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LEXICO-SEMANTIC, SYNTACTIC AND STATISTICAL CHARACTERISTICS OF THE WORD ‘FLOW’ IN TEXT CORPORA OF SCIENTIFIC AND TECHNICAL DISCOURSE

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This article examines the semantic structure of the English noun ‘flow’ as it appears in texts referred to scientific and technical discourse. The availability of real texts allows for the “language-speech” dichotomy to be realized. The material used are the text corpora from three technical disciplines: “Automation of Thermal Power Processes”, “Chemical Engineering”, and “Acoustics”. The texts from the first two disciplines primarily describe production processes, while the third, “Acoustics”, focuses on communication means. Thus, it is clear that although the texts embody specialized areas of scientific and technical discourse, their thematic concepts (as well as terminology) are entirely different. Under these unequal conditions, the lexical-semantic, syntactic, and statistical properties of the word ‘flow’ are determined. The total volume of the text corpora amounted to 600,000 tokens, a sufficiently representative figure for the study of speech phenomena. Webster’s normative dictionary is used as the language system capturing the semantic structure of the word ‘flow’. A thorough contextual analysis is used to identify lexical and semantic variants of meanings. These lexical and semantic variants are then compared to the meanings of definitions in the normative dictionary, determining whether they coincide or differ. To describe the syntactic features of the word ‘flow’, contextual analysis is also used to distinguish the basic models in which this word functions, they are eight. The results of the study show that the word ‘flow’ in the texts of the three specialties embodies, although not all, but the main meanings recorded in the normative dictionary definitions. The results also demonstrate that all meanings can be attributed to the general scientific lexical layer. Syntactic characteristics are determined using statistical methods

for counting the occurrence of the word ‘flow’ in each of the syntactic models. Of the eight syntactic models found in the texts “Automation of Thermal Power Processes” and “Chemical Engineering” specialties, the word ‘flow’ appears in all models, although the frequency is lower in the “Chemical Engineering” texts. In the acoustics texts it appears in only four of the eight models.

ЛЕКСИКО-СЕМАНТИЧНІ, СИНТАКСИЧНІ ТА СТАТИСТИЧНІ ХАРАКТЕРИСТИКИ СЛОВА ‘FLOW’ У ТЕКСТОВИХ КОРПУСАХ НАУКОВО-ТЕХНІЧНОГО ДИСКУРСУ

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Ключові слова: *лексико-семантичний варіант, дефініція, статистика, слововживання, контекстуальний аналіз.*

У цій статті розглядається семантична структура англійського іменника ‘flow’, якій зустрічається в текстах, що стосуються науково-технічного дискурсу. Наявність реальних текстів дозволяє реалізувати дихотомію «мова-мовлення». Використаним матеріалом є текстові корпуси з трьох технічних спеціальностей: «Автоматизація теплоенергетичних процесів», «Хімічна інженерія» та «Акустика». Тексти з перших двох спеціальностей переважно описують виробничі процеси, тоді як третя, «Акустика», зосереджена на засобах комунікації. Таким чином, очевидно, що хоча тексти втілюють спеціалізовані галузі науково-технічного дискурсу, їхні тематичні поняття (а також термінологія) є абсолютно різними. За цих нерівних умов визначаються лексико-семантичні, синтаксичні та статистичні властивості слова ‘flow’. Загальний обсяг текстових корпусів склав 600 000 слововживань, що є достатньо репрезентативним показником для вивчення мовленнєвих явищ. Як мовна система, що фіксує семантичну структуру слова ‘flow’, використовується нормативний словник Webster. Для виявлення лексико-семантичних варіантів значень використовується ретельний контекстуальний аналіз. Потім ці лексико-семантичні варіанти порівнюються зі значеннями дефініцій в нормативному словнику, визначаючи, чи вони збігаються, чи відрізняються. Для опису синтаксичних особливостей слова ‘flow’ також

використовується контекстуальний аналіз, що дозволяє виділити основні моделі, в яких функціонує це слово, їх вісім. Результати дослідження показують, що слово ‘flow’ в текстах трьох спеціальностей втілює, хоча й не всі, але основні значення, зафіксовані у дефініціях нормативного словника. Результати також демонструють, що всі значення можна віднести до загальнонаукового лексичного шару. Синтаксичні характеристики визначаються за допомогою статистичних методів підрахунку входження слова ‘flow’ у кожну із синтаксичних моделей. З восьми синтаксичних моделей, знайдених в текстах спеціальностей «Автоматизація теплоенергетичних процесів» та «Хімічна інженерія», слово ‘flow’ зустрічається у всіх моделях, хоча частота нижча в текстах спеціальностей «Хімічна інженерія». В текстах з акустики воно зустрічається лише у чотирьох з восьми моделей.

