that because of them science is limited within its own method and goals and that as a consequence rational speech is confined within set frames of reference. He then argues that the drive for accuracy constrains imagination and subjective interpretation within fixed parameters, and renders scientific discourse similar to a code, i.e., "...system of signs whose elements receive their meanings within this system" (GRASSI, 1980, 23). Hence, he alleges that this speech type lacks the inventive function supplied by metaphors whose "...functions is that of invention-the seeing of new relationships...that produces each new code" (GRASSI, 1983, 70).
In fact, scientific argumentation uses metaphors and other figures of thought as effectively as any other speech type. The difference lies mostly in the purpose for which these rhetorical figures are employed. Science applies them to explain, visualize and support factual information in order to extend knowledge and achieve consensus. Poetic language, whose primacy over rational speech is defended by Grassi, uses "...the emotional power of figural language to suggest affinities..." (Vickers, 1988, 316), and to exploit stylistic effects mainly for aesthetic gratification. However, even in the discourse of the liberal arts meaning seems not to be totally independent of socio-cultural and other constraints. Hence, also in this field of communication it must be code related and confined to some degree.

On the other hand, I. A. Richards considers accuracy and adherence to reality the driving force of "symbolic" or "referent" language, i.e., scientific discourse. According to him: "In symbolic speech, the essential considerations are the correctness of the symbolization and the truth of the references" (Richards, 1923, 239).

Richards first illustrates how words work or convey meaning in terms of 'symbol', 'reference' and 'referent' via his semantic triangle (cf. Richards, 1923, 11). Then, he discusses the "canons" which regulate the use of words in science and prevent ambiguity and misunderstanding. In the process he also explains that "reference" and "adequacy", i.e., actual value of terms, are in relation to a universe of discourse and that understanding depends on foreknowledge and experience, besides familiarity with a language system and its mechanics. (cf. Richards, 1923).

Richards moves from the theory of meaning to that of interactive communication when he introduces the notion of context: "...a recurrent set of mental events peculiarly related to one another so as to recur, as regards their main features, with partial uniformity." (Richards, 1923, 57). He considers this "entity" the source of recognition, inference and other thinking strategies which make possible encoding and decoding processes. Consequently, he explains that discourse thrives on the activation of clusters of concepts which are rooted in different "comparison-fields". (cf. Richards, 1955). These consist of the various cognitive and practical experience of the people involved in the communication effort, hence, they provide the 'context' from which the symbols derive their meaning. In fact, it is access to shared comparison-fields that determines retrieval and monitoring of information and guides "feedforward" and "feedback" operations which underlie linguistic exchanges.

Thus, after Richards, rational speech can be considered a system of systems based on knowledge and experience shared by the participants and manifested through "...the finely-meshed language most adequate to serve the needs of science..." (Richards, 1983, 96). The "cold fusion" episode, discussed earlier seems to confirm this phenomenon. For, as noticed, the scientists built their discussions on information related to various cognitive fields.
In fact, M. FOUCAULT considers knowledge the lifeblood of "scientific discursive practice", i.e. all the tested conceptual frames, conventions and rules which are accepted as true by scientific communities. He argues that without specific knowledge, there cannot be discourse, and that it is knowledge that determines the form the discourse assumes (cf. FOUCAULT, 1972).

In particular, he sees scientific communication as governed by systems of rules; some active on the "exterior", others "internal" to the argumentation procedures. The first "...function as systems of exclusion, ..." (FOUCAULT, 1970, 220). They include the event observed and the discipline-based techniques used to analyse and quantify it. The second comprise: "rules, where discourse exercises its own control; rules concerned with the principles of classification, ordering and distribution" (FOUCAULT, 1970, 220). Hence, they include the logical strategies and the formal structures chosen to support and justify the argument.

In addition, FOUCAULT points out that the validity and acceptance of scientific efforts depend on "...established or always redemonstrable truth; ..." and on their "...membership in a systematic ensemble, and not on reference to the individual who produced them,..." (FOUCAULT, 1975, 610). As a result, in this discourse type the "author-function" fades in favour of other variables.

The single scientific endeavour is in fact only a piece of a complex design. Its value depends on how well it fits within the whole, as well as on what it contributes towards the explanation and understanding of a given phenomenon. Therefore, in a scientific text referencing focuses on techniques and results which validate or disprove claims through discussion of qualitative and quantitative data and other objective information. It serves to relate methods and theories to facts and data and not to lend credence to the discussion by appealing to recognized authority in the field.

FOUCAULT believes that all the forementioned characteristics influence markedly point of view, person, voice, modality and other linguistic properties. Thus, he concludes that scientific speech is a distinct "typology of discourse" (cf. FOUCAULT, 1975).

However, the strong factual and impersonal bias of this discourse type does not make it less dependent on man's ability and individual creativity and choices. R. M. WEAVER (1953) draws attention to this aspect when he ascribes scientific progress to the ability man has to originate theories, laws, generalizations and other concepts which can help him explore the world of facts. He believes that subjective decisions guide the scientist's choice which regards to both the field of study he will engage in and the aspect of the phenomenon he will explore. At the same time, he marks the social dimension which is embedded in scientific activities. In fact, he states that:

"The scientist has some interest in setting
forth the formulation of some recurrent features of the physical world, although his own sense of motive may be lost in a general feeling that science is a good thing because it helps progress along" (WEAVER, 1964, 69).

