Characteristics of English for Science and Technology

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Keywords: English for science and technology, lexical characteristics, syntactic characteristics, rhetoric characteristics.

Abstract. With more and more works and papers on science and technology published in English, English for science and technology has developed into an important variety of modern English with its unique characteristics that contribute to the style of science and technology materials. The paper explores the characteristics of EST through exemplification at the different language levels, with the aim of arousing an awareness of such characteristics among ES workers for better scientific and technological communication.

Introduction

English for Science and Technology (EST) generally refers to English used in scientific publications, papers, textbooks, technical reports and academic lectures, etc. It is used to describe the physical and natural phenomena, their processes, properties, characteristics, laws and application in productive activities. As an outcome of the rapid development of science and technology after World War Two, EST initially emerged in the 1950s. Since the 1970s, together with the shift development of science and technology as well as the popularity of the English language, "EST has developed into an important variety of modern English in many countries" , as pointed out by Qian Sanqing [1]. Due to its main functions of statement, description, exposition, definition, classification, instruction, comparison, exemplification, inference and reasoning, EST has achieved its own language characteristics that contribute to the formal, concise, precise, impersonal and economical style of scientific documents. The paper explores the characteristics of EST through various examples at such language levels as the lexical, syntactic and rhetoric levels, aiming to arouse the awareness of such characteristics among ST workers so as to improve their use of EST for communication.

The Lexical Characteristics of EST

The high-level profession and preciseness of ST materials are tactfully achieved by such lexical characteristics of EST as the frequent use of science and technology (ST) words, the replacement of verb phrases by verbs and the extensive use of abstract nouns and descriptive adjectives..

The Frequent Use of ST Words Although function words and general words constitute the largest part of EST vocabulary, the frequent use of ST words in EST and the complicated way that they vary in formation, meaning and use still form a remarkable feature of EST vocabulary.

Generally, ST words fall into 4 categories according to the way that they are different in formation, meaning and use:(1) Pure ST words such as *hydroxide, diode, promethazine* and *isotope* etc. These words mostly composed of Latin or Greek morphemes are monosemic and professionally used in a special field.(2) Semi ST words such as *frequency, density, energy, magnetism*, etc.. Compared to Pure ST words, these words are also monosemic but more commonly and frequently used in fields of different professions.(3) Common ST words such as *feed, service, ceiling, power, operation, work,* etc.. These are specialized common words carrying different meanings in fields of different professions. For example, the word *feed* with the basic meaning of *to give food to a person or an animal* can be used in different fields with different meanings such as *to supply water, to provide electricity, to deliver, to load, cutting feed, power source,* ect. Such polysemous common ST words

are freely collocated with other words and are most widely and frequently used in fields of various professions.(4) Built ST words such as *microbicid, waterleaf, medicare, CSMA*, which are built through different ways of word building such as affixation, compounding, blending, acronyms, etc.. Built words are much more frequently used in EST than in general English to achieve the conciseness and preciseness of scientific documents. Such extensive use of various types of ST words seems to be a challenge for EST users; however, an awareness of the monosemy of pure and semi ST words, the specialization of common words and the polysemy of specialized common words together with knowledge of word-building will eventually lead to a good command of ST words.

The Extensive Use of Abstract Nouns and Descriptive Adjectives In EST there exist a large number of abstract nouns, which are used to indicate means, existence, tools as well as the results and states of actions, behaviors and movements. This kind of nouns mostly have the same roots with general verbs or adjective from which they are derived. For example, *insulate--insulation*, *expand-expansion*, *stable-stability*, *humid-humidity*, etc. Similarly, in EST also appear quite a quantity of descriptive adjectives used to describe the state, feature, degree, size and shape of natural phenomona and matters. These adjective are mostly derived from verbs and nouns using suffixes such as *–ac/iac*, *-al*, *-ar*, *-ato*，*-eal*, *-ed*, *-ic- ible/able*, *-ing, -ing, -ive, -oid,- ose, ous, -y*. In addition, abstract nouns and descriptive adjectives are collocated to indicate highly professional existences. From such examples as *favorable prognosis*, *bacterial infection*, *systematic disorder*, it can be seen the lexical collocation of abstract nouns and descriptive adjectives is another striking feature of EST vocabulary. The reason behind the fact that ST articles prefer such abstract nouns and the descriptive adjective is that the process, result, state, specialty and feature of existences in nature can be precisely and impersonally explained by abstract nouns and descriptive adjectives.

The Replacement of Verb Phrases by Verbs A large number of English verbs and their corresponding verb phrases share the same meaning in a certain language context. For example, *absorb-take in; examine-look into; rotate-turn around; utilize-make good use of,* etc.. Comparatively, single verbs of limited use are more monosemous and more formal, while verb phrases are more colloquial, synomemous and more widely used in spoken English. For example, *absorb* shares the same meaning with *take in* both meaning *assimilate*, but the latter flexibly carries different meanings of *understand*, *deceive*, *shorten* when used in different informal contexts. In order to avoid the ambiguity or colloquialism as well as to achieve the formality and preciseness of ST literature, formal verbs are preferentially used instead of verb phrases in EST.

