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# Word-by-Word Translation

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When I learned that I had been summoned to address myself to the topic of word-by-word translation I felt like a geographer invited to discuss the utility of the conception that the world is flat. In short, I can only say that word-by-word translation is not possible, if we are to understand by the term a wordwise transverbalization from one language into another, particularly from German into English.

It was, indeed, the discovery of the impossibility of wordwise translation that prompted the syntactical investigation outlined in Proposals for the Mechanical Resolution of German Syntax Patterns. The research of the summer of 1950 was begun by translating word by word into English various German texts in the field of mathematics. Our efforts rapidly came to grief, chiefly because of the lamentable fact that the German "articles" are also "words", but words of Protean transformations when carried over into English. Take the harmless-looking little form der. A word-by-word transverbalization into English would require, to be complete, a listing of the following possibilities: "the" (der Mann); "of the" (der Frau or der Frauen); "to the, for the" (also der Frau); "he" (der kommt nicht); "her, to her" (der geb' ich's nie); "who" (der Mann, der kommt ...); "whom" (die Frau, der ich es gab) – and diverse other other more subtle variants. The other forms of the "article" require almost all equally complex transverbalizations. When to circumstances such as these there is added the distressing oddity of German word order, word-by-word translation from German to English becomes either a jest or a horror. To be quite sure of the impossibility of wordwise translation, we concocted diverse multiple-choice translations — primitive ancestors of Mr. Bar-Hillel's appendix to "The Present State of Research on MT" – and these translations we submitted to our mathematical colleagues, who could make no sense out of the gibberish and were thereby confirmed in their conviction that people who dabbled with MT were crackpots. In the appendix you can consult one of the less horrific samples that I found in my files and see for yourselves how tedious it is even to try to make one's way through such a transverbalization maze.

The happier results that can be obtained from block-by~block transverbalization, in which process problems of syntactic ambiguity are solved by the connection of each syntactic segment to the other, and the fluid German word order is resolved into a rigid English sequence, are, I take it, familiar to you from the Proposals. I think there can no longer be any doubt that the data of syntactical connection require us henceforth to think in terms not of word-by-word, but of block-by-block translation.

At this point I think it will be in order to defend myself briefly from the charge of having failed to realize the importance of producing "one sequential system" of syntactical operations. Quite on the contrary, I have always been of the conviction that such a system is a sine-qua-non of MT. I fear that my critic has "mistook me all this while," and that he, as a theoretician, has misunderstood my pragmatism.

The fact is that there can be only theoretical fascination, but no actua1 usefulness, in any complete system that is not devised for a specific mechanism and for a specific purpose. All sorts of complete sequential systems are possible, but we cannot determine which one will be most desirable for MT until we decide how MT is to be accomplished – what functions in the process are to be assigned to machines, what are to be left to human operators, and above all, in what fashion the vocabulary of the FL is to be transferred to the TL. There is no a priori "operational syntax." There are only operational syntaxes, whose elaboration will vary as the deviser's presuppositions and aims vary. Take Pollard's system, for instance, which I admire with more reserve than some do. It is "complete",

to be sure, but it presupposes a human translator with a grasp of what we vaguely call "the elements" of German, a translator who is, for instance, equipped to find his way among multiple choices of the sort I outlined above. Pollard's rule 1 is that when a noun (identifiable by capitalization) occurs on a "break" (comma, period, etc.) it is possible to translate word-by-word from the beginning of the sentence to the break in question. It is possible, that is, if the translator can recognize the patterns of syntactic connection and knows, or can establish, the significance of the meaning-bearing words — a task which, unfortunately, our poor machines, without benefit of "elements," are incapable of performing. All that the Proposals intended to demonstrate was that machines can be instructed to recognize syntactic connection. Any complete system will have to be devised to meet the operations of some specific machine or of some specific combination of man and machine.

Meanwhile, we must investigate the other sine-qua-non for block-by-block translation: the problem of the interpretation of the meaning-bearing words. Syntactic connection will almost infallibly identify word-function, and we now know that a recognition of syntactic connection can be built into the "memory" of machines of the high speed computer type. Word-meaning, on the other hand, is not a factor capable of being solved mechanically except by an elaborate reduction of the possibilities of multiple significance: that is by the production of a large — possibly very large — number of glossaries that pertain to one radically limited field of discourse.

I do not think we should discard the possibility of a mechanical solution of the problem of multiple meaning until we have explored it more carefully than has hitherto been proposed. I greatly admire Mr. Reifler's conception of an FL pre-editor – as, indeed, I admire all of his ingenious proposals. But I do not believe that his combination of pre-editor with a mechanical dictionary constitutes the ultimate solution of our problem. In fact, I am of the opinion that we must grapple with the problem precisely at the point where Mr. Reifler abandons it. His proposals are most enlightening for the solution of problems of general language, but he has excluded problems of specific language (the jargons of medicine, mathematics, linguistics, geology etc.) from the domain of mechanical solution. We shall be much closer to the realization of mechanical translation, if we can mechanize the components of his "mechanized" dictionary.

Mr. Bull's counts of function frequency and distribution, the purpose of which we have apparently failed to make completely clear, have produced fascinating results on which he will himself report. For my purpose it is enough to point out that he has demonstrated empirically something we have hitherto had to assume on the basis of impressionistic observation: the only meaning-bearing forms that we can purposefully isolate are nouns, verbs, adjectives, and — probably – adverbs. All the other "words" when transverbalized from one language into another are susceptible of such diverse interpretation that they must either, like the German article, be treated primarily as elements of syntactic connection, or else, like prepositions, be transverbalized in a multiplicity of meanings from among which an editor is expected to make his choice.

