Conférence Internationale sur le traitement
Automatique des Langues.

- - - - - - - - - - - -

MAN-AIDED COMPUTER TRANSLATION FROM ENGLISH INTO FRENCH USING AN ON-LINE SYSTEM TO MANIPULATE A BI-LINGUAL CONCEPTUAL DICTIONARY, OR THESAURUS.

Author: MARGARET MASTERMAN

Cambridge Language Research Unit,
20, Millington Road,
CAMBRIDGE.
ENGLAND.

Conférence Internationale sur le traitement Automatique des Langues.

Author: Margaret Masterman

Institute: Cambridge Language Research Unit,
20, Millington Road, CAMBRIDGE, ENGLAND.

Title: MAN-AIDED COMPUTER TRANSLATION FROM ENGLISH INTO FRENCH USING AN ON-LINE SYSTEM TO MANIPULATE A BI-LINGUAL CONCEPTUAL DICTIONARY, OR THESAURUS.

Work supported by: Canadian National Research Council.
Office of Naval Research, Washington, D.C.

background basic research earlier supported by:
National Science Foundation, Washington, D.C.
Air Force Office of Scientific Research, Washington, D.C.
Office of Scientific and Technical Information, State House, High Holborn, London.

[N.B. References will be denoted thus: ( )]

I. Long-term querying of the current state of despondency with regard to the prospects of Mechanical Translation.

The immediate effect of the recently issued Report on Computers in Translation and Linguistics, LANGUAGE AND MACHINES (1) has been to spread the view that there is no future at all for research in Mechanical Translation as such; a view which contrasts sharply with the earlier, euphoric view that (now that disc-files provide computers with indefinitely large memory-systems which can be quickly searched by random-access procedures) the Mechanical Translation research problem was all but "solved".
It is possible, however, that this second, ultra-despondent view is as exaggerated as the first one was; all the more so as the Report is written from a very narrow research background without any indication of this narrowness being given. For example, an M.T. Thesaurus has never yet been put on a machine; (2) and the analogy between M.T. and Information-Retrieval has never yet been explored, (yet retrieving a translation in response to a user's request is basically the same as retrieving any other piece of information in response to a user's request.) (3) No mention, moreover, is made in the Report of the work of

(e.g.) Dolby and Resnikoff in analysing the nature and structure of natural-language dictionaries, (4) nor is any recommendation made that more of this evidently necessary work should be done. Moreover, the need for basic research into the true problem posed by the ambiguity and extensibility of individual language-signals of any order of length, and the connection of this with other learning-problems and character-recognition-problems, has never yet been faced. In fact, the situation is worse; a particular application has been pronounced useless and/or impossible before the general field of examining the basic semantic nature of human communication has been created.

II. Recommendation: do not look at the theoretic complexities of current researches into language-problems; look rather at the technological advances which have already been made.

Thus the basic recommendation given in the Report, namely that practical research into Mechanical Translation should be discontinued, while present, very narrow and fragmentary trends of "pure" theoretic linguistics research should be supported, can be queried both ways round. For the advances in this field are precisely coming from the technologies, as the Report itself shows, and that in several areas i) Thus computer-type-setting, in which hyphenation can be done with a "logic", that is, without a dictionary, is now an accomplished fact (5) ii) within information retrieval, mechanized retrieval systems of increasing sophistication and efficiency, are being constructed for practical use at Universities and within industry: iii) synthetic speech considered as synthetic message, - passed over in the Report because created by telephone engineers and not by linguists, - is making great strides ahead; iv) high-level programming languages increasingly operate more like natural languages, so that the machine can pick up and process something more like the user's normal way of thinking; v) the Mannheim and Luxembourg machine-aided translation-systems are acknowledged in the Report to save 40 - 60 per cent of a translator's time; (6) and vi) research in automatic character-recognition has now reached such a point that consideration of the extent to which this will slash M.T. costs and increase M.T. usefulness should have not been ignored. (7)

III. Report on an actual experiment in man-aided M.T.

The experimental work to be reported on in this paper and which is still in progress, is the development of a computer-aided procedure for the full translation of <u>one single paragraph</u> of governmental report-style English into governmental-report-style Canadian French, to be made in such a way that the translation <u>actually</u> produced accounts for the <u>actual</u> non-literal translation which was <u>actually</u> made by the official Canadian Government Translator.

