Multilinguality in ETAP-3: Reuse of Lexical Resources

Igor BOGUSLAVSKY
Universidad Politecnica de Madrid
28660 Boadilla del Monte, Madrid, Spain
igor@opera.dia.fi.upm.es

Leonid IOMDIN
Institute for Information Transmission
Problems, Russian Academy of Sciences
19, B. Karetnyj
Moscow, GSP-4, Russia
iomdin@cl.iitp.ru

Victor SIZOV
Institute for Information Transmission Problems, Russian Academy of Sciences
19, B. Karetnyj
Moscow, GSP-4, Russia
sizov@cl.iitp.ru

Abstract

The paper presents the work done at the Institute for Information Transmission Problems (Russian Academy of Sciences, Moscow) on the multifunctional linguistic processor ETAP-3. Its two multilingual options are discussed – machine translation in a variety of language pairs and translation to and from UNL, a meaning representation language.

For each working language, ETAP has one integral dictionary, which is used in all applications both for the analysis and synthesis (generation) of the given language. In difficult cases, interactive dialogue with the user is used for disambiguation. Emphasis is laid on multiple use of lexical resources in the multilingual environment.

1   General Information on ETAP

The multifunctional ETAP-3 linguistic processor, developed by the Computational Linguistics Laboratory (CLL) in Moscow (see e.g. Apresjan *et al.* 1992a,b, 1993, 2003), is the product of more than two decades of laboratory research and development in the field of language modeling. The most important features of the processor are as follows.

(1) ETAP-3 is based on the **general linguistic framework** of the Meaning ⇔ Text theory, proposed by Igor Mel'cuk (e.g. Mel'cuk, 1974) and complemented by the theory of systematic lexicography and integrated description of language proposed by Jurij Apresjan [Apresjan 1995, 2000].

(2) ETAP-3 has a declarative organization of linguistic knowledge.

(3) One of the major components of ETAP-3 is the innovative combinatorial dictionary. Apart from syntactic and semantic features and subcategorization frames, the dictionary entry may have rules of 8 types. Many dictionary entries contain **lexical functions** (LF).

(3) ETAP-3 makes use of a formalism based on three-value predicate logic, in which all linguistic data are presented.

(4) The ETAP-3 processor has **a modular architecture**. All stages of processing and all types of linguistic data are organized into modules, which warrants their reusability in many NLP applications both within and beyond ETAP-3 environment.

At the moment, the ETAP-3 environment comprises the following main options: 1) a rule-based machine translation system; 2) a Universal Networking Language (UNL) translation engine; 3) a system of synonymous paraphrasing of sentences; 4) a workbench for syntactic annotation of text corpora; and 5) a grammar checker. All the applications make use of the same dictionaries, but only the first and the second are multilingual. In Section 2 we will discuss multilingual lexical resources used in machine translation, and in Section 3 – in the UNL module.

2   Multilinguality in ETAP

2.1   Structure of the Dictionary Entry

To support multilinguality, the dictionary entry of the ETAP dictionary has several sub-zones. There is one general zone and several zones oriented towards various languages. The general zone stores all types of monolingual information: part of speech, syntactic features, semantic features, subcategorization frames, lexical functions, syntactic and pre-syntactic rules, generation rules, and some other data. Each bi-lingual sub-zone serves for establishing

correspondence between the given language and another one (see Fig. 1).

