# Current Research in Machine Translation

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ABSTRACT: This paper, accompanied by peer group commentary and author's response, is a discussion paper concerning the state of the art in Machine Translation. The current orthodoxy is first summarized, then criticized. A number of research projects based on the standard architecture are discussed: they involve the use of Artificial Intelligence techniques, advanced linguistic theories, and sublanguage. Alternative approaches discussed are systems which develop or update their grammars semi-automatically, dialogue MT, and corpus-based MT including example-based and statistical approaches.

KEYWORDS: Second generation, linguistics, sublanguage, dialogue MT, corpus, statistical.

## 1. INTRODUCTION

This discussion paper is based on the presentation I gave at the Third International Conference on Theoretical and Methodological Issues in Machine Translation of Natural Languages at Austin, Texas, in June 1990. It has been revised and updated, in particular to take account of new relevant papers which I heard both at Austin, and a few weeks later at COLING in Helsinki; and I have trimmed down the final section in which I discuss some of the 'new' directions. Apart from that, I have not changed much: in particular, it is still my intention to be a little controversial, and to generate some debate on the issues I bring up.

The purpose of this paper is to give a view of current research in Machine Translation (MT). It is written on the assumption that readers are in fact more or less familiar with most of the well-known current MT projects, or else can find out more about them by following up the references given. I will make some slightly opinionated remarks about certain of these projects, which, I will claim, have in common a direct line of descent from the classical 'second generation' design. I will then briefly allude to what I believe to be a significantly different set of current MT research projects – mostly rather less well-known – which form a heterogeneous group having in common only the feature that they in some sense reject the conventional orthodoxy that typifies the first group.

Two recent personal experiences have led me to the views on current MT research which I wish to elaborate here.

The first was in 1988 when, at the second conference in the series

*Machine Translation* 7: 231–246, 1993.

mentioned above, which was held at CMU in Pittsburgh, I participated in a panel session and addressed the question "Where will MT be in the next 20 years – honestly?" (Somers 1988). At that time I thought that the main developments would be investment in lexical development, and work on making the environment for MT more user-friendly, especially by having linguistically sophisticated MT-oriented word processing for post-editing. Looking back, I am struck by the fact that neither development really represented either a theoretical or methodological advance. The other thing that happened at CMU which made an impact was the reaction to the presentation of IBM's Peter Brown on the same panel (Brown *et al.* 1988a; cf. Brown *et al.* 1988b): it was hostile, to say the least, despite the fact that early results were not significantly worse than results of more orthodox systems. I joined the attack, the main thrust of which was to ask where was the linguistics, without realising that precisely what the research was doing was to question some of the fundamental assumptions underlying MT research since 1966, and try to find out which of them were really valid.

With hindsight, I can see that what this research was doing was saying that in the 20 years since ALPAC, the second generation architecture had led to only slightly better results than the architecture it replaced; so it was timely to question *all* the assumptions that had been accepted unequivocally in that period, *just to see what would happen.* I will return to this view later.

The second personal experience, which strengthened my opinion that the received view of the future of MT research was at best too restricted, or at worst totally misguided, was my attendance at an MT conference in Tbilisi, organised by the then USSR's Vsyesoyouznyi Centr Perevodov, in November/December 1989. The significance of the Tbilisi conference was that many of the papers presented by Soviet researchers revealed that, due to the state of computer technology in the USSR, MT research in that country was about fifteen years behind the West, and following faithfully in its footsteps. It seemed obvious that the mainstream of Soviet research would continue, as much as possible, to emulate the research of the West, including reaching the same, not entirely positive, conclusions some fifteen years from now. It occurred to me that they could be saved a lot of wasted effort if someone could indicate succinctly what those conclusions would be, and allow them to jump to the position I believe we in the West already find ourselves in, and embark on research projects which try to address these shortcomings. Perhaps part of this paper will provide such an indication.

