本田財団レポート　№105

「日本語ワードプロセッサの研究開発とその社会的影響」

東芝テック株式会社　相談役

森　健一

Commemorative Lecture on the Occasion of Receiving the Honda Prize “Research and Development of a Japanese Word Processor and Its Social Consequences”

Ken-ichi Mori
Adviser to the Board of Toshiba Tec Corporation

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Adviser to the Board of Toshiba Tec Corporation

■略歴

1938 年	東京都で生まれる
1962 年	東京大学工学部応用物理学科卒業
1962 年	東京芝浦電気株式会社（現　株式会社東芝）総合研究所勤務
1962〜87 年	この間 1971 年からカナ漢字変換の研究に入り、初めての日本語ワードプロセッサを開発したグループのチーフをつとめる。
1993 年	同社　情報機器事業本部長
1994 年	同社　取締役　パーソナル情報機器事業本部長
1995 年	同社　取締役　映像メディア事業本部長　兼記憶情報機器事業本部長
1996 年	同社　常務取締役
1998 年	株式会社テック（現　東芝テック株式会社）専務取締役
1999 年	同社　代表取締役社長
2003 年	同社　相談役

■受賞歴

1970 年	東京大学から「手書き文字認識の研究」により工学博士号を授与
1970 年	自由手書き郵便番号自動読取り区分機の研究開発により特許庁長官賞、大河内記念技術賞を受賞
1980 年	日本語ワードプロセッサの研究開発により科学技術庁長官賞を受賞
1991 年	日本語ワードプロセッサの研究開発により特許庁長官賞、大河内記念技術賞を受賞
1992 年	日本語ワードプロセッサの研究開発により日本文化デザイン賞を受賞
1997 年	日本語ワードプロセッサの研究開発により高柳賞記念奨励賞を受賞
2000 年	日本語ワードプロセッサの研究開発とその普及への貢献により電子情報通信学会のフェローに選出

■Personal History

1938	Born in Tokyo.
1962	Graduated from the Department of Applied Physics, the Faculty of Engineering, the University of Tokyo.
1962	Joined Tokyo Shibaura Electric Co., Ltd. (present Toshiba Corporation) and worked for the Research & Development Center.
1962-87	Went into research to enter kanji using Kana-Kanji conversion in 1971 and served as the chief for the group who developed a Japanese word processor for the first time in Japan.
1993	Group Executive, Information Equipment & Automation Systems Group
1994	Vice President and Group Executive, Information Equipment Group
1995	Vice President and Group Executive, Video & Electronics Media Group and Storage Media Business Group
1996	Senior Vice President
1998	Executive Vice President, TEC Corporation (present Toshiba TEC Corporation)
1999	President and Chief Executive Officer
2003	Adviser to the Board

■Awards

1970	Received a doctor's degree in engineering for “Handwriting Recognition Research” from the University of Tokyo.
1970	Awarded the Japanese Patent Office Commissioner Award and Ohkouchi Memorial Technical Award for research and development of Handwritten Postal Code Number Reader and Sorter.
1980	Awarded the Science and Technology Director General's Prize for research and development of the Japanese word processor.
1991	Awarded the Japanese Patent Office Commissioner Award and Ohkouchi Memorial Technical Award for research and development of the Japanese word processor.
1992	Awarded the Japan Cultural Design Award for research and development of the Japanese word processor.
1997	Awarded the Takayanagi Memorial Award for research and development of the Japanese word processor.
2000	Elected as a fellow of the Institute of Electronics, Information and Communication Engineers for research and development of the Japanese word processor.

Commemorative Lecture on the Occasion of Receiving the Honda Prize "Research and Development of a Japanese Word Processor and Its Social Consequences"

I am very honored to be awarded the prestigious Honda Prize. Today, I would like to talk about "the *kana-kanji* conversion system" for the Japanese input method currently used in many Japanese information equipment such as personal computers and cell phones, and the research and development of a Japanese word processor to which this technology was first applied. And I will touch on the social consequences of this research and development. Before taking the main subject, I would like to express my thanks to all those persons who have led me to the honor of receiving the Honda Prize.

In the first place, I would like to express my profound gratitude to Mr. Hiromori Kawashima, President of the Honda Foundation, and other staffs of the Honda Foundation for choosing me as the prize winner for this year. I would like to thank every body of the Honda Foundation for all their kind considerations they had shown to me. And I would like to express my deep gratitude to all the members of the Selection Committee of the Honda Prize.

I would also like to express my sincere thanks to Chairman Nishimuro and other members of the management of Toshiba who have supported me during many years for the research, development and diffusion of the Japanese word processor, to all my colleagues who have participated in my joys and sorrows taking part in the research and development of the Japanese word processor at the Research and Development Center and the Ohme Factory, and to the entire sales personnel who have endeavored in the diffusion of the new product. In particular, Mr. Tsutomu Kawada, Mr. Shinya Amano and Mr. Kimihito Takeda who formed a research team with me contributed greatly in the creation of a product concept by defining what functions a good Japanese typewriter should have in the research and development program of the Japanese word processor that began in 1971, and by finding a practical solution for realizing a "*kana-kanji* conversion system" which was considered impossible then. I would also like to express my profound thanks to all the members of the development team including Mr. Tetsuya Mizoguchi and Mr. Kohji Kodama who buckled down to the difficult task of merchandizing the Japanese word processor. And I would furthermore like to express my sincere thanks to the late Mr. Ken-ichi Sawazaki who was the director of a research institute when we started the research and development of a Japanese word processor as an under-the-table research project for his warm support and encouragement to our research team which took six long years in the basic research.

