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Evaluation of an Esperanto-Based Interlingua Multilingual Survey Form Machine Translation Mechanism Incorporating a Sublanguage Translation Methodolgy

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Evaluation Of An Esperanto-Based Interlingua
Multilingual Survey Form
Machine Translation Mechanism
Incorporating A Sublanguage Translation Methodology

A dissertation to be submitted in partial fulfilment
of the requirements for the degree of

Bachelor of Science Honours
(Communications & Information Technology)

by

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Michael Collins

Date of submission: 29 March 2004

Abstract

Translation costs restrict the preparation of medical survey and other questionnaires for migrant communities in Western Australia. This restriction is compounded by a lack of affordable and accurate machine translation mechanisms. This research investigated and evaluated combined strategies intended to provide an efficacious and affordable machine translator by:

- using an interlingua or pivot-language that requires less resources for its construction than contemporary systems and has the additional benefit of significant error reduction; and
- defining smaller lexical environments to restrict data, thereby reducing the complexity of translation rules and enhancing correct semantic transfer between natural languages.

This research focussed on producing a prototype machine translation mechanism that would accept questionnaire texts as discrete questions and suggested answers from which a respondent may select. The prototype was designed to accept non-ambiguous English as the source language, translate it to a pivot-language or interlingua, Esperanto, and thence to a selected target language, French. Subsequently, a reverse path of translation from the target language back to the source language enabled validation of minimal or zero change in both syntax and semantics of the original input.

Jade, an object-oriented (OO) database application, hosting the relationship between the natural languages and the interlingua, was used to facilitate the accurate

transfer of meaning between the natural languages. Translation, interpretation and validation of sample texts was undertaken by linguists qualified in English, French and Esperanto. Translation output from the prototype model was compared, again with assistance from linguists, with a 'control' model, the *SYSTRAN On-Line Translator*, a more traditional transfer translation product.

Successful completion of this research constitutes a step towards an increased availability of low cost machine translation to assist in the development of reliable and efficient survey translation systems for use in specific user environments. These environments include, but are not exclusive to, medical, hospital and Australian indigenous-contact environments.

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Declaration

I declare that this study does not incorporate without acknowledgment any material previously submitted for a degree in any institution of higher education, and that, to the best of my knowledge and belief, it does not contain any material previously published or written by any other person except where due acknowledgment is made.

Signature: 

Date: 29/08/04

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"Well, of course I would never use a preposition to end a sentence up with, because it might be difficult to make sense out of, and, after all, what would I want to use a preposition to finish a sentence that you cannot make any sense out of up with for?"

(It was a Dark & Stormy Night: The Final Conflict)

1 INTRODUCTION

1.1 Introduction to the Study

Translation costs restrict the preparation of medical survey questionnaires for migrant and Aboriginal communities in Western Australia. This is compounded by a lack of affordable and accurate machine translation (MT) mechanisms. This research investigated and evaluated combined strategies intended to provide an efficacious and affordable machine translator to meet these needs by:

- using an interlingua or 'pivot-language', which requires less resources for its construction than contemporary systems, with the additional benefit of significant error reduction; and
- using a word group-based natural language environment to reduce the complexity of translation rules and enhance correct transfer of meaning between natural languages.

This research focussed on producing a prototype machine translation mechanism that would accept questionnaire texts as discrete questions and suggested answers from which a respondent may select. The prototype was designed to accept as input non-ambiguous English as the source language, translate it to an Esperanto-based interlingua and thence to a selected target language, French. Subsequently, a reverse path of translation from the target language back to the source language enabled validation of minimal or zero change in both syntax and semantics of the original input.

The research was based firmly upon the use of Esperanto as an interlingua. Esperanto incorporates many desirable features for such use, including a robust, rule-based syntax and a lexicon designed to remove the grammatical ambiguities common to natural languages (Morneau, 1992; Schubert, 1988).

Translation of intended meaning requires a highly sophisticated machine translation system to avoid the likelihood of error. The study examined previous research into sublanguage methodologies (Arnold, Balkan, Meijer, Lee Humphreys, and Sajler, 1994; Henisz-Dostert, Macdonald, and Zarechnak, 1979, pp. 121-122). These studies described machine translation mechanisms capable of achieving higher translation accuracy than those obtained from traditional machine translation mechanisms. This study tested the ability of the sublanguage methodology to facilitate these translation improvements and to determine whether a significant reduction of the machine translation engineering structure was achievable.

A small machine translation prototype model was constructed to permit translation between two natural languages: English and French. Jade, an object-oriented (OO) database application, hosting the relationship between the natural languages and the interlingua, was used to facilitate the accurate transfer of meaning between the natural languages. Translation and interpretation of sample texts was undertaken by linguists qualified in English, French and Esperanto. Use was made of a traditional machine translation mechanism, a 'control model' based on a word-for-word translation methodology, to compare against the performance of the prototype model. Such comparison would initially determine the level of translation accuracy obtained from each

model. Secondly, the study would analyse and compare the structure of both models to determine whether the prototype model used significantly less complex engineering to achieve high accuracy results.

Successful completion of this study realised a step towards an increased availability of low cost machine translation to assist in the development of reliable and efficient survey translation systems for use in specific user environments. These environments include, but are not exclusive to, academic, medical, hospital and Australian indigenous-contact environments.

1.2 Outline of the Study

This chapter introduces the topic, presents an overview of the challenges involved and, then, identifies needs associated with machine translation research. It incorporates a description of the aims of this study and a synopsis of the remainder of this document.

Chapter 2 presents the background to the study and states the different strategies that may be used to improve machine translation mechanisms. The significance of the study is presented and is followed by a description of the challenges normally associated with the traditional methods of constructing machine translation mechanisms. A lack of accurate, affordable machine translation applications available to translate between many languages is identified. The research questions are stated, following which the techniques used to evaluate the study are described.

Chapter 3 provides a review of the literature relevant to machine translation history and its development. The review is used to justify both the approach taken and the purposes of this study.

Chapter 4 combines those requirements outlined in the introduction with the principles identified by the literature review to develop the concepts of enhancing machine translation employed in this study. A description is given of the research design and methods, together with the specific processes, control and prototype models used to validate the study.

Chapter 5 describes the findings of the study and presents summaries of the results obtained to answer the research questions.

Chapter 6 provides a discussion of the findings and presents conclusions for the study. Additionally, the study's implications for machine translation are discussed and the potential for further investigation and research in the field is identified.

A glossary of terms used in this document is attached as Appendix A for ease of reference. Appendix B contains a copy of the survey questionnaire on which the translated texts were based. A user's guide providing instructions for populating the Jade database application is attached as Appendix C. The remaining appendices contain the results of the sample texts produced by the control and prototype machine translation models to test the research questions.

2 THE PROBLEM

2.1 Background to the Study

This study was prompted by a need to provide an affordable machine translation mechanism, capable of producing reliable, high-accuracy translations. The study will assist in an existing project requiring such technology: a web-based survey for Princess Margaret Hospital that seeks feedback from the parents of cancer-affected child patients.

Many members of this target group either do not speak English or comprehend it in a limited way. Whilst it is important to capture their input during the surveys, such capture by manual translation incurs a high cost in terms of time and expense. Machine translation applications may cost tens of thousands of dollars and are often beyond the reach of many potential users (Gross, 1992), rendering them non-viable as an alternative to manual means. More affordable applications, including *Déjà Vu*, the Windows XP language translator, and freeware programs available on the Internet, provide inaccurate high-level translation unsuitable for survey research (Boitet, 1994). Although high accuracy translation mechanisms exist for languages such as English, French and other European languages (Boitet, 1994), there is a paucity of reliable systems for other languages.

A lack of affordable, reliable machine translation applications poses difficulties for economical translation between natural languages (Gross, 1992; Kay, 1996). Furthermore, some applications fail to provide accurate translations without manual

intervention and/or substantial customisation to meet the user's specific needs (Gross, 1992; Kay, 1996).

2.2 The High Cost of Machine Translation Research and Development

The shortage of affordable applications may relate to the complexities, such as those associated with syntax, of developing machine translation programs compared to single-language applications including electronic dictionaries, spelling and grammar checkers (Boitet, 1994). Overcoming such complexity results in high development resources for machine translation applications and consequential high purchase and licence costs. Despite rapid advances in machine translation development in recent years, most machine translation systems relate to transferring from one Western language to another. In the 1980s, a limited number of machine translation applications were available to translate Asian languages (Office of Japan Affairs, 1990, p. 8). According to the Office of Japan Affairs (1990, p. 8) most Japanese to English machine translation research is undertaken in Japan, rather than in the United States or the United Kingdom. The Office of Japan Affairs believed it was more beneficial to undertake machine translation research in the country of the target language but, in the case of Japanese to English machine translation, this had not occurred because:

Japanese-developed Japanese to English systems are not widely used in the United States. Lack of compatibility between hardware and software is one of the impediments . . . The University of Wisconsin's Biotechnology Center planned to use a Bravice system on an experimental basis to scan and translate Japanese databases on biotechnology, but has been unable to do so because of the high cost of the necessary hardware. Currently there is no U.S.-developed Japanese to English machine translation system on the market (Office of Japan Affairs, 1990, pp. 11-12).

Machine translation research was costly, with an obvious negative effect on the development of a wider and more affordable range of applications. Japanese machine translation researchers reported that:

... large Japanese companies working on machine translation do not believe that this business will yield great profits, at least in the short term. They do, however, see machine translation as a mechanism for learning more about natural language processing technology in general, which they judge to be a key technology in the next century. Despite the interest in machine translation technology, profits in the United States and Europe are very slim, if there are any at all. While there are companies developing systems for internal use, the independent developers are ... few in number (Office of Japan Affairs, 1990, pp. 11-12).

Many developers found that the high cost of research and development made it impracticable to recover costs by marketing to smaller consumers. Consequently, major commercial machine translation systems have been mainframe-based and traditional markets have been limited to:

... translation bureaus, multinational corporations and intelligence and information gatherers, particularly in government ... Research has followed two courses: large scale, general purpose, mainframe-based system for use by major companies and governments and the small-scale MT system for use by small to medium sized companies to translate for specialised applications. A third development is an intermediary stage between the two systems mentioned above (Office of Japan Affairs, 1990, p. 13).

Although machine translation strategies and system types were more or less universal, the approaches used by researchers in the United States and Japan were fundamentally different: the American approaches were more theoretical, while the Japanese were more pragmatic and experimental. Of special relevance to this study are the following comments on producing systems of greater practical application:

Much of the researcher's time is devoted to writing papers and developing new models of natural language. As a result, critics argue that U.S. researchers

construct models that are elegant but not amenable to practical use. At the same time, we should remember that the strides that have been made in basic computational linguistics, a research approach recommended by the ALPAC report, make today's machine translation systems possible (National Academy of Sciences, 1966)

The following section outlines some of the more significant technical and linguistic factors that make machine translation development costly.

2.3 Previous Machine Translation Research – Computing and Linguistic Challenges

Much earlier machine translation research was abandoned when it became apparent that computer-aided systems would not support a fully automated universal translator (Boitet, 1994). In 1959 Bar-Hillel (Bar-Hillel, 1960, 1964; Henisz-Dostert et al., 1979) asserted that in principle it was impossible to create Fully Automatic, High Quality Machine Translation (FAHQMT). Bar-Hillel (1960) provided a simple example wherein he maintained it was impossible for machine translation programs to interpret precise meaning automatically. He concluded that extra linguistic knowledge was required to determine the intended meaning. Bar-Hillel's (1960) prediction that FAHQMT was unattainable has been challenged but not disproven (Macklovitch, 1995). However, it did stimulate research on "more fundamental issues in the processing and understanding of human languages" (Arnold et al., 1994).

Research in the 1950s and 1960s failed to take into account the semantic as well as the syntactic structure of texts (Hutchins, 1995; Morneau, 1992, p. 3). Consequently, emphasis centred on understanding and analysing the linguistic aspects of machine translation research. Hjelmslev (1943) asserted that natural languages all follow some

basic structural rules and are “universally divided” into two separate levels, namely, expression and content. The differences between the levels in each language create significant challenges to translators.

Cultural differences inherent in natural languages, according to Eco (1995, pp. 20-24), have been a recurring impediment to ‘perfect language’ and artificial language (AL) development, and, thus have challenged machine translation researchers. The processes of converting idiosyncratic natural language syntax into algorithms, robust enough to deliver accurate translation, requires considerable skill and knowledge of both linguistics and systems design (Henisz-Dostert et al., 1979, pp. 98-99).

The ability to interpret the correct meaning for a given phrase from the source language requires a sophisticated machine translation system (Gross, 1992). Translating such meaning into the correct equivalent phrase in the target language increases the likelihood of errors occurring that would distort the intended meaning (Henisz-Dostert et al., 1979, pp. 121-122). In consequence, machine translation developers have pursued novel approaches to achieve high-level translation results. Such approaches included pre-editing and post-editing processes and a stronger focus on linguistic issues (Boitet, 1994), including more sophisticated machine translation programming rules to interpret syntax in the various languages modelled.

2.4 Disadvantages of Contemporary Machine Translation Systems

Contemporary systems have limited efficacy because:

- they use a dictionary customised for each language pair (Arnold et al., 1994; Boitet, 1994), and
- they use poorly structured syntax and, consequently, produce erratic, inconsistent results (Dennett, 1995; Gross, 1992).

2.4.1 Disadvantages of Contemporary Systems Because of Language Pairing

Arnold et al. (1994, p. 64) elaborate on how the need for additional dictionary pairs in contemporary systems restricts the development of additional language modules.

They point to the following disadvantages:

- the engine will run in one direction only, for example, from German to English;
- to go in the other direction the transformer rules have to be rewritten;
- when the transformer rules include bilingual dictionary rules, the engine has to be supplied with two bilingual dictionaries;
- the use of two bilingual dictionaries is inefficient because of the differences in their directionality and there is a duplication of lexical data; and
- the engine links a single pair of languages only and when additional languages are created, the transformer rules have to be rewritten.

Figure 1 shows a contemporary translation system where each language dictionary is linked directly to every other language dictionary. The number of translation pathways in

the schema may be represented by the formula $n(n-1)$, where n equals the number of languages involved. This 'square law' means that, for every language added, a machine translation system must establish dictionary pairs with every other language in the mechanism.

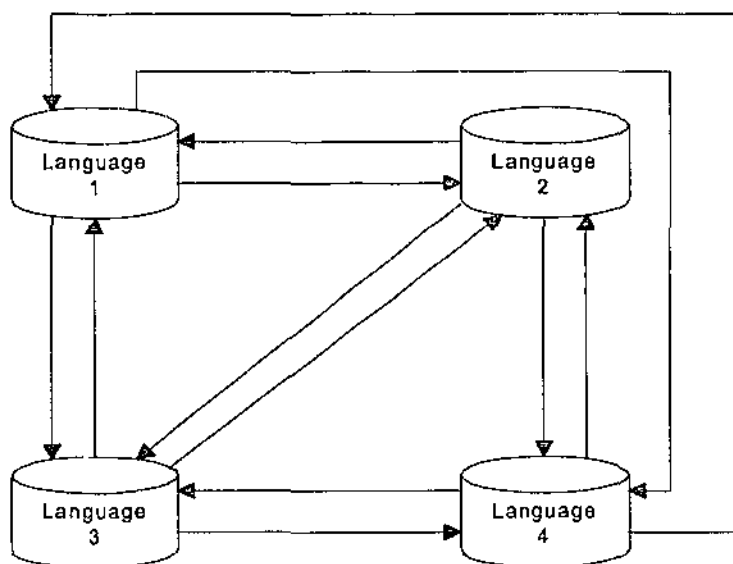


Figure 1 Traditional schemata

2.4.2 Disadvantages of Contemporary Systems Because of Structured Syntax and Lexical Complexities

Syntactic analysis of the grammar and construction of phrases and word groups, handled at a subliminal or instinctive level by human translators, is less challenging than designing an effective computer program to complete the same processes. Semantic analysis relating to the intended meaning of a specific word or word group poses further challenges (Gross, 1992). The translation challenges posed by the lexical, syntactic and semantic dynamics of natural languages require additional translation rules to ensure preservation of correct meaning during translation.

Contemporary machine translation systems use one of two translation systems to complete the translation of natural languages: transformer translation and language knowledge (LK) or the transfer methodology (Arnold et al., 1994, pp. 66-67; Morneau, 1992). According to Arnold (1994, p. 66):

- transformer translation relies on knowledge of the source language and some knowledge about how to transform partly analysed source sentences into strings that look like target language sentences, while;
- LK architecture translation relies on extensive knowledge of both the source language and target language and of the relationships between analysed sentences in both languages.

According to Dennett (1995, p. 13) a disadvantage of transformer architecture is its inability to identify and translate accurately poorly structured source language grammar. It

... will rarely incorporate sufficient enough grammatical knowledge to detect, let alone reject, poor source language grammar, and hence will immediately stumble on poorly written source language texts. Poor quality of the source text is a significant problem for human translators, it being very difficult to express in perfect language a concept from the source text which cannot be understood because it is so poorly expressed.

Dennett (1995, p. 15) is also critical of the translation abilities of LK systems claiming that the methodology produces inaccurate translations in the target language:

Their ability, however, to produce a structure in the target language which is grammatically correct whilst being a completely incorrect translation of the original still leaves their output some way short of the results a human translator may be expected to achieve.

Because of the poor quality results produced by transformer and LK methodologies, more recent research has attempted to improve the quality of machine translation methodologies. Possible solutions to these problems are discussed in the following section.

2.5 Possible Solutions to the Problem

The literature review in Chapter 3 outlines the history, linguistic and technical challenges in machine translation research that are relevant to this study. It specifically describes these research challenges and different research methods tested to try to overcome them. This study will describe the construction of a model, using the following two strategies, which merit further evaluation as viable solutions to the linguistic and technical challenges inherent in contemporary machine translation design. These two strategies are based on:

- an interlingua to reduce issues with language pairs and enhance syntax and semantic translations; and
- a sublanguage methodology incorporating a word group strategy to enhance these translations.

2.5.1 Use of an Interlingua System to Enhance Translations

In the 1950s some machine translation developers recognised that some form of intermediary or interlingua system was required to enforce lexical, syntactic and semantic consistency between the source language and target language (Arnold et al., 1994; Kay, 1996, pp. 64-66). An interlingua may overcome some of the shortcomings peculiar to contemporary automated translation mechanisms (Hutchins, 1995; Leavitt et al. 1994;

Schubert, 1998). The following two sections describe briefly how an interlingua system compares with contemporary systems.

2.5.1.1 Use of an Interlingua to Reduce Issues with Language Pairs

Arnold et al. (1994, p. 76) compared the structure of contemporary systems with an interlingua system and noted the need for extra dictionary pairs in contemporary systems requiring additional resources to create and maintain them. This contrasted sharply with their observations of the interlingua methodology which:

- made it possible to add a new language to a system simply by adding analysis and synthesis components;
- avoided the need to include analysis, synthesis and transfer components in all the other languages involved in the system; and
- only required one transfer for each language pair, thus reducing the number of dictionary pairs.

Figure 2 shows how the number of dictionary pairs shown in Figure 1 is reduced to four by the use of an interlingua.

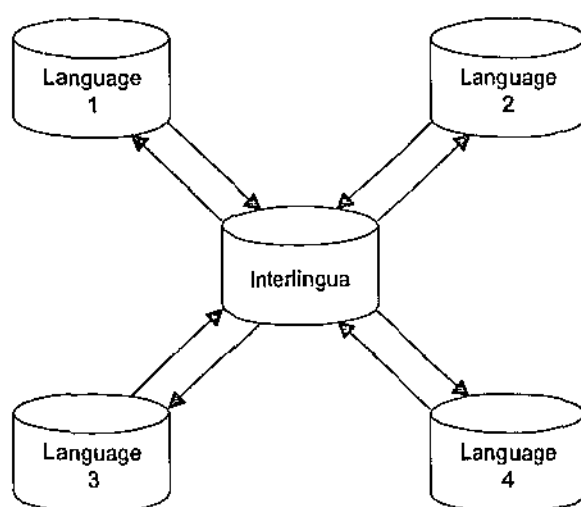


Figure 2 Translation paths via an interlingua

Boardman (1999) concluded that a carefully designed interlingua was more easily constructed than equivalent natural language by reducing the amount of analysis required to translate documents in several languages:

By authoring directly in the language-neutral form, expensive analysis processing of natural language source text may be avoided. The synthesis component may still be relatively complicated. Due to the abstract nature of these representations, effective authoring support must be provided. Study into this includes the WYSIWYM technique (Power & Scott 1998). The main cost saving is that the organisation will only need to author one version of each document, as opposed to effectively many parallel authorings when the translation is carried out manually. This efficiency savings [sic] should also lead to a reduction in the number of synchronisation, linguistic and distributional problems introduced into the workflow (Boardman, 1999).

Leavitt et al. (1994, p. 2) identified the basic linguistic and technical challenges for machine translation design and observed that an interlingua offered significant advantages to translators involved in constructing machine translation databases. Leavitt et al. (1994, p. 2) compared the advantages of an interlingua-based machine translator with contemporary models and highlighted the following points:

- contemporary models require different knowledge sources for the various languages to be developed by separate language experts;
- such domain knowledge has to be encoded into the domain model by an expert in the domain;
- this encoding requires modular architecture that:
 - separates knowledge sources from processing engines;
 - shields different languages from each other to avoid language-pair-specific development;
 - provides module interfaces for language experts who are not necessarily skilled programmers; and
- the solution is to divide the problem into source language analysis and target language generation with an interlingua as an interface between two components.

The following section outlines the selection and justification for the interlingua medium that was chosen to evaluate the prototype model.

2.5.1.2 Choice of Interlingua

For an interlingua to fulfil its role as an accurate translation template it must express ideas in a way similar to the major natural languages with which it must interface. Most importantly, it must be capable of expressing meaning in a precise and unambiguous manner (Sabaris et al. 2001). Morneau (1992, pp. 24-26), a proponent of interlingua machine translation systems, analysed a number of natural languages seeking, without success, one with precise lexical and syntactic form suitable for use as an

interlingua. In his experiments to create an interlingua Morneau (1992, pp. 24-26) attempted to create a syntax within the English language based on a morpheme structure. However, to create a new interlingua would be laborious and an unnecessary venture, as Esperanto, according to Sabaris et al. (2001), is:

.... seen as a living example of an artificial language that works efficiently in practice. We have chosen Esperanto among the several existent artificial languages as it is the most developed of them all. It has complete dictionaries and grammars, and has been used as a second language by a community of hundreds of thousands of speakers around the world for more than a century.

In 1999, the Universal Translation Language (UTL) machine translation project proposed a new approach to multilingualisation, based on the usage of an artificial unambiguous human language or interlingua (Sabaris et al., 2001). According to Sabaris et al. (2001), the UTL project was based on Esperanto as:

Many of the characteristics necessary for a *translational* language like UTL are already present in Esperanto, though a few new features have been incorporated into the language in order to optimize its unambiguity and semantical capabilities.

In the 1980s Esperanto was used as an interlingua to reduce language pairs and reduce linguistic and technical challenges during the Distributed Language Technology (DLT) project at the Buro voor Systeemontwikkeling (Schubert, 1988; Witkan, 1988) in the Netherlands. Although there is a paucity of data to support the results of the research, those involved advocated the efficacy of Esperanto as an interlingua and as a contributor to the technical achievements of the project (Schubert, 1988). Consequently, Esperanto was selected for the interlingua to be implemented in this study. It was used as the first strategy to build a prototype model to evaluate the research question posed by the study.

The second strategy used to improve translation accuracy was the adaptation and use of a sublanguage methodology to reduce lexical and syntactical complexities. The next section describes that strategy and justifies its inclusion as part of the prototype model.

2.5.2 Using a Sublanguage Methodology to Preserve Correct Meaning in Translations and Reduce Significantly Linguistic and Technical Problems

The use of precise, defined natural language environments in machine translation systems has been positively demonstrated with high-accuracy translation results (Arnold et al., 1994, pp. 150-151; Boardman, 1999; Mitamura et al. 1991). Previous attempts to “define controlled input languages” (Mitamura et al. 1991, p. 2) have tried to reduce complexity either by limiting the vocabulary to a very small size or by limiting syntax to just a few constructions. Boardman (1999) reported that “the use of sublanguages enables restrictions to be placed on the range of text for translation and thus enhance the machine translation output quality achieved, without any significant increase in processing demand.” He also advocated the efficacy of sublanguages as:

... in many types of domain-specific specialised knowledge there will be an associated sublanguage (for example: weather forecasts, software manuals, chemical terminology, stock market reports etc.). There are many examples of sublanguage definitions in various specialist domains, for example aircraft maintenance ... The restrictions in syntax complexity and size of vocabulary offer many benefits towards MT system design, including simpler analysis and synthesis modules, a smaller lexicon, an increase in tractability and the avoidance of difficult constructs such as idioms. Simplified semantic and temporal dimensions can also be used. In general, system complexity is reduced.

However, Boardman also cautioned that there is a disadvantage with sublanguage systems, which:

... should be seen as a trade-off with the ability of the system to act in a general-purpose way and handle novel constructs. It may also be difficult to reuse components within other sublanguage applications.

A methodology based on the combined use of an interlingua and a sublanguage offers an alternative strategy for enhancing translation accuracy by reducing the complexities in linguistic and technical machine translation design. The viability of this strategy was investigated by Mitamura et al. (1991, pp. 1-2) at the Center for Machine Translation at Carnegie Mellon University in 1991. They concluded that a sublanguage methodology differed significantly from contemporary, syntactic and lexical-based methodologies. A sublanguage methodology places less reliance on analysing the syntax of a sample of text based on the relationship between each word in the text. Mitamura et al. (1991, pp. 1-2) and Zens (2002, pp. 1-3) concluded that the sublanguage methodology takes groups of words and defines the equivalent meaning of the entire text in the interlingua as a word group or 'cluster'. They observed that, compared to contemporary systems, this methodology preserved a significantly higher level of semantic meaning and enhanced the lexical and syntactical attributes of the translated word groups.

Chapter 3 describes in detail the background and different methods of using the sublanguage methodology. The following section identifies the best solutions considered to complete this study.

2.6 Identification of Best Solutions

Section 2.4 identified two issues that challenge the design of contemporary machine translation systems:

1. the use of dictionaries customised for each language pair (Arnold et al., 1994; Boitet, 1994), making inefficient use of technical and linguistic resources; and
2. the use of translation methodologies incorporating complex linguistic and technical structures, producing poor syntax and, consequently, creating erratic, inconsistent results (Dennett, 1995; Gross, 1992).

This study aims to evaluate strategies that would counter factors 1 and 2 above. It aims to counter factor 1 by:

- using an established, strictly rule-based interlingua as a means of translation, rather than creating a language paired translation mechanism. The use of language pairs necessitates the production of $n(n-1)$ (where ' n ' is the number of selected languages) mechanisms to achieve translation (Kay, 1996), whereas an interlingua requires only $2n$ translation mechanisms to achieve the same results (Arnold et al., 1994, pp. 74-75).

It aims to counter factor 2 by:

- using an interlingua, to enhance syntax and semantic translations, combined with a sublanguage methodology to enhance translation through a precise language

environment to reduce syntactical, lexical and semantic translation problems inherent in traditional machine translation methodologies.

2.7 Significance of the Study

Published research results, as identified below, suggest that:

- an interlingua model requires less resources for its construction than contemporary systems (Kay, 1996) and has the additional benefit of significant error reduction in preserving semantic meaning of the original text (Arnold et al., 1994; Schubert, 1988, 1997, 1998; Witkan, 1988); and
- a sublanguage methodology enhances semantic translation and requires less linguistic and technical resources (Henisz-Dostert et al., 1979, pp. 15-16; Kamphuis, 1998, p. 206).

The potential benefits of these two strategies appear to be the ability to produce high-level translation and simplicity in model design and construction. The study investigated the potential to harness these two strategies into a prototype mechanism that translated targeted phrase styles, e.g., those found in well-designed surveys. Likely benefits would be a simplified machine translation mechanism capable of producing high quality survey translations, initially for the academic community. A successful prototype model, incorporating less complex and, thereby, less costly construction and translation costs, may have commercial applications and may attract continued funding from survey vendors.

2.8 Purposes of the Study

The purposes of this study are:

1. to investigate the feasibility of constructing a prototype machine translation mechanism using an interlingua to generate high-level translation output by:
 - using Esperanto as the interlingua; and
 - incorporating a sublanguage methodology.
2. to construct a prototype model, incorporating the above two strategies and compare its structural attributes with those of a contemporary model to determine whether a significant reduction of development resources and costs could be achieved.

The anticipated outcome of the project will be a pilot implementation of an interlingua machine translation mechanism incorporating a sublanguage based on a strictly defined natural language lexicon. Evaluation of the output translations will determine the level of translation accuracy, including semantic accuracy. The project will also examine the efficacy and flexibility of the lexicon and syntax structures contained in the sublanguage modules. Analysis of the lexicon and syntax structure will assist in the design of improved translation rules for future models. In addition, these evaluations will determine whether a reliable and inexpensive mechanism may be created for survey design.

2.9 Research Question

This research was designed to examine the over-arching question:

May an Esperanto-based interlingua machine translation mechanism, using a sublanguage methodology, achieve high-accuracy translations between two natural languages and reduce the complexity of the technical construction?

2.10 The Major Components of the Research Question

The major components of the overall question are:

Sub-question 1:

May Esperanto as an interlingua preserve a high standard of meaning when translating text between two natural languages?

Sub-question 2:

May a sublanguage methodology preserve a high standard of meaning when translating between two natural languages?

Sub-question 3:

May a sublanguage methodology reduce the complexity of technical resources needed to translate text between two natural languages?

Sub-question 4:

May a combined interlingua and sublanguage methodology mechanism simplify the construction of language dictionaries for non-technical translators?

2.11 Evaluation of Results

Professional translators were used in this study to translate the words and syntax used to construct the English, French and interlingua language dictionaries for the prototype model. The translators also evaluated the accuracy of the sample output texts used in the control model based on the transfer methodology, an alternative contemporary design, with the output sample texts from the prototype model. These methods were used to facilitate comparison of the two sets of sample text results and to enable evaluation of the levels of translation accuracy.

An estimate of the resources required to construct contemporary machine translation systems was compared to the resources required in constructing the prototype model. Evaluation of the difficulty of constructing the language dictionaries in the prototype model was undertaken and compared to contemporary models. There is, as yet, no generally accepted method of evaluating the accuracy of human or machine translations (Zens et al. 2002 , p. 11). Evaluations are normally based more on intuition than systematic research:

Overall assessments of machine translation are less useful than evaluations of specific systems because the evaluation depends very much on the needs of a specific user. Japanese developers note that in some cases a reasonably accurate or even a rough translation may be appropriate, while in other cases where high levels of accuracy are essential, machine translation is unacceptable . . . While no commercially available system can do it, some Japanese to English systems now in use by researchers in Japan reportedly can identify inaccurate text. Leaders in Japanese to English machine translation research, however, note that no accurate data are available to judge particular systems and that the assessments of accuracy and intelligibility are not based on rigorous testing. Nor are there unambiguous cost evaluations of machine translation systems, although developers contend that the time taken and cost are generally less than with pure human translation (Office of Japan Affairs, 1990, pp. 11-12, 26).

According to the Office of Japan Affairs (1990, p. 25) such evaluations currently depend on subjective judgments as to what constitutes acceptable levels of cost and accuracy. The institution also observes that "what may be unacceptable text to one user may be usable to another." Hutchins (1995, p. 9) expresses a similar view:

... MT research continues to attract the perfectionists. It has been regarded as a field in which new linguistic formalisms or new computational techniques can be tried out; MT has been seen as a testbed for theories. The reason is obvious: the quality of MT and translation can be judged by non-experts, at least in a superficial manner - reliable and systematic evaluation is quite another matter.

Arnold et al. (1994, p. 162) found that merely observing the intelligibility of translated text only provides a partial evaluation of the translation quality. They consider it essential that the translated text must be intelligible, but must also ensure that the meaning of the source language text is preserved in the target language translation. They refer to this essential attribute as accuracy or fidelity. In combination with an intelligibility rating, it may be used to evaluate machine translation performance. Arnold's translation accuracy scoring scheme requires the scorers to be able to refer to the source language text (or a high quality translation of it if they cannot speak the source language) to compare the meaning of input and output sentences.

The form of evaluation considered by Arnold et al. (1994, p. 163) acknowledges that high accuracy scores are much less interesting than intelligibility scores. This is because accuracy scores are often closely related to the intelligibility scores; high intelligibility normally means high accuracy. They advocate dispensing with accuracy scoring altogether and simply counting cases where the output appears erroneous, concluding that devising and assigning quality scores for machine translation output is not

a straightforward strategy. They also found that interpreting the resultant scores is also problematic, observing:

it is virtually impossible even for the evaluator - to decide what a set of intelligibility and accuracy scores for a single MT system might mean in terms of cost-effectiveness as a 'gisting' device or as a factor in producing high quality translation (Arnold et al., 1994, p. 163).

Another machine translation evaluation methodology proposed by Arnold et al. (1994, pp. 164-165) is one of focusing on the errors made by the machine translation mechanism. This technique determines how seriously errors affect the translation output and involves counting and prioritising errors in terms of the significance of translation accuracy. A weighting factor is added to the level of error significance and an aggregate of errors will provide an accuracy rating for sample translations. Arnold et al. (1994, p. 166) observe that, whilst this method gives more direct information on the usefulness of a machine translation system, there are immediate problems with using detailed error analysis:

The first is practical: it will usually require considerable time and effort to train scorers to identify instances of particular errors and they will also need to spend more time analysing each output sentence. Second, is there any good basis for choosing a particular weighting scheme? Not obviously. The weighting is in some cases related to the consequences an error has for post-editing: how much time it will take to correct that particular mistake. In some other cases it merely reflects how badly an error affects the intelligibility of the sentence. Consequently, the result will either indicate the size of the post-editing task or the intelligibility of the text, with its relative usefulness. In both cases devising a weighting scheme will be a difficult task. There is, however, a third problem and perhaps this is the most serious one: for some MT systems, many output sentences are so corrupted with respect to natural language correlates that detailed analysis of errors is not meaningful. Error types are not independent of each other: failure to supply any number inflection for a main verb will often mean that the subject and verb do not agree in number as required. It will be difficult to specify where one error starts and another ends and thus there is the risk of ending up with a general error scale of the form one, two, . . . lots. The assignment of a weighting to such complex errors is thus a tricky business.

Chapter 4 outlines the methodology used to evaluate the results obtained to answer these sub-questions. It also describes evaluation techniques used to compare the combined Esperanto interlingua and sublanguage model with a contemporary translation model. The contemporary model, based on the transfer methodology, is a word-for-word translation system incorporating complex lexical and syntax rules to facilitate machine translation. Chapter 5 shows the results of the translated sample texts and construction of both models and discusses the outcomes and significance of the research.

3 A REVIEW OF THE LITERATURE

3.1 Introduction

This chapter covers the history of machine translation research and describes milestones from the 1950s to the present. It outlines the different types of machine translation systems and recent research related to this study in the areas of interlingua, word group translators and sublanguages. It also considers the use of Esperanto as an interlingua.

3.2 General Literature

3.2.1 Early Research

During 1947 and 1948, researchers tested and developed detailed dictionary coding, thus facilitating greater efficiency in the use of the limited computer memory of the time (Henisz-Dostert et al., 1979, p. 9). In 1948, Weaver (1955 , pp. 15 - 23) wrote of the possibility of extending the use of computers in machine translation research by studying the “decomposable elements” in the translation process (Henisz-Dostert et al., 1979, p. 6). Weaver (1955 , pp. 15 - 23) challenged potential developers to determine if natural languages might be broken down and then reconstructed as another language through the medium of computers. He believed that machine translation was possible, especially after its use during the second World War in the field of cryptology.

In 1950, Reifler (Henisz-Dostert et al., 1979, p. 13) produced a study of the two machine translation concepts of pre-editing and post-editing text. Until 1950, there had been a general assumption that machine translation would be fully automated, requiring no human editing of the text other than the source language. Reifler's reasoning had fundamental consequences for machine translation research, culminating in the 1955 joint experiment by Georgetown University and IBM which firmly established the feasibility of machine translation (Henisz-Dostert et al., 1979, pp. 13, 23-25).

The decade from 1950 was a productive one for machine translation, producing prototype models and some thought-provoking research conclusions. According to Boitet (1994) and Henisz-Dostert et al. (1979, pp. 15-16, 18, 27, 29) and others, the following issues were under active investigation during the period:

- research centring on linguistic factors rather than on improving technical capabilities of computers. Slow computer processors, low data storage capabilities and primitive operating systems all caused difficulties;
- designing pre-editing and post-editing synonym tables to define correct meaning during translations (Kay, 1996);
- eliminating pre-editing by listing all target equivalents in the target text, while preserving the original word order;
- improving the design of automatic storing and retrieving full and split forms of text offering more streamlined machine translation design;

- investigating problems associated with word selection and rearrangement in automatic solutions because the ratio of three or more possible equivalents in a target language was technically problematic;
- testing and championing various methodologies: including syntactic analysis, code-matching and verification that the word-for-word machine translation method was more effective than the sentence-for-sentence method; and
- hypothesising that the core machine translation problem is a matter of decision, involving the precise interpretation of text and then using an appropriate algorithm, capable of recognising decision points and cues, to ensure accurate conversion of the output in the target language.

3.2.2 Challenges to Achieving Fully Automatic High Quality Machine Translation (FAHQMT) Mechanisms

In 1959 Bar-Hillel (Bar-Hillel, 1960; Henisz-Dostert et al., 1979) suggested the improbability of creating FAHQMT. Bar-Hillel provided a simple example whereby he maintained it was impossible for machine translation to interpret precise meaning automatically. The quandary in his example related to finding the correct translation for the noun ‘pen’ in the following sentence:

“Little John was looking for his toy box. Finally he found it. The box was in the pen. John was happy” (Arnold et al., 1994).

What concerned Bar-Hillel was the capability of machine translation to identify correctly the exact meaning of ‘pen’ that, from the context, is clearly a playpen rather than a writing instrument, a female swan or a general enclosure. To identify the correct ‘pen’

implied the requirement to have encyclopaedic world knowledge. He doubted that computers could incorporate sufficient knowledge to achieve such identification.

Bar-Hillel asserted that extra linguistic knowledge was necessary if any degree of certainty was possible in the determination of the intended meaning. Bar-Hillel persuaded contemporary researchers to believe that, whilst humans may access and process vast amounts of knowledge instantaneously due to their ability to infer meaning, it was highly unlikely that machine translation would ever achieve such spontaneous results (Bar-Hillel, 1960; Macklovitch, 1995).

3.2.3 Machine Translation Research in the 1960s

Bar-Hillel's arguments had a profound impact on research initiatives. Indeed some machine translation historians (Kay, 1996) describe the 1960s as a decade of inactivity, in which machine translation was effectively the preserve of the Mormon Church which had an interest in Bible translation. However, research at the Brigham Young University in Utah eventually led to the development of two commercial machine translation systems, WEIDNER and ALPS (Kay, 1996). Similar prototype systems, developed in Canada, the former Soviet Union, Japan and several European countries, showed potential to advance machine translation development (Arnold et al., 1994, p. 14; Kay, 1996).

Despite differences of opinion about fully automatic versus human-editing systems, machine translation research in the 1960s continued to develop important

research outcomes. In 1960, various attempts were made to identify similarities in the work of American and European machine translation pioneers (Henisz-Dostert et al., 1979, p. 32). Researchers from various countries had achieved mixed success, including the following:

- In 1961, the first international conference on machine translation was held in the United Kingdom. Research into Chinese to English translation was undertaken and similar comparative work undertaken with other languages (Henisz-Dostert et al., 1979, p. 32);
- A comparative study of Slavic languages was undertaken to develop a system of transcription compatible with the orthographies of the language group (Henisz-Dostert et al., 1979, p. 32);
- The Simulated Linguistics Computer (SLC), a prototype machine translator, was generalised for adaptation to any machine translation situation (Henisz-Dostert et al., 1979, p. 32); and
- A Georgetown University research team published a telegraphic-code Chinese-English dictionary for machine translation for a pilot translation project using the two languages (Henisz-Dostert et al., 1979, p. 32).

Bar-Hillel's assertion that FAHQMT was unattainable, while challenged, had not been disproven (Macklovitch, 1995). Moreover, it had the effect of focussing research on more fundamental issues in the processing and understanding of human languages (Arnold et al., 1994). One avenue of investigation accepted that FAHQMT was beyond

the reach of the early researchers, but proposed that systems using some human input or editing did offer viable semi-automatic machine translation systems.

This essential human input led to two areas of research with ill-defined boundaries: Machine-Aided Human Translation (MAHT) and Human-Aided Machine Translation (HAMT). The boundaries between MAHT and HAMT are uncertain and the term Computer-Aided (or Computer-Assisted) Translation (CAT) may sometimes cover both. However, the central core of machine translation itself is the automation of the full translation process (Arnold et al., 1994).

Since the 1950s, the United States has operated a number of automatic translation facilities but it is generally accepted by researchers such as Boitet (1994) that the results have been mediocre. Subsequently, the National Academy of Sciences' National Research Council established the Automatic Language Processing Advisory Committee (ALPAC). ALPAC was intended to carry out a two-year study into machine translation (Automatic Language Processing Advisory Committee, 1966). The committee's research conclusions supported Bar-Hillel's earlier prediction that there was little prospect of fully-automated machine translation and that human translation and editing would remain an essential component (Garvin, 1972).

Garvin's (1972, p. 11) research into FAHQMT identified two extreme views of the core issues. On the one hand, he believed that the ALPAC assertion relied on an assumption that, with sufficient computer memory, machine translation was possible without resorting to a complex algorithm. On the other hand, he described a

“perfectionist” approach, which insists that without a complete theoretical knowledge of the source language and target language and a thorough understanding of translation, plus an ability to model these mathematically, the task could not be undertaken.

According to Garvin (1972, pp. 10-11), the program would require either a large dictionary containing words and phrases or an equally large table of grammar rules. He believed that ALPAC experiments, which used both options, produced limited translation accuracy because “both systems are fundamentally unimprovable, since they allow only mechanical extensions of tables which create as many or more errors as they rectify.” Consequently, ALPAC conceded that FAHQMT was not achievable. Garvin was also concerned that an over emphasis on theoretical language studies had led research into a blind alley. Garvin (1972, p. 11) proposed an engineering solution, thus avoiding the pitfalls of these two extremes.

3.2.4 Machine Translation Research in the 1970s

By the mid-1970s, Bar-Hillel had moderated his views on FAHQMT, which some researchers felt signalled a return to a more pragmatic approach to machine translation research (Henisz-Dostert et al., 1979, pp. 34-36). At the beginning of the 1970s, no operational possibilities for machine translation were apparent, but Bar-Hillel’s change of heart, his acceptance of some human editing, coupled with improved computing technology and an eventual change from the preoccupation with FAHQMT, opened up new avenues of research (Henisz-Dostert et al., 1979, p. 37).

Consequently, a number of the components Bar-Hillel believed necessary for effective machine translation to work were achieved (Henisz-Dostert et al., 1979, pp. 37-38). The ability to input data through speedier, more advanced means, and the availability of large dictionaries with automated algorithmic routines, helped greatly to advance machine translation development. However, semantic coding and programming either was absent or poorly developed, thereby posing a serious impediment to accurate and effective translation. A small amount of funding was allocated to “more fundamental research on Computational Linguistics, and Artificial Intelligence, and some of this work took machine translation as a long term objective ...” (Arnold et al., 1994, p. 14).

By the end of the 1970s, machine translation research had experienced a ‘renaissance’ (Arnold et al., 1994, p. 14) because of several notable developments. The first was the purchase by the Commission of the European Communities (CEC) of the English-French version of the SYSTRAN system. Simultaneously, the CEC commissioned work on other dual language translation versions of the system and set up the EUROTA natural language processing project (Arnold et al., 1994, p. 14).

3.2.5 Machine Translation Research in the 1980s

Between 1950 and 1979, much of the machine translation architecture was direct or transformer architecture (Arnold et al., 1994). Machine translation research in the 1980s concentrated on different methodologies to improve translation accuracy and reduce technical complexities that had frustrated earlier research (Kay, 1996). Notably this research included the transfer and interlingual methodologies. The transformer and

transfer methodologies are outlined in the following sections. The interlingua methodology, designed to convert the source language into an interlingua and, thence, into the target language, currently a theoretical concept and the subject of this research study, is described in more detail later in this chapter.

3.2.5.1 Transformer or Direct Machine Translation Methodology

The transformer or direct translation method deals only with single language pairs and translates words directly from one language to another (Office of Japan Affairs, 1990, p. 21). Used for most of the earlier systems, it involved very little or no linguistic analysis and produced inaccurate translations. Although not designed to handle translations of complete documents, it has been used for machine translation of large databases, tables of contents and titles of technical publications (Office of Japan Affairs, 1990, p. 21).

Transformer methodologies transform texts in the source language into target language texts by using parsing rules that replace source language words with the equivalent target language words from a bilingual dictionary, and then re-arrange the word order to comply with the target language syntax (Arnold et al., 1994, pp. 59, 69-70).

According to Arnold et al. (1994, pp. 59, 69-70), the first stage of processing involves the parser, which completes preliminary analysis of the source language sentence. Arnold et al. (1994, pp. 59, 69-70) describe a process which is passed to a package of rules which in turn transforms the sentence into information provided by the parsing process. The transformation rules include bilingual dictionary rules and various rules to re-order words and, according to Arnold et al. (1994, pp. 59, 69-70):

Most of the engine's translational competence lies in the rules which transform bits of input sentence into bits of output sentence, including the bilingual

dictionary rules. In a sense a transformer system has some knowledge of the comparative grammar of the two languages - of what makes the one structurally different from the other.

The following diagram, after Arnold et al. (1994, p 79), highlights the processes involved in translating sentences using transformer methodology:

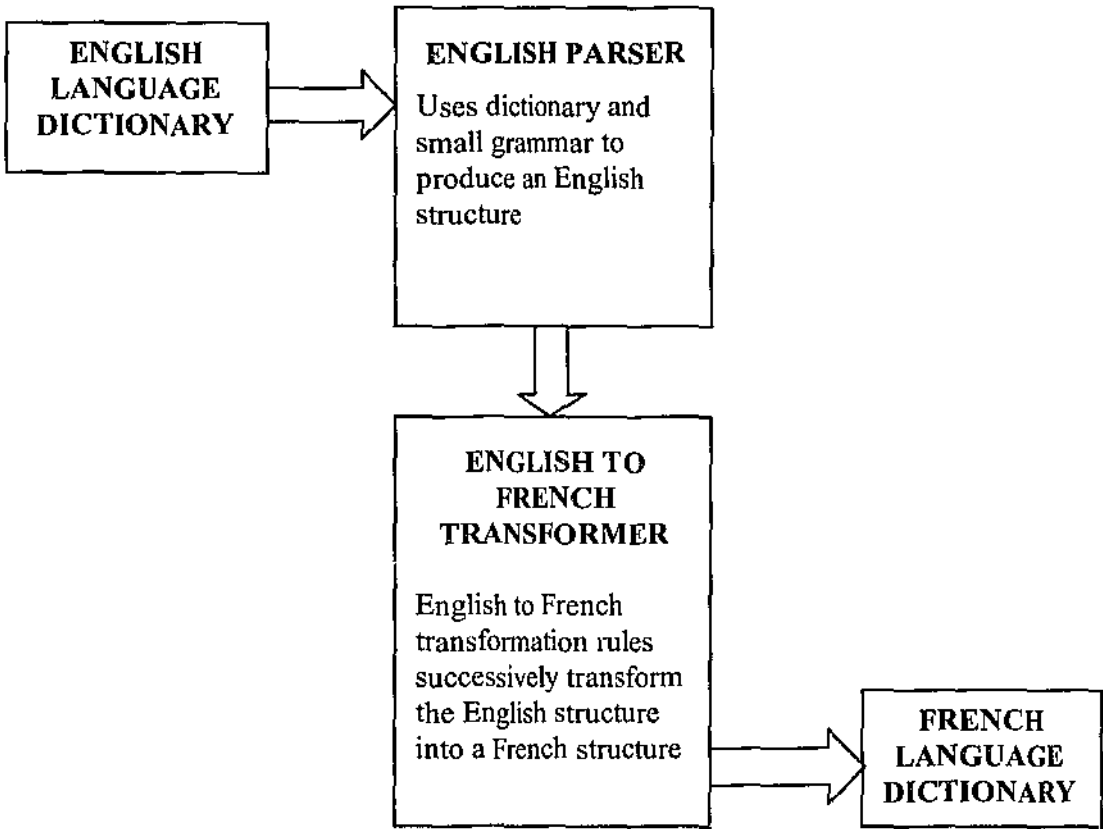


Figure 3 Sample transformer architecture

Transformer architecture proved to have drawbacks as it usually does not contain large grammar dictionaries (Gross, 1992). Moreover, it requires the input sentences to be simple in context and usually requires some modification by pre-editing processes to facilitate the translation processes (Arnold et al., 1994, p. 64).

3.2.5.2 The Transfer or Linguistic Knowledge Methodology

The transfer system is the most widely used machine translation strategy. It analyses the source language and then converts it into representations or a metalanguage capable of transposition into sentence structures through semantic analysis (Office of Japan Affairs, 1990, p. 21). The source language representations are then converted to the target language transfer representations. The final process synthesises the transfer language representations into target language text. This strategy works best when the language pairs are closely related. In transformer methodologies, the translation process relies on some knowledge of the source language and some knowledge on transforming partly analysed source sentences into strings that look like target language sentences (Arnold et al., 1994, p. 66).

