VISIBLE LANGUAGE
Volume V, Number 3, Summer 1971

COVER: Detail of *The Sixth Patriarch Tearing up a Sutra* by Liang K'ai. See Figure 1 on page 251.

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A Prototype Computerized Page-design System

Aaron Marcus

The graphic designer has need for an interactive computerized design system to enable him to match the capabilities of available computerized type-editing and typesetting systems. This article describes a prototype system devised to investigate both the problems and capabilities of using computers for page design. The two aspects of the investigation are the appropriate representation of graphic material on a low resolution television-like display and the development of interactive features. The ability to add, delete, and move blocks of symbolized type and illustration on the display has the advantage that the computerized form of the final design is immediately compatible with computerized typesetting systems.

Computer-assisted type-editing and typesetting systems for the graphic arts industry have made considerable progress in recent years, but the graphic designer, who organizes typographic and illustrative material and who makes decisions which ultimately control these devices, has had much less computerized assistance made available to him.

In general, the typographic systems which have been developed are ones using special purpose devices designed for typographic situations. They are concerned (1) with the input of text for a given page of a book or magazine, or (2) with the final output display of the typography for use in making printing plates. To date, text-editing systems (such as MACE at Bell Telephone Laboratories) or typesetting systems (such as the Harris-Intertype Fototronic or the Mergenthaler Linotron system) have only begun to deal with a wide variety of non-typographic material (Miller, 1969; Anderson, 1970). Such systems concentrate on the two "ends" of the complete chain of activities: from the input of an author's text to the output of finished typography and illustration necessary for the production process. This paper describes a prototype computerized system which was developed by the author at Bell Telephone Laboratories, Murray Hill, N.J., and which addresses itself to the requirements of the

graphic designer who occupies a middle position in this sequence of activities.

The graphic designer's role entails more than mere administration of pieces of type; he seeks to provide a stimulating and appealing composition at all levels of design. It is the complexity of the factors governing aesthetically successful design which prevents an algorithm (i.e., a set of instructions) for the entire process from being developed. The nature of the design process therefore requires human intervention and judgment within a computerized system. An interactive system requires the designer to remain at the center of the design activity while predetermined algorithms take over as much of the mechanical subtasks as possible. Even in relatively simple problems of page design, the creation of a program capable of dealing with all logical possibilities, of ranking their desirability, and of optimizing the page composition would be an extremely difficult programming task. For the present, both the computer and the human being possess capabilities which ought not to be underused or misused.

In composing a page, the graphic designer requires a model or diagram of his work with an appropriate level of precision and accuracy. In some cases, often in the beginning, a few pencil strokes will suffice; in other circumstances, he must see a comprehensive diagram.

In addition to a model which he can easily interpret, the designer requires quick, reciprocal interaction between himself and his diagrams. The designer makes changes on the basis of the visual displays available to him whether they are pencil-line sketches, photographic reproductions, or electronic displays. He works back and forth between alternatives trying to account for certain prescribed rules and responding directly to visual forms, adjusting them to incorporate the semantic and the pragmatic parameters of explicit communication as well as the syntactic aspects of form-making which incorporate long professional experience and aspects of implicit communication at a deep, broad cultural level. The more feedback a system provides the designer as he alters visual form, the better he can judge the validity and coherence of his decisions.

Among other capabilities, a computerized page-design system must simulate the traditional tools of pencil, paper, scissors, and paste. The designer must be able to add, subtract, or move elements freely within a normal display area. This area might be the two-page

spread of a book or magazine on which the designer usually composes across the entire surface available to the reader, comparing elements visually on either of the two opposing pages.

Since the designer usually manipulates visual elements by pointing to them and moving them to tentative positions, some analogue device must serve to translate his spatial gestures into appropriate information for a digital computer. Certain of the designer's reactions to the display may be based on clearly formulated rules. In so far as an algorithm for such a response may be described, that subtask of the graphic designer's total activities which is repetitive in nature can advantageously be taken over by computer control.

Having briefly indicated how a computer might assist the designer, a more detailed examination of the problems of developing such a system follows. The first question that arises concerns the appropriate kind of visual display and the nature of a meaningful abstraction of graphic elements symbolized on it. The second question concerns the kind of interactive features appropriate to the graphic designer's activities.