Problem statement. Modern linguistics is largely characterized by the use of the dichotomous “language – speech” pair in experiments. The availability of standard dictionaries and, simultaneously, text corpora based on real texts, allows not only to realize this dichotomy but also to trace the interdependence of these linguistic aspects in the development of linguistic and speech units.

The phenomenon of polysemy in this process is one of the main factors influencing the emergence of new and the disappearance of old norms of word usage in speech and language [Frazier, Reyner, 1990; Goddard C., Wierzbicka, 2002; Lyons, 1977]. Therefore, to obtain reliable results when describing the semantic components of text units likely to be included in a future dictionary entry, it is necessary to strictly adhere to statistical [Mańczak, 2000] and contextual [Кочерган, 1980] methods of analysis. Only through examples and the counting of text units and phenomena can one provide the appropriate evidence base.

One of the key issues to consider when selecting text samples for future analysis is stylistic features. Therefore, a strict distinction is made between the semantics of lexical units in texts belonging to different types of discourse [Wilson, Hartley, Sharoff, & Stephenson, 2010; Pustejovski, 1991].

While in colloquial speech or fiction, many verb meanings remain vague, their use relying on the interaction of characters or the author's distinctive style (and sometimes this ambiguity is not resolved by either micro- or macro-context), in technical texts, the realization of word meanings is subject to the specific patterns of functioning of a particular scientific discipline. This is due to the type of discourse itself, which is subordinated to a single goal: the precise and systematic presentation of scientific issues in order to communicate new research results and to substantiate certain propositions, hypotheses, and arguments.

Thus, the semantics of lexical units in specialized texts describing technical fields and referred to scientific and technical discourse has a number of specific features, as evidenced by the presented analysis of the polysemantic word ‘flow’, considered in text corpora of several specialties.

It has been established that there is a tendency toward a direct proportional ratio between word frequency and its qualitative characteristics [Klein, 2001]. Qualitative characteristics typically include the following criteria: polysemy, the ability to form words, compose words, and form phraseological units. Of all these criteria, polysemy is the most indicative for verb lexemes in the texts “Acoustics”.

In determining the lexical and semantic characteristics of the noun ‘flow’, methods of contextual analysis, statistical methods for calculating the frequency of occurrence of a word in texts, as well as determining the belonging of the lexical unit to the lexical layer were used: commonly used, general scientific or terminological.

Goal of article. The aim of the work is to describe the lexical-semantic, syntactic and statistical characteristics of the noun ‘flow’, functioning in texts referred to scientific and technical discourse.

Basic material. The subject of this work is corpus linguistics and its units.

The object is one of the elements of a text corpus and its main characteristics.

To achieve the goal, the following tasks must be completed:

– to select three specialties related to scientific and technical discourse for study: two of them have virtually identical thematic problems, and the third has no common topics with the other two;

– to compile a set of texts from the three specialties related to scientific and technical discourse;

– to develop probabilistic-statistical models (frequency dictionaries) for the three specialties;

– to divide the entire set of model lexemes into lexical layers: common, general scientific, and terminological;

– to select a lexeme from the general scientific layer of vocabulary that may be common to all technical specialties;

– to analyze its (lexeme) lexical-semantic, syntactic and statistical characteristics in order to obtain

the stylistic markers and form conclusions probably common for all specialties of scientific and technical docourse.

The primary material for analyzing the semantic structure of the word 'flow' is the text corpora compiled from the texts on three disciplines: “Thermal Process Automation” (TPA), “Chemical Engineering” (CE), and “Acoustics” (Ac). As we can see, all of them belong to the scientific and technical discourse type. The most attractive characteristic of this choice is the significant difference in the thematic issues addressed by these three disciplines. While “Thermal Process Automation” (TPA) and “Chemical Engineering” (CE) share a certain focus on production processes, acoustics issues are related exclusively to communication means and the various devices that support such communications. Therefore, analyzing the word 'flow' in texts of these thematically different disciplines can lead to some general conclusions.

