Problems of Machine Translation Systems: Effect of Cultural Differences on Sentence Structure

Yoshihiko NITTA
Advanced Research Laboratory, Hitachi Ltd., Kokubunji, Tokyo 185, Japan

The potential and the limitation of current machine translation is discussed by comparing the output of human translation and that of virtual machine translation. Here, "virtual machine translation" means a kind of syntax-oriented literal translation which may be regarded as an idealized competence of today's practical machine translation. The above comparison shows that the main reason for the limitation or the incompleteness of current practical machine translation systems is the insufficient ability to treat "structural idiosyncrasies" of sentences. Also, some translation examples tell us that, without "understanding" the total meaning of the source sentence, it is quite difficult to manipulate the idiosyncrasies in sentence structure. Idiosyncratic gaps between source and target sentence structure usually originate in cultural differences, so that the computational treatment of these gaps is a very difficult problem.

But the translation examples also give us some encouraging evidence that the principal technologies of today's not-yet-completed machine translation have sufficient potential for producing barely acceptable translation.

The current practical efforts to treat such structural idiosyncrasies are also mentioned together with some long-range, basic-research type of approaches.

1. Introduction

Recent times have been ripe for developing practical machine translation systems as they are now eagerly desired by various business fields. But today, not all the prerequisite technical problems have been solved. Some very deep and formidable problems are still far from satisfactory solutions. Thus, it may not be so unfair to say that today's various practical machine translation systems are not a completed version but a developing version.

In this paper, first, we will sketch the typical language-modeling techniques on which current machine translation systems are constructed. Second, we will examine the difference between the principal mechanism of machine translation and that of human translation from the viewpoint of language-understanding ability. Third, we will illustrate the idiosyncrasies of sentence structures by comparing sample sentences in English and in Japanese. These sentences share the same meaning. This comparison will be made by a somewhat new method which we call "Cross Translation Test (CTT)," which eventually reveals the various gaps in idiosyncratic sentence structures that have their origins in the difference of culture, i.e., in the way of thinking or in the way of representing conceptions. But at the same time, CTT provides some encouraging evidence that the principal technologies of today's not-yet-completed machine translation have the potential for producing barely acceptable translation, if the source language sentences are taken

North-Holland
Future Generations Computer Systems 2 (1986) 101–115

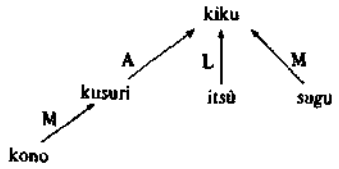
from documents of fewer equivocations. Finally, we briefly comment on promising, but long-range, basic-study type of approaches to overcoming the cultural idiosyncratic gaps between source and target sentence structures. The current, rather quick-remedy-type approaches to resolving such gaps are also mentioned from a practical viewpoint.

2. Modeling of Natural Language

Modeling natural language sentences is, needless to say, very essential to all kinds of natural language processing systems inclusive of machine translation systems. The aim of modeling is to reduce the superficial complexity and variety of the sentence form, so as to reveal the indwelling structure which is indispensible for computer systems to analyze, to transform or to generate sentential representations.

この	薬は	胃痛に	すぐ	効く。	
●Kono	kusuri-wa	itsû-ni	sugu	kiku.	
[this]	[medicine]	[on stomachache]	[immediately]	[take effect]	(J1)

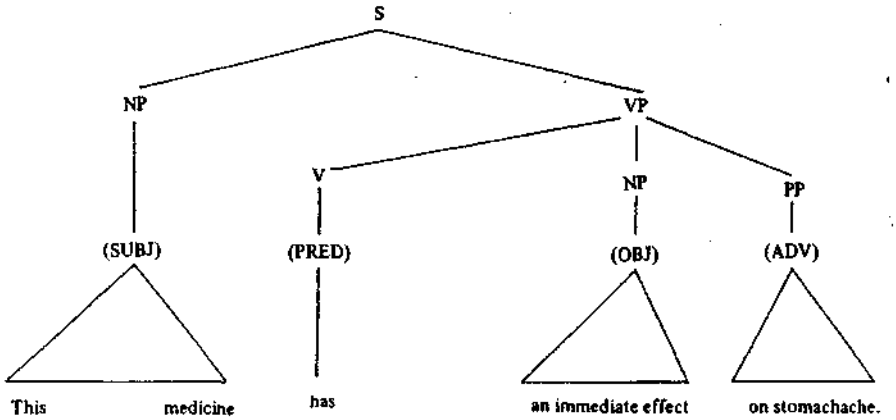
● Lit. This medicine takes effect on stomachache immediately. (E'1)



A, L, M : Semantic Roles (or Case Markers).
A : Agentive, M : Modifier, L : Locative.

Fig. 1. An Example of Dependency Structure Modeling.

● This medicine has an immediate effect on stomachache. (E1)
● Lit. この 薬は 胃痛の 上に すばやい 効き目を 持っている。 (J'1)
Kono kusuri-wa itsû no ue-ni subayai kikime-wo motte-iru.



SUBJ, PRED, OBJ, ADV : Syntactic Roles,
SUBJ : Subject, PRED : Predicate Head, OBJ : Object, ADV : Adverbial.

Fig. 2. An Example of Phrase Structure Modeling.

So far, various modeling techniques have been proposed (see for example [13] or [10, chap. 5]), but here let us note two: dependency structure modeling (Fig. 1), and phrase structure modeling (Fig. 2).The former is associated with semantic role labeling such as case marker assignment that is indispensable in analyzing and generating Japanese sentence structure (see for example [9]), and the latter is associated with syntactic role labeling such as governor-dependent assignment, head-complement assignment, or mother-daughter assignment (see for example [8]) that is essential in analyzing and generating English sentences.

"To what extent should we treat semantics of sentences?" is also very crucial to the decision for selecting or designing a linguistic model for machine translation. But it might be fairly asserted that the majority of today's "practical" machine translation systems are syntax-directed or syntax-oriented. Semantics are used only for disambiguation and as a booster in various syntactic processes, but are not used for the central engine for transformation and generation [9,12]. Here "practical" means "of very large-scale commercial systems" or "of daily usage by open users", but neither "of small-scale laboratory systems" nor "of theory-oriented experimental systems." For syntax-oriented machine translation systems, both dependency structure modeling and phrase structure modeling are very fundamental technical tools.