Graphic Abstraction

The graphic designer distinguishes between a great variety of visual elements. He must be able to recognize headlines of varying importance, main text, footnotes, captions, continuously appearing material, page numbers, tables, and line and halftone images. At a finer scale, he may have to discern differences in the style (e.g., roman or italic), size, weight, or setting (e.g., ragged-right or justified) of the type.

In a realistic system, an analogue for each of these elements must be available on the display in order that the designer may properly discriminate these particular features. In addition, the system must be capable of displaying individual graphic elements with enough precision that they validly serve as a basis for aesthetic judgments relating to the rhythms of size, location, orientation, shape, and color. A suitable abstraction of the printed page has been devised which can signify basic information to the designer.

There exist presently no high resolution displays which can present a large amount of detailed information on a page and which can change displays fast enough for use in an interactive mode. Therefore, a low resolution display has been considered.

The experiments discussed here utilize a scanned television-like display controlled by a Honeywell DDP-224 computer. The primary advantage of this scanned display is its ability to output large amounts of data without flicker. This would be necessary to display a full page of typographic or illustrative material. The TV display presently operates with four levels of brightness, and a scanned image of 240 points in width by 254 points in height is put out every 30th of a second (Noll, 1971).

Dummy text incorporated into the program as "input" can be displayed on two facing pages each of whose dimensions may vary up to $8\frac{1}{2} \times 11$ inches. For type unit sizes (type size plus leading) between 8 points and 12 points—a range wide enough to cover the normal limits of variation for body text sizes—the display requires from 176 to 237 raster lines to display 11 inches of page height, with each line of standard type represented by one to three raster lines on the screen. No attempt is presently made to provide exact word-for-word display of a given text. This would require a powerful text-editing and hyphenation program such as is already provided by programs like MACE (Miller, 1969). An editing program would be necessary in order to change sizes, column widths, and settings of any text typography, since this necessitates altering end-of-line word breaks. Using dummy text, the current program allows such alterations of typography and ignores some details of exact word break changes.

However, the system does provide precise (to the typographic point unit as a first stage), accurate locations of all graphic material. For this reason calculations are more time consuming to program and to execute. Essentially, the data concerning locations of text and illustrations must be kept on a micro-grid of typographic point unit measures while the information for the display is computed according to coarse units related to the particular display device. Not only does this allow the program to be relatively easily altered for different display devices, but the exact location data is available for any precise typesetting device which might be interfaced at some later time.

One aspect of the prototype system is that the vertical screen raster is adjusted to correspond exactly to the main type in the display; i.e., the type unit is represented by an integral number of raster lines on the display screen for ease of vertical alignment visually. On the other-hand, the horizontal raster is arbitrarily fixed. This assumes that the

designer is less concerned about exact horizontal positioning, often being interested only in the basic column positions, and he can be less demanding about the precision of the display horizontally.