## 2. WHAT'S WRONG WITH CLASSICAL SECOND GENERATION ARCHITECTURE?

Let us start by considering the classical second generation architecture. Examples would be GETA's ARIANE system (Boitet & Nedobejkine 1981, Vauquois 1985, Vauquois & Boitet 1985), TAUM's MÉTÉO (Chevalier *et al.* 1981, Lehrberger & Bourbeau 1988), and the European Commission's Eurotra (Raw *et al.* 1988, 1989; Steiner, 1991), and there are plenty of other systems which incorporate most of the typical design features. These include the well-known notions of linguistic rule-writing formalisms with software implemented independently of the linguistic procedures, stratificational analysis and generation, and an intermediate linguistically motivated representation which may or may not involve the direct application of contrastive linguistic knowledge. The key unifying feature is *modularity*, both 'horizontal' and 'vertical': the linguistic formalisms are supposed to be declarative, so that linguistic and computational issues are separated; and the whole process is divided up into computationally and/or linguistically convenient modules.

While these are admirable design features, at least insofar as they seem to address the perceived problems of MT system-design pre-ALPAC, they also lead to several general or specific deficiencies in design.

In general, they reflect the preferred computational and linguistic techniques of the late 1960s and early 1970s, which have to a great extent been superseded. There are now several viable alternatives to the procedural algorithmic strictly-typed programming style; while in linguistics the transformational-generative paradigm and its associated stratificational view of linguistic processing (morphology – surface syntax – deep syntax) has become somewhat old-fashioned.

The stratificational approach engenders two other problems which cast a shadow over second generation-style MT. First, there seems to be a tendency, once the general design of the MT system has been fixed, to go about the finer details, and the implementation, in a bottom-up manner: it is as if there is an attitude of doing what is known to be feasible (morphology, context-free parsing, incorporating simple semantic constraints, some tree transductions), seeing how far that gets you, and taking it from there. When the ideas run out, call whatever you've got an 'intermediate representation', do some 'transfer', and then a more or less deterministic generation of target text (this approach to generation in particular being criticised as long ago as 1985, at the first conference in this series, as being out of date (McDonald 1987:200ff)). A more appealing way to design an MT system would of course be to *start* by considering what sort of intermediate representation (or, more generally, what sort of contrastive processes) underlie the system, and then to consider how to analyse source texts into that representation, and how to generate target texts from it.

A second, perhaps more serious problem with the stratificational approach is the extent to which it encourages an approach to translation which I have called "structure preserving translation as first choice" (Somers *et al.* 1988:5). This stems from the commitment to compositionality in translation, i.e. that the translation of the whole is some not too complex function over the translations of the parts. This leads to a strategy which embodies the motto "Let's produce translations that are as literal as we can get away with" (cf. Somers 1986:84). Notice that this is in direct contrast with the human translator's view, which is roughly "structure preserving translation as last resort". This attitude can be seen again in discussions of the need to limit 'structural transfer' and to build systems which are essentially interlingual systems with lexical transfer. But we know very well the difficulties of designing an interlingua, even if we remove the burden of a 'conceptual lexicon'.

I must admit that I do not have a ready solution here. But it seems to me important to recognise the limitations and pitfalls of the now traditional stratified linguistic approach to both processing and representation, so that even the apparently well established technique should not necessarily be assumed as a 'given' in MT system design.

I will end this section by making two other observations. The first is that all MT systems so far have been designed with the assumption that the source text contains enough information to permit translation. This is obviously true of non-interactive systems; but it is also true even of the few systems which interact with a user *during processing* in order to disambiguate the source text or to make decisions (usually regarding lexical choice) about the target text. Notice, by the way, that I want to distinguish here between truly interactive systems, and those which merely incorporate some sort of interactive post-editing. In fact, very few research systems are truly interactive in this sense (e.g. ENtran (Whitelock *et al.* 1986, Wood & Chandler 1988), and see below). However, the point I want to make concerns how MT researchers view this problem: it is seen as a deficiency of the system – that is to say, either the linguistic theory used, or its implementation – rather than of the text. Consequently, the solutions offered almost inevitably involve trying to enhance the performance of the part of the system seen to be at fault: incorporating a better semantic theory, dealing with translation units bigger than single sentences, trying to take account of contextual or real-world knowledge. Of course these are all worthy research aims, but I think the extent to which they will address the problems they are supposed to solve is generally exaggerated.