The Syntactic Characteristics of EST

The accuracy, conciseness and objectivity of EST documents are also achieved by some syntactic characteristics of EST, such as the extensive use of postpositive attributive, non-predicative verbs, passive voice as well as long and complicated sentences.

Common Use of Postpositive Attributive Postpositive attributives commonly appearing in ordinary English are more frequently used in EST because of the preciseness requirement of ST documents. Generally, the use of postpositive attributives in EST can be realized through the following five structures: (1) Prepositional phrase. e.g. *The explanations of the earth's magnetic field are generally accepted.*(2) Adjectives or adjective phrases. e.g. *All radiant energy has wavelike characteristics, analogous to those of waves .* (3) Adverbs. e.g. *The force upward equals the force downward so that the balloon stays at the level.* (4) Participles. e.g. *In 1983, there were only 200 computers connected to the Internet .*(5) Attributive Clauses. e.g. *The loads a structure is subjected are divided into dead loads, which include the weights of all parts of the structure, and live loads, which are due to the weights of people, moveable equipment.* Besides, encouragingly used in EST are some postpositive attributives of more complicated structure, which are actually combinations of the the above postpositive attributives of simple structure. For example, in the sentence *Hand is the body part at the end of a person's arm that includes the fingers and thumb, used for picking up, holding, and touching things,* the scientific definition of *hand* is precisely and compactly presented by a combination of prepositional phrase, attributive clause, and participle phrase.

Extensive Use of the Passive Voice Another prominent characteristic of EST syntactic structure is the extensive use of passive voice. According to the statistical research by Swales, J. [2]., at least one third of predicative verbs in EST documents are used in the passive voice.The extensive use of passive sentences meets the requirements of ST materials for objectivity, compactness and coherence. Firstly, the recounting and reasoning of ST works demand the objectivity of expression, and the use of the passive voice instead of the active voice helps to create a sense of objectivity. Secondly, in ST materials, the object of action is of greater importance than the subject, the actor who performs the action, and the use of the passive voice helps the object hold the head or the prominent position of the sentence. Additionally, in many cases, the prominence of the object of action will contribute to the compactness and coherence of ST literature. The following example will illustrate the advantages of passive voice in EST. *The Harry Diamond Laboratories performed early advanced development of the Arming Safety Device (ASD) for the Navy' s 5-in guided projectile. The early advanced development was performed in two phrases. In phrase 1, the ASD was designed, and three prototypes were fabricated and tested in the laboratory. In phrase 2, the design was refined, 35 ASD' s and a large number of explosive mockups were fabricated, and a series of qualification tests was performed. The qualification tests ranged from laboratory tests to drop tests and gun firing. The design was further refined during and following the qualification tests. The feasibility of the design was demonstrated.* The use of 8 passive clauses in the passage not only highlights the main contents being explained, but also creates objectivity, compactness and coherence of the whole passage.

Wide use of non-predicative verbs The non-predicative verbs usually taking three forms, namely "to + V" (the Infinitive), "V-ing" (the Present Participle or the Gerund) and "V-ed" (the Past Participle) are not limited by a subject or inflected by categories such as tense, aspect, mood, number, gender, and person, while at the same time play different roles of nouns, adjectives, or adverbs [3]. Such flexible use of non-finite verbs creates the objectivity, conciseness, flexibility, and preciseness of expression, and thereby helps to avoid the subjectivity in meaning or the abundance in structure in ST materials. Therefore, non-predicative verbs are far more frequently used in EST than in general English to serve the purpose of explaining ideas impersonally, concisely and precisely. Consider the following sentence: *They use new and high technologies and non-public ownership mechanisms to enliven, transform and upgrade traditional industries, forcefully promoting the attainment of the objectives of "upgrading old enterprises, nurturing new industries and building large enterprises.* The sentence includes an infinitive phrase *to enliven, transform and upgrade traditional industries* and a participle phrase *forcefully promoting the attainment of the objectives of upgrading old enterprises, nurturing new industries and building large enterprises*, of which the latter is more complicated in that it further employs the gerund phrase *upgrading old enterprises, nurturing new industries and building large enterprises* as the object of the complicated prepositional phrase that modify *the attainment*, the object of the participle *promoting*.