Semantic network modeling, which has recently been regarded as an essential tool for semantic processing for natural languages [11], might also be viewed as a variation of dependency modeling. However modeling problems are not discussed further here.

In comparing Fig. 1 and Fig. 2, note that dependency structure modeling is more semantics-oriented.

3. Machine Translation vs. Human Translation

Today's practical machine translation systems (See for example [5] and [12].) are essentially syntax-oriented literal type, or more precisely, structure-bound type *. The reasons for this somewhat extreme judgment are as follows:

(1) The process of MT (machine translation) is always under the strong control of structural information extracted from source sentences;
(2) In all the target sentences produced by MT, we can easily detect the traces of wording and phrasing of the source sentences;
(3) MT is quite indifferent as to whether or not the output translation preserves the proper meaning of the original sentence, and what is worse, MT is incapable of so judging whether or not;
(4) MT is quite deficient in extra-sentential information such as situational information, world knowledge and common sense which give very powerful command of language comprehension.

Now let us see Fig. 3. This rather oversimplified figure illustrates the typical process of Japanese-English machine translation. Here the analysis and transformation phase are based on dependency structure modeling (cf. Fig. 1) and the generation phase is based on phrase structure modeling (cf. Fig. 2) (For further details see for example [9].). This figure reveals that the entire process is bound by the grammatical structure of the source sentence, but not by its meaning.

Thus, MT can easily perform a literal syntax-directed translation such as 'from (J1) into (E'1)', (cf. Fig. 1). But it is very very difficult for MT to produce a natural translation which reflects the idiosyncrasy of the target language, preserving the original meaning. (E1) is an example of a natural translation of (J1). In

* Of course, we know that some of the ambitious machine translation systems are genuinely semantics-oriented and meaning-(or concept-) understanding type. But, unfortunately, they are very small-scale or laboratory models. Thus, they are not included in practical systems. Practical systems should have a good command of a very large vocabulary, say in the range of tens or hundreds of thousands of terms, or more, and should manage an enormous volume of translation documents daily. And yet some aggressive researchers or developers may insist that their systems are genuinely semantics-oriented types as well as large-scale practical types. But in that case, we can logically infer their faults from the fact that the computational mechanism for language understanding is still an unsolved, open problem which is now the concern of many challenges. First, we should establish the concept of a classifying thesaurus and a concept-describing method that can cover worldwide phenomena. Such a thesaurus or method are clearly not yet established, but are pursued currently. So it may be more moderate to note that today's semantics-oriented systems can only manage very partial events and phenomena.

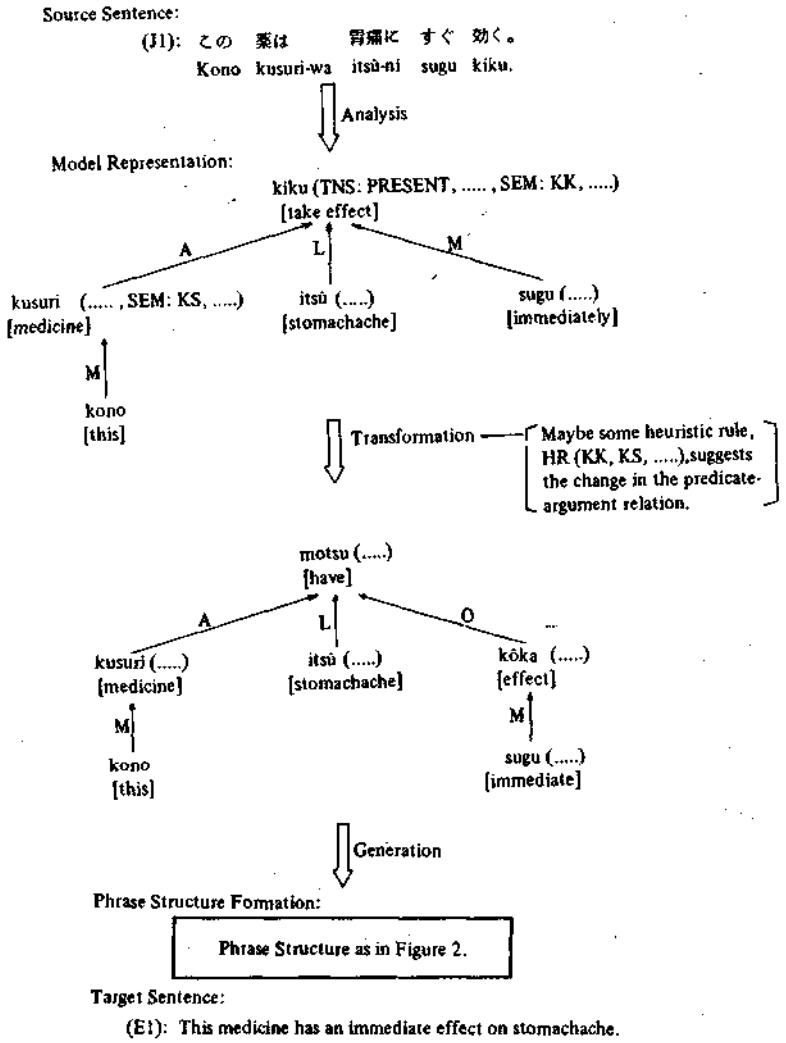


Fig. 3. A Simplified Sketch of Machine Translation Process.

order for MT to produce this (E1) from (J1), it may have to invoke a somewhat sophisticated heuristic rule. In Fig. 3, the heuristic rule, HR (KK, KS, ...), can successfully indicate the change of predicate which may improve the treatment of the target-sentence idiosyncrasy.

But generally, the treatment of an idiosyncratic gap such as 'that between (J1) and (E1)' is very difficult for MT. It might be almost impossible to find universal grammatical rules to manipulate such kind of gaps, and what is worse, the appropriate heuristic rules are not always found successfully.

In contrast, human translation is essentially semantics-oriented type or meaning-understanding type. The reasons for this judgment are as follows:

(1) HT (human translation) is free from the structure, wording and phrasing of a source sentence;
(2) HT can "create" (rather than translate) freely a target sentence from something like an image diagram obtained from a source sentence (Fig. 4); (Of course, the exact structure of this image diagram is not yet known.);
(3) HT often refers to extra-linguistic knowledge such as common sense and culture;
(4) Thus, HT can overcome idiosyncratic gaps freely and unconsciously.