The second point is the observation – whisper it – that despite nearly 25 years since the ALPAC report, results are not much better than those of the first generation systems which have over the same period continued to be developed (though probably with less invested effort overall): obvious examples are SYSTRAN (World Systran Conference 1986, Trabulsi 1988) and SPANAM (Vasconcellos & León 1985). As Wilks says of the former, "its real techniques owe a great deal to good software engineering, good software support..." (Wilks 1989:59). No one would deny that the second generation systems are more elegant, or even that they can be extended in a more principled way. But for all the investment, and the bold talk in, say, the mid to late 1970s, perhaps one could have expected better results. With the exception of METAL in the West, and two or three systems in Japan, notice that *all* commercial systems are first generation in design. Notice too that people buy them.

## 3. CURRENT RESEARCH DIRECTLY DESCENDED FROM THAT ARCHITECTURE

I want to look now at current research projects which I take to be directly descended from the second generation architecture, and which therefore, in a sense, can be said to be subject to the same criticisms. The research projects in this group can be divided into subgroups according to which specific part of the problem of MT, as traditionally viewed, they try to address. So we have projects which address the problem of insufficient contextual and real-world knowledge; projects which seek a more elegant linguistic or computational linguistic framework; and projects where translation quality is enhanced by constraining the input.

For a while now it has been the conventional wisdom that the next advance in MT design – the 'third generation' – would involve the incorporation of techniques from AI. In his instant classic, Hutchins (1986) is typical in this respect: "the difficulties and past 'failures' of linguistics-oriented MT point to the need for AI semantics-based approaches: semantic parsers, preference semantics, knowledge databases, inference routines, expert systems, and the rest of the AI techniques" (p.327). He goes on to say "There is no denying the basic AI argument that at some stage translation involves the 'understanding' of a [source language] text in order to convey its 'meaning' in a [target language] text" (*idem*). In fact this assertion has been questioned by several commentators, e.g. Johnson (1983:37), Slocum (1985:16) etc., as Hutchins himself notes.

### *3.1. Incorporating AI Techniques*

Returning to the question of AI-oriented 'third generation' MT systems, it is probably fair to say that the most notable example of this approach is at the Center for Machine Translation at Carnegie-Mellon University, where a significantly sized research team was explicitly set up to pursue the question of 'knowledge- based MT' (KBMT) (Carbonell & Tomita 1987). What then are the 'AI techniques' which the CMU team have incorporated into their MT system, and how do we judge them?

In the Nirenburg & Carbonell (1987) description of KBMT, the emphasis seems to be on the need to integrate discourse pragmatics in order to get pronouns and anaphora right. This requires texts to be mapped onto a corresponding knowledge representation in the form of a frame-based conceptual interlingua. More recent descriptions of the project (Nirenburg 1989, Nirenburg & Levin 1989) stress the use of domain knowledge. These are well respected techniques in the general field of AI, and we cannot gainsay their application to MT. But as 20 years of AI research has shown, the step up from a prototype 'toy' implementation to a more fully practical implementation is a huge one. And there still remain doubts as to whether the improvement of quality achieved by these AI techniques is commensurate with the additional computation they involve.

