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Studies in Mechanical Translation

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M T
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by

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The Meaning Of Signal

Signals in the sense of MT are coded messages to the computer ordering distinctive mechanical processes (FL signals) and their decoded form (TL signals). For the different kinds of MT signals we refer to ## 54 - 58.

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I N D E X
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Far Eastern

Our Approach to the Problem of Mechanical Translation of Foreign Language Material.

(By Erwin Reifler, Associate Professor of Chinese, University of Washington,Seattle)

Abbreviations: MT . . . . Mechanical Translation
SL . . . . Selected Languages
FL . . . . Foreign Language
TL . . . . Target Language

Quotations: 1. Leonard Bloomfield, Language:

 a) "A task for linguists of the future will be to compare the categories of different languages and see what features are universal or at least widespread." (p. 270)

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

 c) "As to denotation, whatever can be said in one language can doubtless be said in any other . . . " (p. 278)

 d) ". . .the difference will concern only the structure of the forms, and their connotation." (p. 278)

 2. Joseph Vendryes, La Comparaison En Linguistique, Bulletin de la Societe de Linguistique de Paris, 1945:

 a) ". . . à certains égard l'anglais . . . pourrait admettre une (classification), où il figurerait par exemple à côté du Chinois; puisque, abstraction faite de toute parenté, évidemment hors de question, l'anglais et le chinois présentent, dit-on, certaines ressemblances de structure" (p. 5)

 b) "Cela entraîne le linguiste à appliquer la comparaison aux traits semblables qu'il observe en diverses langues, sans souci d'en tirer la preuve, ni même la recherche, d'une parenté. C'est une étude riche d'enseignements (p. 5 . . . Ce n'est plus une tâche généalogique ou strictement historique, comme celle à laquelle depuis cent cinquante ans s'applique la grammaire comparée. C'est une tâche psychologique qui consiste à grouper des faits communs aux langues les plus diverses pour atteindre, derrière la réalité linguistique, l'esprit dont elle est sortie. Cette tâche est d'une étendue immense et d'une portée incalculable. En multipliant les enquêtes. on opérera une véritable révolution dans la pratique de la méthode comparative et pour tout dire, dans la linguistique. Le linguiste n'aura plus pour objet d'établir par la comparaison un rapport de parenté entre des états de langue séparés dans l'espace et dans le temps; il tirera de de la comparaison des états de langues une connaissance précise

des besoins universels de l'esprit humain et des lois
générales qui en régissent l'activité. Ses conclusions
seront d'autant plus sûres que la comparaison portera
sur des langues plus nombreuses, n'ayant entre elles
aucun lien de parenté.

On en revient ainsi aux études de linguistique gén-
érale, si en faveur au temps jadis, mais par une voie où
elles ont toute chance de se renouveler avec plein succès
(p. 6) . . . à côté de la grammaire comparée traditionelle
il y a place pour une linguistique comparative largement
humaine, qui reprendrait avec des moyens d'information
amplement accrus et des données plus nombreuses et mieux
classées, le travail qui avait été seulement soupçonné par
les philosophes de la fin du XVIIIème siècle." (p. 7)

c) "Assurément cette recherche d'une doctrine générale n'est
pas nouvelle. Il y a une partie de la linguistique où
elle est pratiquée depuis plusieurs décades et où elle a
obtenu des résultats décisifs. C'est la phonétique. . ."
(p. 7)

d) "Le travail du cerveau reste enveloppé de mystère; seul
le résultat enfermé dans les langues est accessible à l'étude.
Pour constituer une grammaire générale dont les lois soient
conformes à la réalité, la première tâche paraît donc être
de dresser un répertoire de tous les faits de grammaire
observés dans toutes les langues. Seule une enquête com-
plète poursuivie méthodiquement fera connaître le caractère
propre, l'étendue, la fréquence de chacune des catégories
possibles de l'entendement humain. Un système à priori,
bâti par raisonnement abstrait sans base solide dans le
réel, devient rapidement caduc. L'intuition est danger-
euse quand elle se substitue aux enseignements de l'expér-
ience." (p. 9)

e) ". . . Une enquête générale sur les langues du monde fera
connaître les lacunes et des manques dans l'usage des
catégories grammaticales. Mais elle montrera aussi quelles
sont les plus répandues, celles qui paraissent nécessaires
et qui répondent à un besoin de l'esprit humain. Cette
recherche sera d'une importance capitale pour la psychologie
tout court, à laquelle le langage offre un champ d'observation
si vaste et si varié." (p. 12) . . . Il faut constituer un
tableau aussi complet que possible des catégories grammati-
cales et des procédés qu'ont employés les langues pour les
exprimer." (p. 15)

f) ". . . L'enquête qu'il y aurait lieu de faire sur l'évolution
des faits grammaticaux pourrait naturellement être étendue
aux faits de vocabulaire. On peut imaginer la comparaison
sur la façon dont les noms sont donnés aux choses et dont
les noms une fois créés évoluent. La sémantique est une
science qui doit aussi faire appel à la méthode comparative
en l'appliquant à toutes les langues . . . . Il s'en dégage

assurément quelques idées justes: c'est d'abord que les
créations de mots répondent souvent à des lois générales
suivant lesquelles certains sens sont naturellement associés
à certains sons. C'est aussi que les mots qui désignent
les opérations de l'esprit et en générale l'activité psych-
ique sont le plus souvent empruntés à des notions matér-
ielles; la vie morale ne s'est que peu à peu dégagée de
l'animalité et le fonds le plus ancien du vocabulaire té-
moigne d'un état social qui nous ramène aux premiers âges
de l'humanité.

Il est particulièrement interessant de suivre l'évol-
ution des mots . . . La façon dont se sont constitués les
vocabulaires techniques, ceux de la religion et du droit,
mérite d'être étudiée dans l'ensemble des langues. . . Une
sémantique générale est aujourd'hui aisément concevable
après certaines études très poussées qui ont été faites
sur la constitution de telle ou telle famille de mots dans
les langues classiques. La comparaison devra seulement
en étendre les conclusions. L'examen de l'origines des
mots et des causes qui en modifient la signification
fournira de bons indices des tendances générales de l'esprit
humain . . . On s'étonne parfois de rencontrer les mêmes
formules populaires, les mêmes proverbes, les mêmes fables,
le mêmes thèmes de folklore dans des pays differents fort
éloignés les uns des autres. On est alors tenté de croire
à des transmissions effectuées au cours des âges et qui
auraient provoqué des emprunts. L'emprunt est vraisemblable,
ou même assuré, dans certains cas; mais il y en a d'autres
aussi où il faut admettre une rencontre accidentelle. L'idée
d'une même proverbe a pu venir independamment à l'esprit
de deux êtres humains sans qu'ils se soient concertés. Pa-
reilles rencontres sont admissibles aussi dans l'invention
ou le choix des métaphores dont les poètes ornent leurs vers.

. . . Il y aurait en tout cas une enquête générale à
faire qui porterait sur les métaphores poétiques aussi bien
que sur les dictions resumant l'experience des relations
sociales et sur les proverbes par lesquels s'exprime la
sagesse des nations.

On peut croire que les mêmes sentiments produisent
à peu près les mêmes effets chez tous les peuples. Ces
effets doivent se refléter dans le langage. Il y a dans
la nature humaine un fonds de poésie qui subsiste partout
identique malgré la variété des moeurs et des croyances,
des institutions et des modes locales. Ce fonds est ali-
menté par les passions qui sont le ressort de la vie et par
les besoins qui en sont la rançon. . . Une étude de ce
fonds commun aboutirait à une sorte de 'dictionnaire des
idées reçues' qui ne serait pas limité au monde bourgeois
d'un temps, mais qui aurait une valeur universelle . . .
Ce dictionnaire sera fort utile pour la connaissance de
l'histoire des mots. (pp. 16-17)

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Our Approach:

#1. This approach is based on our work in semantic universals in different languages* and on our experience gained in classwork in translation problems. The most important ideas underlying this approach are:

A. Conditions for the Possibility of MT

#2. MT is only possible if different languages can somehow be mechanically correlated. A mechanical correlation is only possible if:

a) they have something in common and if

b) what they have in common is expressed or expressible in distinctive signals.

#3. A large number of linguistic features are known to be either universals, widespread (quotations 1a, b; 2 b) or shared by at least two languages (quot. 2 a).

#4. Certain common or comparable features concern the phonetic aspect of language (quot. 2 c).

#5. Those, however, which concern the logical aspect of language are especially numerous. They are found in the grammar (quot. 1 a, b; 2 d, e) as well as also in the lexicon (quot. 1 c, d; 2 f).

#6. The crucial problem, however, for the success of MT is the problem of distinctiveness of FL signals (cf. #2 b).

B. The Concerns of MT

#7. The primary concern of all translation is meaning. Therefore, while the universal features of the logical aspect of language will be of primary importance for MT, universals in phonetics have no bearing on it.

#8. Of the conventional signals of language only the phonic and graphic signals fall within the sphere of interest of MT as chief means for a mechanical correlation.

#9. However, MT is, at least in its beginning stage, less interested in the spoken than in the written form of languages. Moreover, the conventional phonic signals are in a number of important languages often far less distinctive than their corresponding conventional graphic signals (so, for instance, in Chinese and Japanese, but also in languages like French and English, that is in languages with a "historical" form of writing. Consider also the extremely interesting case of certain Semitic languages mentioned in ## 26, 27, 28, 30, 32).

