Mechanical Translation Research at MIT †

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WORK IN THE FIELD of mechanical translation started at MIT in 1951 when Y. Bar-Hillel became perhaps the first full-time worker in the field. In 1952, he organized the first international conference on mechanical translation. It, too, took place at MIT. Compared to this second conference, the first one was small. We have contributions from over thirty people at this conference compared to thirteen four years ago — striking evidence of how fast the field is growing.

Bar-Hillel was interested in syntactic questions and was one of the foremost early exponents of the point of view that a machine would have to handle syntactic problems in order to provide adequate translations. Much of the work at MIT has continued from this point of view. The rather considerable difference in word order between German and English sentences indicates that a translation on a word-for-word basis without word order change would not be desirable.

Word order change, from German to English at least, often turns out to be phrase order change. For example, the order of adverbial expressions (phrases) of time and place frequently has to be reversed, or they have to be placed differently with respect to various objects or prepositional phrases. Routines for making such word order changes would seem to require some mechanical procedure for separating the sentence into phrases and clauses and identifying each of them as to kind or type. In other words, a machine routine for changing word order from German to English could be based on a routine for recognizing German sentence structure.

Besides word order changes, the correct meanings of the words must be selected. Many suggestions have been proposed for choosing among the various possible meanings of words. The method that we are exploring in detail promises to solve some of the multiple-meaning problems; namely, those that are connected with sentence structure. These very difficult multiple-meaning problems can be resolved by machine routines based on the same sentence structure analysis that the machine would make in order to initiate the word order changes. Examples of the sort of choices of meaning that could be made on the basis of sentence structure are not at all hard to find. Take, for example, the word "der". Various meanings are 'the', 'of the', 'who', 'that', 'which', 'he', 'it'. If the sentence structure is known, then it is known whether "der" is an article, relative pronoun, etc., and many, if not all, of the incorrect meanings can be eliminated. Each of the other parts of speech offers many more examples.

An alternative to the use of rules based on sentence structure is the use of what may be called ad hoc rules. For example, if "der" follows a word that is capitalized without an intervening comma, the translation 'of the' will be right about 95 per cent of the time. But it will be wrong in those very cases in which the ad hoc rule does not correspond to the facts of sentence structure. The difficulty with ad hoc rules does not end with this 5-per-cent error; many times it is virtually impossible to find any satisfactory ad hoc rule for a situation that is quite clear on a structural basis.

In the course of our work, one thing has become very clear. If the machine is to recognize the sentence structure, we must have a description of sentence structure to serve as a basis for the recognition routine. Some sort of a description is required for any recognition routine. Even ad hoc rules are based on a description — not a proper description of sentence structure, but a description of certain statistical features of a sample text and its translations, such as: "In 95 per cent of the cases where 'der' should be translated by 'of the', 'der' is preceded, without an intervening comma, by a capitalized word." A few simple ad hoc rules can provide a rough translation that is better than a word-for-word translation, but the addition of more and more ad hoc rules is not the way to better and better translations, because these rules will become very involved and entangled one with another. A straightforward description of sentence structure may provide much simpler routines , and routines that will handle problems that ad hoc rules

can't handle.

In spite of the wealth of material on German grammar and syntax, we have been unable to find an adequate description of the language on which recognition routines could be based. And this for perhaps two reasons: In the first place, there has probably been no pressing need prior to MT for such a grammar and syntax. In the second place, perhaps linguists have not known how to make such a grammar, or how to tell a good grammar from a bad one.

It is these problems that have been occupying N. Chomsky. He has been working on a theory of grammar that gives many new and powerful insights into the structure of language.

J. Applegate has been working on the detailed structure of the German noun phrase. His descriptive statements will take their place in a complete grammar of German. R. Lees and G.H. Matthews, in the short time that they have been with the project, have looked into the structure of the German verb phrase, and the range of applicability of certain recognition rules of the type proposed by Oswald and Fletcher.

It is hoped that our work will lead to an adequate description of the German and English languages and thus to accurate syntactic translations with the proper choice of word order and constructions in English from a German input. Many multiple-meaning problems will be solved at the same time. There will still be problems left, however. These are connected with the so-called meaning words. Perhaps these problems can be solved by utilizing a more sophisticated classification of the meaning of words than one has with a series of field glossaries.