For example, the Russian zone of an English dictionary entry contains all the information needed to translate English words into Russian, the Arabic zone provides translation into Arabic, etc. Conversely, the information needed to translate Russian words into English is stored in the English zone of the Russian dictionary entries.
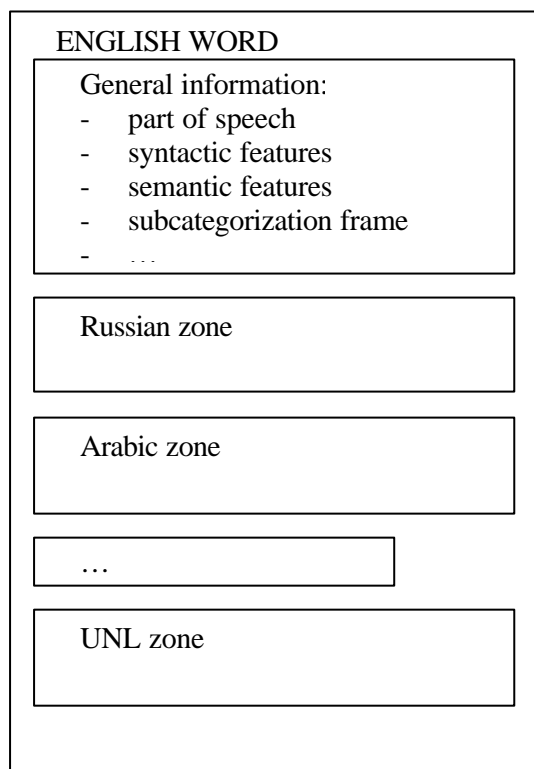
```
┌─────────────────────────────────────┐
│  ENGLISH WORD                        │
│  ┌────────────────────────────────┐  │
│  │  General information:          │  │
│  │  -   part of speech            │  │
│  │  -   syntactic features        │  │
│  │  -   semantic features         │  │
│  │  -   subcategorization frame   │  │
│  │  -   …                         │  │
│  └────────────────────────────────┘  │
│  ┌────────────────────────────────┐  │
│  │  Russian zone                  │  │
│  └────────────────────────────────┘  │
│  ┌────────────────────────────────┐  │
│  │  Arabic zone                   │  │
│  └────────────────────────────────┘  │
│  ┌────────────────────────────┐      │
│  │  …                         │      │
│  └────────────────────────────┘      │
│  ┌────────────────────────────────┐  │
│  │  UNL zone                      │  │
│  └────────────────────────────────┘  │
└─────────────────────────────────────┘
```

Fig. 1

2.2 Default and Specific Translation

The information stored in a bi-lingual zone consists of two parts: a default translation and lexical translation rules. Default translation is a single word that translates the given word in non-specific contexts (it is introduced by a special label: TRANS). Any other type of translation is carried out by means of rules. If the word is translated by a phrase consisting of several words, the rule shows how the words in the phrase are connected to each other and how this phrase is incorporated into the sentence. For example, in the entry *bachelorship* we find a reference to one of the standard translation rules (TRADUCT2.42). The slots of the rule are filled with specific lexical items, grammatical features or syntactic relations.

TRAF:TRADUCT2.42
LR1:STEPEN',LR2:BAKALAVR,T2:SG,
T3:QUASIAGENT

The rule says that *bachelorship* should be translated into Russian with a phrase consisting of two words – *stepen'* ('degree') and *bakalavr* ('bachelor'). These words should be connected by the quasiagent(ive) syntactic relation, and the number feature of *bakalavr* should be singular.

If the word is translated in a specific way in a specific context or in specific phrases, the rule describes this context and the resulting structure. When a word is translated, normally first the translation rules in its dictionary entry are tried. If no rule applies in the given sentence, then the default translation is used.

2.3 Multiple Translation

The default option of ETAP produces a single translation of the sentence – the one that corresponds to the first lexico-syntactic structure obtained by the parser. The option of multiple translation produces much more. First, it generates all lexico-syntactic structures that are compatible with the grammar and the dictionary. Since these structures are disambiguated both syntactically, and lexically, this set of structures contains all lexical variants for the source sentence. Then, for each structure all possible translation variants are tried. As is known, even disambiguated words can be translated into another language in different ways and it is not always possible to formulate a rule that could select an appropriate variant. For example, English *adjuration* can be translated into Russian as *mol'ba* and as *zaklinanie, adventurer* – as *avantjurist* and as *iskatel' prikljuchenij* (literally, 'adventure seeker'), *alarm* – as *trevoga* and as *avarijnyj signal* ('alarm signal'). In all these cases, we are most probably dealing with a single meaning of the English word and yet translation variants are not fully synonymous. Since we cannot choose among these variants by means of rules and at the same time do not want to lose any of them, we have to treat them as alternative translations to be activated in the "Multiple translation" option. As mentioned in the previous section, there are two types of translation devices in the bilingual zones of the dictionary: a default translation (a single word) and rules. In both cases, it is possible to provide alternative translations. For example, in the entry for *adjuration* alternative translations are listed in the default part since both of them are single words:

ADJURATION
…
TRANS: *MOL'BA / ZAKLINANIE*

If the user selects the "Single translation" option, only the first of these variants will be used. If

he/she wishes to get all possible translations and activates the "Multiple translation" option, both alternatives will be produced.