The philosophy behind this research is that before employing automatic-translation-devices on a large scale, you have got to understand what translation is yourself; just as before building a liner-smoke-funnel you have got to understand wind-flow. You may not in the end use, to assist translation, all the mechanical procedures which you develop in order to understand translation, but you have got to know what these are; mechanically speaking, you have not got to be continually surprised and taken aback by what the human translator actually does.

Even the amount of experimentation which we have performed so far has sufficed to convince us that nobody does know, in terms of automatic procedures, what translation is. So-called M.T. programs, up to now, though they have performed more or less sophisticated feats in bi-lingual transformation of individual words and of individual constructions, have never in the true sense of the word, translated anything.

We have now, however, started to put on a machine a more realistic translation-model of the following form. The model draws on ii) iii) iv) and v) of the technological devices mentioned above. i) As is standard practise now on Information Retrieval, the model uses a Thesaurus. This Thesaurus, however, is not merely an Information-Retrieval-type Thesaurus of terms, but a "Roget's Thesaurus" type of technical dictionary, though of a novel kind. ii) The retrieval-procedure works by using as its "requests" a unit longer than the word, and which has been called a "phrasing" (<u>Fr</u>: <u>phrase rhythmique</u>); (8) a computer-program, (written by J. Dobson for the Titan Computer at Cambridge University Mathematical Laboratory) now exists which derives phrasings from written text (see appendix A) iii). The user is on-line to a computer, on which the whole Thesaurus is stored; and he reacts with this Thesaurus by means of question-and-answer routines operating in real time which are programmed into the machine by using the very sophisticated programming language T.R.A.C. (9). And v), the experiment presupposes the validity of the result that, in operation, the computer-stored dictionaries at Luxembourg and Trier (to which the user is not on-line and with which he cannot therefore react,) already, in spite of these limitations save 40-60% of the translators' time. It is inferred from this that on-line use of more sophisticated dictionaries by man-machine interaction in the conversational mode is the right way, from now on, for M.T. research to go.

III. <u>The Basic Principle of the Man-Machine interaction</u>.

The input to the machine is a <u>stressed and contoured phrasing</u>, i.e. a phrasing with some stresses marked and minimal syntactic naming of the constituent words. Research to produce this input mechanically, by a phrasing-stresser-and-parser, is currently being supported by the Office of Scientific and Technical Information, London; at present the program (Mark II) segments the text into phrasings mechanically, but does not either mark the stressed words or provide any snytactic naming. (see Appendix A). In the mini-demonstation of the man-machine interaction, therefore, (the only one which is already operational as a machine,) the operator at present types in a single phrasing at a time <u>minus the stressed words</u>, which have been pre-marked on his text. Thus, he does not type in a complete phrasing, but what we have called a <u>phrasing-frame</u>. (Later the machine will compute the phrasing-frame from the text.) Examples of assorted phrasing-frames are given below:

<u>ASSORTED PHRASING-FRAMES</u>

HE..........ED TO THE..........
[PAST VERB] [NOUN]

THERE IS A.......... IN THE..........
[NOUN] [NOUN]

HE <u>WENT</u> ▲ TO THE..........
[NOUN]

.... ()
[ABSTRACT NOUN]

....
[ADJ] [NOUN]

ON...................... ()
[ABSTRACT NOUN]

ON................ ....
[ADJ] [NOUN]

<u>ANY</u>..▲.......... ()
[NOUN]

A............... ....
[ADJ] [NOUN]

SUCH AS............... ()
[NOUN]

SUCH AS............... IN............
[PARTICIPLE] [NOUN]

MUST BE PARTICULARLY ▲............
[ADJ]

TO.................. ITS............
[VERB INFIN.] [NOUN]

key: .... stressed word omitted

() silent beat

▲ do not translate though stressed.

