Purpose and Idea: a Lesson Drawn from Machine Translation[1]

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Résumé

L'article traite des problèmes de l'analyse syntaxique des textes en langage naturel dans les systèmes de traduction automatique. Une attention particulière est attachée à la qualité de la description syntaxique des langues de travail. Il est affirmé qu'aucun analyseur, aussi sophistiqué qu'il soit, n'est pas exempt de lacunes. Il en est ainsi parce que beaucoup de phénomènes linguistiques, qui jouent un rôle critique dans l'analyse syntaxique, n'ont jamais été pris en considération par les linguistes pour la simple raison qu'ils ne disposaient pas de matériaux linguistiques, résultant d'une analyse syntaxique erronée ou extravagante. Or des matériaux pareils sont produits en abondance par les systèmes de traitement automatique du langage naturel (TALN) de haut niveau. A condition de les traiter correctement ces matériaux peuvent aider à identifier les lacunes d'un analyseur et à les éliminer. Par conséquent, l'expérimentation dans le cadre de TALN devient un instrument très efficace, qui ouvre de nouvelles perspectives devant ceux qui s'occupent de la recherche linguistique. On pourrait même dire que les recherches appliquées commencent à stimuler le développement de la théorie linguistique, inversant ainsi les rôles dévolus traditionnellement à la science fondamentale par rapport à la science appliquée dans le TALN. Pour illustrer cette tendance un type particulier de la proposition copulative composée en langue russe est analysé en détail. Un nouveau type de traits syntaxiques est introduit pour traiter telles propositions de façon appropriée.

Abstract

The paper discusses certain problems of natural text parsing that emerge during the operation of a machine translation system. Emphasis is laid on adequacy of syntactic description of the

working languages. It is claimed that no parser, however sophisticated, can be made completely free of lacunae. The reason is that many of the linguistic facts, critical for parser operation, have never come into view of researchers because they have not had at their disposal mass material of unexpected or incorrect parsing. It is exactly such material that is abundantly provided by the output of a highly developed NLP system. If handled properly, this material helps the researcher to locate the gaps of linguistic descriptions and eliminate them. Consequently, linguistic experimentation with NLP systems becomes a rightful and very promising scientific method. In a way, linguistic applications start to stimulate theoretical research, thus inverting the situation that has existed ever since NLP came to life. To substantiate this standpoint, a specific type of Russian copulative compound sentences is considered in detail. A new type of syntactic feature is introduced in order to adequately handle such sentences.

Keywords – Mots Clés

1   Introductory Remarks

This theoretical paper was stimulated by mass experiments with a machine translation system, ETAP-3 (Apresjan *et al*. 1989, Apresjan *et al*. 1993), which is being developed in Moscow by the Laboratory of Computational Linguistics with the active participation of the author. In a recent paper (Iomdin 2002), I tried to show that the output of an MT system contains unique and exceedingly valuable negative linguistic material, which can be used to reveal remarkable linguistic phenomena. In what follows I will discuss one such phenomenon.

In the course of experimental exploitation of the Russian-to-English module of the ETAP-3 MT system, it was asked to translate various short texts, in particular, newslines published in the Web by news agencies, such as ITAR-TASS, Reuters, BBC etc. Any newsline is a constantly updated flow of short messages about politics, economics and culture. As a rule, these messages consist of one or two sentences written in the stylistically neutral journalistic style. From the viewpoint of system development and testing, such a newsline appears to be an ideal source of experimental material. Despite their lexical and syntactic variety, the texts normally stay well within the modern literary standard, hardly use any exotic locutions or cumbersome syntax, and can be considered as being moderately complex. It is all the more surprising that when processing such texts the linguist is faced with the phenomena that have not been adequately described in the grammar and/or the dictionary.

2   A Lesson in Syntax and Lexicography

Last spring, the ITAR-TASS newsline published the following "news" message:

(1) *Glavnaja cel' Velikogo posta, kotoryj načalsja dlja pravoslavnyx – nravstvenno vozvysit'*
      main   purpose   great fasting   which   began   for   Orthodox   morally   elevate

   cheloveka
     human

'The main purpose of the Lent (lit. 'Great fasting') that has begun for the Orthodox is to elevate a person morally'.