By comparison, Arnold et al. (1994, p. 66) assert that the transfer methodology relies on extensive knowledge of both the source language and target language and of the relationships between analysed sentences in both languages. The transfer methodology accords the target language the same status as the source language, requiring a substantial grammar from both the source language and target language. These grammars are converted into a metalanguage representing their syntactical structure. They are then analysed by parsing programmes to determine the syntax structure of the source language. The process is completed by manipulation of the parsed data by language generators to produce output texts in the target language (Arnold et al., 1994, p. 66). These processes are summarized in the following diagram, after Arnold et al. (1994, p. 66):

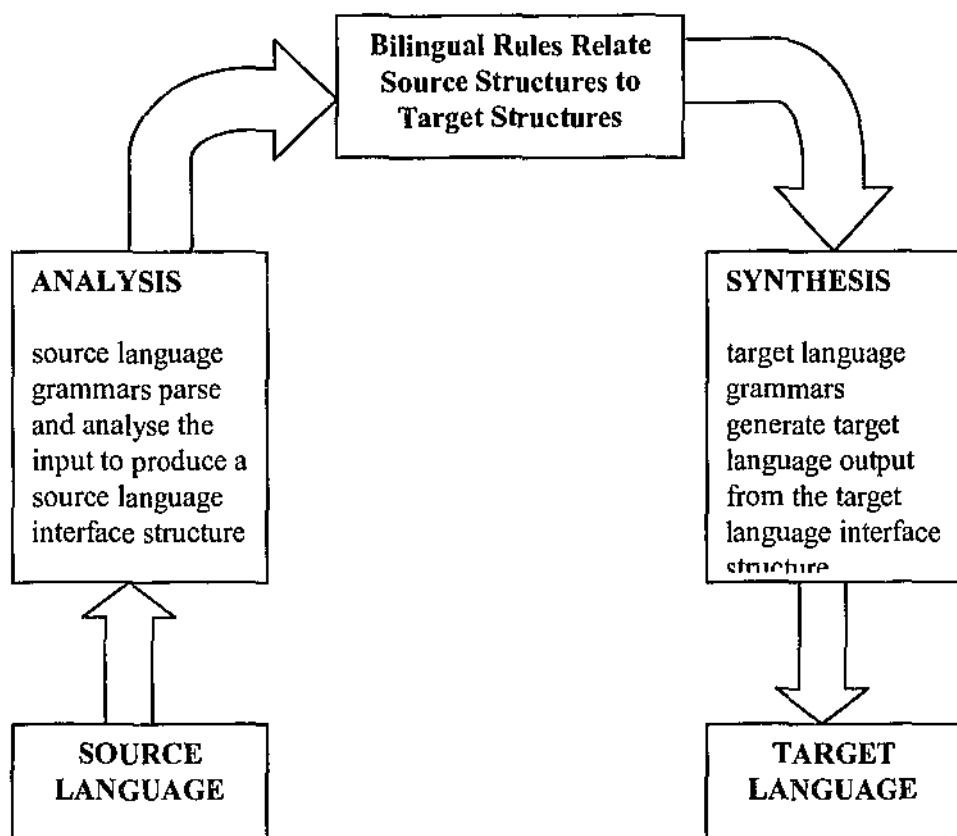


Figure 4 Basic structure of machine translation transfer architecture

The transfer methodology dominated machine translation research in the 1980s, taking a lead over transformer architecture and placing more reliance on linguistics (Gross, 1992). Specifically it required a more detailed understanding of both the source language and the target language (Gross, 1992). Arnold et al. (1994, pp. 66-69) point out that the translation from the source language to the target language is intended, but in practice most programs have problems ensuring that the lexical rules work in both directions. Human intervention is required to correct linguistic ambiguities detected by the machine translation mechanism and to confirm the correct version of the text according to the user's perceptions. This editing process, a key feature of machine translation, is described below.

3.2.5.3 Pre-editing and Post-editing Methodologies

Using direct or transfer translation methodologies, there are two possible ways in which human intervention may occur: pre-editing and post-editing. Pre-editing, in turn, may involve two kinds of operations. According to the Office of Japan Affairs (1990, pp. 11-12, 22), in one operation, texts are revised to eliminate structural or lexical ambiguities before being translated by a machine translator and, in a second operation, pre-editing of input text is produced for the machine translator. According to the Office of Japan Affairs (1990, pp. 11-12, 22), of the three editing options, post-editing is costly but is the most widely used option in terms of human input:

Usually a professional translator, the post-editor corrects the machine's output. This is more efficient when done directly on the screen using appropriate word processing software. If the post-editor writes the corrections on hard copy and they are then entered into the computer, the process is much slower. Some estimate that an experienced post-editor can produce 4,000 to 8,000 words a day and in some cases as many as 10,000.

Since human intervention is costly, the goal of some developmental efforts is fully automatic operation of a machine translation system. When the application involves merely gleaning the "gist" of the text, some of the large, general-purpose systems are used on a fully automatic basis. If a more careful translation is needed, output can be post-edited. Such systems include general-purpose systems that are able to handle a wide variety of source texts and special purpose systems designed to translate a special type of source text such as weather reports or abstracts of technical articles in particular fields (Office of Japan Affairs, 1990, pp. 11-12, 22-23).

3.2.6 Research from the 1990s to the Present

In more recent years, considerable discussion has concentrated on attempts to overcome the research problems inherent in machine translation design. Some researchers have concluded that the deepest level of sentence decomposition is not always desirable. A flexible system would deal with complex language structures more

effectively than through a more traditional word-by-word translation process (Arnold et al., 1994, p. 175). Research into sublanguage methodologies started in the 1980s and continued through to the present day, as did a study of 'integration' as a methodology to:

... combine MT with other Natural Language processing technologies, or to the (non-trivial) problems of integration of MT into general document processing that arise as one tries to make a practically and commercially usable system out of a research prototype MT system (Arnold et al., 1994, p. 173).

Translation applications, such as TransCheck, which permits translation verification much in the same way as word-processing spelling and grammar checking tools operate, became more available in the 1990s. While research into the development of more advanced models realised notable success in the case of TransCheck, results fell short of creating fully automated machine translation systems (Macklovitch, 1995, p. 10). Further efforts at overcoming pre-editing and post-editing issues were attempts to produce machine translation applications with the ability to reason or analyse some of the key component in a language sample. Arnold et al. (1994, pp. 180-182) described the development of the domain model, or knowledge-based machine translation, which was being undertaken at various centres in the USA. Ongoing experiments attempted to deal with issues such as metaphors, idioms and in-depth text analysis, in the hope of achieving high quality outcomes (Arnold et al., 1994, pp. 180-182; Morneau, 1992).

Long-standing engineering challenges included the need for a sophisticated understanding of linguistics and the development of robust grammatical and lexical resources, thereby overcoming the difficulty of manipulating and managing these resources to produce high quality results (Arnold et al., 1994, p. 182). In attempts to overcome these hurdles, which required huge resources and funding, some researchers

looked at alternative approaches. One of the more notable approaches was research into statistical methodologies (Arnold et al., 1994, p. 191).

In the 1990s, IBM examined the feasibility of a statistical or empirical approach to language processing, based on the probability of translating the correct word or phrase (Arnold et al., 1994, p. 191). The statistical approach paralleled technology used in speech recognition applications that use a ‘fuzzy logic’ to find the appropriate word (Arnold et al., 1994, p. 191). Some of the more promising commercial machine translation applications that became available during the 1990s included translation software developed by IBM, pre-editing software developed by a subsidiary of Xerox, updated versions of SYSTRAN’s original machine translation software used by the US Department of Defense and *Softissimo* which operates on IBM and Macintosh platforms (Arnold et al., 1994, p. 191). By the end of the twentieth century, machine translation still appeared to fall short of the earlier predictions (Garvin, 1972; Locke and Booth, 1955; Masterman, 1982) that it would deliver accurate, speedy and fully automated outcomes.

Commonly occurring syntax issues in natural languages impact heavily on the design of machine translation mechanisms, especially transfer-based methodologies described earlier in this chapter (Gentzler, 1993). The control model, SYSTRAN, used as part of the evaluation component of this study, is based on the transfer methodology. The following sections describe the key issues affecting the design and translation capabilities of transfer-based machine translation mechanisms. This section describes the linguistic complexities affecting transfer mechanisms and some of the machine translation strategies used to overcome them.

3.2.7 Issues of English Syntax

This section provides a brief insight into English language syntax and its effects on machine translation design. It shows how conjunctions, a basic syntactic structure and homonyms present considerable challenges to machine translation design. The first section introduces the problems caused by ambiguity in texts because of the vagaries of natural language syntax.

3.2.8 Coordination and Homonyms

According to Morneau (1992, p. 16), coordination is the linking together of two or more constituents with the same structure, creating, in effect, a single complex structure.

These linking elements are called coordinating conjunctions:

A language can have simple coordinating conjunctions, such as English "and", "or" and "but", as well as compound ones, such as English "either ... or ...", "both ... and ..." and "not only ... but also ..."

Morneau (1992, pp. 23-24) notes that coordinated structures are often ambiguous in meaning and highlights the impact that conjunctions have on text in the following example:

Consider, for example, the following sentence: *John wants to buy the painting of the fireplace and the Persian carpet.* Does John want to buy one item (a painting in which one can see both a carpet and a fireplace), or two items (a carpet and a painting)? Note that the ambiguity is present only in the written sentence. When spoken, a different stress, timing and intonational pattern (i.e., a different prosodic pattern) would be used for each meaning.

Coordinated structures are not the only ones that can suffer from ambiguity as homonyms and synonyms present similar problems to human and machine translators (Morneau, 1992, pp. 24-25). The ambiguity of meaning in natural languages may have

serious impacts upon machine translation research, especially in the case of homonyms, words with the same spelling but a range of possible meanings. Fowler (1968, p. 248) provides the following explanation of homonyms and synonyms:

Broadly speaking, homonyms are separate words that happen to be identical in form, and synonyms are separate words that happen to mean the same thing. *Pole*, a shaft or stake, is a native English word; *pole*, the terminal point of an axis, is borrowed from Greek; the words, then, are two and not one, but being identical in form are called homonyms. On the other hand *cat*, the animal, and *cat*, the flogging instrument, though they are identical in form and mean different things, are not separate words, but one word is used in different senses; they are therefore not homonyms. True synonyms, i.e. separate words exactly equivalent in meaning and use, are rare, and the word is applied more frequently to pairs or sets in which the equivalence is partial only ...

The effects of homonyms are highlighted in the following example:

John saw the man with a telescope. Did John use a telescope to see the man, or did the man have the telescope? In this case, the problem is with the English word "with," which can be interpreted in the sense of either accompaniment or instrument ... it's interesting and perhaps instructive to look at how natural languages deal with this ambiguity. In English, you could rephrase the sentence as follows (assuming John has the telescope): John watched with a telescope the man observing the crowd (Morneau, 1992, pp. 24-25).

Homonyms present a challenge to the translator because their meanings are ambiguous and, while meaning may be deduced by the human observer, machine translation mechanisms require additional data in order to make the correct interpretation (Hutchins, 1999). Textual word order is another factor that affects the design of transfer and similar machine translation methodologies. The wide variety of word order amongst natural languages and the difficulties that have to be overcome to ensure fluent translation are outlined in the following section.

3.2.9 Word Order

Morreau (1992, p. 2) asserts that one of the first patterns that typologists look at is the basic relationship between subject (S), verb (V) and object (O) in simple declarative sentences:

Determining these patterns is not always that simple, because many languages are inflected in such a way that they have a great deal of freedom in ordering their words. But even these languages will have some restrictions, or will tend to have dominant, preferred or unmarked word orders. There are six possible orderings: VSO, SVO, SOV, VOS, OVS, and OSV. It turns out that a very large majority of the world's languages fit within the first three categories; i.e., where the subject comes before the object. Here are some examples:

SOV - Turkish, Tamil, Japanese, Tibetan, Quechua

This is the largest single grouping, and probably accounts for slightly more than 40% of all languages.

Sample sentence: John fish ate.

SVO - English, Swahili, Chinese, Indonesian

This is also a very large group, although not quite as large as SOV. It probably accounts for slightly less than 40% of all languages.

Sample sentence: John ate fish.

VSO - Welsh, Hawaiian, Berber, Classical Arabic

This is not a very large group, but it is still quite significant. It probably accounts for about 15% of all languages.

Sample sentence: Ate John fish.

OVS - Guarijio (Azteco-Tanoan family, Mexico) Hixkaryana (Carib family, Brazil)

Sample sentence: Fish ate John.

VOS - Fijian (Austronesian family, Fiji) Terena (Arawakan family, Brazil)
Malagasy (Austronesian family, Madagascar)

Sample sentence: Ate fish John.

OSV - Jamamadi (Arawakan family, Brazil)

Sample sentence: Fish John ate.

The ability to identify accurately the word order rule in the source language and then transfer that through to the equivalent word order in the target language is an additional task necessary to guarantee that not only the correct meaning is transferred, but that the grammar is correct too (Arnold et al., 1994). The lexical meaning of words and word groups overlap and influence the syntax of texts, often resulting in complex word and grammatical relationships. Natural languages use dictionaries to define the various lexical forms of words and, often, their relationships with other words. The following section shows how dictionaries provide a similar function when used in a machine translation setting.

3.2.10 Dictionaries and their Importance to Machine Translation Mechanisms

Detailed description of dictionaries used in transfer methodology-based and other machine translation mechanisms is a complex field of research (Arnold et al., 1994, p. 86). Although lengthy discussion is beyond the scope of this study, it is important to provide an insight into the structural complexities of such dictionaries when used in a machine translation setting. Such an insight will also facilitate comparison of the dictionary structures of the control model and that of the prototype created for this study. According to Arnold et al. (1994, p. 83), dictionaries in existing machine translation systems are diverse in terms of formats, coverage, level of detail and precise formalism for lexical description, with different machine translation methodologies placing different requirements on the contents of the dictionaries. Arnold et al. (1994, p. 83) emphasise

these diverse formats by identifying the different dictionary structures in the three main machine translation methodologies:

... dictionaries in an interlingual system need not contain any translation information *per se*, all that is necessary is to associate words with the appropriate (collections of) interlingual concepts.

By contrast, transformer systems will typically give information about source language items, and their translations, including perhaps information that is really about the target language, and which is necessary to trigger certain transformations (e.g. to do with the placement of particles like *up* in *look it up*, and *look up the answer*).

Since transfer systems typically use more abstract levels of representation, the associated dictionaries have to contain information about these levels. Moreover, in a transfer system, especially one which is intended to deal with several languages, it is common to separate monolingual dictionaries for source and target languages (which give information about the various levels of representation involved in analysis and synthesis), from bilingual dictionaries which are involved in transfer (which normally relate source and target lexical items, and which normally contain information only about the levels of representation that are involved in transfer) (Arnold et al., 1994, p. 84).

Arnold et al. (1994, p. 84) believe that it is impractical to provide an exhaustive dictionary for most languages within a machine translation mechanism, because of the possibility of forming new words out of existing ones by various morphological processes:

One can get an idea of the sheer volume of information of this kind that may be needed by considering that for commercial purposes a lexicon with 20,000 entries is often considered as the minimum. This however is still only a modest percentage of existing words – the *Oxford English Dictionary* contains about 250,000 entries without being exhaustive even of general usage. In fact, no dictionary can ever be really complete. Not only do dictionaries generally restrict themselves to either general, or specialist technical vocabulary (but not both), in addition, new words are constantly being coined, borrowed, used in new senses, and formed by normal morphological processes (Arnold et al., 1994, pp. 84-85).

Arnold et al. (1994, p. 87) observe that dictionaries are the central component of machine translation systems and were initially treated in machine translation mechanisms as “little more than a list of rules ... which only allows information about part of speech to

be represented or translation rules that simply paired up the citation forms of source and target words.” However, they assert that, although some of the information that is found in a printed dictionary is of limited value in machine translation:

It is useful to make a distinction between the characteristics of a word itself (its inherent properties) and the restrictions it places on other words in its grammatical environment. Although this distinction is not explicitly drawn in paper dictionaries, information of both types is available in them. Information about grammatical properties includes the indication of gender in the French part of the bilingual dictionary entry, and the indication of number on nouns (typically, the citation form of nouns is the singular form, and information about number is only explicitly given for nouns which have only plural forms, such as *scissors*, and *trousers*) (Arnold et al., 1994, p. 87).

In general, the quality and detail of the information needed for a viable machine translation mechanism is at least equal to that found in printed dictionaries. This attention to quality and detail is highlighted in the following section.

3.2.11 Dictionaries and their Importance to Machine Translation Mechanisms – Subcategorisation

According to Gross (1992), the grammatical environments in which words appear may be divided into two distinct categories:

- subcategorisation information, which indicates the syntactic environment; and
- selectional restrictions, which describe semantic properties of the environment.

Arnold et al. (1994, p. 87) estimate that an adequate English dictionary would probably have to recognize at least twenty different subclasses of verbs and a similar number of adjectives and nouns. There is a degree of imprecision because subclasses depend on the level of distinctions required and the degree rules that are required in the

dictionary to capture regularities. Transitive verbs, such as the English word 'meet', depending on their syntactical form, may require special subcategorisation to ensure identification of the correct form during the analysis of the source language.

Syntactical structures are complicated further by the semantic attributes of commonly occurring transitive verbs, for example 'button'. The challenge of processing semantic attributes of words through a machine translation mechanism is shown in the following analysis:

Subcategorization information indicates that, for example, the verb *button* occurs with a noun phrase OBJECT. In fact, we know much more about the verb than this - the OBJECT, or in terms of semantic roles, the PATIENT, of the verb has to be a 'buttonable' thing, such as a piece of clothing, and that the SUBJECT (more precisely AGENT) of the verb is normally animate. Such information is commonly referred to as the selectional restrictions that words place on items that appear in constructions where they are the HEAD. (Arnold et al., 1994, p. 88).

As Arnold et al. (1994, p. 88) observe, these word attributes require extra rules to identify them in addition to inherent information about each word. Consequently, entries for each word in a machine translation dictionary would record these attributes and values as shown in the following example of the noun form of the English word 'button':

```
lex = button
cat = n
ntype = common
number =
human = no
concrete = yes
```

(Arnold et al., 1994, p. 88).

The above notation identifies the attributes of 'button' as being a common, non-human and concrete or non-abstract noun. The verb form of 'button' might be represented as follows:

lex = button
cat = v
vtype = main
finite =
person =
number =
subcat = subj obj
sem agent = human
sem patient = clothing

(Arnold et al., 1994, p. 89).

The above representation bears some resemblance to a dictionary providing the basic lexical, syntactical and semantical attributes of each word. The following section shows how these word attributes may be harnessed for computer processing through conversion into a metalanguage. The section outlines some of the technical and linguistic processes contemporary machine translation mechanisms use to codify lexical, syntactic and semantic attributes of texts into a metalanguage capable of translating natural languages.

3.2.12 Use of Metalanguages to Convert Natural Language

There are three factors inherent in language translation: word or lexical meaning, grammar or syntax, and semantics (Henisz-Dostert et al., 1979, p. 91). The lexical attributes of individual words, when translated into the equivalent target language words, will not always convey the correct meaning as they are often modified by syntax (Garvin, 1972, p. 11). Furthermore, syntax and semantic rules seem to overlap and it is often difficult to differentiate between them (Gentzler, 1993, p. 28; Henisz-Dostert et al., 1979, p. 10).

According to Piron (2003), contemporary machine translation systems normally require complex word relationship rules to identify the correct meaning of each word, while additional rules are required to recognise the syntactical attributes of words. Terry (1996) recognised that the conversion of natural language into computational notations faces inherent challenges:

... it is difficult to find languages which satisfy both requirements – efficient implementation seems to require the use of low-level languages, while easy description seems to require the use of high-level languages.

Consequently, considerable effort has gone into developing programming languages capable of defining natural languages effectively (Morneau, 1992). Such languages or metalanguages must be able to detect and manage the ambiguity common to natural languages to avoid error occurrence (Morneau, 1992). In a machine translation setting, elimination of errors engenders smooth translation of the user's natural language through the metalanguage to the lower-level programming languages (Terry, 1996).

Metalanguages consist of strings of symbols representing sentences or phrases to facilitate the identification and categorisation of the syntax and semantic rules inherent in sentences. Terry (1996) describes syntax as the form of the sentence, equivalent to grammar constructions, while semantics relates to the actual intended meaning based on a correctly constructed sentence. Jinks (1999) reasoned that developing mathematical rules to define semantics was highly problematic. He noted that, although it is possible to define a meaning for each token in a metalanguage-based alphabet, by placing tokens together, subtle interactions in meaning make precise semantic definition of a language difficult. Such interactions pose difficulties in translating natural languages through human effort, as is highlighted below:

Take the following English language example: “*The bank president ate a plate of spaghetti.*” Programs that attempt to understand the semantics of English often translate this to mean the president of a river bank ate a plate, and then a bunch of spaghetti fell on his lap. Solutions for describing the semantics of a language tend to be exponential, since interactions between a modifier and the object of the modifier have to be described. Consider how you would tell a computer, in a generic way, that *bank* in the above example refers to a financial institution. After you’ve developed a solution consider how the computer would then handle the following: ‘*The boat washed up onto the bank*’ (Jinks, 1999).

In defining the syntax for a language, a series of tokens creates strings in the metalanguage alphabet to facilitate the translation computation. Jinks (1999) asserts that these strings, or sentences, require a unique, metalanguage alphabet and a set of rules to manipulate the alphabet. In his following example, which highlights the importance of identifying the object or the accusative part of a sentence, Jinks (1999) uses the term “object” to mean the subject component of the English subject – verb – object sentence construction:

According to the rules of the English language, a sentence must have an object and an action on that object. In addition a sentence can have prepositional phrases, modifiers, and other constructs, which we do not necessarily need for this example. The following sentence is an example of an English language sentence: The cat sat. In this example there are three tokens, or members of the alphabet: *The*, *cat* and *sat*. There is an object *cat* and a verb *sat*. The following are not English language sentences: Sat ran run jump. We will refer to these as *phrases*. The first phrase is made of four tokens. It does not meet the rules of English for two reasons. The first is that it is missing an object, and the second is that it has four actions, not one. The second phrase also contains four tokens, and is not an English sentence because it is missing an object (Jinks, 1999).

Terry (1996) describes the formal study of syntax as applied to programming languages, which evolved into a system of notations for describing syntax:

The formal study of syntax as applied to programming languages took a great step forward in about 1960, with the publication of the *Algol 60 report* by Naur (1960, 1963), which used an elegant, yet simple, notation known as Backus-Naur-Form

(sometimes called Backus-Normal-Form) . . . Simply understood notations for describing semantics have not been so forthcoming, and many semantic features of languages are still described informally, or by example.

Syntax, therefore, is a set of rules, symbols and special words used to construct a program (Dale et al. 1997, p. 40).

3.2.13 Chomsky Normal Form (CNF)

In the 1950s, Noam Chomsky attempted to develop a metalanguage as a formal method of describing language (Jinks, 1999). He was the first to divide language study into syntax and semantics and to develop a set of tokens to specify languages (Jinks, 1999). Chomsky's metalanguage, known as CNF, uses a series of intermediate tokens to describe syntax rules. The left side of an expression in CNF shows a string with intermediate symbols, the right side shows how that string may be translated. CNF led to an important system of defining the length of the sentence by the expedient of permitting the defining symbol to be used within the expansion rules. Jinks (1999) highlights the use of this recursive language in the following example:

$$S \rightarrow \text{EXPRESSION}$$

The symbol EXPRESSION can be broken down into further translatable parts:

$$\text{EXPRESSION} \rightarrow \text{TERM} \mid \text{TERM} + \text{EXPRESSION} \mid \text{TERM} - \text{EXPRESSION}$$

Each of these 'sub' parts can be further expanded:

$$\text{TERM} \rightarrow \text{FACTOR} \mid \text{FACTOR} * \text{EXPRESSION} \mid \text{FACTOR} / \text{EXPRESSION}$$
$$\text{FACTOR} \rightarrow \text{NUMBER} \mid (\text{EXPRESSION})$$

NUMBER -> 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 | 0 |

1 NUMBER | 2 NUMBER | 3 NUMBER | 4 NUMBER | 5 NUMBER |
6 NUMBER | 7 NUMBER | 8 NUMBER | 9 NUMBER | 0 NUMBER

While these formulae are intended to turn a higher-level English sentence into a form more readily converted to programming language, they may be used for machine translation purposes for defining how any given natural language may be codified and organised (Jinks, 1999). The formulae facilitate conversion of the syntax into a computer readable format.

3.2.14 Backus Naur Form (BNF) and Extended Backus Naur Form (EBNF)

Backus and Naur independently developed a similar form for specifying language grammar (Jinks, 1999). BNF specified some languages more compactly than CNF and, subsequently, other researchers added symbols to BNF, creating EBNF. For example, EBNF uses the symbol := to specify assignment from the right to left sides of a rule, while terminal symbols are placed in single quotes. With EBNF, it is possible to define specific segments of the expression to be recursive or non-recursive as can be seen in Jinks' example below:

$S \text{ := EXPRESSION}$

$\text{EXPRESSION := TERM | TERM \{ [+,-] TERM \}}$

$\text{TERM := FACTOR | FACTOR \{ [*,/] FACTOR \}}$

$\text{FACTOR := NUMBER | '(' EXPRESSION ')'}$

$\text{NUMBER := '1' | '2' | '3' | '4' | '5' | '6' | '7' | '8' | '9' | '0' |}$

$\text{'1' NUMBER | '2' NUMBER | '3' NUMBER | '4' NUMBER | '5' NUMBER |}$
 $\text{'6' NUMBER | '7' NUMBER | '8' NUMBER | '9' NUMBER | '0' NUMBER}$

The use of curly braces allows the creation of strings of defined length. In the above example, FACTOR is an example of a recursive rule. Jinks (1999) highlights two other advantages EBNF has over CNF: EBNF supports loops to avoid some recursion, allowing for more efficient compilers. EBNF is a more standardised format for compiler writers than CNF.

3.2.15 Use of EBNF with Natural Languages

EBNF and other meta-notations, therefore, provide efficient vehicles with which to codify language for use with compilers. Such notational methods allow the user to select a notation that is more understandable than lower-level programming languages. Following the examples set out above, it may be surmised that sophisticated syntax structures may be created. Such a meta-notation based on a natural language, especially for machine translation creation, would mirror in detail the structure of the natural language. The syntax would contain basic elements of a sentence such as:

Letters:	a, b, c . . .
An alphabet:	{ a, b . . . z }
Tokens or Terminals representing:	words
Non-Terminals, that is:	<Sentence>, <Subject>, <Object>, <Clause>
Nouns:	<Noun> <Proper Noun> or <Common Noun>
Verbs:	<Regular>, <Irregular>, <Verb Tense>
Verb tense:	<Present Tense>, <Past tense>, <Future Tense>.

It follows that other parts of speech such as adjectives, prepositions and articles would be defined similarly, ensuring codification of the complete sentence syntax.

However, there are significant hurdles in codifying natural language syntax:

... properties expressed in natural language are typically neither precise enough to allow for easy mathematical analysis, nor in a form that invites the use of computational support in dealing with them. On the other hand, simply exhaustively enumerating languages ... is also clearly ineffective - in fact, impossible (Searls, 1993, pp. 44, 49).

As Searls (1999, p. 49) asserts, natural languages are not easily translated into computer languages because of their inherent complexity. Searls doubted the ability of large, sophisticated databases to catalogue the syntactic diversity of a natural language by notating every conceivable word-phrase combination.

3.2.15 Syntax Rules

In analysing the syntax of natural languages, linguists attempt to produce a set of grammar rules to which natural conversation and written text are 'expected' to conform. The following example highlights how this may be constructed using the English sentence: "The kind old man watched the boats in the harbor." Searls (1993, pp. 60-63) dissects this sentence as follows:

Here, the top-level rule says that a sentence consists of a noun phrase followed by a verb phrase. Following this are the phrase-level rules, and finally the lexical entries - the tokens in this case being English words - given according to their parts of speech. The study of human language has led to the creation of much more complex and specialized grammar formalisms, and parsers to deal with them:

sentence →	noun_phrase verb_phrase
noun_phrase →	article modified_noun modified_noun

modified_noun →	adjective modified_noun modified_noun prepositional_phrase noun
verb_phrase →	verb_phrase noun_phrase verb_phrase prepositional_phrase verb
prepositional_phrase →	preposition noun_phrase
noun →	man boats harbor
verb →	watched
adjective →	old kind
article →	the
preposition →	in

Such sentences may be effectively codified, but Searls (1993) reminds the researcher of the ambiguity of meaning found in all natural languages, including at the syntactic level. Manipulating the above sentence to change the meaning to “The old man the boats,” demonstrates how human analysis would attempt to obtain accurate understanding:

Most persons first parse man as a noun modified by old, then must backtrack upon “unexpectedly” encountering the end of the sentence, to reparse old as a noun and man as a verb. (Many, however, consider such phenomena to be jarring exceptions that prove the rule, that the human “parser” is ordinarily deterministic.) There has been much debate on the subject of where natural language lies on the Chomsky hierarchy, but there is little doubt that it is not regular, given the apparent capacity of all human languages to form arbitrarily large sets of nested dependencies (Searls, 1993, p. 62).

3.2.17 Nested Dependencies

The occurrence of nested dependencies, exemplified above, shows how important it is to ensure a precise compilation of the metalanguage. The compilation must be able to define the syntax of more complicated clauses and sentences to ensure that the correct

meaning of the source language is retained (Searls, 1993, pp. 61-62). Natural languages contain ambiguities and, when taken out of context, many clauses and sentences often have one or more different meanings from that intended by the original author (Piron, 2003).

Searls (1993, p. 62) provides an even more confusing example “The reaction the enzyme the gene the promoter controlled encoded catalyzed stopped.” He is able to deconstruct this sentence using the rules in the earlier example and then to demonstrate that it is a valid English sentence. Searls asserts that, to codify such complicated meanings, the program would require the construction of context-free grammar, to express such constructions. The issue of context-free language is described below:

There has been much debate on the subject of where natural language lies on the Chomsky hierarchy, but there is little doubt that it is not regular, given the apparent capacity of all human languages to form arbitrarily large sets of nested dependencies. An exaggerated example of such a construction would be “The reaction the enzyme the gene the promoter controlled encoded catalyzed stopped.” Moreover, a consensus appears to have formed that natural language is in fact greater than context-free (Schieber, 1985); this is largely because of the existence of crossing dependencies in certain languages . . . which are not suited to pushdown automata for reasons that should by now be apparent. In Dutch, for example, phrases similar to the one above have a different word order that crosses the dependencies (Bresnan et al. 1982).

Evidence that English is greater than context-free is typified by the sentence:

Some bourbon hater lover was nominated, which bourbon hater lover fainted (Postal & Langendoen, 1984). Here, the instances of hater and lover form crossing dependencies, and these can theoretically be propagated indefinitely into forms such as “bourbon hater lover lover hater . . .” which must be duplicated in a sentence of this type, in effect forming a copy language (Searls, 1993, p. 63).

The above examples of nested dependencies provided by Bresnan and Searls challenge human translation and pose problems for the linguistic and technical design of

machine translation mechanisms. With this challenge in mind, the following section introduces the use of EBNF in the control model.

3.2.18 Use of EBNF for the Construction of the Control Model

Artificial languages such as computer languages are designed to inhabit the lower levels of the Chomsky hierarchy, for reasons of clarity and efficiency. The standard EBNF for specifying computer language syntax is a context-free grammar format. Such metalanguages must be unambiguous to allow for fast parsing by compilers (Searls, 1993, p. 63). Cognisant of the challenges facing machine translation developers, use of the EBNF, according to Jinks (1999), allows the user to work with a notation that is more readily understandable than lower-level programming languages. Having converted the sentence into a metalanguage, some form of mathematical conversion process is required to complete the next phase of the translation process. This process or parsing is described in the following section.

3.2.19 Parsing Metalanguage Samples during the Transfer from the Source Language to the Target Language

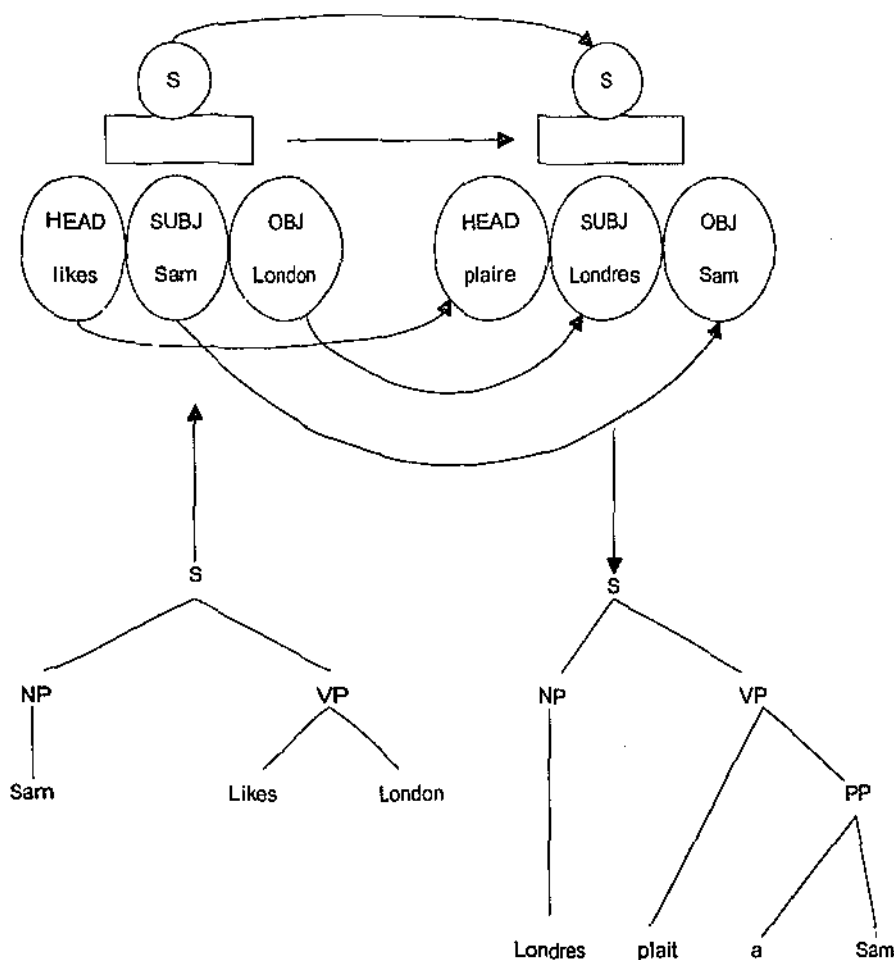
Quesada (1997) and Pereira (1998) observed that effective machine translation requires a robust natural language parsing algorithm to identify words in a sentence that are related in both structure and in meaning. A good parser must be able to determine the functionality of words and their roles in sentence structure according to the specified grammar. Aravind (1996) noted that the process of parsing a sentence in machine translation requires the following features:

- mathematical characterization of derivations in a grammar and the associated parsing algorithms;
- computing the time and space complexities of these algorithms in terms of the length of the sentence and the size of the grammar;
- comparing different grammar formalisms and showing equivalences among them wherever possible, thereby developing uniform parsing algorithms for a class of grammars;
- characterising parsing as deduction and a uniform specification of parsing algorithms for a wide class of grammars; and
- combining grammatical and statistical information for improving the efficiency of parsers and the ranking of multiple parses for a sentence.

Parsing tree structures are used to describe the structure of a sentence. They play a vital part in the transfer methodology to complete the conversion of source language text before comparison with equivalent text in the target language:

The structural descriptions provided by a grammar depend on the grammar formalism to which the grammar belongs. For the well-known context-free grammar (CFG) the structural description is, of course, the conventional phrase structure tree associated with the sentence. The parse tree describes the structure of the sentence. It is also the record of the history of derivation of the sentence. Thus, in this case the structural description and the history of the derivation are the same objects (Aravind, 1996).

Figure 5 shows how a short English sentence, “Sam likes London” is converted to a parse tree, highlighting the deconstruction of the English sample text and its French equivalent.



(Arnold et al., 1994, p. 73):

Figure 5 Complex transfers showing the equivalent phrases in the English and French parsing trees

The next stage in the process is the use of an algorithm capable of completing the parsing process. Aravind (1996) observed that during the 1980s a number of new grammar formalisms were introduced. These formalisms, designed to improve machine translation, included:

- eliminating transformations in a grammar;
- constructing linguistic structures beyond the reach of context-free grammars; and
- integrating syntax and semantics directly.

According to Aaravind (1996), among these new formalisms, there is one class of grammars called “mildly context-sensitive grammars”:

In particular, it has been shown that a number of grammar formalisms belonging to this class are weakly equivalent, i.e., they generate the same set of string languages. Specifically, tree-adjoining grammars (TAG), combinatory categorial grammars (CCG), linear indexed grammars (LIG), and head grammars (HG) are weakly equivalent. From the perspective of parsing, weak equivalence by itself is not very interesting because weak equivalence alone cannot guarantee that a parsing technique developed for one class of grammars can be extended to other classes, or a uniform parsing procedure can be developed for all these equivalent grammars. Fortunately, it has been shown that indeed it is possible to extend a recognition algorithm for CFGs (the CKY algorithm) for parsing linear indexed grammars (LIG). Then this parser can be adapted for parsing TAGs, HGs, as well as CCGs (Aravind, 1996).

According to Nakkhongkham (1998), after all the words in the sentence have been parsed, those words will be tagged for their functionality. Briscoe (1996) explained that a tagger will tag all words in a sentence to define their purposes in the sentence. At the same time, all words will be stored in a tree of words. When the tagger determines the functionality of all words, those words will be mapped to the words that have the same meaning and functionality in the other language. Park (1998) showed that this process can be completed by using a target tree that contains all words that have the same meaning in another language.

According to Zaenen (1996), no practical domain-independent parser of unrestricted text has been developed. Such a parser, once developed, should return the correct or a useful close analysis for 90 per cent or more of input sentences. To achieve high accuracy translations, the parser would need to overcome three major challenges:

- ‘chunking’ or appropriate segmentation of text into syntactically parsable units;
- disambiguation or selection of the unique semantically and pragmatically correct analysis from the potentially large number of syntactically legitimate ones returned; and
- undergeneration or dealing with cases of input outside the systems’ lexical or syntactic coverage.

These challenges pose severe problems for conventional parsers utilising standard parsing algorithms with a generative grammar. Zaenen (1996) observed that conventional parsers typically fail to return any useful information when faced with problems of undergeneration or chunking. Furthermore, they must rely on domain-specific detailed semantic information for disambiguation. Chunking, disambiguation and undergeneration are described briefly in the following sections.

3.2.19.1 Chunking

Chunking relates to the issues of punctuation that may contribute to inaccuracy in machine translation translations. The issue of chunking is exemplified by text sentences, beginning with a capital letter and ending with a period, which contain text adjuncts delimited by dashes, brackets or commas (Zaenen, 1996). Zaenen explains that such texts may not always stand in a syntactic relation with surrounding material. Hindle (1983) describes a system which copes with related problems, such as false starts and restarts in transcribed spontaneous speech. Jones (1994) describes a parser which makes limited

use of punctuation to constrain syntactic interpretation. According to Sampson (1994), analysis of a 150 kilobyte word balanced grammar reference revealed that over 60 per cent of sentences contain internal punctuation marks and around 30 per cent of these contain text-medial adjuncts. The challenges posed by chunking are significant and further research is required to build upon linguistic accounts of punctuation (Nunberg, 1990).

3.2.19.2 Disambiguation

Disambiguation relates to identifying the correct meaning within texts that contain one or more ambiguous interpretations. According to Zaenen (1996), disambiguation, using knowledge-based techniques, requires the specification of too much detailed semantic information to yield a robust domain-independent parser. She emphasises this by describing the analysis of the Susanne Corpus with a crude parser that found more than 80 per cent of sentences are structurally ambiguous. Other researchers (de Marcken, 1990; Hindle, 1983; Mitchell, 1980) have reported that several parsers, yielding a single canonical parse, are often applied to a (partially) disambiguated sequence of lexical syntactic categories. This simplification of the input to the parser circumvents many problems of lexical coverage suffered by systems which require rich sets of syntactic subcategories, encoding, for example, valency of verbs (Jensen, 1991). Jensen (1991) describes this method of parsing as canonical parsing which has been used to construct large hierarchies or 'treebanks' of parsed texts manually.

According to Marcus et al. (1983) and Leech et al. (1991), the availability of treebanks and, generally, large bodies of machine-readable textual data has provided

impetus to statistical approaches to disambiguation. Marcus et al. and Leech et al. report that some approaches use stochastic language modelling inspired by the success of lexical category disambiguation. They observe that while these techniques yielded promising results, the techniques have been largely supplanted by statistical parse decision techniques. In turn, these systems have yielded results of around 75 per cent accuracy in analysing test sentences from the same source as the unambiguous training material (Magerman et al. 1990). Zaenen (1996) observes that improvement of such results currently depends on the need to use more discriminating models of context, requiring more annotated training material to estimate adequately the parameters of such models. She believes that this approach may yield a robust automatic method for disambiguation of acceptable accuracy, but the grammars applied still suffer from undergeneration and are labour-intensive to develop.

3.2.19.3 Undergeneration

Undergeneration refers to the predictability of incorrect interpretation of texts occurring within a defined language environment and the resultant translation errors that occur. Considering problems associated with undergeneration, Zaenen (1996) noted that one project, a grammar for sentences from computer manuals containing words drawn from a restricted vocabulary of 3000 words, failed to analyse 4 per cent of unseen examples. Early work on undergeneration focussed on knowledge-based manual specification of error rules or rule relaxation strategies (Kwasny et al. 1981). This approach, similar to the canonical parse approach to ambiguity, is labour-intensive and suffers from the difficulty of predicting the types of error or extra-grammaticality liable to occur (Jensen, 1991). More recently, statistical induction to 'learn' the correct grammar

for a given corpus of data, using generalizations of maximum-likelihood re-estimation techniques, attempted to overcome prediction difficulties. This research was extended into a 'stochastic' language modelling from disambiguation to undergeneration by:

assuming the weakest grammar for a given category set --- that is, the one which contains all possible rules that can be formed for that category set --- and using iterative re-estimation of the rule probabilities to converge on the subset of these rules most appropriate to the description of the training corpus (Lari et al. 1990).

Several problems inherent in these statistical techniques have only been partially addressed in more recent research. As Zaenen (1996) observes, re-estimation involves considering all possible analyses of each sentence of the training corpus given a (initially) weak grammar, the search space is large and the likelihood of convergence on a useful grammar is low. Pereira et al. (1992) and Schabes et al. (1993) have carried out some promising research into statistical techniques to overcome undergeneration. They demonstrated that, by constraining the analyses considered during re-estimation to those consistent with manual parses of a treebank, they were able to reduce computational complexity significantly and to develop a useful grammar. While their results achieved almost 100 per cent grammatical coverage, Zaenen (1996) observes that the use of the resulting language model for disambiguation only yields fully correct analyses in about 30 per cent of cases.

The linguistic and technical issues posed by the three issues described above provide an insight into the complexities of the computing involved in the design of transfer-based methodologies and concludes the literature review of traditional machine translation methodologies. The following section provides a review of

research similar to this study and focuses on how the transfer-based designs influenced the development of new research into an interlingua based machine translation.

3.3 Summary of Studies Similar to this Research

Recent machine translation research has shown potential methods for improved translation and these methods form the foundation for this study. This study investigated the feasibility of using an interlingua incorporating a precise sublanguage methodology to translate the sample survey texts. The study examined the inherent machine translation design problems and identified strategies capable of producing high-accuracy translations. The following sections provide a history of the interlingua methodology and a description of the linguistic and technical attributes of the methodology.

3.3.1 A Brief History of the Interlingua Methodology

Some machine translation developers recognised that the deeper they investigated disassembling natural languages to translate the original meaning and then transfer it with full integrity into a target language, the more some form of intermediary system was required (Arnold et al., 1994; Kay, 1996, pp. 64-66). Applications of such intermediary or interlingua systems to enforce lexical, syntactic and semantic consistency between the source language and the target language have shown greater promise than conventional machine translation approaches (Arnold et al., 1994, pp. 75-76). The intermediary stage where meaning between the source language and target language is the same may be

described as an interlingua system (Arnold et al., 1994, pp. 75-76; Witkan, 1988).

Although research into the interlingua methodology commenced in the 1950s (Arnold et al., 1994, p. 64), the methodology is still largely a theoretical concept.

Commercial applications based on an interlingua methodology include the PIVOT system of NEC (Okumura et al. 1989); the ATLAS II of Fujitsu (Okumura et al. 1989; Uchida, 1989) and the LOGOS system (Office of Japan Affairs, 1990, p. 21). PIVOT and ATLAS II are systems based on the two-step method by which texts are translated from the source language to an artificial interlingual representation and, then, into the target language. The LOGOS system makes use of an hybridised interlingual/transfer architecture.

In the 1980s, Dutch interlingua researchers examined the use of natural or artificial languages and developed the Distributed Language Translation (DLT), based on a modification of Esperanto and the Rosetta system and an experimentation with Montague semantics (Arnold et al., 1994; Witkan, 1988). The DLT experiment, carried out by Buro voor Systeemontwikkeling, received some publicity before it ended in 1990 (Schubert, 1988). In 1999, the Universal Translation Language (UTL) machine translation project proposed a new approach to multilingualisation, based on the usage of an artificial unambiguous human language or interlingua (Sabaris et al., 2001). The UTL aimed to provide a tool to convert a specific text written in a given natural language into an indefinite number of other languages in a process of human assisted machine translation:

The role of the human translator involved in this process will be confined to provide the computer with a translation of the original text into a special artificial language (the UTL language) that the computer can “understand” and translate better than the original text (written in a natural language). The UTL language is therefore a constructed human language, based on Esperanto, which has been optimized for being processed accurately by a translating software, and which is to be employed by a UTL human translator who has previously been instructed in it (Sabaris et al., 2001).

The UTL project designers considered that an interlingua for machine translation might face insurmountable challenges and, so, used a novel approach by applying human translators to process the input from the source language. They believed that:

... it became obvious that our language could also be used within an already built MT interlingual system. In these systems, writing directly in the interlingual code may be the most accurate way to prepare an interlingual document free of errors, but it would be a quite slow and complicated task even in the hands of a trained user. The UTL language may serve here as a language-interface which allows programming interlingual code in an indirect and faster manner, in the same way that, in computer science, high-level languages are used to program in a faster and simpler way than with low-level languages (Sabaris et al., 2001).

A small prototype was developed in the Computer Science Faculty of the University of Coruña in Spain. The concept was adapted for an ‘interlingual’ machine translation project currently under development at the Institute of Advanced Studies of the United Nations University (UNU) in partnership with other research institutes, universities, and research and development groups in several countries (Sabaris et al., 2001). Details of the efficacy of the UNU prototype were not available at the time this study was submitted. Interlingua research carried out by Carnegie Mellon University, Pittsburgh, using knowledge-based systems within the artificial intelligence (AI) community, also produced some encouraging results, which Arnold et al. (1994, p. 77) used in their more recent research in the 1990s. They made the following observation:

The argument is that MT must go beyond purely linguistic information (syntax and semantics); translation involves “understanding” the content of text and must refer to knowledge of the “real world.” Such an approach implies translation via intermediate representations based on (extra-linguistic) “universal” elements.

Leavitt et al. (1994, p. 4) outlined some of the earlier research into interlingua methodologies, which included:

- the creation of a highly structured language-neutral representation not subject to the nuances, ambiguities, and other vagaries of natural languages (Leavitt et al. 1994, p. 4);
- the use of human languages, planned or otherwise, such as Esperanto (Witkan, 1988) and Aymara (Guzmán de Rojas, 1988) as interlinguas;
- the generation of multiple target language texts directly from raw data interlinguas collected by expert systems over a subdomain, effectively avoiding natural language complexities on input, e.g., marine weather forecasts or employment statistics reports (Kittredge, 1993).

An interlingua may overcome some of the inherent shortcomings of contemporary automated translation mechanisms (Hutchins, 1995, p. 4; Leavitt et al. 1994, p. 2; Schubert, 1998). The following two sections emphasise how an interlingua system offers two potential advantages over contemporary machine translation systems, namely, a reduction in the number of dictionary pairs required and the ability to reduce linguistic complexities during translation processes.

3.3.2 Use of an Interlingua to Reduce Issues with Language Pairs

Arnold et al. (1994, p. 76) compared the structure of contemporary systems with an interlingua system. They found that the additional use of dictionary pairs in contemporary systems required significant resources to create the additional dictionaries:

... an interlingual system promises to be much easier to extend by adding new language pairs, than a transfer system (or a transformer system). This is because, providing the interlingua is properly designed, it should be possible to add a new language to a system simply by adding analysis and synthesis components for it. Compare this with a transfer system, where one needs not only analysis and synthesis, but also transfer components into all the other languages involved in the system. Since there is one transfer for each language pair, N languages require transfer components (one does not need a transfer component from a language into itself). For example, extending a system for 3 languages into one for 5 means writing 14 new transfer components (as one goes from 6 to 20 transfer components), and going from a 5 language system to a 9 language system means going from 20 components to 72.

Figure 2, shown in Chapter 2, highlights how the number of dictionary pairs are reduced to 4 using the interlingua formula of $2n$ where $n = 4$. The interlingua system converts the source language into the intermediary lingual form and then converts the interlingual form to the final source language output format (Arnold et al., 1994). Figure 6 shows the sequences of these processes:

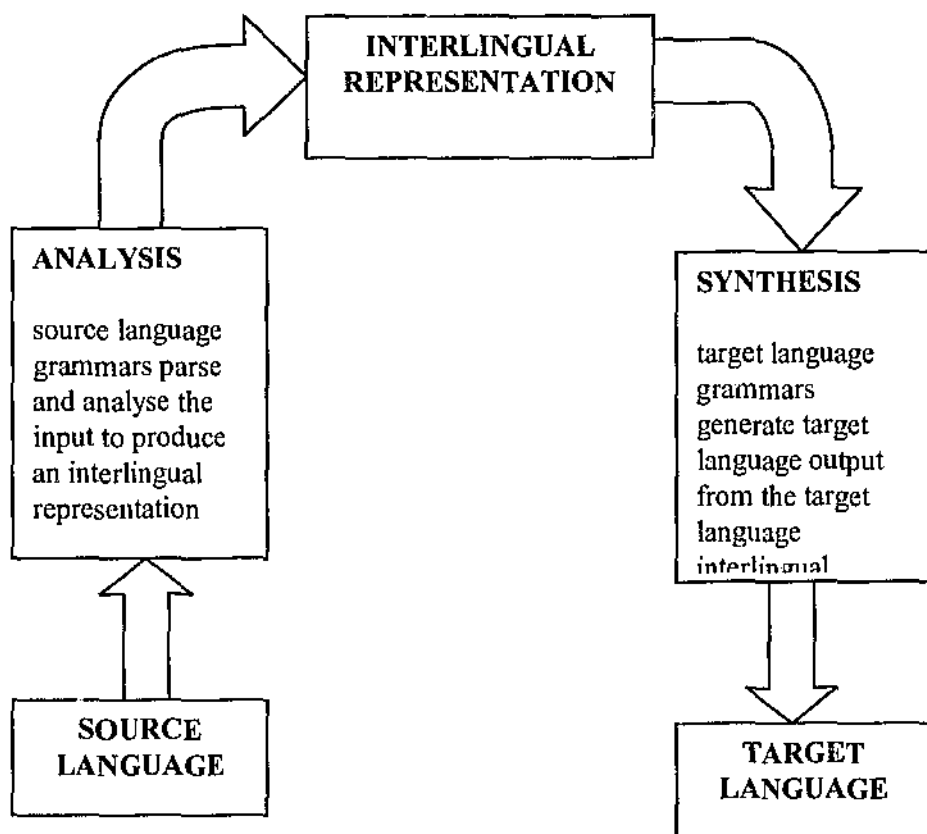


Figure 6 An interlingua mechanism showing how source language text is converted into an intermediary form before being converted to the target language

The following section describes how an interlingua system has the potential to reduce the syntax and lexical complexities inherent in contemporary systems.

