MT

MECHANICAL TRANSLATION

DEVOTED TO THE TRANSLATION OF LANGUAGES WITH THE AID OF MACHINES

Bibliography

EDITORIAL
ABOUT THIS NEW PUBLICATION

We have marked this issue of MT (Mech-anical Translation) Vol. 1, No. 1. By this we show our intention that there will be other issues. However, we intend that publication will be only occasional and at irregular intervals in 1954.

The field of mechanical translation (MT) is very new, the number of serious workers is few, and the literature is scanty and little known. There seems to be a need for better communication between those interested in MT to prevent needless duplication of effort and to advance knowledge in the field.

ABOUT MECHANICAL TRANSLATION

There are some people concerned with the fact that scientific, technical and cultural knowledge is recorded as literature in a multitude of languages so that no one person has easy access to it all. This state of affairs is very costly in duplication of effort in science and technology, lack of understanding in cultural matters, lack of necessary information in political matters, and time spent in learning several languages.

Many efforts have been made to alleviate the situation. There have been proponents of dozens of "international" languages. For one reason or another they have failed to catch on. We are forced to fall back on TRANSLATION as a way through the barriers. However, nearly all of the world's printed output remains untranslated, and a large portion of the most worthwhile material, by any standard, remains untranslated. The cost of translation is high.

Qualified translators are difficult to find. But can we afford not to translate?

With the advent of the electronic digital computer and the application of automatic or semiautomatic machine methods to accounting and business problems, process control and information handling, many people have conceived of the possibility that perhaps machine methods could be used to help with the translation of languages, or perhaps actually to do the whole job. It was a dream with great promise. Today it is still a dream. It is our hope that succeeding issues of MT will document gradual progress in making this dream come true. That the progress will be gradual, there is no doubt. Serious workers in the field are the first to admit the great difficulties in the way to an acceptable solution. On the other hand, they have very good reasons for believing that an acceptable solution can be found.

ABOUT THIS ISSUE

This first issue consists of a bibliography of papers concerned with mechanical translation. We have gone to considerable effort to make it complete and hope that we have succeeded. We have included only articles which are actually concerned with mechanical translation, thus we have excluded many interesting and valuable articles from adjacent fields. Perhaps specialists in these fields might want to round up such articles for future issues.

The entries are designed both as abstracts of the papers and as a brief history of MT. For this reason they are arranged in approximate chronological order. If other pertinent works come to our attention, we will attempt to abstract them. It would be very helpful, however, if authors themselves would make a point of providing their papers with abstracts, as is done in many scientific and technical fields. An abstract should be adequate as an index and as a

summary. As an index, it should give all subjects concerning which new information is presented. As a summary, it should give the conclusions of the article. It should be concise and complete in itself.

For the convenience of those who may wish to file the bibliography on cards, it has been arranged so that individual entries may be clipped and pasted to 3 x 5 cards.

BIBLIOGRAPHY

Warren Weaver   1
Translation
Mimeographed, 12 pages, July 15, 1949

This memorandum contains an account of
the early history of machine translation
comprising, among other things, an ex-
tremely interesting exchange of letters
between Weaver and Norbert Wiener in
1948, with Wiener on the sceptical side.
Weaver also mentions here a memoran-
dum by A. D. Booth, now Director of
the Computation Laboratory in Birkbeck Col-
lege, University of London, dated Febru-
ary 12, 1948, in which translation with the
help of a mechanized dictionary is consi-

Weaver - Translation (Cont.)

dered. (I was unable to obtain a copy of
this memorandum.) Weaver, however, was
apparently the first to consider machine
intervention going beyond a mechanized
dictionary. Though Weaver's contribution
was admittedly of a rather speculative na-
ture, it gave, no doubt, the major impetus
for subsequent research on machine trans-
lation in the United States.
                                        Y. B-H.

Erwin Reifler   2
Studies in Mechanical Translation No. 1, MT
Mimeographed, 51 pages, January 10, 1950

Suggests pre-editing by insertion of extra
graphic symbols to the source language for
interpretation and removal of grammatical
and logical inexplicitness. Such interpre-
tation can not be mechanized at present and
can be done better by a pre-editor who un-
derstands the source text than by the read-
er of the output who is faced with lists of
alternative translations for each word.
Discusses methods of doing this. Dis-
cusses multiple meaning, translatibility,
idioms, word order.