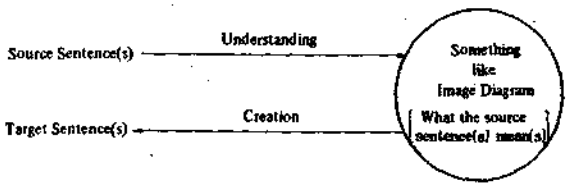
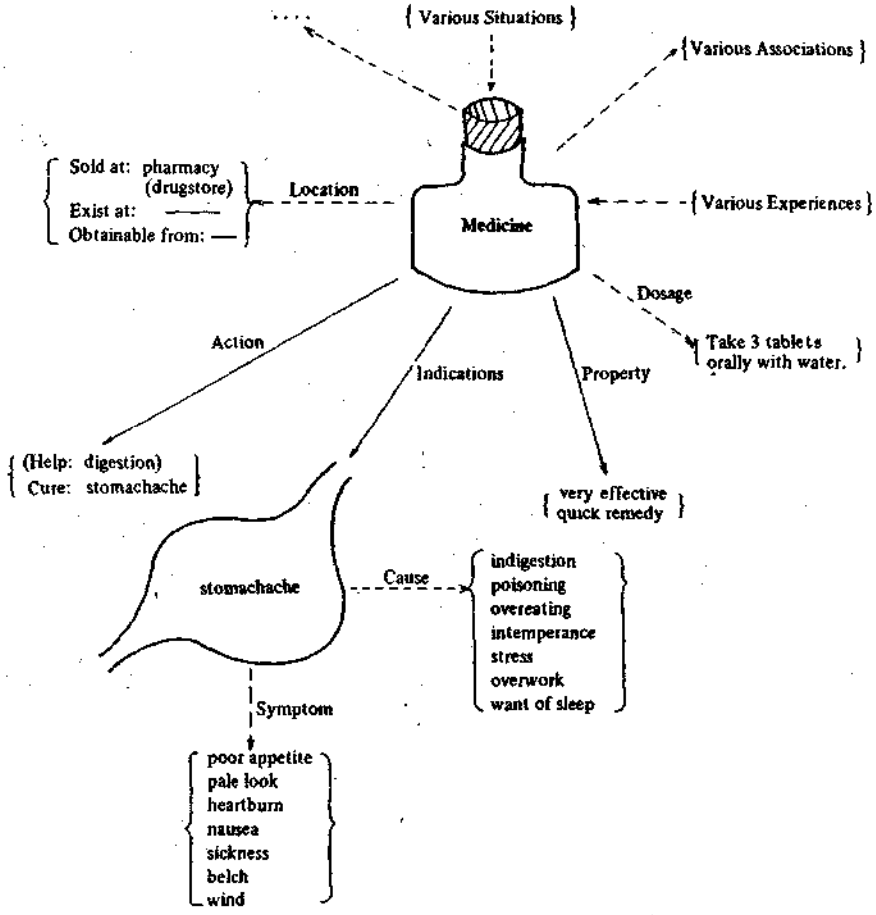


Fig. 4. Translation Process by Human.



——→ : Information directly obtained from a source sentence.

- - - → : Information obtained from outside of a source sentence; (including common sense, world knowledge, and so on);

Source Sentence:

(J1): この 薬は 胃痛に すぐ 効く。
Kono kusuri-wa itsû-ni sugu kiku.
[this] [medicine] [stomachache] [immediately] [take effect]

Lit. (E'1) : This medicine takes effect on stomachache immediately.

Fig. 5.

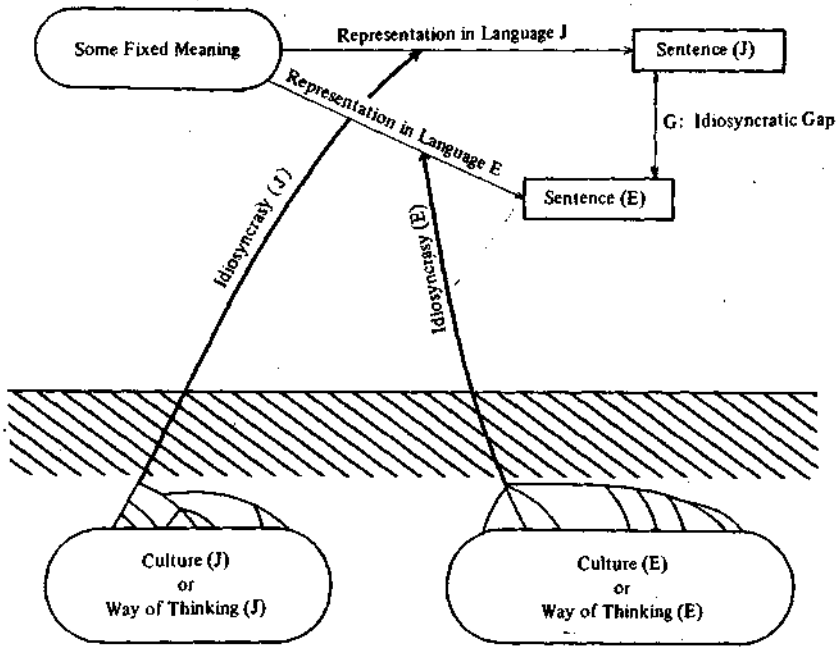
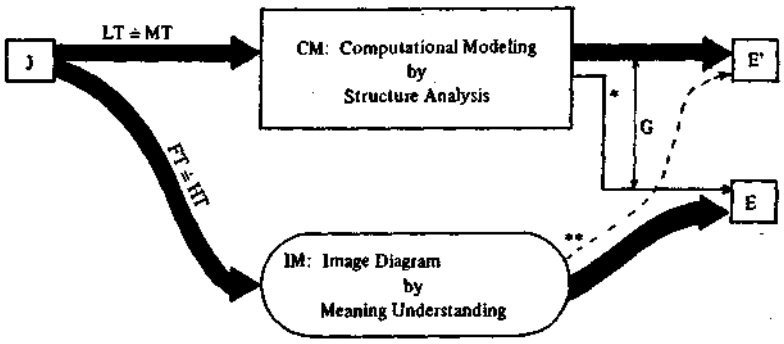


Fig. 6. Culture and Idiosyncratic Gap.



LT: Literal Translation,
MT: Machine Translation,
FT: Free Translation,
HT: Human Translation,

G: Idiosyncratic Gap,
*: It is very difficult for MT (≒LT) to take this root because of the gap G.
**: Mediocre HT often drifts into this root;

J: Source Language Sentence,
E: Target Language Sentence,
E': (Awkward) Literal Translation.