3.3.3 Use of an Interlingua to Reduce Structured Syntax and Lexical Complexities

Leavitt et al. (1994, p. 2) identify the linguistic challenges to machine translation design:

Multilingual machine translation is a complex problem. The different knowledge sources for the various languages need to be developed by separate language

experts, and domain knowledge has to be encoded into the domain model by an expert in the domain. This calls for a modular architecture that separates knowledge sources from processing engines, shields different languages from each other to avoid language-pair-specific development, and that provides module interfaces that are habitable for language experts who are not necessarily skilled programmers.

Leavitt et al. (1994, p. 2) advocate the use of an interlingua to minimise linguistic challenges to machine translation design:

The solution to these challenges is to divide the problem into source language analysis, and target language generation. . . The interface between these two components is an intermediate language called the interlingua. It is a language-independent, unambiguous representation of the meaning of the input text that has to fulfill [sic] a simple functional condition: the interlingua representation must be sufficient for accurate translation in a technical domain.

The basic design of Leavitt et al.'s (1994, p. 3) interlingua model, highlighting the conversion of source language text into three different target languages, is shown in

Figure 7:

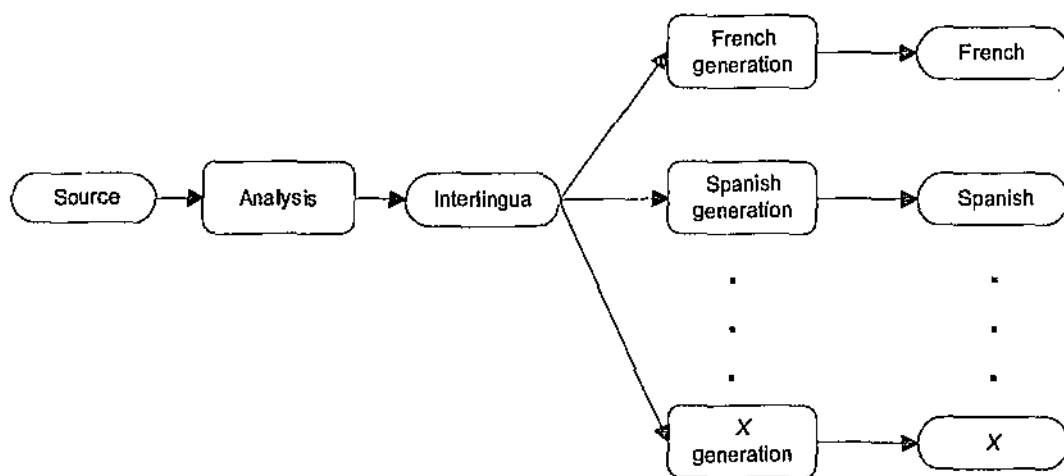


Figure 7 Basic design of Leavitt's interlingua model showing conversion of source language into several target language forms

A carefully designed interlingua system offers a simpler analysis than equivalent natural language as:

By authoring directly in the language-neutral form, expensive analysis processing of natural language source text can be avoided. The synthesis component may still be relatively complicated. Due to the abstract nature of these representations, effective authoring support must be provided. Study into this includes the WYSIWYM technique (Power & Scott 1998). The main cost saving is that the organisation will only need to author one version of each document, as opposed to effectively many parallel authorings when the translation is carried out manually. This efficiency savings should also lead to a reduction in the number of synchronisation, linguistic and distributional problems introduced into the workflow (Boardman, 1999).

The obstacles affecting interlingua design and construction, because of the difference in word order structure between two or more natural languages, are heightened when the natural languages have widely differing word order regimes (Office of Japan Affairs, 1990, pp. 11-12, 22). In widely disparate languages the meaning present in the different language texts would require additional cataloguing to reflect the relationships between the interlingua and the natural languages (Office of Japan Affairs, 1990, pp. 11-12, 22). This study uses two related natural languages, English and French, which, although they have different vocabularies and variations in syntax, also share some linguistic similarities. This study was cognisant of these factors and observations were made to see whether the different vocabularies affected significantly the ability of the interlingua, incorporated in the prototype model, to achieve accurate translations without the need for any additional cataloguing rules.

This study uses Esperanto because of its reported ability, as a spoken and written language, to overcome the issue of word order difficulties outlined earlier in this chapter. Esperanto has a syntax specifically designed to identify 'the subject, verb, object and

indirect object in more complex texts (Stuttard, 1952, pp. 16-19). This ability to identify syntax correctly ensures the precise definition of the natural language texts (Stuttard, 1952, pp. 16-19) and was used in the study to ensure an accurate compilation of the language dictionaries. Moreover, the actual word order, in spoken and written Esperanto, is itself unimportant as the use of suffixes to modify key words guarantees unambiguous results. The reasons justifying the selection of Esperanto as the interlingua are outlined in 2.5.1.2.

The following section describes the second strategy used in this study, a sublanguage methodology. It includes a history of sublanguages and a description of the linguistic and technical attributes of the methodology.

3.3.4 An Outline of the History of Sublanguage Methodologies

In the 1980s, machine translation programs used in commercial contexts produced some improved outcomes. A manufacturer, Perkins Engines, claimed it had made significant savings in translating manuals by using a version of the WEIDNER machine translation program (Arnold et al., 1994, p. 7). These researchers concluded that working with a smaller, defined lexicon produced higher translation accuracy than if they had been using larger, encyclopaedic dictionaries. Boardman (1999) lauded the successes of sublanguage systems that, by restricting syntax complexity and the size of the lexicon, offered benefits for machine translation system design, including:

... simpler analysis and synthesis modules, a smaller lexicon, an increase in tractability and the avoidance of difficult constructs such as idioms. Simplified semantic and temporal dimensions can also be used. In general, system complexity is reduced ... A key example is the Météo system ... which is

possibly the most successful MT system to date and has been translating weather reports from English to French for the Canadian Office of Meteorology for nearly two decades. Météo was based on the specialised sublanguage of weather forecasts, used a simple set of temporal dimensions and avoided constructs such as idioms (Boardman, 1999).

Still in use in the 1990s, Météo required approximately 4 per cent human intervention to ensure accuracy of interpretation (Boardman, 1999; Mitamura et al. 1991). The significance of this program was the use of a sublanguage designed for communicating between experts in such areas as science, medicine or technology (Arnold et al., 1994, pp. 150-151).

Many of the more successful machine translation programs are of this nature, relying on smaller, specialised, non-natural language vocabularies (Arnold et al., 1994, pp. 150-151; Kay, 1996). As observed by Mitamura et al. (1991, p. 2), previous attempts to “define controlled input languages” have tried to reduce complexity either by limiting the vocabulary to a very small size or by limiting syntax to just a few constructions. The following section describes the fundamental processes involved in sublanguage methodologies.

3.3.5 A Description of Sublanguage Methodologies

According to Mitamura et al. (1991, pp. 2-3), there are two broad classes of sublanguage systems that may be adapted to machine translation processing:

- non-domain specific, where words used in the source text are limited to a basic vocabulary of about 14,000 distinct word senses; and
- domain-specific, where technical terms are limited to a pre-defined vocabulary.

The idea of using controlled languages to simplify translation between natural languages arose during the 1930s, when linguists and scholars devoted considerable effort to establishing a 'minimal' variety of English (Arnold et al., 1994, p. 146). The 'minimal' variety attempted to make English accessible to the largest possible number of persons worldwide:

Basic English, as it was called, differed from previous attempts to construct universal languages in that it was a perfectly well-formed part of English, rather than some entirely artificial or hybrid construction such as Esperanto. One of the central ideas of the Basic English movement was that the number of general-purpose words needed for writing anything from a simple letter of receipt through to a major speech on the world economic situation could be a few hundred rather than the 75,000 upward available to skilled native speakers. This lexical economy was to be achieved in part by using 'operator verbs' with the set of nouns and adjectives to stand in for the vast number of derived verbs which are frequently used (Arnold et al., 1994, p. 147).

The introduction of controlled languages led to two important additional benefits:

First, the readability and clarity of a controlled language technical text often seems better than uncontrolled texts - even for native English readers. Second, controlled languages produce better results with MT than uncontrolled languages (Arnold et al., 1994, p. 147).

Controlled languages provided superior machine translation performance because:

First, the restricted vocabulary means that fewer words need to be added to the MT system dictionaries and more effort can be put into getting the entries which are required right. Second, the grammar component of the system can be tailored to handle all and only those constructions which are licensed by the controlled language specification, a specification which excludes the most difficult and

ambiguous constructions anyway ... Using a restricted pool of words and terms also means that the system dictionaries can be tailored (by the MT supplier or responsible translator) to cover exactly that set of words and their translations. Being consistent about the use of terms will also help to improve the overall consistency and quality of the texts being translated ... Thus, concentration on a sublanguage not only restricts the vocabulary and the number of source and target language constructions to be considered, it can also restrict the number of possible target translations (Arnold et al., 1994, p. 147).

Given that sublanguages offer potential improvements in output of machine translation systems, and the fact that most commercial institutions have their major translation needs in defined areas, it is not surprising that many research systems concentrated on restricted input (Arnold et al., 1994, p. 147). Arnold et al. (1994, p. 147) provided the following comparison between a complex standard English sentence and its Basic English version. This example illustrates the advantage of the precise and relatively uncomplicated Basic English:

Standard English

It is equally important that there should be no seasonal changes in the procedures, as, although aircraft fuel system icing due to water contaminations is more often met with in winter, it can be equally dangerous during the summer months.

Basic English

Use the same procedure all the time, because water in the fuel system can freeze during winter or summer (Arnold et al., 1994, p. 147).

In research undertaken by Mitamura et al. (1991, pp. 2-3) use of the KANT strategy overcame earlier problems by using controlled input languages during translation:

In contrast to systems which limit vocabulary to just a few thousand words, KANT allows a larger vocabulary to be represented in the lexicon. KANT also places principled grammatical limitations on the source text that are loose enough to allow a degree of stylistic variation which supports productive authoring, while controlling the complexity of the input in areas that are crucial for accurate translation.

Of interest to this study was the use of word groups or phrases in translation research carried out by Mitamura et al. (1991, pp. 2-3):

Although it is possible to reduce ambiguity by limiting the use of certain kinds of phrases, some phrases which introduce a high level of ambiguity (such as prepositional phrases) cannot be ruled out. To resolve the ambiguity introduced by multiple possible phrase attachments, KANT uses an explicit domain model to narrow the set of potential interpretations.

The KANT system incorporated a set of syntactic structures or word group phrases with synonym rules to avoid ambiguous interpretations. The researchers believed this made it possible for KANT to assign a complete and accurate semantic representation to each input sentence (Mitamura et al. 1991, pp. 2-3). KANT is not designed to translate all of the English language, only a precisely defined subset that forms a constrained technical English (Leavitt et al. 1994, pp. 1-2). Research into the use of controlled languages as a subset of the sublanguage methodology has also produced some implications for machine translation development.

According to Zens et al. (2002, p. 2), a key issue in modelling the metalanguage string in transfer-based models is the difficulty of deciding how to define the correspondences between words of the target sentence and the words of the source sentence. They explain, that in typical cases, a pairwise dependency may be constructed that considers all word pairs between two languages. Models based on these constructions are called alignment models. Zens et al. (2002, p. 5) also assert that the major disadvantage of single-word-based alignment models is that contextual information is not taken into account. They explain that the semantic meaning is often lost when there is over-reliance on lexical and syntactical constructions. Zens et al. (2002, pp. 5-6)

advocated the use of a phrase-based translation (PBT) strategy that segments the source language sentence into phrases or word groups, then translates the word groups and finally composes the target language. Figure 8 shows an example provided by Zens et al. of the word group format:

SOURCE: abends würde ich gerne entspannen und vielleicht in die Sauna gehen	
Source segmentation	translation
abends	in the evening
würde ich gerne entspannen	I would like to relax
und	and
vielleicht in die Sauna gehen	maybe go to the sauna
TARGET: in the evening I would like to relax and maybe go to the sauna	

Figure 8 Example of phrase-based translation

In their adaptation of the PBT strategy, Zens at al. (2002, p. 6), constructed phrases for extraction from a bilingual word aligned training corpus. They added two constraints to the structure: that the words are consecutive and are consistent with the word alignment matrix. An example of aligned bilingual phrases is shown in Figure 9 below:

source phrase	target phrase
ja	well
ja,	well,
ja, guten Tag	well, hello
ja, guten Tag.	well, hello.
,	,
, guten Tag	, hello
, guten Tag	, hello.
guten Tag	hello
guten Tag	hello.
.	.

Figure 9 An example of an aligned bilingual phrase

However, because the strategy used by Zens et al. (2002, p. 7) is transfer methodology-based, they used a series of algorithms to construct the links between the bilingual pairs and to search the bilingual dictionaries for other word groups that may precede or succeed the primary word group. This study includes some features of the PBT strategy that will be incorporated in an interlingua mechanism, not a transfer system, to test the efficacy of the PBT strategy.

3.4 Chapter Summary

This chapter has provided an insight into the history of machine translation research as far as it affects this study. It described the different types of machine translation models, the limitations of each type of model and alternative models, which offered some compensating strategies. Two of these strategies invited further study: an interlingua model incorporating a sublanguage methodology. This study will test the efficacy of these combined strategies through the construction of a prototype model. It will examine the translation accuracy of the prototype model and evaluate its technical and linguistic structures. The results of these tests will then be compared with the translation capability and structures of a transfer-based control model.

This study proposes that the prototype model will incorporate features of an Esperanto-based interlingua set. It will possess strictly defined syntax and lexical environments to reduce the complexity of the translation mechanisms employed, with consequent reduction in the probability of error. There appears to be much merit in the use of such a model, but this does not preclude some design challenges. Chapter 4 will

describe the research design used to test and evaluate the prototype model and its comparison with the control model.

4 THE RESEARCH DESIGN

4.1 Introduction

This chapter outlines the design used to answer the research question in 2.9 and sub-questions stated in section 2.10. It describes the structure of the control and prototype models and the methodology used in each case to process the sample texts. It explains the methodology of analysing the efficacy of each model by comparing the two sets of translation results. Finally, this chapter will provide a rationale for evaluating the efficacy of the two strategies incorporated in the prototype model.

4.2 General Method

This research centred on the use of a hospital survey questionnaire, an English language document, which is attached in Appendix B. Sample texts from the questionnaire were translated by each model to obtain data for comparison. The research was restricted to analysing the linguistic relationships between words and their direct impact on the construction of the prototype model. Therefore, no detailed description of the engineering techniques used to operate the prototype is included in this study. Moreover, the identical sample texts used in the research were limited to a maximum size of eleven words because of resource and time constraints.

The structures of each model are based on two different machine translation methodologies, which are outlined in Chapters 2 and 3. For ease of reference, the key features of each model's structure described in this chapter are referenced to these methodologies in the preceding chapters. The ability to 'reverse engineer' the control model application software was desirable to facilitate comparison with the prototype model structure. However, this was impracticable because of technical and copyright issues. Notwithstanding these difficulties, two machine translation research papers (Senellart et al. 2002; SYSTRAN, 2002) outlining the general methodology of the control model were located, thus facilitating a theoretical reconstruction of the basic structure of the control model. The prototype model is an experimental model, and a detailed description of its construction, methodology and the processes involved in translating the sample texts is included in this chapter. The inclusion of this information facilitated comparison of the two models and enabled evaluation of their structures.

4.3 Specific Procedures

This chapter is divided into three sections: the structure and methodology of the control model; a description of the structure and methodology of the prototype model; and, an outline of the methodology used to evaluate the results obtained from the control and prototype models.

4.3.1 The Control Model: Structure and Methodology

This section describes the structure of the control model and the processes involved in translating sample texts through the transfer methodology. It provides examples of translation of sample texts for comparison with the results obtained from the prototype tests.

4.3.1.1 The Control Model: Selection

To ensure that the comparison of the translation results between the two models was meaningful and relevant, the control model had to meet four key selection criteria. It needed to:

1. be capable of translating sample texts of between one and eleven words. The length of sentences used in the survey questionnaire was restricted to a maximum of eleven words to reduce the occurrence of complex syntax that would require investigation beyond the scope of the study;
2. be capable of translating English to French and French to English, as required for the evaluation of the efficacy of the prototype mechanism;
3. be transfer methodology-based. The transfer methodology was selected, as this is the most commonly used architecture as described in Chapter 3. It was logical to compare the results from this methodology to those using the interlingua model; and

4. cost between \$A50 and \$A2,000. Cost factors prohibited the evaluation of expensive applications, therefore publicly available on-line applications were surveyed for use as potential control models.

A number of different applications were sampled to ascertain their suitability as the control model:

- *SDL International Translator* <http://www.sdlintl.com/>
- *Babelfish On-line Translator* <http://www.babelfish.com/>
- *SYSTRAN On-Line Translator* <http://www.systranbox.com/systran/box>, with 34 translation dictionaries.

The *SDL International Translator* and the *Babelfish On-Line Translator* were found to be unsuitable for use as a control model. The translation capability of the *SDL International Translator* was found to be below the level of translation sophistication required. The *Babelfish On-line Translator* was no longer available for cost-free translations and was eliminated as a candidate model. The *SYSTRAN On-Line Translator* was selected as the control model when preliminary examination confirmed it met the above criteria.

4.3.1.2 The Control Model: Description of the Methodology of the *SYSTRAN On-Line Translator*

The SYSTRAN Software company (SYSTRAN, 2003) claims that thirty years of machine translation research culminated in its latest range of machine translation applications, including the *SYSTRAN On-Line Translator*. Senellart et al. (2002, p. 1) outlines the features incorporated in this translation software application:

- a transfer-based methodology;
- a morphological analyser;
- a statistical guesser;
- a finite-state automaton;
- a context-free grammar;
- a cross-application approach for high quality dictionary building in terminology import and exchange; and
- an intuitive methodology to guess the meaning of words with an intuitive grammar selection methodology.

The statistical grammar identification methodology selects and interprets source language texts before converting them into the target language output and uses an intuitive grammar identification based on a statistical analyser. According to Senellart et al. (2002), such analysers interpret the meaning of the source language text based on the probability of translating the correct word or phrase. The translation accuracy of this methodology is reportedly low and an overview of its key features is provided in section 3.2.6.

To demonstrate how the key linguistic and technical factors are addressed by the transfer methodology, the following sections use sample texts from the survey questionnaire. The purpose was to highlight the linguistic dynamics incorporated in the control model and to relate them back to the description of the methodologies set out in Chapter 3.

4.3.1.3 The Control Model: Analysis and Translation of Individual Sample Words in the English Language

Each word entered into the control model's English and French dictionaries requires lexical and syntactical classification. Using such classification systems ensures that the mechanism recognises any alternative meanings of each word and its relationships with other words. These machine translation dictionaries, which are referred to in 3.2.10 and 3.2.11, play a crucial part in determining meaning through the mechanism's ability to recognise the attributes of each word and its interrelationships with other words contained in the same language dictionary. With the need to incorporate dictionaries as part of a machine translator, preliminary analysis focussed upon the following sample question selected from the survey questionnaire and its possible alternative answers:

How important is this need to you now?

Not at all
A little
Somewhat
Very much
Extremely

Of these, the answer 'Not at all' was selected as the primary sample text. Analysis of the three words contained in the phrase was completed. This examination provided an insight into the various English language grammatical and lexical forms of each word. Analysis of both forms was required to show the linguistic issues affecting the translation processes incorporated in the control model. The following section details the linguistic attributes of the three words contained in this sample text.

4.3.1.3.1 Analysis of Individual English Word group 'Not at all'

'Not' is defined as an adverb denoting absence, reverse or opposite of something (Landau, 1985, p. 447). On its own, its meaning is explicit and it is not a homonym. The word could be codified as follows:

'not' = an adverb which modifies the verb and may be positioned before or after the verb.

According to Landau (1985, p. 39) 'at' is a preposition with twenty possible meanings:

- in or on the position of, e.g., at the centre of a circle; or
- of time, on or upon the stroke of, e.g., at noon; or
- during the course or lapse of, e.g., at night; or
- in contact with, on, upon, e.g., at sea; or
- to or towards, i.e., look at the sunset; or
- through, by way of, e.g., smoke came out at the windows; or
- within the limits of, present in, e.g., at home; or
- engaged or occupied in, e.g., at work; or
- attending: at a party; or
- in the state or condition of, e.g., at war; or
- in the region or vicinity of, e.g., at the door; or
- with an interval of, e.g., at sixty paces; or
- having reference to, or in connection with, e.g., he winced at the thought; or
- in the manner of, e.g., at a trot; or

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- of time, on or upon the stroke of, e.g., *at noon*; or
- during the course or lapse of, e.g., *at night*; or
- in contact with, on, upon, e.g., *at sea*; or
- to or towards, i.e., *look at the sunset*; or
- through, by way of, e.g., *smoke came out at the windows*; or
- within the limits of, present in, e.g., *at home*; or
- engaged or occupied in, e.g., *at work*; or
- attending: *at a party*; or
- in the state or condition of, e.g., *at war*; or
- in the region or vicinity of, e.g., *at the door*; or
- with an interval of, e.g., *at sixty paces*; or
- having reference to, or in connection with, e.g., *he winced at the thought*; or
- in the manner of, e.g., *at a trot*; or

- in pursuit or quest of, in the direction of, against, e.g., *to catch at straws*; or
- dependent upon, e.g., *at an enemy's mercy*; or
- according to, e.g., *proceed at your discretion*; or
- amounting to, e.g., *interest at two percent*, or
- from, out of, e.g., *to draw water at a well*; or
- on the occasion of.

The word 'at' may act as a synonym with 'in' and 'on' with reference to time and may be interchanged with 'in' in regard to location. As a preposition in English, the meaning inferred by the word 'at' or its synonyms is understood when used with contiguous words in a given text (Landau, 1985, p. 39). The word 'all' may take the form of an adjective, noun, pronoun or an adverb. Landau (1985, p. 16) defines the different meanings for each grammatical form:

Adjectival form:

- the entire substance or extent of, e.g., *all Europe*; or
- the entire number of, e.g., *known to all men*; or
- the greatest possible, e.g., *in all haste*; or
- any whatever, e.g., *beyond all doubt*; or
- every, used in phrases with manner, sorts and kinds, e.g., *all manner of men*; or
- nothing except, e.g., *he was all skin and bones*.

Noun form:

- everything that one has , e.g., *to give one's all*; or
- whole being, totality.

Pronoun form:

- everyone, e.g., *all are condemned*; or
- everything, e.g., *all is lost*; or
- every part, as of a whole, e.g., *all of it is gone*.

Adverbial form:

- wholly, entirely, e.g., *fallen all to bits*; or
- exclusively, only, e.g., *the desk is all for me*; or
- for each, on each side, e.g., *a score of three all*.

4.3.1.3.2 Summary of Analysis of English Single Words

The wide range of meanings possessed by ‘at’ and ‘all’ supported earlier research findings (Fawcett, 1997; Gross, 1992; Henisz-Dostert et al., 1979; Piron, 2003) regarding the complexity of languages, especially with regard to words with more than one meaning. This complexity of language structure was further evident during the grammatical and lexical analysis of the data obtained that required separation into synonyms and, then, translation into the equivalent French forms. The following section describes the structure of the alternative French words, leading to the construction of a model capable of translating the sample in the final section of this phase of the research.

4.3.1.4 The Control Model: Selection, Analysis and Translation of Individual Sample Words in the French Language

The phrase ‘not at all’ translates into French as, ‘pas du tout’ (Bayle-Exterieur, Gradussov and McCarney, 2003, personal communication). However, as outlined in section 3.2.12, transfer methodologies are based on individual word relationships and require each word to be catalogued according to its alternative meanings. Each word

within a given text is not treated in isolation in real life and imparts meaning and grammatical order to the text. Each word contributes to the structure upon which meaning, tense and grammatical sense rely and in turn convey the correct meaning.

According to Bayle-Exterieur, Gradussov and McCarney (2003, personal communication) the equivalent of the English word 'not' in French may normally take two forms: 'ne ... pas' or 'ne ... point'. The two words may be used together, but often are used by modifying the verb, for example "je **ne** sais **pas**" – "I do not know". The presence of single word homonyms and alternative meanings in word groups is common in French and not exclusive to the English language, as will be shown in the following word analysis. The French equivalent of the English word 'at' also takes the form of a preposition and may be interchanged with other synonyms (Bayle-Exterieur, Gradussov and McCarney, 2003, personal communication). The following examples (Bayle-Exterieur, Gradussov and McCarney, 2003, personal communication) describe and define the equivalent French words:

'à' examples include: à l'école - at school or à cinq heures - at five o'clock or en guerre - at war. Interchangeable in some texts with 'en'.

'en' example *en Angleterre* meaning in England as opposed to or *en guerre* - at war

'chez' this means at the home of some person or at a place, e.g., *chez ma tante* - at my aunt's home.

While the synonyms of a word such as 'at' may pose no great linguistic challenge to the human translator, in an machine translation system, lacking human intuition and the

ability to correct errors in a more timely way, it may provide adverse translation outcomes. However, there are other texts in French where other forms are used to express 'at'. For example, to translate the English phrase 'at one blow', the literal translation would be 'of one blow' or 'd'un seul coup' (Bayle-Exterieur, Gradussov and McCarney, 2003, personal communication). The French equivalent of the English word 'all' also takes the forms of preposition, noun, pronoun and adjective as described and defined as:

Adjectival form:

- 'tout' or 'toute' are the male and female, singular forms respectively, the plural forms are masculine 'tous' and female 'toutes', e.g., *tout le monde* - *everyone*
- 'entier' whole, entire, complete

Noun form:

- 'entier' a masculine noun, e.g., *en entier* - *in full, completely*; or
- 'tout' a masculine noun the whole, all; entirely, e.g., *pas du tout* - *not at all*.

Indefinite pronoun:

- 'tout', 'tous', e.g., *nous tous* - *all of us* and *six fois en tout* - *six times in all*.

Adverb:

- 'tout' this may be used in the following example, *tout à coup* - *all at once*, but may take the alternative form, which has the same meaning, *tout d'un coup*.
- 'entièrement' in its entirety or entirely, completely (Bayle-Exterieur, Gradussov and McCarney, 2003, personal communication).

The English phrase, 'all the better', however, translates as 'tant mieux', and does not use 'tout' at all. Similarly, the English phrase, 'all but', translates as, 'à peu près'.

Not surprisingly, the analysis revealed the presence of synonyms and semantic expression that related more to convention than any strict grammar rules. The adverbial form of 'all' in French highlighted this and is analysed in the following section. While 'tout' as an adverb has a precise meaning, it does interpret other English phrases that do not contain the word 'all' as:

- *tout à fait* - *completely*;
- *tout à l'heure* - *a few minutes ago; in a few minutes*;
- *tout au plus* - *at the very most*;
- *tout autant* - *quite as much or many*;
- *tout d'abord* - *at first*;
- *tout de suite* - *at once*;
- *tout en* - *while* (a gerund) or *although* (indicative);
- *elle est toute étonnée* - *she is quite astonished*; and so forth (Bayle-Exterieur, Gradussov and McCarney, 2003, personal communication).

The above analysis shows the different lexical and syntactical attributes of each word that is incorporated within both dictionaries. The following section shows how the lexical and syntactical factors may be treated within a transfer-based methodology.

4.3.1.5 The Control Model: Construction and Analysis of a Combined English and French Language Sample Three Word Group to Test the Translation

This phase initially involved building the word relationship and definition tables within the English and French dictionaries. Once completed this phase facilitated selection of the correct equivalent combination of words in the target language. Complex

algorithms and statistical analysis incorporated within the control model then allowed selection of the correct target language equivalent through a machine translation metalanguage. As this study did not have the resources to create such algorithms, it created basic parsing rules to illustrate the complexities involved and to enable comparison with the prototype model.

The codification of the English phrase 'not at all' and its French equivalent was undertaken with the creation of word relationship structure and definitions. These processes are described in the following sections, commencing with the English, then French constructions and finally with a model showing how the translations were engineered. The three words were identified as:

- | | | | | |
|-------------|---|-------|---|---|
| First word | = | 'not' | = | an adverb denoting absence, reverse or opposite of something; may precede or succeed a verb; a verb is usually present, but is not essential. |
| Second word | = | 'at' | = | a preposition; usually precedes nouns, adjectives, adverbs and definite or indefinite articles (the, a, or an); synonyms: in, on. |
| Third word | = | 'all' | = | takes the adjectival, noun; pronoun or adverbial forms; variety of positions within a sentence or phrase; various meanings (Landau, 1985). |

The relationship between these words evolved as follows:

- 'not' is entered and a search is undertaken in the English dictionary;

- the word is located but there is no complete sentence or phrase located in the dictionary;
- the next word 'at' is entered, the mechanism searches for 'not' + 'at' and although it finds each word and individual word meanings, no matching sentence or phrase is located;
- the next word is entered and the following analysis is completed.

These sequences are shown in Figure 10 and highlight how the mechanism must complete a series of tasks to seek the meaning of each word in the source language dictionary before attempting to identify the syntax of the complete phrase or sentence:

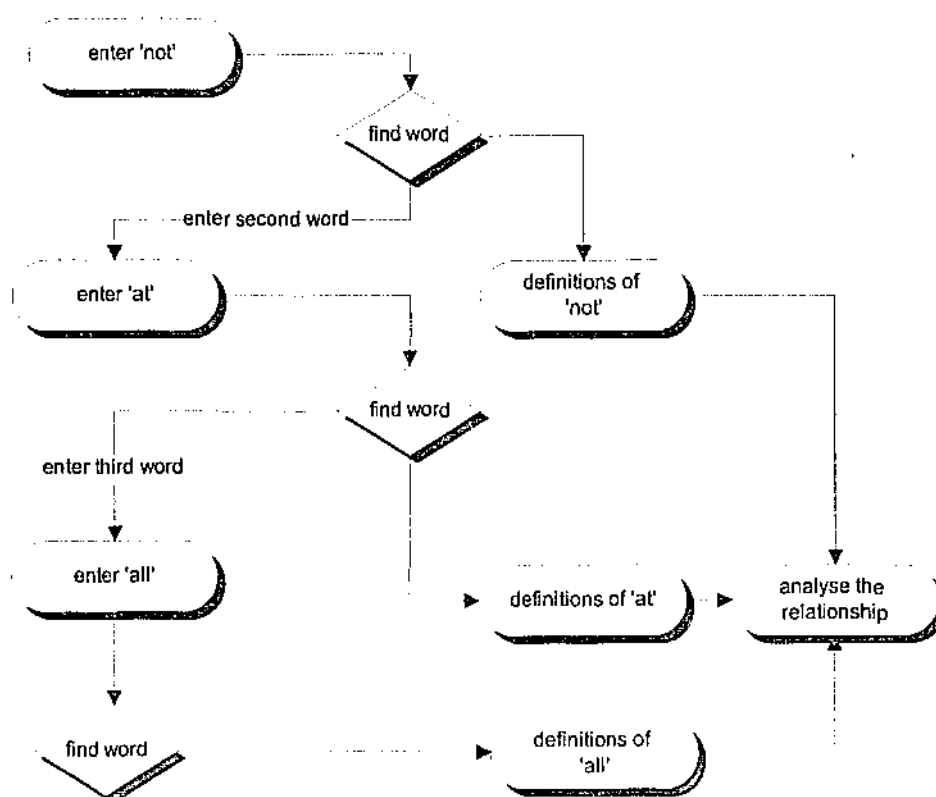


Figure 10 Control Model: Process of identifying lexical and syntactical attributes

Figure 10 shows how the mechanism located the various grammatical and lexical definitions of each of the individual words, but has not identified their relationship with each other. The construction of complex relationship rules for each word would result in the following scenario:

'not'	may equal	'ne ... pas'
'at'	may equal	'à', or 'chez', or 'en', or 'd'un'
'all'	may equal	'tout', or 'toute', or 'tous', or 'toutes', or 'entier'

At this stage, the mechanism recognises the lexical and syntactic attributes contained within the metalanguage of each word as outlined in section 3.2.12. By means of parsing rules, the system processes the metalanguage 'string' and attempts to identify the relationship of each word in the sample text to verify the meaning of the text in the source language. The sequences shown in Figure 11 below outline the computation involved to enable identification of the source language text. By means of complex mathematical formulae, reconstruction of the source language sentence into the equivalent target language text is attempted by interrogation and manipulation of the target language dictionary, thus completing the translation. Conversion of the syntax of the words into a metalanguage was based on the EBNF metalanguage as described in section 3.2.18.

Figure 11 shows the analysis of the text to verify its syntactical structure:

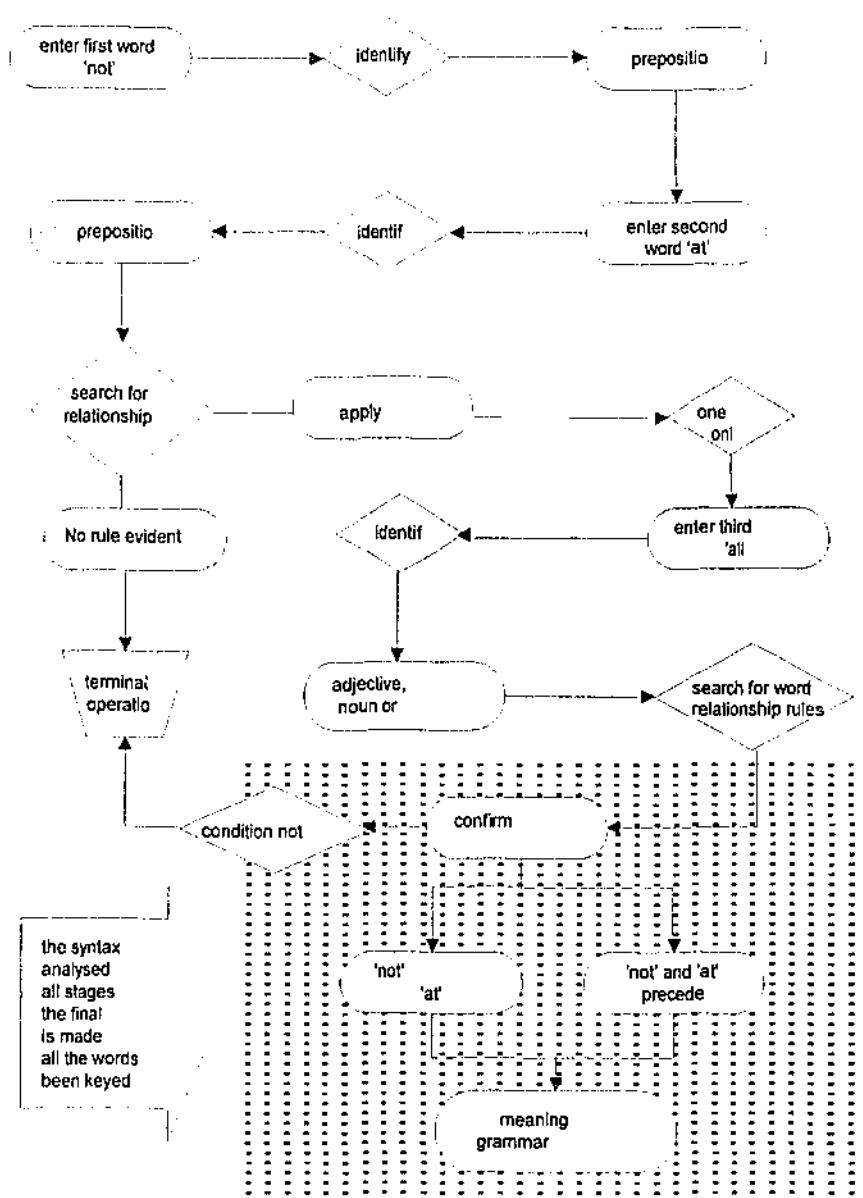


Figure 11 Control Model: Identifying words through parsing the word group metalanguage

Using an EBNF metalanguage, the phrase may be converted as follows:

word ::= preposition | not

word ::= preposition | at

word ::= noun | all

The phrase consists of three words: a preposition followed by a preposition and then a noun. This structure in EBNF may be written as a prepositional phrase:

phrase ::= preposition | preposition | noun

prepositional_phrase ::= preposition noun_phrase (Morneau, 1992).

This prepositional phrase in the above example is a relatively simple structure. However, to include a large number of longer and more complex texts or sentences in the dictionary that was linked to the equivalent texts or sentences in the target language would require more resources. Machine translation mechanisms attempt to replicate human translation by identifying syntax and meaning from the word order and text structure.

The following sections describe the processes involved in a transfer-based methodology to translate a sample sentence from the English questionnaire to the French language equivalent. The processing of the reverse translation of the text from French back into the original English is described.

4.3.1.6 The Control Model: Selection, Analysis and Translation of a Sample Sentence in the English and French Languages

The sample sentence selected from the questionnaire was "I need to feel there is hope." Figure 12 illustrates the basic grammar structure of the sample:

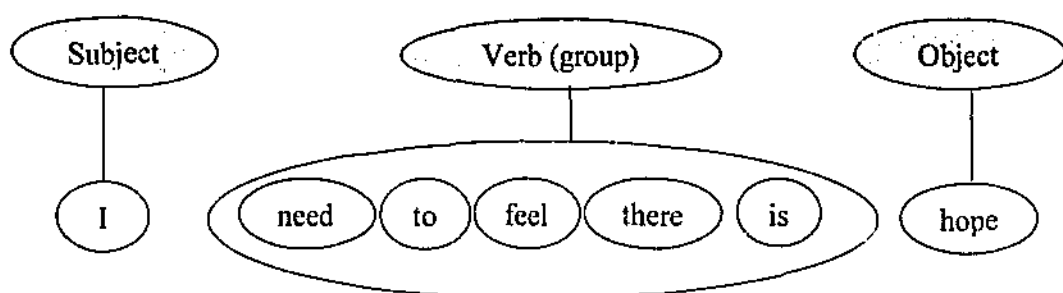


Figure 12 Syntactical structure of the sample sentence “I need to feel there is hope.”

The importance of the Subject-Verb-Object structure of sentences, shown in the above diagram, must be clearly identified during the machine translation otherwise, as Morneau (1992) stresses, it has the potential to produce an inaccurate translation when transferred to the target language. Using the EBNF the sentence would be represented as consisting of a typical Subject-Verb-Object construction. This representation may be written as follows, with a breakdown of the individual components of the metalanguage:

```

sentence ::= subject | verb | object
subject ::= pronoun
verb ::= verb_phrase
object ::= noun

```

Analysis continued to clarify how this grammatical rule could be confirmed in text input into the mechanism. However, analysis of the grammar of individual words was required at the micro-level, before an overall strategy could be tested to recognise the overlying grammar rules. The analysis is discussed in the following paragraphs.

4.3.1.6.1 Lexical and Syntactical Analysis of Individual Words in the Sample Sentence

Examination of each word in the sample text provided the following grammatical breakdown:

Subject >	Pronoun >	First Person Singular	=	I
Verb >	Verb >	Irregular Verb Present Tense	=	need
		Irregular Verb Infinitive Present Tense	=	to feel
	Adverb >		=	there
	Verb >	Irregular Verb Present Tense	=	is
Object >	Noun >	Abstract Noun	=	hope

Each word was examined to determine its meaning and to detect any special features that might affect translation. The subsequent analysis of the sentence is set out below. It commenced with a detailed examination of the pronoun 'I' used in conjunction with other words and its position within the sentence.

4.3.1.6.2 The Pronoun 'I'

The pronoun 'I' has a unique meaning, is the 'first person singular' and may be used in conjunction with a verb or another part of speech, for example:

I need	-	pronoun + verb
He and I	-	pronoun + conjunction + pronoun

There was no requirement to specify this word for translation to French, because of its unique meaning and grammatical identity. However, a variation of the pronoun, 'me', would require some distinction between the two during the reverse direction translation. For example, the two variants could be identified as follows:

I = first_person_singular_personal

Me = first_person_singular_indirect

It was evident in the case of 'I need' the pronoun 'I' was the subject of the sample text. Therefore, a translation rule was required that stated "When 'I' precedes a verb it is the subject of the sentence." This rule also depended on the condition that 'I' commenced the sentence by itself or followed a conjunction only. For example, "He and I need to feel." The correct use of single words already appeared complex and simple word structures required a strict set of rules governing the syntax within the dictionary.

4.3.1.6.3 The Noun 'Need'

The word 'need' is a homonym and is defined as a verb in present, past and future tenses in various person forms, e.g., I need, I will need, they had need, and so forth (Landau, 1985). It may also be used as an abstract noun as in "He has a need." 'Need', therefore, may take the following grammatical forms:

Noun form	=	a need	- indefinite article + noun, or
		the need	- definite article + noun
Verb form	=	I, you, we need	- pronoun + verb

However, the process of word-meaning verification becomes even more challenging when the word has multiple meanings, which often depend on word order and inter-relationship with other words. The *English – Esperanto Dictionary* (Fulcher & Long, 1921, p. 180), for example, shows three similar but different meanings for ‘need’ in noun form:

<u>English</u>	<u>Esperanto</u>
A penury need	‘bezonego’
A requirement need	‘bezono’
A necessity need	‘neceso’

According to Bayle-Exterieur, Gradussov and McCarney (personal communication, 2003), the French equivalents, depending on the text, could be expressed as follows:

<u>English</u>	<u>Esperanto</u>
A requirement	‘besoin’
A penury need	‘nécessaire’
A necessity	‘question’

‘Need’ may also be replaced with synonyms such as desire, want, wish or compelling force (Landau, 1985, p. 439). While the verb form is the correct form in the sample text, some additional rules would be required to define the variations that require clarification between the various meanings as well as the grammatical forms. ‘Need’, therefore, may be written in EBNF as:

Need = noun (requirement)

- = noun (necessity)
- = verb_present_tense
- = verb_future_tense
- = verb_past_tense

However, while individual word identification and codification would suffice for a basic word-to-word translator, more complex phrases and sentences would require a more structured relationship to preserve meaning and syntax (Piron, 2003). The sample word 'need' has already been discussed at length, but some further analysis was required to link it to other words in the sample text and to define its status as the active verb specially linked to the subject and direct object. The following table shows how 'need' used as a verb in the present tense, relates to the preceding pronoun:

I need	-	1 st person singular
You need	-	2 nd person singular
We need	-	1 st person plural
You need	-	2 nd person plural
They need	-	3 rd person plural

These definitions may be expressed as syntactical translation rules to determine meaning depending on the following conditions:

- if 'need' is preceded by a definite article or an indefinite article then it is a noun.
- if 'need' is preceded by a pronoun then it is a verb.

The above expressions do not cover the other present tense verb form of 'need' for pronouns and nouns, e.g., "it needs" and "he needs" and so forth. The complexity of irregular verbs emphasises the additional number of rules required for translation.

4.3.1.6.4 The Preposition 'To'

The word 'to', the next word appearing in the sample text, is a preposition that normally precedes the verb and indicates its infinitive form. It forms part of a composite verb when sandwiched between verbs as in "I want to go" or "I need to feel." The word 'to' also serves as a conjunction linking two words such as "From here to there." These forms required some rules to differentiate them within an entered text and to facilitate their use in an effective synonym table. The following grammar rules were constructed to fulfil these requirements:

- if 'to' precedes a verb then the verb takes the infinitive form and 'to' becomes part of the verb;
- if 'to' follows a verb and precedes a verb then the three words form a composite verb; and
- if 'to' precedes a noun, then it is a conjunction.

4.3.1.6.5 The Verb 'Feel'

The next word that follows 'to' in the sample text is the verb 'feel'. As 'to' precedes the verb, then the rule described identifies 'feel' as the infinitive form. It also confirms that 'to' is a preposition used to modify the verb. The use of the two syntactical rules here, confirms the relationship between the two words, but not the precise meaning

of the verb 'feel', which is a homonym. The alternative meaning of 'feel' is discussed in section 4.3.1.7 below.

4.3.1.6.6 The Adverb 'There'

In the sample text, 'there' as an adverb (Landau, 1985, p. 701) modifies the preceding verb, 'feel' (Fowler, 1968, p. 633).

4.3.1.6.7 The Verb 'Is'

'Is' takes the form of the present indicative, third person singular of the English irregular verb 'to be' (Landau, 1985, p. 345).

4.3.1.6.8 The Abstract Noun 'Hope'

The last word in the sample text, 'hope', takes the abstract noun form in the text, but may also take an alternative form as a verb (Landau, 1985, p. 309). The following rules were built to describe these alternative grammatical forms:

- | | | |
|--------------------|---|---|
| Verb + noun | = | if 'hope' is preceded by a verb then it is a noun, or |
| Adjective + noun | = | if 'hope' is preceded by an adjective then it is a noun,
or |
| Conjunction + noun | = | if 'hope' is preceded by a conjunction then it is a noun,
or |
| Article + noun | = | if 'hope' is preceded by a definite or an indefinite
article then it is a noun, or |
| Pronoun + verb | = | if 'hope' is preceded by a pronoun then it is a verb, or |
| Preposition + verb | = | if 'hope' is preceded by a preposition then it is a verb |

However, these rules may not be adequate as 'hope' may also be a proper noun indicating a female personal name (Landau, 1985, p. 309). Identification and verification to ensure accuracy of translation is required under these conditions to ensure integrity of meaning. In addition to syntax rule tables, it was necessary to construct a synonym table to clarify the meaning of 'hope'. The issue of homonyms and how they affect the control model are discussed in the following section.

4.3.1.7 The Control Model: The Issue of Homonyms

Other homonyms within the sentence are based on the word 'feel' which may take similar but different forms in English (Fulcher and Long, 1921, p 105):

To feel as in a sense of touch

To feel as in a non-physical sensory way

The word 'feel' may also take the form of an abstract noun as in "I like the feel of the cloth" (Landau, 1985, p. 233). Without lexical verification of each word in the sample text, a number of incorrect sentences entered into the mechanism would not be correctly identified. For example, the intended meaning is, "I need to feel or believe that there is some hope of some future event." The intended meaning would be misinterpreted if the wrong or unintended meaning was translated as, "I need to feel physically, touch or prod a person called Hope." While the second version is a farcical translation, a poorly designed machine translation mechanism might not automatically recognise the correct version.

According to Senellart et al. (2002, p. 1), the treatment of homonyms by the control model is based on a statistical analyser. The analyser selects what appears to be the correct meaning of each word based on statistical probability. As will be shown in section 4.3.2.9, the prototype model relies on synonym tables to recognise homonyms and to allow the user to select the correct meaning. Before completing the translation and analysis of the complete sentence, individual words were examined to derive an understanding of their attributes and the ways in which they may affect the translation processes.

4.3.1.8 The Control Model: Defining Word Order and Syntax in the Source Language

The grammatical forms of each word were identified in preparation for conversion to the EBNF:

First word	=	'I'	=	1 st person singular personal
Second word	=	'need'	=	preceded by a pronoun = verb
Third word	=	'to'	=	preposition precedes a verb = infinitive verb form
Fourth word	=	'feel'	=	preceded by a preposition = infinitive verb
Fifth word	=	'there'	=	adverb follows the verb
Sixth word	=	'is'	=	present indicative, third person singular
Seventh word	=	'hope'	=	preceded by verb = noun = male or female proper noun

The EBNF sentence string may now be written as follows:

Sentence ::= subject | object | verb; or

Sentence ::= pronoun | verb-phrase | noun; or

Sentence ::= pronoun | verb | preposition | verb | adverb | verb | noun

The next challenge for a transfer-based mechanism to overcome would be the definition of the subject, verb and object order as, to ensure that the correct meaning is preserved, it is necessary to define the nature of the word order. English texts often do not define the subject or the object, leaving the verb to float within the text and relying on the intuition of the reader to define the syntax (Stuttard, 1952, pp. 16-17). This difficulty in identifying the subject and object parts of a sentence, may be overcome as demonstrated by using the above sentence as a basic model:

Sentence ::= pronoun | verb | preposition | verb | adverb | verb | noun

Analysis: encountered a pronoun

followed by a verb group

followed by a noun

Conclusion: the pronoun is probably the subject, as in English, the subject often precedes the text

the verb group is the verb,

the noun may be the object.

The completion of these word relationship and syntax rules in the English language preceded a similar process in the French language dictionary. The following

section outlines how the completion of word relationships and syntax rules was accomplished.

4.3.1.9 The Control Model: Identifying the Equivalent French Language Words in the Sample Sentence

The equivalent French translation to the English sentence “I need to feel there is hope” is “J’ai besoin de sentir il-y-a l’espoir” (Bayle-Exterieur, Gradussov and McCarney, 2003 personal communication). This may be translated literally, as “I have a need to feel there is hope.” The word order is different in the French version. In addition, the word groups and their relationships within the French sentence are not identical to the English sentence.

“J’ai besoin de sentir il-y-a l’espoir” may be deconstructed as follows:

Pronoun	‘J’	The pronoun equates to I and has two possible equivalent Forms in French and one variant form: ‘Je’ first_person_singular_personal ‘J’ first_person_singular_personal_abbreviated ‘Moi’ first_person_singular_indirect
Verb	‘ai besoin de’	‘avoir besoin de,’ literally a verb group: ‘to have need of’ which is ‘avoir besoin de’ modified according to tense and Noun/pronoun status.
Verb	‘sentir’	‘to feel’; there are two meanings in French: ‘sentir’ - the infinitive verb form relating to a belief or an emotion; and ‘toucher’ - the infinitive verb form as in the physical form of touching.

Adverb/ Verb	'il-y-a'	'there is'
-------------------------	----------	------------

Noun	'espoir'	'hope'
-------------	----------	--------

The same complexities, of defining the lexical and syntactical attributes of each word and phrase experienced during the construction of the English dictionary, occurred during the construction of the French dictionary. Uniquely defined within its respective dictionary, each word combines with other words through a complex matrix of relationships and syntactical rules. Once added to the target language dictionary, each word may be catalogued into a metalanguage where each word may then be sought by the transfer system when it attempts to locate the equivalent words and syntactical structure to complete the analysis. Please refer to Figure 5, in Chapter 3, which illustrates the basic steps involved in the linking between the source language and target language metalanguage representations.