N.B. Other markers e.g. the marker ■ to set in operation a routine to inter-connect syntactically connected phrasings will be discussed in a further publication

On receiving the phrasing-frame, the machine questions the operator in order to make him specify further, from his general knowledge of the text and of its subject, what the context of the particular phrasing-frame is. The example given below, in which is progressively specified the correct French translation of an English verb of motion (one of the notoriously difficult English forms to translate into French) shows how complicated this questioning can be. Not more than three rounds of questioning are allowed, and when the operator has produced his specification, the unique correct translation of the frame is stored in the immediate-access store of the machine (see Appendix B). In the example set out below, however, the differing French translations of all possible answers obtainable under Round II and Round III of the inter-action are set out immediately underneath the English statements which the machine would actually print out on the console, in order to show the underlying reason for the whole enterprise.

STAGE I:

ROUND I

Operator types in the phrasing-frame:

HE XX-ed TO THE XX
[PAST VERB] [NOUN]

Machine asks: DO YOU MEAN

A HE MOVED TO SOME POINT ?

B HE DETERIORATED (idiom)?

C HE CROSSED OVER SOME OBSTACLE ?

D HE COMMUNICATED WITH SOME BEING ?

Operator answers: A

ROUND II

Machine then asks: DO YOU MEAN

A HE DEPARTED TO SOME DESTINATION ?
Il partit pour ...

B HE TRAVELLED TO SOME DISTANT REGION ?
Il s'en alla à ...

C HE FLED TO SOME REFUGE ?
Il se réfugia chez ...

D HE ARRIVED AT SOME DESTINATION
Il arriva à ...

E HE VISITED SOME PLACE ?
Il visita ...

Operator answers: B

ROUND III

Machine then asks: HOW DID HE TRAVEL?

A BY PLANE ?
Il prit l'avion pour ...

B BY SEA ?
Il voyagea par bateau à ...

C BY ROAD ?
Il voyagea en voiture à ...

D BY TRAIN ?
Il prit le train pour ...

E ON FOOT ?
Il se rendit à pied à ...

F BY BICYCLE ?
Il s'en alla à bicyclette à ...

G BY SWIMMING ?
Il alla à la nage à ...

Operator answers: A

STAGE TWO

The operator then types in the two stressed words:

FLEW and FRONTIER

The machine then dictionary-matches and resolves:

FLEW = XX-ed = ALREADY TRANSLATED: DELETE

XX = FRONTIER = FRONTIÈRE (f)

and immediately, for the text:

He flew to the frontier

The Machine prints out the translation:

IL PRIT L'AVION POUR LA FRONTIÈRE

— — — — — — — — — o — — — — — — — — —

Detailed examination of this example shows that behind this particular way of making an on-line system interact with an operator there lies a strategy, a hypothesis and a prospect.

V. The strategy is at all costs to avoid post-editing; but to allow maximal pre-processing of the input text by the machine interacting with the operator, all the question-and-answer routines being in the operator's native language.

The argument against post-editing (as the U.S. Report conclusively shows) is that it is either mechanical - e.g. the resolution of French gender-concord - in which case the machine itself can be programmed to do it - or it is creative and/or intuitive, in which case it cannot be done at all without extensive reference back to the input text, (Who could interpret "Shakespeare Overspat", which was the title of a Russian "Pravda" article as translated by the U.S. Air Force computer? The real meaning was "Shakespeare is now a back number"), in which case the post-editor might as well have translated the whole text himself in the first place.