#10. MT will, therefore, in the first place make use of the conventional graphic forms of linguistic forms as signals for MT correlation. It is, for instance, not concerned with homophones, but with homographs (See sections 23, 24, 26, 27, 46a/b1, 52, 53)

C. The Practical Aspect of MT

#11. The importance for MT of descriptive and historical linguistics and especially of the linguistic analysis of languages as far as grammar and lexicon are concerned is emphasised. It has, however, to be pointed out that the aim of MT is entirely practical. It need, therefore, not strictly adhere to the results of scientific research. Wherever these serve its purpose, it will consider them. It will ignore them in those cases where an arbitrary treatment of the language material serves better the purposes of MT (cf. "attributable universals" in ## 11, 69c, 77). We have, moreover, already pointed out that MT is primarily concerned with meaning, a feature of language often treated as a poor relation by many linguists and referred to psychology or philosophy. On the other hand MT is concerned only with the "what" of meaning and not at all with the "how" and "why". Thus also psychology and philosophy will probably be able to contribute only their

factual knowledge and experience to the solution of the language problems involved in MT. Linguistic, psychological and philosophical theories are not likely to have any bearing on it.

D. The Mechanisation Aspect of MT

#12. MT is a mechanical problem only insofar as it has to adjust its language material to the limited capabilities of a computer. The solution on the language side must be one which does not require a computer with infinite variability, or with a variability too astronomical to be practical. In order to cut down the quantity of necessary mechanical processes to that minimum which makes the production of an MT computer-feasible we have to reduce the lack of explicitness of the FL text to the lowest possible degree. This we can do by:

   a) establishing all those features that are common (or attributable, cf. Sections 58, 77) to all languages or, at least, to all SL, and have distinctive conventional graphic signals,

   b) establishing all those features that are common (or attributable) to all languages, or at least, to all SL, and have in certain languages no distinctive conventional graphic signals,

   c) establishing those features of b which admit of a logical arrangement in groups. (cf. Section 75)

   d) arbitrarily creating additional distinctive graphic signals for the features indicated under c,

   e) removing the inexplicitness of the FL text concerning the features mentioned under c by inserting the signals mentioned under d.

#13. We fully realize that this means the exclusion of a very import-
ant aspect of translation from the process of mechanization, namely that of
interpretation (see Section 63). We contend, however, that:

    a) whatever the native reader has to do by way of interpretation
       in the case of non-distinctive features of the FL text, can
       at least at the present stage of computer development, not be
       mechanized. Therefore, all that an FL text leaves to the FL
       reader to determine concerning lexical meaning, connotations,
       grammatical meaning, and word order, has to be added to the
       FL text before it is fed into the computer. And it has to be
       added in a form the computer can "digest";

    b) the preparation of the FL text suggested above is the only
       possible, or at least the only satisfactory solution to our
       problem of dealing with a very large section of non-distinctive
       features in many languages (all zero representations of gram-
       matical meaning, differences in word order and certain kinds
       of multiple meaning).

#14. To use "wider context" as a means to make non-distinctive signals
distinctive and thus make them "digestible" for the computer is ruled out
by the fact that the possible contextual co-occurrences of each FL signal
are practically infinite, whereas the actual number of its possible gram-
matical or multiple lexical meanings is very limited (see Mr. W. Weaver's
Memorandum on MT. p. 8, #5). Only those cases of contextual co-occurrences
can be made accessible to mechanization which can be treated as "idiomatic
signal units" (cf. #56d and e, #87).

#15. We believe that the machine cannot, at least at the present stage
of computer development, be interposed between an FL text and a TL reader, but

only between the interpreting brain of the native reading the FL text and the ultimate reader of the TL text. The native has to read the FL text and, in the cases of inexplicitness of the text, record in it by additional (universal) graphic signals the result of his mental processes re grammatical meaning, word order and certain types of multiple meaning (cf. ## 51, 52, 53, 55, 56, and 88-90. This means that the FL text has to be edited. (See Section 63)

#16. What the computer can do is only:

a) to take the place of a polyglot whose FL knowledge is limited to the extent that concerning all questions of grammar and lexicon not graphically explicit in the FL text he is dependent on the assistance of a native, another polyglot, or on reference books.

b) speed up all other processes of general (into all SL) or specific (into one TL) translation (including the use of dictionaries).

#17. The maximum requirement of MT in the human sphere — as far as the language side of the MT problem is concerned — is, on both sides of the assembly line, a monoglot.

#18. The final form of the interpreted FL text must be such that anybody ignorant of the meaning of the FL text, but familiar with the conventional written form of FL (for instance Chinese, Arabic, Greek), with the universal additional graphic signals and with the controls of the computer, can "dial" it into the computer.

E. The Language Aspect of MT

#19. Thus MT has primarily to be solved on the language side.

#20. What we need on the language side is <u>distinctive graphic signals</u>.
These are lacking in the case of:

        a) multiple meanings,

        b) in zero representation of grammatical meaning (for instance
        "sheep", indicative of singular as well as of plural), -

        c) in non-distinctive graphic signals of grammatical mean-
        ing, that is graphically non-distinctive grammatical
        forms (as, for instance, "-d" in "decided", indicative
        of past tense as well as of past participle) and graph-
        ically non-distinctive word order (as, for instance 傷風
        where 風 , though following the verb 傷 , is not its
        direct object. This case will, however, be treated as
        an "idiomatic graphic signal unit".)

#21. We have, therefore, a twofold task:

        a) <u>On the FL side</u>: to supply, as far as possible, additional
        distinctive graphic signal for all meanings lacking them.

        b) <u>On the TL side</u>: to select, as far as there are, by means
        of a comparative semantic research TL words which share
        all, most, the most important, or at least two of the
        multiple meanings of the FL signal concerned. ("shared
        transferred meanings", see ## 71b, 72, 73.)

        F. <u>The Signal Aspect of MT</u>.

#22. As we have already indicated above (## 9 and 10), MT is not concerned
with <u>linguistic forms</u>, but only with their <u>conventional written</u> forms and their
meaning. Moreover these conventional written forms (conventional graphic sig-
nals as different from the arbitrary graphic signals especially created for

the purposes of MT) are for us not of linguistic interest, but concern us only as more or less distinctive drawings or sequences of symbols that can be fed into a computer and can release a more or less distinctive mechanical reaction.

#23. MT is, therefore, not interested, for instance, in homophones, but in "homographs" of words of different origin (homophones or allophones represented by the same conventional graphic signal, for instance, English "pole", a long stick, and "pole" in "North Pole". Homophones represented by allographs (cf. English "two", "too", and "to") are, of course, no problem to MT since they are represented by distinctive conventional graphic signals.

#24. A homograph of words of different origin is, for the purposes of MT, considered as one graphic signal with multiple meanings.

(Secondary Graphic Signals)

#25. But how about all non-distinctive conventional graphic signals of the FL text (cf. # 6)? Can these be made distinctive? We have already previously indicated in which cases distinctive signals are lacking (# 20) and outlined the double task (that is on the FL and TL side) which thus confronts MT (# 21). With respect to the use of addtional graphic signals (#21 a) we should like to point out:

(Conventional Supplementary Graphic Signals)

#26. There actually are a number of languages, important for MT, which use (sometimes optionally) additional graphic signals: Chinese, Japanese, Arabic, Hebrew (and to a limited degree also in French and Greek), for instance, have two conventional forms of a written representation, one less explicit, the other explicit to an often very high degree. Moreover, some of these languages are characterised by an extraordinary number of homographs, so, for instance, Chinese in the case of characters associated with multiple pronunciations and meanings,

Japanese when written either without kana or only in Kana, Arabic and Hebrew

if entirely written in consonants, as, for example, Hebrew ־ֿ֒ versus ־ֿ֒,

meaning "he ruled", ־ֿ֒ meaning "king", and ־ֿ֒, meaning "Moloch". This

is also, though to a much lesser degree, the case in French and Greek, as seen,

for instance in French la, meaning "her ", versus là, meaning "there"; ou

meaning "or", versus où, meaning "where"; a meaning "has", versus à meaning "to";

du meaning "of the", versus dû meaning "due"; sur meaning "upon" or "sour",

versus sûr meaning "sure"; fut meaning "he was", versus fût, meaning "shaft",

etc., and in Greek εἰς, meaning "to", versus εἷς, meaning "one"; πού, meaning

"where", versus ποῦ, meaning "anywhere"; πότε, meaning "when?", versus ποτέ

meaning "at any time, once", etc.

#27. As already indicated by some of these examples (־ֿ֒ versus ־ֿ֒,

־ֿ֒, ־ֿ֒; εἰς versus εἷς and εἷς), homographs are often used not only

for homophones, but also for allophones (cf. # 23). This is especially frequently

the case in Japanese where often the same characters are used for synonyms and

even for allophonic allonyms, namely when the same Chinese character is in one

case used for its semantic, in another case for its phonetic value. This is

also often the case in Chinese, namely when one and the same character is used

either for words of the same origin but characterised by certain phonic variations

(often associated with different lexical or gammatical semantic aspects of the

same fundamental semantic there), or when one and the same character is used

for words of different origin but similar (though different) pronunciations

(in the case of certain phonetic loans).