In the *adventurer* entry, the alternative translation *iskatel' prikljuchenij* should be introduced by a rule, since it is not a single word but a phrase. Such rules are supplied by a special marker, OPT(ional), which shows that the translation is alternative.

ADVENTURER
…
TRANS: *AVANTJURIST*
TRAF:TRADUCT2.42
OPT:1
LR1:*ISKATEL'2*,LR2:*PRIKLJUCHENIE*,T2:PL,
T3: ATTRIB

This is another instance of the same rule that we saw above in the *bachelorship* example: the only difference is that it introduces different words, connects them with a different syntactic relation (attributive) and generates a different number feature. The marker OPT:1 shows that the translation introduced by this rule is less common than the default translation *avantjurist* and should be presented to the user after it. Should it be otherwise, the rule would have the marker OPT:0 and have a priority over the default translation.

2.4 Interactive selection of the translation equivalent

It is well known that ambiguity of linguistic units is one of the most difficult problems in NLP. In ETAP there is no single stage of processing that expressly deals with disambiguation. The sentence is gradually disambiguated at different stages of processing on the basis of restrictions imposed by the linguistic knowledge of the system. However, in many cases this knowledge is not sufficient for complete disambiguation, since the understanding of a text by humans is not based on their linguistic knowledge alone. To cope with this problem, we are developing an interactive option that at certain pivotal points of text processing is expected to ask for human intervention and use human assistance to resolve those ambiguities that are beyond the scope of linguistic knowledge of the system (Boguslavsky et al 2003). It should be stressed that the interactive tool is only resorted to if an ambiguity cannot be resolved automatically and therefore requires human intervention. This work is in line with the approach proposed in a series of publications by the GETA group (Blanchon, 1995, 1996, 1997, Boitet & Blanchon, 1995).

As mentioned above, the dialogue with the user is activated at different stages of the processing depending on the tasks solved at each stage.

During the parsing, which results in the construction of the lexico-syntactic structure of the sentence, all lexical and syntactic ambiguity should be resolved. However, this is done entirely within the processing of the source language text and represents monolingual ambiguity. It is not directly relevant for our topic of multilinguality. Of relevance here are cases of the so-called translational (or transfer) ambiguity (Hutchins, Somers, 1992: 87). The source language words can be unambiguous for the native speakers of this language but can be translated by a number of different target language expressions. In this sense, they are ambiguous from the viewpoint of the target language and have to be dealt with at the translation stage. An example is the English verb *wash* with respect to Russian. It translates differently depending on the type of object that is being washed: if it is something made of cloth, for example clothes, a special verb has to be chosen. If the dictionary provides semantic information on what objects are made of, the correct choice of the verb can in principle be made automatically. Cf., however, cases like *We must wash it* where such information is definitely missing.

This must be viewed as a relatively inoffensive case, though, because most sentences will be translated correctly with the help of a simple rule (and if not, the mistake is not too important). There are many words for which it is much more difficult to write a disambiguation rule. A notorious example is English *blue* that corresponds to two Russian adjectives, one meaning 'light blue' and the other – roughly – 'dark blue'. The only way to translate this word correctly in most of the contexts is to get assistance from the user. The dialog with the user is based on the information stored in the dictionary and activated at the appropriate moment.

This is how the interactive disambiguation currently works. The sentence to be translated is entered in the upper window of the ETAP environment (Fig. 2)
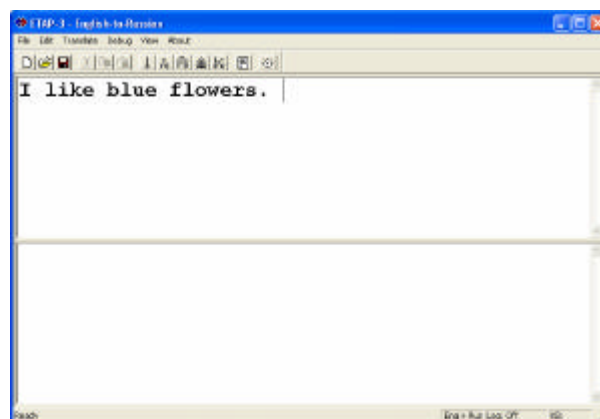
Fig. 2

