Please Pay Your Attention to the Keyboard Layout

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1 — First of All

In early summer of this year (1991), I changed the workstation in my professor's office from Sun3 to Sparkstation2. It was quite fast and comfortable, but as is always talked about, there is a subtle difference in the keyboard layout between the old calculator and the new one, which made me feel depressed for a while. I've gotten used to it over time, but I think this is a big problem for computer users. Since I have the opportunity to discuss this kind of nation and state, I would like to write a little about keyboards today.

Calculators have made great strides in many aspects since their introduction about 40 years ago, but one thing that has remained the same is the keyboard. Since the keyboard had a glorious history as a typewriter before that, it has a nearly established architecture, and the people who use it have not progressed at all, so it seems understandable that it will remain the same forever. do. However, rather than remaining unchanged, it can be said that the situation is worsening. In short, I have no idea what computer manufacturers think of keyboards. It is true that the mechanical performance of keyboards has improved compared to a generation ago, making them much easier to type on, and they are less likely to break down. However, the problem is the huge number of keys and their arrangement, which changes like a cat's eye.

The ultimate in the number of keys is the Space Cadet keyboard, as described in Hacker's Dictionary [1] . I mean a keyboard full of keys to use, just as an astronaut candidate would use to operate the many controls in the cockpit of a spaceship, and specifically his Lisp machine at Symbolics.

Mouse menu methods are also very popular these days, but they still require a keyboard to enter file names. When I compare a keyboard-based operating system (operating system) with a mouse/menu-based system, I feel that keyboard users can type in commands far into the future before the current task is finished. , Mouse/menu enthusiasts feel frustrated because they can't do anything until the menu appears.

Also, as you get used to the keyboard, you will be able to type at a fairly high speed, and you can compete to see how many characters you can type per minute, but as you can see from the fact that there is no competition when using a mouse, it is much faster to type on the keyboard. It can be done.

I don't intend to draw any conclusions based on this comparison, but it seems that keyboards will still be used for some time to come, and computer manufacturers need to give careful consideration, and users will never lose out on learning touch typing.

Professor Van der Poel, a Dutch computer scientist, lists "learn typing" as the first requirement for learning computer science . [2] It's good to learn, but the stumbling block is the layout of the keyboard.

2 — Character set

The first thing to consider when discussing keyboards is the set of characters that are entered using the keys. For English, there was a character set contained in common office typewriters, and for Japanese, there was a character set contained in Kanamojikai typewriters, while the teletype also had its own character set. The history of typewriters is detailed in Mr. Yamada's explanation [3] , but what I always find very unique about old typewriters is the following passage from Kenji Miyazawa's "Biography of Guskov Dori.”

> On the right hand wall of the room, a map of the whole of Ihatov had been made into a huge, beautifully colored model, so that the railways, towns, rivers, and fields could all be seen at a glance; There are mountain ranges that look like rolling hills, mountains that seem to edge along the coast, and a line of mountains that branch out and form islands in the sea, all covered in red. Orange and yellow lights were on, and they changed colors and chirped like cicadas, and numbers appeared and disappeared. On a shelf along the lower wall, there were three rows of what looked like black typewriters, no more than a hundred of them, all moving and making noises.

It's hard to believe that it was written in the Taisho era, but upon further investigation, teletypes have a similar history. To put it simply, the character set of Teletype is the same as Morse code, and in the case of Japanese, in other words, it is a call list (phonetic) that starts with "Asahi A" that was in the telephone directory until recently code). The key arrangement for teletypes had been decided for a long time. It is already listed in the communication engineering handbook (1925 edition) in the author's department library as a Klein system keyboard puncher for Japanese (Figure 1).

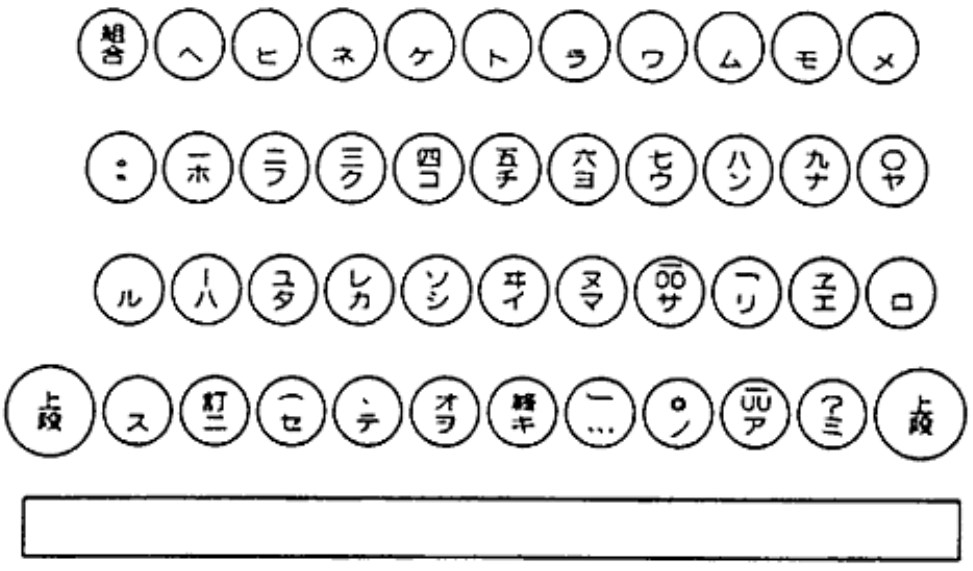
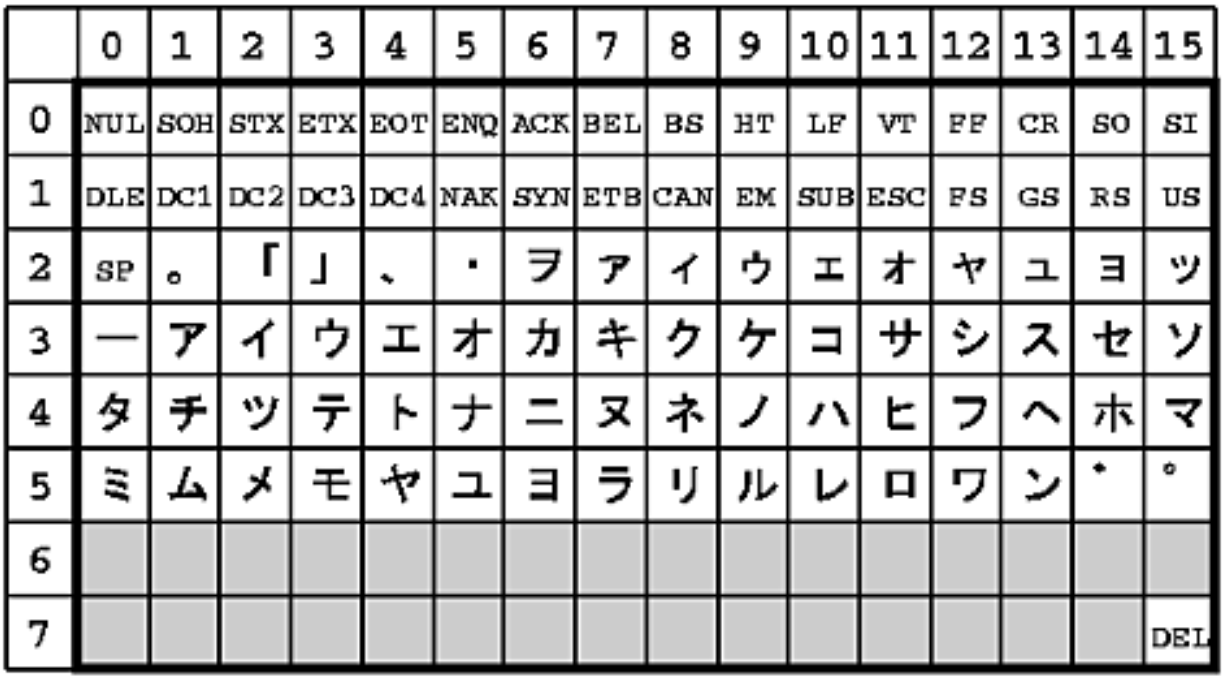