#28. In these cases the use of the more explicit graphic form, consisting

of the unaugmented conventional graphic signals plus a small number of supple-

mentary graphic signals, often serves to make homographs distinctive (as, for

instance, the opt onal kana in Japanese). Let us illustrate this with examples
from Chinese whic , though possessing such supplementary graphic signals, uses
them much less t an the other languages mentioned:

#29. In the spoken forms of Chinese different tones often distinguish
multiple lexical and grammatical meanings which in the written form mostly are
in zero representation. Chinese has, however, the conventional supplementary
graphic signals ⌐⌐, for the graphic indication of tones. These supplementary
signals often appear in classical Chinese texts added to certain characters
in order to indicate different pronunciations and/or meanings (for instance 說
in the opening passages of the 論語). The following examples will show how
such supplementary graphic signals also serve to distinguish multiple meaning:

    a) <u>lexical meaning</u> 曲 in the first tone means "crooked",
in the third tone "song"; 挨 in the first means "to
lean to", in the second "to suffer"; 蹶 in the second
means "to stumble", in the third "to kick", in the fourth
"to excite" (note in the latter case also the difference
in the romanized forms: "chüeh^2" and "chüeh^3" versus
"kuei^4").

    b) <u>grammatical meaning</u>: 種 in the third means "seed", in the
fourth "to sow"; 王 in the second means "king", in the
fourth "to rule" (cf. Hebrew מֶלֶךְ versus מָלַךְ, "king" and
מָלַךְ, "he ruled"); 卷 in the fourth means "a roll
or scroll", in the third "to roll up"; 好 in the third
means "good", in the fourth "to love"; 重 in the fourth
means "heavy, etc.", in the second "to repeat, etc." (note
in the latter case also the difference in the romanized
lexical form: "chung^4" versus "ch'ung^2").

(The Educated Native Knows The Form And Value Of The Conventional Supplementary
Graphic Signals Of His Language)

#30. We should like to emphasize that in the cases of languages mentioned
for their use of conventional optional graphic signals the educated native is
well aware of the existence of the distinguishing peculiarity concerned in the
spoken form of his language (for instance, the tones in Chinese, different pro-
nunciations of one and the same character in Chinese and Japanese, or of the
consonantal form in Hebrew, Arabic, etc.) and is well acquainted with the use
and value of the supplementary graphic signals concerned. Thus the use for
the purposes of MT of these conventional supplementary signals in the case of
the FL concerned would be an easy task and extremely valuable.

#31. In the cases of languages possessing such supplementary signals
MT is, therefore, confronted with two possible FL texts, a less explicit one and
a much more explicit one. Which one is MT going to use? The answer can only
be in favor of the latter.

(The FL Text Has To Be Edited)

#32. But if we, in these cases, decide in favor of an augmented FL
text, we shall, mostly, have to do some editing. Since, however, the educated
native is well acquainted with the use and value of the conventional secondary
graphic signals of his language (# 30), this will not be difficult for the FL
reader concerned. But here several new problems arise which have first to be
decided:

With the exception of, for instance, French and Greek, all the languages
mentioned for their conventional use of supplementary optional signals admit of
different degrees in an editing process aiming at increasing the explicitness of
their texts. For instance, in Hebrew texts intended for adult or educated readers --
with the exception of scientific texts of linguistic import, the Bible and prayer

books — the conventional vowel signs and diacritic marks (for instance the
dagesh) are added only in the case of certain words, namely wherever an omission
of these optional signals would even in the case of adult or educated readers
make the selection of the incident meaning (the incident reading) difficult.
On the other hand, wherever mental processes of the adult or educated reader
result in a correct interpretation of lexical or grammatical meaning in zero
representation in the consonantal text, the supplementary signals are customar-
ily omitted. Mutatis Mutandis we have the same situation in Japanese and, to a
lesser degree, in Chinese. Furthermore, the use of supplementary signals
in these languages shows varying degrees of extensity according to the edu-
cational level of the reading public for whom the texts are intended or accord-
ing to the different aims of the writers. The question which confronts MT here
is the following:

#33. Shall we in these languages decide on any particular educational
level or shall we, in the editing of the FL text concerned, use the conventional
supplementary signals to their fullest possible extent? Since distinctiveness
of the signals of FL is the crucial problem of MT, and since the native FL reader
will often be unable to decide which conventional primary signal or signals
(the FL signal less its supplementary signal or signals) are explicit enough,
and since, anyway such decisions, if left to the FL reader, would enormously
increase the time of editing, the answer will in most cases be in favor of the
second alternative. We shall probably have to make an exception in the case of
the Chinese language where the number of multiple meanings representable by con-
ventional supplementary signals indicative of tones is comparatively small and
thus may not warrant their indiscriminate use. Here it may be more advisable
to insert the tone signals only in cases where multiple meanings are involved
and where they can be thus distinguished, but not in those where they do not

indicate differences in meaning. Since the educated Chinese is always conscious of such semantically conditioned differences in tone, his insertion of the supplementary signals will not require much time. A further restriction of the use of the tonal signals in the FL text may be recommendable: multiple lexical meanings characteristic of one form class (## 39 b, 53 Ba/ga, 79) and all possible grammatical meanings are, in General MT, anyway made distinctive by universal arbitrary signals (# 53 Bb and c). Therefore, a special study will have to be undertaken in order to determine whether and how a double graphic indication of these meanings can be avoided in tonal languages like the Chinese and whether it is desirable to avoid it (cf. #59). In Specific MT conventional supplementary signals indicative of grammatical meaning will sometimes probably be preferable to the universal arbitrary signals indicative of the same meanings (cf. ## 54 b, 55 b).

#34. Another problem peculiar to the Chinese (and perhaps to other tonal languages) is that presented by the differences in the number and distribution of tones in the traditional literary system and the different modern dialects. The literary system has four, Standard Mandarin has also four, lacks however, the fourth of the literary system and has split the first tone of the literary system into two tones. Cantonese has nine tones. A special study has to be undertaken in order to determine whether the choice of any particular tonal system affects the graphic explicitness of the literary form of the Chinese language. If, for instance, arbitrary graphic signals based on the nine tones of Cantonese give greater graphic distinctiveness than those based on the four tones of Standard Mandarin or than the conventional supplementary signals (based on the traditional literary tones), MT will, of course, decide in favor on the first. The Chinese FL readers would then have to be Cantonese.

#35. Thus MT will in the case of certain languages use supplementary graphic signals in order to increase their MT value (their graphic explicitness) to the fullest possible degree, namely in those languages which already have conventional supplementary signals. The obvious question which arises here for MT is whether or not this method can be extended to languages lacking such conventional supplementary graphic signals? Before we can answer this question, we have first to find out what made the use of conventional supplementary graphic signals desirable and possible in the languages possessing them:

#36. In these languages such supplementary graphic signals were desirable and possible because of:

    a) the existence of certain variant features of their spoken form not represented in their conventional primary written form (written form less supplementary signals) and

    b) because of the fact that the educated native speakers concerned were and are well aware of these distinguishing features of the spoken form.

#37. An analogous treatment is, therefore, desirable and possible wherever this double phenomenon occurs. Thus it is desirable and possible wherever in a language:

    a) the spoken form distinguishes differences of multiple meanings not represented in the written form, and wherever

    b) the educated speakers are well aware of these differences.

(Universal Abritrary Graphic Signals)

#38. The conditions for a treatment analogous to that accorded languages characterized by the possession of conventional supplementary graphic signals (##26-35) are common to all SL in the case of those graphically non-distinctive multiple meanings which are:

a) absolute or attributable universals (Sections 11, 69c,77) and which

b) can be made distinctive by their grammatical meaning or by the department of knowledge in which they occur.

#39. This holds true for:

a) all cases of multiple grammatical meaning in graphic zero-representation,

b) those cases of graphically zero-represented multiple lexical meanings that are characteristic of one form class (Sections 53 Ba/aa, 79)

c) those cases of graphically zero-represented multiple lexical meanings which can be made distinctive by their grammatical meaning (Sections 53 Bc, 80)

d) those cases of graphically zero-represented multiple lexical meanings, other than those described in b and c, which can be made distinctive by subject labels indicative of the department of knowledge in which the meaning occurs (for instance German "Schiff" ⚓ , meaning "ship"; "Schiff" ⚙ , meaning "boiler"; "Schiff" ⚮ , meaning "nave". (Cf, the symbols used in Muret-Sanders, Enzyklopädisches Deutsch-Englisches Wörterbuch, 16th edition, p XVII. In the case of the most common meaning -- in our example that of "ship" -- of an FL word the distinctive symbol may, of course, always be omitted. (Cf. Sections 53 Ba/bb)

#40. We have, however, here to distinguish between General MT (translation from one FL into all selected TL) and Specific MT (translation from one FL into one TL). It is clear that in Specific MT the supplementary signalisation will

be worked out in consideration of the agreements or disagreements peculiar to each set of two languages (Cf. Sections 49, 61). But in General MT an adjustment is necessary for the following reasons:

#41. Many cases of #39 a) will, in spite of their graphic zero-representation, be semantically quite distinctive in their FL form as well as also in all of their MT-ed TL forms on account of the universality or attributability of grammatical concepts, namely by grammatical context. In Chinese, for instance, the occurrance of a subject or of certain adverbs of time in a sentence make person and tense of the predicate quite explicit. Thus 曰 in 王 瞀 曰 can only refer to the third person and to the past on account of the co-occurrence of 王 and 瞀 . Moreover, the cases of grammatical zero-representation vary from language to language. On the other hand many cases of #39 b) are in many SL graphically (and phonically) non-distinctive, and furthermore, the phenomenon of "shared transferred meanings" (71 b, 72; 73) varies for every set of two SL. The question which confronts MT here is how to deal on a universal scale with these cases?