The English translation that the ETAP-3 system produced for (1) was, surprisingly, inadequate and ungrammatical:

(1a) **The main purpose of the Lent that has begun for the Orthodox – it is moral to elevate a person.*

2.1 Erroneous Parsing

What are the sources of the system's error? The answer to this question, which in my opinion is very interesting and far from trivial, will constitute the main content of the paper.

One of the sources of the translation error is quite obvious and could be detected at once. The parser treated the syntactically ambiguous right-hand part of the copulative sentence (1), namely

(2) *nravstvenno vozvysit' čeloveka*

as a full sentence with an infinitive subject and a zero copula: 'to elevate a person is moral', rather than an infinitive clause 'to morally elevate a person'. Indeed, the syntactic structure (SyntS) produced by the ETAP-3 parser for (1) looked as follows[2]:

(1′)

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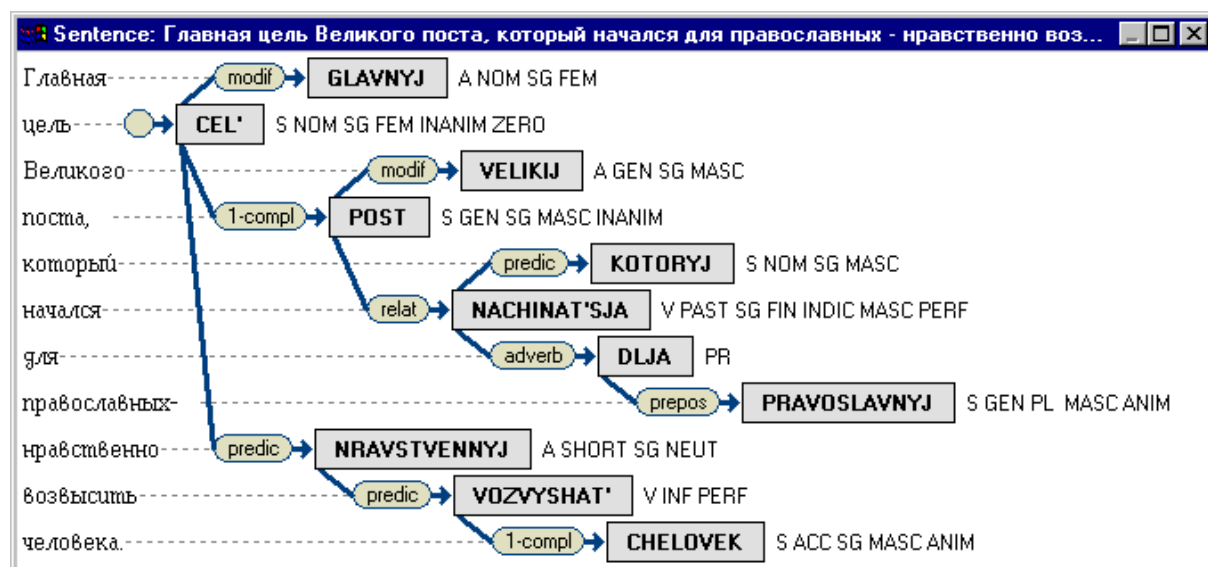
[2] We are using here syntactic dependency structures of sentences as they are understood by Igor Melčuk's Meaning ⇔ Text theory (Melčuk 1974). The ETAP-3 MT system is largely based on MTT. Structures (1′) and (1″) below have been transliterated to facilitate the understanding to readers who do no know Cyrillics.

Here, the circle denotes the top node of the tree, ovals contain names of syntactic relations, rectangles represent names of lexemes, followed by part-of-speech labels and morphological features. As a matter of fact, SyntS (1′) even contains two zero copulas: *Glavnaja cel' Velikogo posta* $\varnothing_{be}$ *... nravstvenno* $\varnothing_{be}$ *vozvysit' čeloveka* (lit. The main purpose of the Lent IS: to raise a person IS moral). The fact that neither of the zero copulas are presented in (1′) is of purely technical nature. It is explained by some of the particularities of the ETAP-3 parsing algorithm and need not be discussed here.