Fig. 7. Machine Translation, Human Translation and Idiosyncratic Gap.

Let us see Fig. 5 which tries to illustrate the image diagram invoked from the understanding of the original sentence (J1). This diagram may (or should) be completely free from the superficial structure such as wording, phrasing, subject-object relation and so on, and may be strengthened and modified by various extra-linguistic knowledge. Doubtlessly, it is easy for human to compose sentences such as (J2) and (E2) from this image diagram. It is also doubtless that sentences such as (J'1), (J'2), (E'1) and (E'2) will never be composed by human under normal conditions.

● この	薬を	飲むと	胃の痛みが	すぐ	とれる。	(J2)
Kono	kusuri-wo	nomu-to	i-no-itami-ga	sugu	tore-ru.	
[this]	[medicine]	[if (you) take]	[stomachache]	[soon]	[deprived]	

● Lit. If you take this medicine you will soon be deprived of a stomachache. #(E'2)
● This medicine will soon cure you of a stomachache. (E2)
● [Lit. この 薬は あなたを すぐに 胃痛から 救うだろう。 #(J'2)
Kono kusuri-wa anata-wo sugu-ni itsû-kara sukuu-darô.

Now, note that there are big structural gaps between (J1) and (E1), and between (J2) and (E2), which are natural reflections of linguistic idiosyncrasy originating in the culture, i.e., the differences in the way of thinking (Fig. 6). So far we have seen that MT is poor at the idiosyncrasy treatment and conversely HT is good at that. This difference between MT and HT depends on whether or not the ability for meaning understanding exists (Fig. 7).

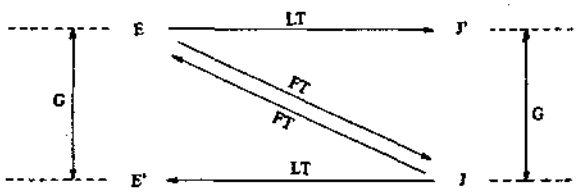
4. Idiosyncrasies in Sentence Structures

In the preceding sections we have seen that if we could explicate the mechanism of understanding or could formalize the image diagram, then we could improve or reconstruct machine translation systems so that they could treat the idiosyncratic gaps, and eventually we could construct a complete machine translation system which could produce free translation the same as a human can do. But in the present circumstances both the mechanism of understanding and the image diagram are quite unknown and have posed intractable open problems since computer science started.

Thus, let us examine the idiosyncratic gaps between two sentences which share the same meaning but each of which belongs to a different language (cf. Fig. 6). The reason for comparing the two sentences is that we can not examine a linguistic idiosyncrasy itself. Because, currently, we can not fix the one abstract neutral meaning without using something like an image diagram which is not yet elucidated. The ideal way of examining an idiosyncratic gap may be as follows: First, fix one abstract meaning using a kind of image diagram; Second, compose sentences, say SENT (J) and SENT (E), in two different languages, say J and E, so that the two sentences, SENT (J) and SENT (E), represent the original meaning; Last, compare SENT (J) and SENT (E) carefully so as to detect structural difference which may suggest an idiosyncratic gap. But we can not adopt this ideal method because of the unelucidated image diagram.

Therefore, we have devised a next best but practical method, which we term "Cross Translation Test (CTT)", in order to examine the idiosyncratic gap. CTT functions as follows: First, take an appropriate well-written sample sentence written in one language, say English; Let E denote this sample sentence; Second, select or make the proper free translation of E in the other language, say Japanese; Let J denote this proper free translation; J must properly preserve the original meaning of E; At the same time, make a literal translation of E in the same language that J is written in; Let J' denote this literal translation; Lastly, make a literal translation of J in the same language that E is written in; Let E' denote this literal translation.

Here, the "literal" translation means the translation that is preserving the wording, phrasing and various sentential structure of the original (source) sentence as much as possible. Then, eventually we may be able to define (and examine) the ideosyncratic gap, G, in Fig. 8. In other words, we may be able to



G: Idiosyncratic (Structural) Gap,
LT: Literal Translation,
FT: Free Translation,
E, E': Sentence Written in English,
J, J': Sentence Written in Japanese,
In this paper, we have assumed that:
LT ≒ MT, and FT ≒ HT,
where, MT: Machine Translation, and HT: Human Translation.

Fig. 8. Illustrative Definition of Idiosyncratic Gap.

examine and grasp the idiosyncratic gap by comparing the structure of E with that of E′, or by comparing that of J′ with that of J.

Now, note that we can assume the relationships,

$$LT \fallingdotseq MT,$$

and

$$FT \fallingdotseq HT,$$

where " $\fallingdotseq$ " denotes "nearly equal" or "almost equivalent to." Namely, we can assume that the literal translation, LT, which preserves the wording, phrasing and structure of the source sentence, is almost equivalent to the idealized competence of today's practical machine translation, MT. The rationale of this assumption has already been discussed in Section 3, especially in its footnote.

In this paper, the literal translation, LT ($\fallingdotseq$ MT), is performed by tracing the procedural steps of a virtual machine translation system (VMTS) theoretically. Here, the VMTS is a certain hypothetical system which never models itself upon any actually existing machine translation system, but which models the general properties of today's practical syntax-oriented machine translation systems. In this paper, we will omit both the detailed description of each internal step of VMTS and the specification of VMTS because of the limited space allotted to the author.

In any case to sum up, the Cross Translation Test (CTT) is the examination of idiosyncratic structural gaps by comparing the structures of the quadruplet [E, J′, J, E′] such as in Fig. 8. CTT provides also a method to measure the distance of idiosyncratic gaps, but in this paper we will only make an intuitive observation of the gap G through CTT.

The result of CTT has various uses, some of which are as follows.

1) One can obtain a detailed picture of the different wording, phrasing and composing in the sentences of the source and target languages.
2) One can use the above pictures to make or improve the heuristic rules for treating idiosyncratic gaps, and can use that to design or improve sublanguages [3], controlled languages [4] or normalized languages [14]. The purpose of all these specially tailored languages is to improve the quality of machine translation by modifying or restricting the grammatical structure or the vocabulary of the source and target languages. Here the aim of the modification and restriction is, of course, to reduce the ambiguity of both source and target sentences, which also eventually contributes to the reduction of the idiosyncratic gaps.
3) One might be able to obtain some clue to help design a gap-free neutral image diagram that can describe the meaning of sentence in a language independent way. But this may be a kind of distant future usage.