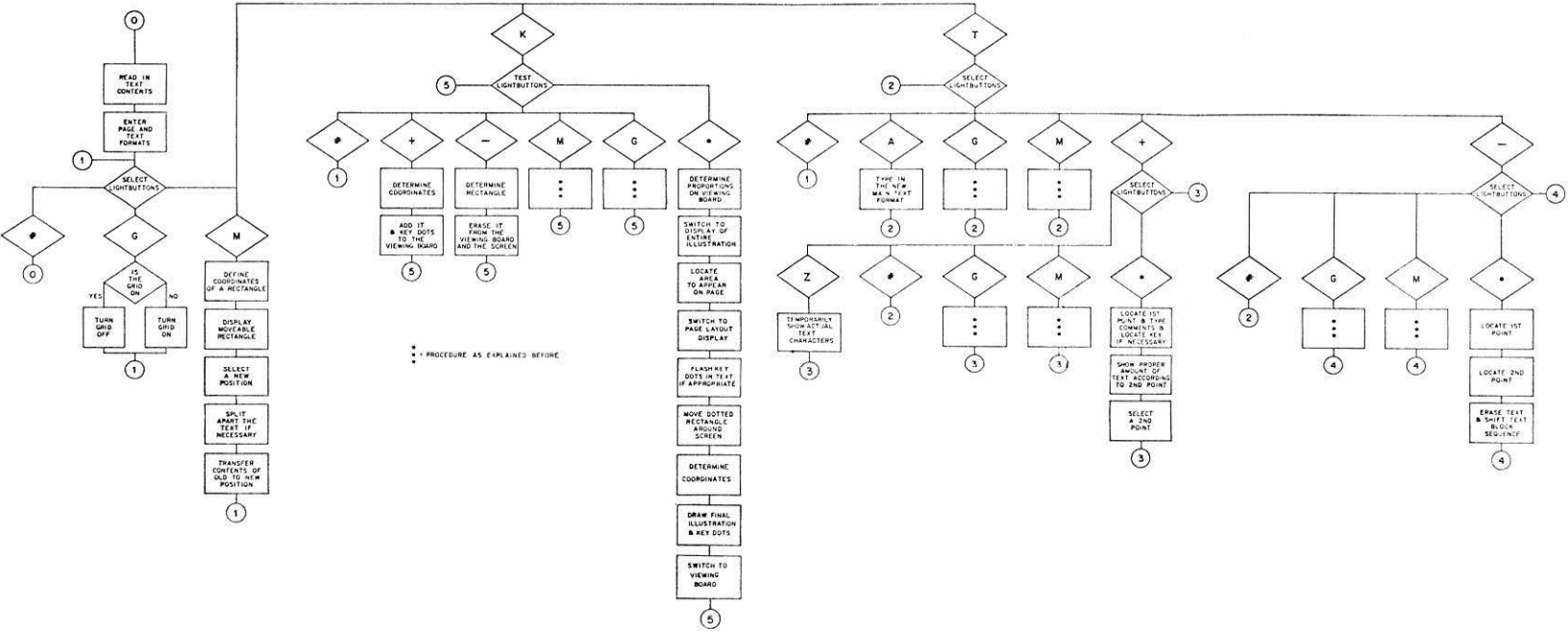
Another feature of the system is that references between text material and illustrative material can be simply distinguished even on the coarse raster display through the use of flashing dots which locate certain desired text sections and particular illustrations; e.g., to signal where an illustration is mentioned in the text. The flashing dot calls the user's attention to this special relationship between graphic elements.

Finally, the decision has been made to show typographic material as white dots against a black background. This form reverses the "normal" color situation of black type on a white paper surface. The display hardware on the DDP-224 computer can produce with equal convenience either black type on a white field or white type on a black field. Perceptual effects make it more difficult to represent lines by vacancies in a white dot background array than vice-versa, because the area of the missing dot associates itself with the small blank area around every white array dot. White type against black background did not seem to cause "perceptual" discomfort and was quickly accepted as natural. However, the effects of reversed display viewing on design situations should be further studied.

The low raster resolution of the presently available hardware is undesirable for the precise graphic needs of some design situations, but even this coarse depiction of typography might satisfy the requirements of design situations for some catalogues and journals whose typographic requirements do not vary as greatly as, for example, those of popular magazines. The illustrations indicate that the prototype system does enable basic parameters to be shown and easily interpreted. Among variants displayable on this low resolution screen are roman vs. italic; light, medium, or bold type; ragged right vs. justified settings; and variations in column width and type size.

Interactive Features

Among other interactive features, a page-design system should display, when necessary, a grid used for the proper location of all graphic materials. It should also enable the designer to preview in some way graphic material before it is placed in the final position on the pages