To avoid post-editing, however, the output produced by a man-machine reactive M.T. program has either got to be a blank space (when the program fails), or a unique translation which is known to be correct. Now uniqueness of output can be brutally produced, as everybody knows, by programming the machine only to print out one of any set of alternatives. Correctness, however, can only be achieved by the target-language translation having been approved beforehand by the operator, from cues which the machine gives him, or which he gives the machine - in his own language; i.e. in the source language. The real use, therefore, of the three-stage question-and-answer routine exemplified above, is that it enables an Englishman with a console but who does not know any French to produce a unique and correct idiomatic French translation of an English text, provided that he is prepared to take the trouble to pre-process the English text so that it is finally restated in a Frenchified sort of way. After this the machine can of course transcribe it into French.

In other words, a machine-aided translation program basically consists -

a) of programming the machine to pick up the ambiguities in the source language which the target-language will not tolerate (not the other way round) and of making the operator produce the additional information which will resolve them.

Take, as example, the phrasing

/for a <u>standby</u> <u>force</u>/.

This looks technical and unambiguous in the English, but comparative examination of bi-lingual text showed that it translated into French (and in the same document) as either

i)/d'une force d'urgence/ i.e./"of an <u>emergency</u> force"/
or ii) /pour une force de réserve/ i.e. /"for a <u>reserve</u> force"/,

according to sophisticated considerations of context. Therefore, when the operator types the technical term STANDBY FORCE into the machine, in order to fill up the gaps in the phrasing-frame /FOR A........ ....
[Adj] [Noun]

the machine has got to answer him back:

DO YOU MEAN

A AN EMERGENCY FORCE

B A RESERVE FORCE

The operator then has to choose, and type back into the machine the alternative he wants, after which the machine can make the translation.

b) Similarly, a way must be found of enabling the machine to pick up, from cues in the source language, the metaphors and idioms which the target-language will not tolerate, and to assist the operator to rephrase the stretch of text concerned, in terms which the target-language will tolerate. The difference between idioms and metaphors is that idioms can be mechanically picked up and matched by an idiom dictionary, whereas metaphors can't.

c) Similarly again, the machine must be programmed to pick up, from the source language input, the constructions which the target-language will not tolerate, and assist the operator to transform these into constructions which the target-language will tolerate (e.g. to turn English passives into French actives, and the adjectives of English adjective-noun strings into French post-positioned prepositional phrases).

Thus the whole translating work, really, is done within the source language. Once you can preprocess your English input into a Frenchified shape in the respects a), b), c), above, the machine can transform this Frenchified English, with no trouble at all, into elegant French.

The strategic hope, of course, is that by analysing the printouts produced by a large number of sequences of such machine-man interactions, in translating many types of texts, we shall ultimately learn how to make the machine answer, as well as ask, some of the rounds of questions, (as is already being done in a whole range of machine "edit" programs), so that the machine shall progressively become able to do more of the Frenchification process for itself; thus finally producing, (if the machine ever became able completely to take over) exceedingly slow but reliable machine translation, - which could, subsequently again, be speeded up.

Before further discussion of the extent to which this strategic hope is a real hope and how much a mere pious aspiration, i.e. the prospect, I will now set out the hypothesis (as opposed to the strategy) of the experiment.

VI. The hypothesis which the translation-model gives is the following:

Translation consists of the pairing of a phrasing, P_7^A, in Language A, with another phrasing, P_2^B, in Language B, in such a way that P_1^B ~~[illegible]~~ forms an analogy with P_1^A, in a sense of "analogy" which can be ostensively defined in terms of the model. Thus translating a phrasing into another language is no different, (according to this translation-model) from defining it, producing a parallel-phrasing to it, reiterating or otherwise further specifying it, in the same language.

The advantage of the model is that unambiguous criteria of the formation of such a pairing can be given. For any response given by the operator to a machine-question will form such a pair: the first member of the pair will be the original phrasing, (in English), the second the chosen machine-specification (called by us a template) also in English. Then another pair will be formed whenever the machine translates the operator's final choice of template into French; the first member of the pair in this case, will be the final template chosen, and the second member will be the translation into French, with the stressed words translated and inserted into their correct places. Then again, an intermediate pair may be formed of which each member is a template; the first member of such a pair will be a more abstract template chosen at the first round of man-machine interaction, while the second member of it will be the more concrete template chosen by the operator at the second round of man-machine interaction; and so on recursively.