4.3.1.10 Summary of the Control Model Structure and Translation Methodology

The transfer sequences shown in Figure 5 are a simplified expression of the actual processes that occur within the control model. The control model relies on each word encoded in the metalanguage being identified and its relationship with other words in a given text to be placed mathematically. The codification of each word gives the transfer model the advantage of using the syntax of a language as well as the lexical attributes of individual words as described in section 3.2.5.2. Consequently, a more flexible use of language dictionaries is based on algorithmic formulae. The control model also relies on a statistical analysis of word order and likelihood of translation outcomes.

One of the main differences between the control model and the interlingua-based prototype model is the requirement of the control model to codify each word in both language dictionaries in some metalanguage format. The prototype model does not use this strategy. The prototype model relies, instead, on a semantic representation of word groups stored in the natural language dictionaries that connect to their equivalent word groups held in the interlingua dictionary.

4.3.2 The Prototype Model: Structure and Methodology

This section describes the structure of the prototype model and the processes involved in translating the identical sample texts through the combined interlingua and sublanguage methodology. It provides a description of the interlingua strategy and its use as a filter to translate texts between the source language and target language. It also includes an explanation of the sublanguage strategy and its use to translate words and word groups.

4.3.2.1 Description of the Combined Interlingua and Sublanguage Methodologies

The prototype model, constructed by using the Jade object-oriented database, included the following key features:

- an interlingua mechanism linking the English and French dictionaries to the Esperanto-based interlingua dictionary;
- English and French dictionaries consisting of a sublanguage methodology incorporating single words and word groups of up to eleven words;

- a matching mechanism linking each word and word group in the English and French dictionaries with the equivalent word and word group in the interlingua dictionary;
- synonym look-up tables providing alternative natural language word definitions where word ambiguities have been identified;
- a splicing mechanism capable of joining two word groups in the English dictionary and, through the interlingua, able to identify the equivalent combined word group in the French language dictionary; and vice-versa,
- a splicing mechanism capable of joining two word groups in the French dictionary and, through the interlingua, able to identify the equivalent combined word group in the English language dictionary.

The following sections provide a detailed description of the prototype model, together with reference to the sub-questions of this study.

4.3.2.2 The Prototype Model: Description of the Interlingua Mechanism

The prototype model incorporated an Esperanto-based interlingua linked to English and French language dictionaries. Each language dictionary contained words and word groups taken from the survey questionnaire. Each of these words and word groups was linked to the equivalent words or word groups contained in the interlingua. Figure 13 shows examples:

ENGLISH	ESPERANTO	FRENCH
SOMEWHAT	ION	ASSEZ
VERY MUCH	EGE	BEAUCOUP
EXTREMELY	TRE EGE	EXTREMEMENT

Figure 13 Examples of English and French words and word groups and their equivalents in the interlingua dictionary

Unlike the control model, which links the English and French languages directly through a parsing mechanism, the prototype model uses the interlingua as the pivot or hub language. The interlingua's ability to be used as an intermediary device, capable of defining the precise lexical meaning of words and word groups incorporated in the natural language dictionaries, was investigated by this study.

Specifically, testing of this strategy addressed the sub-questions:

May Esperanto as an interlingua preserve a high standard of meaning when translating text between two natural languages?

May Esperanto as an interlingua reduce significantly the cost of linguistic and technical resources when translating text between two natural languages?

4.3.2.3 The Prototype Model: Description of the English, French and Interlingua Dictionaries

English, Esperanto and French speakers translated sample texts from the questionnaire. English texts were translated into the equivalent Esperanto. The Esperanto texts were then translated into their French equivalents. These translations are attached as Appendices D to I. The translations were analysed and a matrix was built to

catalogue the relationships between the natural languages and the interlingua. The following section describes the word group strategy.

4.3.2.4 The Prototype Model: Description of the Word Group Methodology

The ideal machine translation mechanism with the ability to produce 100 per cent accuracy in translation of complete natural languages is a long way from achieving realisation – please refer to section 3.2.2. Even as an alternative strategy, the large number of potential phrase and sentence combinations within any natural language means it is not feasible to catalogue every conceivable phrase and sentence. The contemporary machine translation systems use complex algorithm-based parsing mechanisms but achieve only mediocre results (Hutchins, 1995, p. 4; Leavitt et al. 1994, p. 2; Schubert, 1998).

The word group strategy attempts to remove the need to define the lexical and syntactical attributes of each word in the prototype dictionaries – please refer to section 3.3.3. Instead, it relies on identifying those natural language word groups made up of between one and seven words that have a unique meaning. Each word or word group is then linked to the equivalent word or word group in the interlingua. The construction of these word and word group dictionaries initially requires a considerable amount of data input. This study will determine whether the extra lexical build is offset significantly by a saving in linguistic analysis and technical construction. The strategy also includes linking word groups together to make complete sentences.

The perceived advantage of clustering or clumping word groups, and using the results in combination, is that lexical and syntactical rules are already extant within the word groups. Machine translation mechanisms, which include semantic transfer of text, offer greater levels of accuracy than models that do not incorporate the strategy. This study evaluated the semantic features within individual and combined word groups to ascertain if they eliminated many of the relationship rules required to overcome reliance on syntactical and lexical dynamics claimed by several sources (Arnold et al., 1994; Boitet, 1994). Testing of this strategy addressed the sub-questions:

May a sublanguage methodology preserve a high standard of meaning when translating between two natural languages?

May a sublanguage methodology reduce significantly the cost of linguistic and technical resources when translating text between two natural languages?

The success of the prototype model was contingent on the mechanism being able to identify English and French word groups and combined word groups keyed into the mechanism. It was designed to facilitate identification of the correct equivalent word groups in the target languages. The mechanism searched for the exact equivalent word group or combined word groups stored in the interlingua. When it was successful, the mechanism then searched for the equivalent word group or combined word groups in the target language dictionary.

These processes must be capable of being reversed from the target language through the interlingua, where searching for the correct equivalent combined word groups enables selection of the correct source language equivalent word group or combined word

groups. When this process is completed successfully, then the model has met the set requirements. If the word group is not located in the English dictionary, the process is terminated. Successful identification of the equivalent interlingua word group automatically identifies the equivalent French word group because the two are already linked. Figure 14 illustrates the process.

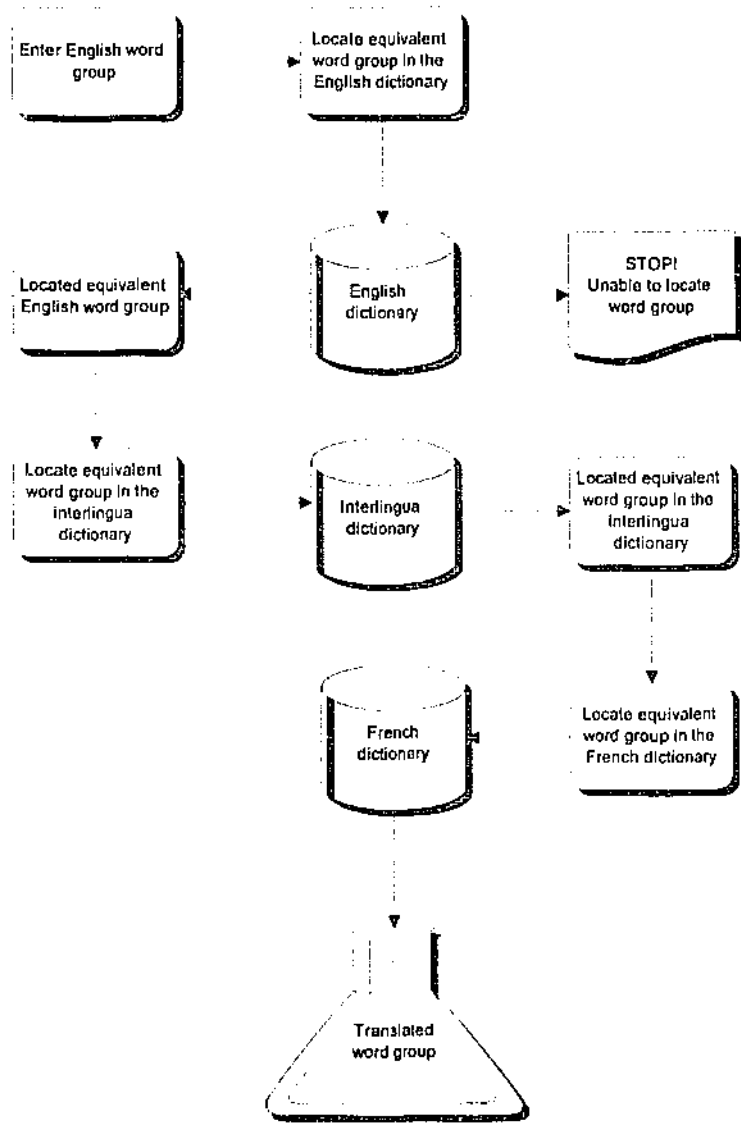


Figure 14 Translation of a single English word group through the interlingua to produce the French equivalent word group

Figure 15 shows the processes involved in translating two combined French word groups. The mechanism locates the two equivalent word groups in the interlingua dictionary and then the English equivalent word groups are located and the translation process is completed.

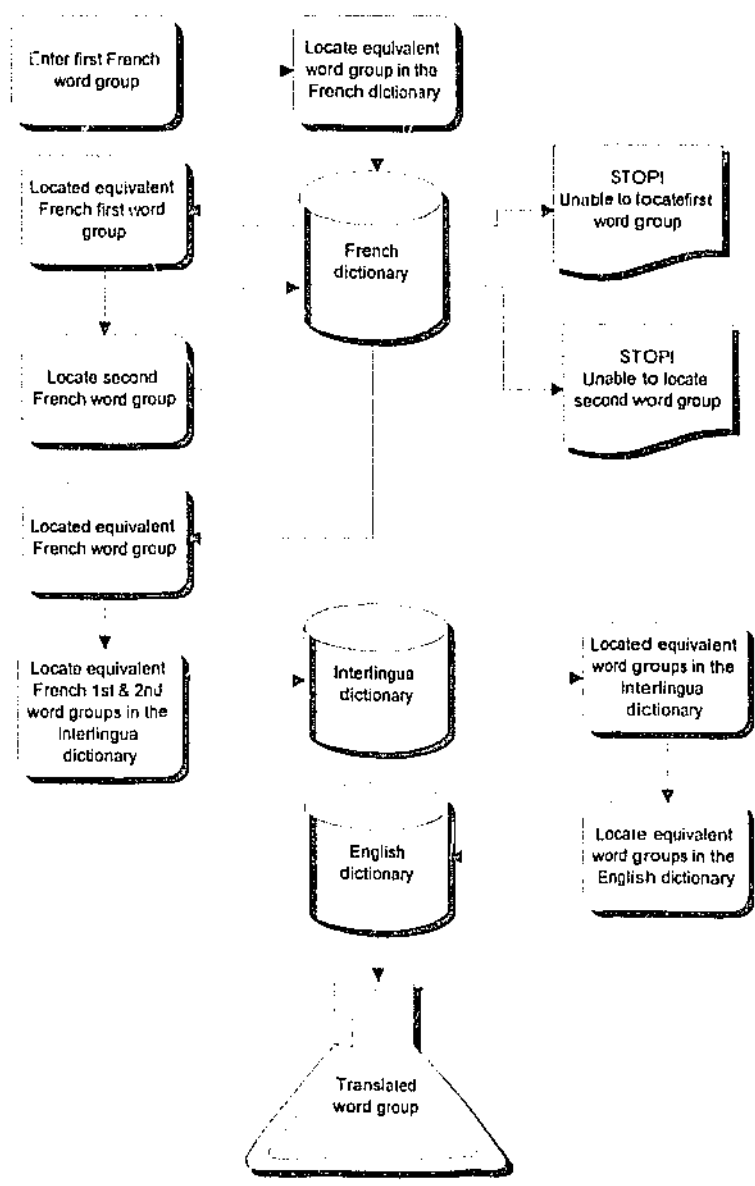


Figure 15 Translation of two French word groups through the interlingua to produce the English equivalent.

This process of combining word groups is intended to avoid reliance on parsing techniques involving the creation of a metalanguage and word attribute rules. The example shown in 4.3.1.6.1 of transfer methodology encoding of each word in the sample sentence “I need to feel there is hope” may be avoided using the word group strategy. For example, the sentence could be bisected to form the following combination: “I need to feel | there is hope.” By using interchangeable word groups these word groups might form a dictionary table such as:

I need to feel | there is hope;
I need to feel | some hope;
I need to feel | optimism;
Do you need to feel | some hope

and so on.

4.3.2.5 The Prototype Model: Preliminary Examination of Word Groups

Based on the methodology described in the previous section, the construction of the prototype model proceeded with research focussing initially on word groups consisting of between one and three words. Because smaller word groups seemed to offer less likelihood of complex linguistic relationships, it was anticipated that this approach would provide a clear understanding of the linguistic dynamics involved and enhance understanding of the challenges involved in the prototype design.

The preliminary research attempted to determine whether less complex linguistic relationships were evident in smaller word groups. If verifiable, the strategy would avoid or reduce the requirement for additional linguistic and engineering resources but still ensure accurate translation results. Examination of the survey questionnaire confirmed

that single word and small word groups, consisting of between two and three words, were being used repeatedly throughout the document. The example below shows the optional responses to the main question:

How important is this need to you now?

Not at all
A little
Somewhat
Very much
Extremely

Translation of each optional answer undertaken by the Esperanto and French translators produced a variety of results. As will be discussed further in this chapter, analysis of these results confirmed previous research described in sections 3.2.2 and 3.2.8, which identified the challenges presented by homonyms and intricacies of relationships between individual words. The first word group, 'not at all', translated into Esperanto without requiring additional rules to ensure translation accuracy. The translators, Bayle-Exterieur, Gradussov, McCarney and Mendelawitz (2003, personal communication), confirmed that the interlingua had a precise equivalent, 'tute ne', which in turn was equivalent to the French word group 'pas du tout'. This early study facilitated the building and designing of the language dictionaries, which are described in the following section.

4.3.2.6 The Prototype Model: Construction of the Language Dictionaries

Translations of these English word groups into the interlingua were completed and then the equivalent word groups were identified in the French language. Figure 16 shows an example of the same sample text, 'not at all', that was used in the control model, to

illustrate the simple relationships between the interlingua and the English and French dictionaries:



Figure 16 Relationships between the interlingua and equivalent English and French word groups

To assist further in the design of the prototype model, translation and analysis of the second optional answer ‘a little’ was completed. This phrase is an English adverbial group with the noun ‘little’ preceded by the indefinite article ‘a’ (Fulcher and Long, 1921, p. 160). Used in a lengthier sentence, it could also take the adverbial or adjectival form, which is discussed in more detail in the next subsection of this chapter (Fulcher & Long, 1921, p. 160). According to the *Funk and Wagnalls Standard Desk Dictionary* (Landau, 1985, p. 379) the English word ‘little’ is a homonym which, in the noun form, has a number of different meanings:

- a small amount, e.g., give me a little;
- an insignificant amount, e.g., little can be done about it; and
- a short while or distance, e.g., little by little.

In the context of the specific question contained in the questionnaire, “How important is this need to you now?”, ‘a little’ infers a small degree of importance regarding the specified need. Translation of ‘a little’ as an independent word group equated with precise equivalents in the interlingua’s ‘iomete’ and the French ‘un peu’ (Gradussov et al., 2003, personal communication). The variant noun forms did not

complicate the relationship as the analysis proved that as an independent word group 'a little' can only have the same meaning as the interlingua equivalent word 'iomete' (Gradussov et al., 2003, personal communication). Figure 17 demonstrates this relationship:



Figure 17 Example of the relationships between the interlingua and the English and French dictionaries – 'a little'

As this separate word group has a unique meaning, it does not require any linguistic relationship rules, such as a synonym table, to clarify ambiguous meanings. However, in its adjectival and adverbial forms, 'little' displays a variety of subtle differences in meaning. Landau (1985, p. 379) provides examples:

(a) adjectival form indicating:

- small or smaller in terms of size, e.g., a little house;
- not long, short or brief, e.g., a little time, a short distance;
- small in terms of quantity or degree, e.g., little wealth or little probability;
- having small force or effectiveness, , e.g., a little effort;
- not having great influence, power or significance, or trivial, e.g., a little martinet; and
- narrow or limited viewpoint, e.g., petty little minds.

(b) adverbial form (less, least):

- only slightly, not much, e.g., he sleeps little;
- not at all, used before a verb, e.g., she little suspects.

In Esperanto, the equivalent of the noun form of 'little' is 'mal multo', while the adjectival form is 'mal multa' and the adverbial form is 'mal multe'. Thus, the various grammatical forms of 'little' are represented by different words in the interlingua, which forces precise meaning during translation.

To define the presence of homonyms appearing in sample text through a machine translation mechanism, complex parsing rules are needed to define the correct meaning, as described in section 3.2.19. Word-for-word translation mechanisms are primarily concerned with both homonym occurrences and surrounding syntax of each clause or sentence. This would not necessarily guarantee accurate identification, however, as often the meaning may need to be elicited from contiguous text (Morneau, 1992, pp. 23-24).

Figure 18 shows the equivalent English and French word groups for the single word 'little' in each of its distinct grammatical forms, which have been coupled to the interlingua:

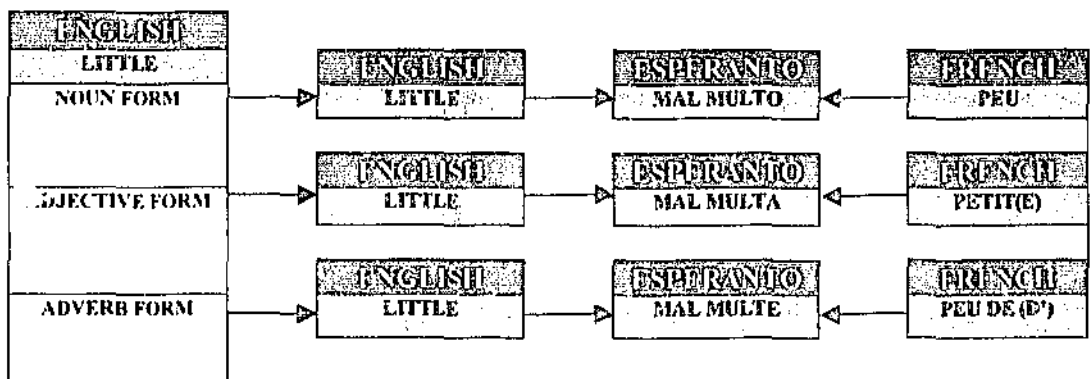


Figure 18 Diagram showing the interlingual and French equivalents of the noun, adjectival and adverbial forms of the English word 'little'

It was, thus, essential to verify accurately the intended meaning of 'little' whenever it occurred within any text. In this instance, the interlingua assisted in identifying precise meanings for the varying English equivalents (Gradussov et al., 2003, personal communication). The likelihood of 'little' appearing by itself in a survey was considered improbable, so there was no reason to build a synonym table for this single word. The potential grammatical complexities and homonym characteristics, noted at this preliminary stage of the prototype construction, confirmed the earlier research identifying these issues described in detail in Chapter 3.

4.3.2.7 Construction of the Language Dictionaries Within the Jade Database

The construction of the Jade database and the dictionary design was undertaken at the same time to ensure compatibility between the linguistic and technical designs. The database design incorporated requirements for the translators engaged in building the dictionaries and for the researcher planning to use the completed model for language translation.

- For translators, features provided included:
 - a minimum number of steps to input words and word groups;
 - prompts to include synonym and special language rules including gender variations;
 - prompts to link input data to the interlingua dictionary;
 - the ability to add new natural language dictionaries; and
 - the use of UNIX code to handle different characters used in French, Esperanto, etc.

- For researchers, features included:
 - two basic search strategies to enhance selection of word groups and combined word groups; and
 - automatic prompts, which highlight the occurrence of homonyms or special language rules such as gender variations in pronouns in different natural languages.

A user manual describing the processes involved in the building of the language dictionaries is attached as Appendix C. The processes involved in translating natural language texts are described in the following sections.

During the early design stages of the prototype model, it became apparent that homonyms occurring required identification and some special handling. The word group strategy was used to investigate whether it would overcome the challenges posed by homonyms. If successful, then it would be incorporated into the prototype model for further evaluation. To estimate the occurrence of homonyms, other small word groups were analysed to determine whether the model required a synonym look-up table to reduce translation inaccuracies. Samples of some of these findings are described in the following section.

4.3.2.8 The Prototype Model: Creating Synonym Tables to Recognise and Process Homonyms and Grammatical Anomalies

The small word group samples included analysis of the remaining terms in the other optional answers found in the questionnaire. 'Somewhat', 'very much' and

'extremely' were analysed to identify whether each word or word group had multiple meanings and to identify the correct equivalent in English. None of these words or word groups had any ambiguous meaning in the English language. The Esperanto and French translators translated the English word groups into the equivalent interlingua word groups and confirmed that the interlingua provided a precise template of meaning for homonyms in the natural languages. Similarly, the interlingua word groups translated accurately to French language equivalent word groups. The following diagram illustrates the relationships between the three languages:

ENGLISH	ESPERANTO	FRENCH
SOMEWHAT	ION	ASSEZ
VERY MUCH	EGE	BEAUCOUP
EXTREMELY	TRE EGE	EXTREMEMENT

Figure 19 Relationship diagram of the remaining word groups in the first sample from the questionnaire

The following questions were then selected from the survey questionnaire to identify homonym occurrence:

Have we provided a satisfactory service to your child? How well has this need been met for you? Please tick the following answer which best reflects your answer to this question:

- Not a need
- Not met at all
- Partly met
- Well met
- Completely met

These, and similar responses, are used extensively in the questionnaire, making them candidates for inclusion in the language dictionaries used in the prototype model. Analysis of these optional answers, however, confirmed the presence of the English

language homonyms ‘need’ and ‘met’. The first response examined was ‘not a need’. It was translated and identified with two alternative word group equivalents in the interlingua: ‘ne estas bezono’ or ‘not a requirement’ and ‘ne estas neceso’ or ‘not a necessity’ (Gradussov et al., 2003, personal communication). Each interlingua word group was translated into French language word groups, respectively: ‘pas de besoin’ and ‘pas nécessaire’. Figure 20 shows these relationships, highlighting two alternative meanings of ‘need’:

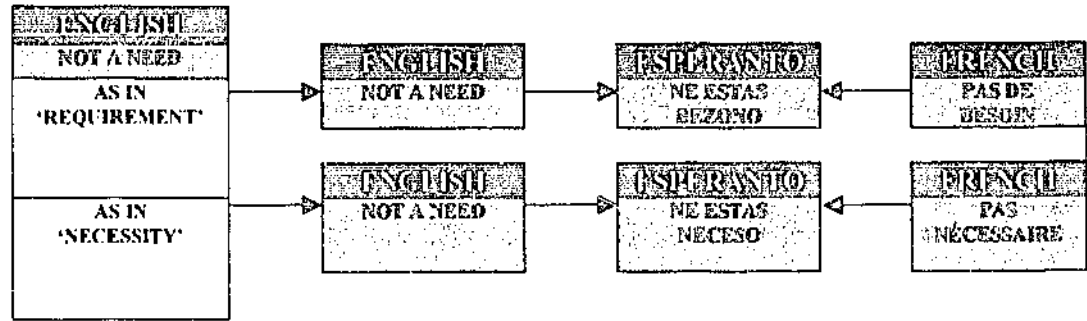


Figure 20 Example of English homonym ‘need’ highlighting its two main forms in relationship to the interlingua and French dictionary

During this translation, the English noun ‘need’ was identified as a homonym which, according to Fulcher and Long (1921, p. 180), possesses several similar but different meanings. It is represented in Esperanto as:

- ‘bezono’ This refers to a requirement being fulfilled, e.g., “Has the hospital fulfilled the requirement (need) to treat your child?”
- ‘neceso’ This refers to a necessity being fulfilled, e.g., “Has the hospital fulfilled the necessity (need) to treat your child?”

In Esperanto, ‘bezono’ and ‘neceso’ have precise meanings but may be treated as synonyms and are often a matter of choice by the user or influenced by the context

(Stuttard, 1952). To ensure that the correct translation was captured from the English in the interlingua, the different English forms of 'need' were studied in two language references. According to Landau (1985, pp. 438-439) 'need' and 'necessity' have the following meanings when used as nouns:

(a) need:

- the fact, quality or condition of lacking of something necessary or desirable; or
- a desire or longing, e.g., the need for revenge; or
- obligation; necessity, e.g., no need to be afraid; or
- a condition of want, danger or helplessness; or
- something wanted or required, e.g., modest needs; or
- poverty, hardship.

(b) necessity:

- that which is indispensable or requisite, especially towards the attainment of some end; or
- the quality, condition or fact of being necessary; or
- the conditions that make compulsory a particular course of action, e.g., to resign out of necessity; or
- urgent or desperate need, as because of poverty or accident; also, a time of such need; or
- that which is unavoidable because it is part of an invariable process, as in nature, logic, etc.; also, the process itself.

Fowler's Modern English Usage (1968, p. 519) states that 'requirement' and 'requisite' are synonyms and "the two are so far synonyms that in some context either will

do ... But requirement means properly a need, and requisite a needed thing.” The translators confirmed that ‘neceso’ was the preferable choice in the context of the questionnaire sample (Bayle-Exterieur, Gradussov and McCarney, 2003, personal communication). Consequently, both ‘neceso’ and ‘bezono’ were included in the interlingua dictionary.

The remaining texts ‘not met at all’, ‘partly met’, ‘well met’ and ‘completely met’ were analysed to assist further in the construction of the prototype model and the evaluation of its handling of homonyms. The English word ‘met’ when used as the past tense of the verb ‘to meet’ has three distinct meanings (Fulcher and Long, 1921, p. 170):

- to fulfil a requirement;
- to encounter a person or thing; or
- to come to terms with someone or thing.

Figure 21 illustrates these different meanings of ‘met’, which are represented by three distinct words in Esperanto:

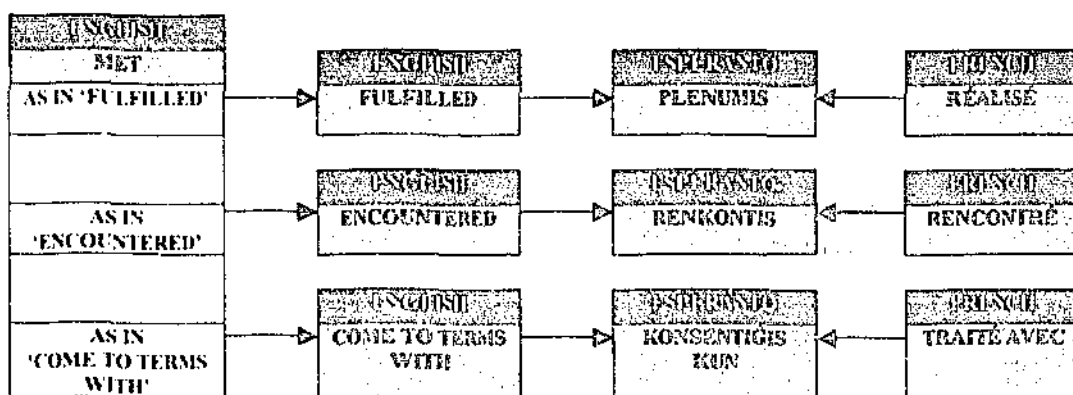


Figure 21 Comparison of the English homonym 'met' and its three synonyms to the equivalent in Esperanto and French

Figure 21 also shows the French texts that correspond to their Esperanto counterparts. In this instance the homonym 'met' does not have a French equivalent (Gradussov et al., 2003, personal communication) and, consequently, no synonym look-up table is required when translating from the French to English. Figure 22 shows the three alternative versions of 'met' used in the word group clause, 'have we met'. To the right of the word group are the three alternative English homonym equivalents, 'have we fulfilled,' 'have we encountered' and 'have we come to terms with':

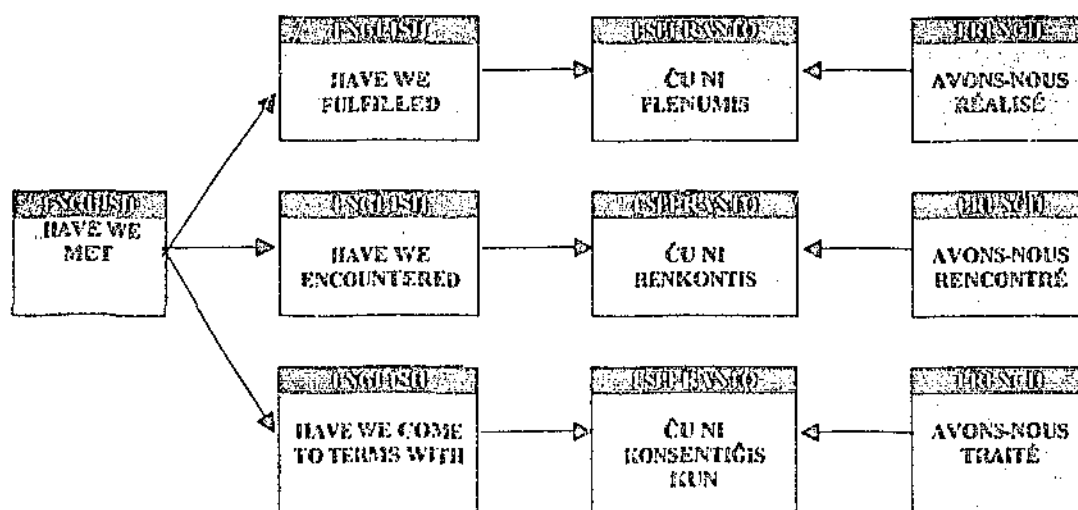


Figure 22 Synonym list for the English word group 'have we met' showing the interlingua and French equivalent word groups

The relationship required to represent the alternative meanings for the other sample answers, 'not met at all', 'partly met', 'well met' and 'completely met' may be structured as shown in the following figures:

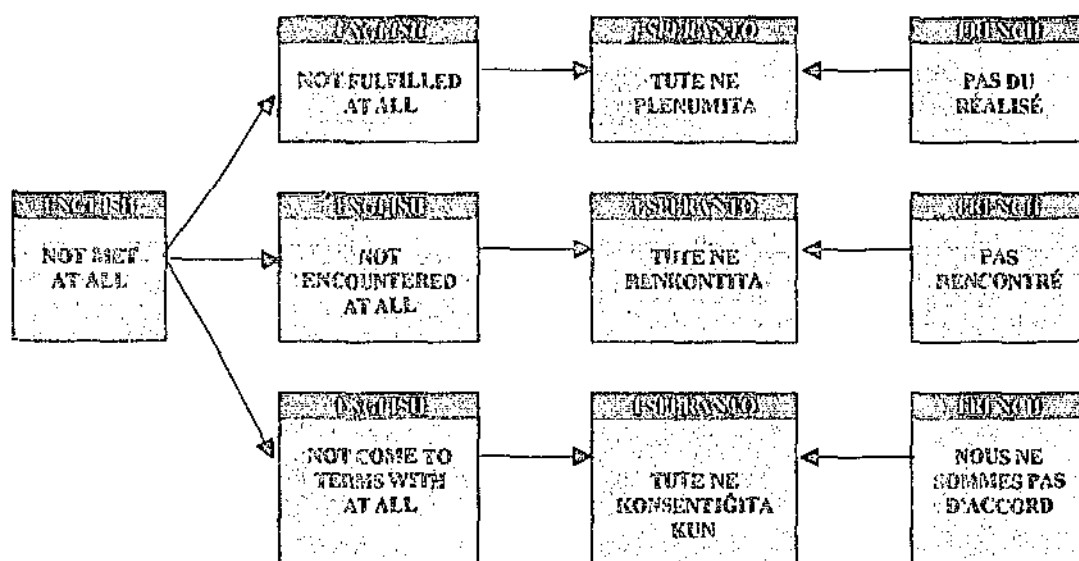


Figure 23 Synonym list for the English word group 'not met at all' showing the interlingua and French equivalent word groups

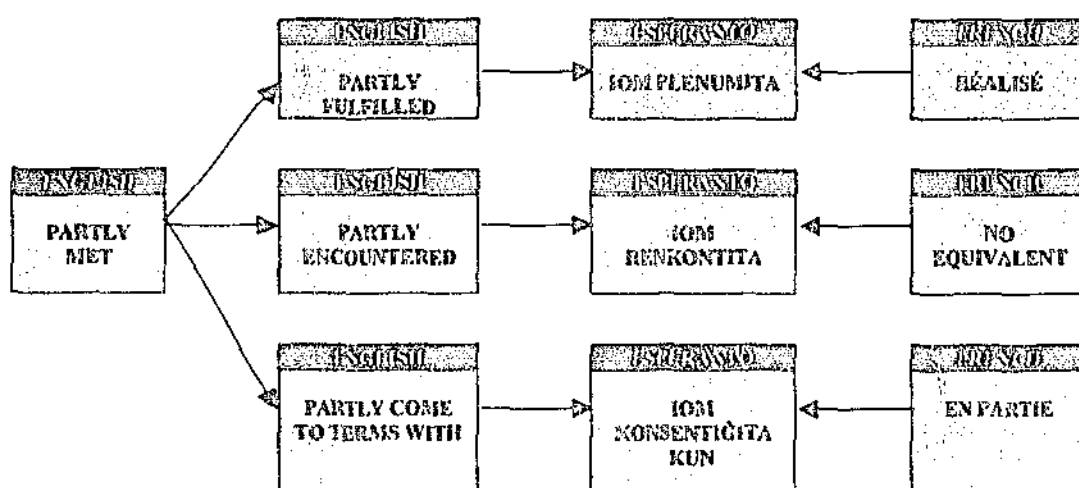


Figure 24 Synonym list for the English word group 'partly met' showing the interlingua and French equivalent word groups

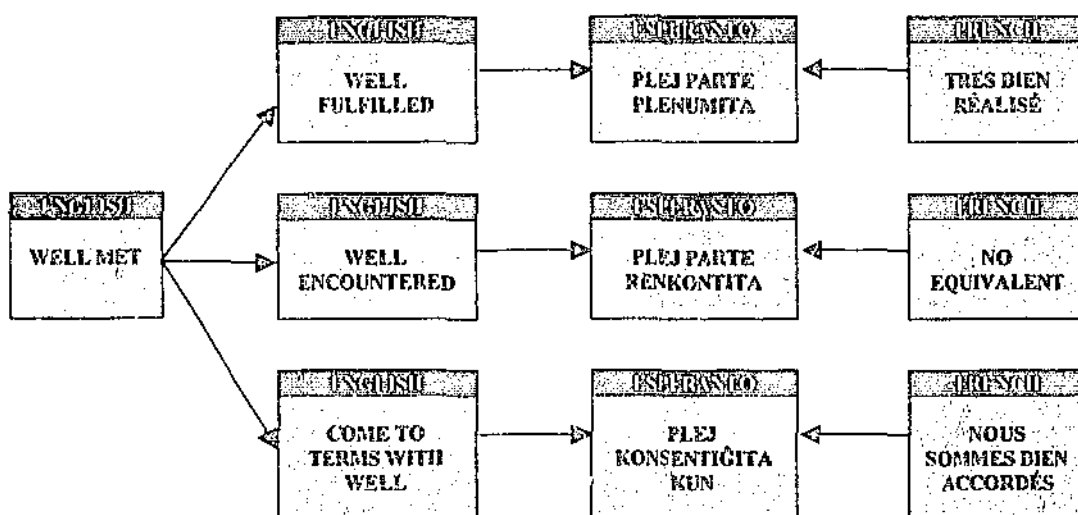


Figure 25 Synonym list for the English word group 'well met' showing the interlingua and French equivalent word groups

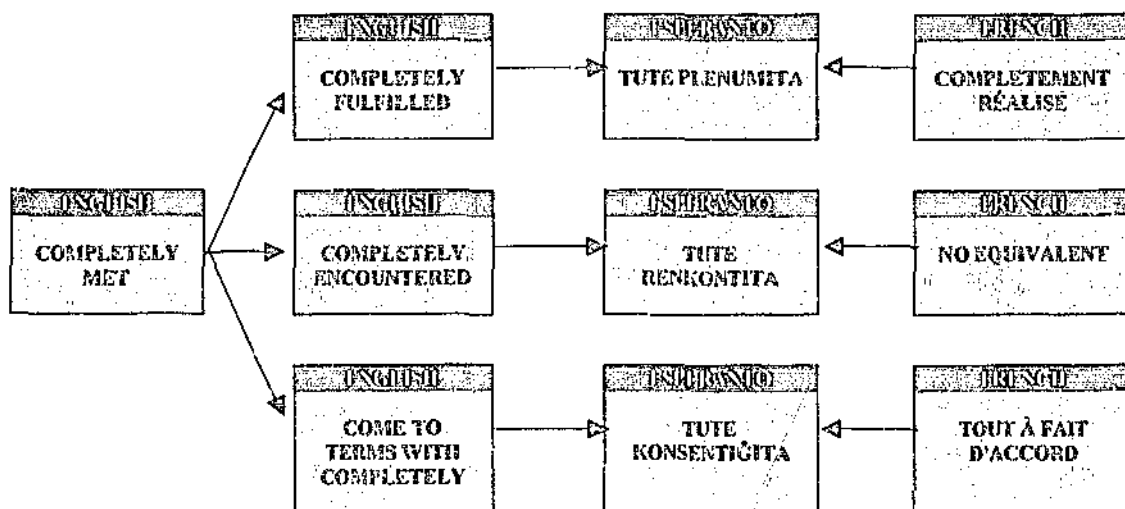


Figure 26 Synonym list for the English word group 'completely met' showing the interlingua and French equivalent word groups

4.3.2.9 The Prototype Model: Introduction to Synonym Tables

Homonyms and ambiguous texts, where the syntax is unhelpful to those deducing the intended meaning, have fuelled much debate amongst machine translation researchers (Garvin, 1972). The use of pre-editing and post-editing tools built into a machine translation mechanism may help to overcome the vagaries of natural languages (Arnold et al., 1994). Synonym look-up tables are one such tool and the regular occurrence of homonyms within the survey questionnaire required the inclusion of a synonym table in the English and French dictionaries to allow users to select the correct synonym.

Further examination of the homonyms found in the survey questionnaire assisted in the design of the prototype model. The alternative English language word groups ‘not a requirement’ and ‘not a necessity’ could be available to a user entering either English word group for translation as shown in Figure 27. The synonym table provides details of each synonym the user may select when keying in the desired alternative.

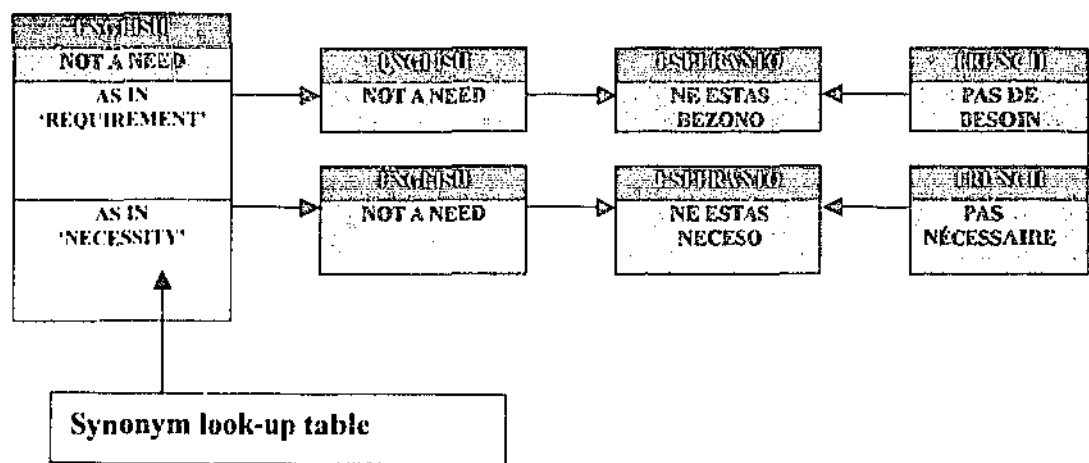


Figure 27 Synonym table incorporating the English homonym ‘need’

The word group strategy was tested to determine if it reduced the complexities of word-for-word translation. An attempt was made to see if word groups containing ‘little’ required synonym tables to assist the user to differentiate between variant meanings. A sample text ‘Do you understand the process a little better?’ was used to test the strategy. The sentence was bisected into the following word groups:

‘Do you understand the process | a little better?’

The first word group or ‘leader’ used in conjunction with other ‘follower’ word groups could represent sentences likely to appear in a survey questionnaire, such as those shown in Figure 28:

‘Leader’ word group	‘Follower’ word group
Do you understand the process	a little better
Do you understand	a little more
Do they understand	
Does your family understand	
Does your child understand	

Figure 28 An example of the ways in which word groups may be combined with other word groups.

‘Little’ and ‘a little’ had, in the context of these interchangeable combinations, a precise and unambiguous meaning, i.e., a small quantity. The interlingua equivalent and its French translation were unambiguous. In this example, the word group strategy avoided the necessity to create any relationship synonym rules. This translation is highlighted in Figure 29:

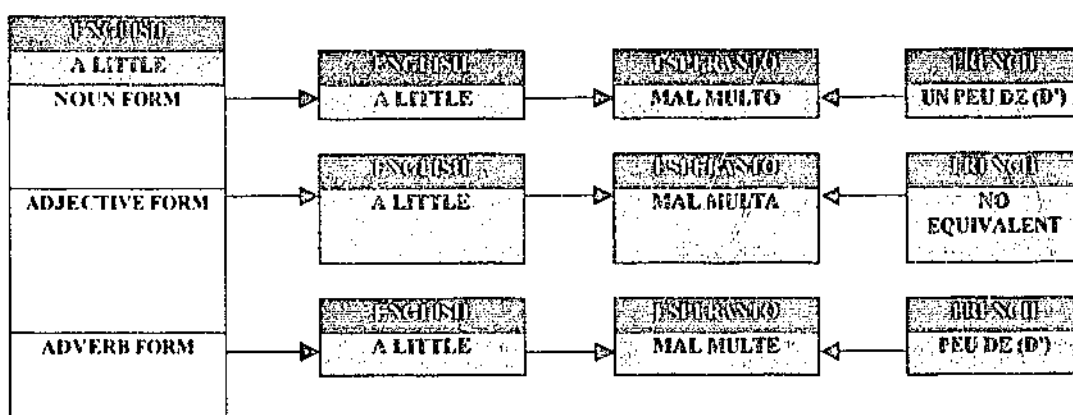


Figure 29 Diagram showing the interlingua and French equivalent of the noun, adjectival and adverbial forms of the English 'a little'.

It should be noted that the indefinite articles 'a' or 'an' are implicit in all Esperanto nouns. The analysis completed during the construction of the prototype English and French dictionaries identified those word groups capable of manipulation to ensure preservation of correct meaning during translation. These observations were used to determine whether:

- complex syntax rules could be avoided or minimised; or
- there was a requirement to construct synonym look-up tables; or
- the defined language environment strategy could be used to enhance translation between the dictionaries.

Data collected during this stage of the research provided the information required to answer the sub-question:

May Esperanto as an interlingua preserve a high standard of meaning when translating text between two natural languages?

The three sets of word group translations were added to each respective language dictionary. The English and French word groups were then linked to equivalent word groups in the interlingua. The database then incorporated the word group, relationship rules and any necessary synonym look-up tables. Testing of the database confirmed the robustness of the Jade environment and the research progressed to the next stage, which involved combined word group relationships. Data collected during this stage of the research provided the information required to answer the sub-question:

May a sublanguage methodology preserve a high standard of meaning when translating between two natural languages?

The preliminary testing of combinations of word groups informed the construction of the prototype model. Recognition of homonyms and their treatment by the prototype model provided a blueprint to design and evaluate the combined word group strategy. This part of the study is described in the following section.

4.3.2.10 The Prototype Model: Construction of Combined Word Group Structures

The prototype model relies on being able to identify both word groups and combined word groups that are stored in the interlingua. A source language word group is entered into the prototype mechanism, the equivalent word group is located in the interlingua and the matching target language word group is confirmed. Please refer to Figure 16 above for an illustration. The process also succeeds with, for example, sentences consisting of two word groups. This research also examined the relationships between combinations of word groups to determine the quality of the translations.

4.3.2.11 Selection of Sample Word Group

The research focussed on combining small word groups in the interlingua to create complete sentences. The maximum number in each word group was restricted to seven. During this process the use of word groups and the associated strategies, independently or in combination, raised a number of questions about factors that were likely to affect the translation of the majority of word groups entered into the model. These factors were:

- the frequency with which a given word group would occur within the defined language environment;
- which alternative form or forms would most frequently occur;
- determining the best alternative form or forms for retention in the dictionary; and
- defining the composition of the synonym tables to reflect the selection or omission of alternative forms.

The use of word groups to preserve correct meaning during translation was investigated and, subsequently, more advanced routines were built to test more complex structures. Short sentences that comprised two word groups were constructed in the interlingua. The first example took the form of a simplified question used in the survey questionnaire, 'Have we met your needs?' The exact Esperanto translation is 'Ĉu ni plenumis viajn bezonajn?' This sentence occurred frequently in the questionnaire, so there was potential benefit in translating such regularly occurring sentences as one discrete group. It was thus examined to determine how it might best be bisected into word groups and to determine:

- whether the two word groups in the English and French dictionaries have equivalents in the interlingua;

- whether the equivalent word groups in the English and French dictionaries combined to form a sentence in the interlingua; and
- how well that sentence preserved the intended meaning between the English and French dictionaries.

The large number of sentences required to populate a dictionary in a non-defined language environment would require huge resources. However, a restricted environment may include only those sentences and phrases likely to appear within that environment. Such restriction would avoid the construction of overly complex dictionaries.

The experiments were designed to determine whether the strategy would preserve all of the linguistic attributes of a translated sentence without the use of a metalanguage and complex computing rules. Results from the experiments with combined word groups are detailed in section 5.2.2. The examination of combined word groups would contribute to an answer for the sub-question:

May Esperanto as an interlingua preserve a high standard of meaning when translating text between two natural languages?

During the design of the prototype model, it was apparent that the regular presence of homonyms and differences in the grammar of English and French made it unavoidable that these features must be recognised during the translation processes. Unlike the transfer methodology, which has complex syntactical and lexical rules that identify these anomalies, the prototype model required a different system to deal with them. The

following section describes how synonym tables overcame these challenges to ensure accurate translations.

4.3.2.12 Constructing the Synonym and Word Group Selection Tool

The first part of the text 'have we met' contains the homonym 'met' described previously in section 4.3.17. (Please also see Figure 20.) This word group was used as the first or leader word group to which follower or secondary words or word groups may be added to form a sentence. In this case 'your needs' is added to complete the sentence 'Have we met your needs?' The word group 'your needs' also contains the homonym 'need'. This requires the prototype to complete additional tasks during the translation. Both word groups must be interrogated to verify if homonyms are present. If a homonym is present in either word group the mechanism provides the user with the option to select the desired alternative meaning.

The mechanism then identifies the exact word group selected and the equivalent phrase is identified within the interlingua dictionary. (Please refer to Figure 16.) Figure 31 below shows in detail how this basic process of identifying the word group and determining whether there are any alternative meanings takes place.

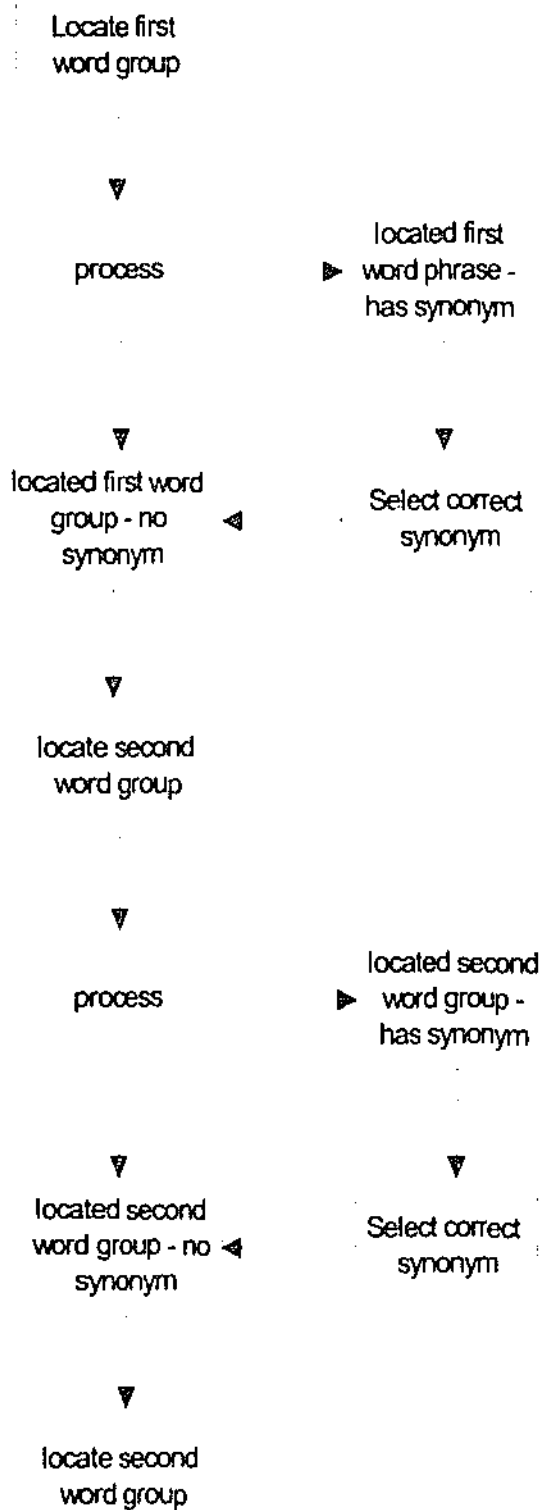


Figure 30 The process of entering search text in the source language dictionary to locate two word groups and synonyms

Examination of the processes used to identify the combined two word groups 'Have we met | your needs' shows how the synonym table and word group selection strategies processed the input text:

- the first word group 'have we met' is entered into the mechanism;
- the mechanism identifies the homonym 'met' within the English dictionary and offers three alternative meanings:
 - the verb 'to fulfil';
 - the verb 'to be acquainted with';
 - the verb 'to come to terms with';
- the user selects the verb 'to fulfil' as this is the intended meaning of the word group;
- this selection is stored in the data memory of the mechanism;
- the second word group 'your needs' is entered into the mechanism
- the mechanism identifies the homonym 'needs' within the English dictionary and offers two alternative meanings:
 - the noun 'requirements'; or
 - the noun 'necessities';
- the user selects the noun 'requirements' and this is combined with the first word group;
- the combined word groups are identified within the interlingua dictionary:
 - have we met (fulfilled); and
 - your needs (requirements);
- the equivalent word groups are then identified within the interlingua dictionary:
 - ĉu ni plenumis
 - viajn bezonajn

- the equivalent French word groups are identified within the French dictionary:
 - avons-nous réalisé; and
 - vos besoins;
- the translation is completed with the sentence: “Avons-nous réalisé vos besoins?”