0
READ IN TEXT CONTENTS
ENTER PAGE AND TEXT FORMATS
1
SELECT LIGHTBUTTONS
#
0
G
IS THE GRID ON
YES
NO
TURN GRID OFF
TURN GRID ON
1
M
DEFINE COORDINATES OF A RECTANGLE
DISPLAY MOVEABLE RECTANGLE
SELECT A NEW POSITION
SPLIT APART THE TEXT IF NECESSARY
TRANSFER CONTENTS OF OLD TO NEW POSITION
1
K
5
TEST LIGHTBUTTONS
#
1
+
DETERMINE COORDINATES
ADD IT & KEY DOTS TO THE VIEWING BOARD
5
–
DETERMINE RECTANGLE
ERASE IT FROM THE VIEWING BOARD AND THE SCREEN
5
M
5
G
5
•
DETERMINE PROPORTIONS ON VIEWING BOARD
SWITCH TO DISPLAY OF ENTIRE ILLUSTRATION
LOCATE AREA TO APPEAR ON PAGE
SWITCH TO PAGE LAYOUT DISPLAY
FLASH KEY DOTS IN TEXT IF APPROPRIATE
MOVE DOTTED RECTANGLE AROUND SCREEN
DETERMINE COORDINATES
DRAW FINAL ILLUSTRATION & KEY DOTS
SWITCH TO VIEWING BOARD
5
: : = PROCEDURE AS EXPLAINED BEFORE
T
2
SELECT LIGHTBUTTONS
#
1
A
TYPE IN THE NEW MAIN TEXT FORMAT
2
G
2
M
2
+
SELECT LIGHTBUTTONS
3
Z
TEMPORARILY SHOW ACTUAL TEXT CHARACTERS
3
#
2
G
3
M
3
•
LOCATE 1ST POINT & TYPE COMMENTS & LOCATE KEY IF NECESSARY
SHOW PROPER AMOUNT OF TEXT ACCORDING TO 2ND POINT
SELECT A 2ND POINT
3
–
SELECT LIGHTBUTTONS
4
#
2
G
4
M
4
•
LOCATE 1ST POINT
LOCATE 2ND POINT
ERASE TEXT & SHIFT TEXT BLOCK SEQUENCE
4

or before it is even brought onto the page display. It should enable text material, as needed, to appear on the page. It should enable all graphic elements to be moved about the page or to be erased from the page and prevent overlapping of the graphic elements unless desired. Finally, it should allow digitalized photographs to be viewed.

The program devised to meet these requirements was written in FORTRAN, a widely used programming language, with some subroutines in assembly language. The Honeywell DDP-224 computer used in this project has one tape drive and two disk drives (Table I). The tape drive is used as secondary storage for text to be displayed; the disks are used primarily for rapid storage and interchange of complete page displays.

Interactive input to the program is primarily through a typewriter and a two-dimensional input device similar to a "joystick." The typewriter allows entry of page size and typographic specifications and also allows warning or advisory messages to be given by the program. The input device allows the user to easily specify a position and to leave the device at that position while both hands are involved with typing or with using an auxiliary sense-switch box which controls various modes that the program may enter. The system uses the input device to control a tracking dot around the screen and an "under-lining" flag which activates light buttons that appear to the right of the two-page spread shown on the screen.

Table I. A flowchart summary of the interactive features of the computerized page-design system. Below are light button symbols used to represent these options which appear in the flowchart.

G GRID. Enter option to display a page grid.

K RECTANGLES. Enter option to add, erase, move, or select rectangles representing illustrative material.

M MØVE. Enter option to move any part of the display to a new location.

T TEXT. Enter option to add, erase, or move blocks of text type.

Z ZØØM. Enter option to "zoom in" and view magnified version of type or illustration.

+ ADD. Enter option to add a new element.

— DELETE. Enter option to subtract (i.e., erase) an element.

≠ FINISHED (RETURN). Enter option to declare the present state finished and to return to a previous state.

. DØT. Enter option to select a particular element.

Text may be added, subtracted, or moved about the display. Rectangles symbolizing digitalized photographs may be added to or subtracted from an auxiliary display (referred to as a viewing board) and may be brought onto the page display for final positioning. A grid display based on the main text specifications can be mixed with the page display at almost every stage in the page design activity in order to help locate typographic and illustrative material according to pre-established positions.

All text masses and illustrations displayed on the screen have their co-ordinates constantly re-specified exactly on a microgrid with a basic unit equal to one typographic point. In addition, their co-ordinates are re-specified for the TV display.

The language of the program speaks of text entries, text blocks, and picture (illustration) blocks. Text entries may be considered to be paragraph-lengths of text characters, although they may possess only enough characters to fill one text line (e.g., subheads within the text) or no characters at all, implying one skipped line. Text blocks refer to columnar areas on the screen which are to be filled with type and which may require more than one text entry of characters to fill them. The top left and the bottom right base-line end points are kept track of as well as the particular character of each text entry asociated with both of those locations. Thus, any particular character and its location within the text entry may be found. Picture blocks refer to rectangular areas drawn on the screen to symbolize illustrations, and their locations are recorded in a manner similar to text blocks.