Fig.1-Keyboard of Kleinschmidt keypunch

Early computers used teletypes as input/output devices, but flexowriters and the character sets for modern computer keyboards originated from office typewriters, which are different from teletypes. In English, the two have been merged, but in Japan they are still separate systems, and the keyboard layout is completely different. In short, teletype characters have "ｻ" and "ｺ", while calculator characters have "ya" and “yu".

	0	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15
0	NUL	SOH	STX	ETX	EOT	ENQ	ACK	BEL	BS	HT	LF	VT	FF	CR	SO	SI
1	DLE	DC1	DC2	DC3	DC4	NAK	SYN	ETB	CAN	EM	SUB	ESC	FS	GS	RS	US
2	SP	!	"	#	$	%	&	'	(	)	*	+	,	-	.	/
3	0	1	2	3	4	5	6	7	8	9	:	;	<	=	>	?
4	@	A	B	C	D	E	F	G	H	I	J	K	L	M	N	O
5	P	Q	R	S	T	U	V	W	X	Y	Z	[	\	]	^	_
6	'	a	b	c	d	e	f	g	h	i	j	k	l	m	n	o
7	p	q	r	s	t	u	v	w	x	y	z	{	|	}	~	DEL

Figure-2 ASCII codeFig.2
-ASCII character set



	0	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15
0	NUL	SOH	STX	ETX	EOT	ENQ	ACK	BEL	BS	HT	LF	VT	FF	CR	SO	SI
1	DLE	DC1	DC2	DC3	DC4	NAK	SYN	ETB	CAN	EM	SUB	ESC	FS	GS	RS	US
2	SP	。	「	」	、	・	ヲ	ァ	ィ	ゥ	ェ	ォ	ャ	ュ	ョ	ッ
3	―	ア	イ	ウ	エ	オ	カ	キ	ク	ケ	コ	サ	シ	ス	セ	ソ
4	タ	チ	ツ	テ	ト	ナ	ニ	ヌ	ネ	ノ	ハ	ヒ	フ	ヘ	ホ	マ
5	ミ	ム	メ	モ	ヤ	ユ	ヨ	ラ	リ	ル	レ	ロ	ワ	ン	゛	゜
6																
7																DEL

Fig.3 JIS X 0201 katakana 7-unit code tableFig.3
-JIS X 0201 katakana character set

Leaving aside the teletype character set first, and limiting ourselves to the character sets used in computers, the English character set is the ASCII code (Figure 2), and the Japanese character set is the JIS X0201 [4] katakana 7-unit code (Figure 2). 3) is the standard. This figure is in horizontal orientation, whereas a normal table is in vertical orientation. The reason why it is placed horizontally is that when the value of a bit combination of a character code increases by 1, we want to express it so that the corresponding code position advances horizontally. The idea is the same as placing the quickly rotating index horizontally in a matrix. In the table of JIS "But it's understandable. However, if the translation of "row" is "row", it might be said that it is confusing because in a matrix, the vertical is called a column and the horizontal is a row, and in a 50-tone chart, the vertical is called a row, as in "A row". I don't know what that means, but for now I'd like to call the horizontal rows a row.

In such a code table, the chord position is usually expressed as x=y, where the column is x and the position within the column is y. For example, in an ASCII table, "A" is represented as 4/1.

In both ASCII and JIS, the 0 and 1 columns are occupied by control characters called the C0 set. DEL in 7/15 is also a control character, but this is a vestige from the days of 7-unit paper tape, and a single character called Cx forms a set. SP of 2/0 is a space (interval), and until a while ago it was a combination of graphic characters and control characters, but recently it has completely joined the group of graphic characters. The reason that ASCII and JIS have the same control characters is because they actually have a common ancestor, and both inherit the control characters determined by that ancestor. The ancestor standard is ISO 646 [7] , which prescribes graphical characters, but allows a partially changed version to be specified depending on the country and application. ASCII put "$" in place of the currency symbol in 2/4, and Japan added "\" and necessary kana in place of graphic characters on May 12th. Columns 6 and 7 are left undefined.

