

5—THE FUTURE OF MACHINE TRANSLATION

By Yehoshua Bar-Hillel

TRANSLATION is AN ACTIVITY that requires, in general, a good amount of intelligence, in addition, of course, to a good knowledge of both languages involved, the source and the target language. With the advent of electronic digital computers, the question how seriously the term "intelligence" has to be taken in this context attained particular importance. By 1946, these computers had already proved their uncanny ability to carry out long and complex computations at enormous speed and great accuracy and thereby to perform tasks which had until then been considered to be the privilege of human intelligence. It was then that people began looking around in earnest for other activities requiring intelligence as candidates for automation and happened to hit upon translation as one such likely candidate.

It was, of course, quickly realized that there existed big differences between computation and translation. Whereas perfect algorithms (or working rules) were available for the performance of the elementary arithmetical and logical operations, of which every computable function is composed, so that only meticulous programming and craftsmanlike construction were required in order to ensure (almost) faultless computation by a computer that was able to perform these operations and was equipped with a large enough memory, no such algorithms were in existence for translation. Moreover, whereas the notion of a "correct" computation is unproblematic—leaving aside certain philosophical reservations which are irrelevant in our context—and, whenever approximations due to round-offs or other reasons are indicated, the degree of approximation is perfectly well determined, the notion of a "good" translation is ridden with problems and no serious criterion for the comparison of degrees of adequateness of translations is in view.

When, in 1951, I got myself interested in the automation of translation, I tried at first to find out what psychologists knew about

human translation, only to discover to my dismay that very little was known that was not purely anecdotal or speculative. Machine simulation of human translating having consequently been discarded as one possible approach, a "let's-see-how-far-we-can-get" attitude was generally adopted. Almost from the start there was a differentiation between those who thought that fully automatic and good quality translation was a reasonable goal to aim at and those who regarded such a goal as utopian, at least for the foreseeable future, and preferred to work towards a man-machine partnership in translation, with the machine doing the routine chores and the man making the "intelligent" decisions. At that time, however, this difference was based more on intuitive judgment (and temperament) than on rational deliberation, since no analysis of the translation process into "routine" and "intelligence-requiring" had yet been performed.

In the beginning, MT—the trademark of machine translation—made great strides forward. Already in 1952, it turned out that the hand-simulated output of certain machine programmes for Russian-to-English translation of scientific and technological material, based on nothing more sophisticated than a (simulated) mechanical dictionary in which each Russian word had one or more (or none, on occasion) English words or short phrases as its counterparts, was most of the time of such a quality that an English reader, expert in the appropriate field and with a good amount of effort and time, could make sense, and most of the time good sense, of it. In addition, the mechanical determination of syntactic structure made good progress, too, promising a further increase in the quality of the machine output and thereby a further reduction of the interpretative effort required of the reader.

Thousands of other major and minor problems found their solution. One quickly learnt how to deal with idioms, how to economize in the size of the dictionary, a step which was a practical necessity due to the then relatively small size of the rapid-access machine memories, how to optimize dictionary look-up, and so on.

Two years later a highly publicized demonstration was staged in the United States which, though proving nothing to the small group of experts, certainly had the effect of drawing MT into the public limelight and turning it into a battlefield of international prestige. Whereas until then MT had been studied only in the United States and England, immediately thereafter Soviet Russia moved into the field with such a concentrated effort that it became, within a couple of years, the leading country of MT. Other coun-

tries quickly followed suit, and today MT research groups exist in most European countries, as well as in the United States, Mexico, Japan, China and Israel. More countries will doubtless join in the near future.

There are three journals which are exclusively dedicated to MT, and many others willingly accept papers on this topic. Many national and international conferences gathered to deal with MT, starting with the 1952 conference at the Massachusetts Institute of Technology, which I had the privilege of organizing and which was "international" owing to the presence of a lone British participant, and coming to its climax so far with a conference held at Teddington, Middlesex, in the autumn of last year. I could easily go on and bolster the success story of MT with statistics about the amount of man-years and money spent on MT research in 1960 compared with, say, 1950. But let me spare the reader this.

In spite of all this rapid development, there are some who feel that MT has reached an impasse from which it is not likely to emerge without a radical change in the whole approach. It seems now quite certain to some of us, a small but apparently growing minority, that with all the progress made in hardware (i.e., apparatus), programming techniques and linguistic insight, the quality of fully autonomous mechanical translation, even when restricted to scientific or technological material, will never approach that of qualified human translators and that therefore MT will only under very exceptional circumstances be able to compete with human translation.

