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Some Problems of the Mechanical Translation of Languages

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by

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The present paper has a twofold aim: First it intends to create interest at our University for a problem to which much thought, time and energy is already being devoted elsewhere. Second it will attempt to outline one possible approach to the solution of the problem with the intention to receive as much constructive and destructive criticism as possible. This approach was able to consider only the small number of languages of which I have some knowledge, actually only German, English, French, Latin, Greek, Chinese, Japanese and Hebrew. It stands to reason that on account of this limitation, I must have ignored a number of peculiar language problems which have to be considered for the purposes of mechanical translation. Here your specialized knowledge will be very important. In the opinion of one of the electronic computer experts whom I am going to quote further below, such machines could already be used for mechanical translations without any modification of their design.

Thus the problem of mechanical translation is now rather a linguistic than a mechanical problem. However, from the very outset I have to stress that we are here not concerned with the so-called primitive, or, perhaps, better the non-literary languages. We are concerned only with literary languages, and among these only with those which are of practical value for mechanical translation. Finally I should like to add that I am by no means an expert on mechanical translation. As a matter of fact, experts on mechanical translation do not yet exist today. The problem is entirely new and therefore rests entirely with the general linguist and the engineer.

Anybody who knows something about the multiple differences not only between

unrelated languages, but also between related languages cannot help being very sceptical about the possibilities of a mechanical translation from one language into another.

You can, therefore, imagine my feelings when in October 1949, I received from Dr. Warren Weaver, Director, The Natural Sciences, The Rockefeller Foundation, a copy of his manuscript dealing with the problem of mechanical translation.

I was, at first, surprised at being the recipient of such a manuscript, for I had never before concerned myself with such a problem. This, however, was soon explained. Dr. Weaver, after pointing out in his manuscript that "there are certain invariant properties which are,.....not precisely but to some statistically useful degree, common to all languages", refers to a report in the periodical Science about a paper I had read the year before at the Annual Meetings of the American Philosophical Society, demonstrating a number of cases of analogous semantic change in Chinese and other, unrelated, languages.

Fully realizing and anticipating the great volume of scepticism the mere suggestion of the possibility of mechanical translation is bound to face, Dr. Weaver prefaces his manuscript with the following words:

"I have worried", he says, "a good deal about the probable naivete of the ideas here presented; but the subject seems to me so important that I an willing to expose my ignorance, hoping that it will be slightly shielded by my intentions."

After mentioning that "his attempt to interest (Professor Norbert) Wiener (of the Massachusetts Institute of Technology).....failed to produce any real result", Dr.Weaver informs us that the problem of mechanical translation has been seriously considered elsewhere, namely in Prof. J. D. Bernal's department in Birkbeck College, University of London. In a memorandum dated February 12, 1948, Dr. Andrew D. Booth, who had been active in computer design and construction, said:

"A concluding example, of possible application of the electronic computer,

is that of translating from one language into another, we have considered this problem in some detail and it transpires that a machine of the type envisaged could perform this function without any modification in its design."

On May 25, 1948, Dr. Weaver visited Dr. Booth in his computer laboratory at Welwyn, London, and learned that "they had, at least at that time, not been concerned with the problem of multiple meaning, word order, idiom, etc.; but only with the problem of mechanizing a dictionary."

Dr. Weaver then mentions newspaper reports about "the use of one of the California computers as a translator," The published reports did, however, not indicate much more than a word - into— word sort of translation and, according to Dr. Weaver, there has been no indication of how the problems of multiple meaning, context, word order, etc., were to be handled.

Dr. W*eaver* then goes on to say that these computer translation schemes did not seem "to give an appropriately hopeful indication of what future possibilities may be," "These possibilities", he says, "should doubtless be indicated by persons who have special knowledge of languages and of their comparative anatomy." Nevertheless, at the risk of being foolishly naive", as he says, he then indicates "four types of attack."