When it comes to translating the word *blue,* the system finds that there are two options and no way to choose among them and activates the dialogue (Fig. 3).
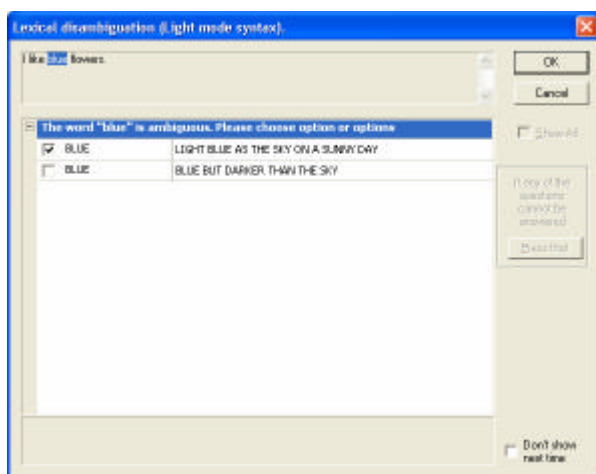

Fig. 3

In the dialogue box each option is provided with a short comment and/or example that helps the user choose among them. The user has to click the appropriate option (in Fig. 3 'light blue' is selected) and the system moves on. The result of the translation of this sentence is shown in Fig. 4.
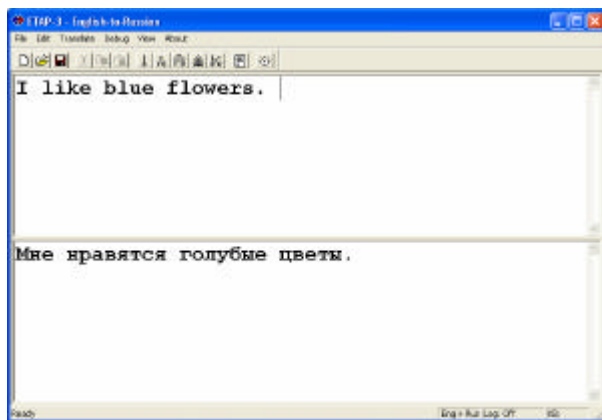

Fig. 4

Should we have selected the other option in the dialogue in Fig. 3, the result would have been different (Fig. 5).
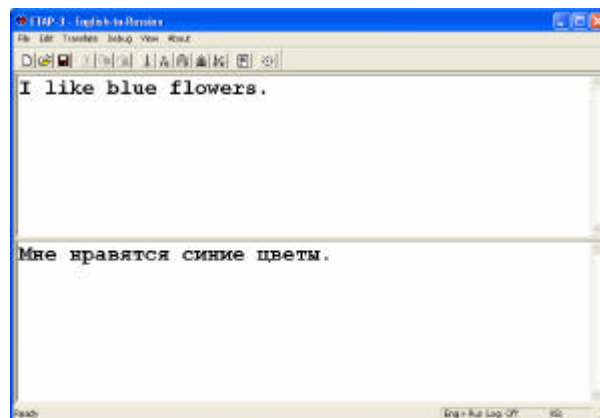

Fig. 5

It is important to note that the interactive disambiguation mode fully corresponds to the multiple translation possibilities discussed in the previous section. In particular, the dialogue takes into account all types of alternative translations irrespective of the way they are presented in the dictionary. It can be lexical or syntactic ambiguity that manifests itself in different lexico-syntactic structures of the source sentence, one-word translation variants within the same lexical meaning (of the *adjuration* type discussed above) or more complex phrases that translate a source word (of the *adventurer* type above).