And I would also like to express my profound thanks to Professor Yoichiro Murakami of the International Christian University who kindly recommended me as a candidate for the prestigious Honda Prize and Assistant Professor Kazuchika Ota of Shinshu University who wrote an enthusiastic letter of recommendation. I am really thankful of the kindness of all the persons concerned.

And finally I would like to express my deepest thanks to Professor Makoto Nagao, President of the Kyoto University. Professor Nagao kindly guided us in our study of pattern recognition and of natural language processing. He is our beloved teacher who directly guided Messrs. Tsutomu Kawada and Shin-ya Amano, my colleagues, at the beginning of our research and development of the Japanese word processor at the Kyoto University.

Twenty-five years have already passed since September 1978 when the first Japanese word processor JW-10 was launched on the market by Toshiba and put to practical use in Japan. Now the Japanese word processor as a specialized equipment ended its role, but the Japanese input process according to "the *kana kanji*[*1] conversion system" developed thereby is now widely used in PCs, cell phones, PDAs, computer terminals, work stations, etc. and is used by many people. The realization of a good Japanese typewriter had long been strongly sought in the Japanese society since the Meiji era. However, in view of the fact that more than 3,000 characters are necessary for the types of *kanji*, *hiragana* and *katakana*[*2] characters and the Roman numerals and codes used daily and that there are a very large number of homonyms in *kanji* words, it had been considered impossible to realize a "*kana kanji* conversion system" and consequently a simple and easy-to-operate Japanese typewriter that any Japanese people can use and similar to a European language typewriter.

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*1 *Kana* is the Japanese syllabary (alphabet) and *kanji* is the Chinese characters imported from China sometime in the Sixth Century A.D. and adapted into the Japanese language. Many *kanjis* are similar to the Chinese characters presently used in the Mainland China and Taiwan while some are completely different.

*2 *Hiragana* is the cursive *kana* letter and *hiragana* is the square form of *kana* letter used to describe foreign or imported words.

And now I will explain in what circumstance we undertook our research and development of a Japanese word processor. At first, our research group worked on the subject of “study on the pattern recognition.” As we entered into an era of co-existence between humans and machines, we thought that we should study and develop a technology that enable machines to understand the information transmitted by letters and voices used by us humans to communicate between themselves and to record as they are. Electronic computers of those days depended on the conversion of data recorded on slips and programs into digital information recorded on punch cards and magnetic tapes by the work of operators. Humans converted information for the sake of machines. For this reason, we thought that we should create a machine useful for us humans by developing a machine that can read documents written by the hand or that understands the words spoken by humans and we established a Pattern Recognition Research Group. The first research result of the Group was the development of a technology for reading hand-written numerals. We developed the first automatic reader/sorter of hand-written postal codes in the world by applying this technology. This machine is still used at present by the Japanese postal offices for automatically sorting freely hand-written postal codes.

FIG. 1. Automatic reader / sorter of freely handwritten postal codes.

Then, we could further advance our researches on the pattern recognition and increase the types of recognizable characters to more than 3,000 hand-written *kanji* or Chinese characters. However, even if a machine can read hand-written or printed characters one by one, the machine cannot process sentences for humans by understanding the contents of orders given by men or those of documents if it cannot understand the meaning of the whole sentence composed by such characters. After the research on pattern recognition, it was necessary to conduct researches on the comprehension of sentences.

One of research subjects for the research on the comprehension of sentences is "machine translation." When an attempt is made to have a machine translate automatically Japanese texts into English, any direct translation made by a machine without correctly understanding the meaning of the original text can be a completely absurd erroneous translation. In order to realize a machine translation, it is necessary to pass through three processes; to analyze the construction and meaning of the original text, to convert the construction of the original text to that of the target language by using grammatical knowledge and to form a semantically correct sentence of the target language. When we were about to start the research, we faced the fact that there was no reasonably affordable Japanese typewriter for inputting Japanese texts while we could use a teletypewriter for inputting English texts. Upon investigation, we found that the realization of a good Japanese typewriter was an unsolved important task although it had long been a subject of research in Japan. And we realized that the analysis of the construction of Japanese *kana* (Japanese alphabet) text and its conversion into a text consisting of a mixture of *kana* and *kanji* by using grammatical knowledge may constitute a part of a research on machine translation. Thereupon, we decided to make a detour and to conduct researches on "the *kana-kanji* conversion system" before undertaking researches on machine translation.