Therefore, the character set on which the discussion is based is:

Kana characters (JIS Symbols for kana characters (JIS X 0201)
. 「」、・ー゛゜ (8 characters)

Uppercase alphabetic characters (ISO 646)
ABCDEFGHIJKLMNOPQRSTUVWXYZ (26 characters)

Lowercase letters (ISO 646)
abcdefghijklmnopqrstuvwxyz (26 characters)

Alphabetic symbols (ISO 646)
!"#$%&()*+,-.$/;:<=>?@[\]^_`{|} (32 characters)

Number (ISO 646)
0123456789 (10 characters)

In addition, the 4th ward (hiragana) and the 5th ward (katakana) of JIS

3 — Keyboard Standards

ISO 2126-1975 Office machines - Basic arrangement for the alphanumeric section of keyboards operated with both hands [8] (Figure 4)

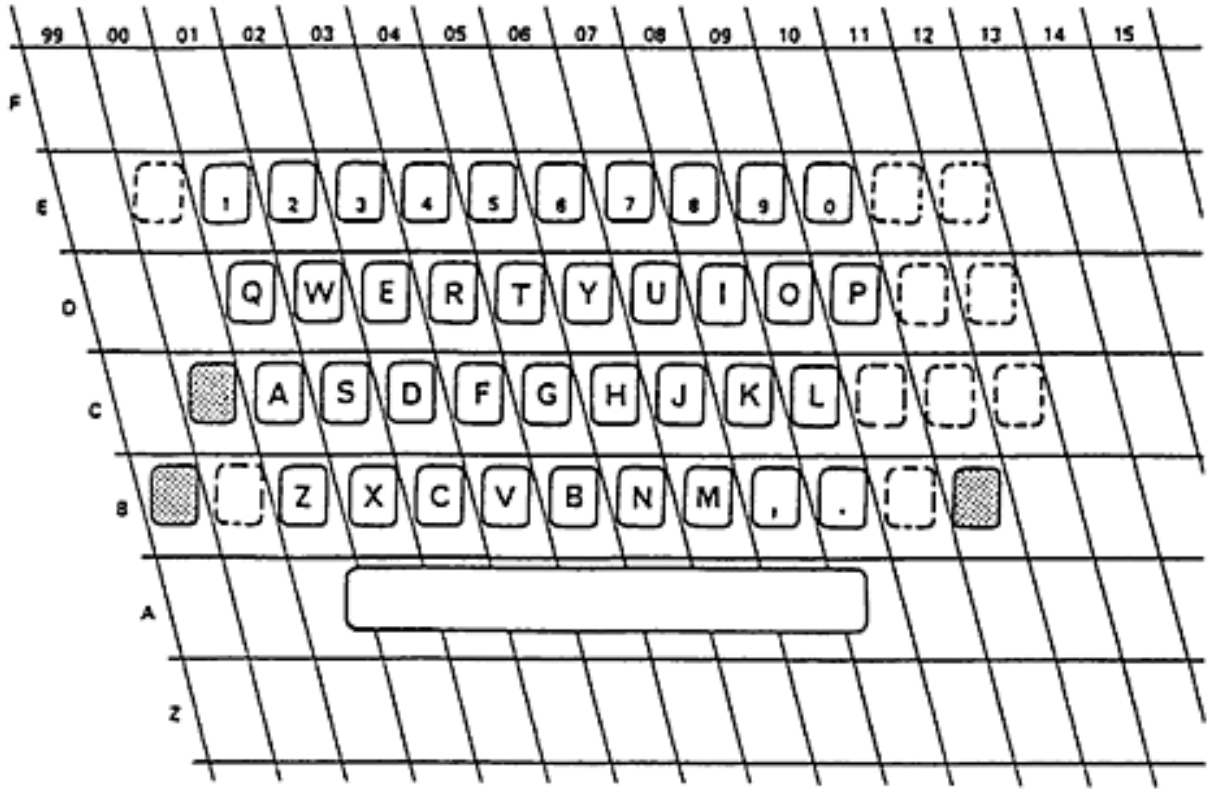


Fig.4
-Keyboard layout of ISO 2126

The only characters that appear on this keyboard are uppercase letters, numbers, commas, and periods. I want you to remember how to express the position of the keyboard with this diagram. I was able to place a Shift on both sides of the B stage and a locking Shift on the left of the C stage. This uses 38 keys, but there are 10 additional key positions available, allowing you to place up to 48 keys. What is noteworthy about this arrangement is that the left Shift is one place away from Z (B99).

ISO 2530-1975 Keyboard for international information processing interchange using the ISO 7-bit coded character set - Alphsnumeric area [9] (Figure 5)

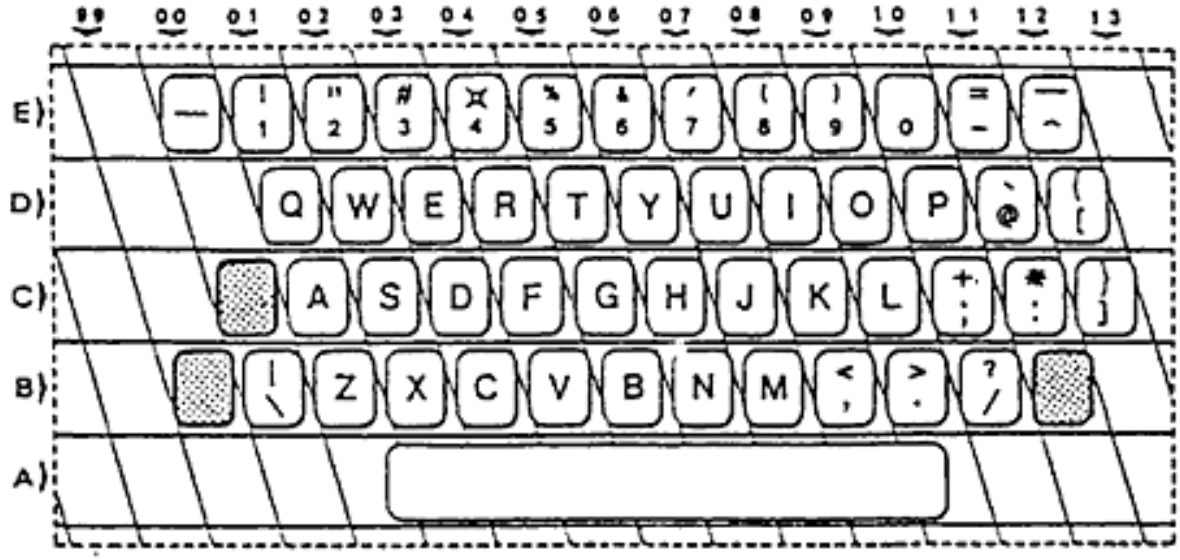


Fig.5
-Keyboard layout of ISO 2530

This keyboard is for ASCII 95 graphic characters. To be precise, it is a code called IRV (International Reference Version) of ISO 646. His IRV at that time also had 2/4 as the currency symbol, not $. Now, in the layout of this standard, 94 characters excluding SP and DEL from the ASCII code table are to be placed on the 47th or 48th key in four rows. SP is of course the space bar in front of you. Set the characters in the corresponding positions of columns 2, 3, 4, 6, 5, and 7 of the ASCII table to determine the shift side and unshift side. I also used the preliminary positions from the previous standard (ISO 2126) for placement. In terms of shift correspondence, the partner for "0" is SP, and the partner for "_" (underline) is DEL. Since both partners exist as independent keys, there is no need to pair them. With 48 keys, each partner It is left without, but the 47 key is paired with this.