Abraham Kaplan   3
*An Experimental Study of Ambiguity in
Context
Mimeographed, 18 pages, November 30,1950

Presents the results of tests where sub-
jects are asked to identify the meanings of
nouns, verbs, and adjectives which are
surrounded by contexts of different num-
bers of other words.   A context consisting
of one or two words on each side of the key
word has an effectiveness not markedly
different from that of the whole sentence.

Victor A. Oswald, Jr. and   4
Stuart L. Fletcher, Jr.
*Proposals for the Mechanical Resolution of
German Syntax Patterns
Modern Language Forum, Vol. XXXVI, No.
3-4, pages 1-24 (1951)

Starting from the assumption that MT from
German is impossible without rearrange-
ment of word order, proposes a method of
searching the German sentence for the va-
rious sentence elements.   The elements
are sought for and arranged in a fixed se-
quence according to English word order.
Many examples are given.   The authors
claim that the proposals are in no sense
definitive but that they imply that such pro-
blems are not insoluable.

Erwin Reifler   5
Studies in Mechanical Translation, No. 2,
Some Problems of the Mechanical Trans-
lation of Languages
Mimeographed, 18 pages, April 9, 1951

Discusses Warren Weaver's memorandum.
Outlines his paper No. 1.

Yehoshua Bar-Hillel 6
*The Present State of Research on Mechanical Translation
American Documentation 2:229-237, 1951
(appeared 1953)

Discusses and evaluates critically the work done through 1951. Concludes that high accuracy MT will require human intervention to eliminate semantical ambiguities, that a machine which solves syntactic problems requires an "operational syntax ". Many difficulties are pointed out and discussed.

Y. Bar-Hillel 7
* **Mechanical Translation: Needs and Possibilities
Typewritten, 6 pages

Introduction to the conference; a brief history of MT, the need for translation, some of the problems, brain-machine partnerships, economic aspects.

Olaf Helmer 8
**The Structure of the Problem of Mechanical Translation.
Mimeographed, 1 page abstract, June 1952

Objectives must be formulated; input and output devices must be perfected; syntactical and semantic problems solved.

James W. Perry 9
**Machine Techniques for Index Searching and for Machine Translation
Mimeographed, 9 pages, June 1952

The two fields share many problems. For index searching, a machine language with a special consistent and logical grammar must be provided.

Erwin Reifler 10
* **Studies in Mechanical Translation, No. 3, MT with a Pre-Editor and Writing for MT
Mimeographed, 16 pages, June 1952

MT without human intervention may be impossible, especially because the co-occurrences of contextual criteria for determination of meaning are exceedingly numerous. Discussion of requiring material to be submitted in an artificial language. Use of a mechanical dictionary to assist the pre-editor. Proposes pre-editorial capitalization of the first letter of all nouns, second letter of verbs, third letter of attributive adjectives, etc. If this orthography were

Reifler - MT with a Pre-editor (Cont.)

to become universal it would greatly assist students in learning languages, and would make the pre-editor unnecessary.

Y. Bar-Hillel   11
*   **The Treatment of "idioms" by a
Translating Machine
Typewritten, with discussion, 8 pages

Several methods for treatment of idioms
proposed. (1) Add definitions to the words
so that the idiomatic meaning is one of the
choices.   (2) A phrase dictionary contain-
ing the idiomatic phrases.   (3) Instruct
reader or post-editor to recognize cer-
tain word combinations as idioms.

Victor A. Oswald, Jr.   12
**Word-By-Word Translation
Mimeographed, 7 pages, June 1952

Word-by-word translation is impossible.
Syntactic problems must be solved.   The
limitations of the pre-editor and the post-
editor.

Stuart C. Dodd   13
*   **Model English for Mechanical Trans-
lation
Mimeographed, 9 pages, June 1952

English is regularized as to grammar and
syntax by ten ideal rules.   Other languages
may be treated similarly for use either at
the input or the output of a machine.

