

CONFERENCE ON MECHANICAL TRANSLATIONS

Massachusetts Institute
of Technology

June 17-20, 1952

Reported by A. C. Reynolds, Jr.

General Background - Mechanical Translation

The concept of mechanical translation originated in two areas, the first being cryptographic work conducted by various governments during the late war, and the second being the successful inauguration and employment of the simultaneous translation schemes presently being employed by the UN and other international conferences. Broken down into basic essentials, translation consists of memory scanning for identification of meaning in two different symbolic systems, called languages, and simultaneous editing by the translator to convert the syntactical relationships of the language being translated to those of the translated language. Of these, the memory scanning is definitely paralleled in computer techniques. If one to one correlations in meaning existed between words of different languages, programming on existing computers would be completely successful. Syntactical relationships and shading of meaning by the context of the words makes the problem of mechanization exceedingly difficult in the absence of a mechanical means of converting from one syntax to another.

Much work was stimulated by a memorandum written by Dr. Warren Weaver of the Rockefeller Foundation which was distributed to a selected group of linguists, psychologists, computer engineers, and philosophers. Dr. Yehoshua Bar-Hillel, acting under a grant from the Rockefeller Foundation and currently conducting his research at MIT, acted as the coordinator of the groups actively interested in mechanical translations. As part of his work, Dr. Bar-Hillel prepared a summary entitled "Present Interest in Mechanical Translation," listing the individuals actively working on the application of computers and computer techniques to mechanical translation.

These two letters contain pertinent information regarding the history and background of mechanical translations prior to the first conference on mechanical translation, and are appended to this report. A list of the participants in the conference and the program of the conference are also appended.

The proceedings of the conference, except for the open public session, were recorded by stenotype. The complete proceedings will be published as a book in the near future. The book will contain the full papers

presented before the conference and also all of the discussion that took place regarding the contents of the papers and the concepts formulated by the participants as the conference progressed. The complete set of papers is available and on file in the Endicott Laboratories for the use of interested persons during the necessary time lapse before publications of the proceedings. The main body of this report is concerned with providing a precis of the papers.

Session I - June 17, 1952
Public Session

The Public Session of the Conference on Mechanical Translation was announced by invitations extended by Dr. Yehoshua Bar-Hillel to persons who might be interested in the problems of mechanical translation, and, in particular, to members of the Conference on Linguistics which immediately preceded the Conference on Mechanical Translation. The program followed at the public session is appended to this report. Papers were not presented, but short talks were given by each of the five participants outlining their work in the field and their tentative proposals for future work.

Dr. Bar-Hillel discussed the need and possibilities for mechanical translation, the need primarily arising in the fields of science and of diplomatic analysis of popular periodicals of various countries. Although a person may be versed in the cultural or popular language of several countries, this does not necessarily mean that the same individual is capable of translating scientific treatises originating in the same countries. This is due to the well known fact that each scientific discipline creates its own jargon, assigning very specific meanings to common words of the language, these meanings being peculiar to the particular science itself. There is, therefore, a need for translators who are capable of making meaningful interpretations, not only in the more popular writings, but also in specific areas of scientific research. The volume of material appearing in popular periodicals is appalling in its magnitude and complete scanning of a particular nation's output is virtually impossible as long as human translators must be relied upon. He concluded that it is in these areas that mechanical translation is capable of making a major contribution to society.

Prof. Leon D'Ostert, Director of the Institute of Languages and Linguistics, Georgetown University, Washington, D. C., spoke on the subject of human translation versus machine translation. Prof. D'Ostert drew on his experience in setting up the translation system employed at the Nuremburg trials in Germany and in working with IBM in the development of the simultaneous translation system used at the UN and other international conferences. In discussing this problem, he made the statement that, except in the very specialized areas discussed by Dr. Bar-Hillel, there is no shortage of human translators, owing apparently to the fact that the current workload is regulated by their availability. The contribution a machine can make is in the processing of the vast amount of material that is currently not even being touched in the specialized fields. He described systems employed in setting up efficient

simultaneous translation systems and also rapid printed translations in international gatherings. The systems he employed were remarkably similar in their organization to machine organization for computer application. He concluded from his acquaintanceship with computer techniques that mechanical translation is possible.