I shall have something to say later about the microsemantics of nouns, the only set of the meaning-bearing group I have studied. For the moment, let us take a generalized view of the problem. The point must be made that no system as yet proposed will solve the problem of multiple significance. A pre-editor can do much to simplify syntactic connection for mechanical "digestion," but I do not see how, as an operator in the FL, he can effectively guide either the machine or the machine and a post-editor through the mazes of multiple meaning in the TL. Nor do I think we can hope for much accurate help from one monolingual post-editor or even from one bilingual consultant. What has been overlooked is the fact that the competence required in the post-editor, even if he be bilingual, is only partially linguistic. The real prerequisite for him is an intimate knowledge of the field to which the translated text pertains.

Let us take the case of a hypothetical bilingual post-editor. He may have a perfect competence in translating literary German into English: he may have a working knowledge of geology, let us say, or of chemistry, or of anatomy, or of zoology, or— in an exceptional case — of all of these fields; but unless he knows mathematics well he is never going to decide that Menge in certain contexts must be translated "set" and not "quantity" or "multitude" or "mass" or "crowd" or anything of the like. I am

afraid that the appendix to "The Present State of Research in MT" is apt to be misleading. Although the text is apparently specific, it is actually in the nature of a passage from "General Science". Given the one key word "microscope," the remainder of the words fall rather readily into relationship to it. Fortunately almost any educated editor would be expected to know what a microscope is and what sort of functions are expected of it. On the other hand if the key-word were the name of some less generally familiar device — let us say an oscilloscope or a kymograph (as used in phonetics laboratories), only an editor familiar with the gadget and its uses could surmise what functions it might be expected to perform. Some of us have seen bilingual experts trying to make just the sort of interpretation proposed for a bilingual editor: professors of German deciphering the efforts made by graduate students to translate material in their field for the purpose of passing a language-proficiency requirement. The results are all-too-often simply ludicrous. One of my colleagues almost flunked a mathematics student for translating Eigenwerte by the apparently preposterous form "eigenvalues", though this is, nevertheless, the proper English equivalent of the German original in a mathematical context. The fact that the bilingual professor spoke German like a native and knew zoology quite as well as he knew Goethe contributed, you see, nothing to his interpretation of this particular translated text.

In short, no one post-editor, not even a bilingual, — unless he were a marvel of universal knowledge, in which case he would probably have something better to do than tinker with other people's texts – would be capable of solving the problem of multiple significance in the TL. A monolingual specialist in the particular field would unquestionably do far better. But in that case our process of MT would require a whole battery of monolingual experts, each of whom, if he would work on MT at all, would have to be taught the techniques appropriate to our operation, and each of whom would be susceptible to all the ills that flesh is heir to: human fallibility, death, illness, vacations, and better offers.

Before we surrender our mechanistic autonomy, I suggest that we thoroughly explore the possibility of substituting for specialists, mechanized special micro-glossaries – glossaries which will reduce the range of choice of meaning from a bewildering multiplicity to a matter of – at the most – two or three. In fact, if the field be radically limited, we can probably produce bilingual glossaries with a preponderance of one-to-one equivalents.

To resume my points in brief: word-by-word translation is literally impossible: the smallest unit with which we can operate is the syntactic block; the blocks can certainly be manipulated, either by mechanical operation alone or by a combination of pre-editing with mechanical operation, in such a way as to resolve patterns of syntactic connection and of word order from the FL into the TL; identification of meaning in the TL cannot be facilitated efficiently by a pre-editor; a monolingual — or even bilingual — post-editor could be useful for producing a smoothly flowing text in the TL (e.g., solving the special problems of idioms, making satisfactory choice of significances for prepositions and conjunctions), but he cannot be expected to make choice among multiple significances for meaning-bearing forms in specialized contexts; therefore indispensable would be either a battery of post-editors with an intimate knowledge of diverse fields of specialization, or a body of separate mechanical micro-glossaries.

One of our immediate problems is to determine whether we actually have a choice between specialist post-editors and micro-glossaries; that is, whether micro-glossaries can be devised. Thereafter we should have to determine which choice would provide greater efficiency.

**Appendix** to Word-by-Word Translation

Running Substitution
(page 1 of Joos Kaluza, "Höhere Mathematik")

Note: Choice must be made whenever variances are supplied in parenthesis.

111. Permutation(s). The combination(s) concern(s) self with the (of the, which) arrangement(s) of(from) thing(s) whose nature(s) indifferent is and the(which) we element(s) call(s) will.

It be now a number(s) various element(s) given the(which) we after(accord-ing to) some principal(s) order(s). We can for instance each(every) element(s) through(by) a number(s) designate(s) and the element(s) in the(of the, which) sequence(s) the(of the, which) natural number(s) put down. We can but(however) also some other(s) sequence(s) choose and designate(s) each(every) arrangement(s) as a permutation(s) the(of the, which) element(s). We ask(s) now: how much(many) different arrangement(s) [permutation(s)] of(from) element(s) are(is) there? We begin(s) with 2 element(s) the(which) 2 permutation(s) give(s). Add(s) we a third to so can we this(of this) in(at) each(of each) the(of the, which) two(both) permutation(s) in(at) the 1st 2nd or 3rd place(s) put(s) 3 element(s) give therefore 2*3 permutation(s). A added 4th element(s) can its(his) place(s) in(at) each(of each) the(of the, which) 6 permutation(s) again at(on, in) 1st 2nd 3rd or 4th place(s) have there is(are) therefore for 4 element(s) 1*2*3*4 permutation(s). One recognize(s) immediately the general law(s):