Y. Bar-Hillel   14
*   **Operational Grammar
Typewritten, with discussion, 11 pages

There must be a standard procedure
worked out (operational) by which the ma-
chine can attack each sentence.   Proposes
that a modification of the word classifica-
tion scheme of Ajdukiewicz would provide
such a grammar.   Gives illustrative ex-
amples of the scheme.

Victor A. Oswald, Jr.   15
 * **Microsemantics
Mimeographed, 10 pages, June 1952

The compilation of specialized glossaries of
the meaning-bearing words from a
given field, say brain surgery, reduces
the number of entries required in the dic-
tionary to translate in this field, and also
assists in the choice of the meanings for
these words.

William E. Bull   16
**Problems of Vocabulary Frequency and
Distribution
Mimeographed, 8 pages, June 1952

Vocabulary appears to fall into three ma-
jor classes: words primarily indifferent
to the subject of discourse, words of es-
pecially high frequency in the theme of
discourse, all the rest which appear with
low frequencies.   The limitation of ma-
chine translation is the inadequacy of a
closed vocabulary for operating in an open
system.

Erwin Reifler   17
* **Studies in Mechanical Translation,
No. 4, General MT and Universal Gram-
mar
Mimeographed, 6 pages, June 1952

Translation from one language into many.
A Universal Grammar may not exist, but
there are language universals and pseudo-
universals.   The grammar of the output
language can be adjusted so as to conform
more nearly to a given input or source
language, following S. C. Dodd, but may
have many different types of Model Eng-
lish corresponding to different source
languages, thus making translation easier.
Output would be bad English, but perfectly
intelligible.

R. H. Richens and A. D. Booth   18
*   **Some Methods of Mechanized Trans-
lation
Mimeographed, 31 pages, June 1952

The basic premise is that syntax is of
quite minor importance in understanding a
language.   Proposes procedure to break
words down into stem and ending.   Gram-
matical meaning of ending is to be deter-
mined from knowledge of category to
which stem belongs, and indicated by an
abbreviation such as f for future.   Excep-
tions are entered in dictionary in full.
Dictionary to have supplements of techni-
cal terms for particular subjects.   Alter-
native meanings to be supplied when re-

Richens and Booth - Some Methods (Cont.)

quired.   A routine for the separable pre-
fixes of German is proposed.   Examples of
the output to be expected are given for 20
languages.   Output text is then to be re-
written into good English.   Methods are
described for using magnetic drums and
punched cards for the storage.   Compara-
tive estimates of the speed are given.

Calvin N. Mooers   19
Machines for Information Retrieval, Learn-
ing, and Translation
Mimeographed, 2 pages, June 1952

Discusses use of information retrieval
techniques in translation.   States belief
that machine translation will follow from
the development of machines capable of
learning.

Erwin Reifler   20
*Studies in Mechanical Translation, No. 5,
Report on the First Conference on Mech-
anical Translation, June 17-20, 1952 at the
Massachusetts Institute of Technology,
Cambridge, Mass.
Mimeographed, 22 pages, July 18, 1952

Report on and reactions to the conference.

Erwin Reifler   21
Studies in Mechanical Translation, No. 6,
Report on Research Results in Mechanical
Translation in Connection with the Rocke-
feller Grant for the Summer Quarter, 1952
Mimeographed, 7 pages, August 30, 1952

A report and introduction to the two following
papers.   Reports growing conviction that a
pre-editor is not needed for German to English
mechanical translation.

Erwin Reifler   22
Studies in Mechanical Translation, No. 7,
The Mechanical Determination of the Con-
stituents of German Substantive Composita
Mimeographed, 27 pages, September 3,1952

Detailed discussion of the contents of a
German-English "Capital Memory."   Pro-
poses methods by which compound nouns
not entered in "Capital Memory" would be
split up into their constituents.

James W. Perry   23
Machine Techniques for Index Searching
and for Machine Translation
Mimeographed, 6 pages, September 22,1952

Machine techniques are described for
searching in sequence over an entire in-
dex of recorded information by successive
pattern matching operations, and for the
selection of those patterns which satisfy
certain associative relations between va-
rious parts of the pattern.   These techni-
ques, primarily developed for library in-
dex searching may be of use in translating.