Interestingly, the syntactic ambiguity of text fragment (2), namely, the possibility to parse it as an infinitive clause or a full predicative sentence, is accounted for by an interplay of a number of lexical and syntactic factors and may be viewed as a lucky coincidence. In the absence of the ambiguous word *nravstvenno* (which can belong to the paradigm of an adverb 'morally' or an adjective 'moral', where it is the singular neutral short form), as in

(3a) *Glavnaja cel' Velikogo posta, kotoryj načalsja dlja pravoslavnyx – vozvysit' čeloveka.* 'The main purpose of the Lent that has begun for the Orthodox is to elevate a person'

or in the case where this adverb would be replaced by a close synonym *etičeski* 'ethically' or *duxovno* 'spiritually'[3], as in

(3b) *Glavnaja cel' Velikogo posta, kotoryj načalsja dlja pravoslavnyx – etičheski < duxovno vozvysit' čeloveka.* 'The main purpose of the Lent that has begun for the Orthodox is to elevate a person ethically <spiritually>,

the right-hand part of the sentence would lose its ambiguity, it could not be interpreted sententially, and we would be deprived of the object of the present investigation.

So, the first source of the erroneous parsing is the ambiguity of the second part of the copulative sentence (1). We now have to explain why this ambiguity does not extrapolate to the whole sentence, i.e. why (2) as the second part of (1) does not allow for a sentential interpretation and can only be treated as an infinitive clause. Is it not the case that copulative sentences, either in Russian or in English, cannot contain full predicative clauses as their integral part? Of course they can. Moreover, we can easily construct an immaculate copulative sentence of this kind if we introduce a minimal lexical change to (1), namely, if we replace the noun *cel'* 'purpose' with another noun, *ideja* 'idea':

(4) *Glavnaja ideja Velikogo posta, kotoryj načalsja dlja pravoslavnyx – nravstvenno vozvysit' čeloveka.*

In contrast to unequivocal sentence (1), the above sentence (4) is syntactically ambiguous and can be interpreted as having a predicative clause or an infinitive clause in the right-hand part. Since, in contradistinction to Russian, English does not have an ambiguity similar to that illustrated by (2) (because it does not use a zero copula.), the two readings of (4) must be translated differently:

(4a) *The main idea of the Lent that has begun for the Orthodox is that it is moral to elevate a person;*

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[3] To be more precise, the adverb *etičeski* is not ambiguous at all while the adverb *duxovno* is homonymous with the adjective *duxovnyj* 'spiritual', which, however, cannot be used in constructions similar to (2): sentences like **vozvyshat' cheloveka – duxovno* (lit. 'it is spiritual to elevate a person') are ungrammatical.

(4b) *The main idea of the Lent that has begun for the Orthodox is to elevate a person morally.*

Sentence (4a) contains a predicative clause and (4b) an infinitive clause. Unlike (1a), both translations (4a) and (4b) are acceptable and both are grammatically correct (I prefer not to dwell on the issue of their sacral value).

It can thus be seen that SyntS like (1′), namely, SyntS of copulative sentences whose left-hand part is a nominal phrase and whose right-hand part (following the copula) is a predicative clause are not configurationally wrong.[4] Their acceptability depends on lexical instantiation of the head noun of the left-hand NP, and a thorough investigation will enable us to determine which lexical instantiation is admissible in (1′) and which is not.

2.2   Two Syntactic Features

In particular, if the NP part of the copulative sentence is formed by predicate nouns like *cel'* 'purpose, aim, goal, target', *naznačenie* 'destination', *prednaznačenie, missija* 'mission', *namerenie* 'intention', *stremlenie* 'ambition, aspiration', *prizvanie* 'vocation', *želanie* 'wish', *strast'* 'passion', *zadača* 'task', *problema* 'problem', the SyntS of type (1′) will remain faulty.