The first type he discusses in a section entitled "Meaning and Context." The idea is to make use of what he calls the "micro-context", to settle the difficult cases of ambiguity. The brain of the electronic computer would here consider the immediately preceding and following words before making up its mind, that is to say, before setting in motion distinctive mechanical processes resulting in a more or less accurate translation.

The next section, headed "Language and Logic", refers us to a theorem of McCulloch and Pitts published in 1943 (Bulletin of Mathematical Biophysics 5, pp. 115-133) which says "that a robot (or a computer) constructed with regenerative

loops of a certain formal character is capable of deducing any legitimate conclusion from a finite set of premises." Dr. Weaver, stressing certain alogical elements in language, such as intuitive sense of style, emotional content, etc, is here pessimistic about the problem of literary translation, but believes that "insofar as written language is an expression of logical character, this theorem assures one that the problem is at least formally solvable.

The third type of attack, under the heading "Translation and Cryptography", considers every foreign language text as a coded form of an English text. In Dr. Weaver's own words, "it is very tempting to say that a book written in Chinese is simply a book written in English which was coded into the "Chinese code." If we have useful methods for solving almost any cryptographic problem, may it not be", he asks, "that with proper interpretation we already have useful methods for translation?" He stresses that "this approach brings into the foreground..... the statistical character of the problem. 'Perfect' translation", he says very correctly, is almost surely unobtainable." But "processes, which at stated confidence levels will produce a translation which contains only X per cent 'error', are almost surely attainable", he concludes. He furthermore emphasizes "that statistical semantic studies should be undertaken as a necessary preliminary step."

"The cryptographic-translation idea", he continues, "leads on to the fourth and most general suggestion, namely that translation make deep use of language invariants," He calls this approach the most promising one, namely one "that goes so deeply into the structure of languages as to come down to the level where they exhibit common traits." He elucidates this point by the following very pictorial description:

"Think", he says, "by analogy, of individuals living in a series of tall closed towers, all erected over a common foundation. When they try to communicate with one another they shout back and forth, each from his own closed tower. It

is difficult to make the sound penetrate even the nearest towers, and communication proceeds very poorly indeed. But when an individual goes down his tower, he finds himself in a great open basement, common to all the towers. Here he establishes easy and useful communication with the persons who have descended from their towers."

"Thus may it be true that the way to translate from Chinese to Arabic, or from Russian to Portuguese, is not to attempt the direct route, shouting from tower to tower. Perhaps the way is to descend, from each language, down to the common base of human communication.....and then re-emerge by whatever particular route is convenient,"

So far Dr. Weaver. As you will see from the following, I have worked along the lines of this fourth suggestion of Dr. Weaver. I have tried to find, in the divergent structures of towers representing a number of different literary languages important for mechanical translation, for each of our 3 important problems, namely multiple non-grammatical meaning, divergent expression of grammatical meaning and different word order, 3 common levels on which I can build 3 basements linking the staircase of one language tower to the staircase of another language tower. It is fundamentally the same problem as that involved in the process of adding up 2 or more fractions with different denominators. In order to do so, we have first to find a common denominator.

A detailed discussion of all issues raised in this investigation and of the suggestions for meeting them transcends the possibilities of to-night's meeting. I have embodied them in a manuscript of 51 typewritten pages. To-night, I shall be able to give only a rough outline. Before I begin with this, I should like to emphasize that this approach by no means pretends to have solved all or, as a matter of fact, any of the problems involved. It is only an attempt to indicate one of the ways in which they may be solved. As I have indicated before, I shall

be very grateful for any positive and negative criticism and suggestions.

The ultimate aim of all translation is to make thoughts, garbed in an unfamiliar kind of symbolization, intelligible—whether the unfamiliar symbols are speech noises, graphs or others. Furthermore, translation is only possible if all possible thoughts are somehow expressible in all languages, whether by the traditional means at their disposal, or by new formations out of traditional forms, by new indigenous creations, or by loan translations and loanwords. Here we refer to Bloomfield's statement that "as to denotation, whatever can be said in one language can doubtless be said in any other....." (Language, p. 278). This is, of course, also a condition for mechanical translation. However, since all mechanical translation requires the mechanical correlation of semantically distinctive symbols of at least 2 languages, we have to add another condition, namely:

Mechanical translation is only possible if the existing or potential common thought treasure of the languages concerned is expressed or expressible by semantically distinctive symbols.