This arrangement makes it easy to generate codes because the key and the lower 4 bits of the code are determined independently of the shift. This correspondence arrangement is called logical pairing.

JIS B 9509-1964 Kana/Romaji typewriter keyboard layout [10] (Figure 6)

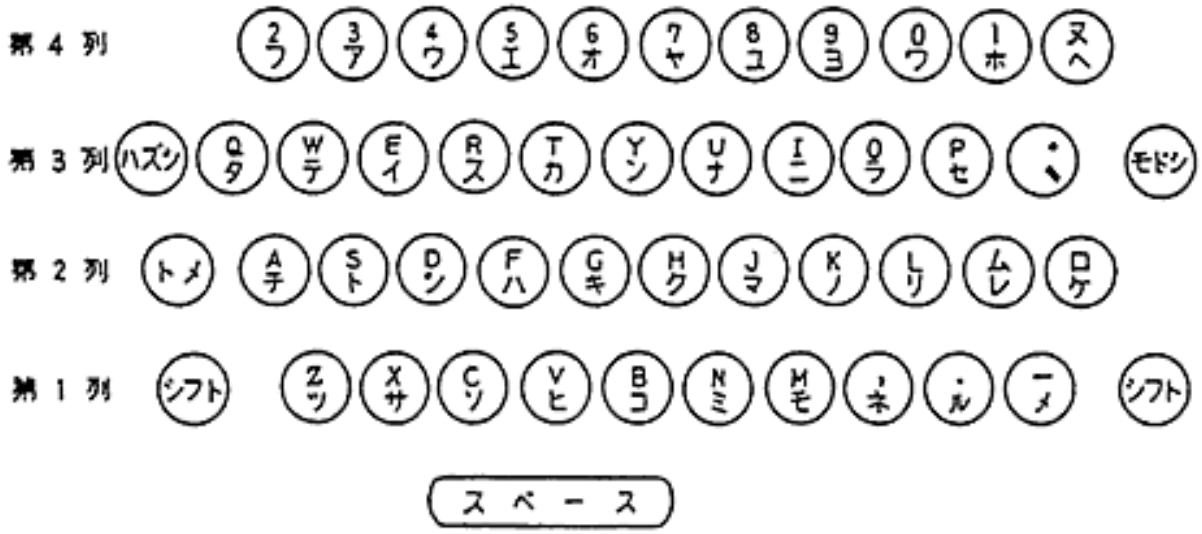


Fig.6
-Keyboard layout of JIS B 9509

This will now become a national standard. This standard stipulates the arrangement when you buy a foreign-made typewriter and want to include kana characters. A total of 86 characters are placed on 43 keys, including 26 uppercase letters, 10 numbers, 45 katakana (without ``wo''), symbols comma, period, and 3 minus signs. For the time being, it is arranged like Kanamojikai's typewriter.

JIS X 6001-1961 Printing telegraph machine board arrangement and codes [11] (Figure 7)

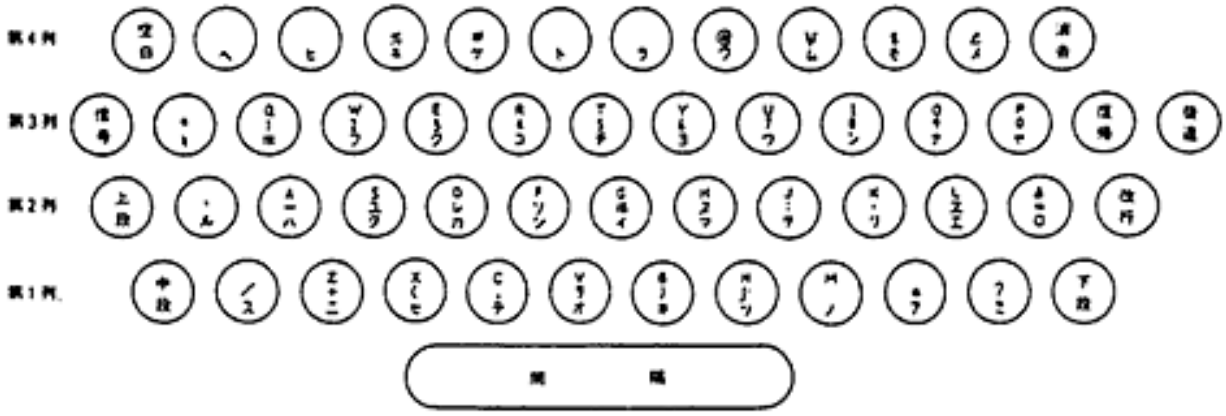


Fig.7
-Keyboard layout of JIS X 6001

Specifies a three-speed shift teletype keyboard. There are 42 keys for graphic characters, so 48 kana characters cannot fit into one row. I also put the voiced mark in the lower row, so the kana that fit in the lower row was 41 characters, and the seven characters of ``Yuresonuioio'' protruded into the middle row. There were numbers in the middle row, but there was still an empty space, so I remember the keyboard with the four letters ``Kosehino'' placed in the middle row as well. The reason why these four characters were also included in the number

column is solely my opinion, but in telegrams at the time, the day of the day was often expressed with ``nanhi'', and morning and afternoon were often expressed with ``se'' and ``ko''. It is also thought that addresses were expressed as ``Ni-no-go'', and these characters were often used together with numbers.