In order to be correct, the second part of the copulative sentence with such an NP must be an infinitive clause, as in (4), (5), or (7-8), a nominal phrase (as a rule, it must be formed by another predicate noun, as in (6)), or a subordinate clause with the conjunction *čtoby* 'so that', as in (9), but never a predicative clause —— even if such a clause contains a modal verb which might compensate for the infinitive or ČTOBY-clause. Cf.

(5) *Naša cel' - ustanovit' istinu* 'Our purpose is to establish the truth'

or

(6) *Naša cel' - ustanovlenie istiny* 'Our purpose is the establishment of the truth'

but not **Naša cel' – istina dolžna byt' ustanovlena* (lit. Our purpose is: the truth must be established',

(7) *Velikim knjaz'jam i ne nužno teper' imet' v Novgorode priveržennuju k sebe storonu; ix cel' - rano ili pozdno uničtožit' samostojatel'nost' Novgoroda* 'The Grand Dukes do not need to have a loyal party in Novgorod, their purpose is to destroy Novgorod's independence sooner or later' (Sergey Solovyov),

but not **...ix cel' - rano ili pozdno nužno uničtožit' samostojatel'nost' Novgoroda* '… their purpose is: one needs to destroy Novgorod's independence sooner or later'

(8) *Osnovnoju moej cel'ju bylo vse-taki otvleč' Axillesa ot razgovora o Xarone* 'Still, my basic purpose was to distract Achilles from the talk about Charon (Arkady and Boris Strugatsky),

but not **Osnovnoju moej cel'ju bylo: Axilles dolžen otvleč'sja ot razgovora o Xarone* 'My basic purpose was: Achilles must be distracted from the talk about Charon;

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[4] In my opinion, the NP is most likely the p r e d i c a t e of such a copulative sentence rather than its subject, while the predicative clause part is its s u b j e c t . Detailed validation of this opinion lies beyond the scope of this work; suffice it to say here that the NP part of the sentence can be in the instrumental case, as in example (8) below, which is extremely untypical for a subject.

(9) *Glavnaja cel' - čtob sosedi ne videli* 'the main purpose is that the neighbours should not notice' (Vasily Aksenov)*,*

but not **Glavnaja cel' - sosedi ne uvidjat* 'the main purpose is: the neighbours will not notice'.

On the other hand, the copulative construction with the sentential second part will be perfect if its first NP part is formed by a sufficiently broad class of nouns, such as *ideja* 'idea'*, mysl'* 'thought'*, smysl* 'meaning'*, pafos* 'pathos, spirit'*, posylka* 'premise'*, tezis* 'thesis'*, položenie* 'thesis, proposition'*, princip* 'principle'*, postulat* 'postulate'*, utverždenie* 'assertion, claim'*, vyskazyvanie* 'utterance, statement'*, lozung* 'slogan'*, deviz* 'motto'*, rezul'tat* 'result'*, itog* 'result, total'*, urok* 'lesson' etc. Cf. sentences like

(10) *Osnovnaja ideja konkursa - pust' pobedit sil'nejšij* 'The main idea of the competition is: let the strongest win';

(11) *Pervaja mysl' - vy zabyli, o čem vy razgovarivali* 'The first thought was – you forgot what you talked about' (Alexander Solzhenitsyn);

(12) *Čudnyj rezul'tat - pjatno taet, taet i isčezaet* 'A marvellous result: the stain is thinning out and disappears' (Mikhail Bulgakov);

(13) *Populjarnym lozungom brežnevskix vremen bylo - ekonomika dolžna byt' ekonomnoj* 'A popular slogan from the Brezhnev era was: the economy must be economic';

(14) *Važnyj urok stixotvorenija Pasternaka - byt' znamenitym nekrasivo* 'An important lesson of Pasternak's poem is: it is not seemly to be famous'*,*

etc.

Mutatis mutandis, these limitations also hold for English. In particular, all English nouns used as equivalents to Russian nouns of the first type (*purpose, aim* etc.) listed above do not allow for the copulative sentence at issue to have a predicative clause, whereas the nouns of the second type (*idea, thought, slogan* etc.) make such a sentence immaculate.