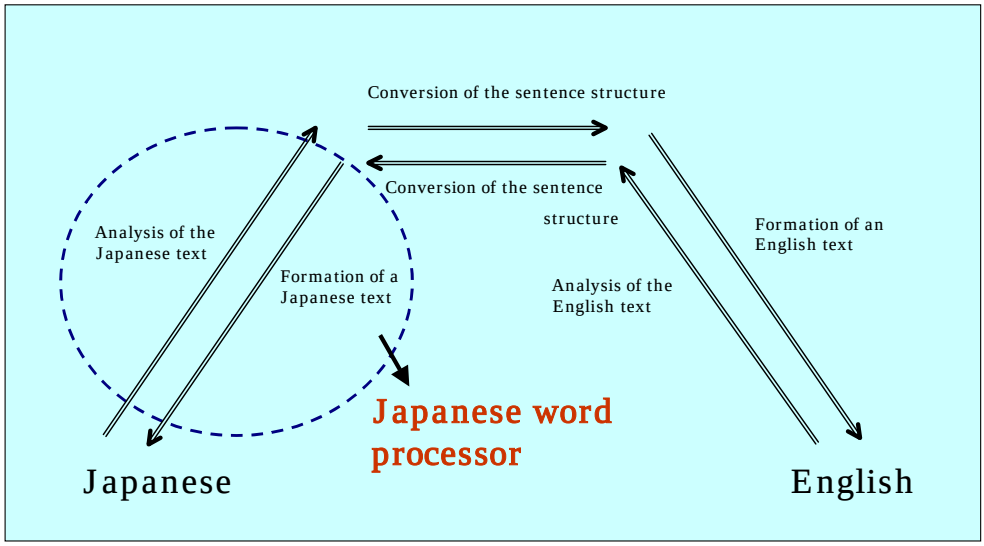

FIG. 2. Process of machine translation

Japanese *kana* texts written by a *kana* typewriter are difficult to read to anyone unaccustomed to it and the Japanese typewriters are slow in writing. These facts constituted problems. Accordingly, in offices most documents were written by hand, and only official documents, contracts and other specific documents were normally written out fair by a Japanese typewriter. As the first step of the research and development of the Japanese word processor, an inquiry was undertaken to find out what functions were desired for a good Japanese typewriter. With the cooperation of many people in government offices, press and other offices, a large number of potential desires of the future customers were collected. It was necessary to determine what is the most important and what is the essential among many desires. We thought that, unlike Japanese typewriters used only by specially trained persons, it must be a product that any speaker of Japanese whether adult, elderly, child or anybody can use at offices, schools and families. As a result of repeated discussions, we concluded that the following three points were the most important functions that should be studied and developed. These points are rearranged in an order that we foresaw as the future market would require its realization. I think that it is most important for the future Japan to foresee the future market, to create the concept of new products that the market requires, to do researches and develop an unexplored and innovative technology and to cultivate a new business.

① The device should be able to write Japanese documents faster than writing out fair by hand.
② The device should be portable and should be easy to carry to anywhere.
③ The prepared document files should be freely accessible and transmittable from anywhere via telephone circuits.

In around 1971 when we started researches on "*kana-kanji* conversion system," various colleges and private businesses were doing researches on various new input systems of the Japanese language. However, no decisively good system was yet developed. As it was possible to express Japanese sentences by using only *kana* letters, if a "*kana-kanji* conversion system" could be realized for converting appropriate portions into *kanji*, it would be an important system that fills the requirement of Item ① above. Professor Kurihara of Kyushu University and NHK Technology Research Institute were conducting pioneering researches in this respect.

However, the problem lay in the processing of homonyms. Homonyms were a peculiar characteristic of the Japanese language. However, as no good processing method of homonyms was available then, there was no other choice than displaying all the candidate words and having the user choose one of them. This method required the user choose a specific word from a number of candidate words every time a homonym appeared. Therefore, the whole process was time-consuming and very unfriendly to the user. And as for the method of referring the inputted sentence to the dictionary of words, a method called “the longest match method” was used. This was a method in which only the longest matching string of characters was preferably chosen from among a number of possibilities for analyzing *kana* sentences. For example, a string of characters “ひとは(hitowa)” contains possibilities of “人は(Man used in the subjective case),” “日とは(as for day or the sun),” “火とは(as for fire). However, according to the longest match method, “人は(Man used in the subjective case)” is always chosen as the first candidate word. Because of such a problem, the hit rate of choosing correct a homonym remained in the range of 75-80 percent. This cannot be said to have attained the level of practical use.

To tell the conclusion obtained from the result of our researches, the key to realize a practical level “*kana kanji* conversion system” lay in making the Japanese grammar more precise and the development of a function in which a machine itself learns automatically the information on the frequency of use of homonyms by users.

The Japanese grammar taught at the Japanese middle schools divides nouns into ordinary nouns and proper nouns. A finer classification of nouns to enable efficient processing of homonyms is an example of making the Japanese grammar precise. For example, the noun corresponding to the portion of “koushou「こうしょう」” of a kana expression “koushousuru 「こうしょうする」” may be 交渉(negotiation), 考証(historical investigation), 厚相(minister of public welfare), 高承(your esteemed approval), 高尚(highbrow or elegance), 好尚(taste), 公証(public notary), 哄笑(loud laughter), 公称(nominal, public), 校章(school badge), 鉱床(mineral deposit or ore deposit), 公傷(injury sustained while on duty), 工匠(artisan), 高唱(advocacy) etc. and may represent many other homonyms. However, when the words that can be converted into verbs by adding “suru「する」” at the end of “koushou「こうしょう」” are classified, the candidate words can be reduced to 交渉(negotiation), 考証(historical investigation), 高尚(highbrow or elegance), 公証(public notary), 哄笑(loud laughter), 公称(nominal, public), 高唱(advocacy) etc.