#42. The answer can only be an approach analogous to that used in the case of conventional supplementary graphic signals (See ## 32 and 33), that is the use of the universal arbitrary MT signals throughout, in those cases as well in which the lexical and grammatical meanings concerned are not in zero-representation as also in the cases where they are "shared transferred meanings" of two SL. In other words, we have, for the purposes of General MT to treat all SL as if they were in the cases of these meanings on the same graphic zero level (see ## 42, 46, 47, 48, 49, 53 Ba/aa; b; 79, 83, 84, 86, 88-90). In this way General MT is able to make all SL, in the cases of the meanings concerned, equally explicit.

#43. Thus also in the case of languages <u>not possessing</u> conventional supplementary graphic signals MT can, by the use of <u>arbitrary</u> signals, reduce the difficulty of multiple meaning to a very large extent, namely with respect to <u>all grammatical meanings</u>, all <u>lexical meanings characteristic of one form case</u>, and all those <u>lexical</u> meanings which can be made distinctive by their <u>grammatical</u> meaning — that is with respect to meanings concerning whose grammatical distinctiveness the educated and trained FL reader is fully aware on account of his intimate knowledge of his language — and, at last, with respect to all those <u>lexical</u> meanings which can be made distinctive by <u>subject labels</u>.

#44. But how about multiple meanings not falling into these categories, that is the large majority of multiple lexcial meanings? How can we here reduce the problem of non-distinctive conventional signals to its lowest possible minimum?

#45. In these cases a different approach is necessary which will be discussed in the chapter dealing with "The Meaning Aspect of MT" (Sections 81, 82, 92). Here we should only like to indicate that in these cases we believe the answer to be:

    a) <u>on the FL and TL side</u>:

        a1) a semantic research aiming at detecting "shared transferred meanings",

        b1) consecutive reference numbers accompanying every FL signal or unit of signals,

    b) <u>on the FL side</u>:

        a mechanized "MT-dictionary".

(Cases in which MT is not interested in the Distinctiveness of Conventional Graphic Signals)

#46. In spite of the paramount importance for MT of the graphic distinctiveness of conventional graphic signals (## 6, 9, 20, 22) this distinctiveness is in General MT, for the reasons given in ## 41 and 42, ignored in the following cases:

    a) on the side of the FL text

        al) all possible graphic transformations of any contextual word indicative of grammatical meaning (including all cases of suppletion) are considered as signals only for its lexical meanings (but see # 48; cf. Sections 83, 84, 86).

        bl) all homographs representing multiple lexical meanings characteristic of one form class are considered as signals only for the grammatical meaning common to all members of the form class concerned. (79).

    b) on the side of the TL text

        The equivalents of al) appear in all cases only in the form of the headwords of their paradigms.

#47. These conventional graphic signals are, in general MT, made distinctive by universal MT-signals identical for the FL and TL side (Section 57). (Modification of Section 46 al)

#48. With respect to #46 a/al) we have to mention certain exceptional cases in which different grammatical forms of one FL word are associated with different lexical meanings. This is the case, for instance, with Hebrew דוֹיִּת

which in its Qal form 　יָרָה means "he threw", in its Hiph'il or causative form

הוֹרָה means "he thanked", and in its Hithpael or reflexive form הִתְוַדָּה

means "he confessed". Such cases are, for the purposes of MT, not considered

different grammatical forms of one FL word, but as isolated grammatical forms

of _different_ (defective) FL words. Their conventional graphic signal is con-

sidered as a signal only for the lexical meaning or meanings associated with

them, and not as a signal for the lexical meanings associated with the headword

of their paradigm.

These exceptional cases could be merged with the overwhelming majority

intended in #46 a)1), that is those in which all possible graphic transformations

indicative of _grammatical_ meaning of an FL word have the same _lexical_ meaning

or meanings as the headword of its paradigm. MT theory would then have to

(arbitrarily) lump them together with those in which universal MT signals can

simultaneously make graphically distinctive zero-represented multiple grammatical

and non-distinctive _lexical_ meanings (cf. 光 noun equals "light", 光 adjective

equals "shining", glistening, polished, etc.", 光 adverb equals "only", etc.

See # 39 c and 56 Bb). That is the lexical meanings exclusively associated

with certain of their grammatical forms could very well be "attributed" to

the headword of their paradigm as additional transferred meanings and then be

considered as made distinctive by the universal MT signal for grammatical meaning.

However from the point of view of mechanical correlation the effect

would be the same whereas from the point of view of General MT theory it may

be advisable to keep those exceptional cases separate from those whose gramma-

tical meanings are, in the conventional written form, in zero-representation

(as exemplified above by 光).

<u>(exception to #46)</u>

#49. For the purposes of <u>Specific</u> MT the rule laid down in #46 has to be invalidated in those cases in whcih a grammatical form of an FL word has an <u>exact</u> equivalent in TL. In these cases a graphic transformation of a contextual FL word indicative of grammatical meaning (including all forms of suppletion) is to be considered a distinctive signal for both lexical and grammatical meanings (cf. Sections 40, 61)

#50. The rules laid down in ## 46-49 solve for MT the problem of differences in the structure of forms in different languages (quotation d). These are no obstacle to MT because MT, though considering the structure of forms of FL in the process of selecting the appropriate MT signals for grammatical meanings, ighores it in the process of mechanization, except in the cases indicated in ## 48 and 49.

<u>(The Concept of "Labelling" in MT)</u>

#51. The concept of labelling will, perhaps, best characterize our approach. We believe that MT can only be succecsful if we succeed in "labelling" graphically non-distinctive meardngs of conventional graphic signals of FL by additional (universal) graphic signals indicative of a <u>distinguishing feature</u> known to the educated FL <u>speaker</u>, but unrepresented in the conventional written form. Such distinguishing features are, for instance, differentiating situations or actions (see Bloomfield, <u>Language</u>, p. 39, 1st paragraph: "facial expression, mimicry, tone of voice,... insignificant handling of objects, ... and, above all, gesture.") But only those which are "proscribed by the conventions of language" (cf. Bloomfield, ibid.) can be used for "labelling" by MT because the distinguishing features must be those which are <u>conventionally</u> associated with particular

phonic signals. Thus graphically non-distinctive meanings of conventional graphic

signals can be "labelled" by additional graphic signals indicative of:

A. Semantic differences associated with phonic differences,

B. Semantic differences not associated with phonic differences.

Let us demonstrate this with some examples:

#52.　I.　In the case of languages possessing conventional supplementary
signals:
A. The "labelling" of conventional primary graphic signals

by conventional supplementary graphic signals indicative

of semantic differences associated with phonic differences:

a) multiple lexical meanings:

German	(die) Sage (legend)	(die) Säge (the saw)
	(die) Bande (ties) ———————	—(die)Bände(volumes)
Greek	ἰέναι (to go)	ἐέναι (to send)
Hebrew	곡ֶֶלֶ곡 (king)	곡ֶלֶ곡 (Moloch)
Chinese	蹶 (to stumble); 蹶 (to kick);	蹶 (to excite)
Japanese	行く (to go)	行 (to behave,etc)
	里 (native place)	里 (Japanese mile)

b) multiple grammatical meanings:

German	Vater (father)	Väter (fathers)
Greek	ποῦ (where)	ποῦ (anywhere)
Hebrew	곡ֶֶלֶ곡 (king)	곡ֶלֶ곡 (he ruled)
Chinese	種 (seed)	種 (to sow)
Japanese	乱した (disorder)	乱した (to throw into disorder)

c) multiple lexical and grammatical meanings

German	Stunde	(hour)	:	Stünde (he would stand, with capital initial after a period)
Greek	εἶμι	(I shall go)	:	εἰμί (I am)
Hebrew	אַלָּה	(oak); אָלָה (he cursed);		אֵלֶּה (these)
Chinese	惡	(to dislike)		惡 (where? how?)
Japanese	生む	(to beget) :	生 (raw) :	生 (life)

B. The "labelling" of conventional primary graphic signals by conventional supplementary graphic signals indicative of semantic differences not assoicated with phonic differences:

a) multiple lexical meanings (of ひ and む):

Japanese	日ひ (sun)	:	火ひ (fire)	*)
	熟む (to ripen)	:.	生む (to beget)	*)

b) multiple grammatical meanings (of から, あと and Band):

Japanese	自から (since, postposition):	故から (since, conjunction)	*)
	あと (ago, before); 跡あと (a precedent, etc.):	後あと (the place where one has gone)	*)
German	band (he bound)	: Band (ribbon, volume)	*)

c) multiple lexical and grammatical meanings (of き and に etc.)

Japanese	木き (tree); 黄き (yellow):	来き (the coming)	*)
	に (in, into); 二に (two):	荷に (a burden)	*)
French	la (her)	: là (there)	
	ou (or)	: où (where)	
	a (has)	: à (to)	

du	(of the)	:	dû	(due)
sur	(upon, sour)	:	sûr	(sure)
fut	(was)	:	fût	(shaft)

*) Note that in the Japanese cases of B a, b and c we consider — from the point of view of MT -- the Chinese characters as the conventional supplementary (because distinguishing) signals, whereas in the German case of B b we consider the difference between the small and the capital initial, when used to distinguish nouns from other words, as a conventional supplementary signal.