3   UNL module in ETAP

One of ETAP-3 options is translation between Russian and the Universal Networking Language (UNL), put forward by H. Uchida of the United Nations University. Full specification of UNL and references to publications can be found at *http://www.undl.org.*

UNL is a formal language intended to represent information in a way that allows the generation of a text expressing this information in a large number of natural languages. A UNL expression is an oriented hyper-graph that corresponds to a NL sentence in the amount of information conveyed. The arcs are interpreted as semantic relations like *agent, object, time, place, manner,* etc. The nodes are special units, the so-called Universal Words (UW), interpreted as concepts, or groups of UWs. The concepts are built on the basis of English. When needed, English concepts can be modified by means of semantic restrictions in order to match better with the concepts of other languages. The nodes can be supplied with attributes which provide additional information on their use in the given sentence, e.g. @*imperative,* @*generic,* @*future,* @*obligation.*

3.1 Architecture

Since ETAP-3 is an NLP system based on rich linguistic knowledge, it is natural to maximally re-use its knowledge base and the whole architecture of the system in all applications. Our approach to UNL (described in Boguslavsky et al. 2000) is to build a bridge between UNL and one of the internal representations of ETAP, namely Normalized Syntactic Structure (NormSS), and in this way link UNL with all other levels of text representation, including the conventional orthographic form of the text.

The level of NormSS is best suited for establishing correspondence with UNL, as UNL expressions and NormSS show strong similarities. The most important of them are as follows:

a) Both UNL expressions and NormSSs occupy an intermediate position between the surface and the semantic levels of representation. They roughly correspond to the so-called deep-syntactic level. At this level the meaning of lexical items is not decomposed into semantic primitives, and the relations between lexical items are language independent.

b) The nodes of both UNL expressions and NormSSs are terminal elements (UWs in UNL vs. lexical items in NormSS) and not syntactic categories.

c) The nodes carry additional characteristics used in particular to convey grammatical information (attributes).

d) The arcs of both structures are non-symmetrical dependencies.

At the same time, UNL expressions and NormSSs differ in several important respects:

a) All nodes of NormSSs are lexical items, while a node of a UNL expression can be a sub-graph.

b) Nodes of a NormSS always correspond to one word sense, while UWs may either be broader or narrower than the corresponding English words.

c) A NormSS is a tree, while a UNL expression is a hyper-graph, which is a much more complicated object. Its arcs may form loops and connect sub-graphs.

d) The relations between the nodes in a NormSS are purely syntactic and are not supposed to convey a meaning of their own, while UNL relations denote semantic roles.

e) Attributes of a NormSS mostly correspond to grammatical elements, while UNL attributes often convey a meaning that is expressed in English or other natural languages by means of lexical items (e.g. modals).
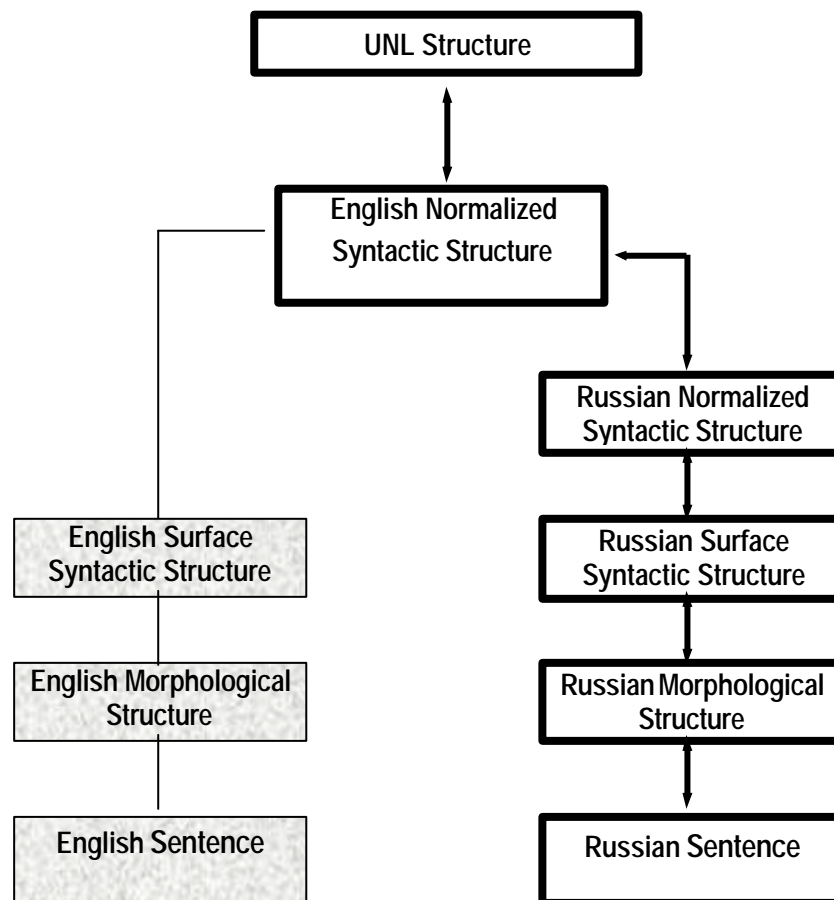
Fig. 6

f) A NormSS contains information on the word order, while a UNL expression does not say anything to this effect.

