## Translation by Computer

There has long been an interest in language translation and, in particular, the prospects for automatic translation by computer. As a research psychologist who is concerned with both the translation process itself and with the quality of translations, I would like to add some recent observations.

In 1963, when we began our translation studies at the Institute for Defense Analyses, there was already considerable stirring among professional linguists and others about the efficacy of translation by computer or machine translation (MT). At that time we undertook the comparison of different modes of translation, that is. human translators versus different versions of MT. Recently we have been able to add to our observations from the output of the latest MT system that has become operational. Given the investment in the 1971 MT system and the shift to it from the earlier model, we can well ask, What have we gotten for our money? Has there been any qualitative improvement in MT as a result of recent developmental efforts?

In 1964, with the cooperation of the Air Force's Foreign Technology Division, we submitted a Russian paper for translation by the then operational MT system. However, no analysis of the output was done at that time, and the material has been dormant until now.

The installation of a new MT system prompted us to have the same Russian paper translated again in 1971.

The translations were prepared from an English paper containing 1680 words. A professional translator provided a Russian text from the English text. The Russian was then retranslated into English by MT (1964) and remained unedited (just as it came out of the computer). Two human translations by professional linguists (working independently) were also made in 1964.

Two versions of the translation by MT (1971) were produced, one unedited and one edited (that is corrected and revised by a bilingual editor). An additional human translation was made in 1971.

Two characteristics of MT output are (i) untranslated words and (ii) translated words that have two or more possible meanings in the target language (English in this case). Using each of these characteristics as a crude index of translation efficiency, differences between the 1964 and the 1971 MT systems were found to be slight and not consistently favoring one or the other system. The MT (1964) translation contained 1.2 percent untranslated words and 6.3 percent multiple meanings. The MT (1971) translation contained 2.3 percent untranslated words and 5.3 percent multiple meanings. None of the three translations by linguists contained either type of error.

An examination of the post-translation editing (available for the 1971 MT output only) showed that many changes had been made: each of the approximately 80 English sentences had had some editorial modifications, most of them extensive. About 35 percent of the English words printed by the computer had been altered by the editor.

In the case of the 1971 system, computer processing and print-out time was negligible, that is, only a few minutes. However, the rate of post-translation editing was slightly less than the rate of human translation. Manual translation worked at a rate of about 450 words per hour, and the bilingual editors worked with the computer printout at 400 words per hour.

It would be unwise to conclude on a less-than-optimistic note because of one set of observations. However, if our present data are at all indicative of the state of MT, it is apparent that little progress has been made during recent years. Moreover, I do not know of any demonstrated advantages of MT over

human translations. (Advocates of translation by computer will claim that the 1971 MT system is still developmental, but what computer-based process is not?) Other methods should be applied to determine the readability of translations. We are now collecting such data.

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