Of course, the progress the scientist is primarily interested in relates to advancement in his research project which, in turn, will benefit his field of study and the community of which he is a member owing to his professional affiliation and experience. He has been trained in order to contribute to this progress. Consequently, he accepts willingly to carry out his work and to present his results in observance of set criteria.

These criteria respond to norms of behaviour condensed in WEAVER's "dialectic" and "rhetorical" phases or conceptualization and exposition stages of any scientific activity. It draws on the ability the individual has to perceive "similitude", "analogy", "cause and effect", "contrast" and other phenomena intrinsic to the world of facts. However, in order to become scientific facts, individual perceptions and deductions have to be objectively described and proven through systematic procedures.

The second phase relates to the exposition and discussion of the data obtained during the experimental stage. This calls for analysis and re-synthesis of the information which has to be transmitted through language structures with consequent influence on choice and value of grammatical categories, argument type, functions and exposition strategies. (cf. WEAVER, 1953)

But, the adequacy and organization of scientific argumentation depends also on another determinant criterion. S. TOULMIN focuses on this feature and ascribes it to: "The kind of involvement that the participants have with the outcome of the reasoning ... and the ways in which possible outcomes of the argument are tested and judged" (TOULMIN, 1979, 7). According to him this variable is at the basis of the proof-warranting process which characterizes every step of scientific discussion. Thus, it conditions micro- and macro-structures, their functions and the "argument lay-out" of this discourse type.

TOULMIN defines the inter-related constituents of a scientific presentation as: a claim - the conclusion that the report proposes; the grounds - established information on the subject; the warrant - qualitative and quantitative facts supporting the new hypothesis; the modality - value indicating the degree of certainty regarding the event reported; the rebuttal - elements of doubt concerning the claim made (cf. TOULMIN, 1958).

Obviously, the claim is the core of the discussion and every structure and function in the text must produce reasons for its justification. This is achieved through the use of terms and strategies whose value is determined by categories of "force" and "criteria" (cf. TOULMIN, 1958). The first category relates to the field invariant or system-bound meaning embodied in each lingui-
tic item. The second signals field variant meaning; the pragmatic and qualifying connotation that each structure has within the specific context of situation.

TOULMIN cautions that in scientific communication people "...test ideas critically...in situations that raise the question of whether those ideas are worth sharing" (TOULMIN, 1979, 9). Hence, a scientific argument is sound only if it survives the criticism and tests of the specific community and if the proposal made complies with requirements of 'fertility', i.e. potential for further developments and applications in the field of study.

In light of the methods and procedures whereby the validity of scientific argumentation is tested, J. HABERMAS (1979) collocates rational speech within the theoretical and meta-theoretical discourse types. According to him, the first type can attain validation through confrontation with factual reality; the second through theoretical models. Thus, he draws a distinction between the discourses of applied and pure science and places them in separated conceptual domains.

HABERMAS analyses the theoretical type with respect to content value, contextual relation, function of grammatical sentences and attitude of participants in the linguistic exchange. Thus, in view of its semantic and pragmatic properties, he classifies this discourse type according to the following correlations:

<table>
<thead>
<tr>
<th>Mode of Communication</th>
<th>Type of Speech</th>
<th>Theme</th>
<th>Thematic Validity</th>
</tr>
</thead>
<tbody>
<tr>
<td>Cognitive</td>
<td>Constatives</td>
<td>Propositional content</td>
<td>Truth</td>
</tr>
</tbody>
</table>

(HABERMAS, 1979, 58)

He then explains that in scientific discussions the focus is on "what happens in the world" (HABERMAS, 1979, 48), analysed through knowledge-based procedures. This gives the language structures propositional meaning. Consequently, in this discourse type both the source and the receiver of the message assume: "...the objectivating attitude of observers who correctly report their experience in propositions" (HABERMAS, 1979, 48).

In addition, he points out that in situations of scientific argumentation the participants not only have equal opportunity to speak and evaluate content matter but are also required to justify their discourse in terms of mutually recognized norms. Thus, he suggests that in scientific settings the participants are in the discussion are active-actants in so much as they work on the same assumptions and can contribute to the evaluation of the message content. This factor makes scientific discourse different from other communication interactions where the receivers can be mere spectators or passive listeners.
The selection of opinions which has been presented above reveals that scientific activity is a cooperative venture whose determinant factors are the content matter, goals, methods, conceptual networks, conventions, norms and validation procedures shared and accepted by the specific community. Thanks to these factors scientific discourse has a clear linguistic purpose. It is built around a central semantic nucleus which is closely linked to the context-of-situation and expectations shared by the participants in the communication act. Hence, besides contributing to a process whose aim is exploring factual truth, these factors reduce idiosyncratic extremes and favour symmetric relationship among the partners engaged in the communication exchanges.

Naturally, these properties of scientific argumentation are reflected through language structures. Thus, they must control choices and values at lexical, grammatical, syntactic and textual levels. Consequently, both the "conversation" or interpersonal and the "expressivity" or textual principles underlying this discourse type must be influenced by them.

It can be thus concluded that SE should be considered as a distinct "...typology of discourse ... that cannot be constructed solely from the grammar features, formal structures and other object of discourse..." (FOUCAULT, 1975, 613). Probably, a better understanding and a more effective description of this area of discourse would follow if linguistic analysis were carried out also in consideration of the information available in Modern Rhetoric on the subject.

References:


CORBLUTH, J.D., "English? - or 'Special English?'". In English Language Teaching Journal 29, (4), (277-286), 1975.


FOUCAULT, M., "What is an Author?" In Partisan Review. (Trans. JAMES VENIT) 42, (603-14), 1975.