Dr. Olaf Helmer, Director of Research, Mathematical Division, Rand Corporation, Santa Monica, California, discussed the structure of the problem of mechanical translation. Meanings of particular words and phrases may be idiomatic or may be changed or modified by the context in which they appear. Further, each group of languages has its own syntactical relationships which are peculiar to the group, and most frequently also vary in minor details among members of the same group. The machine must be capable of resolving idiomatic, contextual, and syntactic ambiguities if human editing is to be kept at a minimum and maximum intelligibility is to be achieved. Dr. Helmer discussed schemes that have been tentatively investigated by the Rand Corporation for solving this problem. His conclusion is that high speed general purpose computing machines will be able to handle the main translation task.

Dr. Andrew D. Booth, Director, The Electronic Computer Section, Birbeck College, University of London, discussed the popular misconceptions covered by the question, "How intelligent can a machine translator be?" The conclusions necessarily were that intelligence as applied to machines involves a complete misunderstanding both of intelligence and of machines. No intelligence is required, on the part of the machine at least, in mechanical translation.

Dr. James W. Perry, Director of International Studies, MIT, discussed machine techniques and index searching and translation. The basis of Dr. Perry's talk was the index searching machine developed by H. P. Luhn of IBM to solve the problem of scanning vast amounts of information and extracting certain specific items. He discussed the development of coding on punched cards in order to employ a machine at maximum efficiency. He concluded on the basis of his acquaintanceship with existing machines and machine techniques that mechanical translation was not only feasible but far closer to realizations than possibly the audience recognized.

A period of discussion from the floor followed the presentation of the talks. There was fundamental agreement on the part of both the panel and the audience that mechanical translation was feasible. It was interesting to note that the computer engineers present presented all of the difficulties standing in the way of producing a mechanical translator from the engineering standpoint; the linguist, from his standpoint; and the psychologists and philosophers from the standpoint of their respective disciplines. Each agreed, however, that, if the other two groups did their work, we could in the near future produce adequate and intelligible machine programmed translations.

Session II - June 18, 1952
Chairman - Dr. Leon D'Ostert

Prof. Erwin Reifler, Far Eastern and Russian Institute, University of Washington, Seattle, Washington, presented the first two papers of the morning session entitled, "Mechanical Translation with Pre-editing," and "Writing for Mechanical Translation."

The first paper concerned itself with the fact that syntactical relationships differ amongst languages. For ease in programming on a mechanical translator, a source language should be arranged according to the syntax of the target language (language into which the material is being translated). Where this is not possible due to the fact that the syntax is inseparable from the actual word form (such as the dative case in Latin) certain keys, such as scheme insertion of capital letters, or use of diacritical marks, can be inserted as recognizable signals for a machine whose input is a print scanning device. Pre-editing then would imply the use of a human editor to rearrange the source language insofar as possible in accordance with the syntax of the target language, and secondly, employment of various inserted signals to notify the machine of syntactical arrangements inseparable from the word form.

The second paper, on "Writing for Mechanical Translation," would necessitate the training of all writers, and more particularly their secretaries, in the required conventions for arrangement of an article for translation into a given language. The discussion of these two papers indicated that the use of a pre-editor, rather than educating all authors and all secretaries in techniques of writing for mechanical translations, is far preferable. As a matter of fact, a person skilled in keyboard operation could be readily trained to insert syntactical recognition signals at the time of keying in information to the machine. This, of course, also holds for the preparation of a manuscript for machine scanning.

Dr. Yehoshua Bar-Hillel presented a paper on Mechanical Translation employing a post-editor. Since a one-to-one correlation does not exist between meanings of words expressing essentially the same idea in various languages, if a machine operates on a comparison basis only or even if it is capable of computing syntactical relationship, a multiplicity of words in the target language can be derived for any single work of the source language. For a particular sentence, say of 10 words length, this can easily result in possible combinations of words in the target language extending to several thousands of more or less meaningful combinations. It is necessary, therefore, to incorporate some form of post-editing in order to resolve the ambiguities inherent in this relationship between languages. Dr. Bar-Hillel is much concerned with the tremendous increased demands in terms of machine storage capacity which this situation implies. It is, however, not quite so grave as appears on the surface, since particularly in scientific writings, a vast number of one-to-one correlations do exist.