The design of the prototype model enables this process to be reversed by inputting the text through the French dictionary, then through the interlingua to produce the translation in the English dictionary. Once the design stage of the prototype model was completed, word groups were constructed and translated into the interlingua and English and French dictionaries. These activities included identification of homonyms and the inter-relationships of the word groups and are described in the following section.

4.3.2.13 Analysis of Two Combined Word Groups

The research then focussed on testing how separate groups of word groups combined with other groups so that they form complete, intelligible sentences in the interlingua. Sentences from the questionnaire were bisected into separate word groups, the word group that commenced each original sentence and a second word group that completed the sentences. This phase collected data to consider how linguistic dynamics may affect the construction and viability of word group relationships within the interlingua and natural language dictionaries.

Testing of the viability of combined word groups in the interlingua was undertaken. The word groups were then used in conjunction with the equivalent combined English and French word groups to produce intelligible and accurate sentences

in English and French, respectively. The combined word group structures were examined in detail to determine the extent to which the combined word groups in English and French related to the interlingua. Data was collected to analyse these relationships, to examine the syntax structure of the interlingua samples, and to compare the relationships between the equivalent English and French word group syntax. This analysis was necessary to detect any incompatibility between the interlingua word groups and the English and French equivalents. These findings are set out in section 5.2.2.

The next section describes the search identification methodology incorporated in the prototype model. This methodology enables the mechanism to search and select the correct combined word groups that form part of a source language sentence that is being translated into the target language.

4.3.2.14 Design of Word and Word Group Selection Methodology: First Found First Selected Versus Largest First

To translate a sentence from the source language to an equivalent sentence in the target language, the user must convert the input text into a series of word groups. These word groups are fragments or components of a complete sentence, ranging from one word to full sentences. One of the major steps in translating the sentence is the selection of these word groups. When processing an input string, the translator must select an appropriate word group from within the chosen English or French dictionary. During the word group selection process, the mechanism prompts the user to select the 'most appropriate' word group available. To achieve this, two possible selection processes have been defined:

1. the first found first selected (FFFS) and
2. the largest first (LF) strategies.

These two selection processes were developed during the construction of the prototype model when it became apparent that there were several selection options available to the user of the mechanism (Pride, S., 2003, personal communication).

Although these two processes are similar, they may return different results. The translator may either use one method as a default or alternate between the two when appropriate. Furthermore, whilst the two selection strategies are different, they both require the input string to be tokenised. Tokenisation converts the input string, through a lexical analysis and a parsing function, into valid segments based on the unique character of the words in the string. The input string is analysed by the mechanism splitting the sentence where it finds a space, thus breaking the sentence up into words. The resultant collection of words, known as a string array, is then analysed by the mechanism's selection process to identify the equivalent word and word groups in the source language dictionary.

4.3.2.14.1 First Found First Selected

Essentially, the FFFS strategy selects the first word group it can find for the largest possible input string. Initially, the string used to search the database is the entire untranslated sentence. If an appropriate match is not located, the user will shorten the search string by removing a word from the end. This process continues until either a word group is found, or the input string cannot be shortened. If the search resulted in an appropriate word group, the user will add it to a collection of 'selected word groups' and remove the found string from the set of untranslated words. The process will then

continue, this time using the shorter original text as its initial search string. If the string cannot be shortened, because the search string contains only one word, then the input string cannot be processed.

By continually removing the last word in the search string, the FFFS strategy will find the largest word group in the dictionary that will satisfy the start of the untranslated text. Word groups are only found at the beginning of the string, but the strategy will pick up erroneous words anywhere within the string. The user may also receive an error message stating that the word group cannot be located within the dictionary. The user may then try the Largest First strategy described below.

4.3.2.14.2 Largest First

The LF strategy, like the FFFS process, aims to select a collection of the largest word groups possible. Instead of searching at the start of the string, the LF process will seek the largest word group in the database from each word in the input sentence. For example, given the input sentence *Does the senior heart surgeon favour polka-dot bikinis or bland smocks in his operating room?*, the LF strategy will use the FFFS strategy to find the largest word group for ‘does the senior heart surgeon ...’, then for ‘the senior heart surgeon favour ...’ and so on until each word has been tested. The LF process will then select the word group with the largest length it found and then add that to the collection. The LF strategy will then perform the same actions on the untranslated text to the right of the found word group, as well as to the left. This strategy is achieved through recursive searching for selected text until a collection of found word groups fitting the search request are located and provided to the user.

The LF strategy may return a different set of results than the FFFS strategy. The FFFS strategy may return the following list of word groups for the input sentence *Does the senior heart surgeon favour polka-dot bikinis or bland smocks in his operating room?*:

- Does the
- senior heart surgeon
- favour
- polka-dot bikinis
- or
- bland smocks
- in his
- operating room

With the same input sentence, the LF strategy may produce:

- Does
- the senior heart surgeon
- favour
- polka-dot bikinis
- or
- bland smocks
- in
- his operating room

Although both strategies are successful at selecting word groups, the types of word groups they select may have a bearing on the quality of the translation. Testing of the LF strategy during the construction stage often identified more single words than word groups, but further testing showed this not always to be the case. Both the dictionary and the input sentence are contributing factors to the success of the selection. Testing of the two strategies during the construction of the mechanism confirmed that in some instances, FFFS may produce the best results, whilst in other instances, LF may succeed when the FFFS fails (Pride, S., 2003, personal communication).

According to Pride (2003, personal communication), the LF strategy is a little slower and requires more system resources than the FFFS strategy as it is a recursive method. The LF strategy will essentially repeat the FFFS process, at least as many times as there are words, which will also decrease performance. However testing with Pride (2003, personal communication) confirmed that when the different search methods were used during the evaluation of the prototype model translations, there were no discernible differences in the time used to process each search. Both searching strategies may be used, and if one fails to produce a result, then the other strategy may be used. Testing during the construction of these strategies showed that by using both the system had a greater success rate in selecting the correct word groups. According to Pride (2003, personal communication), the limitations of one strategy are offset by the advantages of the other.

4.3.2.15 Completion of the Jade Database Construction

The construction of the Jade database incorporated relationships between individual word groups that when combined formed a complete sentence. Testing of the relationships identified those word groups combined within the interlingua that could be matched with equivalent word groups in the English and French dictionaries. While the engineering challenges were surmountable, the linguistic issues discussed in 4.3 required additional engineering to guarantee word group matching whenever synonyms were present in the dictionaries. The translation outcomes were then evaluated. The evaluation methodology is described in the following section.

4.3.3 Evaluation of the Results Obtained from the Two Models

This section describes the evaluation methodology used to compare the sample translation results obtained from the two models and, thus, evaluate the efficacy of the translation results produced by the prototype model. A comparison was also made of the structure of the two models to verify any significant reduction in the complexity of linguistic and technical features of the prototype model.

The difficulties facing a meaningful evaluation of machine translation mechanisms were described in 2.1.1. The texts used to compare the translation output of the control and prototype models were based on sentences and phrases taken from the hospital questionnaire. Qualified and experienced translators manually translated the English texts into their equivalent texts in Esperanto and French. The translation processes involved examination of each word, word group and sentence, to identify any anomalies including the presence of homonyms and interpretation of semantic factors. Once completed these translations were used as a standard to measure:

- the accuracy of the English and French translations produced by the SYSTRAN control model; and
- to verify that the English and French translations produced by the prototype model software were identical with the translations completed by the human translators.

4.3.3.1 The Parameters of the Experiments

The translators were briefed on the background of the questionnaire and the objectives of the study. This briefing was essential, as the language extracted from the questionnaire was that used to question the parents of hospitalised children. The terminology of the questionnaire was translated into the equivalent format in Esperanto and French. The language of the questionnaire is formal, but makes use of plain English text. The same plain text was represented in the French translations. This requirement was communicated to the translators undertaking the French translations to avoid the inclusion of colloquialisms in the dictionary.

Because of limited time and resources, the experiments to test the study were limited to sentences containing no more than eleven words. For similar reasons punctuation marks were omitted, with the exception of spaces between words. No attempt was made to construct relationship rules between the word groups used in the prototype model as input text relied on the word group content of the three dictionaries built into the model.

4.3.3.2 Collection and Analysis of Data from the Control and Prototype Models

Texts used to test the control model were built into the dictionaries of the prototype model. It was anticipated that the results of the translations processed through the prototype model would be the same as the manually created translations. The test would be to see if sentences consisting of combined word groups would be produced accurately during the translation process. Concerning the control model, the accuracy of its sentence output would be compared in the English and French sentences manually

created and used to populate the prototype model dictionaries. The reasons for this different evaluation of the two models are:

- the control model relies on the transfer methodology, requiring each entry in the language dictionaries to be catalogued in a metalanguage format incorporating complex syntactical relationship rules; and
- the prototype model sublanguage methodology incorporates the word group strategy that avoids the necessity of using a metalanguage and syntax rules.

The control model evaluation is based on assessing the sentence output in English and French to determine intelligibility and accuracy. In other words, it is important to verify whether the control model output sentences have maintained the meaning of the source language sentences. The results of these translation tests will facilitate comparison between the two models and help to determine whether there is any significant difference between the translation output of each model.

While recognising the difficulties of evaluating translation output described in section 2.11, this study required that the translations meet specific requirements. The translated text had to retain the intended meaning and conform with the syntax and semantic features that are appropriate to a medical survey environment. The translated texts had to make sense to the survey respondents. Where there is an alternative meaning, the mechanism had to provide the user with the option to select a desired alternative. The translated texts produced by both models were examined against the following criteria:

- the accuracy of meaning;
- the occurrence of any inaccurate meaning based on lexical, syntactical and semantic factors;
- whether the mechanisms were unable to produce a translated text;
- whether synonyms and alternative meanings were identified and whether the user was able to select alternative meanings; and
- the ability of the word group strategy to link the English and French word groups with the equivalent word groups in the interlingua to facilitate translation between the English and French languages.

As described earlier in this chapter, evaluation of the translation output of the prototype model was made through comparison with the output of the control model. Further testing determined the viability of the combined word group strategy between English and French within the confines of the language environment described in the previous section. The translated words, word groups, combined word groups and complete sentences translated during the experiments may be found in Appendices D to I.

The findings obtained from the experimental data are discussed in detail in Chapter 5. They include an analysis of the data results and their relevance to the sub-question:

May a combined interlingua and sublanguage methodology mechanism significantly simplify the construction of language dictionaries for non-technical translators?

4.4 Potential Enhancements not Incorporated in the Study

Previous research has shown that the basic word group strategy may also involve more advanced relationship rules between different categories of word groups (Zens et al. 2002, p. 11). These advanced techniques are intended to provide a more robust mechanism capable of some improved analysis and identification of likely meanings and a reduction of the reliance on synonym tables. Other research describes manipulation of texts in an interlingua mechanism that translates texts between natural languages with significantly dissimilar grammars to overcome these greater obstacles (Mitamura et al., 1991, p. 6). However, time and resource constraints effectively denied inclusion of these additional techniques in this study.

During the preliminary research into the linguistic design of the prototype model, investigation centred on the composition of the words and synonyms occurring in the questionnaire. An attempt was made to catalogue these 120 words and define relationships between them that were considered likely to occur in a medical environment. It became apparent that a manual construction of a lexicon containing combinations of the 120 words was a time-consuming and tedious task. However, it was essential to undertake this task to ensure that word groups populated the language dictionaries in the prototype model.

Consequently, a computer application capable of filtering the large number of word group combinations was tested in the hope of reducing the time resources and the large number of lexical errors detected during the manual construction of the language

dictionaries. While intended as a time saving and error-reducing programme, it was not incorporated into the study because the number of words and word groups selected were manageable and were processed manually. This application would warrant further testing as a possible tool used during the construction of a larger scale model based on the prototype model.

4.5 Summary

This chapter has described the structure and methodology of the transfer-based control model and the combined interlingua and sublanguage prototype model. These descriptions highlight the differences in methodology and provide a basis upon which to examine the construction and the translation quality of each model. Also described in this chapter was the methodology used to compare the two models and evaluate the results obtained from the experiments. Chapter 5 provides an analysis of the experimental results generated by this study.

5 IMPLEMENTATION AND FINDINGS

5.1 Introduction

Chapter 4 introduced the various phases of the research design of the study and the relationship each phase had to the research questions. This chapter describes the implementation of the research and its findings. These findings are analysed and used to compare the translation accuracy and the structure of each model.

5.2 Implementation of the Study

As described in section 2.8, in order to provide ‘proof of concept’, it was necessary to:

- investigate the feasibility of constructing a prototype machine translation mechanism using an interlingua to generate high-level translation output by:
 - using Esperanto as the interlingua; and
 - incorporating a sublanguage methodology;
- construct a prototype model, incorporating the above two strategies and to compare its structural attributes with those of a contemporary model to ascertain whether a reduction of development resources could be achieved.

The construction of the prototype model was a challenge that required some detailed analysis of the linguistic dynamics upon which to base the engineering design.

While recent research into interlingual and sublanguage methodologies were located and are described in section 3.3.5, no replica of the prototype model used in this study could be located. Therefore, the research was based on using the basic interlingua methodology and designing a simple word group strategy, which when combined with the interlingua, formed the prototype model. The construction of a more sophisticated model was beyond the time and resources available. Consequently, it was essential that the prototype design was simple, yet sufficiently robust to produce translations worthy of evaluation to establish the 'proof of concept'.

The processes involved in building the prototype model were documented and the linguistic and engineering design data collected. Examination of this data was undertaken to verify whether there were any results to answer the research question. The first investigation confirmed that the model could be constructed and could produce translations within the scope of the research. The accuracy of these translations was compared with the translation results obtained from the control model. The effectiveness of Esperanto as an interlingua was also investigated and the results noted. The second investigation centred on a comparison of the structures of the control and prototype models. The researcher also considered whether there was any reduction in resources required to construct the technical and linguistic components of the prototype. The following sections detail the results of these investigations.

5.2.1 Analysis of the Translation of Sample Text to Determine the Accuracy of Output Sentences Produced in the Source Language

The texts used to test the accuracy of output sentences in the source language through the control and prototype models may be found as follows:

For the control model:

English to French: Single words and word groups	- Appendix D
English to French: Combined word groups	- Appendix E
French to English: Single word and single word groups	- Appendix F
French to English: Combined word groups	- Appendix G

For the prototype model:

English to French to English: Single word and single word groups	- Appendix H
English to French to English: Combined word groups	- Appendix I

The results of the examination of the control and prototype models are described respectively in the following two sections.

5.2.2 Control Model Translation Results

The sample texts were entered into the control model in two stages. Firstly, the English sample texts were keyed into the mechanism and the French output sentence results were recorded. In the second stage, the French sample texts were keyed into the mechanism and the English output sentence results were recorded. The results were examined to observe:

- the level of accuracy of the translated sample;

- whether there were any instances where no translation output was recorded; and
- whether synonyms and alternative meanings were provided.

The following subsections describe the results of the tests.

5.2.2.1 Control Model Translation Results: English to French Single Word and Single Word Groups

Two hundred and thirty single words, word groups and synonyms totalling 300 were translated from English to French. Table 1 provides a breakdown of the results, while full details are shown in Appendix D:

Total number of sample texts	Correct translations	Inaccurate translations	No synonym provided
300	153	70	77

Table 1 Translation results of English to French single word and word groups.

For a translation to be deemed accurate, a precise match was required. In those cases where the meaning or the syntax was seen as inadequate, the match was classified as inaccurate. In the case of the word groups, the semantic nature of the translations also played an important part as the fluency of the translations required formal expression in everyday use and not archaic or prosaic language as was observed in some of the translations. (Please refer to Appendix D for further detailed examples.) It was also evident that the control model had no provisions to alert the user to the possibility of synonyms or homonyms.

5.2.2.2 Control Model Translation Results: English to French Combined Word Groups

Thirty-five combined word group samples were translated from English to French. Table 2 provides a breakdown of the results, while full details are shown in Appendix E:

Total number of sample texts	Correct translations	Inaccurate translations
35	10	25

Table 2 Translation results of English to French combined word groups.

The inaccuracies detected during this testing ranged from incorrect syntax to identification of an incorrect synonym.

5.2.2.3 Control Model Translation Results: French to English Single Word and Single Word Groups

Two hundred and thirty single words, single word groups and synonyms totalling three hundred were translated from French to English. Table 3 provides a breakdown of the results, while full details are shown in Appendix F:

Total number of sample texts	Correct translations	Inaccurate translations	No synonym provided
309	183	126	4

Table 3 Translation results of French to English single word and word groups.

To be classed as accurate the translations required a precise match. In those cases where the meaning or the syntax was seen as inadequate, the match was classified as inaccurate. In the case of the word groups, the semantic nature of the translations also played an important part as the fluency of the translations required formal expression in

everyday use. Please refer to Appendix F for details. It was evident that the control model provided no means to alert the user to the possibility of synonyms or homonyms.

5.2.2.4 Control Model Translation Results: French to English Combined Word Groups

Thirty-five combined word group samples were translated from French to English. Table 4 provides a breakdown of the results, while full details are shown in Appendix G:

Total number of sample texts	Correct translations	Inaccurate translations
35	2	33

Table 4 Translation results of French to English single word and word groups.

The less than six per cent hit rate for correct translations was a low score for combined word group translations. The inaccuracies detected ranged from incorrect syntax to identification of an incorrect synonym. Detailed analysis of these results is included in Appendix H.

5.2.3 Prototype Model: Word Group Translation Results

Two hundred and thirty sample texts consisting of single words and single word groups including synonyms and totalling three hundred sample texts were first translated from English to French. The reverse procedure was then completed from the French to English. These results are shown in Appendix H. The results also show where the synonym look-up table and the verb tense gender rules were incorporated into the model to ensure accuracy in translating the selected version. The test log also records the testing undertaken with the two search strategies incorporated within the prototype model. The second part of the test used thirty-five texts consisting of combined word groups that were

translated first from English to French and then back to English. These results are shown in Appendix I.

The results of the testing provide the following information:

- no inaccuracies in translation were detected;
- the synonym look-up tables were correctly constructed and were able to identify homonyms and verb and pronoun gender attributes;
- the word group strategy preserved the semantic meaning of the texts; and
- the results were identical when using the two search strategies separately and jointly.

To highlight the difference in these results the following comparison is made. An example of the combined word group strategy taken from Appendix I, consisting of the following word groups, demonstrates how the prototype model translated an eleven word sentence, which preserved the syntax and semantic qualities of the English and French sample texts:

Do you think we can improve the treatment + your child received?

Pensez-vous que nous puissions ameliorer le traitement + qu'a reçu votre enfant?

By comparison the control model produced the following poor results. Please refer to Appendices E and F.

Think you that we can improve the treatment which a received your child?

Nous pensez-vous pouvez-vous améliorer le traitement que votre enfant a reçu?

This comparison highlights the poor quality of the control model results in both English and French. The sample text highlighted above is a complex sentence containing precise word order and semantic characteristics. For example, the jumbled word order in the control model results may still be intelligible but the poor syntax and semantics, render it unsuitable for inclusion in a questionnaire.

5.2.4 Prototype Model: Investigation of Esperanto as an Interlingua

The varying complexity of the sample texts provided the following information to evaluate the use of Esperanto as an interlingua:

- precise meanings were found in Esperanto that equated to the English and French samples;
- the absence of irregular verbs and verb tenses in Esperanto simplified the construction of the interlingua dictionary, thus potentially reducing translation complexities and errors; and
- during the creation of the Esperanto dictionaries, the translation processes encouraged more detailed investigation of the meaning of the English and French word groups to ensure the correct equivalent word group was created in the interlingua.

The use of a structured language such as Esperanto, instead of a natural language such as English or French, avoided many of the irregularities inherent in natural

languages. Matching a natural language dictionary to another language dictionary within an interlingua-based system may be more time and resource consuming than using a precise language such as Esperanto. While the observations made during this study are encouraging, further testing of Esperanto using texts that are more complex would better validate its suitability as an interlingua.

5.2.5 Analysis of the Main Construction Features of the Control and Prototype Models

The control model described in more detail in Chapter 4 has the following key features:

- the use of algorithms, metalanguage and a parsing generator to identify the meaning and syntax of each word contained in the language dictionaries;
- statistical analysis based on the probable meaning of texts based on the attributes of each word within; and
- no means for handling the occurrence of homonyms and other syntactical anomalies.

The prototype model, in contrast, incorporates the following key features in its design:

- there is no requirement to include any algorithms to identify syntax and lexical relationships;
- each word group is defined manually and then translated into the interlingua;

- word groups are not linked to other word groups, thus reducing the use of resources required for dictionary construction;
- the mechanism does require a significant number of synonym tables to be constructed for homonyms that are likely to occur within the defined language environment; and
- the use of the FFFS and LF selection tools ensured that complete word groups and combined word groups may be retrieved successfully from the English and French dictionaries.

5.3 Findings

Once the testing and analysis were completed, the findings were processed and associated with the research questions to determine the outcomes of the investigation. Conclusions were then made, based on the accuracy of the translations and on a comparison of the structures of the two models. These conclusions are described in the following sections.

5.3.1 Comparison of the Translation Output of the Control and Prototype Models:

The translation inaccuracies observed in the control model results were high in comparison to the 100 per cent accuracy of the prototype model. Moreover, the control model failed to provide details of homonyms, thus denying the user the ability to choose the desired meaning from a selection of synonyms. A significant number of the combined word groups, translated by the control model from English to French and French to English, were inaccurate. In some cases, parts of the French source language texts were

transferred to the English target language output sentence in French format. In other cases, poor quality English target language translations were produced showing a lack of attention to English lexical and syntax issues. (Please refer to Appendices D to I for examples.)

5.3.2 Comparison of the Main Construction Features of the Control and Prototype Models

The design of the control model is contingent on the statistical probability of identifying the correct meaning in any given text (Senellart et al., 2002). The control model's reliance on word-for-word analysis and codification contrasts sharply with the prototype model's reliance on word group translation. As described in Chapter 4, the prototype design requires no technical expertise for the dictionary builder to construct the language dictionaries. All that is required is a linguistic knowledge of the natural language and compliance with the simple user guide shown in Appendix C.

A comparison of the key features of each model based on the literature review and research carried out during the study are set out in Table 5 below:

The Control Model	The Prototype Model
Uses a metalanguage to convert each word in the language dictionaries.	No requirement to use a metalanguage.
Requires parsing generator to manipulate the metalanguage.	Minimum parsing required within the Jade database.
Uses a statistical analyser to locate probable equivalents in the target language.	Precise equivalents are pre-stored in the interlingua. The use of the FFFS and LF

	search tools enhances retrieval of the correct word group and combined word groups.
No provision for synonym look-up tables.	Synonym look-up tables are provided. Esperanto provides precise meaning to facilitate language pair relationships.
Technical expertise is required to design and construct the dictionaries.	No technical knowledge is required.
Technical expertise is required to design and construct the word relationship rules.	No technical knowledge is required.
Linguistic expertise is required to design and construct the dictionaries.	Linguistic expertise is required to construct the dictionaries.
Linguistic expertise is required to design and construct the word relationship rules.	No linguistic expertise is required.

Table 5 Comparison of the key features of the Control and Prototype models

5.4 Discussion

The evidence obtained to provide answers to the sub-questions posed by the research is addressed in the following section.

5.4.1 Evidence Found To Support the Research Questions

Sub-question 1

May Esperanto as an interlingua preserve a high standard of meaning when translating text between two natural languages?

The interlingua provided an interface between the English and French dictionaries and in doing so provided precise meanings in Esperanto. This facilitated the

identification of homonyms and the creation of links to synonyms included in the dictionaries. The ease of use of Esperanto in the study reinforced the belief that it does possess the precision and flexibility required of an interlingua.

Sub-question 2

May a sublanguage methodology preserve a high standard of meaning when translating between two natural languages?

The experiments show that 100 per cent accuracy may be achieved in translations observed in the prototype model, compared to low accuracy translation produced by the control model. Moreover, these translations preserved the semantic meaning of each word and word group between the English and French dictionaries.

Sub-question 3

May a sublanguage methodology reduce significantly the complexity of technical resources when translating text between two natural languages?

The use of the word group strategy overcame the need to convert words into metalanguage and construct complex parsing rules to identify and transfer words into the equivalent target language. The word group strategy achieved this with a high level of accuracy of translation output.

Sub-question 4

May a combined interlingua and sublanguage methodology mechanism significantly simplify the construction of language dictionaries for non-technical translators?

No technical resources are required to create the dictionaries and word group attribute rules in the prototype model, while the control model did require significant technical and linguistic resources in its construction. The features of the prototype model facilitate construction of the database dictionaries without the need for any technical knowledge. While there is a need to include a large number of synonym tables in the prototype model, this is also a requirement of an effective transfer-based model. It was noted that this feature was not included in the structure of the control model.

The Main Question

May an Esperanto-based interlingua machine translation mechanism, using a sublanguage methodology, achieve high-accuracy translations between two natural languages and reduce the complexity of the technical construction?

This research has shown a combined Esperanto-based interlingua and sublanguage methodology may produce high accuracy translations and requires no programming knowledge to construct the databases.

5.5 Summary of the Findings

In Chapter 5, details of the investigation sections outlined in Chapter 4 were presented. The investigation combined the needs outlined in the Chapter 2 with the

foundations described the literature review at Chapter 3 Chapter 5 also described the findings of this study, providing excerpts of the tests completed into the control and prototype models schemas. It presented a comparison of the results to provide answers to the research questions as they were presented in section 2.8. Owing to a lack of reasonably affordable and reliable machine translation applications, it is difficult to translate a variety of natural languages in a specific environment. Additional resources and time spent in developing complex applications significantly increase the purchase and licence costs. This study concludes that these costs may be attributed to the complexity of the linguistic and technical expertise required to construct transfer based machine translation mechanisms. The analysis of the translation accuracy and the structure of the prototype model showed that it was possible to minimise the technical and linguistic resources, yet maintain a higher level of translation accuracy.

6 CONCLUSIONS

6.1 Implications of this Study

This study has detailed the phases involved in developing a prototype model based on a combined interlingua and sublanguage methodology capable of producing high accuracy translations. From the analysis of the data collected and correlated throughout the investigation, each research question has been answered. The goals of the project have been accomplished and the findings revealed.

The interlingua and sublanguage concepts presented by various researchers in Chapter 3 (Arnold et al., 1994; Boardman, 1999; Boitet, 1994; Mitamura et al., 1991; Zens et al., 2002) are still very much at an experimental stage. This study has shown that, when combined, these strategies may produce high accuracy translations with minimal technical expertise. The advantage of the word group strategy over other machine translation systems is that it avoids reliance on complex parsing and metalanguage structures. Chapters 3 and 4 confirm that the construction of transfer-based systems requires complex technical and linguistic expertise.

The experiments undertaken to construct the prototype model demonstrate that the Jade-hosted database is capable of importing the language dictionaries and linking data to facilitate translations with no technical expertise. By comparison, the technical developers engaged on constructing a transfer-based system would require some

understanding of the languages of the dictionaries under construction to ensure that relationship rules were applied correctly. The cost of employing this expertise and the time used to complete the construction of the model would be greater than that required for the design and construction of the dictionaries used in a prototype-based mechanism.

The added benefit of the word group strategy is its ability to preserve sufficient semantic meaning in each word group to ensure fluency of translation. However, the large number of word groups that would be required to populate the language dictionaries would require manual translation. In a small, defined language environment, several hundred words would be required to meet user requirements (Arnold et al., 1994, p. 147). The combination of sentences and phrases derived from this word source could conceivably number more than one thousand. Research by Arnold et al. (1994, p. 147) supports the view that a defined environment offers the following advantages:

- fewer words need to be added to the machine translation system dictionaries and more effort can be put into ensuring the translations are accurate;
- the grammar component of the system may be tailored to handle all constructions;
- the dictionaries may be tailored to incorporate sets of word groups to comply with the defined language environment; and
- consistency about the use of word group forms helps to improve the overall consistency and quality of the texts being translated

This study accepted the above advantages reported by Arnold et al. (1994), to which it added the word group strategy. The word group strategy provided encouraging results for a relatively small sample of combined word groups. If used in combination with a defined language environment this may form the basis of a viable machine translation strategy. The number of word groups required may also be manageable in terms of human translation resources. Moreover, by constructing word group matrices, a larger number of combinations may be created without having to translate complete sentences. The examples shown in Figure 28 in Chapter 4 and in Appendix I exemplify the ability of word groups to be combined to form complete sentences. This avoids having to translate complete sentences, thus reducing the manual translation resources involved. However, another challenge facing builders of dictionaries for the prototype model is the need to identify homonyms that occur in word groups and to build look-up tables when their inclusion is required.

The prototype model offers natural language translators the opportunity to build more sophisticated models for full-scale translation tasks. The effort and resources saved in the technical construction of the control model methodology may be redirected to constructing word group matrices between different natural languages and the interlingua. Further research might examine linguistic dynamics of more diverse languages than English and French and may verify whether Esperanto may serve as a suitable interlingua to overcome differences in the syntax of such languages.

7 APPENDICES

7.1 Appendix A Definition of Terms

Adjective phrase	A complete construction headed by an adjective. Adjectival phrases typically modify nouns and occur as complements to verbs such as <i>be</i> , <i>seem</i> , <i>become</i> . For example: <i>The man guilty of this heinous crime was imprisoned. John seems rather stupid.</i>
AI	Artificial Intelligence , including computer programs. The branch of Computing Science concerned with simulating aspects of human intelligence such as language comprehension and production, vision, planning, etc.
ALPAC	Automatic Language Processing Advisory Committee . A committee established by the National Academy of Sciences' National Research Council in the United States of America to research machine translation.
CAT	Computer-Aided Translation . Similar to HAMT and MAHT machine translation systems that involve a degree of interaction between the human user and the computer translation program.
CEC	Commission of the European Communities .
DET	Distributed Language Translation . Dutch experiment using Esperanto as an interlingua.
EBNF	Extended Backus Naur Form . Provides an efficient vehicle on which to codify language for use with compilers. EBNF allows the user to work with a notation that is more readily understandable and less abstract than lower-level programming languages.
FAHQMT	Fully Automatic High Quality Machine Translation . Requires only the input of a selected text to produce a high quality translation output.
Grammar	The term is generally used to include syntax and morphology but may also be used in a wider sense to include rules of phonology and semantics . A grammar is a collection of linguistic rules, which define a language.

HAMT	Human-Aided Machine Translation. Involves a degree of input from the human user during the translation process.
Interlingua	A hub-language or pivot-language. An intermediary language that serves to preserve meaning between two or more natural languages.
Jade	Jade is a Java-based interface between the object-oriented database and the Java programming language
KANT	The KANT system is a multilingual, interlingual machine translation system, which translates technical documents from English to Japanese, French and German.
Language Knowledge	Language Knowledge or LK – please see Transfer methodology.
Lexicon	A dictionary or words defining meaning and application and various grammar components. It contains information about the pronunciation, the meaning, morphological properties, and syntactic properties of its entries.
LK	Indirect or Linguistic Knowledge – a form of machine translation architecture
MAHT	Machine-Aided Human Translation. Involves a degree of human input in the pre-editing and post editing of machine translation.
Machine Translation	Machine Translation. Computer-assisted natural translation mechanism
Natural language	A term, which denotes a (naturally occurring), opposed to computer languages and other artificial languages.
Noun phrase	A complete construction headed by a noun . It can be substituted by, or act as antecedent for, a pronoun of the appropriate sort: <i>The man who I saw yesterday has just knocked at the door. Can you let him in?</i>
Post-editing	A program that performs some operations on the output of another program, typically formatting the output for some device or filtering out unwanted items
Prepositional Phrase	A phrase headed by a preposition, a word such as <i>on, in, between</i> . Prepositions combining with other constituents (usually noun phrases) to form prepositional phrases , as in <i>The man sat on the bench</i>

Pronoun	A word that can substitute for a noun or noun phrase (e.g., <i>he</i> can substitute for <i>John</i>).
Semantics	The intended or implicit meaning of a natural language phrase or word group. The branch of linguistics which studies meaning in language facilitating the difference between the study of the meanings of words (lexical semantics) and the study of how the meanings of larger constituents come about (structural semantics).
Source Language	Source Language. The language one is translating from; in French to English translation, French is the Source Language .
Sublanguage	A language used to communicate in a specialized technical domain or for a specialized purpose, for example, the language of weather reports, expert scientific polemic or other modes of scientific discourse, user or maintenance manuals, drug interaction reports, etc. Such language is characterised by the high frequency of specialized terminology and often by a restricted set of grammatical patterns. The interest is that these properties make sublanguage texts easier to translate automatically.
Syntax	The grammar of a natural language. The rules of a grammar, which govern the way words, are combined to form sentences and other phrases in a language.
Target Language	Target Language. The language one is translating into; in French to English translation, English is the Target Language .
Transfer Methodology	Transfer or Language Knowledge methodology is a machine translation methodology currently in use that relies on metalanguage, parsing techniques and complex algorithmic formulae to identify the lexical and syntactical attributes of text before converting the text into the target language.
Transformer Methodology	An earlier machine translation methodology that used word for word translation techniques and produced low accuracy translations of large phrases and sentences. It is used extensively in electronic dictionaries, spell checkers, etc
UTL	Universal Translation Language. An experiment using Esperanto as a universal translation mechanism
Word group	A group of two or more words used in the prototype model to overcome linguistic complexities. A strategy within the word group sublanguage methodology

WYSIWYM

What You See Is What You Meant. A process which allows domain experts to encode their knowledge directly, by interacting with a feedback text, generated by the system, which presents the knowledge defined so far and the options for extending or revising it.

7.2 Appendix B The Princess Margaret Hospital (PMH) Survey Questionnaire

Welcome to the ECU PMH Parents' Support Needs Questionnaire

Welcome to the Paediatric Oncology Touch Screen Study. We are doing this study because previous research has shown that parents and other family members of children with cancer have important needs. We as health professionals need to be aware of the needs of parents and other family members so that we can provide care that is more appropriate and helpful during their child's illness.

The study will involve you completing the survey on this Touch Screen. This survey contains a list of 17 items identified by some family members who have a child with cancer. You will need to read each item on the screen, and then use your finger to touch the button that best represents how important each item relates to your present situation. For each item there are three questions you should answer. Don't worry if you have little or no experience with computers. The instructions on the screen will guide you through the questionnaire. The Research Nurse will also be with you and will be able to help you or answer any questions you may have about using the computer.

I need to feel there is hope

How important is this need to you now?

- Not at all
- A little
- Somewhat
- Very much
- Extremely

How well has this need been met for you?

- Not a need
- Not met at all
- Partly met
- Well met
- Completely met

Would you like to learn more about this need?

- Not at all
- A little
- Somewhat
- Very much
- A great deal

I need to know when to expect side effects to occur

How important is this need to you now?

Not at all

A little

Somewhat

Very much

Extremely

How well has this need been met for you?

Not a need

Not met at all

Partly met

Well met

Completely met

Would you like to learn more about this need?

Not at all

A little

Somewhat

Very much

A great deal

I need to know what side effects the treatment can cause

How important is this need to you now?

Not at all

A little

Somewhat

Very much

Extremely

How well has this need been met for you?

Not a need

Not met at all

Partly met

Well met

Completely met

Would you like to learn more about this need?

Not at all

A little

Somewhat

Very much

A great deal

I need to know about how to care for my child at home

How important is this need to you now?

Not at all
A little
Somewhat
Very much
Extremely

How well has this need been met for you?

Not a need
Not met at all
Partly met
Well met
Completely met

Would you like to learn more about this need?

Not at all
A little
Somewhat
Very much
A great deal

I need to know that health-care professionals offer me the opportunity to participate equally in my child's care

How important is this need to you now?

Not at all
A little
Somewhat
Very much
Extremely

How well has this need been met for you?

Not a need
Not met at all
Partly met
Well met
Completely met

Would you like to learn more about this need?

Not at all
A little
Somewhat
Very much
A great deal

I need to have trust in the health-care system

How important is this need to you now?

Not at all
A little
Somewhat
Very much
Extremely

How well has this need been met for you?

Not a need
Not met at all
Partly met
Well met
Completely met

Would you like to learn more about this need?

Not at all
A little
Somewhat
Very much
A great deal

I need to be informed of changes to my child's condition

Not at all
A little
Somewhat
Very much
Extremely

How well has this need been met for you?

Not a need
Not met at all
Partly met
Well met
Completely met

Would you like to learn more about this need?

Not at all
A little
Somewhat
Very much
A great deal

I need to know what treatment my child is receiving

How important is this need to you now?

Not at all

A little

Somewhat

Very much

Extremely

How well has this need been met for you?

Not a need

Not met at all

Partly met

Well met

Completely met

Would you like to learn more about this need?

Not at all

A little

Somewhat

Very much

A great deal

I need to feel that the health care professionals are sincere in caring about my child

How important is this need to you now?

Not at all

A little

Somewhat

Very much

Extremely

How well has this need been met for you?

Not a need

Not met at all

Partly met

Well met

Completely met

Would you like to learn more about this need?

Not at all

A little

Somewhat

Very much

A great deal

I need to have explanations given in terms that are understandable to me

How important is this need to you now?

Not at all

A little

Somewhat

Very much

Extremely

How well has this need been met for you?

Not a need

Not met at all

Partly met

Well met

Completely met

Would you like to learn more about this need?

Not at all

A little

Somewhat

Very much

A great deal

I need to be told when and why changes are being made in my child's treatment plans

How important is this need to you now?

Not at all

A little

Somewhat

Very much

Extremely

How well has this need been met for you?

Not a need

Not met at all

Partly met

Well met

Completely met

Would you like to learn more about this need?

Not at all

A little

Somewhat

Very much

A great deal

I need to know I can ask questions any time

How important is this need to you now?

Not at all

A little

Somewhat

Very much

Extremely

How well has this need been met for you?

Not a need

Not met at all

Partly met

Well met

Completely met

Would you like to learn more about this need?

Not at all

A little

Somewhat

Very much

A great deal

I need to know to whom I should direct my questions

How important is this need to you now?

Not at all

A little

Somewhat

Very much

Extremely

How well has this need been met for you?

Not a need

Not met at all

Partly met

Well met

Completely met

Would you like to learn more about this need?

Not at all

A little

Somewhat

Very much

A great deal

I need to know the probable outcome of my child's illness

How important is this need to you now?

Not at all

A little

Somewhat

Very much

Extremely

How well has this need been met for you?

Not a need

Not met at all

Partly met

Well met

Completely met

Would you like to learn more about this need?

Not at all

A little

Somewhat

Very much

A great deal

I need to know how to give information to my other children (appropriate to his/her age) (Only answer if you have other children)

How important is this need to you now?

Not at all

A little

Somewhat

Very much

Extremely

How well has this need been met for you?

Not a need

Not met at all

Partly met

Well met

Completely met

Would you like to learn more about this need?

Not at all

A little

Somewhat

Very much

A great deal

I need to know what information to give to my other children (appropriate to his/her age)

(Only answer if you have other children)

How important is this need to you now?

Not at all

A little

Somewhat

Very much

Extremely

How well has this need been met for you?

Not a need

Not met at all

Partly met

Well met

Completely met

Would you like to learn more about this need?

Not at all

A little

Somewhat

Very much

A great deal

I need to know how to handle the feelings of my other children

(Only answer if you have other children)

How important is this need to you now?

Not at all

A little

Somewhat

Very much

Extremely

How well has this need been met for you?

Not a need

Not met at all

Partly met

Well met

Completely met

Would you like to learn more about this need?

Not at all

A little

Somewhat

Very much

A great deal

7.3 Appendix C User Guide for the Prototype Interlingua/Sublanguage Machine Translation Model

User Guide: Creation of Dictionary and Synonym Table.

Installation

A fully functional version of JADE 6, specifically the single user version is required before the system is upgraded/installed. Installation and configuration instructions for JADE 6 may be found within the JADE developer and administration notes, found on the installation CD.

From Fresh

To install a fresh copy of the machine translator:

1. If the files are compressed, extract all the files to a temporary directory.
2. Start JADE 6 Single user.
3. When prompted for a password, ensure that 'Browse Classes' is selected and press enter (a password is not required).
4. Once JADE is loaded the Schema Browser Screen will be displayed.
5. Select 'Root Schema' in the schema browser, right click and select 'Load'
6. Check the 'Multiple Schemas' check box.
7. Click the Browse button and navigate to the temporary directory (where the files were previously extracted).
8. Select the **.mul** file in the directory, click OK and then click OK again.
9. Ignore any messages about class number clashes - JADE will automatically repair the inconsistencies.

Once the installation process has finished (a message box may say Batch load completed or something similar), you can now use the system as per the user guide below.

Upgrade

To upgrade a version of the machine translator, the process is exactly the same as when installing from fresh. However, there may be a requirement to reorganise the database. To do this:

1. With JADE running, click 'TranslatorModel' in the schema browser.
2. If the traffic lights on the toolbar are red, it will be necessary to reorganise the database. To do this, just click the traffic lights and follow the onscreen instructions.
3. If the traffic lights are green, then there is no need to reorganise the database.

Administration

The administration feature of the Machine Translator is used to populate the translator's databases and also to maintain their integrity. In later revisions, the administration side will allow various levels of interaction/access, which will allow administrators to be purely translators, rather than having free reign of the system.

Input process

Before entering data into the system it is important to understand how the data interacts and in what order it should be entered.

The translator may be broken into two main areas, the Interlingua and Translation languages. The task of the administrator is to keep updating both of these two areas. Before updating the language, it may be necessary to have some data in the Interlingua. Both may be updated at the same time, but updating is not recommended as it may confuse the user.

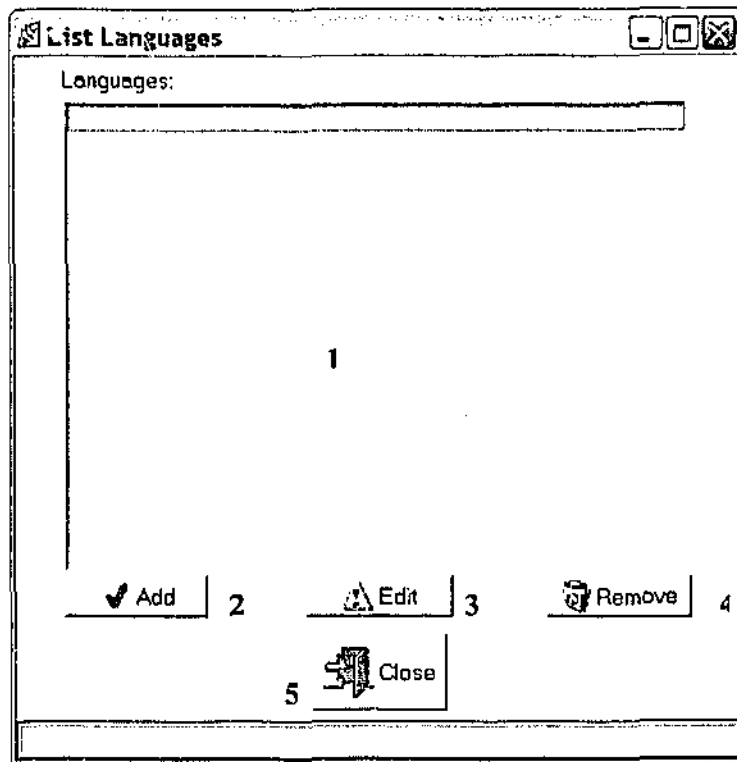
Before the system may be used, at least one language must be created in the system. These instructions are outlined in the following section. Once a language has been included, the user may then start adding word groups. Once a word group has been created the default synonym, must be created or another may be created. (For each synonym use may be made of either the default rule or another may be created.) To create a rule/synonym please follow the steps below. Once a rule is created it must be linked to an equivalent entry in the interlingua. If this link is not present in the interlingua, it will be necessary to create one (see the instructions below).

A word group must have at least one synonym (there is a default created), each synonym must have at least one rule (created by default), which must link to an entry in the interlingua. If either of these is missing, then the translation process will fail (if the word group is found within the input sentence).

Forms/Input Instructions

List/Find Language

The List Languages form will list all the languages in the system. It is possible to edit and remove the languages using this form.



1. All Languages in the system
2. Add new language
3. Edit selected Language
4. Delete the selected language from the system
5. Close this form

Add / Edit Language

Adding a language to the system and editing pre-existing languages may be achieved with the same form. If adding a new language, then the form will be blank. If editing is required, then the form will contain the current values for the data.

The screenshot shows a window titled "Add/Edit Language". Inside the window, there is a text input field labeled "Language Name:" with a cursor inside, and a larger text area labeled "Description:". At the bottom of the window, there are three buttons: "Add/Update" with a checkmark icon, "Reset" with an 'X' icon, and "Close" with a window icon. The form is annotated with numbers 1 through 5:

- 1: Points to the "Language Name:" text input field.
- 2: Points to the "Description:" text area.
- 3: Points to the "Add/Update" button.
- 4: Points to the "Reset" button.
- 5: Points to the "Close" button.

1. Name/Unique Identifier of the language, such as 'English', or 'Swinglish' (MANDATORY)
2. Brief description of the language, may be left blank.
3. Save the data to the database, whether creating a new entry or updating a pre-existing item
4. Reset the data to its initial values. If the language is new, the form will be cleared, otherwise the form will contain the values of the entry when the form was loaded
5. Exit this form

List/Find Word Group

The list/find word groups form facilitates adding, editing, locating and removing word groups for a given language. Selecting the language in the drop down box will automatically list the results in the 'Found Word Groups' list box. Then it is possible either to edit or remove one of these languages, or even add another language according to the wishes of the translator. Changing the language will update the field with the new entries/new language

The screenshot shows a window titled "List Morphemes". At the top, there is a "Language" dropdown menu labeled "1". Below it is a "Filter" input field labeled "3" and a "Reset" button labeled "4". The main area is a large list box labeled "Found Morphemes" with the number "2" in the center. At the bottom, there are four buttons: "Add" (with a checkmark icon) labeled "5", "Edit" (with a pencil icon) labeled "6", "Remove" (with a trash can icon) labeled "7", and "Close" (with a window icon) labeled "8".

1. Desired Language - select the required language.
2. The list of all word groups in the language or returned from a filter/search
3. Filter. Not implemented yet.
4. Reset filter button. Not Implemented yet
5. Add new word group to the selected language. This addition will load the add word group form.
6. Edit the selected word group. The edited word group will load the word group into the edit form.
7. Remove the selected word group and all its components (such as synonyms etc)

Add / Edit Word Group

The add/edit word group form facilitates create or edit a word group functions and also manage its synonyms and corresponding rules. When editing a word group, the word group's details will appear in the form field, all except the language. It is essential to ensure that a language is selected. Before adding a synonym or rules, the word group must be created by using the top portion of the form. Once created the word group synonyms may be added with any required rules to assist user selection during translation.

The screenshot shows a web form titled "Add/Edit Morpheme". The form contains the following elements:

- 1**: A dropdown menu for "Language".
- 2**: A text input field for "Morpheme Text".
- 3**: A text area for "Comments".
- 4**: A button labeled "Add/Update" with a checkmark icon.
- 5**: A button labeled "New" with a checkmark icon.
- 6**: A button labeled "Reset" with a warning triangle icon.
- 7**: A section header "Source Language to Interlingua".
- 8**: A section header "Interlingua to Target Language".
- 9**: A listbox for "Synonyms" under the "Source Language to Interlingua" section.
- 10**: A listbox for "Rules" under the "Interlingua to Target Language" section.
- 11**: An "Add" button for synonyms.
- 12**: An "Edit" button for synonyms.
- 13**: A "Remove" button for synonyms.
- 14**: An "Add" button for rules.
- 15**: An "Edit" button for rules.
- 16**: A "Remove" button for rules.
- 17**: A "Close" button with a door icon.

1. Language the word phrase belongs to. (MANDATORY)
2. The word group text - the text that this word group will translate. (MANDATORY)
3. Administrator comments - for comments on word phrase etc.
4. Add/Update - save any changes to the database (creating a new or updating an old).
5. Create a new word group and disregard changes.
6. Reset the form fields to either blank, or those in the database (when editing). Also used to update the synonyms listbox when a new synonym is added
7. The components needed to translate from the source language -> interlingua
8. The components needed to translate from the interlingua -> source language.
9. All the synonyms for current word phrase
10. All the rules for the selected word phrase
11. Add a synonym to the word phrase
12. Edit the selected Word phrase.
13. Remove the selected word phrase and all its rules.
14. Add a rule to the selected synonym.
15. Edit the selected Rule.
16. Remove the selected rule from the synonym.
17. Close this form and discard all changes.

Add / Edit Synonym

The add/edit synonym form will facilitate the addition of a synonym to the word group or edit an existing synonym. The meaning and description fields are used to help the user select the best synonym, whilst the comments field is for internal comments (for the translator).

The screenshot shows a window titled "Add/Update Synonym". It contains three text input fields: "Meaning" (labeled 1), "Description" (labeled 2), and "Comments" (labeled 3). Below these fields are three buttons: "Add/Update" (labeled 4), "New" (labeled 5), and "Reset" (labeled 6). At the bottom center is a "Close" button (labeled 7) with a mouse cursor icon over it.

1. The meaning of the synonym - the user will see this when picking a synonym.
2. Synonym Description, used to provide more information about the synonym (for the user).
3. Comments and notes about the synonym (internal only)
4. Save the changes/new data to the database.
5. Discard changes and create a new synonym.
6. Reset the fields to the default values.
7. Close the form.