Erwin Reifler   24
Studies in Mechanical Translation, No. 8,
The MT Form-Class Filtering System
Mimeographed, 20 pages, October 1952

Points out how the number of different
possible meanings of a word is reduced
when the word occurs with certain other
words which act as "pinpointers."   "Opera-
tional form classes" are set up for Ger-
man, to be located in different sections of
the memory and to assist in this pinpoint-
ing.

James W. Perry   25
*Machine Translation of Russian Techni-
cal Literature.
Notes on Preliminary Experiments
Mimeographed, 16 pages and appendix,
about October 1952

Words of Russian texts were written on
separate slips of paper, drawn at random,
translated, restored to original order. The
crude word-for-word translation was sub-
mitted to various people for rewriting.
They were able to obtain an insight into
the subject matter, but various mis-
understandings crept in.

James W. Perry   26
* Machine Translation of Russian Techni-
cal Literature.
Notes on Exploitation of the Russian Gram-
mar
Mimeographed, 11 pages, about Nov. 1952

It is proposed that the longest stem entry
which matches the word be looked up first,
then the remaining ending be looked up in
a list selected by a key number which was
obtained from the stem entry.

Yehoshua Bar-Hillel   27
A Quasi-Arithmetical Notation for Syn-
tactic Description
Language, Vol. 29, No. 1, pp 47-58 (1953)

The ideas of the Polish logician Casimir
Ajdukiewicz on syntactic connection are
applied to the problem of devising a me-
thod whereby a machine could analyse the
syntactic structure of a sentence.

Yehoshua Bar-Hillel 28
*Some Linguistic Problems Connected
with Machine Translation
Philosophy of Science, Vol. 20, pp 217-225,
(1953)

The problems of the need for an opera-
tional syntax, of the treatment of idioms
in machine translation, of the intertrans-
latibility of all natural languages, and of
the existence of a universal scheme of syn-
tactical categories are discussed.

Y. B-H.

Anthony Oettinger 29
A Study for the Design of an Automatic
Dictionary
Progress Report No. 26, Nov. 1952 to Feb.
1953, The Computation Laboratory, Har-
vard University, Cambridge, Mass.

Russian is coded into cohesive groups of
several letters for the dual purpose of pro-
viding a less redundant code in order to
save memory space and of assiting in the
isolation of inflectional suffixes. Sample
word-for-word translations are given,
with their interpretations by subjects who
do not know Russian.

Luitgard N. Wundheiler 30
Invariant Syntax as Prerequisite of all
Translation
Mimeographed, 13 pages, about May 1953

The author starts from the work of Ajdu-
kiewicz and others, sets up a "normal
language" which has words which are un-
ambiguous and a syntax specified by rules of
complementation and consecution. Such
a language can be translated with the aid
of a dictionary alone, and may be the best
type of language for any communication
with automatic machinery. Ways in which
natural languages contain features which
render translation difficult are discussed.

Andrew D. Booth 31
Mechanical Translation
Computers and Automation, Vol. 2, No. 4,
pp 6-8 (1953)

Method for searching the (dictionary)
memory of a computer and obtaining an
equivalent in the other language. Method
of breaking up words into stem or stems
and ending to save dictionary space. Pro-
posal to limit the vocabulary to a few gen-
eral entries plus a vocabulary specific to
the subject of the translation. Comparison
of speed of translation by various methods.

Kenneth E. Harper 32
The Mechanical Translation of Russian: A
Preliminary Report
Mimeographed, 26 pages, about June 1953
Scheduled for Fall Issue of Modern Langu-
age Forum

The problem of morphology must take pre-
cedence in the Russian language. Over
1500 sentences were examined, leading to
the conclusion that Russian text will be in-
telligible in English when the word order
is left undisturbed. An estimated vocabu-
lary of 3000 would be needed for mathema-
tics. Problems of morphology and deter-
mination of useful grammatical informa-
tion from a stem-inflectional ending ana-

Harper - Mechanical Translation (Cont.)

lysis is treated in detail. A coding proce-
dure is given with the National Bureau of
Standards Western Automatic Computer
in mind.