Any such pairing formed by the translation model, whether between English phrasing and template, or between template and template, or between template and French phrasing, we shall call a <u>semantic square</u>. A philosophic discussion of the notion of semantic square is given in another publication (10).

A <u>semantic square</u> (in terms of this model) consists of the pairing of any two linguistic sequences P_1 and P_2, P_1 and P_2 each having the following characteristics:

i) each has two stressed segments (which when P_1 is paired to P_2, form <u>points</u> of the square).

ii) each has these embedded in some phrasing-frame, (which, when P_1 is paired to P_2 forms the <u>frame</u> of the square).

iii) each has been <u>selected as synonymous</u> with the other at least once, either by the operator or by the machine.

Thus, according to the model, translation consists of sequential semantic-square forming, the sequence of semantic squares thus formed continuing until it is brought to an end by the machine printing out a square which has a target-language phrasing as its second member.

To make all this clearer, let us further develop the example of man-machine interaction given above, by assuming that the phrasing to be translated is

/HE <u>WENT</u> to the <u>police</u>/.

To translate this, the operator types in

/HE....ED to the......../
[PAST VERB] [NOUN]

and chooses, at the first round of questioning, the abstract template

HE COMMUNICATED WITH SOME ANIMATE BEING

The first semantic aquare of this sequence formed by the model is thus:

/HE WENT TO THE POLICE/

/HE COMMUNICATED WITH SOME ANIMATE BEING/.

The machine then asks: DO YOU MEAN

A HE REVEALED-ALL TO THE ENEMY

B HE TOLD-A-STORY TO SOME LISTENER

C HE CONSULTED WITH SOME AUTHORITY

The operator chooses A, thus forming the second semantic square in the sequence:

/HE COMMUNICATED WITH SOME ANIMATE-BEING/

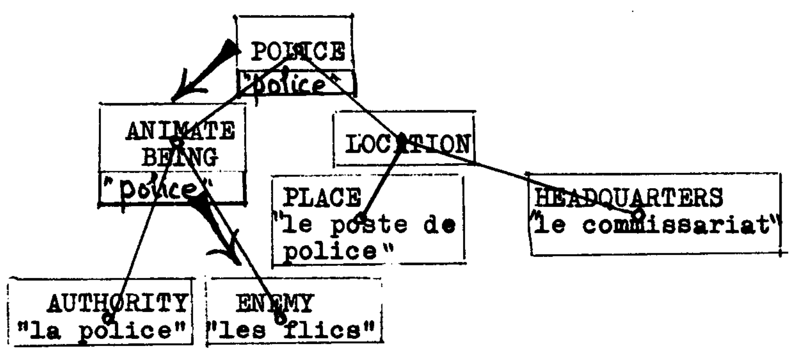
/HE REVEALED-ALL TO THE ENEMY/

The operator then types in the stressed word /POLICE/ (to specify the nature of the enemy), and the machine then forms the final semantic-square:

/HE REVEALED-ALL TO THE ENEMY/

/IL TOUT RÉVÉLA AUX FLICS/

"FLICS" having been pre-chosen by the operator's choices of template from a bi-lingual tree-dictionary-entry for the English word "police" with nodes as follows:



Thus the sequence of semantic-squares formed by this operation of the model is

1 HE WENT TO THE POLICE
HE COMMUNICATED WITH SOME ANIMATE-BEING

2 HE COMMUNICATED WITH SOME ANIMATE BEING
HE REVEALED-ALL TO THE ENEMY

3 HE REVEALED-ALL TO THE ENEMY
IL TOUT REVELA AUX FLICS

This square-sequence, with its AB BC CD overlap of content, I will call the semantic deep-structure of the model's translation-operation, and the tree-structure given above I will call the semantic deep-structure of the dictionary-entry.