Viewed for its abilities for user-oriented page design, the system is equally as primitive as its graphic representation aspects, but it demonstrates several important features. For instance, the system's ability to reference certain characters within the sequence of text characters—namely, those which begin and end sections of text—suggests clearly how actual text character data may be used in a more sophisticated system to display and vary symbolization which would permit crucial word and line breaks and the length of the text to be observed. If the computer knows the characters to be set and the information about the widths of characters, it can compute the lengths of lines, paragraph lengths, number of columns of text, etc. This capability goes beyond that available in many design situations where not until the text has been actually

set does one have such detailed knowledge. By then, resetting mistakes or trying different text settings may be too time consuming.

The system also indicates how auxiliary displays of the page grid and a previewing display for illustrations may be incorporated into a workable system. In addition, the necessary careful bookkeeping of text and illustration positions on a microgrid suggests that relatively easy interfacing can be made with a system to display on a high resolution device the final, exact contents of the two-page spread.

The relative ease of selecting light buttons and of positioning graphic material on the page demonstrates that the user may work quickly and naturally in building up a page composition (see accompanying illustrations). This aspect could certainly be improved given time to perfect the algorithms of the system's response to user-oriented options and to perfect, through human engineering analysis, the physical organization of the hardware.

Discussion

In the next stages of development some approach must be developed for the simultaneous display of a broad range of type sizes. This is an important and immediate feature for all but the most strict design situations. The ability to see a magnified view of a given area of the page display would be another desirable feature. This could use the character generation mode of the TV display to actually "set" with fixed character-width type the given content of the text to be examined, added, subtracted, or moved. Since the program secretariat maintains information about the characters of particular sections of text on the pages, this would be accomplished with relative ease.

The present system has, of necessity, restricted itself to a single display of black and white pages. In the near future interactive color TV displays will be available at Bell Telephone Laboratories and will allow the addition of variable color controls to investigate, as for black-and-white typography and illustration, how adding color to low resolution scanned displays could increase the information to the designer in the abstractions chosen for graphic elements. For example, in the design of directories, two different colors could represent adjacent alphabetical sections of listings. The designer would thus be able to sense where certain changes in the text occur even if the typographic symbols were extremely simple.

It may also be possible that low resolution color displays could provide enough information to permit the designer to evaluate single photographs or entire pages in terms of simple aspects of color balance.

The use of multiple screens would allow the designer to see the material being worked on, completed pages, and the next available material. This is simply a matter of how many display devices are available, since the computer has the ability to store and to display simultaneously many different combinations of text and illustration.

Among the options envisaged for a more sophisticated system, the possibility of putting any display or part of a display onto disk storage together with identifying comments and recalling this at an appropriate time for further manipulation should be made available. This implies that the display could return to its previous state if the most recent change were not finalized.

An option for exact alignment on the page grid of recently added graphic material should be added. When necessary, the graphic elements could be positioned to particular locations. For example, certain horizontal lines might signify the top-most and bottom-most base-lines for main text. Other grid lines might signify special locations for photographs, footnotes, headlines, captions, subheads, etc. If graphic elements were placed near enough to these particular positions, they would be automatically moved to the desired locations.

Lastly, a complete option for examining, cropping, and positioning digitalized illustrations should be added. This would allow the proportions of an illustration quantized into discrete levels to be determined; subsequently a "sampling" of the digitalized illustration would appear on the page display. An appropriate number of gray levels for an abstracted symbol for photographs and other illustrations would have to be determined through experimentation. In the future, it may be possible to place the image from a simple television camera into a previously bounded area on the page display, position the illustration by hand, zoom in or out on it optically, alter its proportions, then fix it permanently on the scanned display screen.

These last three options represent straightforward elaborations of the program structure which time did not permit carrying to a more sophisticated stage in the author's program (with the exception of television camera techniques).