Now let us observe the gap, G, by applying CTT to various sample sentences. First, let us take examples with large gaps.

国境の	長い	トンネルを	抜けると	雪国	であった。	(J3)
Kokkyô-no	nagai	ton-neru-wo	nukeru-to	yuki-guni	de-atta.	
[of border]	[long]	[tunnel]	[after passing through]	[snow country]	[was]	

- Lit. After passing through the long border tunnel, it was the snow country. + (E′3)
- The train came out of the long tunnel into the snow country. (E3)

Lit. 列車は	長い	トンネルを	ぬけて	雪国に	出た。	(J′3)
Ressha-wa	nagai	ton-neru-wo	nuke-te	yuki-guni-ni	de-ta.	

(J3) is taken from the very famous novel "Yuki-guni" written by Yasunari Kawabata, and (E3) is taken from the also famous translation by Seidensticker. (E′3) is a slight modification of [6, esp. p. 27] and (J′3) is taken from the same book. In (E3) the new word "the train [ressha]" is supplemented according to the situational understanding of the paragraph including (J3) which may, currently, be possible only for HT.

(J3) is a very typical Japanese sentence which has the interesting idiosyncrasy, i.e., (J3) has no superficial subject. But in (J3) some definite subject is surely recognized, though unwritten. That is "the eyes of the storyteller," or rather "the eyes of the reader who has already joined in the travel to the snow country by the train." So the actual meaning of (J3) can be explained as follows:

> After I (≈ the reader who is now experiencing the imaginary travel) passed through the long border tunnel by train, it was the snow country that I encountered.

Thus (J3) is very successful in importing to the readers the fresh and vivid impression of suddenly seeing (also feeling and smelling) the snow country. (J3) has a poetic feeling and a lyric appeal in its neat and concise style.

But the English sentence such as (E3) requires the concrete, clearly expressed subject, "the train [= ressha]" in this case, and this concrete subject requires the verb, "came," and again this verb requires the two locative adverbial phrases, "out of the long tunnel" and "into the snow country". Thus, the original phrase "yuki-guni de-atta [= it was the snow country]" in (J3) has completely disappeared in (E3), but the new phrase "into the snow country [= yuki-guni-ni]" appears instead. These drastic changes are made under the strong influence of linguistic idiosyncrasy, and, at the same time, with an effort to preserve the original poetic meaning as much as possible.

Consequently, these changes have invoked a large gap between (J3) and (E3). But this gap is indispensable for this translation from (J3) into (E3),

$$\mathrm{HT}: (\mathrm{J3}) \rightarrow (\mathrm{E3})$$

where

$$|(\mathrm{J3}) - (\mathrm{E3})| \doteq |(\mathrm{E'3}) - (\mathrm{E3})| \approx \mathrm{G} \approx \text{large}.$$

One more comment. Note that as a result of this large gap, the literal translation from (J3) into (E′3),

$$\mathrm{LT}: (\mathrm{J3}) \rightarrow (\mathrm{E'3})$$

where

$$|(\mathrm{J3}) - (\mathrm{E'3})| \doteq |(\mathrm{E'3}) - (\mathrm{E'3})| = 0,$$

has failed to preserve the original meaning, i.e., (E′3) is an unacceptable translation which is misleading. Because (E′3) can be interpreted as:

> After something (= it) finished passing through the long border tunnel, something became (≈ changed into) the snow country.

Second, again let us take other short examples with large gaps. An awkward literal translation is often despised by expert (human) translators who call it "machine-translation-like translation" (See for example [6, esp. p. 110].). Their contempt of machine translation is, unfortunately, not so unfair. The reason for this will be given by the following examples which are owing to [6, esp. p. 110–112] except for a few modifications.

- an irresistible woman. (E4)
  [fuka-kôryoku-no] [on-na]
- Lit. 不可抗力の女 *(J′4)
  fuka-kôryoku-no on-na
- こたえられないほど 魅力的な 女。 (J4)
  kotaerare-nai-hodo miryoku-teki-na on-na.
  [irresistibly] [attractive] [woman]
- Lit. an irresistibly attractive woman. (E′4)
- One thing is certain. (E5)
  [hitotsu-no] [koto] [de-aru] [tashika-na]
- Lit. 一つの 事が 確か である。 (#(J′5)
  Hitotsu-no koto-ga tashika de-aru.
- 確かな 事が 一つ ある。 (J5)
  Tashika-na koto-ga hitotsu aru.
  [certain] [thing] [one] [exist]
- Lit. A certain thing exists by one. #(E′5)
  [tashika-na] [koto] [aru] [hitotsu-dake]
- to tempt fate. (E6)
  [tamesu] [unmei]
- Lit. 運命を 試す。 (J′6)
  Unmei-wo tamesu
- 虎穴に 入る。 (J6)
  Koketsu-ni iru.
  [the lie of a tiger] [go into]
- Lit. to go into the lie of a tiger. (E′6)
- What a great artist dies with me! (E7)
  [nanto-iu] [idai-na] [geijutsuka] [shinu] [to-tomoni] [watashi]
- Lit. 何という 偉大な 芸術家が 私と共に 死ぬのだろうか。 +(J′7)
  Nanto-iu idaina geijutsuka-ga watashi-to-tomoni shinu no-darô-ka.
- 私が 死ねば 何という 偉大な 芸術家が 一人 この世から 去ることになるのだろうか。
  Watashi-ga shine-ba nanto-iu idai-na geijutsuka-ga hitori konoyo-kara saru koto-ni naru-no-darô-ka.
  [I] [if die] [what] [great] [artist] [one] [from this world] [that will imply] (J7)
  [disappear]
- Lit. If I died, it would imply that one great artist disappeared from this world. (E′7)
  [Moshi] [shinu] [koto-naru-darô] [idaina] [saru] [konoyo-kara]
  [watashi] [hitori-no] [geijutsuka]

The following are the comments on the above (four) quadruplets from [(E4), (J′4), (J4), (E′4)] to [(E7), (J′7), (J7), (E′7)].

1) The translation,

HT: (E4) → (J4)

requires the new supplementary adjective "attractive." It may be possible only for a human to accomplish this, because this must be based on a some vulgar knowledge or experience. The phrase, (J′4), is nonsense, which eventually gives one reason for the previous contempt of MT, that is,

M(≒ LT): (E4) → (J′4) ≒ nonsense.