The totality of semantic deep-structures given by the model is the model's total semantic-field.

VII This, stated in the briefest possible terms, is the hypothesis given by the model. Now as to the prospect of developing this line of research.

The first thing to say is that the model makes clear the unsuitability of the ordinary digital computer as compared to a human being for performing translation. For in this translation-model the computer handles each phrasing of the input text as a separate unit, and forces the operator, by successive rounds of questioning, so to specify it that it can be translated unambiguously into French. But the human being, who does not treat each phrasing of a text as a separate unit, but who uses his understanding of the earlier phrasings of a text to guide him in his understanding of the later ones, does not have to ask himself nearly so many questions. A progressive learning-model of translation, then, is what is really required, rather than the present single-phrasing-matching model. On the other hand, the complexity which has to be introduced into the model to account for all the differing French translations which have to be made of a single piece of English, according to its context, this would have to be introduced into any effective M.T. program: since you cannot retrieve from any computerised data-system any data which you have not first put in. But this second type of complexity can be put into the machine gradually, by feeding in data obtained from examining the inter-lingual correspondences in a large corpus of bi-lingual text.

There is, however, another, much deeper obstacle to developing this research, and that is that (as M.T. research-workers have for some time past suspected) bi-lingual dictionaries provide almost no clue to semantic deep-structure.

Within the context of the present experiment this became apparent in examining the English word "deliberations". The examination began with the construction of a dictionary-entry-card of the following form:

English: DELIBERATIONS
French: DELIBÉRATIONS

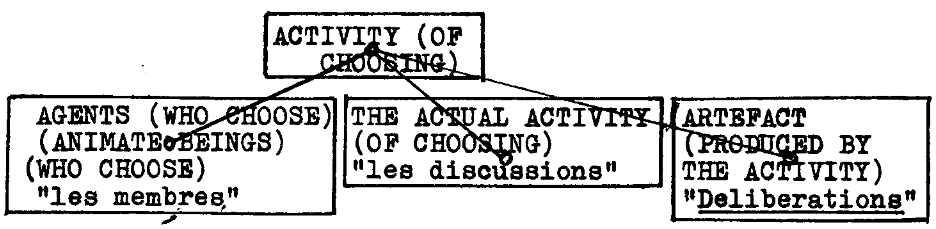
This entry being queried (and the maker of it having defended himself by saying that "deliberations" was the only word he knew of in English which could really be translated by the corresponding word in French), it was checked with Vinay's Dictionary(1) which gave the entry /débats mpl, discussion/. However, when an investigation was made of how it was actually translated in the corpus of text, it only occurred once, where it was translated "membres", as follows:

English
The illustrative and comparative
materials presented
may prove helpful
to the deliberations of this committee

French
Les données explicatives
et comparatives ()
se révéleront, peut-etre
très utiles
pour les membres du comité

Moreover, the translator, in translating it thus, was quite right; not only because "utiles" in French, likes a concrete complement, but also because this is what the passage means.

However, this dictates a semantic deep-structure for the bi-lingual dictionary-entry of "deliberations" of the following form:



It becomes evident, then, that if we are to make a machine account for the translations, which good human translators actually produce, using the kind of model which has been reported on in this paper, the problem is that of finding the deep structures of the dictionary-entries from the data actually given by a bilingual corpus; for the construction of the square-forming templates must depend on these- that is if the template-glossary and the bi-lingual dictionary are to interlock.

Present research efforts are therefore being concentrated on the problem of "firming up" the whole notion of semantic dictionary-entry deep-structure.