Add /Edit Rule

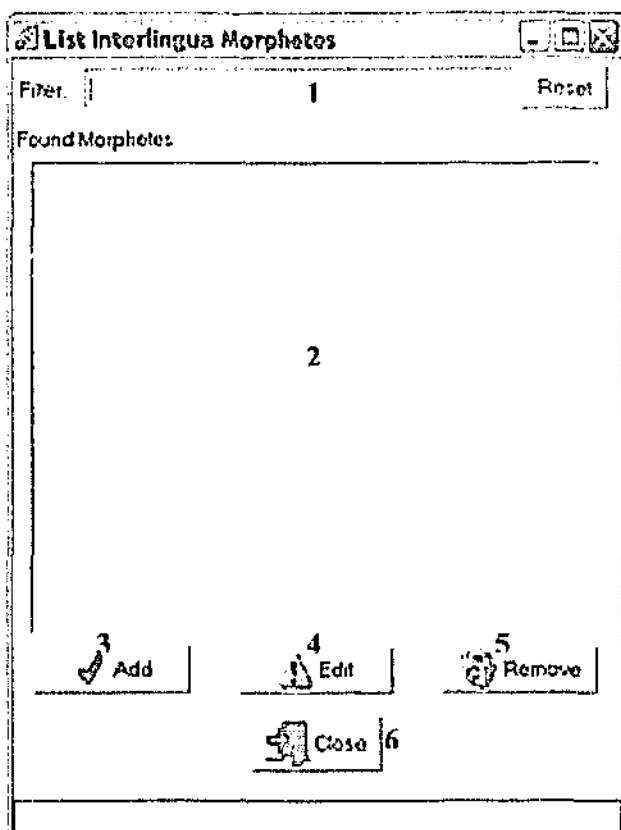
The add/edit rule form will allow the addition of a rule to a synonym (selected in the add/edit form). The rule name is an identifier used only for distinguishing between other rules in the synonym. The rule text is an expression that will be parsed. If the expression evaluates to 'true', then the interlingua equivalent for this rule will be used. If it fails, the translator will try another rule in the synonym.

The screenshot shows a window titled "Add/Edit Rule". It contains several input fields and buttons. The fields are labeled: "Rule Name", "Rule Text", "Comments", "L. Equivalent", and "End". There are also buttons labeled "Add/Update", "New", "Reset", and "Close". A "Validate" button is also present. The form is annotated with numbers 1 through 10, corresponding to the list of instructions below.

1. Rule Name, an identifier to help the administrator distinguish between rules.
2. Rule Text, the syntax of the rule, what will be parsed (see section on rule language below)
3. Validate the rule text, make a 'test parse' to validate the syntax of the expression
4. Comments for the administrator
5. The interlingua entry that will be used if the rule passes.
6. Check to make sure the interlingua equivalent is in the database
7. Save the changes/new data to the database.
8. Discard all changes and create a new rule (in the same synonym).
9. Reset the fields to the values when the form was loaded.
10. Close the form.

List Interlingua Word Groups

The List interlingua word groups form allows the translator to view all the interlingua word groups within this system. From here, it is possible to edit and remove word groups and also add new ones.



1. List filter.
2. Found word groups - all the word groups available or found with the specified filter.
3. Add word group - opens the add/edit interlingua word group so that a word group may be added to the system.
4. Edit Selected word group - opens the add/edit interlingua word group form with the selected word group's attributes enabling editing of the word group.
5. Remove the word group from the database.
6. Close this form

Add / Edit Interlingua

The add/edit Interlingua form allows the addition of entries into the interlingua. Before creating word groups for the source/target language it is necessary to create an interlingua word group.

The screenshot shows a window titled "Add/Edit Interlingua Morpheme". It contains two text input fields: "Morpheme Text" (labeled 1) and "Comments" (labeled 2). Below these fields are three buttons: "Add/Update" (labeled 3), "Discard" (labeled 4), and "Reset" (labeled 5). At the bottom center is a "Close" button (labeled 6). The window has standard OS controls (minimize, maximize, close) in the top right corner.

1. The text of the word group, that is, the Esperanto text this word group represents.
2. Administrator comments.
3. Add the new word group to the database, or update the entry with the new data.
4. Discard the changes and make a new Interlingua word group.
5. Reset the form to its initial state, be it blank, or the values in the database.
6. Close form and discard any updated changes.

User Guide: Researcher Translation Instructions:

The user application icon in the Jade application menu provides a form allowing the user to enter the text. The user selects the input language and the target language as shown in the following form diagram.

The image shows a screenshot of a software window titled "Translator". The window contains the following elements:

- Input sentence:** A text field containing "NOT AT ALL". A number "1" points to this field.
- Input Language:** A dropdown menu showing "english". A number "2" points to this dropdown.
- Target Language:** A dropdown menu showing "FRENCH". A number "3" points to this dropdown.
- Default Selection Strategy:** A group box containing two radio buttons: "FFFS" (which is selected) and "LargestFirs". A number "4" points to the "FFFS" radio button, and a number "5" points to the "LargestFirs" radio button.
- Buttons:** At the bottom, there are two buttons: "Cancel" (with a number "6" pointing to it) and "Next>>" (with a number "7" pointing to it).

At the bottom of the window is a long, empty rectangular box.

1. Source language input sentence
2. Drop down list to selected the source language
3. Drop down list to selected the target language
4. FFFS search tool
5. Largest First selection tool
6. Cancellation to close down the application
7. This icon completes the operation and produces the translation search result

The user then presses 'NEXT' and the translation result is provided. The following form shows the input sentence and the interlingua and translated texts.

Translated Sentence	
Input sentence:	NOT AT ALL 1
Interlingua text:	TUTE NE 2
Translated text:	PAS DU TOUT 3
<input type="button" value="Close"/>	<input type="button" value="Start Again"/>

1. Record of the original source language input sentence
2. Translation to the Interlingua text
3. Translated target language text
4. Close the operation
5. Start again – enables the user to input new text for translation

7.4 Appendix D Translation Table of the Control Model Results: English to French Translations of Single Words And Word Groups

REF.	SAMPLE ENGLISH WORD/WORD GROUP OBTAINED FROM THE SURVEY QUESTIONNAIRE	FRENCH EQUIVALENT PROVIDED BY THE CONTROL MODEL	SAMPLE ENGLISH WORD/WORD GROUP PROVIDED BY THE STUDY TRANSLATORS	EVALUATION OF THE CONTROL MODEL TRANSLATIONS						
				KEY TO ANALYSIS OF RESULTS				ADDITIONAL COMMENTS		
				M	E	N	S			
01	NOT AT ALL	PAS DU TOUT	PAS DU TOUT	1						
02	A LITTLE	NO RESULT	UN PEU			1				
03	SOMEWHAT	LÉGEREMENT	QUELQUE PEU		1			The equivalent word is a synonym and not accurate		
04	VERY MUCH	BEAUCOUP	BEAUCOUP	1						
05	EXTREMELY	EXTRÊMEMENT	EXTRÊMEMENT	1						
06	NOT A NEED (NEED AS A REQUIREMENT)	PAS UN BESOIN	PAS DE BESOIN		1		1	The control model did not provide a synonym selection offer for the two distinct meanings of 'NEED'.		
07	NOT MET AT ALL (MET AS IN TO MEET A REQUIREMENT)	NON RÉUNI DU TOUT	PAS SATISFAIT		1		1	The control model did not provide a synonym selection offer for the two distinct meanings of 'MET'.		
08	PARTLY MET (MET AS IN TO MEET A REQUIREMENT)	EN PARTIE RÉUNI	UN PEU SATISFAIT		1		1	In this example the selection of 'RÉUNI' was inappropriate as this meant 'REUNITED' and not 'FULFILLED'.		
09	WELL MET (MET AS IN TO MEET A REQUIREMENT)	LE PUIITS S'EST RÉUNI	BIEN SATISFAIT		1		1	As above (Sample 09). The control model failed to provide the correct commonly occurring phrase.		
10	COMPLETELY MET (MET AS IN TO MEET A REQUIREMENT)	COMPLÈTEMENT RÉUNI	COMPLÈTEMENT SATISFAIT		1		1	As above (Sample 09).		
11	YES	OUI	OUI	1						
12	NO	NON	NON	1						

				M	E	N	S	ADDITIONAL COMMENTS
13	COMPLETELY DISAGREE (AS IN CONCUR) (AS IN CONSENT)	SOYEZ EN DÉSACCORD COMPLÈTEMENT NO RESULT	COMPLÈTEMENT EN DÉSACCORD COMPLÈTEMENT PAS CONSENTEMENT		1	1	1	No synonym provided by the control model to differentiate between the two meanings of 'AGREE'. The first control model equivalent of the first sample was inaccurate.
14	STRONGLY DISAGREE (AS IN CONCUR) (AS IN CONSENT)	SOYEZ EN DÉSACCORD FORTEMENT NO RESULT	VIGOUREUSEMENT EN DÉSACCORD FORTEMENT PAS CONSENTEMENT		1	1	1	As above (Sample 13).
15	DISAGREE (AS IN CONCUR) (AS IN CONSENT)	SOYEZ EN DÉSACCORD NO RESULT	EN DÉSACCORD PAS CONSENTEMENT		1	1	1	As above (Sample 13).
16	AGREE (AS IN CONCUR) (AS IN CONSENT)	CONVENEZ NO RESULT	EN ACCORD CONSENS		1	1	1	As above (Sample 13).
17	STRONGLY AGREE (AS IN CONCUR) (AS IN CONSENT)	CONVENEZ FORTEMENT NO RESULT	VIGOUREUSEMENT EN ACCORD FORTEMENT CONSENTEMENT		1	1	1	As above (Sample 13).
18	AGREE COMPLETELY (AS IN CONCUR) (AS IN CONSENT)	CONVENEZ COMPLÈTEMENT NO RESULT	D'ACCORD COMPLÈTEMENT CONSENS COMPLÈTEMENT		1	1	1	As above (Sample 13).

				M	E	N	S	ADDITIONAL COMMENTS
19	WELCOME (AS A GREETING)(VERB)	BIENVENUE NO RESULT	BIENVENUE ACCUEILLIR	1		1		No verb form of 'WELCOME' offered by the control model.
20	QUESTIONNAIRE	QUESTIONNAIRE	QUESTIONNAIRE	1				
21	QUESTIONNAIRES	QUESTIONNAIRES	QUESTIONNAIRES	1				
22	NEED (AS A NOUN) (AS A VERB)	LE BESOIN NO RESULT	BESOIN AVOIR BESOIN DE		1	1		No verb form of 'NEED' was offered by the control model. The definite article 'LE' was unsolicited and not required.
23	NEEDS (AS A NOUN)	LES BESOINS	BESOINS (BUT ONLY FOR MORE THAN ONE PERSON)		1	1		No verb form of 'NEED' was offered by the control model. The definite article 'LES' was unsolicited and not required.
24	PARENT	PARENT	PARENT (LE PERE OU LA MERE UN DES DEUX PARENTS)	1				
25	PARENTS	PARENTS	PARENTS	1				
26	SUPPORT (NOUN - THING SUPPORTING) (VERB - AS IN HELP)	APPUI NO RESULT	SOUTIEN SOUTENIR		1	1	1	No verb form of 'SUPPORT' was offered by the control model.
27	FAMILY MEMBER	MEMBRE DE FAMILLE	MEMBRE DE LA FAMILLE	1				
28	FAMILY MEMBERS	MEMBRES DE FAMILLE	MEMBRES DE LA FAMILLE	1				
29	A RESEARCH NURSE (MALE) (FEMALE)	INFIRMIÈRE DE RECHERCHES NO RESULT	UN INFIRMIÈR DE RECHERCHE UNE INFIRMIERE DE RECHERCHE		1	1		The control model failed to include the indefinite article 'UN'. Nor did it offer the female version of the noun.

				M	E	N	S	ADDITIONAL COMMENTS
30	RESEARCH NURSES (MALE)	INFIRMIÈRES DE RECHERCHES	DES INFIRMIERS DE RECHERCHE		1	1		The control model failed to include the preposition 'DES'. Nor did it offer the female version of the noun.
	(FEMALE)	NO RESULT	DES INFIRMIERES DE RECHERCHE					
31	GUIDE (NOUN)	GUIDE	GUIDE	1	1			No verb synonym offered by the Control model
	(VERB - TO GUIDE)	AU GUIDE	GUIDER					
32	GUIDES NOUN	GUIDES	GUIDES	1		1		No verb synonym offered by the Control model
	VERB	NO RESULT	GUIDER					
33	INSTRUCTION	INSTRUCTION	INSTRUCTION	1				
34	INSTRUCTIONS	INSTRUCTIONS	INSTRUCTIONS	1				
35	EXPERIENCE (ONCE OFF - NOUN)	EXPÉRIENCE	EXPÉRIENCE	1		1		No result provided by the control model for the verb form of the sample.
	(LONGER EXPERIENCE)	NO RESULT	ÉPROUVER					
36	EXPERIENCES	A L'EXPÉRIENCE	EXPÉRIENCES		1			The control model provided superfluous prepositions changing the meaning of the translated sample
37	QUESTION	QUESTION	QUESTION	1				
38	QUESTIONS	QUESTIONS	QUESTIONS	1				
39	ANSWER (AS A NOUN)	RÉPONSE	RÉPONSE	1	1			The control model provided a superfluous preposition changing the meaning of the translated verb sample
	(AS A VERB)	POUR RÉPONDRE	RÉPONDRE					
40	ANSWERS (AS A NOUN)	RÉPONSES	RÉPONSES	1				
41	SITUATION (AS A PLACE)	NO RESULT	ENDROIT	1		1	1	No synonym provided to show the two meanings of 'SITUATION'.
	(CIRCUMSTANCES)	SITUATION	SITUATION					

				M	E	N	S	ADDITIONAL COMMENTS
42	SITUATIONS (AS A PLACE) (CIRCUMSTANCES)	NO RESULT SITUATIONS	ENDROITS SITUATIONS			1	1	No synonym provided to show the two meanings of 'SITUATION'.
43	BUTTON (CLOTHING) (FOR MACHINE ETC) (TO TURN SOMETHING ON/OFF)	BOUTON BOUTON BOUTON	BOUTON BOUTON BOUTON	1				The sample included to determine whether there were any variations between English and French. Esperanto provides different meanings to define the type of button used in different circumstances.
44	BUTTONS (CLOTHING) (FOR MACHINE ETC) (TO TURN SOMETHING ON/OFF)	BOUTONS BOUTONS BOUTONS	BOUTONS BOUTONS BOUTONS	1				As above (Sample 44).
45	STUDY NOUN (AS IN RESEARCH) (VERB AS IN RESEARCH)	ÉTUDE NO RESULT	ÉTUDE ÉTUDIER	1		1	1	No synonym provided for the verb form.
46	STUDIES (NOUN AS IN RESEARCH)	ÉTUDES	ÉTUDES	1				
47	SCREEN (NOUN AS IN FURNITURE) (NOUN AS IN COMPUTER) (VERB - FILTER) (VERB - GUARD AGAINST)	NO RESULT ÉCRAN NO RESULT NO RESULT	CLOISON ÉCRAN FILTRER PROTÉGER	1		3	1	No synonyms offered.

				M	E	N	S	ADDITIONAL COMMENTS
48	SCREENS (NOUN AS IN FURNITURE) (NOUN AS IN COMPUTER)	NO RESULT ÉCRANS	CLOISONS ÉCRANS	1		1		No synonyms offered.
49	IDENTIFIED	IDENTIFIÉ NO RESULT NO RESULT NO RESULT	IDENTIFIÉ (M SG) IDENTIFIÉE (F SG) IDENTIFIÉS (M PL) IDENTIFIÉES (F PL)	1		3	1	No gender and no plural forms offered.
50	ITEM (OBJECT) (IN A LIST)	ARTICLE NO RESULT NO RESULT	ARTICLE QUESTION POINT	1		2	1	No synonyms offered
51	ITEMS (OBJECT) (IN A LIST)	ARTICLES NO RESULT	ARTICLES QUESTIONS POINTS	1		2	1	No synonyms offered
52	SURVEY (NOUN - RESEARCH) (VERB - EXAMINE) (VERB - LOOK AT) (VERB - LOOK AROUND)	APERÇU NO RESULT EXAMINER NO RESULT NO RESULT	SONDAGE EXAMINER REGARDER REGARDE AUTOUR DE	1	1	3	1	No synonyms offered. No verb identified.
53	SURVEYS NOUN (RESEARCH) VERB (EXAMINE) VERB (LOOK AT) VERB (LOOK AROUND)	APERÇUS NO RESULT EXAMINER NO RESULT NO RESULT	SONDAGES SEE 52 ABOVE					No synonyms offered
54	FINGER	DOIGT	DOIGT	1				

				M	E	N	S	ADDITIONAL COMMENTS
55	FINGERS	DOIGTS	DOIGTS	1				
56	ILLNESS	MALADIE	MALADIE	1				
57	ILLNESSES	MALADIES	MALADIES	1				
58	HELPFUL (AS IN PROVIDE A SERVICE) (USEFUL)	NO RESULT NO RESULT UTILE UTILES	SERVABLE (SG) SERVABLES (PL) UTILE (SG) UTILES (PL)	1		2	1	Failed to provide synonyms and plural/singular versions of the samples
59	PAEDIATRIC	PÉDIATRIQUE	DE PÉDIATRIE	1				The control model translation was more accurate
60	ONCOLOGY	ONCOLOGIE	ONCOLOGIE	1				
61	TOUCH-SCREEN	ÉCRAN DE CONTACT	ÉCRAN TACTILE	1				Difference in equivalent translations is a matter of user preference.
62	TOUCH-SCREENS	ÉCRANS DE CONTACT	ÉCRANS TACTILES	1				Difference in equivalent translations is a matter of user preference.
63	HEALTH-PROFESSIONAL	PROFESSIONNEL DE SANTÉ	PROFESSIONNEL DE LA SANTÉ		1			Control model did not include the article 'LA'
64	HEALTH PROFESSIONALS	PROFESSIONNELS DE SANTÉ	PROFESSIONNELS DE LA SANTÉ		1			Control model did not include the article 'LA'
65	IMPORTANT	IMPORTANT NO RESULT NO RESULT NO RESULT	IMPORTANT (M SG) IMPORTANTE (F SG) IMPORTANTS (M PL) IMPORTANTES (F PL)	1		3	1	No synonym and plurals forms provided
66	CANCER	CANCER	CANCER	1				
67	CANCERS	CANCERS	CANCERS	1				
68	CHILD	ENFANT	ENFANT	1				
69	CHILDREN	ENFANTS	ENFANTS	1				
70	HOSPITAL	HÔPITAL	HÔPITAL	1				
71	HOSPITALS	HÔPITALS	HÔPITALS	1				
72	RESEARCH (NOUN) (VERB)	RECHERCHE NO RESULT	RECHERCHE RECHERCHER	1		1	1	No verb form provided.
73	RESEARCHER (PERSON WHO RESEARCHES)	CHERCHEUR NO RESULT	CHERCHEUR (M) CHERCHEUSE (F)	1		1	1	No female form provided

				M	E	N	S	ADDITIONAL COMMENTS
74	RESEARCHERS (PERSON WHO RESEARCHES)	CHERCHEURS NO RESULT	CHERCHEURS (M,M+F) CHERCHEUSES (F)	1		1	1	No female form provided
75	APPROPRIATE (ADJECTIVE) (VERB)	APPROPRIÉ NO RESULT NO RESULT NO RESULT NO RESULT	APPROPRIÉ (M SG) APPROPRIÉE (F SG) APPROPRIÉS (M PL) APPROPRIÉES (F PL) APPROPRIER	1		1	1	No female form nor singular/plural form provided
76	DOCTOR (TITLE OF DEGREE HOLDER) (MEDICAL DOCTOR)	DOCTEUR NO RESULT DOCTEUR	DOCTEUR MÉDECIN DOCTEUR	1		1	1	Translators' note: MEDECIN is used for both male and female doctors. DOCTEUR AND DOCTORESSE is also used. No synonym provided.
77	DOCTORS (TITLE OF DEGREE HOLDER) (MEDICAL DOCTOR)	NO RESULT MÉDECINS	DOCTEURS MÉDECINS DOCTEURS	1		1	1	As above (Sample 77)
78	SURGEON	CHIRURGIEN	CHIRURGIEN	1				
79	SURGEONS	CHIRURGIENS	CHIRURGIENS	1				
80	TREATMENT (COURSE OF TREATMENT) (WAY SOMEONE IS TREATED IN GENERAL)	TRAITEMENT NO RESULT	TRAITEMENT TRAITEMENT	1				
81	A QUESTIONNAIRE	UN QUESTIONNAIRE	UN QUESTIONNAIRE	1				
82	THE QUESTIONNAIRE	LE QUESTIONNAIRE	LE QUESTIONNAIRE	1				
83	THE QUESTIONNAIRES	LES QUESTIONNAIRES	LES QUESTIONNAIRES	1				

				M	E	N	S	ADDITIONAL COMMENTS
84	SOME QUESTIONNAIRES	QUELQUES QUESTIONNAIRES	DES QUESTIONNAIRES		1			Incomplete translation.
85	THIS QUESTIONNAIRE	CE QUESTIONNAIRE	CE QUESTIONNAIRE-CI		1			Incomplete translation.
86	THAT QUESTIONNAIRE	CE QUESTIONNAIRE	CE QUESTIONNAIRE-LA		1			Incomplete translation.
87	THOSE QUESTIONNAIRES	CES QUESTIONNAIRES	CES QUESTIONNAIRES-LÀ		1			Incomplete translation.
88	THESE QUESTIONNAIRES	CES QUESTIONNAIRES	CES QUESTIONNAIRES-CI		1			Incomplete translation.
89	WHICH QUESTIONNAIRE?	QUEL QUESTIONNAIRE	QUEL QUESTIONNAIRE?	1				
90	WHICH QUESTIONNAIRES?	QUELS QUESTIONNAIRES	QUELS QUESTIONNAIRES?	1				
91	MY QUESTIONNAIRE	MON QUESTIONNAIRE	MON QUESTIONNAIRE	1				
92	MY QUESTIONNAIRES	MES QUESTIONNAIRES	MES QUESTIONNAIRES	1				
93	YOUR (SINGULAR) QUESTIONNAIRE	VOTRE QUESTIONNAIRE	VOTRE QUESTIONNAIRE	1				
94	YOUR (SINGULAR) QUESTIONNAIRES	VOS QUESTIONNAIRES	VOS QUESTIONNAIRES	1				
95	YOUR (PLURAL) QUESTIONNAIRE	VOTRE QUESTIONNAIRE	VOTRE QUESTIONNAIRE	1				These samples using the 2 nd person were included to detect any anomalies between the French and English languages. None were detected and therefore no adjustment was made to the interlingua dictionary.
96	YOUR (PLURAL) QUESTIONNAIRES	VOS QUESTIONNAIRES	VOS QUESTIONNAIRES	1				
97	HIS QUESTIONNAIRE	SON QUESTIONNAIRE	SON QUESTIONNAIRE	1				
98	HIS QUESTIONNAIRES	SES QUESTIONNAIRES	SES QUESTIONNAIRES	1				
99	HER QUESTIONNAIRE	SON QUESTIONNAIRE	SON QUESTIONNAIRE	1				
100	HER QUESTIONNAIRES	SES QUESTIONNAIRES	SES QUESTIONNAIRES	1				
101	OUR QUESTIONNAIRE	NOTRE QUESTIONNAIRE	NOTRE QUESTIONNAIRE	1				
102	OUR QUESTIONNAIRES	NOS QUESTIONNAIRES	NOS QUESTIONNAIRES	1				
103	THEIR (MALE OR NEUTER) QUESTIONNAIRE	LEUR QUESTIONNAIRE	LEUR QUESTIONNAIRE	1				These samples using the 3 rd person were included to detect any anomalies between the French and English languages. None were detected and therefore no adjustment was made to the interlingua dictionary.
104	THEIR (MALE OR NEUTER) QUESTIONNAIRES	LEURS QUESTIONNAIRES	LEURS QUESTIONNAIRES	1				

				M	E	N	S	ADDITIONAL COMMENTS
105	THEIR (FEMALE) QUESTIONNAIRE	LEUR QUESTIONNAIRE	LEUR QUESTIONNAIRE	1				
106	THEIR (FEMALE) QUESTIONNAIRES	LEURS QUESTIONNAIRES	LEURS QUESTIONNAIRES	1				
107	A NEED (REQUIREMENT) (NECESSITY)	UN BESOIN NO RESULT	UN BESOIN UNE NÉCESSITÉ	1		1	1	No synonym provided to differentiate between the two meanings of 'NEED'
108	THE NEED (REQUIREMENT) (NECESSITY)	LE BESOIN NO RESULT	LE BESOIN LA NÉCESSITÉ	1		1	1	No synonym provided to differentiate between the two meanings of 'NEED'
109	THE NEEDS (REQUIREMENT) (NECESSITY)	LES BESOINS NO RESULT	LES BESOINS LES NÉCESSITÉS	1		1	1	No synonym provided to differentiate between the two meanings of 'NEED'
120	MY NEED (REQUIREMENT) (NECESSITY)	MON BESOIN NO RESULT	MON BESOIN MA NÉCESSITÉ	1		1	1	No synonym provided to differentiate between the two meanings of 'NEED'
121	MY NEEDS (REQUIREMENT) (NECESSITY)	MES BESOINS NO RESULT	MES BESOINS MES NÉCESSITÉS	1		1	1	No synonym provided to differentiate between the two meanings of 'NEED'
122	YOUR (SINGULAR) NEED (REQUIREMENT) (NECESSITY)	VOTRE BESOIN NO RESULT	VOTRE BESOIN VOTRE NÉCESSITÉ	1		1	1	No synonym provided to differentiate between the two meanings of 'NEED'
123	YOUR (SINGULAR) NEEDS (REQUIREMENT) (NECESSITY)	VOS BESOINS NO RESULT	VOS BESOINS VOS NÉCESSITÉS	1		1	1	No synonym provided to differentiate between the two meanings of 'NEED'

				M	E	N	S	ADDITIONAL COMMENTS
124	YOUR (PLURAL) NEED (REQUIREMENT) (NECESSITY)	VOTRE BESOIN NO RESULT	VOTRE BESOIN VOTRE NÉCESSITÉ	1		1	1	No synonym provided to differentiate between the two meanings of 'NEED'
125	YOUR (PLURAL) NEEDS (REQUIREMENT) (NECESSITY)	VOS BESOINS NO RESULT	VOS BESOINS VOS NÉCESSITÉS	1		1	1	No synonym provided to differentiate between the two meanings of 'NEED'
126	HIS NEED (REQUIREMENT) (NECESSITY)	SON BESOIN NO RESULT	SON BESOIN SA NÉCESSITÉ	1		1	1	No synonym provided to differentiate between the two meanings of 'NEED'
127	HIS NEEDS (REQUIREMENT) (NECESSITY)	SES BESOINS NO RESULT	SES BESOINS SES NÉCESSITÉS	1		1	1	No synonym provided to differentiate between the two meanings of 'NEED'
128	HER NEED (REQUIREMENT) (NECESSITY)	SON BESOIN NO RESULT	SON BESOIN SA NÉCESSITÉ	1		1	1	No synonym provided to differentiate between the two meanings of 'NEED'
129	HER NEEDS (REQUIREMENT) (NECESSITY)	SES BESOINS NO RESULT	SES BESOINS SES NÉCESSITÉS	1		1	1	No synonym provided to differentiate between the two meanings of 'NEED'
130	OUR NEED (REQUIREMENT) (NECESSITY)	NOTRE BESOIN NO RESULT	NOTRE BESOIN NOTRE NÉCESSITÉ	1		1	1	No synonym provided to differentiate between the two meanings of 'NEED'
131	OUR NEEDS (REQUIREMENT) (NECESSITY)	NOS BESOINS NO RESULT	NOS BESOINS NOS NÉCESSITÉS	1		1	1	No synonym provided to differentiate between the two meanings of 'NEED'
132	THEIR (MALE OR NEUTER) NEED (REQUIREMENT) (NECESSITY)	LEUR BESOIN NO RESULT	LEUR BESOIN LEUR NÉCESSITÉ	1		1	1	No synonym provided to differentiate between the two meanings of 'NEED'

				M	E	N	S	ADDITIONAL COMMENTS
133	THEIR (MALE OR NEUTER) NEEDS (REQUIREMENT) (NECESSITY)	LEURS BESOINS NO RESULT	LEURS BESOINS LEURS NÉCESSITÉS	1		1	1	No synonym provided to differentiate between the two meanings of 'NEED'
134	THEIR (FEMALE) NEED (REQUIREMENT) (NECESSITY)	LEUR BESOIN NO RESULT	LEUR BESOIN LEUR NÉCESSITÉ	1		1	1	No synonym provided to differentiate between the two meanings of 'NEED'
135	THEIR (FEMALE) NEEDS (REQUIREMENT) (NECESSITY)	LEURS BESOINS NO RESULT	LEURS BESOINS LEURS NÉCESSITÉS	1		1	1	No synonym provided to differentiate between the two meanings of 'NEED'
136	A PARENT	UN PARENT	UN PARENT	1				
137	THE PARENT	LE PARENT	LE PARENTS	1				
138	THE PARENTS	LES PARENTS	LES PARENTS	1				
139	SOME PARENTS	QUELQUES PARENTS	QUELQUES PARENTS	1				
140	THIS PARENT	CE PARENTS	CE PARENT-CI		1			Inaccurate translation
141	THESE PARENTS	CES PARENTS	CES PARENTS-CI		1			
142	THAT PARENT	CE PARENT	CE PARENT-LÀ		1			
143	THOSE PARENTS	CES PARENTS	CES PARENTS-LÀ		1			
144	WHICH PARENT?	QUEL PARENT	QUEL PARENT ? QUEL PARENT?	1				(LEQUEL DES DEUX PARENTS ? QUI, DU PERE OU DE LA MERE ?)
145	WHICH PARENTS?	QUELS PARENTS	QUELS PARENTS ?	1				
146	MY PARENT (MALE)	MON PARENT	MON PARENT	1				
147	MY PARENT (FEMALE)	MA PARENT	MA PARENT	1				
148	MY PARENTS	MES PARENTS	MES PARENTS	1				
149	YOUR (SINGULAR) PARENT	VOTRE PARENT	VOTRE PARENT	1				
149	YOUR (SINGULAR) PARENTS	VOS PARENTS	VOS PARENTS	1				
150	YOUR (PLURAL) PARENT	VOTRE PARENT	VOTRE PARENT	1				
151	YOUR (PLURAL) PARENTS	VOS PARENTS	VOS PARENTS	1				

				M	E	N	S	ADDITIONAL COMMENTS
152	HIS PARENT	SON PARENT	SON PARENT	1				
153	HIS PARENTS	SES PARENTS	SES PARENTS	1				
154	HER PARENT	SON PARENT	SON PARENT	1				
155	HER PARENTS	SES PARENTS	SES PARENTS	1				
156	OUR PARENT	NOTRE PARENT	NOTRE PARENT	1				
157	OUR PARENTS	NOS PARENTS	NOS PARENTS	1				
158	THEIR (MALE OR NEUTER) PARENT	LEUR PARENT	LEUR PARENT	1				
159	THEIR (MALE OR NEUTER) PARENTS	LEURS PARENTS	LEURS PARENTS	1				
160	THEIR (FEMALE) PARENT	LEUR PARENT	LEUR PARENT	1				
161	THEIR (FEMALE) PARENTS	LEURS PARENTS	LEURS PARENTS	1				
162	THE SUPPORT (NOUN - THING SUPPORTING)	L'APPUI	LE SOUTIEN		1		1	No synonym provided – incorrect translation.
163	A SUPPORT (NOUN - THING SUPPORTING)	UN APPUI	UN SOUTIEN		1		1	No synonym provided – incorrect translation.
164	SOME SUPPORT (NOUN - THING SUPPORTING)	CERTAINS SOUTIENNENT	QUELQUE SOUTIEN		1		1	No synonym provided – incorrect translation.
165	THAT SUPPORT (NOUN - THING SUPPORTING)	CET APPUI	CE SOUTIEN-LÀ		1		1	No synonym provided – incorrect translation.
166	THIS SUPPORT (NOUN - THING SUPPORTING)	CET APPUI	CE SOUTIEN-CI		1		1	No synonym provided – incorrect translation.
167	THOSE SUPPORT (NOUN - THING SUPPORTING)	CEUX SOUTIENNENT	CEUX-LÀ SOUTIENNENT		1		1	No synonym provided – particle missing.
168	THOSE SUPPORTS (NOUN - THING SUPPORTING)	CES APPUIS	CES SOUTIENS-LÀ		1		1	No synonym provided – incorrect translation.

				M	E	N	S	ADDITIONAL COMMENTS
169	THESE SUPPORT (NOUN - THING SUPPORTING)	CEUX-CI SOUTIENNENT	CEUX-CI SOUTIENNENT		1		1	No synonym provided – particle missing.
170	THESE SUPPORTS (NOUN - THING SUPPORTING)	CES APPUIS	CES SOUTIENS-CI		1		1	No synonym provided – particle missing.
171	MY SUPPORT (NOUN - THING SUPPORTING)	MON APPUI	MON SOUTIEN		1		1	No synonym provided – incorrect translation.
172	YOUR (SINGULAR) SUPPORT (NOUN - THING SUPPORTING)	VOTRE APPUI	VOTRE SOUTIEN		1		1	No synonym provided – incorrect translation.
173	YOUR (PLURAL) SUPPORT (NOUN - THING SUPPORTING)	VOTRE APPUI	VOTRE SOUTIEN		1		1	No synonym provided – incorrect translation.
174	HIS SUPPORT (NOUN - THING SUPPORTING)	SIEN SOUTIENNENT ERROR	SON SOUTIEN		1		1	No synonym provided – incorrect translation.
175	HER SUPPORT (NOUN - THING SUPPORTING)	SON APPUI	SON SOUTIEN		1		1	No synonym provided – incorrect translation.
176	OUR SUPPORT (NOUN - THING SUPPORTING)	NOTRE APPUI	NOTRE SOUTIEN		1		1	No synonym provided – incorrect translation.
177	THEIR (MALE OR NEUTER) SUPPORT (NOUN - THING SUPPORTING)	LEUR APPUI	LEUR SOUTIEN		1		1	No synonym provided – incorrect translation.
178	THEIR (FEMALE) SUPPORT (NOUN - THING SUPPORTING)	LEUR APPUI	LEUR SOUTIEN		1		1	No synonym provided – incorrect translation.
179	A FAMILY MEMBER	UN MEMBRE DE FAMILLE	UN MEMBRE DE FAMILLE	1				

				M	E	N	S	ADDITIONAL COMMENTS
180	THE FAMILY MEMBER	LE MEMBRE DE FAMILLE	LE MEMBRE DE FAMILLE	1				
181	FAMILY MEMBERS	MEMBRES DE FAMILLE	MEMBRES DE FAMILLE	1				
182	WHICH FAMILY MEMBER?	QUEL MEMBRE DE FAMILLE	QUEL MEMBRE DE FAMILLE	1				
183	WHICH FAMILY MEMBERS?	QUELS MEMBRES DE FAMILLE	QUELS MEMBRES DE FAMILLE	1				
184	THIS FAMILY MEMBER	CE MEMBRE DE FAMILLE	CE MEMBRE DE FAMILLE -CI		1			Translation incomplete – particle missing.
185	THAT FAMILY MEMBER	CE MEMBRE DE FAMILLE	CE MEMBRE DE FAMILLE -LÀ		1			Translation incomplete – particle missing.
186	THESE FAMILY MEMBERS	CES MEMBRES DE FAMILLE	CES MEMBRES DE FAMILLE -CI		1			Translation incomplete – particle missing.
187	THOSE FAMILY MEMBERS	CES MEMBRES DE FAMILLE	CES MEMBRES DE FAMILLE -LÀ		1			Translation incomplete – particle missing.
188	MY FAMILY MEMBER	MON MEMBRE DE FAMILLE	MON MEMBRE DE FAMILLE	1				
189	MY FAMILY MEMBERS	MES MEMBRES DE FAMILLE	MES MEMBRES DE FAMILLE	1				
190	YOUR (SINGULAR) FAMILY MEMBER	VOTRE MEMBRE DE FAMILLE	VOTRE MEMBRE DE FAMILLE	1				
191	YOUR (SINGULAR) FAMILY MEMBERS	VOS MEMBRES DE FAMILLE	VOS MEMBRES DE FAMILLE	1				
192	YOUR (PLURAL) FAMILY MEMBER	VOTRE MEMBRE DE FAMILLE	VOTRE MEMBRE DE FAMILLE	1				
193	YOUR (PLURAL) FAMILY MEMBERS	VOS MEMBRES DE FAMILLE	VOS MEMBRES DE FAMILLE	1				
194	HIS FAMILY MEMBER	SON MEMBRE DE FAMILLE	SON MEMBRE DE FAMILLE	1				
195	HIS FAMILY MEMBERS	SES MEMBRES DE FAMILLE	SES MEMBRES DE FAMILLE	1				
196	HER FAMILY MEMBER	SON MEMBRE DE FAMILLE	SON MEMBRE DE FAMILLE	1				
197	HER FAMILY MEMBERS	SES MEMBRES DE FAMILLE	SES MEMBRES DE FAMILLE	1				
198	OUR FAMILY MEMBER	NOTRE MEMBRE DE FAMILLE	NOTRE MEMBRE DE FAMILLE	1				

				M	E	N	S	ADDITIONAL COMMENTS
199	OUR FAMILY MEMBERS	NOS MEMBRES DE FAMILLE	NOS MEMBRES DE FAMILLE	1				
198	THEIR (MALE OR NEUTER) FAMILY MEMBER	LEUR MEMBRE DE FAMILLE	LEUR MEMBRE DE FAMILLE	1				
199	THEIR (MALE OR NEUTER) FAMILY MEMBERS	LEURS MEMBRES DE FAMILLE	LEURS MEMBRES DE FAMILLE	1				
200	THEIR (FEMALE) FAMILY MEMBER	LEUR MEMBRE DE FAMILLE	LEUR MEMBRE DE FAMILLE	1				
201	THEIR (FEMALE) FAMILY MEMBERS	LEURS MEMBRES DE FAMILLE	LEURS MEMBRES DE FAMILLE	1				
202	I AGREE (AS IN CONCUR) (AS IN CONSENT)	JE CONVIENS NO RESULT	JE SUIS D'ACCORD JE CONSENS		1	1	1	Inaccurate translation – no synonym offered.
203	I AGREE STRONGLY (AS IN CONCUR) (AS IN CONSENT)	NO RESULT JE CONVIENS FORTEMENT	JE SUIS D'ACCORD FORTEMENT JE CONSENS FORTEMENT	1		1	1	Inaccurate translation – no synonym offered.
204	I AGREE COMPLETELY (AS IN CONCUR) (AS IN CONSENT)	NO RESULT JE CONVIENS COMPLÈTEMENT	JE SUIS D'ACCORD COMPLÈTEMENT JE CONSENS COMPLÈTEMENT	1		1	1	Inaccurate translation – no synonym offered.
205	I DISAGREE (AS IN CONCUR) (AS IN CONSENT)	JE SUIS EN DÉSACCORD NO RESULT	JE SUIS EN DÉSACCORD JE NE CONSENS PAS	1		1	1	Inaccurate translation – no synonym offered.

				M	E	N	S	ADDITIONAL COMMENTS
206	I DISAGREE STRONGLY (AS IN CONCUR) (AS IN CONSENT)	JE SUIS EN DÉSACCORD FOTEMENT NO RESULT	JE SUIS FOTEMENT EN DESACCORD JE NE CONSENS PAS FOTEMENT		1	1	1	Inaccurate translation – no synonym offered.
207	I DISAGREE COMPLETELY (AS IN CONCUR) (AS IN CONSENT)	JE SUIS EN DÉSACCORD COMPLÈTEMENT NO RESULT	JE SUIS EN DESACCORD COMPLÈTEMENT JE NE CONSENS PAS COMPLÈTEMENT	1		1	1	Inaccurate translation – no synonym offered.
208	DO YOU AGREE? (AS IN CONCUR) (AS IN CONSENT)	NO RESULT CONVENEZ-VOUS ?	EST-CE QUE VOUS ETES D'ACCORD ? EST-CE QUE VOUS CONSENTEZ ?		1	1	1	Inaccurate translation – no synonym offered.
209	DO YOU AGREE STRONGLY? (AS IN CONCUR) (AS IN CONSENT)	NO RESULT CONVENEZ-VOUS FOTEMENT ?	EST-CE QUE VOUS ETES D'ACCORD FOTEMENT? EST-CE QUE VOUS CONSENTEZ FOTEMENT ?		1	1	1	Inaccurate translation – no synonym offered.
210	DO YOU AGREE COMPLETELY? (AS IN CONCUR) (AS IN CONSENT)	NO RESULT CONVENEZ-VOUS COMPLÈTEMENT ?	EST-CE QUE VOUS ETES D'ACCORD COMPLÈTEMENT? CONSENTEZ-VOUS COMPLÈTEMENT?		1	1	1	Inaccurate translation – no synonym offered.

				M	E	N	S	ADDITIONAL COMMENTS
211	DO YOU DISAGREE? (AS IN CONCUR) (AS IN CONSENT)	ÊTES-VOUS EN DÉSACCORD ? NO RESULT	EST-CE QUE VOUS N'ÊTES PAS D'ACCORD? EST-CE QUE VOUS NE CONSENTEZ PAS ?		1	1	1	Inaccurate translation – no synonym offered.
212	DO YOU DISAGREE STRONGLY? (AS IN CONCUR) (AS IN CONSENT)	ÊTES-VOUS EN DÉSACCORD FORTEMENT ? NO RESULT	EST-CE QUE VOUS N'ÊTES PAS D'ACCORD FORTEMENT? EST-CE QUE VOUS NE CONSENTEZ PAS FORTEMENT ?		1	1	1	Inaccurate translation – no synonym offered.
213	DO YOU DISAGREE COMPLETELY? (AS IN CONCUR) (AS IN CONSENT)	ÊTES-VOUS EN DÉSACCORD COMPLÈTEMENT ? NO RESULT	EST-CE QUE VOUS N'ÊTES PAS D'ACCORD COMPLÈTEMENT? EST-CE QUE VOUS NE CONSENTEZ PAS COMPLÈTEMENT?		1	1	1	Inaccurate translation – no synonym offered.
214	HAVE WE PROVIDED	AVONS-NOUS FOURNI ?	AVONS-NOUS FOURNI	1				
215	HAS THE HOSPITAL PROVIDED	L'HÔPITAL A-T-IL FOURNI ?	L'HÔPITAL A-T-IL FOURNI	1				
216	DO YOU FEEL WE HAVE PROVIDED	NOUS SENTEZ-VOUS AVOIR FOURNI ?	AVEZ-VOUS LE SENTIMENT QUE NOUS AVONS FOURNI	1				Matter of user preference
217	HAVE WE PROVIDED YOUR CHILD	AVONS-NOUS FOURNI VOTRE ENFANT ?	AVONS-NOUS FOURNI À VOTRE ENFANT		1			
218	SATISFACTORY SERVICE	UN SERVICE SATISFAISANT	UN SERVICE SATISFAISANT	1				

				M	E	N	S	ADDITIONAL COMMENTS
219	PROFESSIONAL SERVICE (SERVICE OF PROFESSIONAL TYPE AND STANDARD) (SERVICE BY PROFESSIONALS) (SERVICE FOR PROFESSIONALS)	UN SERVICE PROFESSIONNEL NO RESULT NO RESULT	UN SERVICE DE QUALITE PROFESSIONNELLE UN SERVICE DIGNE DE PROFESSIONNELS UN SERVICE POUR PROFESSIONNELS		1	2	1	Inaccurate translation – no synonym offered.
220	SATISFACTORY CARE	SOIN SATISFAISANT	DES SOINS SATISFAISANTS		1			
221	SUFFICIENT CARE	SOIN SUFFISANT	DES SOINS ADEQUATS		1			
222	EFFECTIVE TREATMENT	TRAITEMENT EFFICACE	UN TRAITEMENT EFFICACE		1			Indefinite article missing.
223	DO YOU THINK WE CAN IMPROVE (DO YOU BELIEVE THAT WE CAN IMPROVE SOMETHING)	NOUS PENSEZ-VOUS POUVEZ-VOUS S'AMÉLIORER ?	PENSEZ-VOUS QUE NOUS PUISSONS AMELIORER		1			
224	ARE YOU SATISFIED WITH (ARE YOU HAPPY IN REGARD TO)	ÊTES-VOUS SATISFAIT DE ?	ÊTES-VOUS SATISFAIT DE	1				
225	OUR PROFESSIONALISM	NOTRE PROFESSIONNALISME	NOTRE PROFESSIONNALISME	1				
226	OUR CARE FOR YOUR CHILD	NOTRE SOIN POUR VOTRE ENFANT	NOS SOINS DONNES À VOTRE ENFANT		1			
227	OUR HELP	NOTRE AIDE	NOTRE AIDE	1				
228	OUR TREATMENT OF YOUR CHILD	NOTRE TRAITEMENT DE VOTRE ENFANT	NOTRE TRAITEMENT POUR VOTRE ENFANT		1			
229	YOUR CHILD'S TREATMENT	LE TRAITEMENT DE VOTRE ENFANT	LE TRAITEMENT DE VOTRE ENFANT	1				

				M	E	N	S	ADDITIONAL COMMENTS
230	THE TREATMENT YOUR CHILD RECEIVED	LE TRAITEMENT QUE VOTRE ENFANT A REÇU	LE TRAITEMENT QU'A REÇU VOTRE ENFANT		1			
				153 70 76 77				TOTAL SCORE

7.5 Appendix E Translation Table of the Control Model Results: English to French Translations of Combined Word Groups

REF.	SAMPLE ENGLISH WORD/WORD GROUP OBTAINED FROM THE SURVEY QUESTIONNAIRE	FRENCH EQUIVALENT PROVIDED BY THE CONTROL MODEL	SAMPLE ENGLISH WORD/WORD GROUP PROVIDED BY THE STUDY TRANSLATORS	EVALUATION OF THE CONTROL MODEL TRANSLATIONS						
				KEY TO ANALYSIS OF RESULTS						
				M = MATCHING RESULT E = NUMBER OF TRANSLATION ERRORS N = NO RESULT PROVIDED S = NO SYNONYM PROVIDED						
				M	E	N	S	ADDITIONAL COMMENTS		
231	HAVE WE PROVIDED SATISFACTORY SERVICE	AVONS-NOUS FOURNI LE SERVICE SATISFAISANT ?	AVONS-NOUS FOURNI UN SERVICE SATISFAISANT ?	1						
232	HAVE WE PROVIDED PROFESSIONAL SERVICE	AVONS-NOUS FOURNI LE SERVICE PROFESSIONNEL ?	AVONS-NOUS FOURNI UN SERVICE DE QUALITE PROFESSIONNELLE ?		1			Incomplete and imprecise translation.		
233	HAVE WE PROVIDED SATISFACTORY CARE	AVONS-NOUS FOURNI LE SOIN SATISFAISANT ?	AVONS-NOUS FOURNI DES SOINS SATISFAISANTS ?		1			Incomplete and imprecise translation		
234	HAVE WE PROVIDED SUFFICIENT CARE	AVONS-NOUS FOURNI LE SOIN SUFFISANT ?	AVONS-NOUS FOURNI DES SOINS ADEQUATS ?		1			Incomplete and imprecise translation		
235	HAVE WE PROVIDED EFFECTIVE TREATMENT	AVONS-NOUS FOURNI LE TRAITEMENT EFFICACE ?	AVONS-NOUS FOURNI UN TRAITEMENT EFFICACE ?	1						
236	HAS THE HOSPITAL PROVIDED SATISFACTORY SERVICE	L'HOPITAL A-T-IL FOURNI LE SERVICE SATISFAISANT ?	L'HOPITAL A-T-IL FOURNI UN SERVICE SATISFAISANT ?	1						

				M	E	N	S	ADDITIONAL COMMENTS
237	HAS THE HOSPITAL PROVIDED PROFESSIONAL SERVICE	L'HÔPITAL A-T-IL FOURNI LE SERVICE PROFESSIONNEL ?	L'HOPITAL A-T-IL FOURNI UN SERVICE DE QUALITE PROFESSIONNELLE	1				
238	HAS THE HOSPITAL PROVIDED SATISFACTORY CARE	L'HÔPITAL A-T-IL FOURNI LE SOIN SATISFAISANT ?	L'HOPITAL A-T-IL FOURNI DES SOINS SATISFAISANTS ?	1				
239	HAS THE HOSPITAL PROVIDED SUFFICIENT CARE	L'HÔPITAL A-T-IL FOURNI LE SOIN SUFFISANT ?	L'HOPITAL A-T-IL FOURNI DES SOINS ADEQUATS ?	1				
240	HAS THE HOSPITAL PROVIDED EFFECTIVE TREATMENT?	L'HÔPITAL A-T-IL FOURNI LE TRAITEMENT EFFICACE?	L'HOPITAL A-T-IL FOURNI UN TRAITEMENT EFFICACE?	1				
241	DO YOU FEEL (FEEL AS IN SENSORY PERCEPTION)	VOUS SENTEZ-VOUS ?	SENTEZ-VOUS?		1			
242	DO YOU FEEL (AS IN TOUCH)	NO RESULT	TOUCHEZ-VOUS?			1	1	No synonym offered for 'TOUCH'.
243	DO YOU FEEL WE HAVE PROVIDED SATISFACTORY SERVICE (FEEL AS IN SENSORY PERCEPTION)	NOUS SENTEZ-VOUS AVOIR SATISFAISANT FOURNI ?	AVEZ-VOUS LE SENTIMENT QUE NOUS AVONS FOURNI UN SERVICE SATISFAISANT ?		1		1	No synonym offered for 'FEEL'.
244	DO YOU FEEL WE HAVE PROVIDED PROFESSIONAL SERVICE (FEEL AS IN SENSORY PERCEPTION)	NOUS SENTEZ-VOUS AVOIR LE SERVICE PROFESSIONNEL FOURNI ?	AVEZ-VOUS LE SENTIMENT QUE NOUS AVONS FOURNI UN SERVICE DE QUALITE PROFESSIONNELLE ?		1		1	Translation incomplete. No synonym offered for 'FEEL'.