And also note that the translation, 'HT: (E4) → J(4)' shows the typical symptom of translation, that is, translation often decreases the quantity (and quality, of course) and, at the same time, increases the number of words (See [6, p. 111] for a good explanation.).

2) In the translation,

HT: (E5) → (J5),

the syntactic role of the adjective "certain [= tashika-na]" has been changed from 'predicative' to 'attributive'. This is a typical example of idiosyncratic difference in phrasing. The sentence (J'5) is still barely understandable but its style is quite unnatural as a Japanese sentence. So, in this case, the machine translation,

MT(≒ LT): (E5) → (J'5)

may not be so successful. The sentence (E'5) is almost unnatural but scarcely understandable. Here the mark "*" denotes "ungrammatical or unacceptable", "#" denotes "barely grammatical and/or scarcely acceptable," "+" denotes "grammatical but unacceptable because the original meaning has been distorted," and "no mark" denotes "grammatical and acceptable."

3) Both (E6) and (J6) are very idiomatic expressions. So the translation,

HT: (E6) → (J6)

requires the knowledge of idioms which is, of course, based on culture. But this kind of gap may easily be treated only by storing many idiomatic expressions in a lexicon. Note that (E'6) is both grammatical and acceptable but the original metaphorical meaning of (J6) is almost lost. So the translation,

MT(≒ LT): (J6) → (E'6)

is almost unsuccessful in this case.

4) The translation,

HT(≒ FT): (E7) → (J7)

requires the situational knowledge that "a great artist" and "me (= speaker of (E7))" are the same person, i.e. "me (= speaker)" is a braggart or a genius. Thus, this kind of gap is intractable for MT. Under the above situation, the sentence (J'7) is unacceptable, because it has distorted the original meaning of a somewhat rhetorical style of (E7). Actually (J'7) suggests that the possibility that "me (= speaker)" and "a great artist" may commit a double suicide. This case is also a typical example of a cultural gap.

However, it is not always the case with idiosyncratic gaps. Lastly, let us now observe the somewhat encouraging examples favorable for machine translation, MT (≒ LT). In the following quadruplets, the gaps are not so small but a gapless translation, i.e., LT (≒ MT) is often acceptable. The sample sentences, (E8), (E9), (E10), (E11) and (E12) are news lines taken from [7].

The free translations, (J8), (J9), (J10), (J11) and (J12) are taken from [1, p. 203] with slight modifications. For the quick understanding of the outline of this news item, it may be recommendable for you to read through '(E8), (E9), (E10), (E11) and (E12)' or '(J8), (J9), (J10), (J11) and (J12)' at one stretch in the first place. This time we can give only a very few comments because of the space limitation, but it may be easy for readers to observe the various gaps and the acceptability of virtual machine translation, MT(≒ LT).

● An Air Florida DC-10 was nearing takeoff from Miami International Airport
[Florida Kôkû] [chikazuki-tsutsu-atta] [ririku] [kara] [kokusai] [kûkô]
last Sept. 22 when its crew heard a large noise.
[kono-mae-no] [9 gatsu 22 nichi][toki] [sono] [jôin] [kiita] [ôkina] [zatsuon] (E8)

● Lit.その 乗員が 大きな 雑音を 聞いたとき フロリダ航空の DC-10が この前の
Sono Jôin-ga ôkina zatsuon-wo kii-ta toki, Florida-kôkû-no DC-10-ga kono-mae-no
9月22日 マイアミ国際 空港からの 離陸に 近づきつつあった。
9 gatsu 22 nichi Miami- Kokusai-Kûkô-kara-no ririku-ni chikazuki-tsutsu-atta. (J'8)

● 9月22日　フロリダ航空の DC-10型　旅客機が　マイアミ　国際　空港から
9 gatsu 22 nichi, Florida-Kôkû-no DC-10-gata ryokakuki-ga Miami-Kokusai-Kûkô-kara
離陸しようと していたところ、乗員は 大きな音を 聞いた。　(J8)
ririku-shi-yô-to shite-ita-tokoro, jôin-wa ôkina oto-wo kii-ta.

● Lit. When a DC-10 type passenger plane of Air Florida was going to
[toki] [DC-10-gata] [ryokakuki] [no] [Florida-kôkû] [shi-yô-to shite-ita]
take off from Miami International Airport on September 22th, the crew
[ririku-suru] [kara] [Miami-Kokusai-Kûkô] [ni] [9 gatsu 22 nichi] [jôin]
heard a loud crash.　#(E'8)
[kii-ta] [ôkina] [oto]

● The right engine had mysteriously disintegrated – and the plane began to
[migi-no] [engine] [shinpi-teki-ni] [bunkai-shi-ta] [soshite] [hikôki] [hajime-ta]
veer to the right.　(E9)
[hôkô-wo henkô-suru] [migi-he-to]

● Lit. 右の　エンジンが 神秘的に　分解して – 飛行機は 右へと　方向を
Migi-no enjin-ga shinpi-teki-ni bunkai-shi-te – hikôki-wa migi-he-to hôkô-wo
変更し　はじめた。　(J'9)
henkô-shi hajime-ta.

● 右　エンジンが 原因不明の　分解事故を　起こし、機は 右に　向きを
Migi enjin-ga gen-in-fumei-no bunkai-jiko-wo okoshi, ki-wa migi-ni muki-wo
変え始めた。　(J9)
kae-hajime-ta.

● Lit. The right engine caused a disintegration accident of unknown origin, and
[migi-no] [enjin] [o koshi-ta] [bunkai] [jiko] [fumei-no] [gen-in] [soshite]
the airplane began to change its direction to the right.　#(E'9)
[hikôki] [hajime-ta] [kaeru] [sono] [hôkô] [migi-ni]

● with seconds to spare, its pilot aborted the takeoff.
[wo-motte] [sû-byô] [ken-yaku-suru tame-no] [sono] [pairotto] [shippai-shi-ta] [ririku]　(E10)

● Lit. 倹約する　ための 数秒を　持って、その パイロットは離陸に 失敗した。
ken-yaku-suru tame-no sû-byô-wo motte, sono pairotto-wa ririku-ni shippai-shi-ta.　+(J'10)

● 間一髪のところで　パイロットは 離陸を　中止した。
Kan-ippatsu-no-tokoro-de pairotto-wa ririku-wo chûshi-shi-ta.　(J10)