CONCLUSION

In view of the great interest which has already been aroused by this experiment, its small scale and pilot nature must be emphasized. (Actual output from a trial run of the program is given in Appendix B). It has been implemented only on an I.C.T. 1202 computer, with T.R.A.C. facility, to which a single keyboard has been attached, just under the print-out, on which the machine's "replies" to the operator, as well as his "questions" appear. This machine has only 4K store with no back-up, and 2K of this is occupied by the T.R.A.C. facility; the rest of the store will therefore only hold enough Thesaurus to process an average of 10 "phrasing-frames" at any one time, so the sections of Thesaurus which are needed for any particular test have to be prechosen by hand from the larger deck of punched cards of which the Thesaurus, in its machine-readable form, consists. Even these cards, however, are only punched as required; the basic triple dictionary, from which the Thesaurus is being built up, is being stored on ordinary business equipment, (Twinlock Handired Binder HRA 3 handled with a Shunic Signalling System for Paper and a SASCO System so as to ensure maximum flexibility and ease of entry-change).

Mark II of this program is to be implemented on an I.C.T. 1903 with disc-file and multiple-access T.R.A.C. facility, but this is not expected to be operational till 1968.

REFERENCES:

1. Language and Machines: Computers in Translation and Linguistics. Available from Printing & Publishing Office, National Academy of Sciences, 2101 Constitution Avenue, Washington, D.C. 20418. Price $4.00.

2. A project supported by the U.S. National Science Foundation at the University of Bloomington, Indiana, has just been started, to make a Thesaurus for Information Retrieval in 50 languages.

   Also a historical Thesaurus of English is being compiled on a long-term basis by Professor Samuel at the University of Glasgow; and another, compiled by John Bromwich, is being put on magnetic tape at the Linguistics Computation Centre, Cambridge University.
   The properties and structure of thesauruses and/or conceptual dictionaries have never yet, however, been mechanically examined; partly because, until lately, machines with rapid-access-time to sufficiently large memories were not available, and partly because of the overall cost of such a project.

3. Margaret Masterman, R.M. Needham & K. Sparck-Jones: The Analogy between Mechanical Translation and Library Retrieval, (Proceedings of the International Conference on Scientific Information, 1958), Washington, D.C., National Academy of Sciences, 1959, p.917.
   See also, on this analogy,
   (i) Margaret Masterman: Translation, (Proceedings of the Aristotelian Society, 1959-60, p.79);
   (ii) R.M. Needham & I. Joyce: The Thesaurus Approach to Information Retrieval, (American Documentation, Vol. 9, 1958, p.192).

4. J.L. Dolby & H. Resnikoff: The English Word Speculum in 5 vols., (Lockheed Missiles & Space Company, Sunnyvale, Cal.) 1964.
   On the Structure of Written English Words (Language Vol. 40, No. 2,) 1964.

5. Language & Machines, p.114. The Report gives this brilliant technical achievement just 3 sentences on p.114, and appears not to know of the fact that a mechanical justifier using a logic and working up to 95% accuracy is now in use on an actual newspaper (personal communication from Dolby & Resnikoff).

REFERENCES (cont.)

6. Language & Machines, p.26.
See also
i) F. Krollmann, H.J. Schuck and U. Winkler: Production of Text-related Technical Glossaries by Digital Computer, (mimeo, undated);
ii) La Terminologie, Problemes de Coopération Internationale,
Expose de M.J.A. Bachrach, Chef du Bureau de Terminologie de la Haute Autorite de la C.E.C.A. a Luxembourg - (The Applied Linguistics Foundation) a Strasbourg - Maison de l'Europe, le 6 Septembre, 1965. (mimeo).
iii) Lydia Hirschberg: Dictionnaires automatiques pour Traducteurs humains, (Journal des Traducteurs, Montreal, Vol. 10, No. 3 (1965), pp. 78-86.
iv) Lydia Hirschberg: Dictionnaires Automatiques Multilingues, Conception, Utilisation, Realisation, (Colloque sur la Terminologie, Luxembourg, ler avril, 1966. Université Libre de Bruxelles, Centre de Linguistique automatique appliquée). (mimeo).