#53. II. In the case of languages not possessing conventional supplementary signals:

A. The "labelling" of homographs by arbitrary supplementary graphic signals indicative of semantic differences associated with phonic differences:

a) multiple lexical meanings:

Russian	Bólna	(wool)	;	Bolná	(wave)
Latin	palus	(swamp)	;	pālus	(a pole)

b) multiple grammatical meanings:

Latin	spiritus (nominative)	:	spiritūs (genitive)

c) multiple lexical and grammatical meanings:

Latin	mănus	(hand)	:	mănus	(good)

B. The "labelling" of homographs by arbitrary supplementary graphic signals indicative of semantic differences not associated with phonic differences:

(For the following demonstration we assume as universal MT signals: ꟼ -- at the side of; ⊤ -- passive voice; ⌐ -- physical ability; ✛ -- possibility; → -- permission; ⧼ -- from; ⬥ -- desire; ✝ -- religion; ✵ -- engineering; ⚓ -- navy; ⊕ -- link; ⊓ -- writing; h -- accusative; p -- past tense; ╥ -- plural; v -- verb; av -- adverb; aj -- adjective; n -- noun; naj -- noun-meaning carried by the adjective):

a) multiple <u>lexical</u> meanings:

Here we have to distinguish two subgroups:

    aa) meanings <u>characteristic of one form class</u>

    bb) meanings <u>not</u> characteristic of one form class.

Group bb) we subdivide further into:

    aaa) meanings <u>peculiar to scientific terms</u>

    bbb) meanings <u>not</u> peculiar to scientific terms

Examples:

    aa) multiple lexical meanings <u>characteristic of one form class:</u>

English   by ⊢ (I sat <u>by</u> him);   by ⟋⫪ (I was beaten <u>by</u> him)

            can ⌐ (ability);   can → (permission)

German   von ⟨ (from)   :   von ⟋⫪ (I was beaten <u>by</u> him

            können ⌐ (ability); konnen ⫯ (possibility); können → (permission)

            mögen ⫯ (possibility); mogen → (permission); mögen ⟨ (desire)

Chinese   由 ⟨ (from)   : 由 ⟋⫪ (I was beaten <u>by</u> him)

            可 → (permission) : 可 ⫯ (possibility)

    bb) multiple lexical meanings <u>not</u> characteristic of one form class:

      aaa) multiple lexical meanings <u>peculiar to scientific</u> terms (cf. # 39 d):

English   nave ⚓ (of a church) :   nave ⚙ (of a wheel)

German   Schiff ⚓ (boat)   : Schiff ⚓ (nave of a church)

Chinese   道 O (road)   : 道 ⚓ (Tao in Taoism)

bbb) multiple lexical meanings <u>not</u> peculiar to

scientific terms:

German   Band ↺ (ribbon)   Band ∞ (tie)   Band 皿 (volume)

Chinese   本 () (root)   本 皿   (volume)

b) multiple <u>grammatical</u> meanings:

English   it 0 (nominative)   ;   it4   (accusative)

         beat 0 (present tense) :   beat$_p$ (past tense)

         sheep 0 (singular)   ;   sheep$_{pl}$ (plural)

German   sie 0 (she)   :   sie$_{pl}$ (they, them)

Chinese   取 0 (take)   取$_p$ took 取 竹 (passive)

c) multiple lexical <u>and</u> grammatical meanings:

English   fast$_v$ (to fast)   :   fast$_{av}$; (quickly, firmly fixed, see Section 61)

German   bloss$_{aj}$ (naked)   :   bloss$_{av}$ (only)

Chinese   光 n (light) 光 naj(shining, etc.) 光 aj (bald, naked) 光$_{av}$ (only).

(The Different Kinds of MT Signals)

#54. We distinguish the following main groups of MT signals:

a) <u>conventional signals</u>, that is the conventional graphic form of contextual words.

b) <u>arbitrary signals</u>, that is those created or adopted (for instance, conventional supplementary signals adopted by MT, (See ## 25-35) for the purposes of MT in order to make distinctive those meanings which in the FL text are either in zero-representation or represented by non-distinctive signals (## 35 - 43). In Specific MT conventional supplementary signals indicative of grammatical meaning may sometimes be found preferable to universal arbitrary signals indicative of the same meanings (See # 33).

#55. Among the conventional signals we distinguish:

    a) primary signals, that is those which constitute the minimum requirements of an FL text intelligible to an educated native reader, for instance, in certain cases of homophony the use of Chinese characters in a Japanese text (cf. # 52 B); the "consonantal" elements in a Hebrew, Aramic, etc. text, a French or Greek text without all accents and diacritic marks and spiritus (cf. # 52 A and Bc), a Chinese text without the (Chinese or Western) conventional punctuation marks.

    b) supplementary signals, that is those conventionally used to make the FL text more explicit, for instance the Kana in Japanese; the vowel signs and other conventional diacritic marks in Hebrew, Arabic, etc.; the accents and other conventional symbols like the trema in French, the accents and spiritus in Greek, the (Chinese or Western) punctuation marks in Chinese. As for the preference of conventional supplementary signals to arbitrary signals in certain cases of Specific MT see # 54 b.

#56. Among the (universal) arbitrary signals we distinguish:

    A. From the point of view of the occurrence or lack of different phonic features of FL:

        a) signals based on phonic differences of FL (cf # 52A; # 53A).

        b) signals not based on phonic differences of FL (cf # 52B; #53B).

    B. From the point of view of different semantic features of FL:

a) signals indicative of multiple lexical meanings which
   again fall into the following subgroups:

    aa) signals "labeling" meanings characteristic of one
   form class (see # 79 and #53 B aa).

    bb) signals "labeling" meanings peculiar to scientific terms
   (cf. # 53 B a/bb/aaa).

    cc) signals "labeling" meanings not peculiar to scientific
   terms (cf. # 53 B a/bb/bbb)). To these belong also
   the signals mentioned under b and c when they simul-
   taneously "label" multiple lexical meanings (cf. Sections
   80, 88-90).

    dd) signals "labeling" meanings which cannot be "labeled"
   by the signals mentioned in aa, bb, and cc. They are
   supplied by the mechanized FL dictionary (cf. # 45 b
   and Sections 81, 82, 92) and have a fixed sequence in
   which they accompany the transferred meanings in the
   MT dictionary.

b) signals indicative of all possible grammatical meanings. They
   often simulataneously "label" multiple lexcial meanings (see
   Ba/cc and c of this #, and Sections 80, 88; cf. ## 39c; 48;
   52A c, Bc; 53Ac, Bc).

c) signals indicative of word order. They have a fixed sequence
   based on a universal logical sequence of all parts of speech
   arbitrarily established for MT purposes. They simultaneously
   "label" the grammatical meaning common to all members of a
   form class and thus often simultaneously "label" multiple
   lexical meanings (cf. Ba/cc and b of this # and ##28 c
   and 37).

d) space markers indicative of the completion of a "MT word" or "MT word unit" (idiomatic MT units, see # 86), that is of those MT signal complexes that are ready for "computer digestion".

e) space markers indicative of the non-completion of an "MT word" or "MT word unit" and resulting in a mechanical "storing".

f) the reference numbers (cf. ## 45a/b1, 60, 82).

#57. With the exception of the arbitrary signals mentioned under # 56 d and e (those indicative of completion or non-completion of an "MT word" or "MT word unit"), all other arbitrary signals of the FL text appear also in the TL text (# 47 and cf. #58)

#58. A special investigation has to be made in order to establish those conventional supplementary signals used in punctuation which are attributable universals (cf. Sections 12a, 77) and have MT value. They are adopted by MT and used
(See #85)
as universal signals. They appear in the FL text as well as in the TL text (cf. # 57).

#59. Practical experience will show that in certain cases the use of one arbitrary signal will make the use of another arbitrary signal superfluous (Cf. ## 33, 48, 49, 54b, 55b, 87). In cases in which, for instance, in a Chinese sentence the subject is graphically represented and distinctive enough (Cf. # 41) the use of a grammatical signal indicative of person will often not be necessary. Moreover, anyone of the signals mentioned in ## 56 B a, b and c, and in # 58 can simultaneously function as space markers indicative of "completion" (# 56B d), namely when it is the last supplementary signal of the FL word and not followed by the signal indicative of "non-completion" (# 56 B e). Thus spacemarkers will only be necessary in the case of the absence of these signals.

#60. The reference numbers (# 56B f) are automatically added by the computer after it has been "informed" of "completion".

#61. In the case of Specific MT any one of the universal signals mentioned in #56, except those mentioned under d, e, and f, may be found superflous under certain condtions, namely wherever a conventional graphic unit in FL has its exact counterpart in TL (cf. #40, #49).

#62. All arbitrary signals have to be simple and, wherever possible, "logical" and cumulative so that they can be easily remembered and reproduced by the FL reader and recognized by the attendant of the computer and the TL reader (cf. #53 B).

(Machine Versus Man)

#63. One of the most important questions of the signal aspect of MT is the relative speed of MT versus translation by a polyglot. It is clear that the exclusion of the interpretative part of translation from the mechanisation process (# 13) and the resultant neressity of editing the FL texts (## 15 and 32) means an enormous slowing down of the MT process. The question which has to be answered here is: Will MT be able to compete with a polyglot translator? The answer is:

#64. Only Specific MT will seriously affected. However, in Specific MT: a) a large amount of editing necessary in General MT will in certain cases be unnecessary on account of the close agreement of the two SL concerned (for instance in the case of German and English, cf. # 61)

b) In the case of languages like Chinese and Japanese, both very important for MT, Specific MT will still be much quicker than human translation (whether done by a FL polyglot, that is a Chinese or Japanese, or by a TL polyglot, that is by a non-Chinese or non-Japanese) because the "brain" of the computer will contain an enormous amount of information difficult

to acquire by either a Far Eastern or Western polyglot, and because its "memory" is far superior to theirs. A human translation from any of these languages is much more difficult and time consuming than the editing done by the native. Here MT will be of real value.