Mechanical translation can, of course, be based either on the phonic form or on the graphic form of language. We can, for instance, set a translation mechanism into motion by speaking into a receiver, or by dialling written forms of language into an apparatus similar to a modern desk telephone. In our study we have limited ourselves to the graphic form because the languages which are of importance for mechanical translation mostly happen to be those with a historical script semantically by and large more distinctive than their respective modern spoken forms. We are therefore, for instance, not concerned with homophones, but with homographs and, furthermore, we are concerned with these homographs irrespective of their historic origin. That is to say that for our purposes we consider the graphic form of a word with multiple meanings not as one graphic form of one word, but as as many homographs as there are meanings.

There are 2 important motivations for the creation of mechanized translation,

namely first the desire to make translation independent from the polyglot, and, second, the desire to speed up the process of translation. This immediately poses the following question:

"To what extant can translation be mechanized, or, what stage or stages in the process of translation can ultimately not be mechanized?"

Here we have come to the realization that the machine cannot, at least at the present stage of computer development be interposed between the ultimate reader of the translation and an un-edited original text, but, only between the ultimate reader of the translated text and an original language text that has been especially prepared for the requirements of the computer by a trained editor familiar with the original language. On the other hand, the linguistic abilities of this editor do not need to go beyond a familiarity of this one language. The minimum, and also the maximum, requirement for mechanical translation on the human sphere on both sides of the assembly line is—-as far as the language problem is concerned, a monoglot. That is on one side a person required to know no more than the foreign language concerned, and on the other side persons who need to know no more than the language into which the foreign text has been translated.

As we shall see further below, questions of multiple non-grammatical meanings, of divergent expression of grammatical meaning and of different word order have to be dealt with by a human editor. This part of the translation process cannot be mechanized. However, the selection of the incident meaning in the case of multiple non-grammatical meanings can be speeded up by a mechanized dictionary. All other aspects of the translation process can be mechanized.

Thus the foreign language text has to be edited before it is fed into the computer. But this editing does not need to go beyond certain limits. Apart from those problems of inexplicitness which concern lexicon and grammar, all other forms of semantic inexplicitness of a foreign language text are of no concern for

mechanical translation. Here belong, for instance, difficulties of philosophical or philological interpretation, those due to lack of specialized knowledge of the foreign text editor, lack of precision, whether intended or unintended by the author, etc., etc. Also a nonsensical or grammatically incorrect foreign language text can be mechanically translated. The computer is not expected to correct an ambiguous or faulty foreign language text. In this respect the "Golden Rule of Mechanical Translation" is:

"The translation does not need to be more intelligible than the original".

Very important in this connection are continuous reference numbers accompanying every written word of the edited foreign language text and automatically added to the translation by the translation mechanism. These numbers permit to refer back to the original in the case of semantic or other difficulties. The process of referring back can, of course, be speeded up by mechanization.

It is clear that the exclusion of the interpretative part of translation from the mechanization process and the resultant necessity of editing the foreign language text means an enormous slowing down of the mechanical translation process. Will under these circumstances mechanical translation be able to compete with a polyglot translator?

Before we can answer this question, we have first to know:

1) What the editor is supposed to do, and

2) what the translation mechanism is supposed to do with the edited text.

And again, before we can answer these questions, *we* have first to become acquainted with the concept of "absolute and attributable universals". You are familiar, of course, with the problem of language universals which Dr. Weaver calls language invariants. Bloomfield, for instance has said: "A task for linguists of the future will be to compare the categories of different languages and see what features are universal or at least widespread" (Language, p. 270), and again he

says: "...a form class comparable to our substantive expressions, with a class-meaning like 'object', seems to exist everywhere....." (ib., pp. 270,271).