(The subject of glossaries to handle the scientific translation was covered in a later session of the conference.)

The fourth paper, "Model English for Mechanical Translation" was presented by Prof. Stuart C. Dodd, Director, Washington Public Opinion Laboratory, University of Washington, Seattle. Dr. Dodd's paper concerned itself with the standardization of English syntax as a means of simplifying the use of English either as a source language or as a target language. A model language, as defined by Dr. Dodd, means any language in which the rules of syntax have been regularized, and in which familiarity of words is a governing criterion. The specific rules used in regularizing a language are itemized in the paper. The examples employed by Dr. Dodd indicate that regularizing, that is, constructing a model language, impairs but very slightly the readability and understandability of the subject matter. In English at least, regularizing leads only to a certain quaintness of expression somewhat similar to the sentence structure employed by the Quakers.

No attempts have been made as yet to regularize languages other than English, but at least for the Romance languages it seems on first view of the field that such regularization can be accomplished.

The particular rules of importance to Mechanical Translation are: One word order; one meaning for each word; and one form for each word.

The experience gained in using model language at the Washington Public Opinion Laboratory indicates clearly that regularization of a language minimizes the points brought out by Dr. Bar-Hillel. The discussion showed that the conference was in substantial agreement that regularization by use of the concepts of a model language is feasible and directly applicable to the problems of mechanical translation. In particular, so far as the machines to be employed are concerned, the machine men present felt that it could be a decided advantage in reducing the complexity of equipment required.

Session III - June 18, 1952

Chairman - A. C. Reynolds, Jr.

Prof. Victor A. Oswald, Department of Germanic Languages, University of California, Los Angeles, presented the first paper entitled "Word-by-Word Translation." Prof. Oswald and Dr. Harry D. Huskey, Assistant Director, National Bureau of Standards Institute for Numerical Analysis, University of California, Los Angeles, conducted jointly experiments in the translation of a text in mathematics and in cerebral surgery from German into English. The investigation by Dr. Oswald indicated that word-by-word translation from German into English was a virtually impossible task, chiefly because of the fact that German "articles" are also "words". Also, the German sentence structure is such that word-by-word translation from German into English becomes virtually impossible. Initial investigation resulted in a published report entitled, "Proposals for the Mechanical Resolution of German Syntax Patterns."

Although word-by-word translation seemed impossible, breaking of the German sentence into a block-by-block formation, in which each block has a certain specific syntactical function, was far more profitable. Regularization of the German language and other languages of similar structure appears then to be dependent upon such block-by-block analysis. The "Proposals" indicate that machines can be instructed to recognize syntactic connection upon this basis.

The second major consideration for block-by-block translation is the problem of recognizing and interpreting the meaning-bearing words within a block. Syntactic connections will almost infallibly identify the word function and hence function recognition can be programmed. Linguistic research, particularly that conducted by Prof. William E. Bull, Department of Spanish, University of California, Los Angeles, (also a participant at the conference) shows clearly that the only meaning-bearing forms that can be isolated are nouns, verbs, adjectives, and possibly adverbs. In general, of these classes, nouns are by far the most useful and used bearers of meaning. No system as yet proposed will solve the problem of multiple significance of the meaning-bearing words. However, within a specific subject, a meaning-bearing word in general has only one specific meaning. This fact can be utilized to advantage in mechanical translation in which the criterion of meaning is determined by the subject matter being considered. Dr. Oswald proposed to take advantage of this fact by the use of what he termed micro-glossaries. These micro-glossaries would be constructed on the basis of the words most commonly used in specific subjects of interest; one such glossary being constructed for each subject to be translated. Mechanically, this means that two memories would be employed in a machine; one, a most used general vocabulary for the languages being processed; and two, a specific micro-glossary to assign specific meanings to words that would otherwise have a multiplicity of meaning, if all their fields of usage were to be considered simultaneously. The concept of a micro-glossary and the use of block-by-block syntactic recognition in the machine met with favor from all the participants in the conference. The linguists appeared certain that block-by-block syntactic analysis of sentences could be accomplished and likewise were in agreement as to the reduction of ambiguity in the meaning of a word when only one field of interest was to be considered. The engineers present fully recognized the advantage of reduction in size of memories required if the micro-glossary concept were to be employed.