Each of the text corpora contains 200,000 tokens. Thus, the total text volume is 600,000 tokens, which is sufficient to consider this set of texts statistically representative. The frequency parameters of the word 'flow' in the three text corpora are as follows: “Thermal Process Automation” (F = 510), “Chemical Engineering” (F = 464), and “Acoustics” (F = 19).

Webster's Standard Dictionary (2002) is used as a linguistic system. The consolidated list of dictionary definitions of possible lexical-semantic variants (LSV) of the noun 'flow', realized in the texts, contains 10 units.

Flow

1: an act of flowing

2: flood sense: the tide's ebb and flow

3a: a smooth uninterrupted movement or progress: a flow of information

b: stream

also: a mass of material which has flowed when molten: an old lava flow

c: the direction of movement or development: go with the flow

4: the quantity that flows in a certain time: a gauge that measures fuel flow

5: menstruation

6a: the motion characteristic of fluids

b: a continuous transfer of energy

7: chiefly African American English: a rapper's lyrical delivery as characterized by cadence, speed, volume, rhyme, etc.: Having a great flow is the skill that can elevate an average rapper to a highly talented one. – Robby Seabrook III

An analysis of industry dictionaries for these specialties and verification of their results using contextual analysis conducted on texts from the technical fields of TPA, HM, and Ac allows us to identify the lexical semantic variants that comprise the semantic structure of the noun 'flow', realized in the texts.

Now we present the lexical semantic variants of the word 'flow' realized in texts from the three specialties (the lexical semantic variants are presented in descending order of frequency of occurrence in the texts). TPA: 1) consumption; 2) stream; 3) supply; 4) flowing, passage. CE: 1) stream; 2) jet; 3) consumption; 4) flowing, passage; 5) supply; 6) circulation. Ac: 1) flowing, passage; 2) stream.

Let's compare the semantic structures of the word 'flow' recorded in real texts of three specialties with those from Webster’s dictionary. Dictionary definition (1), which represents the etymologically original meaning of this word, “an act of flowing,” corresponds to the semantic structure of this noun in TPA texts (LSV4): “*They require power (either battery or line energization) for operation and, to be effective, must be located in the smoke (or ionized gas) flow path*”;

LSV4 XM: “*After flowing over the dam, the granules are cooled in the cooling section of the drum by cold air and passed through the drum countercurrent to the flow of solids*.”

As for the texts on acoustics, the definition (1) of the Webster’s dictionary corresponds to the LSV1 semantic structure of the word ‘flow’: “*Adjusting the weights permits the control of gain and phase on the signal flow paths from each antenna element to the system output at many points in the frequency domain*.”

In terms of the use of lexical-semantic variants in the texts of the specialties under consideration, it is worth noting some overlap between the semantic structure of the word 'flow' (LSV3) in the texts of the specialties TPA and the semantic structure of the same noun (LSV2) in the texts on chemical engineering (LSV5 and LSV6) with the definition unit (1) of Webster's dictionary. This definition unit can be considered an invariant, combining the meanings of the aforementioned LSVs as variants. The relationship between invariant (1) and its variant values LSV3 (TPA), LSV2 (CE), LSV5 (CE), and LSV6 (CE) is one of general-to-specific, which allows us to conclude that this LSV has a broad conceptual basis or its synsemantic nature, i.e., the ability of the word 'flow' as a linguistic unit to express a specific meaning only in combination with other linguistic units or against the background of context. This criterion is confirmed in the texts in these areas of technology. For example, “*Any increase in fuel flow or decrease in air flow at this point would produce an explosive fuel-rich condition in the furnace*” (TPA specialty); “*The flow controller is set at a predetermined flow above the point at which the machine will surge*” (CE specialty). Here, each meaning of the word 'flow' is specified only by context.

Although LSV1, LSV4 in TPA texts; LSV1, LSV2, LSV5, and LSV6 in CE texts are nearly identi-

cal in meaning, they have the right to a separate, independent existence, as they provide the opportunity to express additional, distinct nuances characteristic of the described processes and phenomena in the TPA and CE domains. Such a phenomenon is entirely possible. A new use of a word, which initially does not represent a distinct LSV, can, over time, in a given situation or context, develop a new meaning and create a new lexical-semantic variant.