But, apart from a large number of universals actually shared by many languages, there exists also another kind of universals which we may call "pseudo-universals", namely features in languages to which we arbitrarily impute characteristics of certain wellknown universals because either out of ignorance or for practical purposes, one often attributes to them functions and meanings they actually do not have within their native framework. Let me exemplify this:

Japanese "hito ga kuru" corresponds in meaning to English "a person comes." "Hito" means "a person", "kuru" means "comes." "Ga" is a particle which is conveniently explained as a formal indicator of the nominative case of the preceding noun expression. But in fact "ga" is by no means a particle denoting something like a nominative case, but a particle denoting something like a genitive relation. Sansom says in his Historical Grammar of Japanese: "Ga is by origin a genitive particle. It establishes.....a possessive relation between the two elements which it connects" (p. 231). And earlier, when discussing the Japanese particle "no", the common genitive particle in modern Japanese, he says: "hito no kuru"..... literally can be translated 'a person's coming', 'a person's going on a journey.' But, because the relation between hito and kuru . . . . . is not so much possessive as attributive, such phrases in Japanese tend to be regarded as complete statements corresponding not so much to 'a person's coming' as to 'a person comes.' This tendency", Sansom continues, "is even more marked in the case of the other genitive particle, ga. The sentence hito ga kuru is the usual equivalent of 'a person comes' in the modern colloquial. It is difficult to trace the process by which these usages have developed. They go back to a stage of language where there is incomplete differentiation between substantive and verb . . . . . In modern English an analogy may be found in newspaper head-lines such as 'Death of Jones',

which is another way of saying 'Jones is dead'."(pp. 227,223). So far Professor Sansom. Thus Japanese "ga" is by no means a nominative particle, although the descriptive linguist may in terms of his descriptive system and within the frame of reference of modern Japanese conveniently describe it as a particle denoting the actor. Nor is "kuru" here a verb expression but a noun expression. The Japanese do in this case actually not express the idea "a person comes" by something like "a person comes", but by something like "the coming of a person." It is as if they first become aware of something coming and then that it is a person that comes, and they, therefore, mentally and grammatically subordinate the actor to the action. For all practical purposes, however, we may attribute the function of a nominative particle to "ga" in sentences of this type and then proceed to say that Japanese shares in the fairly widespread feature of a formal indicator of the nominative case or of the actor in sentences of this type.

We are able to impute a more or less general universal character to a very large number of features in many languages and many language teachers actually are doing this daily for practical purposes. This may cause the linguist to shudder in horror. But this fact is extremely beneficial for mechanical translation. For it enables us to devise special arbitrary universal symbols for purposes of graphic distinctiveness in a much larger number of cases than would otherwise be possible. Such arbitrary universal symbols, when added to the foreign language text by the editor, cause specific mechanical reactions in the translation mechanism. These additional symbols are our, or better the editor's, instructions to the computer telling him what to do with the text and its non-grammatical and grammatical meanings and also with its word order. This text and instructions are, before they are fed to the computer, mechanically transformed into positionally distinctive holes on punchcards (see specimen). Computers designed on the lines of those already in existence and used to carry out all sorts of mathematical operations could very well digest a language text and instructions if these have been transformed into

such punchcard holes.

Now consider a series of computer units each of which represents a mechanical correlation between one and the same language and one of the many other languages selected for mechanical translation. Thus there would, for instance, be an English-French unit, an English-Russian unit, an English-German unit, an English-Arabic unit, an English-Chinese unit, an English-Japanese unit, etc.etc. Each unit has its peculiar mechanical brain correlating English with the particular language concerned. If we now feed one and the same punch card carrying an English word with instructions successively into all these units, all units will do different things with it. They will in one case translate the same English word into French, in the other cases into Russian, German, etc. And they will also carry out the same instructions differently, namely according to the requirements of the languages for which they have been designed.