Dr. Yehoshua Bar-Hillel presented the next paper on "Operational Syntax." No proposal had yet been presented to the conference regarding a means of programming a machine for recognizing syntactic connections. Dr. Bar-Hillel, examining this problem as a problem in symbolic logic, has discovered certain relationships that exist within the syntax of sentence structure. Further, he has discovered that these can be quite readily symbolized in the form of symbolic fractions. A simple multiplication of the fractions together, which results in the cancellation of like quantities in the numerator

and denominator), results in a unique symbol indicative of the functions of the word block so analyzed. Use of this analysis permits ready recognition of word blocks functioning as nouns, verbs, adjectives, or adverbs.

The identification results in the ability to rearrange the syntax of the source language into the syntax of the target language. This is a simple arithmetic operation that can be readily programmed on a machine. The investigations to date have been preliminary, but indicate that the field is limited only by the number of languages which it would be profitable to so analyze.

This was a completely new concept to the linguists of the conference who had intuitively felt that such a structure did exist but without the tools of symbolic logic had been unable to isolate the essential features that lead to the exceedingly simple arithmetic operations. The engineers immediately recognized the extreme advantages and the simplicity of the computing loops necessary to give the machine the ability to recognize word block functions and programmed reorganization of sentence structure.

Prof. William N. Locke, Department of Modern Languages, MIT, presented the third paper on "Mechanical Translation of Printed and Spoken Material." This paper was presented orally only, no copies having been made for distribution.

Prof. Locke is interested in the potentiality of using voice input to produce either a voice output or a printed output. He drew extensively on work that has been conducted at the Bell Laboratories and at Columbia University on the analysis of speech and the recognition of the components that form the spoken word. It appears at the present time that 10 such components uniquely determined a sound. Recognition of these 10 elements leads to the identification of one sound to the exclusion of all other sounds. It was Prof. Locke's contention that a machine could be built to recognize these 10 components and give a unique output (phoneme). The phoneme so constructed could be used with other phonemes to locate a specific unit within the memory whose meaning in the target language would be the same as the meaning in the source language. This of course pre-supposes the utilization of the philosophy in constructing memories as outlined in the previous pages of the conference.

The discussion of Prof. Locke's paper was completely speculative since devices capable of so analyzing sounds are not yet in existence and it appears that it will be sometime in the future before such an art can become a science.

Session IV - June 19, 1952
Chairman - Dr. A. Don Booth

Dr. Victor A. Oswald presented the first paper, entitled

"Microsemantics." This paper continued the analysis that Dr. Oswald had presented on the preceding day in his discussion of word-by-word translation. He was now concerned with the fact that in general editing of the subject material would be required both before translation, in the source language, and after translation, in the target language. The problem is to simplify as much as possible the work required in such pre-editing and post-editing.

Assuming that syntactic considerations could be solved by such an analysis as that proposed by Dr. Bar-Hillel, the work of translation would be very greatly facilitated by the use of specialized glossaries concerned with the specific subject matter of the being translated. (Dr. Oswald terms this type of glossary a micro-glossary, and the analysis that leads to it, microsemantical investigation.)

The data obtained from every sort of linguistic frequency count when arranged according to descending numbers forms a monotonic descending curve. The words of highest frequency drop quite abruptly; words of medium frequency start flattening out; and words of highly specialized meaning that are used but seldom cause the curve to asymptotically approach the horizontal axis. The upper segment of the curve contains the words which are usually found in the normal or everyday vocabulary of a language and contains about 80 per cent of the actual volume of the material. Unfortunately, these terms consist mainly of articles which convey but little meaning but the meaning-bearing forms, and in particular the nouns, are represented by the tail of the curve. All languages exhibit this characteristic curve. Thus, in order to find those words conveying the major meaning in any text, we are concerned with the tail of the curve rather than the large grouping of words occurring at the beginning of the curve. Considering that this particular section of the curve is representative of a micro-glossary of a specific subject in the language, the words of this section in general will have one and only one meaning.

To verify this assumption, Dr. Oswald analyzed nearly a hundred papers in German on the subject of brain surgery. Technical nouns were abstracted from the first article. Additional nouns were added from the second article, and so through the complete series of texts employed. Each succeeding text was chosen from a different field of brain surgery. The amazing fact developed that after the fourth article, the glossary derived covered an average of 80 per cent of all the technical nouns in each succeeding article. From this, he constructed a micro-glossary that he considers representative of the field of brain surgery in the German language.