7. Language & the Machine, pp. 32-33.

8. D. Shillan: Spoken English, Longmans, Green (London) 1954/65;
D. Shillan: article in META (Montreal), Vol. XI, No. 3, 1966;
D. Shillan: article in English Language Teaching (Oxford), Vol. XXI, No. 2, 1967.
(See "Segmenting Natural Language by Articulatory Features" in the present Conference.)
The phrasing method offers two operational simplifications
i) by mapping the distribution of stresses on to a binary frame;
ii) by applying a phonetically-derived feature to words, instead of to syllables or phonemes.

9. Calvin Mooers: T.R.A.C., A Procedure Describing Language for the Reactive Typewriter (Vol.9 No.3 1966, Communications of the A.C.M.)
R. McKinnon-Wood,& D.S. Linney: T.R.A.C. (Vol.2 of Report to O.S.T.I. on Automatic Syntax 1966)

10. Margaret Masterman: Semantic Algorithms (Las Vegas Conference on Computer-related Semantics, 1965)

11. Everyman's French-English English-French Dictionary with special reference to Canada, compiled by Jean-Paul Vinay, Pierre Daviault, Henry Alexander, (Dent & Sons, 1962) p.494.

APPENDIX A (a)

JOB TITLE - (JED744/PHRASING SORT)...24 5 67
STREAM 1/0 INITIAL INPUT

0/1/1	*LIMITATIONS
0/1/2	ON *CANADIAN *COMMITMENTS.
1/1/1	*ANY *NATION
1/1/2	*MUST BE *CONCERNED
1/1/3	THAT ITS *OBLIGATIONS
1/1/4	DO NOT *OUTRUN ITS *CAPABILITIES.
1/2/1	A *MIDDLE *POWER
1/2/2	SUCH AS *CANADA
1/2/3	MUST BE *PARTICULARLY *CAREFUL
1/2/4	TO *RATION ITS *COMMITMENTS.
1/3/1	*ALTHOUGH AT THE *END+OF+THE+WAR
1/3/2	*CANADA *COULD+HAVE+DEVELOPED
1/3/3	THE *CAPABILITY
1/3/4	TO *MANUFACTURE *NUCLEAR+WEAPONS
1/3/5	IT *ELECTED
1/3/6	AS A MATTER OF *DELIBERATE *CHOICE
1/3/7	*NOT TO *BECOME
1/3/8	A *NUCLEAR *POWER.
2/1/1	*ALSO, *CANADA
2/1/2	DID *NOT *BECOME+A+PARTY
2/1/3	TO THE *INTER *AMERICAN
2/1/4	*DEFENCE *SYSTEM.
2/2/1	*AND, AT THE *CONCLUSION
2/2/2	OF THE *KOREAN *WAR
2/2/3	*CANADA *WITHDREW
2/2/4	HER *TROOPS FROM *THAT+AREA.

APPENDIX A (b)

2/3/1 *SUBSEQUENTLY, *CANADA

2/3/2 *DID+NOT *ASSUME

2/3/3 *REGIONAL+DEFENCE+OBLIGATIONS IN THE *PACI

2/3/4 SUCH AS *PARTICIPATION IN *SEATO.

2/4/1 IN *CONSEQUENCE

2/4/2 *LIMITS HAVE BEEN *SET

2/4/3 TO OUR *MILITARY *RESPONSIBILITIES.

APPENDIX B (a)

THERE IS A FLAW IN THE PROOF

10

11

V10CL&TRAN11

START

THERE IS A XX IN THE XX

START

APPENDIX B (b)

```
        PROOF

START

          DO YOU MEAN
          A    DEMONSTRATION
          B    TYPOGRAPHIC PROOF

        A

START

          THERE IS A FLAW IN THE PROOF
          IL SE TROUVE UN 7 UNE ERREUR DANS CE 7 CETTE PREUVE
END
```

APPENDIX B (c)

```
        DO YOU MEAN

        A   CONCRETE OBJECT IN ENCLOSURE
        B   CONCRETE OBJECT IN LOCATION

        C   EVENT IN FUTURE TIME
        D   ERROR IN ARGUMENT


      D


START


      FLAW


START
```