Thereupon, we have decided to call the nouns to which sa line (line of sa, shi, su, se, so)[*3] declension verbs "suru「する」"can be added as "sa line declension nouns" to refine the classification of nouns. Such a higher precision in the Japanese grammar contributed to improving the hit rate of correct kana-kanji conversion.

The function of learning the frequency of use of words, on the other hand, is based on the fact that individual users of a Japanese word processor do not use all the homonyms by the same frequency of use and that they have individual habits. Among many existing homonyms contained in a dictionary, users use only a limited number of them for their writing. Therefore, an arrangement whereby a Japanese word processor (machine) itself automatically calculate the frequency of the use of homonyms by the user and display the most frequently used word followed successively by less frequently used words brings about the effect of improving the hit rate of finding a correct homonym as the user advances in the use of the Japanese word processor (long-term learning function). Moreover, there is a fact that specific homonyms may be used repeatedly among the homonyms that appeared in a same document. Therefore, an arrangement whereby the machine store the word chosen finally among the homonyms that appeared while a document is made and the word used finally is preferably displayed when the same homonym is inputted improves further the hit rate of words that the user wishes to input (short-term learning function). By combining grammar processing, "long-term learning function" and "short-term learning function," we succeeded in improving the correct hit-rate of *kana kanji* conversion to 93% or more, and thus we overcame a major technical hurdle towards the completion of a practical Japanese word processor.

In addition, although we could not adopt it because of a very limited memory capacity of the first Japanese word processor JW-10, it is possible to further improve the processing of homonyms by using a dictionary of co-occurrence relations between words. This is a method of utilizing the fact that there is a strong semantic relationship between words that appear in a sentence.

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*3 sa line: The "*kana*" consists of some 51 *kana* letters composed of only vowels a, i, u, e, and o and combinations of consonants and said vowesl. These 51 *kana* letters are disposed in eleven lines beginning with combinations of different consonants and the first vowel a. The sa line is the third of such eleven lines of *kana*.

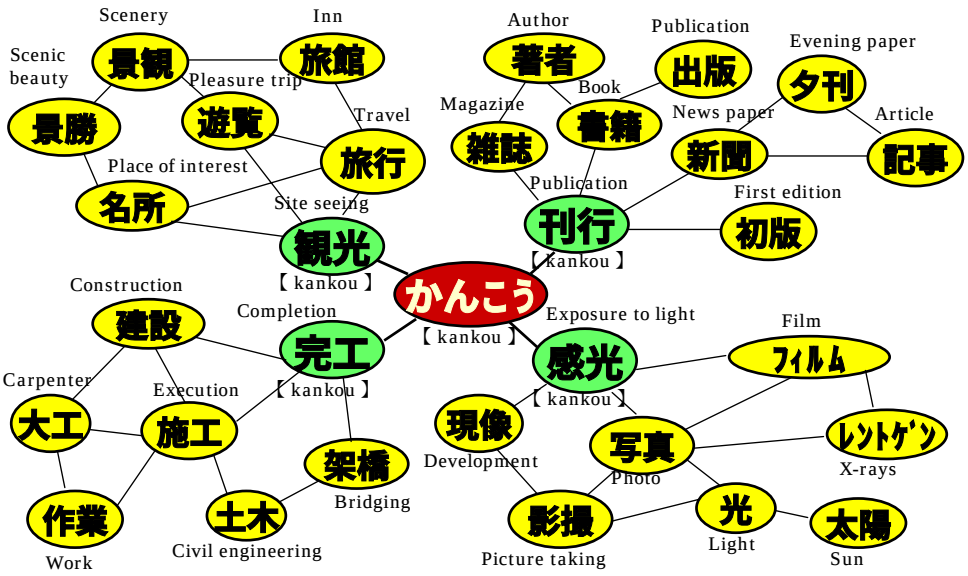


FIG. 3. Dictionary of co-occurrence relations between words.

For example, homonyms corresponding to a *kana* expression “kankou「かんこう」” include 敢行(resolute action), 慣行(habitual or customary practice), 観光(sight-seeing), 刊行(publication), 完工(completion), 感光(exposure to light) 官公(government and municipal offices), 勘考(taking in consideration) etc. However, if there are words such as travel, place of interest and excursion in the same sentence, the probability of hitting a right homonym will be higher when the word 観光(sight-seeing) is chosen from the list of homonyms corresponding to “kankou「かんこう」”. This relationship is called “a relationship of co-occurrence between words (Fig. 3). For a dictionary of 100,000 words, a dictionary of co-occurrence relations between words would contain a million pairs of words. It takes much time to develop a dictionary of co-occurrence relations, but it will be quite effective in processing homonyms. This method is adopted in a personal-type Japanese word processor RUPO in which the memory capacity could be increased. By making the Japanese grammar precise and taking advantage of the technology of a dictionary of co-occurrence relations, we could improve the hit rate of correct homonyms to 98% or more.