### 3.2. *Better Linguistic Theories*

It is normally said that a major design advance from the first to the second generation of MT systems was the incorporation of better linguistic theories, and there is certainly a group of current research projects which can be said to be focussing on this aspect. This is especially true if we extend the term 'linguistic' to include 'computational linguistic' theories. The scientific significance of the biggest of all the MT research projects – Eurotra – can be seen as primarily in its development of existing linguistic models, and notable innovations include the work on the representation of tense (van Eynde 1988), work on homogeneous representation of heterogeneous linguistic phenomena (especially through the idea of 'featurisation' of purely surface syntactic elements, and a coherent theory of 'canonical form') (Durand *et al.*, 1991), as well as, in some cases, the first ever wide-coverage formal (i.e. computational) descriptions of several European languages. As much as anything else, Eurotra has shown the possibilities of an openly eclectic approach to computational linguistic engineering. Nevertheless, 'Eurotrians' will be the first to admit that the list of remaining problems is longer than the list of problems solved or even half-solved. 'Lexical gaps', usually illustrated by the well-worn example of *like/gern*, modality, determination, are just a few more or less purely linguistic problems that remain, before we even think of anaphora resolution, use of contextual and real-world knowledge and so on, already discussed.

Several research projects have taken a more doctrinaire view of linguistics in that they have explicitly set out to use MT as a testing ground for some computational linguistic theory. Most notable of these is Rosetta (Landsbergen 1987a,b) based on Montague grammar, but we could also mention again ENtran, which uses a combination of LFG and GPSG in analysis, and Categorial Grammar for generation. There are several other research projects based on specific linguistic theories notably LFG (Rohrer

1986, Alam 1986, Kudo & Nomura 1986, Kaplan *et al.* 1989, Sadler *et al.* 1990, Zajac 1990), but also GPSG (Hauenschild 1986), HPSG (van Noord *et al.* 1990), Government and Binding (Wehrli 1990), Systemic Functional Grammar (Bateman 1990), Tree-Adjoining Grammars (Abeillé *et al.* 1990), Categorial Grammar (Beaven & Whitelock 1988), Functional Grammar (van der Korst 1989), Situation Semantics (Rupp 1989), and, though it may be regarded as more of a programming technique than a linguistic 'theory' as such, Logic Grammar (Huang 1988, McCord 1989, Isabelle *et al.* 1988). The number of 1990 references in that list points to the fact that this is a significant trend in MT research: and in general, although the particular flavour differs, there is a generally common theme of using unification-type formalisms. In fact, given the right theory and programming environment it is possible to develop very quickly a reasonable state-of-the-art toy system, as a student of mine (Amores Carredano 1990) demonstrated: in only three man-months he built an LFG-based system programmed in Prolog with a coverage comparable to early systems which took many man-years to develop. However, this seems to say as much about our (meagre) expectations of MT systems as it does about the suitablility of LFG and/or Prolog.

In all these cases, I think it is fair to say that under the stress of use in a real practical application, the linguistic models, whose original developers were more interested in a general approach than in working out all the fine details, inevitably crack.

A good example of this is suggested by Carroll (1989). Looking at Rosetta, he shows (pp.37f) how the all-important isomorphy principle found in and adhered to in the prototype Rosetta2 system is effectively abandoned in the expanded Rosetta3 project (Appelo *et al.* 1987:122): since some syntactic rules in Dutch do not correspond in an obvious way with English syntax rules (the example given is the Dutch 'verb second' rule), the isomorphy principle requires a dummy English rule to be added to the English syntax. Since this is not very elegant, a distinction between 'transformations' and 'meaningful rules' is introduced. As Carroll states: "This makes a complete mockery of the claim that the grammars are isomorphic. It would surely have been better to admit that their experience on Rosetta2 has shown that their various principles were no more than working hypotheses, which happened neither to work particularly well nor to be true in any legitimate sense" (p.38).

Other observers of the MT scene have made similar observations concerning the shaky relationship between linguistic theory and MT, none more outspoken than Wilks' (1989) observation that "the history of MT shows, to me at least, the truth of two (barely compatible) principles that could be put crudely as *Virtually any theory, no matter how silly, can be the basis of some effective MT* and *Suc[c]essful MT systems rarely work with the theory they claim to*" (p.59; emphasis original).