What is it that differs the nouns of these two lexical classes? It is my firm conviction that the differences between these classes (let them be called the "purpose" class and the "idea" class, respectively) cannot be explained away by semantics alone. In fact, semantic representations of both lexical classes have much in common. In particular, we can easily see that all nouns of the two classes are predicates that have a valency of content. In all examples above, this valency is instantiated by the second part of the copulative sentence, either a non-predicative clause, as in (5) to (9), or a predicative sentential clause, as in (10) to (14). Furthermore, in all cases the text fragment that implements this valency of content characterizes a particular situation.

I believe that in fact the difference in the behavior of the two classes is of syntactic nature. We can see that all nouns of the "purpose" class have a specific syntactic feature, **predinf**. Let it be reminded that this syntactic feature, fairly popular in the Meaning ⇔ Theory"[5], is assigned

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[5] The "predinf" feature as well as other features of the "pred" series were first introduced in Iomdin, Melčuk, Pertsov (1975) and have been widely used since in theoretical research and applications based on MTT. The English counterpart of "predinf" as introduced in ETAP-3 is "predto" if the infinitive to be used as subject must be preceded by the *to* particle; I do not distinguish between the two features in this paper.

to nouns (or adjectives, see below) that "govern" an infinitive through a real or zero copula, constituting such Russian and English constructions as *Dozvonit'sja na Kavkaz stalo celoj problemoj* [=predinf] 'It has become a serious problem to get somebody on the phone in the Caucasus', *Our primary goal* [=predto] *was to find the right operator; It was my greatest ambition* [=predto] *to please my father,* etc. Note that the infinitive clause instantiates the (semantic) valency of content of the respective nouns *problema* 'problem', *goal* and *ambition* in all these examples even though there is no direct syntactic domination of the infinitive on the part of the predicate noun. Since the noun *cel'* also possesses the "predinf" feature, the parse of sentence (1) as

(1″)
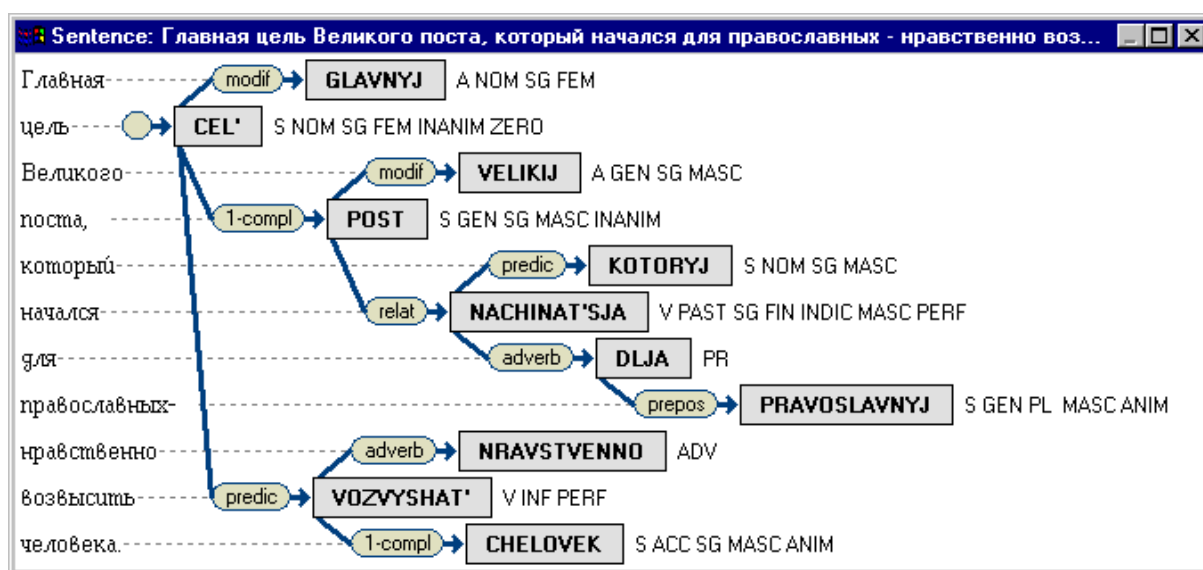
where the second part of the copulative sentence is interpreted as an infinitive clause, is perfectly correct.