In order to realize a Japanese word processor as a devoted specialized machine, it is not enough to simply overcome the hurdle of a language processing software called “*kana-kanji* conversion system.” Japanese language dictionaries available on the Japanese market contain basic words or difficult words. But they do not contain words frequently used in business documents or letters (such as 貴社[you in addressing to a company], 検収[acceptance of products on inspection], 帳票[slips and vouchers], 謹復[cordial reply], 酷寒の候[the coldest season as used in the opening greeting of letters], お慶び[pleasure], and the like),

proper nouns (such as 佐藤[Sato], 木村[Kimura], 御茶の水[Ochanomidzu], 富士山[Mt. Fuji], 利根川[River Tone], etc.), derivative words (such as 不純物[impurities], 高精度[high precision], 同左[ditto], 次世代[next generation], etc.) and abbreviations.

These words will naturally be necessary when you imagine the scenery of using a Japanese word processor. Therefore, we spent time to collect words not contained in Japanese language dictionaries from high school text books, various standard guide books for business documents, the glossary of the House of Representatives, the glossary of the press, and the like to develop a dictionary of words for the Japanese word processor.

Hardware technology necessary for the realization of a Japanese word processor was neither developed then.

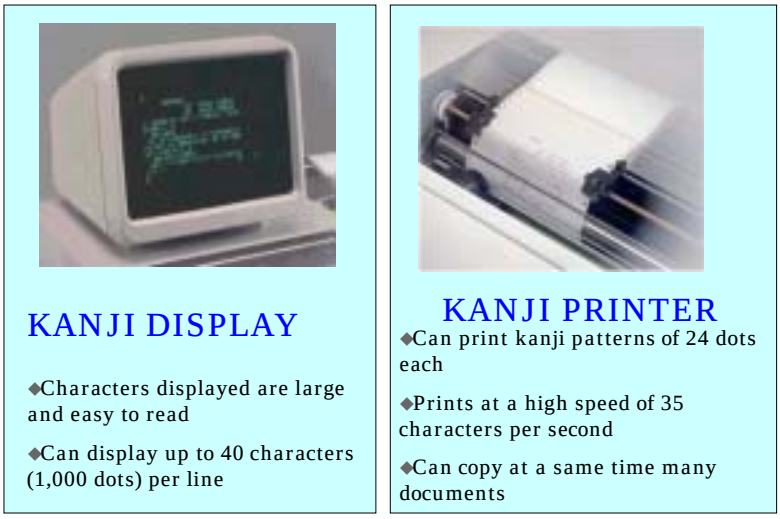
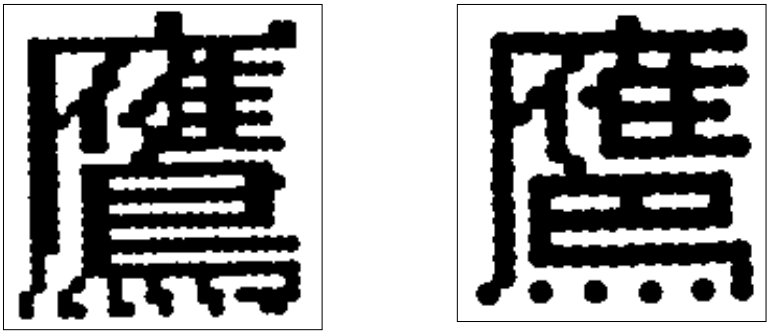


FIG. 4. Development of *kanji* display devices and *kanji* printers

A display device is necessary to display the Japanese text inputted. But the Braun tubes for TV of those days had only a resolution of 600 – 700 lines. A line contains 40 characters when 10 point characters are written horizontally on an A-4 format. To display 40 characters in a line on the Braun tube, a resolution of 1,000 lines is necessary. Thus, with the cooperation of engineers of our Braun tube factory, we newly developed a high-resolution Braun tube. The situation relating to a *kanji* printer was similar. At that time, there was a very expensive *kanji* line printer for computers. But it was too expensive for use in offices. Accordingly, we developed a small 24-dot wire dot-matrix impact *kanji* printer. To express correctly *kanji* composed of many strokes such as 鬱、覧、鸞、酬、and the like by avoiding any wrong characters, it is necessary to compose character patterns at least by 24 black and white dots arranged horizontally and vertically. It took three long years to design 10,000 character patterns composed of 24 x 24 dots.



24 dots　　16 dots

FIG. 5. Development of 24 X 24 dot *kanji* patterns

It took almost six years from founding a Japanese word processor R & D team in 1971 to start the basic research until we had a perspective of being able to realize a practical product in the fall of 1977. With the cooperation of engineers of the Ohme Factory, we developed our product and one year later the first Japanese word processor JW-10 was borne in Japan.