### *3.3. Sublanguage*

Obviously the most successful MT story of all is that of MÉTÉO: a translation task too boring for any human doing it to last more than a few months, yet sufficiently constrained to allow an MT system to be devised which only makes mistakes when the input is ill-formed. Some research groups have looked for similarly constrained domains. Alternatively, the idea of *imposing* constraints on authors has a long history of association with MT. At the 1978 Aslib conference, Elliston (1979) showed how at Rank Xerox acceptable output could be got out of Systran by forcing technical writers to write in a style that would not catch the system out. I was bemused to see much the same experience reported again ten years later, at the same forum, but this time using Weidner's MicroCat (Pym 1990). This rather haphazard activity has fortunately been 'legitimised' by its association with research in the field of LSP, and the word 'sublanguage' is starting to be widely used in MT circles (e.g. Kosaka *et al.* 1988). In fact, I see this as a positive move, as long as 'sublanguage' is not just used as a convenient term to camouflage the same old MT design, but with simplified grammar and a reduced lexicon.

Studies of sublanguage (e.g. Kittredge & Lehrberger 1982) remind us that the topic is much more complex than that: should a sublanguage be defined prescriptively (or even *pro*scriptively) as in the Elliston and Pym examples, or *de*scriptively, on the basis of some corpus judged to be a homogeneous example of the sublanguage in question? And note that even the term 'sublanguage' itself can be misleading: in most of the literature on the subject, the term is taken to mean 'special language of a particular domain' as in 'the sublanguage (of) meteorology'. Yet a more intuitive interpretation of the term, especially from the point of view of MT system designers, would be something like 'the grammar, lexicon, etc. of a particular *text-type* in a particular domain', as in 'the sublanguage of meteorological reports as given on the radio', which might share some of the lexis of, say, 'the sublanguage of scientific papers on meteorology', though clearly not (all) the grammar. By the same token, scientific papers on various subjects might share a common grammar, while differing in lexicon. Furthermore, there is the question of whether the notion of a 'core' grammar or lexicon is useful or even practical. Some of these questions are being addressed as part of one of the MT projects at UMIST, in which we are trying to design an architecture for a system which interacts with various types of experts to 'generate' a sublanguage MT system: I will begin my final section with a brief description of this research.

## 4. Some Alternative Avenues of Research

In this final section, I would like to mention briefly some research projects which have come to my attention which, I think, have in common that they reject, at least partially, the orthodoxy of the 'second generation and derivative' design, or in some other way incorporate some ideas which I think significantly broaden the scope of MT research. I make only a small apology for the fact that a number of these projects are being undertaken in our own research Centre!

### *4.1. Sublanguage Plus*

One of the projects currently under way at UMIST is a sublanguage MT system, the research being funded by Matsushita Electrical Industrial Co. Ltd. (Tsujii *et al.* 1990). The design is for a system with which individual sublanguage MT systems can be created, on the basis of a bilingual corpus of 'typical' texts. The system therefore has two components: a core MT engine, which is to a certain extent not unlike a typical second generation MT system, with explicitly separate linguistic and computational components; and an interactive component which extracts from the corpus of texts the grammar and lexicon that the linguistic part of the MT system will use. Using various statistical methods, we attempt to infer the grammar and lexicon of the sublanguage, on the assumption that the corpus is fully representative (and approaches closure). From our observation of other statistics-based approaches to MT (see below), we conclude that the statistical methods need to be 'primed' with linguistic knowledge, for example concerning the nature of linguistic categories, morphological processes and so on. We are currently investigating the extent to which this can be done without going so far as to posit a core grammar, since we are uneasy about the idea that a sublanguage be defined in terms of deviation from some standard. The system will make hypotheses about the grammar and lexicon, to be confirmed by a human user, who must clearly be a linguist rather than, say, the end-user. In the same way, the contrastive linguistic knowledge is extracted from the corpus, to be confirmed by interaction with a (probably different) human. Again, some 'priming' will almost certainly be necessary.