#65. General MT will certainly be much quicker than human translation since one and the same editing of an FL text serves for the MT into all SL.

#66. Important factors in the race between computer and man will be:

a) Specialization and division of work on the editing side,

b) the mechanized MT dictionary (cf. Sections 68a/dd, 92),

though we realize that such a dictionary can also be made available for the human translator.

C. The Meaning Aspect of MT

#67. We treat here of meaning only from the point of view of the requirements of MT (cf. #11), that is FL meaning in the mirror of TL (cf. Sections 69-73, Section 92).

Meaning Universals

#68. All possible meanings are somehow expressible in all SL, for instance by:

a) existing graphic signals already carrying them, for example English "I pay attention to", classical Greek " ἐπι μ ελομαι " with genitive (I am making myself concerned towards), classical Hebrew " לא לבי שים ני " (I place my heart towards), Chinese " 我注意 " with accusative (I make thoughts flow to).

b) existing graphic signals made to carry them via the
phenomenon of transferred meaning, for example Chinese
電 , "lightening": 電 , "electric".

c) existing graphic signals made to carry them via the
phenomenon of loan translation, for example English
"automobile" (auto meaning "self", mobile meaning
"movable): Chinese 自動車 (自 self, 動 to move,
車 carriage).

d) new graphic signals which are either:

aa) borrowed from another language via the phenomenon
of loanwords, for example German "Ersatz" (sub-
stitute) in an English text.

bb) created under the influence of a foreign language
via the phenomenon of loanwords, for example the
graphic signal "Tao" corresponding to Chinese 道
(in the taoistic sense).

cc) created for new concepts by:

aaa) initiation, for example "ABBA" in "the ABBA
problem in Chinese logography" (describing a
certain type of character growth),

bbb) derivation via the phenomenon of word formation
(derivation in the narrower sense and compounding)
according to the methods peculiar to each of the SL.

FL Meaning in Terms of TL

#69. For all practical MT purposes meaning is always satisfactorily
definable by:

a) The narrower FL context, for example the meaning of "salt"
in "an old salt" (an experienced sailor), as different from,
for instance, "put some more salt into the soup".

b) by the TL equivalent of a graphic FL signal, for example
"salt 2" (assuming that the Universal English Dictionary
of Henry Cecil Wyld is our English MT dictionary and
using its system of differentiating multiple meanings)
equals German "Seebär" (literally "seabear", that is,
"sailor").

c) (In the case of grammatical meaning) by a universal form
of grammatical definition, for example 愛 in 母愛其子
(if this means in TL "the mother loves her child"):
Third person fem. sing. pres. ind. act. voice (cf.
Section 77 for the concept of "attributable universals").

#70. However, apart from the interpretative work of the FL reader (an
FL monoglot) which, of course, is supposed to consider the FL meanings only in
terms of FL, MT is primarily interested in the meanings of FL signals in terms
of TL.

#71. Different languages differ in many cases of semantic association,
but also show identical metaphors in others. Thus natives may often not be con-
scious of a change of meaning, whereas foreigners may feel a change on account
of the semantic habits of their own language (cf. Bloomfield, Language, #9.8,
last section). From the point of view of MT we have here to distinguish two
cases:

a) a bilingual dictionary will on the TL side often have
to indicate multiple meanings where the monolingual
dictionary could well ignore them. Thus from the
point of view of the Chinese language 光 in
光體 , "shining body", and 光頭 , "shining head"

means "shining" and no change of meaning seems to have been felt (at least originally) to have taken place as evidenced by the fact that it did not occur to the Chinese to add a differentiating signific ("radical") to 光 in the sense it has in 光頭 (for instance the signific 髟 , meaning "hair of the head"). But in, for instance, a Chinese-English dictionary, the indication of a change of meaning cannot be avoided because 光體 corresponds to English "luminous body" and 光頭 to English "bald head". In such cases MT has to consider multiple meanings of FL in terms of TL.

("Shared Transferred Meanings").

    b) a bilingual dictionary sometimes could on the TL side ignore multiple meanings of FL where the monolingual FL dictionary will have to indicate them. Thus Chinese 光 in 光身 , "naked body", means "naked", in 他光有兩塊錢 , "he only has two dollars", it means "only". But in terms of, for instance, a Chinese-German dictionary no change of the central meaning seems to have taken place, for the German equivalent for 光 in 光身 is (besides "nackt") "bloss" (naked, bare) which, as an adverb, is used in the sense of "only" (cf. English "bare" and "barely"). It is clear that for the purposes of MT all "shared transferred meanings" can be ignored by the mechanized MT dictionary (cf. Sections 81, 92)

#72. The monoglot FL reader is, of course, not supposed to be aware
of the problems described in #71. The mechanized MT dictionary takes care of
both cases. In the case of #71 a) it will automatically supply him with a
table of transferred meanings in the form of FL synonyms. For instance, in
the case of 光頭 it will give him the Chinese equivalent for "hairless head"
and the appropriate supplementary MT signal (cf. #56 a/dd). In the case of
#71 b) non-action of the mechanized MT dictionary will solve the problem to
the satisfaction of MT (光 will be mechanically correlated to German "bloss"
whether it means "bare" or "only").

#73. Cases in which the (central meaning) equivalent in TL of a
graphic FL signal has transferred meanings different from those of the latter
will only in exceptional cases constitute a difficulty because the TL context
will mostly make the TL signal concerned sufficiently distinctive (but compare
Sections 81 and 82).

(The Different Kinds of MT Meanings)

#74. We distinguish the following main groups of meanings:

a) lexical meanings according to the mechanized MT dictionary
   (Section 92) comprising:

   aa) central meaning

   bb) transferred meaning

b) grammatical meaning (See Sections 77, 83-86)

#75. Among the lexical meanings (#74 a/aa and bb) we distinguish

a) meanings which admit of a group treatment (#12 c):

   aa) meanings carried by scientific terms (cf. #56 a/bb)

   bb) certain meanings not carried by scientific terms (cf. #56a/cc)

   cc) meanings characteristic of a form class (cf. #56 a/aa, 79)

   dd) meanings exclusively associated with a particular grammatical
       meaning (cf. #56 b, 80)

b) meanings that do _not_ admit of a group treatment (cf. §56 a/dd,

Sections 81, 82)

(Primary assumptions)

#76. All possible _lexical_ meanings are expressible in all SL (quotation c)

#77. All possible _grammatical_ meanings, however expressed (by formal differences, special words, word order, context, etc., cf. Sections 12a, 58) are either _absolute_ (quotation b) or _attributable_ _universals_ in all SL. Examples for attributable grammatical meanings are:

a) Chinese 之 , when between two nouns, is from the point of view of the Chinese language an anaphoric pronoun. But for all practical purposes it has mostly been considered to be the equivalent of "'s" in "father's" or of "of the" in "of the father", that is expressive of the grammatical meaning "genitive".

b) From the point of view of historical grammar Japanese "hito ga yuku" means "a man's walking". But for all practical purposes it has in modern Japanese always been considered to be the equivalent of "a man walks", and "ga", in this context really a marker of the genitive, is tacitly considered a marker of the nominative case (cf. G. B. Sansom, _An Historical Japanese Grammar_, pp. 231-234).

Thus the grammatical meaning "genitive" or "nominative" has in these cases been arbitrarily attributed to 之 and "ga" without harming the contextual meaning in terms of TL. We believe that MT can profitably extend this method to many other cases of the same

(Multiple Lexical Meanings)

#78. Of the lexical meanings mentioned in #75 only those under cc, dd and b require further discussion:

(Lexical Meanings Characteristic of Certain Form Classes)

