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## The Outlook for Mechanical Translation\*

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In the future we may have machines to help carry the enormous burden that language barriers impose upon us. To the extent that translation is an art, requiring from the translator the exercise of his highest creative abilities, mechanical devices will probably be of little assistance. But to the extent that translation is a routine, repetitive, and uninteresting task, machines may be very useful. Present technology has given us machines that can be instructed to carry out simple manipulation of symbols. This capability is demonstrated by the various mechanical and electronic calculators as by the automatic dial telephone exchange. Our new technology provides a tool to be used. We who are working on mechanical translation want to learn how to use it. We are trying to find out how much of the process of translation can be described in terms of simple manipulations of symbols.

There are two schools of thought to which workers in mechanical translation belong. The first is favored by those who want to obtain results as soon as possible. They will be satisfied with crude translations if they can be made cheaply and in large quantity. They think that these crude translations will be useful for scanning a large number of documents in order to pick out those few which are of interest for a certain purpose. One possible use might be for surveying a number of the world's newspapers to get their reaction to a particular event.

The devices with which these workers propose to prepare their crude translations should probably not even be called translating machines, but automatic dictionaries. At present no such devices are in operation. It is true that many electronic digital computers can be set up to produce rough translations, but their use for this purpose, for which they were not designed, would be quite uneconomical. It is also true that technology has advanced to such a point that it would be only routine engineering work to build an automatic dictionary. The device would have a keyboard like a typewriter upon which a typist would copy the text to be translated. The keyboard would be connected to the automatic dictionary, which, in turn, would be connected to an automatic typewriter that would type the translation in the second language.

A "translation" produced by an automatic dictionary would be little better than a word-for-word substitution. Each word of the input text would be looked up in the automatic dictionary, and whatever was found there would be printed. There are two basic difficulties in this scheme. First, each word in one language has, in general, several meanings in the other language. From these possible meanings, the machine would not be able to choose the right one. It would be necessary for the machine to list all of the meanings, or perhaps give an abridged list, with the chance that sometimes the correct meaning would not appear. The second difficulty with word-for-word translations is that the word order of two different languages is usually not the same. The machine could not re-

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arrange the words in the proper order. In spite of these two great difficulties, experiments have shown that a reader can find his way through this multiple-choice guessing game and rewrite the material into a fairly good but sometimes inaccurate translation, although it may take him a long time. Considering all of their faults, there may be some utility in word-for-word translations. The proponents claim low cost as one advantage. They also claim as an advantage the fact that such a machine can produce translations without the aid of a person who is bilingual in the languages involved. It is true that a word-for-word translation would not be as good as one that a schoolboy could produce with a comparable dictionary and a little instruction in the languages. However, the machine has several advantages over the schoolboy: it can work rapidly, it will not get tired, and it will never make a mistake in following directions or in looking up words. People who have a large amount of material to be translated need immediate help. Perhaps the greatest advantage of the word-for-word proposal is that we can build automatic dictionaries now with our existing electronic technology.

The second school of thought in the field of mechanical translation is the one to which I belong. We are trying to eliminate some of the shortcomings of the word-for-word translation. We recognize that in the electronic technology of today we can build very powerful machines. Machines can tirelessly perform *routine* operations that have been *specified* for them. They can perform any manipulation of symbols that is useful for translation. Our problem is to find out what manipulations of the symbols are necessary in order to provide an output that is better than a word-for-word substitution. In a sense, the machines would not actually be translating; the persons who devised the routines would in effect, already have made each translation. They would have done this by foreseeing the various problems that the machine might encounter and by providing instructions for handling each situation. The workers who belong to this second school then, are not concerned much with the straight forward details of machines as with the more complex details of the *structure* and *form of languages*, and the *formal equivalences* that can be established. The task will be long and difficult because *today not nearly enough is known about languages and how we translate*. The task is a fascinating one because it has in it the elements of adventure and exploration beyond the borders of our sure knowledge.

The two main difficulties to be overcome in word-for-word translation are those presented by the multiple meaning of, the words and by the differences in the word order. These two difficulties can be restated in terms of two problems: the lexical, or terminological problem; and the grammatical, structural, or syntactic problem. The lexical problem is illustrated, perhaps in the extreme, in words of multiple meaning, such as the German "Zug," English "run," and French "faire." The second, or structural, problem is involved in the difference between "He had painted his house" and "He had his house painted." It is involved in the difference between "I have to work at home," and "I have the work at home". It is also involved in the two different meanings of "The book that he had to read was uninteresting."

It seems that many of the structural problems will yield under a systematic approach to grammar and syntax. If the various words can be properly placed in categories, and if the possible sequences of these categories can be listed, together with their equivalents in the second language, many structural problems will be solved. We shall then be able to specify the manipulations of symbols that the machine must perform in order to provide translations that will be considerably better than word-for-word translations. Of course, the resultant translations will still not be perfect. We shall do the easiest things first. Problems of idiom and style will be left for the reader of the translations to solve. There will always be work to do in improving the translating system.

One might wonder what effect the use of such machines would have in the translation profession. For a precedent we can look at the effect of automatic digital computers in the mathematics profession. These computers are so rapid in their work that they can, for example, perform arithmetic computations about as fast as a million men can perform them with pencil and paper. One might expect that the introduction of these machines would have resulted in mass unemployment among mathematicians. Exactly the opposite has happened. Since the machines are so fast, many calculations that were virtually impossible before, because of the large amount of computing involved, are being performed today. Demand for people to work with the machines has resulted in a severe shortage of mathematicians.

It seems quite likely that the same thing might happen if machines come into general use in the field of translation. The way will be opened to translate much more than is now possible. Millions of words will be translated roughly by machine. The existence of rough translations, adequate for many purposes, will call attention to many articles that are of merit. The demand for accurate, carefully made translations of these important papers will be increased. Thus the demand for competent translators will be greatly increased. In addition, there will be an urgent need for people with linguistic training and the ability to prepare the machine routines for different languages and different types of discourse, and to improve the quality of the output of the machine.