This, however, is only possible if we have previously done several things, namely: 1) if, making ample use of absolute and attributable universals, we have settled the problem of grammatical meaning and word order and devised a universal additional symbolization for them, and 2) if we have settled the problem of non-grammatical meaning and devised universal additional symbols for the graphic distinction of multiple meaning,

Since our approach is not based on speech but on the graphic form of speech, we are not concerned with the comparative semantic differences themselves – whether they are differences in metaphor or in meaning areas, nor are we concerned with the comparative differences in the formal expression of grammatical meaning and word order. What we are concerned with is only the difficulty presented by the comparative irregularity of distribution of the graphic explicitness of non-grammatical and grammatical meaning and word order. A certain word order position is in one language grammatically important and, therefore, graphically explicit, but not in another language. Two meanings of one word are graphically explicit in one case (i.e. German "wieder" and "wider", but not in another (i.e. "to bear a child" and "to bear

a burden"). English "love" may be a verb or a noun, whereas these two grammatical meanings are graphically explicit in German where we have "Liebe" and "lieben".

Our main problem is here to find common denominators for all languages selected for mechanical translation. I shall first discuss the problem of grammatical meanings not linkable to word order (examples: tense, as different from subject, adverb). The procedure I suggest here is one which I call The Arbitrary Levelling Of Graphic Explicitness of Grammatical Meaning. It is based on two demonstrable facts, namely:

1) All possible grammatical meanings of all selected languages are comparatively limited in number and even more limited for each set of two languages concerned in the mechanical translation process.

2) They are, moreover, either absolute or attributable universals.

On the basis of these two demonstrable facts the difficulty presented by the irregularity of distribution of graphic explicitness of grammatical meaning can be overcome in the following way:

For the purposes of mechanical translation we arbitrarily consider all grammatical meaning of the contexts of all selected languages, whether graphically explicit or not, as zero-represented, that is as non-existing. We then raise all contexts of the selected languages to the same level of graphic explicitness of grammatical meaning by means of universal additional symbols which we devise for them. Thus, for instance, English "decide, decides, deciding, decided" are treated by all computer units as if they all were English "decide" and they are all correlated to one French, German, etc. word, namely French "decider", German, "entscheiden", etc. English "he decided to go" then becomes "he decide go", that is, in this particular case it assumes a grammatical form analogous to its classical Chinese equivalent (in other cases there will, of course, still be a difference in word order). The same universal additional symbols indicative of the grammatical meanings involved, added to the English and the Chinese text, make both graphically equally explicit. In the process of mechanical translation the additional symbols are added at the

starting point of the production line by the editor, on the other end of the production line they are added to the grammatically colourless translation by the computer.

The same is, mutatis mutandis, suggested for word order. But here our study showed that we can here go one step further in the direction of mechanization. We first decide on an arbitrary universal word order in which the functions of what is traditionally called the subject, predicate, direct object, indirect object, attributive adjective, adverb, preposition or postposition, conjunction, etc. etc., are expressed by fixed positions. Each of the positions we denote by a special symbol, for instance a Roman number. We then arbitrarily consider for our purposes all rules of word order in all selected languages, whether semantically relevant or not, as non-existing. The editor of the text to be translated will then add to every word of his text that Roman number of our arbitrary universal word order system which, in terms of absolute or attributable universals, is expressive of the grammatical function associated or associable with the word concerned. This will make this word semantically distinctive in terms of our arbitrary universal word order system. But whereas in the case of grammatical meanings not linkable to word order discussed above the respective additional symbols appear not only in the original text but also in its translation and have then by the ultimate reader to be transformed into the grammatical forms required by his language, we can mechanize, as we have already said, this stage of the translation process in the case of word order and the grammatical meanings associated or associable with it. We have indicated this already above when discussing the use of punchcards in connection with a series of computer units. One and the same punchcard, carrying the universal arbitrary word order instructions in the form of positionally distinctive holes will cause different reactions in each computer unit as it passes along from unit to unit. In the English-French unit it will correlate one and the same Roman number represented by a distinctive hole to the word order position required by French in this particular case.