JIS X 6002-1980 Information processing system keyboard arrangement [12] (Figure 8)

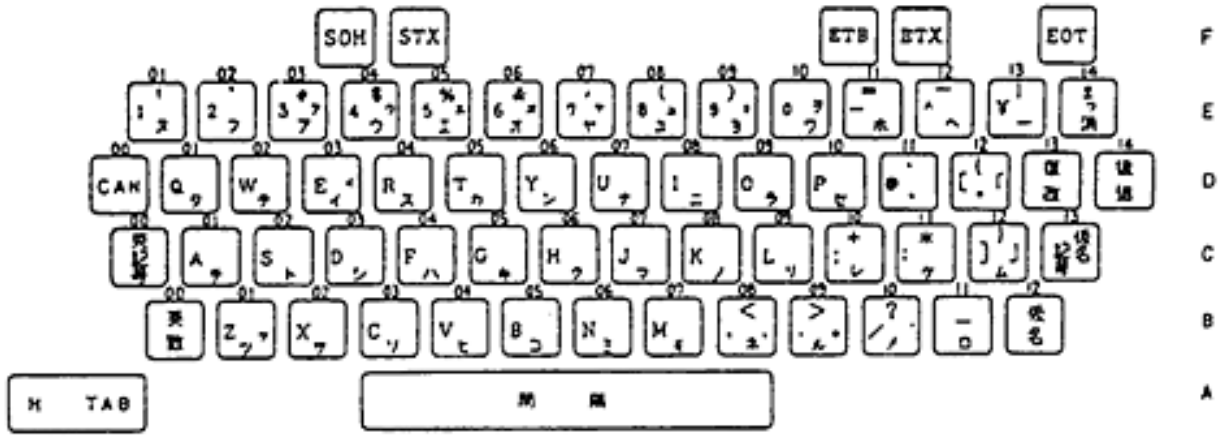


Fig.8
-Keyboard layout of JIS X 6002

Japanese keyboards increasingly have more and more shift stages, and this standard is a four-stage shift. In other words, the English keyboard and the Japanese keyboard each have a two-step shift. The names of the columns are alphanumeric characters, alphabetic symbols, kana, and kana symbols.

JIS _ _

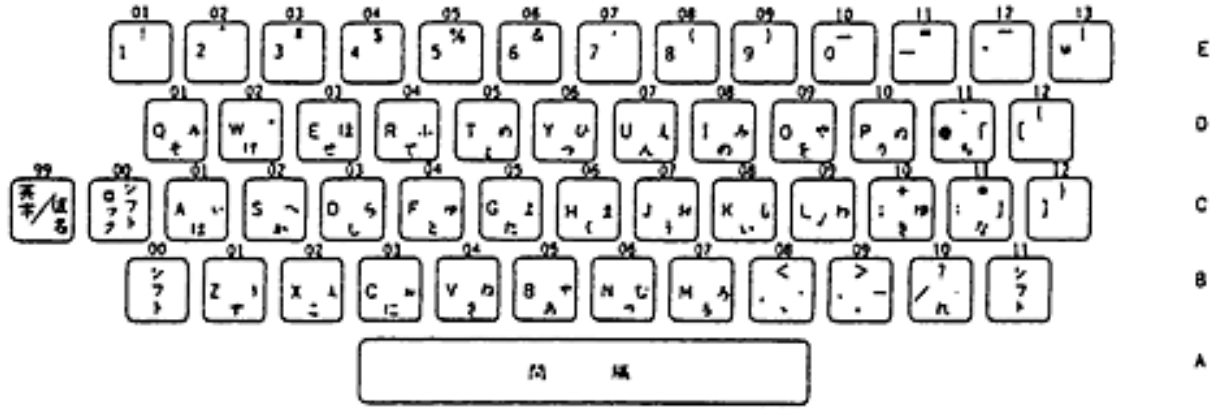


Fig.9
-Keyboard layout of JIS X 6004

This is the latest keyboard layout according to domestic standards. Same as above, 4-stage shift and the character set is exactly the same. However, the kana are only placed in the bottom three rows of B, C, and D. However, strangely, I have never seen a keyboard with this

layout. It seems that they conducted experiments to decide on this arrangement and made it faster to hit, but I wonder why it is not popular.

ISO/IEC DIS 9995 Keyboard layout for text and office systems [14]

This is a draft standard currently under consideration at ISO/IEC JTC/1 SC18. I have a suspicion that you are deciding on a Space Cadet keyboard. In other words, the normal keyboard part is called the Alphanumeric section and placed in the center, the editing section is placed to the right of that, and the numeric section is placed to the right of that. Five function sections are placed above and to the left of these areas, so it is nothing short of spectacular. What is new is that it includes the character arrangement of ISO 6937/2, a standard for text communications. This standard is gradually becoming less and less persuasive. I also don't think they took current keyboards into consideration.

Now, the keyboard I'm currently typing on is SunMicro's Sparcstation2, but it's nothing like that. Since it's made in America, it's probably based on ANSI, but although I haven't looked into it too hard, he says some people say there's no ANSI keyboard standard, while others say there is. In short, it's still not clear.

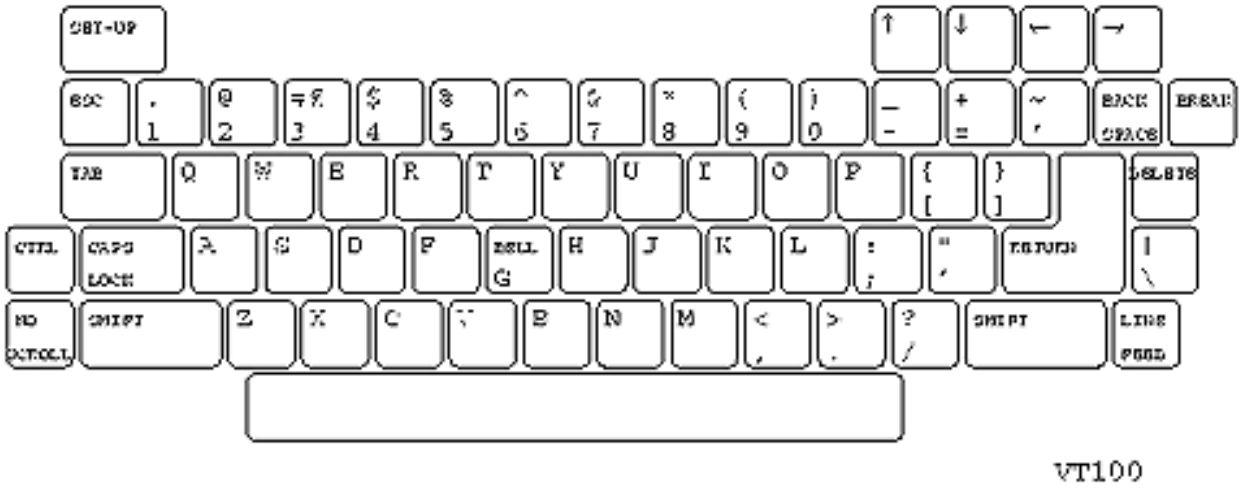
4 — ASCII Keyboard

There are many keyboards in our laboratory, such as DEC's VT100, Apple's Macintosh, Sun Micro's Sun 1, 2, 3, 4 (Sparcstation 1, 2), and Toshiba's Dyna book, all of which meet the above standards. None. In other words, the arrangement of alphabetic symbols is different from that determined by ISO. This is sometimes called an ASCII keyboard, regardless of whether there is a standard or not. The point is that ISO's is a logical pairing, whereas it's a typewriter pairing. Typewriter pairing respects the traditional shifting and unshifting of office typewriters. Recently, JIS keyboards such as Nichiden's PC98 and Toshiba's Sparc LT have arrived in his laboratory full of ASCII keyboards, but he has changed the key bindings on the Sparc LT and uses it as an ASCII keyboard.