A similar glossary of non-technical nouns was also compiled from the same series of articles. The frequency curve of the non-technical nouns was the same as that of the technical nouns. In other words, the brain surgeons are not only compelled to choose their technical nouns from a limited vocabulary, but their pattern of communication is so limited by practice and convention that even the range of non-technical nouns is predictable.

We may generalize although perhaps dangerously, that the same phenomenon will appear in all technical fields of a restricted nature.

The micro-glossary was employed in programming translations on the SWAC in cooperation with Dr. Harry D. Huskey, Assistant Director, National Bureau of Standards Institute for Numerical Analysis, University of California, Los Angeles. The translations so obtained conveyed the meaning of the original article with correlations of meaning better than 90 per cent on the assumption that the problems of syntax and contextual modification had previously been solved. Even without this assumption, the translated articles, when presented to a specialist in the field, in the raw un-edited form, conveyed the major portion of the meaning of the original article in the original language.

The discussion that followed the paper clearly showed that the linguists working in the fields other than the German language were in complete agreement as to the ease with which such micro-glossaries could be constructed. The engineers and scientists, from their knowledge of technical articles in their respective fields, indicated that the size of micro-glossaries in these fields would be as small in comparison to the complete vocabulary of a language as Dr. Oswald postulated. All agreed that the use of such micro-glossaries would enormously reduce the amount of memory required in a translating machine.

In particular, the discussion centered on isolation of nouns as the major meaning-bearing words of a language. A rough analysis was made of the verbal discussion around the table, and it was quite evident that in general verbs employed in conveying meaning through speech are in the present tense and in the vast majority of cases a form of the verb "to be". Since information is adequately conveyed by speech, it seemed reasonable to the participants that a translation which would ignore tenses and concentrate on nouns which -- in newspaper parlance -- convey the who, what, when, where, and how, of a statement, would adequately convey to a post-editor the necessary raw material to be employed in producing a polished translation. Dr. Oswald was congratulated by the group for his work and analysis of this phenomena.

Prof. William E. Bull, Department of Spanish, University of California, Los Angeles, presented the second paper entitled "Frequency Problems in Mechanical Translation." Prof. Bull's investigation in Spanish literature paralleled the investigations of Dr. Oswald. Running texts in Spanish literature, which employed a general vocabulary rather than a restricted vocabulary, verify in detail the existence of the same phenomenon in general language as occurred in the restricted field of brain surgery.

Prof. Bull exhibited numerous slides showing the frequency counts of words, the frequency occurrence of particular parts of speech, and the frequency counts of words within the classification of a particular part of speech. He discussed in some detail the problem of determining syntactic connections

in Spanish sentences. He also discussed the type of work and the type of personnel required to extend knowledge in this field not only in Spanish but also in other languages of interest

Prof. Bull's paper was in part abstracted from a monograph not yet published. Therefore, he did not present a written paper to the participants of the conference, and this material is at present unavailable to us. He did agree however to prepare the slides for publication in the book that will contain the complete reports of the conference

Substantially, Prof. Bull's paper was a verification of the work of Dr. Oswald and indicated the fruitfulness of this approach to the problem of Mechanical Translation. A discussion of the means required to further extend the investigations showed clearly that the analysis could be facilitated by the use of punched cards. Such mechanization can enormously increase our knowledge of language structure, whereas the present handwritten and hand-sorting techniques are far too slow to materially aid in the solution of the problems of mechanical translation. Prof. Bull accepted the suggestion that he investigate the possibilities of employing punched cards as a means of extending the scope of his research

The third paper was presented by Prof. Erwin Reifler and was entitled "General Mechanical Translation and Universal Grammar." Prof. Reifler has inaugurated a new school of linguistic investigation which is currently known as "Comparative Semantics." Prof. Reifler has been investigating languages in order to discover such manners of verbally conveying meaning, underlying the actual words and syntax of a language, as are common to all languages. Such a structure of meaning could form a "Universal Grammar."