● Lit. The pilot stopped takeoff by a hair's breadth.
[pairotto] [chûshi-shita] [ririku] [de] [kami-no-ke ippon-no sukima]　(E'10)

● He may have saved the flight from a tragic
[kare] [kamo-shire-nai] [kyûjo-shi-ta] [sono] [teiki-bin] [kara] [higeki-teki]
repeat performance of the American Airlines DC-10 crash that killed 275
[hanpuku] [jikkô] [no] [tsuiraku] [koroshi-ta] [275 nin-no]　(E11)
people in Chicago in 1979.
[hito-bito] [Chicago-de] [1979 nen-ni]

● Lit. 彼は　その 定期便を、 1979年に シカゴで　275人の 人々を
Kare-wa sono teiki-bin-wo, 1979 nen-ni Chicago-de 275 nin-no hito-bito-wo
殺した　アメリカン航空の DC-10の 墜落の　悲劇的　反復の
koroshi-ta American-Kôkû-no DC-10-no tsuiraku-no higeki-teki hanpuku-no　#(J'11)
実行から 救助した　かもしれない。
jikkô-kara kyûjo-shi-ta kamo-shire-nai.

● これによって　この 機は、死者 275名を　出した 1979年の
Kore-ni-yotte kono ki-wa, shisha 275 mei-wo dashi-ta 1979 nen-no
シカゴ空港での　墜落事故の　悲劇の　二の舞を　避け得たと いえよう。　(J11)
Chicago-kûkô-de-no tsuiraku-jiko-no higeki-no ni-no-mai-wo sake-eta-to ie-yô.

- Lit. It may safely be said that, by this, this airplane could escape from
  [to-ie-yô] [kore-ni-yotte] [kono hikôki] [sake-eta] [kara]
  tragic repetition of crash accident of American Airlines
  [higeki-teki] [hanpuku, ni-no-mai][no] [tsuiraku] [jiko] [no]
  DC-10 in Chicago Airport in 1979 that produced 275 dead persons.
  [Chicago-Kûkô-de-no] [1979 nen-ni] [dashi-ta] [shisha]

#(E'11)

- In the Air Florida case, engine fragments had ripped
  [Florida-Kôkû-no-jiko ni-oite-wa][enjin] [hahen] [hiki-sakete-shi-matta]
  through the aircraft's right wing, damaging
  [wo-tôshi-te] [kôkûki-no] [migi-no] [tsubasa] [sonshô-shi-tsutsu]
  controls to its wing slats.
  [seigyo] [sono] [tsubasa], [suratto]

(E12)

- Lit. フロリダ航空の 事故においては、エンジンの破片が その 翼の
  Florida-Kôkû-no jiko-ni-oite-wa, enjin-no hahen-ga sono tsubasa-no
  スラットの 制御を 損傷 しつつ、 航空機の 右の 翼 を通して
  suratto-no seigyo-wo sonshô-shi-tsutsu, kôkûki-no migi-no tsubasa wo-tôshi-te
  引き裂けてしまった。
  hiki-sake-te-shima-tta.

(J'12)

- 今度の フロリダ航空の 事故は、エンジンの 破片が 右翼を
  Kondo-no Florida-Kôkû-no jiko-wa, enjin-no hahen-ga uyoku-wo
  引き裂いて、その スラット 操作を 不能に した ものである。
  hiki-sai-te, sono suratto-no sôsa-wo funô-ni shi-ta mono-de-aru.

(J12)

- Lit. The last accident of Air Florida is that fragments of the engine
  [kondo-no] [jiko] [no] [Florida-Kôkû] [mono-de-aru] [hahen] [no] [enjin].
  disabled it for a slat manipulation by tearing
  [funô-ni-shi-ta] [sono] [suratto] [sôsa] [hiki-sai-te]
  the right wing.
  [u-yoku]

(E'12)

The following are only a few comments on the above examples.

1) In the translation 'MT(≒ LT): (E8) → (J'8)', "noise" will usually be translated into "zatsuon [= a sound that is neither musical nor pleasant]." In 'MT(≒ LT): (J8) ≒ (E'8)' the word "crash" has equivocality (cf. the following 5), but for "from-Japanese-into-English translation," perhaps there is no problem (Again, see the case in 5 for comparison.).

2) In the translation "MT (≒ LT): (E9) → (J'9), "mysteriously" will usually be translated into "shinpiteki-ni" or "shinpiteki-na-koto-niwa." In 'MT (≒ LT): (J9) → (E'9)', if the correspondence "muki-wo kaeru ↔ veer" is stored in the lexicon then, in (E'9), the word "to veer" will appear instead of "to change its direction."

3) (J'10) is unacceptable because its meaning is completely different from the original's. In the original sentence (E10), the pilot could scarcely escape from a disastrous accident. But in (J'10) he "failed in takeoff [= ririku-ni shippai-shi-ta]," which would inevitably have resulted in a horrible crash. This terrible mistranslation is due to the equivocality of the word, "abort." This word has at least two delicately (but for us, seriously) different meanings, even if its usage is restricted to the aeronautical engineering: one is "shippai-suru [= fail in, come to nothing.]" and the other is "chûshi-suru, zasetsu-suru [= stop, cancel, give up, terminate prematurely.]", both of which are derived metaphorically from the original medical meaning, "ryûzan-suru [= miscarry, give birth to an undeveloped fetus out of due season, make a premature failure in delivery.]." Thus, the translation, 'MT: (E10) → (J'10)' shows the typical symptom that the idiosyncrasy of only one word, "abort," leads to a disastrous mistranslation.

4) In 'MT (≒ LT): (J10) → (E'10)', if the idiom processing ability was higher than this MT together with a well-equipped lexicon, then (E'10) would be:

The pilot *escaped from takeoff* by a hairbreadth,

or,

The pilot escaped from takeoff by the skin of *his* teeth.

5) In 'MT (≒ LT): (E11) → (J'11)', we have the ambiguous word "crash" which has at least three different meanings: "shôtotsu [≒ the violent striking of one solid thing against another]", "dai-onkyô [≒ a sudden loud noise]" and "tsuiraku [≒ the sudden, accidental fall of an aeroplane]". Here the English explanations are due to [2]. Note that even if we limit ourselves to the field of aeronautics, any one of these three translation of "crash" is still possible. The fact that this one English word, "crash", represents one concept that has at least three Japanese translations simultaneously, is a kind of idiosyncratic gap between English and Japanese. This kind of idiosyncratic gap, even though it is the ambiguity of only one word, often deteriorates the quality of the output of MT.