The use of a high speed digital computer would enable the development of a system which could be altered relatively easily to meet the conditions of the required design problem. The multipurpose computer implies a flexibility achieved by changing programs, not special purpose devices, i.e., software not hardware. More specifically, the computer-based system could provide the designer with an accurate description of all typographic and illustrative elements even in the preliminary design stages. Thus, in those design situations in which the designer has to consider and manipulate "dummy" type, he would be in a position to call up a given text in almost any desired format of type style, size, leading, and setting and to see the effects on length of columns, paragraphs, word breaks, etc.—all factors which influence large scale decisions of page design.

Some of the lesser, more mechanical tasks could be done automatically in such a system. For example, if the designer decides to insert some new material into a column of primary text material, the system's logic could account for splitting the column and automatically moving down the text within the primary text material positions which follow. A computer-based system is capable of keeping track of all the pages being worked on and of making changes which a given design causes in preceding or subsequent material. A system provided initially with a set of design rules (either fixed or dynamic) could alert the designer if he violated them so that he would be aware of invalid choices or inconsistencies in his work.

Additionally, a computer-based system could allow, as an automatic feature, the exact alignment horizontally and vertically of all material according to a previously established grid which determined locations for primary text material, footnotes, photographs, etc. This particular capability of a computer-based page-design system is of great importance. In normal page design operations, either the designer himself or an assistant uses the preliminary design decisions to position securely and precisely all pieces of type and all illustrative material horizontally and vertically.

Even if the page design does not follow the specifications of a grid, the ability of the computer to account for the exact location of all graphic material means that this information could be made immediately available to a computer-based high resolution typesetting device which could either present a given page to the designer to

contemplate or directly create the negative or plate for printing. This represents a considerable advantage over photo-mechanical graphic design tools such as that developed by Hycon, Inc., for *Life* magazine.[1] In that system the final form of the designer's decisions is a photostat of illustrations and dummy text which another person interprets in order to place the exact text and illustrations for making printing plates.

Finally, several versions of a given design could be easily constructed and stored in the computer's memory for later evaluation. There would never be a problem of insufficient materials to use in new organizations of the visual elements. In some cases, simultaneous alterations could be made to all other alternatives while the designer worked on a single version—an improbable capability with traditional methods of page design. The designer could thus operate in a human, inexact manner sketching broad patterns with the computer following after him putting every piece into its necessary position. The ability of the designer to create exact compositions of text and illustration and to change them in an exact manner is one of the primary advantages of a computer-based system. With computerized assistance, the designer would have more opportunity to judge alternatives, his essential human task.

Earlier the implications of this prototype system in terms of its low resolution display and the interactive options available were discussed. Several other aspects of an interactive page-design system should also be mentioned.

In the immediate future, the experience with the program described here suggests that page design, particularly for stricter design situations, will better match the electronic speed now available for reading, editing, and setting text and illustrations. It also seems possible that interactive color displays may assist the designer in more quickly evaluating color relationships, even of ink and paper combinations, and the effects of these combinations under different printing and viewing environments.

1. For varying descriptions of this device, see *Life* LXIX (August 14, 1970), 3; *Saturday Review*, LIII (September 12, 1970), 93–94; *Print Magazine*, XXIV (July/August 1970), 66–68.

Furthermore, a computerized intermediary between the human designer and the designed object provides a relatively easy means to record the designer's operations. Algorithms replacing many of the present subtasks of the graphic designer's activities might well result. The projected system would still require the active participation of a skilled, professional designer to provide the decisions in the most creative phases of the visual design process: the inspection of visual displays of appropriate detail and complexity and the alteration of these displays to satisfy the designer's conceptions of clear communication and aesthetic form.

As computerized data communication and display become more sophisticated and ubiquitous, the physical delivery of many forms of visual communications—such as telephone directories, mail, and newspapers—will gradually disappear. Many homes and businesses in highly industrialized societies today possess a means of typesetting, namely a typewriter; tomorrow they will compose not only typography but illustrative material as well and communicate it directly to an audience through electronic means. For the graphic designer, this provides yet another impetus towards his changing role as a designer of processes instead of final products. It suggests that it will be necessary to "pre-design" graphic formats for many kinds of visual displays which will allow a user to create his own finished communication. Interactive design systems, perhaps using Picturephone networks and terminals which are a form of low resolution scanned display, may be integrally involved in daily communication requirements.