Conversely, a correct SyntS like (1′), i.e. a copulative sentence with a predicative clause in the right-hand part, requires that the noun serving as the head for the NP in the left-hand part should possess a **different syntactic feature** that can be defined as the ability to govern a predicative clause through a real or zero copula. By analogy with "predinf" this feature may conveniently be called "**predsent**". No such feature has existed so far in the MTT or in applied NLP systems based thereon. Accordingly, no constraints could be imposed on the makeup of copulative sentences of the type discussed here, which resulted in the generation by the parsing of SyntS (1′) for sentence (1).

By assigning the "predsent" feature to nouns of the "idea" class and placing them in the relevant entries of the combinatorial dictionary, we will be able to formulate the respective constraints and introduce them into parsing rules. As a result, the construction of correct SyntS for sentences like (10) to (14) will become easy. On the other hand, since no "purpose" class nouns should be assigned this feature, the emergence of SyntS like (1′) will be prevented. We will also be able to explain away the ungrammaticality of sentences like

(1b) **Glavnaja cel' Velikogo posta, kotoryj načalsja dlja pravoslavnyx – vozvyšenie čeloveka javljaetsja nravstvennym*,

which is a backward translation of the wrong sentence (1a), as well as the unacceptability of phrases like **Naznačenie etoj pasty – ona xorošo očiščaet zuby* 'the purpose of this paste is: it cleans the teeth well', which occur quite often in uneducated oral and written speech. Last but not least, if we ensure that (1) is parsed as (1″), rather than (1″), we will be able to achieve a more adequate translation in the MT system:

(1c) *The main purpose of the Lent which has begun for the Orthodox is to elevate a person morally.*

2.3 Some Properties of the "Predsent" Feature

Unlike the "predinf" feature that is assigned not only to nouns but also to a great number of adjectives, such as *nravstvennyj* 'moral' (it is due to this feature that sentence (2) could be interpreted sententially)[6], the "predsent" feature in Russian is probably confined to nouns, even though, technically speaking, a few exceptions can be observed in the spoken language for adjectives, as in (15), and predicative adverbs, as in (16-17); cf.

(15) *Xorošo ja vovremja kruto vyvernul rul'* 'It's good I had time to turn the wheel sharply';

(16) *Žal', tebja tam ne bylo* 'Pity you weren't there'

(17) *Ladno by on prosto ušel* 'It would be good if he just left'.

As a matter of fact, (15) and (16) are the results of omission of the conjunction *čto* that introduces the subordinate clause and can thus be viewed as transformations of *Xorošo, čto ja vovremja kruto vyvernul rul* 'It's good that I had time to turn the wheel sharply' and *Žal', čto tebja tam ne bylo* 'It's a pity that you weren't there'. However, such omissions are extremely untypical for Russian unless the subordinate clause is directly dominated by a verb, as in *Ja znaju, čto ty menja ne ljubiš' → Ja znaju, ty menja ne ljubiš'* 'I know (that) you don't love me'. Besides, structures like (15) are subject to a number of further constraints. For instance, they are only possible with a zero copula (**Xorošo bylo ja vovremja kruto vyvernul rul'* 'It was good that I had time to turn the wheel sharply' is totally excluded), cannot be negated or questioned, possess a unique prosodic pattern and have a very peculiar semantics (they convey an idea of rescue or overcoming a difficulty, so that a sentence like *Xorošo u tebja bogataja biblioteka* 'Good you have a rich collection of books' is either infelicitous or else implies that the collection helped solve some urgent problem.

In English, the "predsent" feature is easier assigned to adjectives, cf. *It is interesting they didn't say anything about this, Funny you mention that, It was lucky she had that money on hand* etc.

Let it be emphasized that the two features, "predinf" and "predsent", are not mutually exclusive. While all nouns of the "purpose" class only have the former and not the latter feature, many nouns of the "idea" class must be assigned the "predinf" feature in addition to "predsent". These are Russian words like *ideja, princip, lozung, deviz* and its English equivalents *idea, principle, motto* etc., as in *Zamančivaja ideja – dobit'sja upravljaemogo termojadernogo sinteza'* 'It's an alluring idea to achieve controlled thermonuclear fusion'

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[6] In the combinatory dictionary of the ETAP-3 system, the feature is assigned to about 400 Russian and 700 English adjectives.