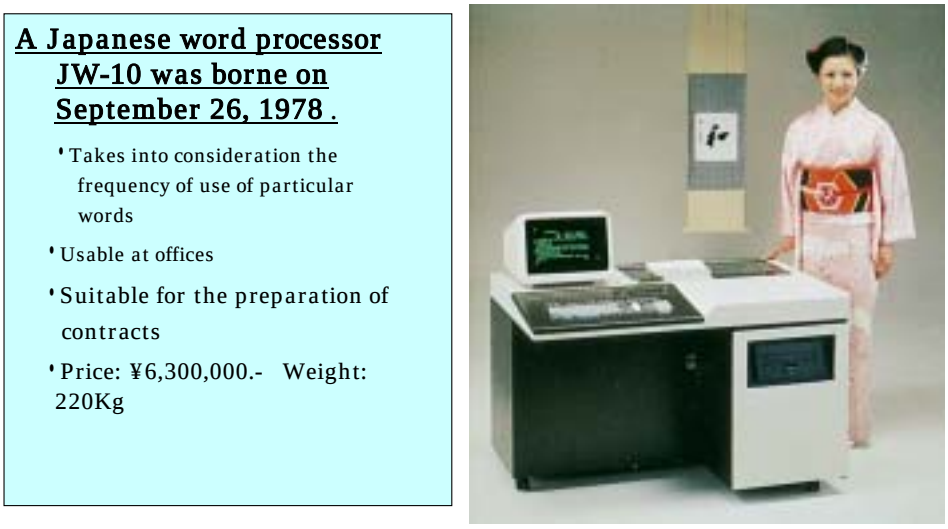


FIG. 6. The first Japanese word processor

In a press interview announcing the launch of the new product, we explained to the reporters present that Items ① to ③ (P.22) were the product concepts of the Japanese word processor, that we foresaw the development of the market according to this order, and that therefore the next target for product development for Toshiba was the development of a portable Japanese word processor. However, sitting in front of JW-10 of the size of an office table (weighing 220 Kg and priced at ¥6.3 million), nobody could believe our explanation that in the future it will be a portable product priced around ¥100,000. And nobody except a

reporter showed any reaction. It was simply logical because at that time even desktop-type PCs were not on the market. We thought that the advent of liquid crystal display devices in place of Braun tubes would enable us to realize portable Japanese word processors, and we strongly requested our component factory to develop a liquid crystal display device. In five years since then, a liquid crystal display capable of displaying two lines of 40 characters each was made on an experimental basis. We quickly obtained this and made on an experimental basis the prototype of a portable Japanese word processor.

- Rupo JW-R10 was borne on June 26, 1985
- Displays two lines of characters of 24 x 24 dots each.
- Rich printing functions
- Light weight, small size weighing 3.5Kg
- Cheap at ¥99,800

FIG. 7. Prototype of the personal Japanese word processor RUPO

As we could set the price of our personal Japanese word processor RUPO below ¥100,000, it gained an explosive popularity and proved to be a great hit. I believe that the diffusion of Japanese word processors among the families and offices throughout Japan owed to the success of the personal Japanese word processor RUPO.

And here I would like to reflect on the history of the Japanese national characters and language problem and the social demand for the Japanese typewriter.

Kanji arrived in Japan around the first century AD from China by passing through Korea, and gave a great impact on Japan which had no letter civilization then. Nihon Shoki written in classical Chinese and Manyoshu written in Manyo kana[*4] using the phonetical pronunciation of kanji were edited. During the Heian Period, katakana letters and hiragana letters were invented and the unique Japanese expression method of using a mixture of kanji and kana began to be used for recording various things and for creation. The letter civilization was initially limited to the upper class, but it spread gradually widely and in particular

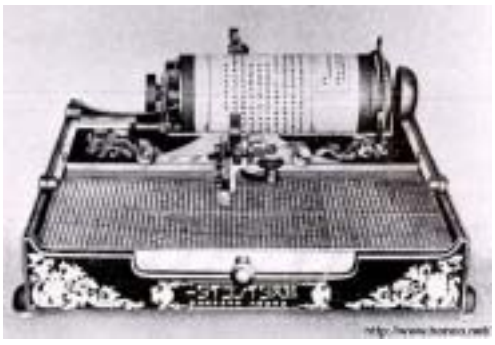
*4 *Manyo kana* is a special type of *kana* used during the Nara Period (714 – 784 A.D.) and particularly in Manyo-Shu (Collection of a Myriad Leaves) containing more than four thousand poems.

during the Edo Period it spread among the masses through the terakoya (private elementary school) system and others. However, at the end of the Edo Period, Hisoka Maejima who later became the first Minister of Posts and Telecommunication submitted a written petition entitled "A Proposal for the Abolition of *Kanji*" to the Shogun Yoshinobu Tokugawa in 1866 advocating that obliging children to learn many characters was a too great burden for them, that *kanji* should be abolished to be replaced by *kana* letters, and that the Japanese grammar should be improved and Japanese dictionaries should be edited.

During the Meiji Period, many informed people were interested in the problem of the Japanese writing and language and expressed their own opinions. Arinori Mori who became the first Minister of Education proposed a radical plan that the Japanese language should be abolished to be replaced by English in order to stand on the equal footing with the Western powers. But he was reportedly admonished by his foreign friends that the civilization of a country depend to a large extent on its national language and that the national language should not be change unscrupulously. After the Meiji Period, the problem of the national script and the national language was seriously discussed from the point of view that it is necessary to improve business efficiency in order to catch up with the advanced countries.

With regard to Japanese typewriters, in 1915 Mr. Kyota Sugimoto made a survey on the frequency of using *kanji* and developed a Japanese typewriter containing about 2,400 fonts. In 1920, Mr. Yoshitaro Yamashita established *Kana* Moji Kyokai (*Kana* Letters Association). In 1923 he developed a *kana* typewriter and endeavored to promote a higher efficiency of business and the diffusion of a *kana* typewriter.