It is therefore important for visual designers of all kinds to recognize the possibilities and limitations of the computer-assisted systems which will certainly be developed in the next decade. It is even more important for them to assist where possible, preferably by direct participation, in the establishment of goals for such systems which will enhance their effectiveness as helpful, human-oriented tools.

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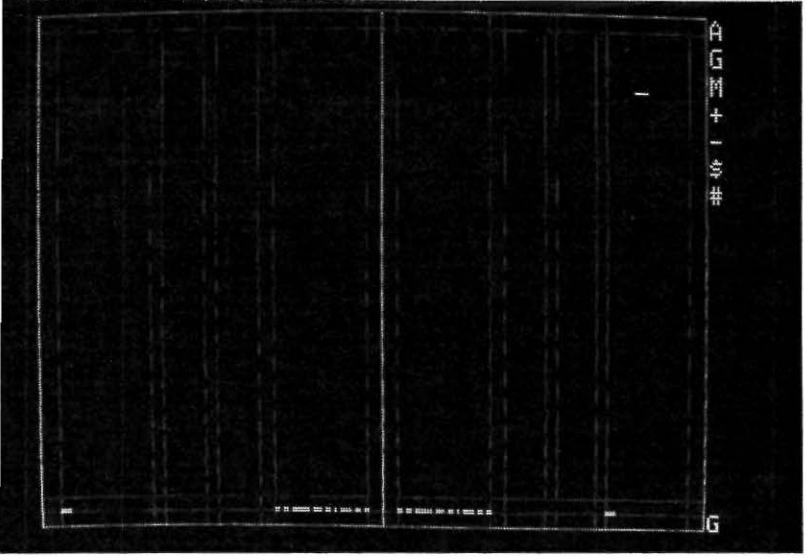


The illustrations which follow demonstrate a sequence of typical interactive page-design activities which are possible with the computerized system. (All photographs are courtesy of Bell Telephone Laboratories and are taken directly from a modified, but conventional, television monitor.)

Figure 1. The designer can check the page grid for basic compositional requirements. The page size has been entered by typing in that information as well as type specifications for the main text. Margins and column placements can be easily changed by altering a few program statements, and are here assumed fixed. It would be relatively simple to make this, too, an interactive option. Normally the grid could be present during most of the page design activity, but for clarity it is not shown in the illustrations which follow.

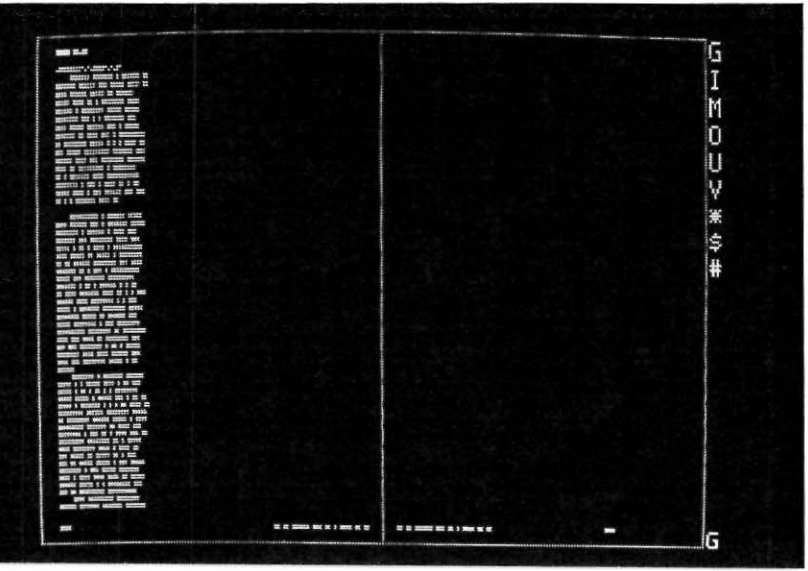
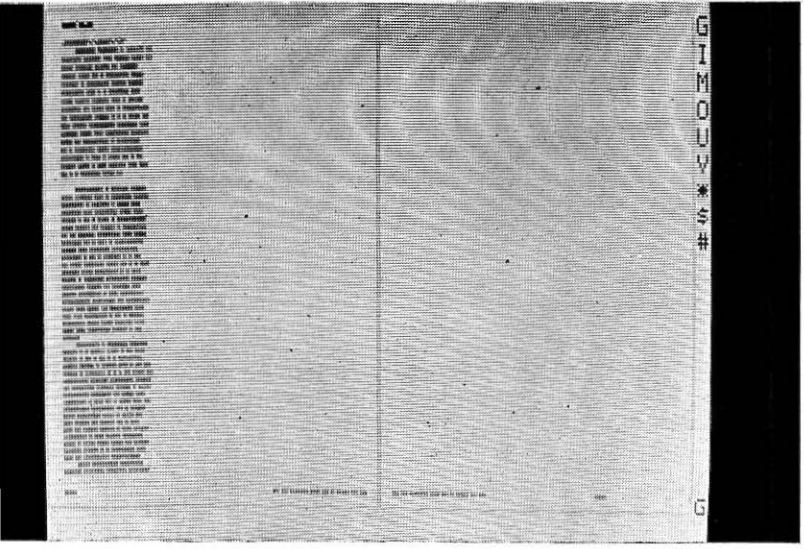