The positions of the English symbols on JIS and ASCII keyboards are different, which is of great concern to Lisp programmers like myself. After all, Lisp uses double parentheses (the left parenthesis is called a ``bracket'' and the right parenthesis is called a ``cocker'') and quotation marks a lot, and it would be unbearable if they were placed in different places depending on the keyboard. It is also a source of frustration when parentheses and cockas are placed above 8 and 9 (JIS) or above 9 and 0 (ASCII).

By the way, as I mentioned at the beginning, most of the keyboards in my area are ASCII keyboards, so it doesn't seem to be a big problem, but there are actually subtle differences between ASCII keyboards. For more details on this, see the article by Mr. Takeuchi of NTT Tsuken [15] . You can see many examples there, but here I would like to highlight the features of the keyboards I have used.

Figure 10 shows the VT100, which was said to be DEC's masterpiece. The feel of this key touch is so wonderful that it is still talked about today. If we just focus on the key layout, it's mostly the standard layout for an ASCII keyboard, but what's surprising is that the (|, \) keys stick out to the right of Return. The layout of the function keys is also acceptable, but I remember frequently touching the Caps Lock located to the left of A (C00) and getting flustered. By bringing Caps Lock to this position, the simultaneous press shift key Control has been pushed further away. I want the simultaneously pressed shift key to be as close to the graphic character as possible, so the left and right Shift keys are fine.



VT100

Fig.10- Keyboard layout of VT100

DEC later released a keyboard called the VT220. It seems to be called the DEC LK series, but this keyboard was difficult to use. The reason is that commas and periods are also placed in the upper row, so "<" and ">" become a pair and go to the left of Z (B00). In other words, the left shift became farther. Also, (~, `) went to the left of 1 (E00), and ESC disappeared from the board. The (|, \) that appeared to the right of Return are now inside Return.

Early Macintosh keyboards had no function keys, which was nice, but they also had some problems (Figure 11). (In Figures 11, 12, and 13, the central part is almost the same as that of VT100, so it has been omitted.) I appreciate that Shift is located closer, but Control (represented by a symbol like a clover) is a space. It is located to the left of the bar and is difficult to hit with a blind touch. (~, `) is to the left of 1 (E00) as in VT220. To use ESC, type (~, `) or hold down Control and type (~, `).

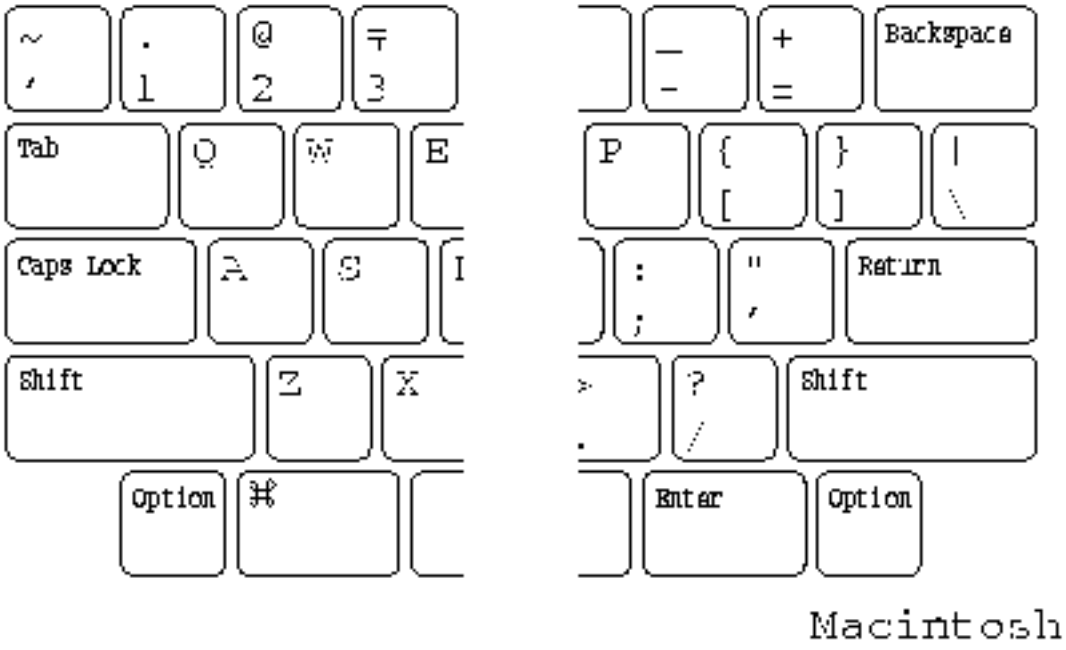


Fig.11
-Keyboard layout of Macintosh

My keyboard journey will now move on to Sun 3 (Figure 12). The Sun 3's keyboard is a perfect example. ESC, Tab, Control, Shift, etc. are now in their standard positions. But this time he had more keys, Left, Right, Alternate, which he didn't know what to use. As shown at the beginning of this article, he switched to Sparcstation (Figure 13) and was once again faced with a different layout.