#79. It is peculiar to all possible lexical meanings characteristic of certain form classes that their distribution over the members of the form class concerned in many cases varies between each set of two languages. Thus for instance in the subformclass of auxiliary verbs of mood the central meaning of German können (to be able) is the central meaning of English "can" and of Chinese 能 . But of its transferred meanings "to be possible" (es kann sein) and "to be permissible" (du kannst hingehen) the first is the central meaning of English "may" (German "mögen"), as, for instance, in "it may be" (es mag sein) and the transferred meaning of Chinese 可 , whereas the second is the transferred meaning of English "can" (you can go now) and of English "may" (you may go now), and the central meaning of Chinese 可 . An analogous situation is peculiar to the form class (pre- or post-) position (cf. #53B a/aa). In these cases it is "desirable and possible" (cf. ## 35, 36, 37, 38, 39 b) for MT to apply a "group treatment" (#12 c, 75a) But whereas in the case of all other lexical meanings which admit of a group treatment (# 75 a/aa, bb, dd) the mere addition of a supplementary MT signal solves the problem of non-distinctiveness, the irregularity demonstrated above in the distribution of the lexical meanings characteristic of certain form classes, and the very limited number of these meanings suggests a treatment similar to that accorded all grammatical meanings (## 41 and 42, 46, 47, 48, 49, 50, 53 bb and 83, 84) We have, however, to point out the following difference: In the case of all grammatical meanings of all SL "all possible transformations of a contextual word indicative of grammatical meaning (including all cases of suppletion) are considered as signals only for its lexical meanings", (# 46 a/al), whereas its grammatical meaning, whether or not zero-represented or merely non-distinctive (#20 c), are considered as zero-represented (#42). In

the case of the form class meanings the treatment has to be chiastically in-
verted: all possible lexical meanings are considered as zero-represented, whereas
all conventional graphic signals carrying them are considered as signals only
for the grammatical meaning of their form class (auxiliary verbs of mood, pre-
or post-positions, etc.). Their graphic transformations indicative of grammat-
ical meaning (for instance German "ich kann, du kannst, wir können, ihr könnt,
ich konnte, etc.") will, of course, be treated like all other cases of this
kind. MT will, therefore, in the case of the meanings characteristic of such
form classes have to add two supplementary signals: one differentiating the
lexical meaning and one differentiating all possible grammatical meanings except
the grammatical meaning of the form class concerned (auxiliary verbs of mood,
pre- or post-position). In the case of auxiliaries of mood this will often not
mean an increase in the number of supplementary MT signals used in the clause
concerned of the FL text since the principal verb accompanying such an auxiliary
(the auxiliary being the finite verb) in the infinitive does not require any
supplementary signal indicative of grammatical meaning. Cases like "could have"
or "might have wanted" in "could have done", "might have wanted to come" have some-
times to be treated as "idiomatic signal units" by means of mechanical "storing"
(See Section 87) for instance, in their German equivalents "hätte tun können"
(had do can) and "er wäre vielleicht gekommen" (he were perhaps come).

Lexical Meanings Exclusively-Associated or Associable with a Particular Grammatical
Meaning.

#80. In some languages certain <u>lexical</u> meanings are exclusively assoc-
iated or <u>associable</u> with particular grammaticaltransformations or <u>grammatical
functions</u>. We distinguish, therefore, two cases:

  a) lexical mdanings exclusively associated or associable with

    particular grammatical <u>transformations</u>, for example, Hebrew

    הוֹדָה , meaning "he thanked", and הִתְוַדָּה , meaning

    "he confessed", the first the <u>causative</u> form, the second the

    <u>reflexive</u> form of יָדָה , meaning "he threw" (compare the semas-

    iological parallelism revealed by the form of the Chinese char-

    acters 射 , meaning "to shoot, to fire" and 謝 , meaning

    "to thank"). Such meanings are also by MT exclusively attrib-

    uted to the grammatical form conventionally carrying them and

    <u>not</u> attributed to the headword of their paradigm. As for

    the <u>grammatical</u> meaning or meanings of the grammatical form

    concerned we have to make the following distinction:

    aa) grammatical meanings of an FL signal <u>non-essential</u> in

        terms of all TL <u>ignored</u> by MT (see sections 46, 85, 86).

        For instance, the grammatical meanings "causative form"

        or "reflexive form" of our Hebrew examples are <u>non-essential</u>

        in terms of all TL because they are valid only as long as

        we consider them as forms of the paradigm of יָדָה . This

        is not done by MT in these cases (See # 48).

    bb) grammatical meanings of an FL signal <u>essential</u> in terms of

        all TL are <u>considered as zero-represented</u> by MT (cf. ## 46 a;

        56 B b; 79; 83) and will, therefore, be "labeled" (cf. ## 51,

        53 B b; 54 b; 56 B b) by supplementary MT signals indicative

        of the grammatical meanings concerned. For instance the

the grammatical meanings associated with the members of the
paradigms of 7 7 ↑.7 and 7 7 1 ⁊ 7 , such as
"perfect" (past), "imperfect" (future), "third person singular",
"active voice", etc. are essential in terms of all TL.

b) lexical meanings exclusively associated or associable with par-
ticular grammatical functions, as for example, Chinese 光
which in terms of, for instance, the English TL as a noun means
"light", as an adjective carrying the (non-grammatical) meaning
of the noun means "shining, brilliant, etc", as an adjective
not carrying the (non-grammatical) noun meaning means "bald,
naked", and as an adverb means "only". Another example is
English "light" which in terms of, for instance, the German
TL as a noun means "Licht", as a verb means "leuchten", as an
adjective carrying the non-grammatical meaning of the noun means
"hell", as an adjective or adverb not carrying the (non-grammatical)
noun meaning means "leicht" (cf. # 24; "light" meaning "leicht"
is not homogenous with the "light" carrying the other meanings.)
Thus, using the supplementary signals explained in # 53B, we
would in the case of English "light" get the following distinctive
FL signals: "lightn" equalling "Licht", "lightv" equalling
"leuchten", "lightnaj" equalling "hell", "lightaj" equalling
"leicht". "Light" in the sense of "to alight" is usually accom-
panied by particular prepositions ("to light off a horse", "to
light from the chariot") which make it distinctive and with which
it is treated as an "idiomatic signal unit" by means of mechanical
"storing" (cf. # 79, last sentence, and # 87; see #53Bc for other
examples). Here our approach makes it possible to solve the problem
of "multiple meanings" for mechanical correlation in a way in which

two types of meanings -- the lexical and the grammatical --
can be indicated by one and the same universal supplementary
MT signal. (It is clear that if the grammatical meaning of
a conventional signal is "subject" or "direct object", there
is no need for graphic indication of the meaning "noun". The
lexical meaning will then be simultaneously represented by
the supplementary signals indicating "subject" or "object".
Here word order signals could also be used to make distinc-
tive lexical meanings. See Sections 56c, 88-90).

Multiple Lexical Meanings That Do Not Permit a Group Treatment

#81. As for the multiple lexical meanings that do not permit of a group
treatment (compare "fast", adjective and adverb, meaning "firmly fixed, etc." and
"fast", adjective and adverb, meaning "rapid", etc.; cf. Dr. Weaver's manuscript,
p. 8, No. 5 Meaning and Context, first section), we refer to ## 44, 45, 56 a/dd;
71 b and 72. The solution suggested in ## 45 b and 72 requires the FL reader
to select the incident meaning from the table of meanings supplied to him by the
mechanized MT dictionary (Section 92). This selection on the FL side slows down
the process of MT (cf. ## 13-18; 63-66). An alternative would be to ignore these
multiple meanings on the FL side and mechanically correlate the non-distinctive
FL signal with one of the TL signals carrying one of the possible meanings con-
cerned (best that of the TL signals involved which has the largest number of
"shared transferred meanings"). A mechanized TL-MT dictionary would then supply
the TL reader with a table of all the possible meanings involved (of course in
the form of the conventional TL signal synonyms) and he would then have to select
the incident meaning. From the point of view of complete mechanisation this
may seem to be preferable because then no human factor would interrupt the purely

mechanical side of MT. However, from the point of view of MT as a whole, the first alternative is still much quicker for the following reasons: Whereas the FL reader has to select the incident meaning in a (FL) context completely intelligible to him, the TL reader has, under the second alternative, to do this in a (TL) context which will necessarily contain a large number of non-distinctive signals with transferred meanings different from those of the corresponding FL signals, that is in a context that often will not be very clear.

#82. Any remaining semantic difficulties of the TL text can quicly be referrred back to the FL text by means of the corresponding reference numbers (## 45 a/b1; 56 f; 60) added automatically by the computer to every "digested" FL signal, and to every TL signal before it leaves the assembly line. Also this process of "referring back" can be speeded up by mechanization.

Grammatical Meaning

#83. All possible grammatical meanings often show great comparative irregularity of distribution of graphic explicitness (cf. Sections 20 , 79), for instance:

a) Within one and the same language:

aa) irregularity of occurrance of graphic explicitness in the case of different types of grammatical meanings peculiar to the same or different form classes, for example: the occurrance of Chinese 之, between two nouns corresponding to English "-'s" after a noun, versus the graphically mostly zero-represented meaning of "singular" and "plural" of Chinese nouns, or versus the graphically often zero-represented meaning of "tense" in Chinese verbs.

bb) irregularity of occurrance of graphic explicitness of grammatical meaning peculiar to the same paradigm of a form class, such as English "stands" versus "I, you, we, they, stand", or versus "(be)stood" (graphic indication

of "third person singular" in the present, non-indication
in the past tense, non-indication of first and second person
singular and plural.)

b) between each set of two languages:

aa) graphic explicitness in FL, non-explicitness in TL, for example,
Modern Mandarin 她们 (plural feminine of the personal
pronoun of the third person) versus English "they" (either
masculine, feminine or neuter).

bb) graphic explicitness of TL versus non-explicitness of FL,
for example: English "come, comes", versus Chinese 來
(either "come" or "comes").

cc) graphic explicitness of both, FL and TL, for example Modern
Manderin 孩子 , English "child", versus 孩子们
English "children".

dd) graphic non-explicitness of both, FL and TL, for example,
Chinese 羊 , English "sheep" (singular), versus 羊
English "sheep" (plural).