More long and complicated sentences Science and Technology is the study of the development, distribution, structure and function of the living things in the outside world, which lie together in interrelated, paradoxical movements. To present the complicated relationships among the existences, EST documents greatly depends on the logic thinking that resort to the linguistic form – long and complicated sentences consisting of clauses and phrases that are mutually conditioned. According to the statistics on 107 million- word-corpus reported by Shanghai Jiaotong University, 21.4 words is the average length of EST sentences , among which those of more than 40 account for 6.3 %, while those of less than7 (including the seven words) only 8.77% [4]. Consider the following long and complicated sentence that is employed to describe the scientific possibility. *With the advent of the space shuttle, it will be possible to put an orbiting solar power plant in stationary orbit 24, 000 miles from the earth that would collect solar energy almost continuously and convert this energy either directly to electricity via photovoltaic cells or indirectly with flat plate or focused collectors that would boil a carrying medium to produce steam that would drive a turbine that then in turn would generate electricity.* This long sentence involves a prepositional phrase *With the advent of the space shuttle* as the adverbial and the infinite phrase *to put an orbiting solar power plant...* as the real subject, which covers four encircled attributive clauses to modify *the orbiting solar power plant*. The long sentence of complicated structure expresses the complicated situation of putting a special solar power plant in a clear, logic and precise way.

The Rhetoric Characteristics of EST

The objectivity, compactness and coherence of ES materials can be further enhanced by the rhetorical features of EST, such as the limited use of tenses, the simple rhetorical choices, the common use of abnormal sentences, and the deliberate use of subjunctive mood and imperatives.

   The Limited Use of Tenses ES writings aims to objectively state the facts, describe the process, and illustrate the features and functions, most of which are of university, frequency and particularity. Therefore, in EST, more commonly used are general statements in simple tenses, mostly the simple present tense and simple past tense, to create timeless notions. Take the passage as an example. *In bear making. Yeast cells break down starch and sugar (present in cereal grains) to form alchol; the froth, or head, of the bear results from the carbon dioxide gas that the cells produce. In simple terms, the living cells rearrange chemical elements to form new productions that they need to live and reproduce. By happy coincidence in the process of doing so they help make a popular beverage.* Five verbs used in present tense, *break down, result from, produce, rearrange, help*, appear in the short passage of 3 sentences.

   The Less Use of Rhetorical Devices and Complex Formation Style Due to its function of stating facts and laws, EST seldom employ such rhetorical devices as metaphor, personification, hyperbole, etc commonly used in literature English. On the contrary, to directly explain the objective world, ST writers tend to adopt simple formational style of writing. For example, they often use the prefixion-statement pattern like the sentence *Sea water can be used for a supply of potable (or drinkable) water if it can be separated from the salt dissolved in it*, in which the main information is put in the head of the sentence, so that the reader can intuitively grasp the main point and understand the author's ideas immediately.

   The Frequent Use of Omission, Inversion and Separation In ST articles frequently appear incomplete, reversed, or fragmented sentences. The existence of such "abnormal" sentences is the rhetoric requirement more than the grammatical requirement. Specially, omission often helps to save space, making the presentation more concise and compact. e.g. *All bodies consist of molecules and molecules of atoms (consist* is omitted after the second *molecules).* Inversion often helps to make a common sense more eye-catching and prominent, the co-text more closely linked to and the description more vivid. e.g. *The most important of the materials in our bodies are the proteins* (the subject *the protein* is inversed with the predicative *are the most important*). Separation helps to enables the overall structure of the sentence more symmetric and balanced. e.g. *Thus, it would be correct to say that the distance to the sun, from where we are on the earth, is about 1 million walking days (the distance* is separated from *is about 1 million walking days*).

   The Deliberated Use of Subjunctive Mood The description of common sense, the proposition of ideas, the discussion of problems and the deduction of formulas often involve a variety of prerequisites and conditions. In order to avoid ambiguity, the use of the subjunctive is always encouraged in EST. Additionally, many authors are willing to adopt subjunctive mood to express their humility and leave room for caution. For example, *If a pound of sand were broken up and turned into atomic energy, there would by enough power to supply the whole of Europe for a few years.* The use of subjective mood in the sentence avoids ambiguity in meaning and also leads to a polite and smooth tone for expressing the result of a supposed condition.

   The tactful use of imperatives Imperatives are often used in EST materials, especially used in operation specifications, work procedures, and precaution matters to provide instructions, suggestions, advice and commands. Let us read the passage that presents the instructions for the process of an experiment. *Fill a test-tube half full of water and heat it nearly to boiling point. Support the tube on a stand and allow it to cool. Take the temperature every minute. Stir carefully with a glass rod. Record the readings you obtain, and plot them on a graph of temperature against time. Repeat this with a tube half-full of crystals. Allow the solid to melt. Heat the liquid to 100 ℃, fix the tube on the stand and allow it to cool. Record the results as before and plot them.* The use of the imperatives in the passage not only helps to make the article refined but also expresses the author's friendly suggestions to the reader. Additionally, each

imperative beginning with a different verb adds to the variation of the writing, thus avoiding dull monotony. Imagine what kind of article it will become if *you* is put in the head of each sentence.

Conclusion

EST displays its own unique features in its evolution and development process. It is undoubtedly helpful for ST workers to understand the characteristics of EST that distinguish it from ordinary or literature English. However, it is also worth noting that the characteristics of EST are relative rather than absolute. In other words, the characteristics of EST also exist in ordinary or literature English but become more prominent in EST, and on the other hand, EST often borrows literary words and sentences or rhetorical devices to enhance the effect of language.

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