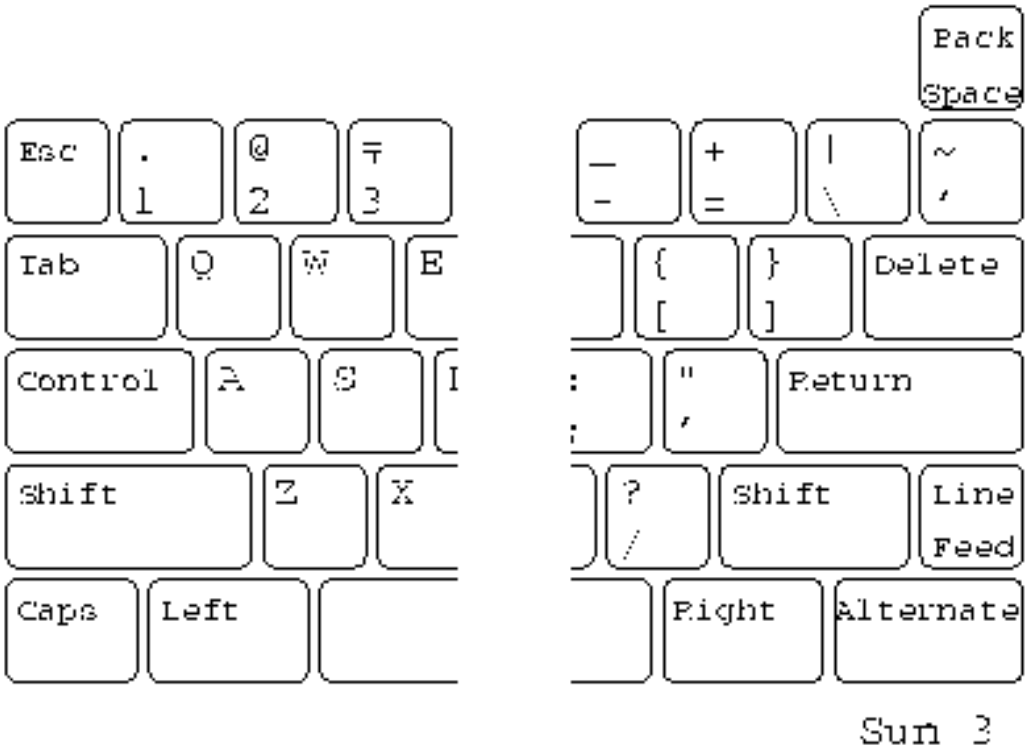


Fig.12
-Keyboard layout of Sun 3

As you can see from the figure, the positions of (~, `) and (|, \) have changed compared to Sun 3. The former came to the right of (", ') (C12). Thanks to this, Return was far away, and at first I was typing backquotes when trying to execute the command.

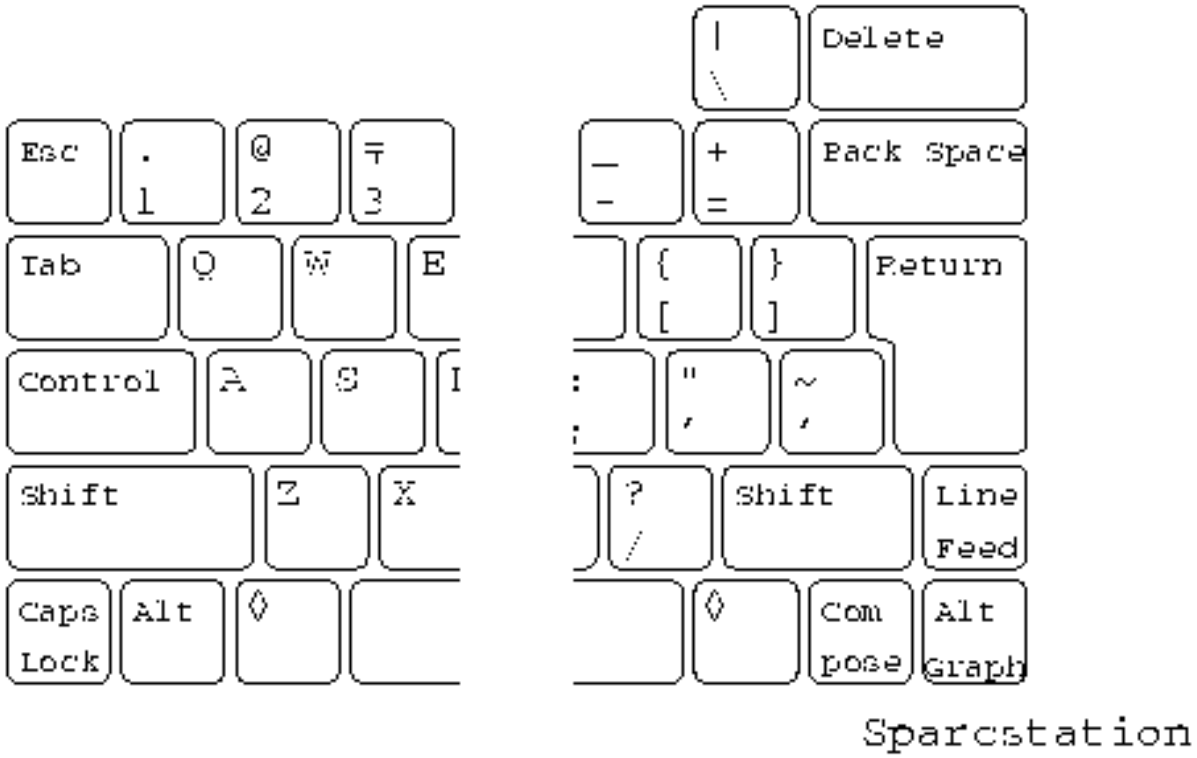


Fig.13
-Keyboard layout of Sparcstation

Looking at it this way, in the case of an ASCII keyboard, there are only two symbols that can be used randomly: (~, `), (|, \). It is being chased to the left, to the top, and to the right.

5 — My Keyboard

If the keyboard layout were to change every time the computer was changed, professional users, apart from occasional users, would have to come up with some kind of defense. Here's how:

1. The computer used is fixed, and other computers are used via the network.
2. Change the key bindings for yourself.
3. Standardize keyboard connectors and carry your own keyboard.
4. Standardize the least common parts of the keyboard and use only those parts.

The simplest solution is the first one. I think it will be practical next time as well, but it is desirable that the graphic characters and function keys are the same. In reality, as we saw above, things with graphic characters jump out to the right, top, or left, so standardization must start from this point.

I wrote "My keyboard" in the title, which means that I would like to consider standardizing the minimum part of item 4 of the above defense measures. For now, I'm designing it and naming it the Alpha Keyboard. At Fujitsu he had his own Lisp machine called Facom Alpha, but it's not related to that. At present, the idea that this level should be the minimum standard is as follows.