Mechanical translation poses the following question: "Is it possible to solve the problems of Mechanical Translation in such a way that one and the same preparation of the code text may serve for a Mechanical Translation into many different languages?" The existence of a universal grammar would most assuredly assist in the solution of this problem if such a grammar could be shown to exist. To date, the science of linguistics states that no such universal grammar exists, but linguists do speak of language universals. In particular, many highly interesting cases of parallel development in the evolution of the grammatic meaning amongst structurally unrelated languages do exist. The universals may be used to re-adjust the language structure to form what Prof. Reifler terms "Adjusted Model Target Languages." This is in line with the recommendation that Prof. Stuart C. Dodd presented in his paper on "Model English." Use of this adjustment clearly simplifies the mechanical translation problem and the engineering required for its solution.

The discussion of the paper reinforced the conclusions of the discussion on Prof. Dodd's paper. It is encouraging to note that where Prof. Dodd has restricted his considerations to English and hypothesised extension to other

languages, Prof. Reifler, working from a completely different viewpoint and another purpose in mind, arrived at the same conclusions as to the feasibility of regularizing a language and further demonstrated our ability to regularize major language groups of the world.

Session V - June 20, 1952
Chairman - Prof. Wm. E. Bull

Dr. Harry D. Huskey, Assistant Director, National Bureau of Standards Institute for Numerical Analysis, University of California, Los Angeles, presented the first talk, "Basic Machine Operations in Mechanical Translation." No paper was prepared for distribution to the members of the conference.

Dr. Huskey reviewed the problems encountered in programming German translations in collaboration with Dr. Oswald. The problems encountered were, to a certain extent, peculiar to the SWAC, which was the machine available for the translation. The basic problems were the construction of a vocabulary for entry into the machine, the derivation of a system of addressing to find particular units in the memory, and the syntactic programming to obtain correct sentence structure in the output of the machine. These problems are basic to any machine translation. In general, the design of the machine will govern the type of programming required. The use of two types of memories seems desirable -- the first having short access time and the second, which will contain words of infrequent use, having a longer access time. The arithmetic operations required for the construction of the correct sentence structure will be dependent upon the arithmetic devices provided with the machine. The complexity of the machine, if a machine is constructed for the sole purpose of mechanical translation, will be a function of the degree of accuracy required in the translation. This in turn will be dependent upon the allocation of time for pre-editing the material for machine input and post-editing of the machine output.

The second paper was presented by Mr. J. W. Forrester, Director of Digital Computer Laboratory, MIT, on the subject of "Problems of Storage and Cost "

This also was presented in the form of a talk, no written material being distributed.

Mr. Forrester presented no cost items that are not known to computers and business machine engineers. His major purpose was to indicate to the linguists present the cost of the machine that they were proposing. Techniques employing magnetic drums, magnetic tapes, and electrostatic storage devices singly and in combination with one another were presented for consideration. The most economical array consists of an intermediate memory and computing unit of low access time and a large scale

memory of long access time. The cost of the machine is dependent on the same considerations as listed by Dr. Huskey.

The third paper was presented by Dr. A. Don Booth, Director, Electronic Computer Section, Birbeck College, London. The title was changed from that listed in the program to "Some Methods of Mechanized Translation," which was written in collaboration with Dr. R. H. Richens of the Biological Laboratories of the University of London. General principles of mechanical translation, as scheduled and programmed on the computer built by Dr. Booth for the University of London, were discussed.

The use of punched card machinery was compared with the use of an automatic digital computer. Time comparisons were worked out that favored the use of the automatic digital computing machinery by a time ratio of at least 7 to 1. Examples of translations in the field of Genetics from Albanian, Danish, Dutch, Finnish, French, German, Hungarian, Indonesian, Italian, Latin, Latvian, Norwegian, Polish, Portuguese, Rumanian, Spanish, Swedish, Turkish, Arabic, and Japanese were given. Usable translations in each of these cases, despite the limited storage available with Dr. Booth's computer, were obtained. Post-editing was necessary in all cases, however, to produce a readable, although not necessarily more intelligible translation.