6) In (E'11), the phrase "that produced 275 dead persons" is very strange and horrible, but MT often produces this kind of stuff unconsciously.

7) In 'HT(≒ FT): (E11) − (J11)', we find a large difference (i.e., idiosyncratic gap) in the subject setting. (E11) takes 'He (= the pilot)' as the subject, while (J11) takes 'kono-ki (= this airplane)' as that. To be more precise, the kernel case pattern of (E11) is:

He(= the pilot) + saved + the flight + from tragedy
⟨Agent⟩ ⟨Predicate⟩ ⟨Object⟩ ⟨Modifier⟩

whereas that of (J11) is:

By this (= the pilot's action) + this airplane (≒ flight) + saved + ⋯.
⟨Instrument⟩ ⟨Agent⟩ ⟨Predicate⟩

It is very difficult to find the origin that accounts for this big idiosyncratic gap and therefore it is almost impossible to predetermine the detail of this gap mechanically (i.e., computationally) before going into the machine translation process.

8) In the translation, 'MT: (J12) → (E'12)', if a powerful tense-agreement mechanism and a discourse-analysis mechanism were implemented, then (E'12) would be:

...fragments of the engine *had* disabled *the pilot* for *his* slat manipulation...,

instead of

...fragments of the engine disable *it* for *a* slat manipulation....

In this section we have only applied the CTT (Cross Translation Test) in a naive and intuitive way, but we may have been able to see that: There are many big idiosyncratic gaps that are hard to be overcome by MT (machine translation), but at the same time, if the source sentences are taken from less ambiguous documents such as news lines or technical reports, today's practical MT will/can play an active role in various business fields.

5. Concluding Remarks

The sentences used in today's various business fields are, clearly, composed on the knowledge of ever-increasing extraordinarily rich vocabulary and innumerable phenomena and intricate situations of this world. This kind of knowledge is very very difficult to formalize as items of the computational knowledge-base. For this reason, the current practical machine translation systems (MTS) are forced to be syntax-oriented or structure-bound, which inevitably lack ability in meaning understanding.

Without meaning-understanding ability, it is very hard for MTS to treat idiosyncratic gaps existing between source and target sentences. So far we have seen a lot of symptoms that the neglect or insufficient treatment of idiosyncratic gaps has resulted in unsatisfactory translations.

But at the same time, we also have found the encouraging fact that gap-free (or rather, gap-neglecting) machine translation could produce so-so acceptable translations provided that the source sentences are taken from documents of less equivocation.

Thus, research on ambiguity reduction is very important from the practical viewpoint. For this purpose, it may be useful to make efforts to construct a highly idiomatic lexicon, and to control sentence forming

by carefully designed languages such as sublanguage, controlled language and normalized language.

On the other hand, we cannot forget the long-range basic studies on the meaning-understanding mechanism and the meaning-describing diagram, in order to obtain the ultimate final result, that is, human-translation-like machine translation.

References

[1] Eikyô [Nihon-Eigo-Kyôiku-Kyôkai] (eds.) (1982), '2 Kyû Jitsuyô Eigo Kyôhon' ('2nd Class Practical English Textbook'), Nihon-Eigo-Kyôiku-Kyôkai, Tokyo, 1982 pp. 202–203 (in Japanese).

[2] Kenkyusha-Jisho-Henshû-Bu (eds.) (1973), 'New Collegiate Dictionary of the English Language' ('Shin-Ei-Ei-Jiten'), Kenkyusha Ltd. 1973 p. 244.

[3] Kittredge, Richard (chair.) (1982), 'Sublanguages', American Journal of Computational Linguistics, vol. 8, no. 2, 1982 pp. 79–84.

[4] Nagao, Makoto (1983), 'Seigen-Gengo-no Kokoromi' ('A Trial in Controlled Language'), in Shizen-Gengo-Shori-Gijutsu Symposium Yokô-Shû, Information Processing Society of Japan, Tokyo, 1983 pp. 91–99 (in Japanese).

[5] Nagao, Makoto (1985), 'Kikai-Hon-yaku-wa Doko-made Kanô-ka' ('To What Extent Can Machine Translate?'), Kagaku, Iwanami, Tokyo, vol. 54 no. 9, 1985, pp. 99–107 (in Japanese).

[6] Nakamura, Yasuo (1973), 'Hon-yaku-no Gijutsu' (Techniques for Translation'), Chû-kô-Shinsho 345, Chûô-Kôron-Sha, Tokyo, 1973 (in Japanese).

[7] Newsweek (1982), 'Newsweek' January, 18, 1982 p. 45.

[8] Nitta, Yoshihiko, et al. (1982), 'A Heuristic Approach to English-into-Japanese Machine Translation', in J. Horecký (ed.). Proc. COLING 82 (at Prague) [Proceedings of the 9th International Conference on Computational Linguistics], North-Holland Publishing Company, 1982, pp. 283–288.

[9] Nitta, Yoshihiko, et. al. (1984), 'A Proper Treatment of Syntax and Semantics in Machine Translation', in Proc. COLING 84 (at Stanford) Proceedings of the 10th International Conference on Computational Linguistics], Association for Computational Linguistics, 1984, pp. 159–166.

[10] Ozeki, Masanori (supervisory ed.) & Y. Aoyama (ed.) (1985), 'OA-no Software' ('Software for Office Automation'), Ohm-Sha, Tokyo, 1985 chap. 5, pp. 113–154 (in Japanese).

[11] Simmons, Robert F. (1984), 'Computations from the English', Prentice-Hall, Englewood Cliffs, New Jersey, 1984.

[12] Slocum, Jonathan (1985), 'Machine Translation: Its History, Current Status and Future Prospects' Computational Linguistics, vol. 11, no. 1, 1985.

[13] Winograd, Terry (1983), 'Language as a Cognitive Process: vol. I: Syntax', Addison-Wesley, Menlo Park, Calif., 1983.

[14] Yoshida, Shô (1984), 'Nihongo-no Kikakuka-ni-kansuru Kisoteki Kenkyû' ('Basic Study on the Normalization of Japanese Language'), Shôwa 58-nen-do Kagaku Kenkyû-Hi Hojokin Ippan-Kenkyû (B) Kenkyû-Seika Hôkoku-Sho (Research Result Report on the General Study (B) Sponsored by the Shôwa 58 Fund for Science Research) Kyushu University, Kyushu, 1984 (in Japanese).