Targets characters in ASCII code. Therefore, most of the ASCII keyboards mentioned above will suffice. The key is where to place (~, `) and (|, \). In the plan described here, I want (~, `) to be the keyboard position of Sparcstation2 (E13), and (|, \) to be the position of the Sun3 keyboard (C12). In other words, it is a cross between Sparcstation2 and Sun3. This is how I drew it, as shown in Figure 14. There is a theory that an inverted trapezoid is the best arrangement for the keys for graphic characters, but with 47 keys, it is not possible to create an inverted trapezoid, so I have no choice but to stick with this shape. (I'm not very confident that the number of keys for graphic characters should be 47 or 48.As explained later, I would like to place kana characters on the 47 keys, but the recent 7-unit codes have 96 keys. There is also a graphic character set, so there may be 48 keys for that.)

Fig.14 Alpha KeyboardFig.14
-Alpha Keyboard

When it comes to function keys, Shift, Control, Tab, ESC, and Return are essential, but what's left is deciding what to place in the limited space. In this proposal, I would like to include Meta and Delete. No, some people may need Line Feed or Back Space rather than something like this. That's what normal keyboards do. However, Line Feed and Back Space can be entered using Control J and Control H, respectively, and this is easier than using remote function keys. On the other hand, even if you look at the ASCII code table for Delete, you won't know which character to combine with Control. Also, Meta is a simultaneous press shift key that sets the 8th bit to 1, but it is necessary because there is no way to set the 8th bit to 1 without it.

Shift, Control, and Meta must be pressed at the same time, which requires confusing fingers, but it's almost certain that 8-bit devices will become mainstream in the future, so I'd like to have this ready. I am proud of myself for saying that the key layout is quite clean.

Some people say the Return key doesn't need to be this big, but I don't have any other plans for it at the moment, so it's the way it is.

What is confusing about ASCII arrays is how to type control characters in the 0 and 1 columns. JIS uses logical pairing, so if you look at the code table, you can easily see which character to combine with Control. However, the correspondence between ASCII and the code table is different, so this is not easy. In VT100, the control character that comes out with a certain key called Control is different from Control, and the control character that comes out with Shift and that key is different. I have a hard time understanding why they made it so difficult to remember, but in this plan, the control characters in columns 0 and 1 will be issued by pressing Control and the corresponding graphic character keys in columns 4 and 5, regardless of Shift. do. In other words, don't hold down Shift and Control at the same time. Table 1 summarizes the above.

It is expected that there are many users who would like to arrange alphabetical characters in JIS format. The number of keys for graphic characters in this arrangement is 47, which is the same as JIS X 6004. Therefore, all you have to do is enter the alphabetic characters and symbols. There are 48 graphic character keys in JIS We will discuss what to do with the katakana ``ro'' in B11 next.

Table-1 Alpha keyboard layout

Position	Keytop	Unshift	Shift	Control
A		SP		
B00	Shift	Shift		
B01	Z	z	Z	SUB
B02	X	x	X	CAN
B03	C	c	C	EXT
B04	V	v	V	SYN
B05	B	b	B	STX
B06	N	n	N	S.O.
B07	M	m	M	CR
B08	,<	,	<	
B09	.>	.	>	
B10	/?	/	?	DEL
B11	Shift	Shift		
B13	Meta	Meta		
C00	Control	Control		
C01	A	a	A	SOH
C02	S	s	S	DC3
C03	D	d	D	EOT
C04	F	f	F	ACK
C05	G	g	G	BEL
C06	H	h	H	B.S.
C07	J	j	J	LF
C08	K	k	K	VF
C09	L	l	L	FF
C10	;:	;	:	
C11	"		"	
C12	`~	`	~	

Table-1 contd.

Position	Keytop	Unshift	Shift	Control
D00	Tab	HT		
D01	Q	q	Q	DC1
D02	W	w	W	ETB
D03	E	e	E	ENQ
D04	R	r	R	DC2
D05	T	t	T	DC4
D06	Y	y	Y	E.M.
D07	U	u	U	NAK
D08	I	i	I	HT
D09	O	o	O	S.I.
D10	P	p	P	DLE
D11	[{	[	{	Esc
D12	]}	]	}	G.S.
D13	Return	CR		
E00	Esc	Esc		
E01	1!	1	!	
E02	2@	2	@	NUL
E03	3#	3	#	
E04	$4	Four	$	
E05	Five%	Five	%	
E06	6^	6	^	R.S.
E07	7&	7	&	
E08	8*	8	*	
E09	9(	9	(	
E10	0)	0	)	
E11	-_	-	_	US
E12		=	+	
E13	\ |	\	|	F.S.
E14	Del	DEL		

6 — Kana Characters

In order for this keyboard to be used in Japan, it would be necessary to include kana characters. Since I type in Roman characters, I'm satisfied with just an ASCII keyboard. In order to include kana, there is a debate as to whether to conform to the currently commonly used JIS X 6002 or to adopt JIS It's easy to put it in.

The JIS X 6002 layout has 11 graphic character keys at the bottom, with Shift far away. It seems that the ``ro'' in katakana is causing trouble for designers. On the Dynabook, "ro" doubles as the right Shift key. In the draft of this article, he said that in JISX 6002, ``wo'' is on the side of the kana symbol, so it is ``ro'', so he remembered that in JIS B 9509, ``wo'' was above ``ke'', so he wrote it there. I put it there. In JIS B 9509, both ``nu'' and ``mu'' were modestly hidden above the other keys, but in JIS At this time, due to the housing shortage, I had Ro return to my old home. This arrangement is shown in Figure 15.

Fig.15
-katakana Keyboard

7 — Conclusion

ISO seems to have plans like the DIS 9995, but I've made a suggestion to make the keyboard I'm currently using a little more comfortable. My motivation was to make the keyboard as small and clean as possible. I used the Sun3 and Sparcstation2 keyboards as a standard, and removed the incomprehensible function keys. I wonder if there will ever be a workstation or notebook computer that uses a keyboard like this.

Although I am of the opinion that a kana character keyboard is not necessary, some readers may be concerned about where the key to switch between Japanese and English characters is when looking at the layout of the keyboard. I haven't thought much about the switching keys, but the kana characters on the key tops are there for the user's convenience, and the codes sent out from the keyboard could be the same as when shifting alphanumeric characters. In other words, the basic idea is that it is sufficient to know which mode you are currently inputting into the calculator or editor. Taking this one step further, you would only need to send the coordinates of the pressed key from the keyboard. This is because computers are much better at converting codes.

Although I didn't touch on it at all this time, there are thumb shift keyboards and new Romaji-Kanji conversion keyboards in Japan. The only reference for the former is Kimura's new book [16] , but for the latter there is an explanation by the inventor Morita [17] . I would appreciate it if you would consider the keyboard, including these points, and make sure that it does not confuse users.