These differences and similarities make the task of establishing a bridge between UNL and NormSS far from trivial but feasible. Between the two types of NormSS readily available in ETAP – the Russian and the English one – we have chosen the latter, since it is the English concepts that serve for UNL as building blocks.

The architecture of the UNL module of ETAP-3 is given in Fig. 6.

3.2 UNL vs. English vs. Russian

As shown in Fig. 6, the interface between UNL and Russian is established at the level of the English NormSS. It ensures the maximum reuse of ETAP's English-to-Russian machine translation facility.

In the simple case, this scenario suggests that the UNL – Natural Language link can be localized within the English dictionary. This dictionary will only provide an English correspondence to UNL, which in most cases is not very difficult, and all the rest will be taken care of by the translation engine of ETAP. In this case, direct link between Russian and UNL is not needed at all, as long as ETAP covers the English-to-Russian correspondence.

However, the situation is not that simple. If we try to look at one language (Russian) through the perspective of another one (English), we encounter well-known problems. Let us illustrate the issue with an example. In Russian, there is no neutral equivalent of the English non-causative verb *to marry* as represented in sentences like *John married Ann in June.* The expression that exactly corresponds to this English verb – *vstupat' v brak* ('to contract a marriage') – is an official term and is not used in everyday life. Instead, Russian speakers make use of two different expressions: *zhenit'sja*, if the agent of the action is a male, and *vyxodit' zamuzh*, if it is a female. Since the English and the Russian words differ in their meaning, they correspond to different UWs. The UW for English *to marry* looks like (1), while Russian expressions have UNL equivalents with a more narrow meaning – (2) and (3), respectively (for simplicity's sake, only the relevant fragments of the UWs are given):

(1) marry(agt>human)
(2) marry(agt>male)
(3) marry(agt>female)

(Here agt stands for "agent").

Suppose the UNL expression that we receive at the input of our generator contains UW (2). Since we have to pass through English, we must first translate this concept into English and then translate the English word into Russian. But English has no direct equivalent of (2). It only has a word with a more general meaning – *to marry.* If our objective were to get the English text, this word would be perfectly in place. But since our target language is Russian, we cannot stop here and have to make a difficult choice between two different Russian equivalents.

This is exactly the problem that faces any translator from English into Russian, human or machine. Sometimes such a problem can be easily solved with the help of the context, sometimes it is less easy to solve or even unsolvable. For example, in the case of *blue* vs. *goluboj – sinij* discussed in 2.4 the context would hardly help to choose an appropriate Russian translation. However, in our example (2) the UNL source expression provides unambiguous information that allows avoiding this problem altogether, since the UW has only one correlate in Russian. If we pass from UNL to English and lose sight of the UNL source, we will lose the control of the semantic information and the quality of the output will deteriorate. This should not be permitted. Our solution to this problem is presented in 3.3.

In view of the above, it may seem that a better idea would be to sacrifice the benefit of reuse and establish a direct link between UNL and Russian.

However, the architecture shown in Fig. 6 has two more advantages that seem crucial.

First, this architecture allows us to make the UNL module of ETAP multilingual, that is to link UNL not only with Russian but also with English. In view of this perspective, it is reasonable to produce a full-fledged English NormSS that is much closer to UNL than the Russian one.

Second, the stock of the UNL concepts is continuously growing through the contributions coming from diverse languages. The UNL dictionaries of different languages grow at different rates and in different directions. Very often, the generator of language L_1 receives the UNL input produced by the UNL group of language L_2 that contains UWs that are absent from the UNL-to-L_1 dictionary. This happens particularly often with the so called multi-word UWs of the type

(4) International Research and Training Institute for the Advancement of Women (pof>General Assembly {(pof>United Nations)}).