I would like to note that copulative identifying[7] sentences with the predicative clause is an example of an improper, mediated syntactic control of clauses by lexical units. Indeed, the ability of the "idea" class nouns to attach a predicative clause via a copula relates to the ability of nouns to directly govern a predicative clause (as in

(18) *Tezis "Bytie opredeljaet soznanie" byl predložen Marksom* 'The thesis "Being determines consciousness" was proposed by Marx')

in the same way as the ability of words with the "predinf" feature relates to direct control of infinitives. (compare sentences *His plan* [= predinf] *was to move to the capital* and *He announced his plan to move to the capital*). However, the correlation between a word having the "predsent" feature and this word's ability to directly dominate a predicative clause is much weaker than the correlation between the presence of the "predto" feature and direct control of an infinitive. While the latter correlation is doubtless (about half the words that have the "predinf" feature also subcategorize for an infinitive), words that subcategorize for a non-interrogative[8] predicative clause are few and they all probably require that the subordinated clause be graphically marked, as in (18). In any case, the phenomena of direct and indirect domination of predicative clauses must be described independently both in the grammar and in the ECD.

To conclude this small study, I would like to note that cases of improper control on the part of nouns are not confined to copulative identifying sentences. For instance, improper control of infinitives can often be observed in a variety of sentence types with specifications, as in (19-20):

(19) *Glavnaja cel' u oboix obščestv odna – vozrodit' moguščestvo zemnoj civilizacii* 'The main goal of both societies is the same – to resuscitate the power of the terrestrial civilization' (Arkady and Boris Strugatsky);

(20) *U nee byla kakaja-to strast' - lovit' vsex na slove, uličat' v protivorečii, pridirat'sja k fraze* 'She had a kind of a passion – take everyone on their word, catch them in contradiction, cavil at the phrase (Anton Tchekhov).

Another type of specifying sentences revealing improper control of the infinitive is represented by the sentences with an introductory *vot* 'this':

(21) *Byt' ili ne byt' – vot v čem vopros* 'To be or not to be, this is the question'.

The same types of specifying sentences reveal cases of improper control of predicative clauses:

(22) *U Bernarda Šou byla zamečatel'naja mysl': svoboda označaet otvetstvennost', poetomu mnogie ee tak bojatsja* 'Bernard Shaw had a splendid thought: Liberty means responsibility. That is why most men dread it'.

(23) *Zdorovyj platit za bol'nogo - vot glavnyj princip medicinskogo straxovanija.* 'The healthy man pays for the sick man – this is the main principle of medical insurance'

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[7] I am using the term as developed in Arutjunova 1976.

[8] A lexical unit's direct or indirect control of an interrogative sentence (*The question why he did not intervene is a very deep mystery* or *Where King moves is a big secret* – the latter is the title of a chess book) is a different linguistic phenomenon that has been thoroughly described in the syntactic part of MTT.

Interestingly, in such cases the nouns that indirectly control a predicative clause show a still more liberal behavior. So, neither of the two nouns '*cel'* 'purpose' and *strast'* 'passion' possess the "predsent" feature if this is to be defined from prototypical copulative sentences. However, both words acquire the respective controlling properties in sentences with specifications:

(24) *U vsex naučno-populjarnyx žurnalov odna strast' - oni propagandirujut nauku i soedinjajut ee s žizn'ju* 'All popular-science journals have one passion: they popularise the science and combine it with life';

(25) *My delaem gazetu dlja prodaži - vot naša cel'* 'We make the newspaper for sale – this is our purpose'.

It can easily be seen that the study of complex syntactic constructions with nontrivial subcategorization properties of lexical units that I had to undertake because of unsatisfactory performance of an MT system is far from being complete. Many of the things require further research and need a detailed explanation. However, the role of negative material produced by the machine is hard to overestimate.

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