The fourth paper was presented by Prof. Wm. E. Bull and was concerned with the possible future effect of the concept of mechanical translation on the teaching of foreign languages. Prof. Bull stated that the concept of mechanical translation necessitates a completely new approach to the problem of language teaching. An analogy was drawn between a machine into whose memory a vocabulary had not been incorporated and a student into whose brain such a vocabulary must also be introduced. The approach in teaching syntactic connections to both the machine and to the student in terms of the programming required to obtain syntactically correct constructions from the memory storage was discussed. Prof. Bull reached the conclusions that the same considerations that govern the choice of vocabulary and the use of intermediate and large scale memories in the machine could be advantageously incorporated in the teaching of languages as well as the design of machines for mechanical translation.

Dr. Louis N. Ridenour was unfortunately unable to attend the conference, and his paper on "Learning Machines" was not presented.

In its place, Prof. James W. Perry, Research Associate, Center for International Studies, Sloan Building, MIT, presented a paper on "Machine Techniques for Index Searching and for Machine Translation." This paper was an elaboration of the talk that Prof. Perry presented at the opening public session of the conference. To a considerable extent, the concepts in the paper were based on Prof. Perry's experience in setting up coding and indexing systems for hand-sorted punched cards, and also on his experience with the library-cataloging machine developed by H. P. Luhn of the Poughkeepsie Laboratory of

IBM. Fundamentally, the same conclusions as to memory and access times were reached by Prof. Perry as had been previously derived by the other participants in the conference.

Session VI - June 20, 1952
Chairman - Prof. Wm. E. Bull

The closing session of the conference was devoted to a consideration of organization for future research. A seven-man committee was organized at this session to act as coordinators and consultants for further work. The committee is composed of Dr. Yehoshua Bar-Hillel, as chairman; Prof. Leon D'Ostert, secretary; and Dr. Olaf Helmer, Dr. Harry D. Huskey, Prof. Erwin Reifler, and Mr. A. C. Reynolds, Jr. as members. Dr. A. Don Booth was placed on the committee as the European representative.

The proceedings of the conference are to be printed as a book. All discussion was recorded on stenotype and is to be reproduced under the direction of Dr. Bar-Hillel. Distribution of the verbatim proceedings to all the participants is to be made in the near future and corrections made by the participants of their remarks and summaries of papers presented. The material, after correction, is to be forwarded to Dr. Booth, who was appointed editor of the proceedings.

In the organization for future research, the conferees were asked to what degree they were interested in future work and in which areas they wished to participate.

Dr. Booth will continue with the work he has already started with Dr. R. H. Richens at the University of London

Prof. Bull is interested in the field of linguistic problems of translation and as part of his research activity will continue with his study of the Spanish language. He is not concerned as such with mechanical translation, but recognizes the necessity for, and the value of, his linguistic work in reaching this goal.

Dr. Dodd will continue his work in the studies of regularizing languages and determine the degree of extension possible in languages other than English.

Prof. D'Ostert intends to work actively, through the Institute of Languages and Linguistics, Georgetown University, in the derivation of principles for the use of machines in translation.

Dr. Olaf Helmer stated that the Rand Corporation is interested from the theoretical viewpoint, but in all probability at the present time will confine itself only to theoretical work as secondary to its work on computers.

Dr. Huskey had no comment other than that he would continue to collaborate with Prof. Oswald.

Prof. Oswald is interested in extending the concept of micro-glossaries and in the study of syntactic relations. He intends to continue work in the programming of translation for machines.

Prof. Reifler is extremely interested in demonstrating the existence of universals in grammar, and in applying these universals to the problem of mechanical translation.

Dr. Bar-Hillel will continue his basic research in symbolic logic and its applications to the field of mechanical translation.

Dr. Jerome B. Wiesner, speaking for the MIT staff present, stated that the research laboratory at MIT is very much interested in the application of computer techniques to the problem of mechanical translation and that if a concrete program was formulated, financial support could quite conceivably be forthcoming from the Research Laboratory.

Mr. Duncan Harkin of the Department of Defense stated that the Department of Defense was vitally interested in this problem and, like Dr. Wiesner, if a concrete proposal for such a translation and subsequent demonstration could be formulated, the Department of Defense would be prepared to give financial backing.

Mr. Reynolds stated that IBM was interested in the application of its present punched card techniques and its computers to this problem and as such would participate on the basis of exchange of theoretical information with the members of the conference.

The conference closed on a note of optimism regarding the potentialities now known to be physically present in the concept of mechanical translation.