Arbitrary Leveling of Graphic Explicitness of Grammatical Meaning

#84. Since all possible grammatical meanings are comparatively limited
in number -- and even more limited for each set of two languages concerned in
every MT process -- and are, moreover, either absolute or attributable universals
(## 68, 77), the difficulty presented by the irregularity of the distribution of
graphic explicitness of grammatical meaning described in #83 can be overcome in
the following way: For the purposes of MT we aribtrarily consider all grammatical
meaning of all SL contexts, whether graphically explicit or not, as zero-represented
(cf. ## 46 a/a1, 5C, 53 B b; see ## 46 a/b1, 48, 49 for exceptions) and then raise
them to the same level of graphic explicitness of grammatical meaning by means of
universal supplementary MT signals (## 47, 53 B b, 56 B b, 57). Thus, for instance,

English "he decided to go" becomes "he decide go", that is, in this particular case, it assumes a grammatical form analogous to its classical Chinese equivalent (in other cases there will still be a difference in word order). The same universal supplementary MT signals indicative of the grammatical meanings involved, added to the English and the Chinese text, make both graphically equally explicit (cf. # 42). In the process of MT the supplementary signals are added on the FL side by the FL reader, on the TL side by the computer. Thus in the case of all possible grammatical meanings the irregularity described in #83 makes "Group treatment" "desirable", their universality, numerical limitation and, most important, the fact that the educated FL reader infers them somehow (at least by context), makes it possible (cf. 36, 37, 38, 39a, see Section 92)

MT Value

ical   #85. MT value is the importance of graphic distinctiveness of FL for TL intelligibility (cf. # 89). We distinguish here:

    a) lexical MT value, that is the importance of graphic distinctiveness of lexical meaning of FL for TL intelligibility (cf. #71 b), and

    b) grammatical MT value, that is the importance of graphic distinctiveness of grammatical meaning of FL for TL intelligibility (cf. # 86)

(Grammatical Meanings Ignored by MT Signalisation)

#86. All grammatical meanings without MT value, that is non-essential in terms of all TL, are ignored by MT signalisation. We suggest here, for instance, the merging of the meanings "imperfect" and "present perfect" in German into the meaning "past tense", or of the meanings "dual" and "plural" in Hebrew into the meaning "plural" (cf. # 80 a/aa).

(Idiomatic Units)

#87. Every sequence of conventional graphic FL signals it, if MT value (cf. ##85, 86) is involved, considered an idiomatic unit. Such an idiomatic unit is, for the purposes of mechanical correlation, treated as if it were one conventioanl graphic FL signal (corresponding to one lexical form). We distinguish here:

A. Cases whose mechanical correlation is not dependent on an editorial preparation, that is uninterrupted sequences:

aa) an FL sequence whose TL equivalent is not a sequence of the TL equivalents for the FL signals forming the FL sequence concerned, that is a unit expressing a universal meaning in an association of thought pictures peculiar to the FL concerned. Example: Chinese 光復 , literally "light's (光) return (復)", meaning "the restoration" (or "the revolution of 1911),

bb) an FL sequence which, though its TL equivalent is a sequence of the TL equivalents for the FL signals forming the FL sequence concerned, has, nevertheless, to be treated as an idiomatic unit if the semantics of its member signals differ from those of their TL equivalents. For instance Chinese 機槍 (short for 機關槍) made up of 機 ("device, machine, opportunity, etc.") and 槍 ("spear, lance, gun"), meaning "machine gun". The treatment of such sequences as units helps to differentiate multiple meanings (cf. #14).

B. Cases whose mechanical correlation is dependant on an editorial preparation, that is interrupted sequences. In such cases the part preceding the interruption is "stored" until the part after the interruption is "signalled" to the computer. For instance, German "er haette es frueher schicken koennen," literally, "he had it earlier send could" (koennen for gekonnt), meaning "he could have sent it earlier" (See #56 d and e).

(Word Order)

#88. Wherever the position of a part of speech in its clause or sentence is fixed by rules, position adds to its graphic distinctiveness. This additional graphic distinctiveness afforded by fixed position may in certain cases be indicative, or may by MT arbitrarily be made indicative, of grammatical and/or lexical meaning (for instance in Chinese 光 I means subject, 光 IV means object, and since in both cases 光 is a noun, it means here "light" and not "shining","bald", nor "only"; cf. 48).

If now all SL would have a fixed word order, FL word order could be easily mechanically correlated to any TL word order.

This is, however, by no means the case. The great comparative irregularity of distribution of graphic explicitness of all possible grammatical meanings in different languages (cf. #83) is, to a large extent, paralleled by a comparatively irregular distribution of semantic distinctiveness of word order. In some languages word order is highly non-distinctive (Latin), in others it is more (Chinese) or less (English) distinctive. Furthermore the more or less semantic distinctiveness in these languages does not follow any set principle for all of them. The grammatical meanings associated or associable with position often differ. A

further complication is often presented by the ability of a language to change the order of words for the sake of emphasis or for other (non-episememic) reasons.

(Zero-Treatment of Word Order)

#89. Under these circumstances only a treatment similar to that accorded all grammatical meanings (cf. #84) can solve our problem for MT. We may here learn from the Japanese. When the Japanese translate a Chinese classical text into Japanese, they first readjust its word order to that of their own language by means of numbers or certain characters indicative of position. In the following exemplification the words in parentheses have no equivalent in the Chinese original and have to be supplied in the English and Japanese translation. It should, however, be noted that their addition primarily satisfies requirements of English and Japanese grammar. The additional semantic explicitness they furnish goes beyond the semantic explicitness of the Chinese original. Thus their omission from the English and Japanese translations, while infringing on grammatical rules in these languages, gives the translations the same degree of semantic explicitness the Chinese original has. Furthermore the numbers (1), (2) and

(3) are indicative of the Japanese sequence of the parts of speech concerned.

Chinese examples: 雖 日 用 三 牲 之 養

Lit. Translation:

雖 　　 日 用 　 三 　　 牲 之 　　 養
Although 　 daily use 　 three 　 animal's 　 sustenance . . .

Free Translation: Although (they) daily use (the) sustenance of (the) three (kinds of) animals . . .

Addition of Japanese Word Order Markers:

This marking shows that word order markers are added only to those words or group of words whose position differs in Japanese.

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Readjustment of the Word Order On the Basis of the Word Order Markers:

In Romanization:

Hibi san sei no 為 (wo) mochiu (to) iyddomo . . .

Lit. Translation:

               (marker of)   (marker of)

Daily three animal's sustenance (accusative) use (conjunction) although . . .

    This method of readjusting the word order of a Chinese text before trans-
lation in fact amounts to ignoring the Chinese word order and substituting another.
The underlying principle can be utilised by MT and applied on a much broader and
universal scale. Since all possible positions in all languages are comparatively
limited in number — and even more limited for each set of two languages con-
cerned in every MT process — the difficulty presented by the irregular dis-
tribution of semantic distinctiveness of word order mentioned above can be
overcome in the following way:

    a) In the case of alternative word orders in a TL we are, for the pur-
poses of MT satisfied with only one. Thus Chinese 父 之 過 corresponds to
English "father's fault" as well as to "the fault of the father." In this
case MT will be satisfied with receiving the first version as its translation.

    b) Moreover, MT will, at least in the initial stage of its life, best
neglect non-grammatical meanings indicated by changes in normal word order
such as the meaning of emphasis.).

    c) Furthermore, for the purposes of MT we arbitrarily consider all
positions of words of all FL contexts, whether semantically distinctive or

not, as zero-distinctive. We furthermore arbitrarily decide on a "logical" universal word order (MT word order), the fixed positions of which we denote by a set of consecutive digits (numbers or letters), the MT word order signals. We then raise the zero-distinctive word order positions of all FL texts to the same level of semantic distinctiveness by the addition of our MT word order markers (signals) in the same way as the Japanese do with Chinese texts.

These MT word order signals, besides being indicative of word position in the arbitrary "logical" MT sequence of all parts of speech, are then used by MT to simultaneously "label" the grammatical meaning associated or associable with them and can thus often be used to simultaneously "label" multiple lexical meanings (cf. #59 Dc).

(The MT of Word Order)

#90. For the MT of Word Order we suggest two possible ways:

    a) Editorial Reshuffling.

    b) Mechanical Reshuffling.

a) Editorial Reshuffling.

Here the MT word order signals added by the FL editor to the FL text are by the computer transferred to the TL text unchanged. The TL editor has to translate these signals into the TL word order in the same way as the Japanese reader of a Chinese text.

b) Mechanical Reshuffling.

Here the MT word order signals added by the FL editor to the FL text (and represented by special holes on the punch-card fed into the computer) do not cause a mechanical reaction until the instruction of the punctuation

signals indicative of the completion of a clause or sentence have been carried out by the computer. Once these instructions have been carried out, the MT word order signals, until then "stored," cause the constituant TL equivalents of the conventional FL signals to "drop out" in the sequence required by the word order principles of the TL concerned. This presupposes, of course, that each (universal) MT word order signal has been mechanically correlated to one particular position -- equivalent in the TL concerned. (Golden Rule of MT)

#91. Apart from those problems of inexplicitness which concern lexicon and grammar, all other forms of semantic inexplicitness of an FL context are of no concern for MT. Here belong, for instance, difficulties of philosophical or philological interpretation, those due to lack of specialized knowledge of the FL reader, lack of precision, whether intended or unintended by the author, etc. etc. Also a nonsensical or grammatically incorrect FL text can be MT-ed. The computer is not expected to correct an ambiguous or faulty FL text. In this respect the Golden Rule of MT is: "TL need not to be more intelligible than FL"

(Mechanized Dictionary)

#92. The mechanized MT dictionary is a monoglot FL dictionary, that is it explains the meanings of FL words in terms of FL, but in the mirror of the TL concerned. For further details see ##45b, 56a/dd, 66b, 67-73, 81 and 82.

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