Kana typewriter
(made by Underwood co,.ltd in 1923)



Japanese typewriter
(made by Nihon Shojiki Shokai in 1915)

"Grand Museum of the Japanese Language"
by Jun-ichiro Kida

FIG. 8. Development of Japanese typewriters and *kana* typewriters

After the end of the World War II, in 1946, the Japanese Ministry of Education published "A List of *Kanjis* Designated for Daily Use" in order to restrict the use of *kanjis*. And the Ministry organized the Council on National Language by designating mainly those who argued in favor of the adoption of *kana* letters and *romaji*[*5] in the future to be used for writing Japanese documents as its members. However, Mr. Seiichi Funabashi and other minority members who defended the use of *kanjis* published a statement of secession stating that they are opposed to the deliberation on a very important issue for the nation such as the issue of national script and the national language behind a closed door in the Council mainly composed of members of biased ideas. Therefore, a large number of people paid attention to this dispute. Mr. Tsuneari Fukuda stated in his work entitled "My National Language School": "The use of characters should not be restricted by machines and if any machine is necessary, it is necessary to invent a new machine depending on the actual condition of the characters." Thus, he expressed his expectation for the invention of a new good Japanese typewriter.

In 1965 the Chairman of the Council on National Language published a statement that since then the mixed writing of *kanji*s and *kana* letters would be the standard script of the Japanese language and thus terminated for a moment the issue of the national script and the national language that had lasted for about 100 years. As there were opinions that even the national language should be changed because of the absence of a good Japanese typewriter, I believe that engineers have the obligation of conducting timely researches and development meeting the requirement of the society.

Now, I would like to touch on the social consequences of the realization of a Japanese word processor based on "the *kana-kanji* conversion system."

In the first place, let's see how the number of word processors and PCs shipped changed during 20 years from 1980 through 1999.

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*5 *romaji* is a method of writing Japanese in Roman characters.

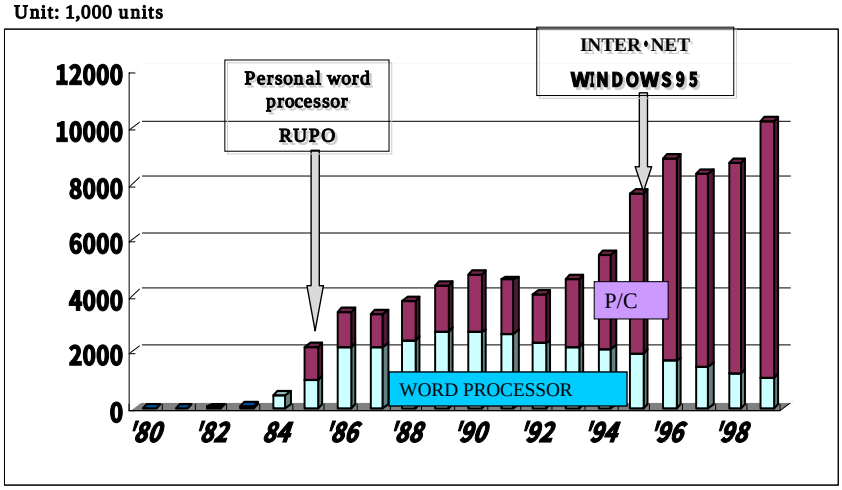

FIG. 9. Number of word processors and PCs shipped

As a majority of PC users are using a *kana-kanji* conversion software, the number of units including this is considered as the number of *kana-kanji* conversion software being used throughout Japan.

According to this figure, as a Japanese word processor by which Japanese documents can be prepared faster than writing by hand as described in Item ①(P.22) was launched on the market, the Japanese information processing began to diffuse at first at offices. And as personal Japanese word processors described in Item ②(P.22) were launched on the market, the use of the Japanese information processing spread to families and schools. Finally, the advent of the Internet of PCs resulted in the realization of Item ③(P.22) and the generalization of the Japanese information process on a full scale. This process was exactly in the same order as we had foreseen in 1971.

It is necessary to verify whether the realization of a Japanese word processor resulted in the possibility of preparing documents at a speed similar to that of European language typewriter as desired by Mr. Tsuneari Fukuda in 1960. The result of a study in which a large number of articles of English newspapers published in Japan and of articles of Japanese newspapers of the same contents were collected and the number of characters used therein was compared is published. This study report revealed that the number of characters used in English text and Japanese text expressing the same content was in average 2.5 : 1. An experienced English typist is reported to type approximately 200 strokes in a minute, which corresponds to 80 characters of the Japanese text in a minute. This speed is roughly the same as the input speed of experienced operators of Japanese word processors. This means that the machine desired by Mr. Tsuneari Fukuda in 1960 has been realized.