In the English-Russian unit the correlation will be with the word order position required by Russian in the same case, and so on and so forth. Thus the original word order can through the medium of the imaginary universal word order be reshuffled into the word order required by the language or languages into which we wish to have the original translated. This reshuffling process is made possible by the fact that computers are able to store information, that is, to hold up final action, until such tim e that all instructions have been received. The final instruction causing final action concerning one word, a sequence of words forming an idiomatic unit, a clause, a sentence, etc. etc., has the form of spacing and punctuation symbols indicative of the completion of one word, a word sequence forming an idiomatic unit, a clause, a sentence, etc. Once this final instruction has been received in the form of distinctive punch holes representing space or punctuation symbols, the computer makes the stored words or word sequences in their translated form "drop out" of line in the sequence required by the word order principles of the language characteristic of the computer unit.

For example let us assume that Roman I, typed to a written word of the original text, denotes the subject, II the adverb, III the auxiliary of mood, IV the principal verb, and V the direct object. And let us assume that the sentence to be translated is "you should see him tomorrow". This sentence would then, after the editorial preparation, look like this:

"You I should III see IV him V tomorrow II".

Now in the English-German unit Roman I is mechanically correlated to German 1, II to 4, III to 2, IV to 5, and V to German 3. This means that the universal word order is automatically reshuffled from:

"You tomorrow should see him" into the German word order:

"You should him tomorrow see", that is in German:

"Du sollst ihn morgen sehen".

In the English-Japanese computer unit Roman I is correlated to 1, II to 2, III to 5, IV to 4 and V to 3, resulting in the Japanese word order: You tomorrow him see should (nanji myonichi karewo miru-beshi).

At last we come to the most difficult problem, namely that of non-grammatical meaning. Take for example the English sentence: "you can lick him", suggested to me by Professor Poppe as a striking example. Here both "can" and "lick" present the problem of multiple meaning. A computer, if not given explicit instructions what to do with the meanings of these 2 words, may create such havoc, that the resultant translation becomes unintelligible in any other language. For English "can" denotes a variety of meanings, such as physical ability, possibility, permission, etc. On the other hand "to lick" means "to pass one's tongue over", "to outdo" or "beat somebody", etc.

Here we have to distinguish first of all between 2 types of non-grammatical meaning, namely:

auxiliaries

1) those characteristic of certain form classes, such as/of mood and pre- or postpositions, and

2) other non-grammatical meanings.

It is peculiar to all possible non-grammatical meanings characteristic of certain form classes that their distribution over the members of the form class concerned in many cases varies between each set of 2 languages. Thus for instance in the subform class of auxiliary verbs of mood the central meaning of German "koennen" (to be able) is also the central meaning of English "can" and of Chinese "neng2" (能). But of its transferred meanings "to be possible" (es kann sein) and "to be permissible (du kannst hingehen) the first is the central meaning of English "may" (German "moegen"), as for instance in "it may be" (es mag sein), and the transferred meaning of Chinese "k'o3" (可), whereas the second is the transferred meaning of English "can" (you can go now) and also of English "may" (you may go now), and the central meaning of Chinese "k'o3" (可). An analogous situation is peculiar to the form

class pre-or postposition. Since, however, in all selected languages, all possible meanings associated or associable with the sub-form class "auxiliary of mood" and with the form class pre-or postposition are numerically very limited and since they are in these languages absolute or attributable universals, a group treatment is here possible. This group treatment is analogous with that accorded all grammatical meanings described above, whether they are linkable to word order or not: The incident meaning of all possible meanings of these form classes is by the editor indicated by an arbitrary universal symbol making this meaning graphically distinctive and thus digestible for every computer unit.

As for the non-grammatical meanings not characteristic of certain form classes the time at my disposal today permits me to mention only 2 different cases, namely:

1) those exclusively associated or associable with particular grammatical functions and

2) those not associated or associable with such functions.