### *4.2. Automatic Grammar Up-dating*

A recently described research project concerns an MT system which revises its own grammars in response to having its output postedited (Nishida *et al.* 1988, Nishida & Takamatsu, 1990). A common complaint from posteditors is that postediting MT output is frustrating not least because the same errors are repeated time and time again (e.g. Green 1982). The idea that such errors can somehow be corrected by feedback from posteditors is obviously one worth pursuing vigorously. When the output from a fairly traditional second-generation type English-Japanese MT system (MAPTRAN) is postedited, the posteditors are asked to identify which of the basic postediting operations (replacement, insertion, deletion, movement and exchange) each correction involves, and, optionally to give a reason, expressed in terms of other words in the text, or some primitive linguistic features, The system, called PECOF (PostEditor's COrrection Feedback), then tries to locate the linguistic rule in the MT system responsible for the error (roughly, by running MAPTRAN in reverse), and then to propose a revision of it (typically an extension to the general rule to cover the particular instance identified), which must be confirmed by the posteditor. The research is apparently still at an early stage, and it is obvious that only a certain category of translation errors can be dealt with in this way. But it seems to be a useful way of extending the grammar and lexicon of the system to account for 'special cases' on the basis of experience, rather than relying on linguists to somehow predict things. If PECOF can also interact with the posteditor to see how generalisable a given correction is, then this is clearly an excellent way of developing a large-scale MT system.

### *4.3. Dialogue MT*

A recent research direction to emerge is an MT system aimed at a user who is the original author of a text to be composed in a foreign language. The idea as perhaps first pursued in the ENtran project, mentioned above (cf. also Johnson & Whitelock 1987), which embeds this idea in a fairly standard interactive MT environment, and where interaction with the machine is aimed at disambiguating the input text. An alternative scenario is one where the interaction takes place *before* text is input, in the form of a dialogue between the system and the user, in which the text to be translated is worked out, taking into account the user's communicative goals and the system's translation ability.

The idea of automatic composition of foreign language texts was suggested by Saito & Tomita (1986), and is the basis of work done at UMIST for British Telecom (Jones & Tsujii 1990). In this system, the user collaborates with the machine to produce high-quality 'translations' of business correspondence on the basis of pretranslated fragments of stereotypical texts with slots in them which are filled in by interaction. The advantage is that the system only translates what it 'knows' it can translate accurately, with the result that the system shows what MT *can* do, rather than what it cannot, as in traditional MT. Obviously though, this strength is also a weakness in the sense of the severe limitation on what the system can be used for.

However, we can extend the idea to make it more flexible, and conceive of a system which has more scope concerning the range of things it can translate, with corresponding degrees of confidence about translation quality. This is the case in our dialogue MT system (Somers *et al.* 1990) which we are working on in collaboration with the Japanese ATR research organisation: we are constructing a system which will act as a bilingual intermediary for the user in a dialogue with a conference office, where the user wants to get information about a forthcoming conference. It is thus a 'dialogue MT system' both in the sense that it enters into a dialogue with the user about the translation (cf. Boitet 1989), *and* in that the object of the translation is the user's contribution to a dialogue. Dialogue is a particularly good example of the problem, inherent in MT, that the translation of the text depends to a greater or lesser extent on the surrounding context (Tsujii & Nagao 1988). In other words, the source text alone does not carry sufficient information to ensure a good translation. We envisage a sort of MT 'expert system' which can play the role of an 'intelligent secretary with knowledge of the foreign language', gathering the information necessary to formulate the target text by asking the user questions, pushing the user towards a formulation of the 'source' text that the system can be confident of translating correctly, on the basis of some existing partial 'model translations' which have been supplied by a human expert beforehand. This is an interesting development away from the current situation where the MT system makes the best of what it is given (and cannot really be sure whether or not its translation is good) towards a situation where quality can be assured by the fact that the system knows what it can do and will steer the user to the safe ground within those limitations.