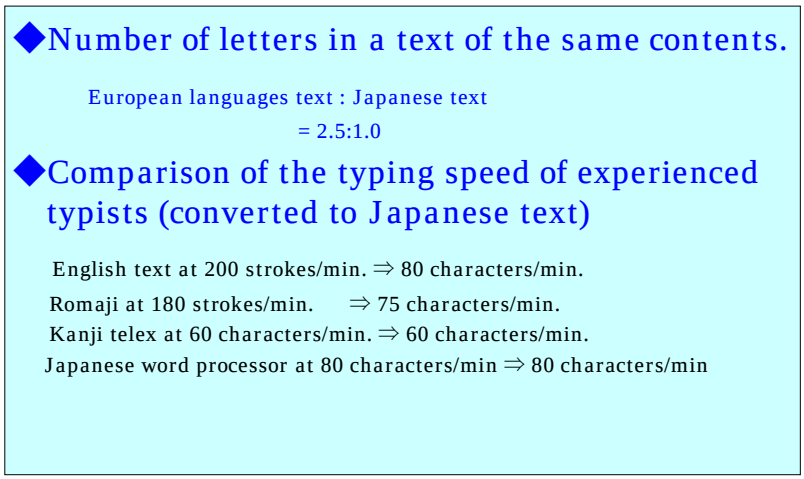

FIG. 10. Comparison of typing speed of European texts and Japanese texts

"The *kana-kanji* conversion system" is widely used not only in Japanese word processors but also in PCs, PDA, cell phone and the like, and has become an essential function for the Japanese information processing. It began to be used at various places of work including offices, schools and households and by people of various professions or in the world of creation. However, the greatest joy we felt as research and development engineers came from the letters of thanks we received from physically handicapped persons who could not communicate with others without the help of family members because of their shaking hands and voices in which they wrote that thanks to the appearance of the Japanese word processor RUPO it has become possible for them to communicate clearly with others, write letters or create poems. We provided, on the keyboard of a Japanese word processor, a thin sheet metal cover bent in the form of the Japanese *katakana* letter コ with holes perforated at positions corresponding to each key of the keyboard. After fixing their attention enough on each target, they thrust their finger into a hole to press a specific key, but as their finger tip shakes, they press on the same key a number of times. We modified a little our Japanese word processor program in such a way that the operation of pressing on a same key a number times within a limited length of time may be interpreted same as that of pressing once on such a key. Such a mechanism enabled physically handicapped persons to type slowly but correctly sentences they wanted to input without the help of others.

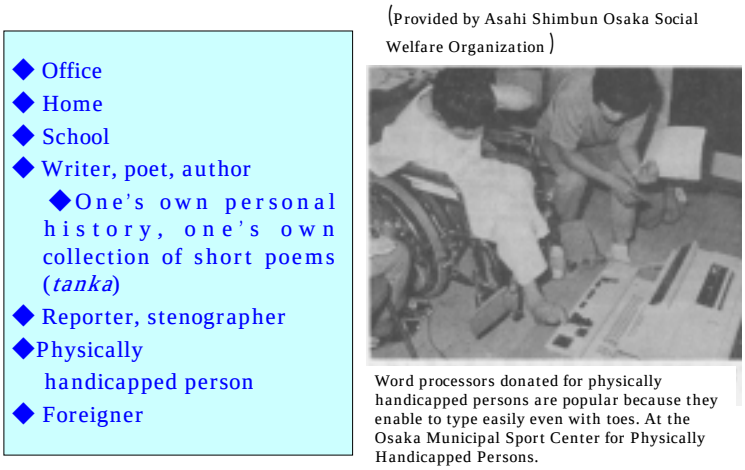

FIG. 11. Word processors supporting the Japanese language culture

The realization of the Japanese word processor made an important impact on word processors of other languages. An English word processor developed more or less at the same time in the United States as the Japanese word processor had only an error correction function and an editing function. However, on learning that Japanese word processors contained a word dictionary, the developer of the English word processor improved their product by including an automatic spell check function based on the use of a dictionary. The success of word processors in Japan stimulated various organizations in China to study and develop various input methods of Chinese, and they totaled more than 500 kinds. However, they could not find a decisively good method. We Japanese owe a great debt to the Chinese who had taught us the Chinese characters 20 centuries ago. Desirous to repay even a part of our debt to them, in cooperation with the Dalien Institute of Technology, we made a Chinese word processor on an experimental basis by applying "the *kana-kanji* conversion system" of the Japanese word processor. In Japan, the Japanese primary school children learn *kana* letters as the first characters in their first year, and in China the Chinese school children learn in their first year pinyin corresponding to *romaji* used in Japan. When a text is inputted by pinyin using "a pinyin Chinese character conversion system" made on an experimental basis, the inputted text is automatically converted into Chinese. It is said that the conversion speed is the fastest among many Chinese input systems that have been developed.

Inputted text: dalianshizhongguobeifangzuidade
gangkouchengshi
Converted text: 大連是中国北方最大的港口城市

Immediately after the announcement of the first Japanese word processor, we were asked whether it may not be possible to develop a voice word processor that converts directly pronounced voices into documents through “the *kana-kanji* conversion system” without using keyboard. Ordinary conversational voices correspond to sosho or a highly cursive style of writing *kanji* and it is difficult to have such voices recognized automatically. Lately however, voice word processors capable of converting quite correctly voices pronounced with some care corresponding to gyosho or a somewhat cursive style of writing *kanji* have been placed on the market.

The research and development and commercialization of Japanese word processor match perfectly with the motto of Honda Motors Co. as proclaimed by Mr. Soichiro Honda: “the joy of buying, the joy of selling and the joy of creating.” If we could contribute even to a small extent to the human society by making the impossible possible through our engineering researches and developments, it is our greatest joy as engineers. With these words, I would like to close my commemorative lecture. I thank you sincerely for your kind attention. And I would like to express again my profound thanks to everybody of the Honda Foundation for awarding me such a prestigious Honda Prize.