An example is Chinese "kuangl" (光). If we are, for instance, concerned with a translation from Chinese into English, than this "kuangl", in terms of the Chinese-English computer, as a noun means "light", as an adjective means "shining, brilliant", "polished, bald, naked", and as an adverb it means "only". Another example is English "light" which, in terms of the English-German computer, as a noun means German "Licht", as a verb means "leuchten" and as an adjective means either "hell" or "leicht". Such cases can be easily dealt with. For the arbitrary universal word order symbols discussed above are all expressive of such grammatical meanings and thus simultaneously serve to make the non-grammatical meanings involved graphically distinctive and thus digestible for all computer units.

But how about those multiple meanings which, forming the overwhelming majority, cannot be tagged on to any form class or grammatical meaning. For this residual element there is only one solution, namely a mechanized dictionary. This mechanized dictionary is interposed between the editor dialling the language text into the trans-

lation mechanism and the computer unit and it is so arranged that when a word with multiple non-grammatical meanings is dialled, it flashes on a screen a dictionary page giving in the language of the original text, but in consideration of the semantic peculiarities of the language or languages into which we want to translate, descriptions and definitions of all possible meanings accompanied by consecutive numbers. These numbers the editor adds and dials after the word concerned making the incident meaning graphically distinctive and so digestible for all computer units. Thus, for instance, to use the same example, "You can lick him" would then appear in the form:

"you I can III lick 2 IV him V"

in which the Roman numbers indicate the imaginary universal word order system, whereas the arabic 2 indicates that "lick" here means "to outdo" or "to beat".

Well, ladies and gentlemen, this is, as said before, only a very rough outline of this approach and its suggestions. After this we can now answer the question posed previously, namely:

"Will under these circumstances mechanical translation be able to compete with a human polyglot translator? The answer is definitely very strongly in the affirmative. We have, however, here to distinguish 2 cases, namely:

1) translation of a text into only one other language. We call this Singular MT.

2) translation into many languages. We call this Plural MT.

Singular MT will be more affected by the delay due to the necessity of editorial work than Plural MT. On the other hand, a large amount of editing necessary in Plural MT will in certain cases be unnecessary on account of the closer agreement between certain languages, for instance between German and English. Furthermore in languages like Chinese and Japanese, both very important for mechanical translation, Singular MT will still be much quicker than human translation, because the "brain" of the computer and of the mechanized dictionary will contain an enormous amount of information difficult to acquire and to retain by either a Far Eastern or Western polyglot, and because its

memory is superior to theirs. A human translation from any of these languages is much more difficult and time consuming than the editing done by a native editor. Here mechanical translation will be of enormous value. But also in the case of all other selected languages Singular MT will save a lot of time and energy because what I would call "the large bulk" of the translation business would be done by machines, leaving only errors of human and mechanical origin to be straightened out with the help of the reference numbers and also, of course, the work of stylistic polishing.

But as far as Plural MT is concerned, there can be no doubt that mechanical translation will be incomparably quicker and cheaper than human translation since one and the same editing of a language text serves for the mechanical translation into all selected languages.

As far as both Singular and Plural MT are concerned, I may add that important factors in the race between computer and man will be:

1) Specialization and division of work on the editing side and

2) the mechanized dictionary, although we have to realize that such a dictionary can also be made available for the human translator.

P.S.: The principal question raised by the audience after hearing the paper was that of idiomatic sequences. My answer was:

Idiomatic word sequences do not constitute any problem for mechanical translation because they are graphically distinctive. The mechanism of the mechanized dictionary is envisaged as built in such a way that, after the final letter of the last word of an idiomatic sequence is dialled, a noise (for instance, the ringing of a bell) draws the attention of the editor to the fact that – in terms of the semantic peculiarities of the language or languages into which the original is to be translated – an idiomatic sequence is involved. He will then by a special additional symbol (for instance underlining the whole sequence) indicate that the idiomatic word sequence is to be considered as one word and as such to be typed into the translation mechanism (that is without spacing the individual words constituting the idiomatic sequence). It is the consideration of the "micro-context" which makes such sequences graphically distinctive for the punchcard mechanism.