Of particular interest is the Webster's dictionary definition (4), "the quantity that flows in a certain time," as it almost entirely corresponds to the LSV1 semantic structure of the noun 'flow' in TPA texts and the LSV3 semantic structure of this word in chemical engineering texts, as evidenced by the following examples:

"*Any increase in fuel flow or decrease in air flow at this point would produce an explosive fuel-rich condition in the furnace*" (TPA specialty);

"*A flow diagram illustrating the application of Allied Chemicals SO2 reduction technology to a roaster gas such as that at Falconbridge is shown in Figure 1*" (Chemical Engineering specialty). Webster's dictionary definition (4) is not found in acoustics texts.

Regarding the dictionary definition (6a) "the motion characteristic of fluids" in the normative dictionary, it also coincides with LSV2 of the semantic structure of the noun 'flow' in TPA texts, for example,

"*The turbo furnace program accurately models radiation at transfer through the entire volume/ including the effects of recirculation and turbulent flow on pulverized coal combustion kinetics*";

"Acoustics" "*The technique may be applicable in cases where electronic noise, structural (platform) noise, or flow noise contribute to the degradation of detection performance."*

LSV1 in HM texts, for example, "*It appears to be extremely difficult to make experimental observations without interfering with flow patterns*."

The dictionary definition (3b) "stream; also: a mass of material which has flowed when molten: an old lava flow" is supported by lexical-semantic variants encountered in the texts and, according to the context, forms the invariants LSV2 and LSV4 in texts on the specialty of TPA; in texts on the specialty of CE – LSV1 and LSV2: "*A rotating camera used to observe fluid flow patterns in a disc centrifuge confirmed the existence of large vortices in the flow*"; in the texts on acoustics – LSV2.

Thus, all of the above allows us to conclude that the semantic structure of the noun 'flow', presented in Webster's normative Dictionary as definitions, is reflected in the texts of three specialties–TPA, CE, and Ac–as lexical-semantic variants quite comprehensively, in accordance with their (specialties') thematic concerns. Lexical-semantic variants corresponding to definitions (1), (3b), 4, and 6(a) are used with a fairly high frequency in the texts.

In terms of the word 'flow' assignment to a particular lexical layer, it is clear that the examples provided, describing the functioning of the lexical unit in the texts on the specialties TPA, CE, and Ac, indicate that it (the word 'flow') primarily exhibits features characteristic of units of the general scientific lexical layer. Firstly, it is found with high frequency in texts from virtually all technical specialties; secondly, its level of terminology is quite low, which precludes its classification as a term included in the terminology systems of technical specialties to denote any concept. However, this also precludes its classification as a common lexeme, since the examples provided represent it as an element of phrases that describe technical and production processes.

The remaining definitions do not demonstrate the meanings necessary to describe the phenomena, processes, and devices described in the texts of the specialties "Automation of Thermal Processes," "Chemical Engineering," and "Aciustics." The hierarchy of definitions recorded in the standard dictionary is not identical to the hierarchy of lexical-semantic variants expressed in the frequency values of use in the texts.

The lexical-syntactic collocation of the word 'flow' is represented by the following eight models (the models are shown in descending order of frequency). Let us recall the frequency values of occurrence of the word 'flow' in the texts of these specialties: "Thermal Processes Automation" (F = 510), "Chemical Engineering" (F = 464), and "Acoustics" (F = 19).

In TPA texts, this word most often functions in the NN pattern (noun + noun; the second noun is 'flow'), F = 210, e.g., *fuel flow, leakage flow, gas flow*, etc.

The next according to the frequency of use in TPA texts is NN pattern (noun + noun; the first noun is the word 'flow'), e.g., *flow pattern, flow model, flow surge*, etc., F = 107.

The VN pattern (verb + noun), e.g., *orient the flow, control the flow, determine the flow*, etc., ranks third in frequency, F = 75.

The fourth most frequent pattern is the AN pattern (adjective + noun), e.g., *poor flow, low flow, left flow*, etc., with an F = 60 occurrences.

Next is the NprepN pattern (noun + preposition + noun (the word 'flow')), e.g., *oxygen in the flow, leakage in the flow*, etc. The frequency of occurrence in ATP texts is F = 22.