				M	E	N	S	ADDITIONAL COMMENTS
245	DO YOU FEEL WE HAVE PROVIDED SATISFACTORY CARE (FEEL AS IN SENSORY PERCEPTION)	NOUS SENTEZ-VOUS AVOIR LE SOIN SATISFAISANT FOURNI ?	AVEZ-VOUS LE SENTIMENT QUE NOUS AVONS FOURNI DES SOINS SATISFAISANTS ?		1		1	Translation incomplete. No synonym offered for 'FEEL'.
246	DO YOU FEEL WE HAVE PROVIDED SUFFICIENT CARE (FEEL AS IN SENSORY PERCEPTION)	NOUS SENTEZ-VOUS AVOIR LE SOIN SUFFISANT FOURNI ?	AVEZ-VOUS LE SENTIMENT QUE NOUS AVONS FOURNI DES SOINS ADEQUATS ?		1		1	Translation incomplete. No synonym offered for 'FEEL'.
247	DO YOU FEEL WE HAVE PROVIDED EFFECTIVE TREATMENT (FEEL AS IN SENSORY PERCEPTION)	NOUS SENTEZ-VOUS AVOIR LE TRAITEMENT EFFICACE FOURNI ?	AVEZ-VOUS LE SENTIMENT QUE NOUS AVONS FOURNI UN TRAITEMENT EFFICACE ?		1		1	Translation incomplete. No synonym offered for 'FEEL'.
248	HAVE WE PROVIDED YOUR CHILD SATISFACTORY SERVICE	AVONS-NOUS FOURNI VOTRE SERVICE SATISFAISANT D'ENFANT ?	AVONS-NOUS FOURNI A VOTRE ENFANT UN SERVICE SATISFAISANT ?		1			Inaccurate translation.
249	HAVE WE PROVIDED YOUR CHILD PROFESSIONAL SERVICE (SERVICE OF PROFESSIONAL TYPE AND STANDARD)	AVONS-NOUS FOURNI A VOTRE ENFANT L'ONU NOUS ONT FOURNI VOTRE SERVICE PROFESSIONNEL D'ENFANT ?	AVONS-NOUS FOURNI A VOTRE ENFANT UN SERVICE DE QUALITE PROFESSIONNELLE ?		1			Inaccurate translation.
250	HAVE WE PROVIDED YOUR CHILD PROFESSIONAL SERVICE (SERVICE BY PROFESSIONALS)	AVONS-NOUS FOURNI VOTRE SERVICE PROFESSIONNEL D'ENFANT ?	AVONS-NOUS FOURNI A VOTRE ENFANT UN SERVICE DIGNE DE PROFESSIONNELS		1			Inaccurate translation.
251	HAVE WE PROVIDED YOUR CHILD SATISFACTORY CARE	AVONS-NOUS FOURNI VOTRE SOIN SATISFAISANT D'ENFANT ?	AVONS-NOUS FOURNI A VOTRE ENFANT DES SOINS SATISFAISANTS ?		1			Inaccurate translation.

				M	E	N	S	ADDITIONAL COMMENTS
252	HAVE WE PROVIDED YOUR CHILD SUFFICIENT CARE	AVONS-NOUS FOURNI VOTRE SOIN SUFFISANT D'ENFANT ?	AVONS-NOUS FOURNI À VOTRE ENFANT DES SOINS ADEQUATS ?		1			Inaccurate translation.
253	HAVE WE PROVIDED YOUR CHILD EFFECTIVE TREATMENT	AVONS-NOUS FOURNI VOTRE TRAITEMENT EFFICACE D'ENFANT ?	AVONS-NOUS FOURNI À VOTRE ENFANT UN TRAITEMENT EFFICACE ?		1			Inaccurate translation.
254	DO YOU THINK WE CAN IMPROVE OUR PROFESIONALISM	NOUS PENSEZ-VOUS POUVEZ-VOUS AMÉLIORER NOTRE PROFESSIONNALISME ?	PENSEZ-VOUS QUE NOUS PUISSIONS AMELIORER NOTRE PROFESSIONNALISME ?		1			Inaccurate translation.
255	DO YOU THINK WE CAN IMPROVE OUR CARE FOR YOUR CHILD	NOUS PENSEZ-VOUS POUVEZ-VOUS AMÉLIORER NOTRE SOIN POUR VOTRE ENFANT ?	PENSEZ-VOUS QUE NOUS PUISSIONS AMELIORER NOS SOINS DONNES À VOTRE ENFANT ?		1			Inaccurate translation.
256	DO YOU THINK WE CAN IMPROVE OUR HELP	NOUS PENSEZ-VOUS POUVEZ-VOUS AMÉLIORER NOTRE AIDE ?	PENSEZ-VOUS QUE NOUS PUISSIONS AMELIORER L'AIDE QUE NOUS VOUS AVONS APPOREE ?		1			Inaccurate translation.
257	DO YOU THINK WE CAN IMPROVE OUR TREATMENT OF YOUR CHILD	NOUS PENSEZ-VOUS POUVEZ-VOUS AMÉLIORER NOTRE TRAITEMENT DE VOTRE ENFANT ?	PENSEZ-VOUS QUE NOUS PUISSIONS AMELIORER NOTRE TRAITEMENT POUR VOTRE ENFANT ?		1			Inaccurate translation.
258	DO YOU THINK WE CAN IMPROVE YOUR CHILD'S TREATMENT	NOUS PENSEZ-VOUS POUVEZ-VOUS AMÉLIORER LE TRAITEMENT DE VOTRE ENFANT ?	PENSEZ-VOUS QUE NOUS PUISSIONS AMELIORER LE TRAITEMENT DE VOTRE ENFANT ?		1			Inaccurate translation.

				M	E	N	S	ADDITIONAL COMMENTS
259	DO YOU THINK WE CAN IMPROVE THE TREATMENT YOUR CHILD RECEIVED	NOUS PENSEZ-VOUS POUVEZ-VOUS AMÉLIORER LE TRAITEMENT QUE VOTRE ENFANT A REÇU ?	PENSEZ-VOUS QUE NOUS PUISSONS AMÉLIORER LE TRAITEMENT QU'A REÇU VOTRE ENFANT ?		1			Inaccurate translation.
260	ARE YOU SATISFIED WITH OUR PROFESSIONALISM	ÊTES-VOUS SATISFAIT DE NOTRE PROFESSIONNALISME ?	ÊTES-VOUS SATISFAITS DE NOTRE PROFESSIONNALISME ?	1				
261	ARE YOU SATISFIED WITH OUR CARE FOR YOUR CHILD	ÊTES-VOUS SATISFAIT DE NOTRE SOIN POUR VOTRE ENFANT ?	ÊTES-VOUS SATISFAITS DE NOS SOINS DONNES À VOTRE ENFANT ?		1			Inaccurate translation.
262	ARE YOU SATISFIED WITH OUR HELP	ÊTES-VOUS SATISFAIT DE NOTRE AIDE ?	ÊTES-VOUS SATISFAITS DE L'AIDE QUE NOUS VOUS AVONS APPORTÉE ?		1			Inaccurate translation.
263	ARE YOU SATISFIED WITH OUR TREATMENT OF YOUR CHILD	ÊTES-VOUS SATISFAIT DE NOTRE TRAITEMENT DE VOTRE ENFANT ?	ÊTES-VOUS SATISFAITS DE NOTRE TRAITEMENT POUR VOTRE ENFANT ?		1			Inaccurate translation.
264	ARE YOU SATISFIED WITH YOUR CHILD'S TREATMENT	ÊTES-VOUS SATISFAIT DU TRAITEMENT DE VOTRE ENFANT ?	ÊTES-VOUS SATISFAITS (DE LE) DU TRAITEMENT DE VOTRE ENFANT ?	1				Inaccurate translation.
265	ARE YOU SATISFIED WITH THE TREATMENT YOUR CHILD RECEIVED	ÊTES-VOUS SATISFAIT DU TRAITEMENT QUE VOTRE ENFANT A REÇU ?	ÊTES-VOUS SATISFAITS (DE LE) DU TRAITEMENT QU'A REÇU VOTRE ENFANT ?	1				
				35	25	1	7	TOTAL SCORE

7.6 Appendix F Translation Table of the Control Model Results of Single Word Groups: French to English

REF.	SAMPLE ENGLISH WORD/WORD GROUP OBTAINED FROM THE SURVEY QUESTIONNAIRE	ENGLISH EQUIVALENT PROVIDED BY THE CONTROL MODEL	SAMPLE FRENCH WORD/WORD GROUP PROVIDED BY THE STUDY TRANSLATORS	EVALUATION OF THE CONTROL MODEL TRANSLATIONS						
				KEY TO ANALYSIS OF RESULTS				ADDITIONAL COMMENTS		
				M	E	N	S			
				M	E	N	S			
01	NOT AT ALL	AT ALL	PAS DU TOUT		1			Inaccurate translation.		
02	A LITTLE	A LITTLE	UN PEU	1						
03	SOMEWHAT	SOMEWHAT	QUELQUE PEU	1						
04	VERY MUCH	MUCH	BEAUCOUP		1			Inaccurate translation.		
05	EXTREMELY	EXTREMELY	EXTRÊMEMENT	1						
06	NOT A NEED (NEED AS A REQUIREMENT)	NO THE NEED	PAS DE BESOIN		1			Inaccurate translation.		
07	NOT MET AT ALL. (MET AS IN TO MEET A REQUIREMENT)	NOT SATISFIED	PAS SATISFAIT		1			Inaccurate translation.		
08	PARTLY MET (MET AS IN TO MEET A REQUIREMENT)	A LITTLE SATISFIED	UN PEU SATISFAIT		1			Inaccurate translation.		
09	WELL MET (MET AS IN TO MEET A REQUIREMENT)	QUITE SATISFIED	BIEN SATISFAIT		1			Inaccurate translation.		
10	COMPLETELY MET (MET AS IN TO MEET A REQUIREMENT)	COMPLETELY SATISFIED	COMPLÈTEMENT SATISFAIT		1			Inaccurate translation.		
11	YES	YES	OUI	1						
12	NO	NO	NON	1						

				M	E	N	S	ADDITIONAL COMMENTS
13	COMPLETELY DISAGREE (AS IN CONCUR) (AS IN CONSENT)	COMPLETELY IN DISSENSION COMPLETELY NOT ASSENT	COMPLÈTEMENT EN DÉSACCORD COMPLÈTEMENT PAS CONSENTEMENT		2			Inaccurate translations.
14	STRONGLY DISAGREE (AS IN CONCUR) (AS IN CONSENT)	VIGOROUSLY IN DISSENSION STRONGLY NOT ASSENT	VIGOREUSEMENT EN DÉSACCORD FORTEMENT PAS CONSENTEMENT		2			Inaccurate translations.
15	DISAGREE (AS IN CONCUR) (AS IN CONSENT)	IN DISSENSION NOT ASSENT	EN DÉSACCORD PAS CONSENTEMENT		2			Inaccurate translations.
16	AGREE (AS IN CONCUR) (AS IN CONSENT)	IN AGREEMENT AGREE	EN ACCORD CONSENS	1	1			Inaccurate translation.
17	STRONGLY AGREE (AS IN CONCUR) (AS IN CONSENT)	VIGOROUSLY IN AGREEMENT STRONGLY ASSENT	VIGOREUSEMENT EN ACCORD FORTEMENT CONSENTEMENT		2			Inaccurate translations.
18	AGREE COMPLETELY (AS IN CONCUR) (AS IN CONSENT)	OF AGREEMENT COMPLETELY AGREE COMPLETELY	D'ACCORD COMPLÈTEMENT CONSENS COMPLÈTEMENT	1	1			Inaccurate translation.

				M	E	N	S	ADDITIONAL COMMENTS
19	WELCOME (AS A GREETING) (VERB)	WELCOME TO ACCOMODATE	BIENVENUE ACCUEILLIR	1	1			Inaccurate translation.
20	QUESTIONNAIRE	QUESTIONNAIRE	QUESTIONNAIRE	1				
21	QUESTIONNAIRES	QUESTIONNAIRES	QUESTIONNAIRES	1				
22	NEED (AS A NOUN) (AS A VERB)	NEED TO NEED	BESOIN AVOIR BESOIN DE	2				
23	NEEDS (AS A NOUN)	NEEDS	BESOINS (BUT ONLY FOR MORE THAN ONE PERSON)	1				
24	PARENT	RELATIVE	PARENT (LE PERE OU LA MERE UN DES DEUX PARENTS)		1			Inaccurate translation.
25	PARENTS	PARENTS	PARENTS	1				
26	SUPPORT (NOUN - THING SUPPORTING) (VERB - AS IN HELP)	SUPPORT TO SUPPORT	SOUTIEN SOUTENIR	2				
27	FAMILY MEMBER	MEMBER OF THE FAMILY	MEMBRE DE LA FAMILLE	1				Matter of user preference.
28	FAMILY MEMBERS	MEMBERS OF THE FAMILY	MEMBRES DE LA FAMILLE	1				Matter of user preference.
29	A RESEARCH NURSE (MALE) (FEMALE)	A INFIRMIÈR OF RESEARCH A NURSE OF RESEARCH	UN INFIRMIÈR DE RECHERCHE UNE INFIRMIERE DE RECHERCHE		2		1	Inaccurate translation. No synonym table present for gender anomalies.

				M	E	N	S	ADDITIONAL COMMENTS
30	RESEARCH NURSES (MALE) (FEMALE)	MALE NURSES OF RESEARCH NURSES OF RESEARCH	DES INFIRMIERS DE RECHERCHE DES INFIRMIERES DE RECHERCHE		2		1	Inaccurate translation. No synonym table present for gender anomalies.
31	GUIDE (NOUN) (VERB - TO GUIDE)	GUIDE TO GUIDE	GUIDE GUIDER	2				
32	GUIDES NOUN VERB	GUIDES TO GUIDE	GUIDES GUIDER	2				
33	INSTRUCTION	INSTRUCTION	INSTRUCTION	1				
34	INSTRUCTIONS	INSTRUCTIONS	INSTRUCTIONS	1				
35	EXPERIENCE (ONCE OFF - NOUN) (LONGER EXPERIENCE)	EXPERIMENT TO TEST	EXPÉRIENCE ÉPROUVER	1	1			Inaccurate translation.
36	EXPERIENCES	EXPERIMENTS	EXPÉRIENCES		1			Inaccurate translation.
37	QUESTION	QUESTION	QUESTION	1				
38	QUESTIONS	QUESTIONS	QUESTIONS	1				
39	ANSWER (AS A NOUN) (AS A VERB)	ANSWER TO ANSWER	RÉPONSE RÉPONDRE	2				
40	ANSWERS (AS A NOUN)	ANSWERS	RÉPONSES	1				
41	SITUATION (AS A PLACE) (CIRCUMSTANCES)	PLACE SITUATION	ENDROIT SITUATION	2				Matter of user preference.

				M	E	N	S	ADDITIONAL COMMENTS
42	SITUATIONS (AS A PLACE) (CIRCUMSTANCES)	PLACES SITUATIONS	ENDROITS SITUATIONS	2				Matter of user preference
43	BUTTON (CLOTHING) (FOR MACHINE ETC) (TO TURN SOMETHING ON/OFF)	BUTTON BUTTON BUTTON	BOUTON BOUTON BOUTON	3				
44	BUTTONS (CLOTHING) (FOR MACHINE ETC) (TO TURN SOMETHING ON/OFF)	BUTTONS BUTTONS BUTTONS	BOUTONS BOUTONS BOUTONS	3				
45	STUDY NOUN (AS IN RESEARCH) (VERB AS IN RESEARCH)	STUDY TO STUDY	ÉTUDE ÉTUDIER	2				
46	STUDIES (NOUN AS IN RESEARCH)	STUDIES	ÉTUDES	1				
47	SCREEN (NOUN AS IN FURNITURE) (NOUN AS IN COMPUTER) (VERB - FILTER) (VERB - GUARD AGAINST)	PARTITION SCREEN TO FILTER FOR SE TO PROTECT	CLOISON ÉCRAN FILTRE PROTÉGER	3	1			Inaccurate translation.

				M	E	N	S	ADDITIONAL COMMENTS
48	SCREENS (NOUN AS IN FURNITURE) (NOUN AS IN COMPUTER)	PARTITIONS SCREENS	CLOISONS ÉCRANS	2				
49	IDENTIFIED	IDENTIFIED IDENTIFIED IDENTIFIED IDENTIFIED	IDENTIFIÉ (M SG) IDENTIFIÉE (F SG) IDENTIFIÉS (M PL) IDENTIFIÉES (F PL)	4				
50	ITEM (OBJECT) (IN A LIST)	ARTICLE QUESTION NOT	ARTICLE QUESTION POINT	1	1			Inaccurate translation.
51	ITEMS (OBJECT) (IN A LIST)	ARTICLES QUESTIONS POINTS	ARTICLES QUESTIONS POINTS	3				
52	SURVEY (NOUN - RESEARCH) (VERB - EXAMINE) (VERB - LOOK AT) (VERB - LOOK AROUND)	SURVEY TO EXAMINE TO LOOK AT LOOK AROUND	SONDAGE EXAMINER REGARDER REGARDE AUTOUR DE	4				Matter of user preference.
53	SURVEYS NOUN (RESEARCH) VERB (EXAMINE) VERB (LOOK AT) VERB (LOOK AROUND)	SURVEYS	SONDAGES SEE 52 ABOVE	4				
54	FINGER	FINGER	DOIGT	1				

				M	E	N	S	ADDITIONAL COMMENTS
55	FINGERS	FINGERS	DOIGTS	1				
56	ILLNESS	DISEASE	MALADIE		1			Inaccurate translation.
57	ILLNESSES	DISEASES	MALADIES		1			Inaccurate translation.
58	HELPFUL (AS IN PROVIDE A SERVICE) (USEFUL)	OBLIGING OBLIGING USEFUL USEFUL	SERVIALE (SG) SERVIALES (PL) UTILE (SG) UTILES (PL)	4				Matter of user preference.
59	PAEDIATRIC	OF PEDIATRY	DE PÉDIATRIE	1				
60	ONCOLOGY	ONCOLOGY	ONCOLOGIE	1				
61	TOUCH-SCREEN	TOUCH SCREEN	ÉCRAN TACTILE	1				
62	TOUCH-SCREENS	TOUCH SCREENS	ÉCRANS TACTILES	1				
63	HEALTH-PROFESSIONAL	PROFESSIONAL OF HEALTH	PROFESSIONNEL DE LA SANTÉ		1			Incorrect syntax
64	HEALTH PROFESSIONALS	PROFESSIONALS OF HEALTH	PROFESSIONNELS DE LA SANTÉ		1			Incorrect syntax
65	IMPORTANT	IMPORTANT IMPORTANT IMPORTANT IMPORTANT	IMPORTANT (M SG) IMPORTANTE (F SG) IMPORTANTS (M PL) IMPORTANTES (F PL)	4				
66	CANCER	CANCER	CANCER	1				
67	CANCERS	CANCERS	CANCERS	1				
68	CHILD	CHILD	ENFANT	1				
69	CHILDREN	CHILDREN	ENFANTS	1				
70	HOSPITAL	HOSPITAL	HÔPITAL	1				
71	HOSPITALS	HOSPITALS	HÔPITALS	1				
72	RESEARCH (NOUN) (VERB)	SEEK TO SEEK	RECHERCHE RECHERCHER	2				
73	RESEARCHER (PERSON WHO RESEARCHES)	RESEARCHER ENQUIRING	CHERCHEUR (M) CHERCHEUSE (F)	1	1		1	Inaccurate translation. No synonym table present for gender anomalies.
74	RESEARCHERS (PERSON WHO RESEARCHES)	RESEARCHERS ENQUIRING	CHERCHEURS (M, M+F) CHERCHEUSES (F)	1	1		1	Inaccurate translation. No synonym table present for gender anomalies.

				M	E	N	S	ADDITIONAL COMMENTS
75	APPROPRIATE (ADJECTIVE)	ADAPTED ADAPTED ADAPTED ADAPTED	APPROPRIÉ (M SG) APPROPRIÉE (F SG) APPROPRIÉS (M PL) APPROPRIÉES (F PL)	4				
	(VERB)	TO ADAPT	APPROPRIER					
76	DOCTOR (TITLE OF DEGREE HOLDER)	DOCTOR	DOCTEUR	3				
	(MEDICAL DOCTOR)	DOCTOR DOCTOR	MÉDECIN DOCTEUR					
77	DOCTORS (TITLE OF DEGREE HOLDER)	DOCTORS	DOCTEURS	3				
	(MEDICAL DOCTOR)	DOCTORS DOCTORS	MÉDECINS DOCTEURS					
78	SURGEON	SURGEON	CHIRURGIEN	1				
79	SURGEONS	SURGEONS	CHIRURGIENS	1				
80	TREATMENT (COURSE OF TREATMENT)	TREATMENT	TRAITEMENT	2				
	(WAY SOMEONE IS TREATED IN GENERAL)	TREATMENT	TRAITEMENT					
81	A QUESTIONNAIRE	A QUESTIONNAIRE	UN QUESTIONNAIRE	1				
82	THE QUESTIONNAIRE	THE QUESTIONNAIRE	LE QUESTIONNAIRE	1				
83	THE QUESTIONNAIRES	THE QUESTIONNAIRES	LES QUESTIONNAIRES	1				
84	SOME QUESTIONNAIRES	QUESTIONNAIRES	DES QUESTIONNAIRES		1			Inaccurate translation.
85	THIS QUESTIONNAIRE	EC QUESTIONNAIRE-CI	CE QUESTIONNAIRE-CI		1			Inaccurate translation.
86	THAT QUESTIONNAIRE	EC QUESTIONNAIRE-LÀ	CE QUESTIONNAIRE-LÀ		1			Inaccurate translation.
87	THOSE QUESTIONNAIRES	THESE QUESTIONNAIRES-LÀ	CES QUESTIONNAIRES-LÀ		1			Inaccurate translation.

				M	E	N	S	ADDITIONAL COMMENTS
88	THESE QUESTIONNAIRES	THESE QUESTIONNAIRES-CI	CES QUESTIONNAIRES-CI		1			Inaccurate translation.
89	WHICH QUESTIONNAIRE?	WHICH QUESTIONNAIRE?	QUEL QUESTIONNAIRE?	1				
90	WHICH QUESTIONNAIRES?	WHICH QUESTIONNAIRES?	QUELS QUESTIONNAIRES?	1				
91	MY QUESTIONNAIRE	MY QUESTIONNAIRE	MON QUESTIONNAIRE	1				
92	MY QUESTIONNAIRES	MY QUESTIONNAIRES	MES QUESTIONNAIRES	1				
93	YOUR (SINGULAR) QUESTIONNAIRE	YOUR QUESTIONNAIRE	VOTRE QUESTIONNAIRE	1				
94	YOUR (SINGULAR) QUESTIONNAIRES	YOUR QUESTIONNAIRES	VOS QUESTIONNAIRES	1				
95	YOUR (PLURAL) QUESTIONNAIRE	YOUR QUESTIONNAIRE	VOTRE QUESTIONNAIRE	1				
96	YOUR (PLURAL) QUESTIONNAIRES	YOUR QUESTIONNAIRES	VOS QUESTIONNAIRES	1				
97	HIS QUESTIONNAIRE	ITS QUESTIONNAIRE	SON QUESTIONNAIRE		1			Inaccurate translation.
98	HIS QUESTIONNAIRES	ITS QUESTIONNAIRES	SES QUESTIONNAIRES		1			Inaccurate translation.
99	HER QUESTIONNAIRE	ITS QUESTIONNAIRE	SON QUESTIONNAIRE		1			Inaccurate translation.
100	HER QUESTIONNAIRES	ITS QUESTIONNAIRES	SES QUESTIONNAIRES		1			Inaccurate translation.
101	OUR QUESTIONNAIRE	OUR QUESTIONNAIRE	NOTRE QUESTIONNAIRE	1				
102	OUR QUESTIONNAIRES	OUR QUESTIONNAIRES	NOS QUESTIONNAIRES	1				
103	THEIR (MALE OR NEUTER) QUESTIONNAIRE	THEIR QUESTIONNAIRE	LEUR QUESTIONNAIRE	1				
104	THEIR (MALE OR NEUTER) QUESTIONNAIRES	THEIR QUESTIONNAIRES	LEURS QUESTIONNAIRES	1				
105	THEIR (FEMALE) QUESTIONNAIRE	THEIR QUESTIONNAIRE	LEUR QUESTIONNAIRE	1				
106	THEIR (FEMALE) QUESTIONNAIRES	THEIR QUESTIONNAIRES	LEURS QUESTIONNAIRES	1				
107	A NEED (REQUIREMENT) (NECESSITY)	A NEED A NEED	UN BESOIN UNE NÉCESSITÉ	2				

				M	E	N	S	ADDITIONAL COMMENTS
108	THE NEED (REQUIREMENT) (NECESSITY)	THE NEED NEED	LE BESOIN LA NÉCESSITÉ	1	1			Inaccurate translation – preposition dropped.
109	THE NEEDS (REQUIREMENT) (NECESSITY)	NEEDS NEEDS	LES BESOINS LES NÉCESSITÉS		2			Inaccurate translation – prepositions dropped.
120	MY NEED (REQUIREMENT) (NECESSITY)	MY NEED MA REQUIRED	MON BESOIN MA NÉCESSITÉ	1				
121	MY NEEDS (REQUIREMENT) (NECESSITY)	MY NEEDS MY NEEDS	MES BESOINS MES NÉCESSITÉS	1				
122	YOUR (SINGULAR) NEED (REQUIREMENT) (NECESSITY)	 YOUR NEED YOUR NEED	 VOTRE BESOIN VOTRE NÉCESSITÉ	2				
123	YOUR (SINGULAR) NEEDS (REQUIREMENT) (NECESSITY)	 YOUR NEEDS YOUR NEEDS	 VOS BESOINS VOS NÉCESSITÉS	2				
124	YOUR (PLURAL) NEED (REQUIREMENT) (NECESSITY)	 YOUR NEED YOUR NEED	 VOTRE BESOIN VOTRE NÉCESSITÉ	2				
125	YOUR (PLURAL) NEEDS (REQUIREMENT) (NECESSITY)	 YOUR NEEDS YOUR NEEDS	 VOS BESOINS VOS NÉCESSITÉS	2				

				M	E	N	S	ADDITIONAL COMMENTS
126	HIS NEED (REQUIREMENT) (NECESSITY)	ITS NEED SA REQUIRED	SON BESOIN SA NÉCESSITÉ		2			Inaccurate translations.
127	HIS NEEDS (REQUIREMENT) (NECESSITY)	ITS NEEDS ITS NEEDS	SES BESOINS SES NÉCESSITÉS		2			Inaccurate translation.
128	HER NEED (REQUIREMENT) (NECESSITY)	ITS NEED SA REQUIRED	SON BESOIN SA NÉCESSITÉ		2			Inaccurate translation.
129	HER NEEDS (REQUIREMENT) (NECESSITY)	ITS NEEDS ITS NEEDS	SES BESOINS SES NÉCESSITÉS		2			Inaccurate translation.
130	OUR NEED (REQUIREMENT) (NECESSITY)	OUR NEED OUR NEED	NOTRE BESOIN NOTRE NÉCESSITÉ	2				
131	OUR NEEDS (REQUIREMENT) (NECESSITY)	OUR NEEDS OUR NEEDS	NOS BESOINS NOS NÉCESSITÉS	2				
132	THEIR (MALE OR NEUTER) NEED (REQUIREMENT) (NECESSITY)	THEIR NEED THEIR NEED	LEUR BESOIN LEUR NÉCESSITÉ	2				
133	THEIR (MALE OR NEUTER) NEEDS (REQUIREMENT) (NECESSITY)	THEIR NEEDS THEIR NEEDS	LEURS BESOINS LEURS NÉCESSITÉS	2				

				M	E	N	S	ADDITIONAL COMMENTS
134	THEIR (FEMALE) NEED (REQUIREMENT) (NECESSITY)	THEIR NEED THEIR NEED	LEUR BESOIN LEUR NÉCESSITÉ	2				
135	THEIR (FEMALE) NEEDS (REQUIREMENT) (NECESSITY)	THEIR NEEDS THEIR NEEDS	LEURS BESOINS LEURS NÉCESSITÉS	2				
136	A PARENT	A PARENT	UN PARENT	1				
137	THE PARENT	THE PARENT	LE PARENTS	1				
138	THE PARENTS	THE PARENTS	LES PARENTS	1				
139	SOME PARENTS	SOME PARENTS	QUELQUES PARENTS	1				
140	THIS PARENT	EC PARENT-CI	CE PARENT-CI		1			Inaccurate translation.
141	THESE PARENTS	THESE PARENTS-CI	CES PARENTS-CI		1			Inaccurate translation.
142	THAT PARENT	EC PARENT-LA	CE PARENT-LA		1			Inaccurate translation.
143	THOSE PARENTS	THESE PARENTS-LA	CES PARENTS-LA		1			Inaccurate translation.
144	WHICH PARENT?	WHICH RELATIVE?	QUEL PARENT?	1				
145	WHICH PARENTS?	WHICH PARENTS?	QUELS PARENTS?	1				
146	MY PARENT (MALE)	MY RELATIVE	MON PARENT	1				
147	MY PARENT (FEMALE)	MA RELATIVE	MA PARENT		1			Inaccurate translation.
148	MY PARENTS	MES PARENTS	MES PARENTS		1			Inaccurate translation.
149	YOUR (SINGULAR) PARENT	YOUR RELATIVE	VOTRE PARENT	1				
149	YOUR (SINGULAR) PARENTS	YOUR PARENTS	VOS PARENTS	1				
150	YOUR (PLURAL) PARENT	YOUR RELATIVE	VOTRE PARENT		1			Inaccurate translation.
151	YOUR (PLURAL) PARENTS	YOUR PARENTS	VOS PARENTS	1				
152	HIS PARENT	HIS/HER RELATIVE	SON PARENT	1				
153	HIS PARENTS	HIS/HER PARENTS	SES PARENTS	1				
154	HER PARENT	HIS/HER RELATIVE	SON PARENT	1				
155	HER PARENTS	HIS/HER PARENTS	SES PARENTS	1				
156	OUR PARENT	OUR RELATIVE	NOTRE PARENT		1			Inaccurate translation.
157	OUR PARENTS	OUR PARENTS	NOS PARENTS	1				

				M	E	N	S	ADDITIONAL COMMENTS
158	THEIR (MALE OR NEUTER) PARENT	THEIR RELATIVE	LEUR PARENT		1			Inaccurate translation.
159	THEIR (MALE OR NEUTER) PARENTS	THEIR PARENTS	LEURS PARENTS		1			Inaccurate translation.
160	THEIR (FEMALE) PARENT	THEIR RELATIVE	LEUR PARENT		1			Inaccurate translation.
161	THEIR (FEMALE) PARENTS	THEIR PARENTS	LEURS PARENTS		1			Inaccurate translation.
162	THE SUPPORT (NOUN - THING SUPPORTING)	THE SUPPORT	LE SOUTIEN	1				
163	A SUPPORT (NOUN - THING SUPPORTING)	A SUPPORT	UN SOUTIEN	1				
164	SOME SUPPORT (NOUN - THING SUPPORTING)	SOME SUPPORT	QUELQUE SOUTIEN	1				
165	THAT SUPPORT (NOUN - THING SUPPORTING)	EC SOUTIEN-LÀ	CE SOUTIEN-LÀ		1			Inaccurate translation.
166	THIS SUPPORT (NOUN - THING SUPPORTING)	EC SOUTIEN-CI	CE SOUTIEN-CI		1			Inaccurate translation.
167	THOSE SUPPORT (NOUN - THING SUPPORTING)	THESE SUPPORT	CEUX-LÀ SOUTIENNENT		1			Inaccurate translation.
168	THOSE SUPPORTS (NOUN - THING SUPPORTING)	THESE SOUTIENS-LÀ	CES SOUTIENS-LÀ		1			Inaccurate translation.
169	THESE SUPPORT (NOUN - THING SUPPORTING)	THOSE SUPPORT	CEUX-CI SOUTIENNENT		1			Inaccurate translation.
170	THESE SUPPORTS (NOUN - THING SUPPORTING)	THESE SOUTIENS-CI	CES SOUTIENS-CI		1			Inaccurate translation.

				M	E	N	S	ADDITIONAL COMMENTS
171	MY SUPPORT (NOUN - THING SUPPORTING)	MY SUPPORT	MON SOUTIEN	1				
172	YOUR (SINGULAR) SUPPORT (NOUN - THING SUPPORTING)	YOUR SUPPORT	VOTRE SOUTIEN	1				
173	YOUR (PLURAL) SUPPORT (NOUN - THING SUPPORTING)	YOUR SUPPORT	VOTRE SOUTIEN	1				
174	HIS SUPPORT (NOUN - THING SUPPORTING)	ITS SUPPORT	SON SOUTIEN		1			Inaccurate translation.
175	HER SUPPORT (NOUN - THING SUPPORTING)	ITS SUPPORT	SON SOUTIEN		1			Inaccurate translation.
176	OUR SUPPORT (NOUN - THING SUPPORTING)	OUR SUPPORT	NOTRE SOUTIEN	1				
177	THEIR (MALE OR NEUTER) SUPPORT (NOUN - THING SUPPORTING)	THEIR SUPPORT	LEUR SOUTIEN	1				
178	THEIR (FEMALE) SUPPORT (NOUN - THING SUPPORTING)	THEIR SUPPORT	LEUR SOUTIEN	1				
179	A FAMILY MEMBER	A MEMBER OF FAMILY	UN MEMBRE DE FAMILLE		1			Inaccurate translation. Incorrect syntax.
180	THE FAMILY MEMBER	THE MEMBER OF FAMILY	LE MEMBRE DE FAMILLE		1			Inaccurate translation. Incorrect syntax.
181	FAMILY MEMBERS	MEMBERS OF FAMILY	MEMBRES DE FAMILLE		1			Inaccurate translation. Incorrect syntax.
182	WHICH FAMILY MEMBER?	WHICH MEMBER OF FAMILY?	QUEL MEMBRE DE FAMILLE		1			Inaccurate translation. Incorrect syntax.

				M	E	N	S	ADDITIONAL COMMENTS
183	WHICH FAMILY MEMBERS?	WHICH MEMBERS OF FAMILY	QUELS MEMBRES DE FAMILLE		1			Inaccurate translation. Incorrect syntax.
184	THIS FAMILY MEMBER	EC MEMBER OF FAMILY - CI	CE MEMBRE DE FAMILLE - CI		1			Inaccurate translation. Incorrect syntax.
185	THAT FAMILY MEMBER	EC MEMBER OF FAMILLE-LÀ	CE MEMBRE DE FAMILLE - LÀ		1			Inaccurate translation. Incorrect syntax.
186	THESE FAMILY MEMBERS	THESE MEMBERS OF FAMILLE-CI	CES MEMBRES DE FAMILLE -CI		1			Inaccurate translation. Incorrect syntax.
187	THOSE FAMILY MEMBERS	THESE MEMBERS OF FAMILLE-LÀ	CES MEMBRES DE FAMILLE -LÀ		1			Inaccurate translation. Incorrect syntax.
188	MY FAMILY MEMBER	MY MEMBER OF FAMILY	MON MEMBRE DE FAMILLE		1			Inaccurate translation. Incorrect syntax.
189	MY FAMILY MEMBERS	MY MEMBERS OF FAMILY	MES MEMBRES DE FAMILLE		1			Inaccurate translation. Incorrect syntax.
190	YOUR (SINGULAR) FAMILY MEMBER	YOUR MEMBER OF FAMILY	VOTRE MEMBRE DE FAMILLE		1			Inaccurate translation. Incorrect syntax.
191	YOUR (SINGULAR) FAMILY MEMBERS	YOUR MEMBERS OF FAMILY	VOS MEMBRES DE FAMILLE		1			Inaccurate translation. Incorrect syntax.
192	YOUR (PLURAL) FAMILY MEMBER	YOUR MEMBER OF FAMILY	VOTRE MEMBRE DE FAMILLE		1			Inaccurate translation. Incorrect syntax.
193	YOUR (PLURAL) FAMILY MEMBERS	YOUR MEMBERS OF FAMILY	VOS MEMBRES DE FAMILLE		1			Inaccurate translation. Incorrect syntax.
194	HIS FAMILY MEMBER	ITS MEMBER OF FAMILY	SON MEMBRE DE FAMILLE		1			Inaccurate translation. Incorrect syntax.
195	HIS FAMILY MEMBERS	ITS MEMBERS OF FAMILY	SES MEMBRES DE FAMILLE		1			Inaccurate translation. Incorrect syntax.
196	HER FAMILY MEMBER	ITS MEMBER OF FAMILY	SON MEMBRE DE FAMILLE		1			Inaccurate translation. Incorrect syntax.
197	HER FAMILY MEMBERS	ITS MEMBERS OF FAMILY	SES MEMBRES DE FAMILLE		1			Inaccurate translation. Incorrect syntax.
198	OUR FAMILY MEMBER	OUR MEMBER OF FAMILY	NOTRE MEMBRE DE FAMILLE		1			Inaccurate translation. Incorrect syntax.
199	OUR FAMILY MEMBERS	OUR MEMBERS OF FAMILY	NOS MEMBRES DE FAMILLE		1			Inaccurate translation. Incorrect syntax.
198	THEIR (MALE OR NEUTER) FAMILY MEMBER	THEIR MEMBER OF FAMILY	LEUR MEMBRE DE FAMILLE		1			Inaccurate translation. Incorrect syntax.
199	THEIR (MALE OR NEUTER) FAMILY MEMBERS	THEIR MEMBERS OF FAMILY	LEURS MEMBRES DE FAMILLE		1			Inaccurate translation. Incorrect syntax.

				M	E	N	S	ADDITIONAL COMMENTS
200	THEIR (FEMALE) FAMILY MEMBER	THEIR MEMBER OF FAMILY	LEUR MEMBRE DE FAMILLE		1			Inaccurate translation. Incorrect syntax.
201	THEIR (FEMALE) FAMILY MEMBERS	THEIR MEMBERS OF FAMILY	LEURS MEMBRES DE FAMILLE		1			Inaccurate translation. Incorrect syntax.
202	I AGREE (AS IN CONCUR) (AS IN CONSENT)	I AGREE I AGREE	JE SUIS D'ACCORD JE CONSENS	2				
203	I AGREE STRONGLY (AS IN CONCUR) (AS IN CONSENT)	I AGREE STRONGLY I STRONGLY AGREE	JE SUIS D'ACCORD FORTEMENT JE CONSENS FORTEMENT	2				
204	I AGREE COMPLETELY (AS IN CONCUR) (AS IN CONSENT)	I AGREE COMPLETELY I AGREE COMPLETELY	JE SUIS D'ACCORD COMPLÈTEMENT JE CONSENS COMPLÈTEMENT	2				
205	I DISAGREE (AS IN CONCUR) (AS IN CONSENT)	I AM IN DISAGREEMENT I DO NOT AGREE	JE SUIS EN DÉSACCORD JE NE CONSENS PAS		2			Syntax is correct but not the right form (style) for the survey questionnaire.
206	I DISAGREE STRONGLY (AS IN CONCUR) (AS IN CONSENT)	I AM STRONGLY IN DISAGREEMENT I STRONGLY DO NOT AGREE	JE SUIS FORTEMENT EN DESACCORD JE NE CONSENS PAS FORTEMENT		2			Syntax is correct but not the right form (style) for the survey questionnaire.
207	I DISAGREE COMPLETELY (AS IN CONCUR) (AS IN CONSENT)	I AM IN DISAGREEMENT COMPLETELY I DO NOT AGREE COMPLETELY	JE SUIS EN DESACCORD COMPLÈTEMENT JE NE CONSENS PAS COMPLÈTEMENT		2			Syntax is correct but not the right form (style) for the survey questionnaire.

				M	E	N	S	ADDITIONAL COMMENTS
208	DO YOU AGREE? (AS IN CONCUR) (AS IN CONSENT)	YOU ETES OF AGREEMENT? DO YOU AGREE?	EST-CE QUE VOUS ETES D'ACCORD ? EST-CE QUE VOUS CONSENTEZ ?	1	1			Inaccurate translation
209	DO YOU AGREE STRONGLY? (AS IN CONCUR) (AS IN CONSENT)	YOU ETES OF AGREEMENT STRONGLY? DO YOU STRONGLY AGREE?	EST-CE QUE VOUS ETES D'ACCORD FORTEMENT? EST-CE QUE VOUS CONSENTEZ FORTEMENT ?		2			Inaccurate translation and use of English split- infinitive.
210	DO YOU AGREE COMPLETELY? (AS IN CONCUR) (AS IN CONSENT)	YOU ETES OF AGREEMENT COMPLETELY? AGREE YOU COMPLETELY?	EST-CE QUE VOUS ETES D'ACCORD COMPLÈTEMENT? CONSENTEZ-VOUS COMPLÈTEMENT?		2			Inaccurate translations.
211	DO YOU DISAGREE? (AS IN CONCUR) (AS IN CONSENT)	YOU ETES NO AGREEMENT? DON'T YOU AGREE?	EST-CE QUE VOUS N'ETES PAS D'ACCORD? EST-CE QUE VOUS NE CONSENTEZ PAS ?		2			Inaccurate translations. Use of abbreviated English form 'DON'T'.
212	DO YOU DISAGREE STRONGLY? (AS IN CONCUR) (AS IN CONSENT)	YOU ETES NO AGREEMENT STRONGLY? DON'T YOU STRONGLY AGREE?	EST-CE QUE VOUS N'ETES PAS D'ACCORD FORTEMENT? EST-CE QUE VOUS NE CONSENTEZ PAS FORTEMENT ?		2			Inaccurate translations.

				M	E	N	S	ADDITIONAL COMMENTS
213	DO YOU DISAGREE COMPLETELY? (AS IN CONCUR) (AS IN CONSENT)	YOU ETES NO AGREEMENT COMPLETELY? DON'T YOU AGREE COMPLETELY?	EST-CE QUE VOUS N'ETES PAS D'ACCORD COMPLÈTEMENT? EST-CE QUE VOUS NE CONSENTEZ PAS COMPLÈTEMENT?		2			Inaccurate translations.
214	HAVE WE PROVIDED	DID WE PROVIDE?	AVONS-NOUS FOURNI		1			Inaccurate translations. Verb tense imprecise.
215	HAS THE HOSPITAL PROVIDED	DID THE HOSPITAL PROVIDE?	L'HOPITAL A-T-IL FOURNI		1			Inaccurate translations. Verb tense imprecise.
216	DO YOU FEEL WE HAVE PROVIDED	HAVE YOU THE FEELING WHICH WE PROVIDED?	AVEZ-VOUS LE SENTIMENT QUE NOUS AVONS FOURNI		1			Inaccurate translations. Verb tense imprecise.
217	HAVE WE PROVIDED YOUR CHILD	DID WE PROVIDE TO YOUR CHILD?	AVONS-NOUS FOURNI À VOTRE ENFANT		1			Inaccurate translations. Verb tense imprecise.
218	A SATISFACTORY SERVICE	A SATISFACTORY SERVICE	UN SERVICE SATISFAISANT	1				
219	PROFESSIONAL SERVICE (SERVICE OF PROFESSIONAL TYPE AND STANDARD) (SERVICE BY PROFESSIONALS) (SERVICE FOR PROFESSIONALS)	A SERVICE OF PROFESSIONAL A SERVICE WORTHY OF PROFESSIONALS A SERVICE FOR PROFESSIONALS	UN SERVICE DE QUALITE PROFESSIONNELLE UN SERVICE DIGNE DE PROFESSIONNELS UN SERVICE POUR PROFESSIONNELS	1	2			Inaccurate translations. Syntax incorrect.
220	SATISFACTORY CARE	SATISFACTORY CARE	DES SOINS SATISFAISANTS	1				
221	SUFFICIENT CARE	ADEQUATE CARE	DÉS SOINS ADEQUATS	1				Synonym selected – matter of user preference.
222	EFFECTIVE TREATMENT	AN EFFECTIVE TREATMENT	UN TRAITEMENT EFFICACE	1				

				M	E	N	S	ADDITIONAL COMMENTS
223	DO YOU THINK WE CAN IMPROVE (DO YOU BELIEVE THAT WE CAN IMPROVE SOMETHING)	THINK YOU THAT WE CAN IMPROVE?	PENSEZ-VOUS QUE NOUS PUISSIONS AMELIORER		1			Inaccurate translation and jumbled syntax.
224	ARE YOU SATISFIED WITH (ARE YOU HAPPY IN REGARD TO)	BE YOU SATISFIES OF?	ÊTES-VOUS SATISFAIT DE		1			Inaccurate translation and jumbled syntax.
225	OUR PROFESSIONALISM	OUR PROFESSIONALISM	NOTRE PROFESSIONNALISME	1				
226	OUR CARE FOR YOUR CHILD	OUR CARE GIVE YOUR CHILD	NOS SOINS DONNES À VOTRE ENFANT		1			Inaccurate translation and jumbled syntax.
227	OUR HELP	OUR ASSISTANCE	NOTRE AIDE	1				
228	OUR TREATMENT OF YOUR CHILD	OUR TREATMENT FOR YOUR CHILD	NOTRE TRAITEMENT POUR VOTRE ENFANT	1				
229	YOUR CHILD'S TREATMENT	TREATMENT OF YOUR CHILD	LE TRAITEMENT DE VOTRE ENFANT		1			Inaccurate translation.
230	THE TREATMENT YOUR CHILD RECEIVED	THE TREATMENT WHICH A RECEIVED YOUR CHILD	LE TRAITEMENT QU'A REÇU VOTRE ENFANT		1			Inaccurate translation and jumbled syntax.
				183	126	0	4	TOTAL SCORE

7.7 Appendix G Translation Table of the Control Model Results Combined Word Groups: French To English

REF.	SAMPLE ENGLISH WORD/WORD GROUP OBTAINED FROM THE SURVEY QUESTIONNAIRE	ENGLISH EQUIVALENT PROVIDED BY THE CONTROL MODEL	SAMPLE FRENCH WORD/WORD GROUP PROVIDED BY THE STUDY TRANSLATORS	EVALUATION OF THE CONTROL MODEL TRANSLATIONS						
				KEY TO ANALYSIS OF RESULTS						
				M = MATCHING RESULT E = NUMBER OF TRANSLATION ERRORS N = NO RESULT PROVIDED S = NO SYNONYM PROVIDED						
				M	E	N	S	ADDITIONAL COMMENTS		
231	HAVE WE PROVIDED SATISFACTORY SERVICE	DID WE PROVIDE A SATISFACTORY SERVICE?	AVONS-NOUS FOURNI UN SERVICE SATISFAISANT ?		1			Inaccurate translation. Incorrect verb tense.		
232	HAVE WE PROVIDED PROFESSIONAL SERVICE	DID WE PROVIDE A SERVICE OF PROFESSIONAL QUALITY?	AVONS-NOUS FOURNI UN SERVICE DE QUALITE PROFESSIONNELLE ?		1			Inaccurate translation and jumbled syntax.		
233	HAVE WE PROVIDED SATISFACTORY CARE	DID WE PROVIDE SATISFACTORY CARE?	AVONS-NOUS FOURNI DES SOINS SATISFAISANTS ?		1			Incorrect verb tense.		
234	HAVE WE PROVIDED SUFFICIENT CARE	DID WE PROVIDE ADEQUATE CARE?	AVONS-NOUS FOURNI DES SOINS ADEQUATS ?		1			Incorrect verb tense.		
235	HAVE WE PROVIDED EFFECTIVE TREATMENT	DID WE PROVIDE AN EFFECTIVE TREATMENT?	AVONS-NOUS FOURNI UN TRAITEMENT EFFICACE ?		1			Incorrect verb tense.		
236	HAS THE HOSPITAL PROVIDED SATISFACTORY SERVICE	DID THE HOSPITAL PROVIDE A SATISFACTORY SERVICE?	L'HOPITAL A-T-IL FOURNI UN SERVICE SATISFAISANT?		1			Incorrect verb tense.		
237	HAS THE HOSPITAL PROVIDED PROFESSIONAL SERVICE	DID THE HOSPITAL PROVIDE A SERVICE OF PROFESSIONAL QUALITY?	L'HOPITAL A-T-IL FOURNI UN SERVICE DE QUALITE PROFESSIONNELLE		1			Inaccurate translation and jumbled syntax.		

				M	E	N	S	ADDITIONAL COMMENTS
238	HAS THE HOSPITAL PROVIDED SATISFACTORY CARE	DID THE HOSPITAL PROVIDE SATISFACTORY CARE?	L'HOPITAL A-T-IL FOURNI DES SOINS SATISFAISANTS ?		1			Incorrect verb tense.
239	HAS THE HOSPITAL PROVIDED SUFFICIENT CARE	DID THE HOSPITAL PROVIDE ADEQUATE CARE?	L'HOPITAL A-T-IL FOURNI DES SOINS ADEQUATS ?		1			Incorrect verb tense.
240	HAS THE HOSPITAL PROVIDED EFFECTIVE TREATMENT?	DID THE HOSPITAL PROVIDE An EFFECTIVE TREATMENT?	L'HOPITAL A-T-IL FOURNI UN TRAITEMENT EFFICACE?		1			Incorrect verb tense.
241	DO YOU FEEL (FEEL AS IN SENSORY PERCEPTION)	FEEL YOU?	SENTEZ-VOUS?	1				
242	DO YOU FEEL (AS IN TOUCH)	TOUCH YOU?	TOUCHEZ-VOUS?	1				
243	DO YOU FEEL WE HAVE PROVIDED SATISFACTORY SERVICE (FEEL AS IN SENSORY PERCEPTION)	HAVE YOU THE FEELING WHICH WE PROVIDED A SATISFACTORY SERVICE?	AVEZ-VOUS LE SENTIMENT QUE NOUS AVONS FOURNI UN SERVICE SATISFAISANT ?		1			Inaccurate translation and jumbled syntax.
244	DO YOU FEEL WE HAVE PROVIDED PROFESSIONAL SERVICE (FEEL AS IN SENSORY PERCEPTION)	HAVE YOU THE FEELING WHICH WE PROVIDED A SERVICE OF PROFESSIONAL QUALITY?	AVEZ-VOUS LE SENTIMENT QUE NOUS AVONS FOURNI UN SERVICE DE QUALITE PROFESSIONNELLE ?		1			Inaccurate translation and jumbled syntax.
245	DO YOU FEEL WE HAVE PROVIDED SATISFACTORY CARE (FEEL AS IN SENSORY PERCEPTION)	HAVE YOU THE FEELING WHICH WE PROVIDED OF THE SATISFACTORY CARE?	AVEZ-VOUS LE SENTIMENT QUE NOUS AVONS FOURNI DES SOINS SATISFAISANTS ?		1			Inaccurate translation and jumbled syntax.
246	DO YOU FEEL WE HAVE PROVIDED SUFFICIENT CARE (FEEL AS IN SENSORY PERCEPTION)	HAVE YOU THE FEELING WHICH WE PROVIDED OF THE ADEQUATE CARE?	AVEZ-VOUS LE SENTIMENT QUE NOUS AVONS FOURNI DES SOINS ADEQUATS ?		1			Inaccurate translation and jumbled syntax.