### *4.4. Corpus-based MT*

The approaches to be described in this final section in common the idea that a pre-existing large corpus of already translated text could be used in some way to construct an MT system.

Three apparently independent pieces of research focus on the idea of using a corpus of example translations as the basis of new translations. In Sato and Nagao's (1990) 'Memory-based translation' (based on an original idea by Nagao 1984), translation is achieved by imitating the translation of a similar example in a database. The task becomes one of matching new input to the appropriate stored translation. In this connection, a secondary problem is the question of the most appropriate means of *storing* the examples. In Sato and Nagao's case, they choose to store *linguistic* objects – notably partial syntactic trees. An element of statistical manipulation is introduced by the need for a scoring mechanism to choose between competing candidates. Advantages of this system are ease of modification – notably by changing or adding to the examples – and the high quality of translation. The major disadvantage is the great deal of computation involved, especially in matching partial dependency trees.

A similar approach which overcomes this major demerit has been developed independently by researchers at ATR in Japan (Sumita *et al.* 1990), and at UMIST in Manchester (Carroll 1990). In both cases, the central point of interest is the development of 'distance' or 'similarity' measures for sentences or parts of sentences, which permit the input sentence to be matched rapidly against a large corpus of existing translations. In Carroll's case, the measure can be 'programmed' to take account of grammatical function words and punctuation, which has the effect of making the algorithm apparently sensitive to syntactic structure without actually parsing the input as such. While Sumita *et al.*'s intention is to provide a single correct translation by this approach, Carroll's measure is used in an interactive environment as a translator's aid, selecting a *set* of apparently similar sentences from the corpus, to guide the translator in the choice of the appropriate translation. For this reason, spurious or inappropriate selections of examples can be tolerated as long as the correct selections are also made at the same time.

The final example of corpus-based approaches to MT is the statistics-based approach of Brown *et al.* (1988a,b). The IBM researchers, encouraged by the success of statistics-based approaches to speech recognition and parsing, decided to apply similar methods to translation. Taking a huge corpus of bilingual text available in machine-readable form (3 million sentences selected from the Canadian *Hansard*), the probability that any one word in a sentence in one language corresponds to zero, one or two words in the translation is calculated. The glossary of word equivalences so established consists of lists of translation possibilities for every word, each with a corresponding probability. For example, *the* translates as *le* with a probability of .610, as *la* with probability .178, and so on. These probabilities can be combined in various ways, and the highest scoring combination will determine the words which will make up the target text. An algorithm to get the target words in the right order is now needed. This can be calculated using rather well-known statistical methods for measuring the probabilities of word-pairs, -triples, etc. Using these methods, Brown *et al.* were able to produce translations which were either the same as or preserved the meaning of the official translations were achieved in about 48% of the cases. Although at first glance this level of success would not seem to make this method viable as it stands, it is to be noted that not many commercial MT systems achieve a significantly better quality. More interesting is to consider the near-miss cases in the IBM experiment: incorrect translations were often the result of the fact that the system contains no linguistic 'knowledge' at all (and indeed this remains one of the main criticisms of the approach). Brown *et al.* (1988a:11) admit that serious problems arise when the translation of one word depends on the translation of others, and suggest (p.12) that some simple morphological and/or syntactic analysis, also based on probabilistic methods, would greatly improve the quality of the translation.

## 5. Conclusions

In this paper I have given a rather personal view of current research in MT. Of course there are probably numerous research projects that I have omitted to mention, generally because I have not been able to get information about them, or simply because they have not come to my notice. I am conscious that readers of this paper will have varying ampounts of experience in the field, to which they will in any case come from different starting points. Therefore, I want to stress that my coverage of the subject here has been from my own viewpoint rather than as a neutral reporter. I hope nevertheless that the reader has found what I have to say stimulating, at least.

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