If our only source of lexical knowledge were the UNL – Russian dictionary, we would not be

able to interpret such UWs, had they not been introduced in this dictionary in advance.

Our UNL-to-English architecture provides a universal solution to all difficulties of this kind. If the UW is not listed in the UNL dictionariy of ETAP, it is analyzed by means of the ETAP English dictionary and, if it is a multi-word expression, the English parser, which results in a reasonably good representation of the UW.

Moreover, it is often possible to correctly translate a UW that is absent from ETAP's UNL dictionary even if its headword is ambiguous. For example, if we receive UW

(5) open(mod<thing)

and do not find it in our UNL dictionary, we can replace it with the English word that stands in the position of the headword, that is *open*. However, this headword is ambiguous. In ETAP's English dictionary there are three entries for *open* - the adjective, the verb and the noun. A simple rule allows selecting the correct entry on the basis of the UW restriction: (mod<thing) means that the headword serves as a modifier of things. Hence, its English correlate is an adjective and not a verb or a noun.

3.3 UNL dictionary vs. English dictionary vs. Russian dictionary

The UNL-related information is distributed among the three ETAP dictionaries: UNL, English and Russian. The general idea is to combine (a) the idea of having the English NormSS as an intermediate level between UNL and the Russian NormSS and as a source of Russian and English generation and (b) the requirement of adequately treating cases of non-isomorphism between the English and the Russian concepts.

As shown in section 2.1, the ETAP dictionary entry contains several bilingual sub-zones, according to the number of working languages. In particular, the Russian dictionary has sub-zones for English and UNL, the English dictionary – for Russian and UNL and the UNL dictionary – for English and Russian.

Let us consider two cases: (1) the Russian and the English words are synonymous (as, for example, *to divorce* and *razvodit'sja*) and (2) they are not synonymous (as, for example, *to marry* and *zhenit'sja*).

The relevant fragments of the dictionary entries (with some simplifications) are as follows.

UNL dictionary:
NAME: divorce(agt>human)
ZONE:EN
   TRANS: divorce
ZONE:RU
   <none>

NAME: marry(agt>human)
ZONE:EN
   TRANS: marry
ZONE:RU
   <none>
NAME: marry(agt>male)
ZONE:EN
   <none>
ZONE:RU
   TRANS: zhenit'sja

English dictionary
NAME: divorce
ZONE: RU
   TRANS: razvodit'sja
ZONE:UNL
   TRANS: divorce(agt>human)
NAME: marry
ZONE: RU
   TRANS: zhenit'sja / vyxodit' zamuzh
ZONE:UNL
   TRANS: marry(agt>human)

Russian dictionary
NAME: razvodit'sja
ZONE: EN
   TRANS: divorce
ZONE:UNL
   TRANS: divorce(agt>human)
NAME: zhenit'sja
ZONE: EN
   TRANS: marry
ZONE:UNL
   TRANS: marry(agt>human)

Suppose we have to process a UNL expression that contains UW "divorce(agt>human)". Since this concept corresponds to both English and Russian words, we can do safely without any information on the Russian word in the UNL dictionary and obtain the NormSS with English *to divorce* taken from the English zone of the UNL entry. This NormSS allows generating both English and Russian texts by means of the standard ETAP transfer and generation facilities.

Let us consider the source UNL expression that contains UW "marry(agt>human)". It may have come from the language that, like English, German or Spanish, but unlike Russian or Polish, does not distinguish between the male-marriage and the female-marriage. The UNL dictionary entry for this UW will have the English translation but no Russian one, since Russian has no direct correlate for this concept. The problem of finding an appropriate Russian term is shifted to the level of the NormSS. At this level, we will have to find an equivalent of English *to marry*, just as if we translated from English and not from UNL. In this

case, the UNL source does not help us make a choice between two types of marriage. What does help is the mechanism of the interactive resolution of translational ambiguity described above, in 2.4.