Victor A. Oswald, Jr. and 33
Richard H. Lawson
An Idioglossary for Mechanical Transla-
tion
Mimeographed, 16 pages, about June 1953
Submitted to Modern Language Forum

Presents the results of the authors' study
of German nouns, verbs, and adjectives in
the field of brain surgery. 4328 entries in
these categories were compiled from 16
articles in the field, thus the total vocabu-
lary would be under 5500. Figures are
given showing the percentage of items and
of running words found in the study for
each article as the glossary was built up.
Prediction of items averages from 75 to

Oswald & Lawson - An Idioglossar (Cont.)

80% and of running words averages 85 to
90%. Proposes rearrangement of word
order be discarded but syntactic analysis
of functional forms be retained. Specimen
translation given.

Yehoshua Bar-Hillel 34
Machine Translation
Computers and Automation, Vol. 2, No. 5,
pp 1-6 (1953)

Fully automatic, completely accurate trans-
lation will need storage of trillions of bits
or a machine which can learn. Otherwise
human assistance will be required or out-
put of less accuracy tolerated. A sample
of what the output of a "mechanical dic-
tionary" would look like and a bibliography
with critical notes is given.

J. E. Holmstrom 35
Unesco Report on Technical Translating
and Related Problems
First draft mimeographed, 196 pages,
August 15, 1953

Treats many aspects of the problem of
providing translations of scientific and
technical material in seven chapters. Sec-
tion 2.1 is on mechanical translation.

Victor H. Yngve 36
Mechanical Translation
Quarterly Progress Report, October 15,
1953, Research Laboratory of Electronics,
M.I.T.

Describes an experiment on a strict word-
for-word partial translation of German to
English. Words such as "der," "sein,"
"auf" are left untranslated and some Ger-
man grammatical endings are retained on
translated stems so that no information is
lost for a person familiar with German
grammar and syntax but not the entire vo-
cabulary. Whirlwind I computer could do
such partial translation at the rate of
20,000 words per hour.

Anthony G. Oettinger 35
A Study for the Design of an Automatic
Dictionary
Mimeographed, 31 pages, November 1953

Preliminary results to be incorporated in
a thesis. Gives a method for recognizing
59 Russian word endings, taking into ac-
count the presence or absence of certain
letters of the stem which immediately pre-
cede the ending by means of a preposition-
al calculus. The stem dictionary is to be
consulted after the splitting off of the en-
ding. On the basis of a small sample it
appears that the number of dictionary en-
tries required is reduced by one-half.

A. D. Booth and K. H. V. Booth   38
Automatic Digital Calculators
Butterworths, London, 1953

One chapter is reported to be concerned
with mechanical translation.

Charles C. Holt   39
Proposals for an Electronic Translating
Machine with Microfilm Memory
Typewritten, 4 pages, received Jan. 1954

Proposes a dictionary memory using pat-
terns of spots on microfilm which is
mounted on the circumference of a wheel.
Various methods of reading are discussed.

L. E. Dostert, P. Garvin,   40
C. C. Hurd, and P. Sheridan
News release.   See for example the New
York Times, Jan. 8, 1954; Newsweek, page
83, Jan. 18, 1954; the Boston Post, Maga-
zine Section, Feb. 7, 1954; Computers and
Automation, Feb. 1954.

The IBM 701 computer has been pro-
grammed to translate about 60 sentences
from Russian to English, using a vocabu-
lary of 250 words and 6 grammatical rules
Technical reports are in preparation.

Yehoshua Bar-Hillel   41
Can Translation be Mechanized?
Scheduled for American Scientist, April
1954

The most up-to-date general discussion of
the problems and possibilities of machine
translation, and their interpretation by the
author.

*These articles have been microfilmed.
Copies of the film are available for $2.60,
including domestic postage.   To order, re-
fer to Papers on Mechanical Translation,
Roll No. 799:
     Microreproduction Service, 14-S234
     Massachusetts Institute of Technology
     Cambridge 39, Massachusetts

**These articles contain material pre-
sented at the first M.I.T. Conference on
Mechanical Translation, June 17-June 20,
1952.