The NV pattern (noun + verb), e.g., *the flow decreases, the flow runs*, etc., has an occurrence frequency 13.

In the two patterns prepN (preposition + noun), e.g., *for the flow, in the flow*, etc., with an F = 11, and NprepN (noun (the word 'flow') + preposition + noun), e.g., *flow for decrease*, etc., the noun 'flow' has the same occurrence value in TPA texts, F = 11.

In the texts on the specialty CE, the noun ‘flow’ functions in the following syntactic models.

The word ‘flow’ is used most frequently in the NN (noun + noun) model; the first noun used in the attributive function is the word ‘flow’, e.g., *flow structure, flow rate, flow speed*, etc., F = 119.

The next most frequent occurrence of the noun ‘flow’ in syntactic models is the NN (noun + noun) model (the noun ‘flow’ is used the second), e.g., *distribution flow, leakage flow, air flow*, etc., F = 113, the word ‘flow’ is used 113 times in this model.

The AN (adjective + noun) model is also quite frequent, e.g., *slow flow, huge flow, unstable flow*, etc., F = 101, the word 'flow' is used 101 times in this model.

Compared to the texts on the TPA specialty, it can be noted that for chemical engineering production processes, the presence of a variety of adjectives defining flow characteristics is very important. This is how the flow and its properties are monitored and information related to its stability and the stability of the entire production process is conveyed.

The next most frequent occurrence of the word 'flow' is the NprepN model (noun + preposition + noun (with 'flow' last), e.g., *diagram for flow, path for flow, structure of flow*, etc., F = 40 units.

The VN model (verb + noun), e.g., *control the flow, determine the flow*, etc., F = 33, the word 'flow' is used 33 times in this model.

The NprepN pattern (noun ('flow') + preposition + noun), e.g., *flow for product, flow in the process*, etc., F = 31.

The NV model (noun + verb), e.g., *the flow strengthens, the flow stops*, etc., F = 15.

The prepN model (preposition + noun), e.g., *under the flow*, etc., F = 12.

Syntactic models that contain the word ‘flow’ in the “Acoustics” texts.

The NN model (noun (the word ‘flow’) + noun), e.g., *flow characteristics, flow control*, etc., F = 8 units.

The AN model (adjective + noun), e.g., *stable flow*, etc., F = 5.

The NN model (noun + noun ('flow'), e.g., *signal flow*, F = 4.

The NprepN model (noun ('flow') + preposition + noun), e.g., *flow for verification*, etc., F = 2.

In the NprepN, NV, VN, and prepN models, the word 'flow' is absent from the texts on the “Acoustics” specialty, and is present in only four models, i.e., half of all the models fixed.

Conclusions. The results of the analysis of the lexical-semantic, syntactic, and statistical characteristics of the noun 'flow', which appears in the texts on three specialties – “Thermal Power Processes Automation,” “Chemical Engineering,” and “Acoustics” – revealed the following.

1. The semantic structure of the noun 'flow', comprising 10 dictionary definitions, is embodied in four LSVs in the texts of the aforementioned specialties, which, however, defined the primary, fundamental meanings of this word. The hierarchy of LSVs also differs significantly from the hierarchy of definitions recorded in the standard dictionary.

2. Based on their lexical meanings, all LSVs of the word 'flow' can be classified as units of general scientific lexical layer, since this word is found in virtually all texts related to scientific and technical discourse and is not included in the nomenclature of terms of any of the specialties under consideration.

3. The study of the syntactic models in which the word 'flow' occurs reveals the presence of eight of the most common distributional models, which function in the texts with a relatively high frequency. The most frequent of these, in which the word 'flow' is realized in three text corpora, are the following: NN, NN, AN, and NprepN. If we consider the realization of the word 'flow' in the syntactic models in each of the text corpora, it can be noted that all eight models are found in the texts specializing in TPA. All eight models are also realized in the texts specializing in CE, albeit with more modest frequency values. In the texts on acoustics, only four of the eight models are found, which is explained by the absence of production situations, processes, and devices in the description of which the word 'flow' could be used.

Further scientific work will be devoted to the study of text units functioning in corpora of other specialties referred to scientific and technical discourse, which will contribute to a better understanding of the cognitive process of engineering text authors.

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