				M	E	N	S	ADDITIONAL COMMENTS
247	DO YOU FEEL WE HAVE PROVIDED EFFECTIVE TREATMENT (FEEL AS IN SENSORY PERCEPTION)	HAVE YOU THE FEELING WHICH WE PROVIDED AN EFFECTIVE TREATMENT?	AVEZ-VOUS LE SENTIMENT QUE NOUS AVONS FOURNI UN TRAITEMENT EFFICACE ?		1			Inaccurate translation and jumbled syntax.
248	HAVE WE PROVIDED YOUR CHILD SATISFACTORY SERVICE	HAVE YOU THE FEELING WHICH WE HAVE WE PROVIDED TO YOUR CHILD A SATISFACTORY SERVICE?	AVONS-NOUS FOURNI A VOTRE ENFANT UN SERVICE SATISFAISANT ?		1			Inaccurate translation and jumbled syntax.
249	HAVE WE PROVIDED YOUR CHILD PROFESSIONAL SERVICE (SERVICE OF PROFESSIONAL TYPE AND STANDARD)	DID WE PROVIDE TO YOUR CHILD A SERVICE OF PROFESSIONAL QUALITY?	AVONS-NOUS FOURNI A VOTRE ENFANT UN SERVICE DE QUALITE PROFESSIONNELLE ?		1			Inaccurate translation and jumbled syntax.
250	HAVE WE PROVIDED YOUR CHILD PROFESSIONAL SERVICE (SERVICE BY PROFESSIONALS)	DID WE PROVIDE TO YOUR CHILD A SERVICE WORTHY OF PROFESSIONALS?	AVONS-NOUS FOURNI A VOTRE ENFANT UN SERVICE DIGNE DE PROFESSIONNELS		1			Inaccurate translation and jumbled syntax.
251	HAVE WE PROVIDED YOUR CHILD SATISFACTORY CARE	DID WE PROVIDE TO YOUR CHILD SATISFACTORY CARE?	AVONS-NOUS FOURNI A VOTRE ENFANT DES SOINS SATISFAISANTS ?		1			Inaccurate translation and jumbled syntax.
252	HAVE WE PROVIDED YOUR CHILD SUFFICIENT CARE	DID WE PROVIDE TO YOUR CHILD ADEQUATE CARE?	AVONS-NOUS FOURNI A VOTRE ENFANT DES SOINS ADEQUATS ?		1			Inaccurate translation and jumbled syntax.
253	HAVE WE PROVIDED YOUR CHILD EFFECTIVE TREATMENT	DID WE PROVIDE TO YOUR CHILD AN EFFECTIVE TREATMENT?	AVONS-NOUS FOURNI A VOTRE ENFANT UN TRAITEMENT EFFICACE ?		1			Inaccurate translation and jumbled syntax.

				M	E	N	S	ADDITIONAL COMMENTS
254	DO YOU THINK WE CAN IMPROVE OUR PROFESSIONALISM	THINK YOU THAT WE CAN IMPROVE OUR PROFESSIONALISM?	PENSEZ-VOUS QUE NOUS PUISSIONS AMELIORER NOTRE PROFESSIONNALISME ?		1			Inaccurate translation and jumbled syntax.
255	DO YOU THINK WE CAN IMPROVE OUR CARE FOR YOUR CHILD	THINK YOU THAT WE CAN IMPROVE OUR CARE GIVE YOUR CHILD?	PENSEZ-VOUS QUE NOUS PUISSIONS AMELIORER NOS SOINS DONNES À VOTRE ENFANT ?		1			Inaccurate translation and jumbled syntax.
256	DO YOU THINK WE CAN IMPROVE OUR HELP	THINK YOU THAT WE CAN IMPROVE the ASSISTANCE THAT WE HAVE YOU APPOREE?	PENSEZ-VOUS QUE NOUS PUISSIONS AMELIORER L'AIDE QUE NOUS VOUS AVONS APPOREE ?		1			Inaccurate translation and jumbled syntax.
257	DO YOU THINK WE CAN IMPROVE OUR TREATMENT OF YOUR CHILD	THINK YOU THAT WE CAN IMPROVE OUR TREATMENT FOR YOUR CHILD?	PENSEZ-VOUS QUE NOUS PUISSIONS AMELIORER NOTRE TRAITEMENT POUR VOTRE ENFANT ?		1			Inaccurate translation and jumbled syntax.
258	DO YOU THINK WE CAN IMPROVE YOUR CHILD'S TREATMENT	THINK YOU THAT WE CAN IMPROVE THE TREATMENT OF YOUR CHILD?	PENSEZ-VOUS QUE NOUS PUISSIONS AMELIORER LE TRAITEMENT DE VOTRE ENFANT ?		1			Inaccurate translation and jumbled syntax.
259	DO YOU THINK WE CAN IMPROVE THE TREATMENT YOUR CHILD RECEIVED	THINK YOU THAT WE CAN IMPROVE THE TREATMENT WHICH A RECEIVED YOUR CHILD?	PENSEZ-VOUS QUE NOUS PUISSIONS AMELIORER LE TRAITEMENT QU'A REÇU VOTRE ENFANT ?		1			Inaccurate translation and jumbled syntax.
260	ARE YOU SATISFIED WITH OUR PROFESSIONALISM	YOU BE SATISFIED WITH OUR PROFESSIONALISM?	ÊTES-VOUS SATISFAITS DE NOTRE PROFESSIONNALISME ?		1			Inaccurate translation and jumbled syntax.
261	ARE YOU SATISFIED WITH OUR CARE FOR YOUR CHILD	YOU BE SATISFIED WITH OUR CARE GIVE YOUR CHILD?	ÊTES-VOUS SATISFAITS DE NOS SOINS DONNES À VOTRE ENFANT ?		1			Inaccurate translation and jumbled syntax.

				M	E	N	S	ADDITIONAL COMMENTS
262	ARE YOU SATISFIED WITH OUR HELP	YOU BE SATISFIED OF THE ASSISTANCE THAT WE HAVE YOU APPORTEE?	ÊTES-VOUS SATISFAITS DE L'AIDE QUE NOUS VOUS AVONS APPORTEE ?		1			Inaccurate translation and jumbled syntax.
263	ARE YOU SATISFIED WITH OUR TREATMENT OF YOUR CHILD	YOU BE SATISFIED WITH OUR TREATMENT FOR YOUR CHILD?	ÊTES-VOUS SATISFAITS DE NOTRE TRAITEMENT POUR VOTRE ENFANT ?		1			Inaccurate translation and jumbled syntax.
264	ARE YOU SATISFIED WITH YOUR CHILD'S TREATMENT	BE YOU SATISFIED (OF) TREATMENT WITH YOUR CHILD?	ÊTES-VOUS SATISFAITS (DE LE) DU TRAITEMENT DE VOTRE ENFANT ?		1			Inaccurate translation and jumbled syntax.
265	ARE YOU SATISFIED WITH THE TREATMENT YOUR CHILD RECEIVED	BE YOU SATISFIED (OF) TREATMENT WHICH A RECEIVED YOUR CHILD?	ÊTES-VOUS SATISFAITS (DE LE) DU TRAITEMENT QU'A REÇU VOTRE ENFANT ?		1			Inaccurate translation and jumbled syntax.
				2	33	0	0	TOTAL SCORE

7.8 Appendix H Translation Table - Prototype Model: English to Esperanto To French Single Words and Single Word Groups

REF	ENGLISH WORD/WORD GROUP	ESPERANTO EQUIVALENT	FRENCH EQUIVALENT	HOMONYM TABLE INCLUDED	
				SYNONYM	GENDER
01	NOT AT ALL	TUTE NE	PAS DU TOUT		
02	A LITTLE	IOMETE	UN PEU		
03	SOMEWHAT	IOM	QUELQUE PEU		
04	VERY MUCH	MULTE	BEAUCOUP		
05	EXTREMELY	EGE	EXTRÊMEMENT		
06	NOT A NEED (NEED AS A REQUIREMENT)	NE ESTAS BEZONO	PAS DE BESOIN	YES	
07	NOT MET AT ALL (MET AS IN TO MEET A REQUIREMENT)	TUTE NE PLENUMITA	PAS SATISFAIT	YES	
08	PARTLY MET (MET AS IN TO MEET A REQUIREMENT)	IOM PLENUMITA	UN PEU SATISFAIT	YES	
09	WELL MET (MET AS IN TO MEET A REQUIREMENT)	PLEJPARTE PLENUMITA	BIEN SATISFAIT	YES	
10	COMPLETELY MET (MET AS IN TO MEET A REQUIREMENT)	TUTE PLENUMITA	COMPLÈTEMENT SATISFAIT	YES	
11	YES	JES	OUI		
12	NO	NE	NON		
13	COMPLETELY DISAGREE (AS IN CONCUR)	TUTE MALAKORDIĜAS	COMPLÈTEMENT EN DÉSACCORD	YES	
	(AS IN CONSENT)	TUTE MALKONSENTAS	COMPLÈTEMENT		

14	STRONGLY DISAGREE (AS IN CONCUR) (AS IN CONSENT)	FORTE MALAKORDIĜAS FORTE MALKONSENTAS	VIGOREUSEMENT EN DÉSACCORD ?	YES	
15	DISAGREE (AS IN CONCUR) (AS IN CONSENT)	MALAKORDIĜAS MALKONSENTAS	EN DÉSACCORD ?	YES	
16	AGREE (AS IN CONCUR) (AS IN CONSENT)	AKORDIĜAS KONSENTAS	EN ACCORD CONSENS	YES	
17	STRONGLY AGREE (AS IN CONCUR) (AS IN CONSENT)	FORTE AKORDIĜAS FORTE KONSENTAS	VIGOREUSEMENT EN ACCORD ?	YES	
18	AGREE COMPLETELY (AS IN CONCUR) (AS IN CONSENT)	TUTE AKORDIĜAS TUTE KONSENTAS	D'ACCORD COMPLÈTEMENT CONSENS COMPLÈTEMENT	YES	
19	WELCOME (AS A GREETING) (VERB)	BONVENON BONVENIGAS	BIENVENUE ACCUEILLE	YES	
20	QUESTIONNAIRE	DEMANDARO	QUESTIONNAIRE		
21	QUESTIONNAIRES	DEMANDAROJ	QUESTIONNAIRES		
22	NEED (AS A NOUN) (AS A VERB)	BEZONO BEZONAS	BESOIN AVOIR BESOIN DE	YES	

23	NEEDS (AS A NOUN)	BEZONOJ	BESOINS (BUT ONLY FOR MORE THAN ONE PERSON)	YES	
	(AS A VERB)	BEZONAS	AVOIR BESOIN DE		
24	PARENT	GEPATRO	LE PERE OU LA MERE UN DES DEUX PARENTS	YES	
25	PARENTS	GEPATROJ	PARENTS		
26	SUPPORT SUPPORT (NOUN - THING SUPPORTING)	SUBTENO APOGO [HELPO]	SOUTIEN	YES	
	(VERB - AS IN HELP)	SUBTENI APOGI	SOUTIEN		
27	FAMILY MEMBER	FAMILIANO	MEMBRE DE LA FAMILLE		
28	FAMILY MEMBERS	FAMILIANOJ	MEMBRES DE LA FAMILLE		
29	A RESEARCH NURSE (MALE)	ENKETADA FLEGISTO	UN INFIRMIER DE RECHERCHE		YES
	(FEMALE)	ENKETADA FLEGISTINO	UNE INFIRMIERE DE RECHERCHE		
30	RESEARCH NURSES	ENKETADAJ FLEGISTOJ	DES INFIRMIERS DE RECHERCHE		YES
		ENKETADAJ FLEGISTINOJ	DES INFIRMIERES DE RECHERCHE		

31	GUIDE (NOUN) (VERB - TO GUIDE)	GVIDO GVIDI	GUIDE GUIDER	YES	
32	GUIDES NOUN VERB	GVIDOJ GVIDAS	GUIDES GUIDER	YES	
33	INSTRUCTION	INSTRUKCIO	INSTRUCTION		
34	INSTRUCTIONS	INSTRUKCIOJ	INSTRUCTIONS		
35	EXPERIENCE (ONCE OFF - NOUN) (LONGER EXPERIENCE)	SPERTO SPERTADO	EXPÉRIENCE ÉPROUVER	YES	
36	EXPERIENCES	SPERTOJ	EXPERIENCES		
37	QUESTION	DEMANDO	QUESTION		
38	QUESTIONS	DEMANDOJ	QUESTIONS		
39	ANSWER (AS A NOUN) (AS A VERB)	RESPONDO RESPONDAS	RÉPONSE RÉPONDRE		
40	ANSWERS (AS A NOUN)	RESPONDOJ	RÉPONSES		
41	SITUATION (AS A PLACE) (CIRCUMSTANCES)	LOKO, SITUO SITUACIO	ENDROIT SITUATION		
42	SITUATIONS (AS A PLACE) (CIRCUMSTANCES)	LOKOJ, SITUOJ SITUACIOJ	ENDROITS SITUATIONS		

43	BUTTON (CLOTHING) (FOR MACHINE ETC) (TO TURN SOMETHING ON/OFF)	BUTONO PREMBUTONO ŜALTILO	BOUTON		
44	BUTTONS (CLOTHING) (FOR MACHINE ETC) (TO TURN SOMETHING ON/OFF)	BUTONOJ PREMBUTONOJ ŜALTILOJ	BOUTONS	YES	
45	STUDY NOUN (AS IN RESEARCH) (VERB AS IN RESEARCH)	STUDO STUDI	ÉTUDE ÉTUDIER	YES	
46	STUDIES (NOUN) (VERB)	STUDOJ STUDI	ÉTUDES ÉTUDIER	YES	
47	SCREEN (NOUN AS IN FURNITURE) (NOUN AS IN COMPUTER) (VERB - FILTER) (VERB - GUARD AGAINST)	VANDO EKRANO FILTRAS ŜIRMAS	CLOISON ÉCRAN FILTRER PROTÈGER	YES	

48	SCREENS (NOUN AS IN FURNITURE) (NOUN AS IN COMPUTER)	VANDOJ EKRAŅOJ	CLOISONS ÉCRANS	YES	
49	IDENTIFIED	IDENTIGITA (SG) IDENTIGITAJ (PL)	IDENTIFIE (M SG) IDENTIFIEE (F SG) IDENTIFIES (M PL) IDENTIFIEES (F PL)		YES
50	ITEM (OBJECT) (IN A LIST)	ERO PUNKTO	ARTICLE QUESTION, POINT	YES	
51	ITEMS (OBJECT) (IN A LIST)	EROJ PUNKTOJ	ARTICLES QUESTIONS, POINTS	YES	
52	SURVEY (NOUN - RESEARCH) (VERB - EXAMINE) (VERB - LOOK AT) (VERB - LOOK AROUND)	ENKETADO ENKETAS, EKZAMENAS RIGARDAS ĶIRKAŪRIGARDAS	SONDAGE EXAMINER REGARDER REGARDE AUTOUR DE	YES	

53	SURVEYS NOUN (RESEARCH) VERB (EXAMINE) VERB (LOOK AT) VERB (LOOK AROUND)	ENKETADOJ EKZAMENAS RIGARDAS ĈIRKAŬRIGARDAS	SONDAGES SEE 52 ABOVE	YES	
54	FINGER	FINGRO	DOIGT		
55	FINGERS	FINGROJ	DOIGTS		
56	ILLNESS	MALSANO	MALADIE		
57	ILLNESSES	MALSANOJ	MALADIES		
58	HELPFUL (AS IN PROVIDE A SERVICE) (USEFUL)	HELPEMA (SG) HELPEMAJ (PL) UTILA (SG) UTILAJ (PL)	SERVIALE (SG) SERVIALES (PL) UTILE (SG) UTILES (PL)	YES	YES
59	PAEDIATRIC	PEDIATRIA (SG) PEDIATRIAJ (PL)	DE PÉDIATRIE		
60	ONCOLOGY	ONKOLOGIO	ONCOLOGIE		
61	TOUCH-SCREEN	TUŜ-EKRANO	ÉCRAN TACTILE		
62	TOUCH-SCREENS	TUŜ-EKRANOJ	ÉCRANS TACTILES		
63	HEALTH-PROFESSIONAL	SAN-PROFESIULO	PROFESSIONNEL DE LA SANTÉ		
64	HEALTH PROFESSIONALS	SAN-PROFESIULOJ	PROFESSIONNELS DE LA SANTÉ		
65	IMPORTANT	GRAVA (SG) GRAVAJ (PL)	IMPORTANT (M SG) IMPORTANTE (F SG) IMPORTANTS (M PL) IMPORTANTES (F PL)	YES	YES
66	CANCER	KANCERO	CANCER		
67	CANCERS	KANCEROJ	CANCERS		
68	CHILD	INFANO	ENFANT		
69	CHILDREN	INFANOJ	ENFANTS		
70	HOSPITAL	MALSANULEJO	HÔPITAL		
71	HOSPITALS	MALSANULEJOJ	HÔPITALS		

72	RESEARCH (NOUN) (VERB)	ENKETADO ENKETI	RECHERCHE RECHERCHER	YES	
73	RESEARCHER (PERSON WHO RESEARCHES)	ENKETULINO	CHERCHEUR (M) CHERCHEUSE (F)		YES
74	RESEARCHERS (PERSON WHO RESEARCHES)	ENKETULOJ ENKETULINOJ	CHERCHEURS (M, M+F) CHERCHEUSES (F)		YES
75	APPROPRIATE (ADJECTIVE) (VERB)	TAŬGA (SG) TAŬGAJ (PL) ALPROPRIGI	APPROPRIE (M SG) APPROPRIEE (F SG) APPROPRIES (M PL) APPROPRIEES (F PL) APPROPRIER	YES	YES
76	DOCTOR (TITLE OF DEGREE HOLDER) (MEDICAL DOCTOR)	DOKTORO KURACISTO	DOCTEUR MÉDECIN DOCTEUR MÉDECIN IS USED FOR BOTH MALE AND FEMALE DOCTORS BUT THEY ALSO SAY DOCTEUR AND DOCTORESSE	YES	YES
77	DOCTORS (TITLE OF DEGREE HOLDER) (MEDICAL DOCTOR)	DOKTOROJ KURACISTOJ	DOCTEURS MÉDECINS DOCTEURS	YES	
78	SURGEON	KIRUO	CHIRURGIEN		
79	SURGEONS	KIRUOJ	CHIRURGIENS		

80	TREATMENT (COURSE OF TREATMENT) (WAY SOMEONE IS TREATED IN GENERAL)	KURACADO TRAKTADO	TRAITEMENT TRAITEMENT		
81	A QUESTIONNAIRE	DEMANDARO	UN QUESTIONNAIRE		
82	THE QUESTIONNAIRE	LA DEMANDARO	LE QUESTIONNAIRE		
83	THE QUESTIONNAIRES	LA DEMANDAROJ	LES QUESTIONNAIRES		
84	SOME QUESTIONNAIRES	IUJ DEMANDAROJ	DES QUESTIONNAIRES		
85	THIS QUESTIONNAIRE	ĈI TIU DEMANDARO	CE QUESTIONNAIRE-CI		
86	THAT QUESTIONNAIRE	TIU DEMANDARO	CE QUESTIONNAIRE-LA		
87	THOSE QUESTIONNAIRES	TIUJ DEMANDAROJ	CES QUESTIONNAIRES-LA		
88	THESE QUESTIONNAIRES	ĈI TIUJ DEMANDAROJ	CES QUESTIONNAIRES-CI		
89	WHICH QUESTIONNAIRE?	KIU DEMANDARO?	QUEL QUESTIONNAIRE?		
90	WHICH QUESTIONNAIRES?	KIUJ DEMANDAROJ?	QUELS QUESTIONNAIRES?		
91	MY QUESTIONNAIRE	MIA DEMANDARO	MON QUESTIONNAIRE		
92	MY QUESTIONNAIRES	MIAJ DEMANDAROJ	MES QUESTIONNAIRES		
93	YOUR (SINGULAR) QUESTIONNAIRE	VIA DEMANDARO	VOTRE QUESTIONNAIRE		YES
94	YOUR (SINGULAR) QUESTIONNAIRES	VIAJ DEMANDAROJ	VOS QUESTIONNAIRES		YES
95	YOUR (PLURAL) QUESTIONNAIRE	VIA DEMANDARO	VOTRE QUESTIONNAIRE		YES
96	YOUR (PLURAL) QUESTIONNAIRES	VIAJ DEMANDAROJ	VOS QUESTIONNAIRES		YES
97	HIS QUESTIONNAIRE	LIA DEMANDARO	SON QUESTIONNAIRE		
98	HIS QUESTIONNAIRES	LIAJ DEMANDAROJ	SES QUESTIONNAIRES		
99	HER QUESTIONNAIRE	ŜIA DEMANDARO	SON QUESTIONNAIRE		
100	HER QUESTIONNAIRES	ŜIAJ DEMANDAROJ	SES QUESTIONNAIRES		
101	OUR QUESTIONNAIRE	NIA DEMANDARO	NOTRE QUESTIONNAIRE		
102	OUR QUESTIONNAIRES	NIAJ DEMANDAROJ	NOS QUESTIONNAIRES		
103	THEIR (MALE OR NEUTER) QUESTIONNAIRE	ILIA DEMANDARO	LEUR QUESTIONNAIRE		
104	THEIR (MALE OR NEUTER) QUESTIONNAIRES	ILIAJ DEMANDAROJ	LEURS QUESTIONNAIRES		
105	THEIR (FEMALE) QUESTIONNAIRE	ILIA DEMANDARO	LEUR QUESTIONNAIRE		
106	THEIR (FEMALE) QUESTIONNAIRES	ILIAJ DEMANDAROJ	LEURS QUESTIONNAIRES		

107	A NEED (REQUIREMENT) (NECESSITY)	BEZONO NECESO	UN BESOIN UNE NÉCESSITÉ	YES	
108	THE NEED (REQUIREMENT) (NECESSITY)	LA BEZONO LANECESO	LE BESOIN LA NÉCESSITÉ	YES	
109	THE NEEDS (REQUIREMENT) (NECESSITY)	LA BEZONOJ LA NECESOJ	LES BESOINS LES NÉCESSITÉS	YES	
120	MY NEED (REQUIREMENT) (NECESSITY)	MIA BEZONO MIA NECESO	MON BESOIN MA NÉCESSITÉ	YES	
121	MY NEEDS (REQUIREMENT) (NECESSITY)	MIAJ BEZONOJ MIAJ NECESOJ	MES BESOINS MES NÉCESSITÉS	YES	
122	YOUR (SINGULAR) NEED (REQUIREMENT) (NECESSITY)	VIA BEZONO VIA NECESO	VOTRE BESOIN VOTRE NÉCESSITÉ	YES	
123	YOUR (SINGULAR) NEEDS (REQUIREMENT) (NECESSITY)	VIAJ BEZONOJ VIAJ NECESOJ	VOS BESOINS VOS NÉCESSITÉS	YES	
124	YOUR (PLURAL) NEED (REQUIREMENT) (NECESSITY)	VIA BEZONO VIA NECESO	VOTRE BESOIN VOTRE NÉCESSITÉ	YES	

125	YOUR (PLURAL) NEEDS (REQUIREMENT) (NECESSITY)	VIAJ BEZONOJ VIAJ NECESOI	VOS BESOINS VOS NÉCESSITÉS	YES	
126	HIS NEED (REQUIREMENT) (NECESSITY)	LIA BEZONO LIA NECESO	SON BESOIN SA NÉCESSITÉ	YES	
127	HIS NEEDS (REQUIREMENT) (NECESSITY)	LIAJ BEZONOJ LIAJ NECESOI	SES BESOINS SES NÉCESSITÉS	YES	
128	HER NEED (REQUIREMENT) (NECESSITY)	ŜIA BEZONO ŜIA NECESO	SON BESOIN SA NÉCESSITÉ	YES	
129	HER NEEDS (REQUIREMENT) (NECESSITY)	ŜIAJ BEZONOJ ŜIAJ NECESOI	SES BESOINS SES NÉCESSITÉS	YES	
130	OUR NEED (REQUIREMENT) (NECESSITY)	NIA BEZONO NIA NECESO	NOTRE BESOIN NOTRE NÉCESSITÉ	YES	
131	OUR NEEDS (REQUIREMENT) (NECESSITY)	NIAJ BEZONOJ NIAJ NECESOI	NOS BESOINS NOS NÉCESSITÉS	YES	
132	THEIR (MALE OR NEUTER) NEED (REQUIREMENT) (NECESSITY)	ILIA BEZONO ILIA NECESO	LEUR BESOIN LEUR NÉCESSITÉ	YES	YES
133	THEIR (MALE OR NEUTER) NEEDS (REQUIREMENT) (NECESSITY)	ILIAJ BEZONOJ ILIAJ NECESOI	LEURS BESOINS LEURS NÉCESSITÉS	YES	YES

134	THEIR (FEMALE) NEED (REQUIREMENT)	ILIA BEZONO	LEUR BESOIN	YES	YES
	(NECESSITY)	ILIA NECESO	LEUR NÉCESSITÉ		
135	THEIR (FEMALE) NEEDS (REQUIREMENT)	ILIAJ BEZONOJ	LEURS BESOINS	YES	YES
	(NECESSITY)	ILIAJ NECESOJ	LEURS NÉCESSITÉS		
136	A PARENT	ĜEPATRO	UN PARENT	YES	YES
137	THE PARENT	LA ĜEPATRO	LE PARENTS		
138	THE PARENTS	LA ĜEPATROJ	LES PARENTS		
139	SOME PARENTS	IUJ ĜEPATROJ	QUELQUES PARENTS		
140	THIS PARENT	ĈI TIU ĜEPATRO	CE PARENT-CI		
141	THESE PARENTS	ĈI TIUJ ĜEPATROJ	CES PARENTS-CI		
142	THAT PARENT	TIU ĜEPATRO	CE PARENT-LA		
143	THOSE PARENTS	TIUJ ĜEPATROJ	CES PARENTS-LA		
144	WHICH PARENT?	KIU ĜEPATRO?	QUEL PARENT?		
145	WHICH PARENTS?	KIUJ ĜEPATROJ?	QUELS PARENTS?		
146	MY PARENT	MIA ĜEPATRO	MON PARENT		
147	MY PARENT	MIA ĜEPATRO	MA PARENT		
148	MY PARENTS	MIAJ ĜEPATROJ	MES PARENTS		
149	YOUR (SINGULAR) PARENT	VIA ĜEPATRO	VOTRE PARENT		
149	YOUR (SINGULAR) PARENTS	VIAJ ĜEPATROJ	VOS PARENTS		
150	YOUR (PLURAL) PARENT	VIA ĜEPATRO	VOTRE PARENT		
151	YOUR (PLURAL) PARENTS	VIAJ ĜEPATROJ	VOS PARENTS		
152	HIS PARENT	LIA ĜEPATRO	SON PARENT		
153	HIS PARENTS	LIAJ ĜEPATROJ	SES PARENTS		
154	HER PARENT	SIA ĜEPATRO	SON PARENT?		
155	HER PARENTS	SIAJ ĜEPATROJ	SES PARENTS		
156	OUR PARENT	NIA ĜEPATRO	NOTRE PARENT		
157	OUR PARENTS	NIAJ ĜEPATROJ	NOS PARENTS		
158	THEIR (MALE OR NEUTER) PARENT	ILIA ĜEPATRO	LEUR PARENT		
159	THEIR (MALE OR NEUTER) PARENTS	ILIAJ ĜEPATROJ	LEURS PARENTS		
160	THEIR (FEMALE) PARENT	ILIA ĜEPATRO	LEUR PARENT		

161	THEIR (FEMALE) PARENTS	ILIAJ GEPATROJ	LEURS PARENTS		
162	THE SUPPORT (NOUN - THING SUPPORTING)	LA APOGO	LE SOUTIEN	YES	
163	A SUPPORT (NOUN - THING SUPPORTING)	APOGO	UN SOUTIEN	YES	
164	SOME SUPPORT (NOUN - THING SUPPORTING)	IOM DA APOGO	QUELQUE SOUTIEN	YES	
165	THAT SUPPORT (NOUN - THING SUPPORTING)	TIU APOGO	CE SOUTIEN-LÀ	YES	
166	THIS SUPPORT (NOUN - THING SUPPORTING)	ĈI TIU APOGO	CE SOUTIEN-CI	YES	
167	THOSE SUPPORT (NOUN - THING SUPPORTING)	TIUJ APOGAS	CEUX-LÀ SOUTIENNENT	YES	
168	THOSE SUPPORTS (NOUN - THING SUPPORTING)	TIUJ APOGOJ	CES SOUTIENS-LÀ	YES	
169	THESE SUPPORT (NOUN - THING SUPPORTING)	ĈI TIUJ APOGAS	CEUX-CI SOUTIENNENT	YES	
170	THESE SUPPORTS (NOUN - THING SUPPORTING)	ĈI TIUJ APOGOJ	CES SOUTIENS-CI	YES	
171	MY SUPPORT (NOUN - THING SUPPORTING)	MIA APOGO	MON SOUTIEN	YES	
172	YOUR (SINGULAR) SUPPORT (NOUN - THING SUPPORTING)	VIA APOGO	VOTRE SOUTIEN	YES	
173	YOUR (PLURAL) SUPPORT (NOUN - THING SUPPORTING)	VIA APOGO	VOTRE SOUTIEN	YES	

174	HIS SUPPORT (NOUN - THING SUPPORTING)	LIA APOGO	SON SOUTIEN	YES	
175	HER SUPPORT (NOUN - THING SUPPORTING)	ŜIA APOGO	SON SOUTIEN	YES	
176	OUR SUPPORT (NOUN - THING SUPPORTING)	NIA APOGO	NOTRE SOUTIEN	YES	
177	THEIR (MALE OR NEUTER) SUPPORT (NOUN - THING SUPPORTING)	ILIA APOGO	LEUR SOUTIEN	YES	
178	THEIR (FEMALE) SUPPORT (NOUN - THING SUPPORTING)	ILIA APOGO	LEUR SOUTIEN		YES
179	A FAMILY MEMBER	FAMILIANO FAMILIANINO	UN MEMBRE DE FAMILLE		
180	THE FAMILY MEMBER	LA FAMILIANO LA FAMILIANINO	LE MEMBRE DE FAMILLE		
181	FAMILY MEMBERS	FAMILIANOJ	MEMBRES DE FAMILLE		
182	WHICH FAMILY MEMBER?	KIU FAMILIANO	QUEL MEMBRE DE FAMILLE		
183	WHICH FAMILY MEMBERS?	KIUJ FAMILIANOJ?	QUELS MEMBRES DE FAMILLE		
184	THIS FAMILY MEMBER	ĈI TIU FAMILIANO	CE MEMBRE DE FAMILLE -CI		
185	THAT FAMILY MEMBER	TIU FAMILIANO	CE MEMBRE DE FAMILLE -LA		
186	THESE FAMILY MEMBERS	ĈI TIUJ FAMILIANOJ	CES MEMBRES DE FAMILLE -CI		
187	THOSE FAMILY MEMBERS	TIUJ FAMILIANOJ	CES MEMBRES DE FAMILLE -LA		
188	MY FAMILY MEMBER	MIA FAMILIANO	MON MEMBRE DE FAMILLE		
189	MY FAMILY MEMBERS	MIAJ FAMILIANOJ	MES MEMBRES DE FAMILLE		
190	YOUR (SINGULAR) FAMILY MEMBER	VIA FAMILIANO	VOTRE MEMBRE DE FAMILLE		
191	YOUR (SINGULAR) FAMILY MEMBERS	VIAJ FAMILIANOJ	VOS MEMBRES DE FAMILLE		
192	YOUR (PLURAL) FAMILY MEMBER	VIA FAMILIANO	VOTRE MEMBRE DE FAMILLE		
193	YOUR (PLURAL) FAMILY MEMBERS	VIAJ FAMILIANOJ	VOS MEMBRES DE FAMILLE		
194	HIS FAMILY MEMBER	LIA FAMILIANO	SON MEMBRE DE FAMILLE		
195	HIS FAMILY MEMBERS	LIAJ FAMILIANOJ	SES MEMBRES DE FAMILLE		

196	HER FAMILY MEMBER	ŠIA FAMILIANO	SON MEMBRE DE FAMILLE		
197	HER FAMILY MEMBERS	ŠIAJ FAMILIANOJ	SES MEMBRES DE FAMILLE		
198	OUR FAMILY MEMBER	NIA FAMILIANO	NOTRE MEMBRE DE FAMILLE		
199	OUR FAMILY MEMBERS	NIAJ FAMILIANOJ	NOS MEMBRES DE FAMILLE		
198	THEIR (MALE OR NEUTER) FAMILY MEMBER	ILIA FAMILIANO	LEUR MEMBRE DE FAMILLE		
199	THEIR (MALE OR NEUTER) FAMILY MEMBERS	ILIAJ FAMILIANOJ	LEURS MEMBRES DE FAMILLE		
200	THEIR (FEMALE) FAMILY MEMBER	ILIA FAMILIANO	LEUR MEMBRE DE FAMILLE		
201	THEIR (FEMALE) FAMILY MEMBERS	ILIAJ FAMILIANOJ	LEURS MEMBRES DE FAMILLE		
202	I AGREE (AS IN CONCUR) (AS IN CONSENT)	MI AKORDIĖAS MI KONSENTAS	JE SUIS D'ACCORD JE CONSENS		
203	I AGREE STRONGLY (AS IN CONCUR) (AS IN CONSENT)	MI FORTE AKORDIĖAS MI FORTE KONSENTAS	JE SUIS D'ACCORD FORTEMENT JE CONSENS FORTEMENT	YES	
204	I AGREE COMPLETELY (AS IN CONCUR) (AS IN CONSENT)	MI TUTE AKORDIĖAS MI TUTE KONSENTAS	JE SUIS D'ACCORD COMPLÈTEMENT JE CONSENS COMPLÈTEMENT	YES	
205	I DISAGREE (AS IN CONCUR) (AS IN CONSENT)	MI MALAKORDIĖAS MI MALKONSENTAS	JE SUIS EN DÉSACCORD JE NE CONSENS PAS	YES	
206	I DISAGREE STRONGLY (AS IN CONCUR) (AS IN CONSENT)	MI FORTE MALAKORDIĖAS MI FORTE MALKONSENTAS	JE SUIS FORTEMENT EN DÉSACCORD JE NE CONSENS PAS FORTEMENT	YES	

207	I DISAGREE COMPLETELY (AS IN CONCUR) (AS IN CONSENT)	MI TUTE MALAKORDIĞAS MI TUTE MALKONSENTAS	JE SUIS EN DESACCORD COMPLÈTEMENT JE NE CONSENS PAS COMPLÈTEMENT	YES	
208	DO YOU AGREE? (AS IN CONCUR) (AS IN CONSENT)	ÇU VI AKORDIĞAS ÇU VI KONSENTAS	EST-CE QUE VOUS ETES D'ACCORD ? EST-CE QUE VOUS CONSENTEZ ?	YES	
209	DO YOU AGREE STRONGLY? (AS IN CONCUR) (AS IN CONSENT)	ÇU VI FORTE AKORDIĞAS ÇU VI FORTE KONSENTAS	EST-CE QUE VOUS ETES D'ACCORD FORTEMENT? EST-CE QUE VOUS CONSENTEZ FORTEMENT ?	YES	
210	DO YOU AGREE COMPLETELY? (AS IN CONCUR) (AS IN CONSENT)	ÇU VI TUTE AKORDIĞAS ÇU VI TUTE KONSENTAS	EST-CE QUE VOUS ETES D'ACCORD COMPLÈTEMENT ? CONSENTEZ-VOUS COMPLÈTEMENT ?	YES	
211	DO YOU DISAGREE? (AS IN CONCUR) (AS IN CONSENT)	ÇU VI MALAKORDIĞAS ÇU VI MALKONSENTAS	EST-CE QUE VOUS N'ETES PAS D'ACCORD ? EST-CE QUE VOUS NE CONSENTEZ PAS ?	YES	

212	DO YOU DISAGREE STRONGLY? (AS IN CONCUR) (AS IN CONSENT)	ĈU VI FORTE MALAKORDIĜAS ĈU VI FORTE MALKONSENTAS	EST-CE QUE VOUS N'ETES PAS D'ACCORD FORTEMENT ? EST-CE QUE VOUS NE CONSENTEZ PAS FORTEMENT ?	YES	
213	DO YOU DISAGREE COMPLETELY? (AS IN CONCUR) (AS IN CONSENT)	ĈU VI TUTE MALAKORDIĜAS ĈU VI TUTE MALKONSENTAS	EST-CE QUE VOUS N'ETES PAS D'ACCORD COMPLÈTEMENT? EST-CE QUE VOUS NE CONSENTEZ PAS COMPLÈTEMENT?	YES	
214	HAVE WE PROVIDED	ĈU NI PROVIZIS	AVONS-NOUS FOURNI		
215	HAS THE HOSPITAL PROVIDED	ĈU LA MALSANULEJO PROVIZIS	L'HOPITAL A-T-IL FOURNI		
216	DO YOU FEEL WE HAVE PROVIDED	ĈU VI OPINIAS KE NI PROVIZIS	AVEZ-VOUS LE SENTIMENT QUE NOUS AVONS FOURNI	YES	
217	HAVE WE PROVIDED YOUR CHILD	ĈU NI PROVIZIS POR VIA INFANO	AVONS-NOUS FOURNI A VOTRE ENFANT		
218	SATISFACTORY SERVICE	KONTENTIGA SERVO	UN SERVICE SATISFAISANT		
219	PROFESSIONAL SERVICE (SERVICE OF PROFESSIONAL TYPE AND STANDARD) (SERVICE BY PROFESSIONALS) (SERVICE FOR PROFESSIONALS)	PROFESIISMA SERVO SERVO FARE DE PROFESIULOJ SERVO POR PROFESIULOJ	UN SERVICE DE QUALITE PROFESSIONNELLE UN SERVICE DIGNE DE PROFESSIONNELS UN SERVICE POUR PROFESSIONNELS	YES	
220	SATISFACTORY CARE	KONTENTIGA VARTO (...OF CHILD)	DES SOINS SATISFAISANTS		
221	SUFFICIENT CARE	ADEKVATA VARTO	DES SOINS ADEQUATS		
222	EFFECTIVE TREATMENT	EFIKA VARTO	UN TRAITEMENT EFFICACE		

223	DO YOU THINK WE CAN IMPROVE (DO YOU BELIEVE THAT WE CAN IMPROVE SOMETHING)	ĈU VI KREDAS KE NI POVAS PLIBONIGI	PENSEZ-VOUS QUE NOUS PUISSONS AMELIORER		
224	ARE YOU SATISFIED WITH (ARE YOU HAPPY IN REGARD TO)	ĈU VI ESTAS KONTENTA PRI	ÊTES-VOUS SATISFAIT DE		
225	OUR PROFESSIONALISM	NIA PROFESIISMO	NOTRE PROFESSIONNALISME		
226	OUR CARE FOR YOUR CHILD	LA VARTO FARE DE NI POR VIA INFANO (THE CARE GIVEN BY US TO YOUR CHILD)	NOS SOINS DONNES A VOTRE ENFANT		
227	OUR HELP	HELPO FARE DE NI	NOTRE AIDE		
228	OUR TREATMENT OF YOUR CHILD (THE TREATMENT GIVEN BY US TO YOUR CHILD)	LA TRAKTADO FARE DE NI POR VIA INFANO	NOTRE TRAITEMENT POUR VOTRE ENFANT.		
229	YOUR CHILD'S TREATMENT	LA TRAKTADO POR VIA INFANO	LE TRAITEMENT DE VOTRE ENFANT		
230	THE TREATMENT YOUR CHILD RECEIVED	LA TRAKTADO KIUN VIA INFANO RICEVIS	LE TRAITEMENT QU'A REÇU VOTRE ENFANT		

7.9 Appendix I Translation Table - Prototype Model: English to Esperanto to French Combined Word Groups

COMBINED WORD GROUPS :				SEARCH STRATEGY USED TO IDENTIFY COMBINED WORD GROUPS	
				FIRST FOUND FIRST SELECTED	LARGEST FIRST
231	HAVE WE PROVIDED SATISFACTORY SERVICE	ĈU NI PROVIZIS KONTENTIGA SERVO	AVONS-NOUS FOURNI UN SERVICE SATISFAISANT ?	RESULT OK	RESULT OK
232	HAVE WE PROVIDED PROFESSIONAL SERVICE	ĈU NI PROVIZIS PROFESIISMA SERVO	AVONS-NOUS FOURNI UN SERVICE DE QUALITE PROFESSIONNELLE ?	RESULT OK	RESULT OK
233	HAVE WE PROVIDED SATISFACTORY CARE	ĈU NI PROVIZIS KONTENTIGA VARTO	AVONS-NOUS FOURNI DES SOINS SATISFAISANTS ?	RESULT OK	RESULT OK
234	HAVE WE PROVIDED SUFFICIENT CARE	ĈU NI PROVIZIS ADEKVATA VARTO	AVONS-NOUS FOURNI DES SOINS ADEQUATS ?	RESULT OK	RESULT OK
235	HAVE WE PROVIDED EFFECTIVE TREATMENT	ĈU NI PROVIZIS EFIKA VARTO	AVONS-NOUS FOURNI UN TRAITEMENT EFFICACE ?	RESULT OK	RESULT OK
236	HAS THE HOSPITAL PROVIDED SATISFACTORY SERVICE	ĈU LA MALSANULEJO PROVIZIS KONTENTIGA SERVO	L'HOPITAL A-T-IL FOURNI UN SERVICE SATISFAISANT ?	RESULT OK	RESULT OK
237	HAS THE HOSPITAL PROVIDED PROFESSIONAL SERVICE	ĈU LA MALSANULEJO PROVIZIS PROFESIISMA SERVO	L'HOPITAL A-T-IL FOURNI UN SERVICE DE QUALITE PROFESSIONNELLE	RESULT OK	RESULT OK
238	HAS THE HOSPITAL PROVIDED SATISFACTORY CARE	ĈU LA MALSANULEJO PROVIZIS EFIKA VARTO	L'HOPITAL A-T-IL FOURNI DES SOINS SATISFAISANTS ?	RESULT OK	RESULT OK
239	HAS THE HOSPITAL PROVIDED SUFFICIENT CARE	ĈU LA MALSANULEJO PROVIZIS EFIKA VARTO	L'HOPITAL A-T-IL FOURNI DES SOINS ADEQUATS ?	RESULT OK	RESULT OK

241	DO YOU FEEL (FEEL AS IN SENSORY PERCEPTION)	ĈU VI OPINIAS	SENTEZ-VOUS ?	RESULT OK	RESULT OK
242	DO YOU FEEL (AS IN TOUCH)	ĈU VI PALPAS	TOUCHEZ-VOUS ?	RESULT OK	RESULT OK
243	HAS THE HOSPITAL PROVIDED EFFECTIVE TREATMENT	ĈU LA MALSANULEJO PROVIZIS EFIKA VARTO	L'HOPITAL A-T-IL FOURNI UN TRAITEMENT EFFICACE ?	RESULT OK	RESULT OK
244	DO YOU FEEL WE HAVE PROVIDED SATISFACTORY SERVICE (FEEL AS IN SENSORY PERCEPTION)	ĈU VI OPINIAS KE NI PROVIZIS KONTENTIGA SERVO	AVEZ-VOUS LE SENTIMENT QUE NOUS AVONS FOURNI UN SERVICE SATISFAISANT ?	RESULT OK	RESULT OK
245	DO YOU FEEL WE HAVE PROVIDED PROFESSIONAL SERVICE (FEEL AS IN SENSORY PERCEPTION)	ĈU VI OPINIAS KE NI PROVIZIS PROFESIISMA SERVO	AVEZ-VOUS LE SENTIMENT QUE NOUS AVONS FOURNI UN SERVICE DE QUALITE PROFESSIONNELLE ?	RESULT OK	RESULT OK
246	DO YOU FEEL WE HAVE PROVIDED SATISFACTORY CARE (FEEL AS IN SENSORY PERCEPTION)	ĈU VI OPINIAS KE NI PROVIZIS KONTENTIGA VARTO	AVEZ-VOUS LE SENTIMENT QUE NOUS AVONS FOURNI DES SOINS SATISFAISANTS ?	RESULT OK	RESULT OK
247	DO YOU FEEL WE HAVE PROVIDED SUFFICIENT CARE (FEEL AS IN SENSORY PERCEPTION)	ĈU VI OPINIAS KE NI PROVIZIS ADEKVATA VARTO	AVEZ-VOUS LE SENTIMENT QUE NOUS AVONS FOURNI DES SOINS ADEQUATS ?	RESULT OK	RESULT OK
248	DO YOU FEEL WE HAVE PROVIDED EFFECTIVE TREATMENT (FEEL AS IN SENSORY PERCEPTION)	ĈU VI OPINIAS KE NI PROVIZIS EFIKA VARTO	AVEZ-VOUS LE SENTIMENT QUE NOUS AVONS FOURNI UN TRAITEMENT EFFICACE	RESULT OK	RESULT OK
249	HAVE WE PROVIDED YOUR CHILD SATISFACTORY SERVICE	ĈU NI PROVIZIS POR VIA INFANO PROFESIISMA SERVO	AVONS-NOUS FOURNI A VOTRE ENFANT UN SERVICE SATISFAISANT ?	RESULT OK	RESULT OK
250	HAVE WE PROVIDED YOUR CHILD PROFESSIONAL SERVICE (SERVICE OF PROFESSIONAL TYPE AND STANDARD)	ĈU NI PROVIZIS POR VIA INFANO PROFESIISMA SERVO	AVONS-NOUS FOURNI A VOTRE ENFANT UN SERVICE DE QUALITE PROFESSIONNELLE ?	RESULT OK	RESULT OK

251	HAVE WE PROVIDED YOUR CHILD PROFESSIONAL SERVICE (SERVICE BY PROFESSIONALS)	ĈU NI PROVIZIS POR VIA INFANO SERVO FARE DE PROFESIOLOJ	AVONS-NOUS FOURNI À VOTRE ENFANT UN SERVICE DIGNE DE PROFESSIONNELS	RESULT OK	RESULT OK
252	HAVE WE PROVIDED YOUR CHILD SATISFACTORY CARE	ĈU NI PROVIZIS POR VIA INFANO KONTENTIGA VARTO	AVONS-NOUS FOURNI À VOTRE ENFANT DES SOINS SATISFAISANTS ?	RESULT OK	RESULT OK
253	HAVE WE PROVIDED YOUR CHILD SUFFICIENT CARE	ĈU NI PROVIZIS POR VIA INFANO ADEKVATA VARTO	AVONS-NOUS FOURNI À VOTRE ENFANT DES SOINS ADEQUATS ?	RESULT OK	RESULT OK
254	HAVE WE PROVIDED YOUR CHILD EFFECTIVE TREATMENT	ĈU NI PROVIZIS POR VIA INFANO EFIKA VARTO	AVONS-NOUS FOURNI À VOTRE ENFANT UN TRAITEMENT EFFICACE ?	RESULT OK	RESULT OK
255	DO YOU THINK WE CAN IMPROVE OUR PROFESSIONALISM	ĈU VI KREDAS KE NI POVAS PLIBONIGI NIA PROFESIIISMO	PENSEZ-VOUS QUE NOUS PUISSIONS AMELIORER NOTRE PROFESSIONNALISME ?	RESULT OK	RESULT OK
256	DO YOU THINK WE CAN IMPROVE OUR CARE FOR YOUR CHILD	ĈU VI KREDAS KE NI POVAS PLIBONIGI LA VARTO FARE DE NI POR VIA INFANO	PENSEZ-VOUS QUE NOUS PUISSIONS AMELIORER NOS SOINS DONNES À VOTRE ENFANT ?	RESULT OK	RESULT OK
257	DO YOU THINK WE CAN IMPROVE OUR HELP	ĈU VI KREDAS KE NI POVAS PLIBONIGI HELPO FARE DE NI	PENSEZ-VOUS QUE NOUS PUISSIONS AMELIORER L'AIDE QUE NOUS VOUS AVONS APPORTEE ?	RESULT OK	RESULT OK
258	DO YOU THINK WE CAN IMPROVE OUR TREATMENT OF YOUR CHILD	ĈU VI KREDAS KE NI POVAS PLIBONIGI LA TRAKTADO FARE DE NI POR VIA INFANO	PENSEZ-VOUS QUE NOUS PUISSIONS AMELIORER NOTRE TRAITEMENT POUR VOTRE ENFANT.	RESULT OK	RESULT OK
259	DO YOU THINK WE CAN IMPROVE YOUR CHILD'S TREATMENT	ĈU VI KREDAS KE NI POVAS PLIBONIGI LA TRAKTADO POR VIA INFANO	PENSEZ-VOUS QUE NOUS PUISSIONS AMELIORER LE TRAITEMENT DE VOTRE ENFANT ?	RESULT OK	RESULT OK

260	DO YOU THINK WE CAN IMPROVE THE TREATMENT YOUR CHILD RECEIVED	ĈU VI KREDAS KE NI POVAS PLIBONIGI LA TRAKTADO KIUN VIA INFANO RICEVIS	PENSEZ-VOUS QUE NOUS PUISSONS AMELIORER LE TRAITEMENT QU'A REÇU VOTRE ENFANT ?	RESULT OK	RESULT OK
261	ARE YOU SATISFIED WITH OUR PROFESSIONALISM	ĈU VI ESTAS KONTENTA PRI NIA PROFESIISMO	ÊTES-VOUS SATISFAITS DE NOTRE PROFESSIONNALISME ?	RESULT OK	RESULT OK
262	ARE YOU SATISFIED WITH OUR CARE FOR YOUR CHILD	ĈU VI ESTAS KONTENTA PRI LA VARTO FARE DE NI POR VIA INFANO	ÊTES-VOUS SATISFAITS DE NOS SOINS DONNES À VOTRE ENFANT ?	RESULT OK	RESULT OK
263	ARE YOU SATISFIED WITH OUR HELP	ĈU VI ESTAS KONTENTA PRI HELPO FARE DE NI	ÊTES-VOUS SATISFAITS DE L'AIDE QUE NOUS VOUS AVONS APPORTÉE ?	RESULT OK	RESULT OK
264	ARE YOU SATISFIED WITH OUR TREATMENT OF YOUR CHILD	ĈU VI ESTAS KONTENTA PRI LA TRAKTADO FARE DE NI POR VIA INFANO	ÊTES-VOUS SATISFAITS DE NOTRE TRAITEMENT POUR VOTRE ENFANT ?	RESULT OK	RESULT OK
265	ARE YOU SATISFIED WITH YOUR CHILD'S TREATMENT	ĈU VI ESTAS KONTENTA PRI LA TRAKTADO POR VIA INFANO	ÊTES-VOUS SATISFAITS (DE LE) DU TRAITEMENT DE VOTRE ENFANT	RESULT OK	RESULT OK
266	ARE YOU SATISFIED WITH THE TREATMENT YOUR CHILD RECEIVED	ĈU VI ESTAS KONTENTA PRI LA TRAKTADO KIUN VIA INFANO RICEVIS	ÊTES-VOUS SATISFAITS (DE LE) DU TRAITEMENT QU'A REÇU VOTRE ENFANT ?	RESULT OK	RESULT OK

7.10 Appendix J References

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