Finally, let us examine the most interesting case - a UNL expression with UW "marry(agt>male)". The dictionary entry of this UW is symmetric to the entry of "marry(agt>human)": it contains a Russian correlate but no English one. In this situation, both English and Russian generations are not quite straightforward. As there is no direct English equivalent of this UW, the translation should be found by means of the UNL Knowledge Base (Uchida, 2003). In the absence of the operational version of KB, the general solution for processing an unknown UW is to extract the headword of the UW (*marry*) and treat it as an English word (cf. above, 3.2). This solves the problem of the generation of the English text. As for Russian, *zhenit'sja* indicated in the Russian zone of the UW entry is attached as a feature to the English node *marry*. At the stage of transfer from NormSS-English to NormSS-Russian, this feature will be lexicalized and replace the word *marry*.

4 Conclusion

The organization of lexical resources of the ETAP system allows reusing the dictionaries in diverse applications, such as machine translation in various language pairs and translation to and from UNL. In all the applications, there are three modes of operation supported by the dictionaries: automatic production of a single (most probable) translation, automatic production of all possible translations and the interactive translation with the dialogue-based disambiguation.

References

Apresjan Ju.D., Boguslavskij I.M., Iomdin L.L., Lazurskij A.V., Mitjushin L.G., Sannikov, V.Z., Cinman, L.L. (1992) *Lingvisticheskij processor dlja slozhnyx informacionnyx sistem. [A linguistic processor for advanced information systems.]* Moskva, Nauka. 256 p.

Apresjan Ju.D., Boguslavskij I.M., Iomdin L.L., Lazurskij A.V., Sannikov V.Z. and Tsinman L.L. 1992b. The Linguistics of a Machine Translation System. *Meta*, 37 (1): 97-112.

Apresjan Ju.D., Boguslavskij I.M., Iomdin L.L., Lazurskij A.V., Sannikov V.Z. and Tsinman L.L. 1993. *Systeme de traduction automatique {ETAP}.* In: La Traductique. P.Bouillon and A.Clas (eds). Montreal, Les Presses de l'Universite de Montreal.

Apresjan, Ju.D. 1995. *Integral'noe opisanie jazyka i sistemnaja leksikografija [An Integrated Description of Language and Systematic lexicography.]* Moscow, Jazyki russkoj kul'tury.

Apresjan, Ju. D. 2000. *Systematic Lexicography.* Oxford University Press, London, 304 p.

Apresian Ju., I. Boguslavsky, L. Iomdin, A. Lazursky, V. Sannikov, V. Sizov, L. Tsinman. 2003. ETAP-3 Linguistic Processor: a Full-Fledged NLP Implementation of the MTT. In: *MTT 2003, First International Conference on Meaning – Text Theory*. Paris, Ecole Normale Superieure, Paris, 279-288.

Blanchon, H. Interagir pour traduire: la TAO personnelle pour redacteur monolingue. *La Tribune des Industries de la Langues. Vol. 17-18-19, 1995, pp. 28-34.*

Blanchon, H. A Customizable Interactive Disambiguation Methodology and Two Implementations to Disambiguate French and English Input. *Proc. MIDDIM'96.* Le col de porte, Isere, France. 12-14 Aout 1996. Vol. 1/1, 1996, pp. 190-200.

Blanchon, H. Interactive Disambguation of Natural Language Input: a Methodology and Two Implementations for French and English. *Proc. IJCAI-97.* Nagoya, Japan. August 23-29, 1997. Vol. 2/2, 1997, pp. 1042-1047

Boguslavsky I., N. Frid, L. Iomdin, L. Kreidlin, I. Sagalova, V. Sizov. 2000. Creating a Universal Networking Language Module within an Advanced NLP System. *Proceedings of the 18th International Conference on Computational Linguistics (COLING 2000)*, 2000, 83-89.

Boguslavsky I., L. Iomdin, V. Sizov. 2003. Interactive enconversion by means of the ETAP-3 system. In "Proceedings of the International Conference on the Convergence of Knowledge, Culture, Language and Information Technologies", Alexandria, 2003.

Boitet, C. & Blanchon, H. Multilingual Dialogue-Based MT for monolingual authors: the LIDIA project and a first mockup. *Machine Translation. Vol. 9(2), 1995, pp 99-132.*

Hutchins W. J., H. L. Somers. 1992. *An Introduction to Machine Translation.* Academic Press, London.

Mel'cuk I. 1974. *Opyt teorii lingvisticheskix modelej "Smysl – Tekst".* Moscow, "Nauka" Publishers.

Uchida H. 2003. *The UW Manual.* http://www.undl.org.