This "pessimistic" evaluation is based upon various considerations, only one of which will be presented here, and even this, for obvious reasons, only very shortly and therefore dogmatically. Expert human translators use their *background knowledge*, mostly subconsciously, in order to resolve syntactical and semantical ambiguities which machines will have either to leave unresolved or resolve by some "mechanical" rule which will ever so often result in a wrong translation. The perhaps simplest illustration of a syntactical ambiguity which is unresolvable by a machine except by arbitrary or ad hoc rules is provided by a sentence, say, ". . . slow neutrons and protons . . .", whereas, in general though by no means always, the human expert reader will have no difficulty in resolving the ambiguity through utilization of his background knowledge, no counterpart of which could conceivably stand at the disposal of computers. Similarly, there are innumerable semantical ambiguities which nothing but plain, factual knowledge or considerations of

truthfulness and consistency will resolve, all of which are beyond the reach of computers.

On the other hand, though the best present machine-produced "translations" of scientific material between languages with closely related syntaxes are "readable" in the sense that in many cases, though not in all, they convey to the expert reader approximately the same information as good human-produced translations, they do so only at the price of greatly increasing the load on the reader, estimated in one report to require about four times as much time as a human translation, in addition to a greater intensity of mental strain which cannot easily be measured and often borders on frustration. This is, of course, utterly intolerable, in general. In practice, therefore, unless this factor can be greatly reduced—and the prospects for such a reduction are none too good, in view of the above-mentioned limitations—the machine output will have to be "post-edited", before submission of the finished product to the readers.

Though I would regard it as likely that, at least for certain language pairs, the quality of a translation product of the combined effort of an appropriately programmed computer and a suitably trained post-editor (whose knowledge of the source language need not be very extensive, this "saving" then being the whole crux of the matter) would by and large be commensurate with that of purely human translation, and on occasion even better since the rough machine output might bring to the post-editor's attention possibilities which a translator might overlook, no such combination is economically feasible today. Nor it is likely to become so in the near future unless much more thought is given to optimizing the workings of such a partnership rather than to the doubtless intellectually much more exciting endeavour of establishing fully automatic, high quality translation.

Not even the advent of print-reading machinery will substantially change the picture. A good part of the savings which direct machine encoding will produce, as against human key-punching, might well be lost due to the fact that a machine will be helpless before very bad type or elementary misprints (which even a dull key-puncher could quickly be trained to correct while doing her typing), and not be able to indicate, as the key-puncher again could easily be made to do, which periods are full-stops, decimal points or abbreviation-indicators, &c., indications that would doubtless save the translation machine time and mistakes.

To sum this part up, I would say that there is no prospect whatsoever that the employment of electronic digital computers in the

field of translation will lead to any revolutionary changes. A complete automation of the activity is wholly utopian, since the fact that books and papers are usually written for readers with a certain background knowledge and an ability for logical deduction and plausible reasoning cannot be over-ridden by even the cleverest utilization of all formal features of a discourse. The hopes to the contrary which many of us had a decade ago just turned out to be by and large unrealizable. The quicker this is understood, the better are the chances that more attention will be paid to finding efficient ways of improving the status of scientific and technological translation—I am not qualified to discuss literary translation—including a judicious and modest use of *mechanical aids*.

Because of the great prestige value that has been attached to machine translation during the past decade, it is likely that in 1962 both the United States and Soviet Russia, and perhaps also other countries, will attempt to impress the world with a demonstration in which, say, a whole article in chemistry or electronics will be automatically translated from Russian into English (or vice versa), perhaps including a mechanical reading of the source text. Few newspaper readers, who will then doubtless be confronted with a reproduction of an original page and its "translation", will be in a position to evaluate the quality of the translation and might therefore be persuaded to regard this feat as another sputnik. They will be badly deceived.

Perhaps the following little (and admittedly very rough) computation could help to harden them against this propaganda effect: it takes a good human translator up to a couple of hours to produce a finished translation of a page from a Russian scientific article into English, and his fee would be, say, two pounds. The demonstrating machine will produce her output in something like a minute and would have charged about the same amount, had the translation been done commercially. Now assume that one hundred scientists will want to read this page. Reading the human translation would take them, say, six minutes on the average, altogether ten scientist-hours for a cost of, say, ten pounds. Reading the machine's output will take, say, twelve minutes on the average (which is half of what the above-mentioned estimate would give!), hence altogether twenty scientist-hours, for a cost of twenty pounds. The saving of two hours human translation time would cause the waste of ten hours additional reading time and of ten pounds additional reading cost. Notice that even if the next computer generation will be able to produce its output in ten seconds and for one pound,

this will make little difference so long as the quality of the output is not improved.

I have deliberately refrained from dealing with any of the countless speculations that create in the field of MT a science-fictional and sometimes lunatic fringe. At the best, as with regard to the speculations on the use of machines with learning and self-organizing abilities for translation purposes, they are premature; at the worst, they exhibit the free flight of fantasy at its wildest recklessness, and I would not have mentioned this point at all were it not that every so often I happen to meet otherwise serious and responsible scientists who have been taken in by these fantasies and gone overboard. But the borderline between imaginative creativity and reckless speculation is surely hard to draw, and no man, angel or machine, will ever develop an algorithm for drawing this line.

The Times Literary Supplement—April 20, 1962