Figure 2. The designer begins placing the next available type, including subheads, adjusting the length of the column as desired. The symbolization shows one line for every line of type that would appear on the final page. The system uses only a dummy text generating sub-routine, because it is not presently connected to an available text-editing program which would determine hyphenation. The dummy text sub-routine allows type specifications to be altered during the design activity, thereby showing that different column widths, paragraph lengths, etc., may be tried for the same text which can appear justified or ragged right. The type symbol shows the x-height in a very simple manner (one, two, or three raster lines), but refinement of the typographic image and thus the "look" of the type is more dependent on the display device than on the program. Roman vs. italic and medium vs. bold weights can be distinguished. As sections of type which are to be keyed to illustrations appear, flashing dots signal their location within the columns. The exact contents of



headlines are typed out on the typewriter for identification and are assumed given, but this arrangement could be easily changed to an interactive option.

Figure 3. The designer can view the display in reverse (black symbols on a white background) at various stages in the design process.

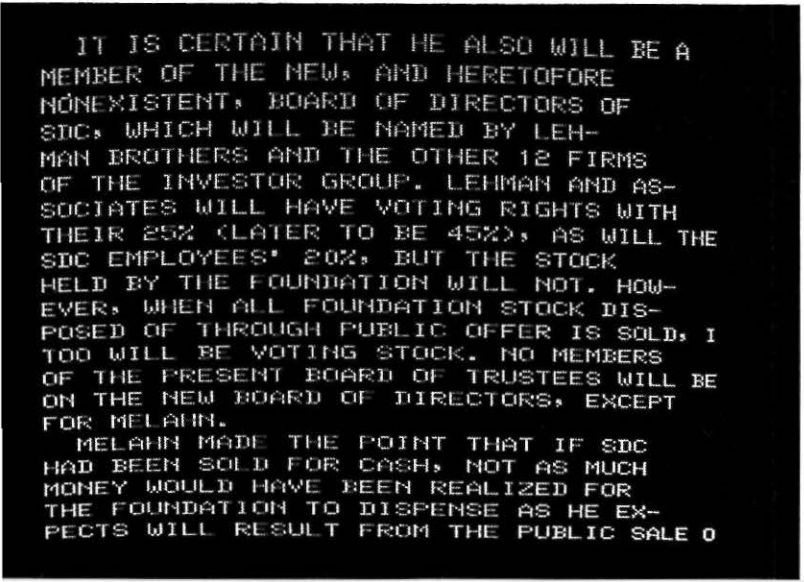


Figure 4. If necessary, the designer may examine the contents of the text on a large character-by-character display, much like a galley proof. In a more sophisticated system using editing programs now available, changes could be made in the text by entering new characters through the typewriter. Eventually such an enlarged display could simulate the spatial placement of the text. For example, by turning a knob the present column would move to the left and the column to the right would come into view, thus giving a magnified version of the low resolution page display.

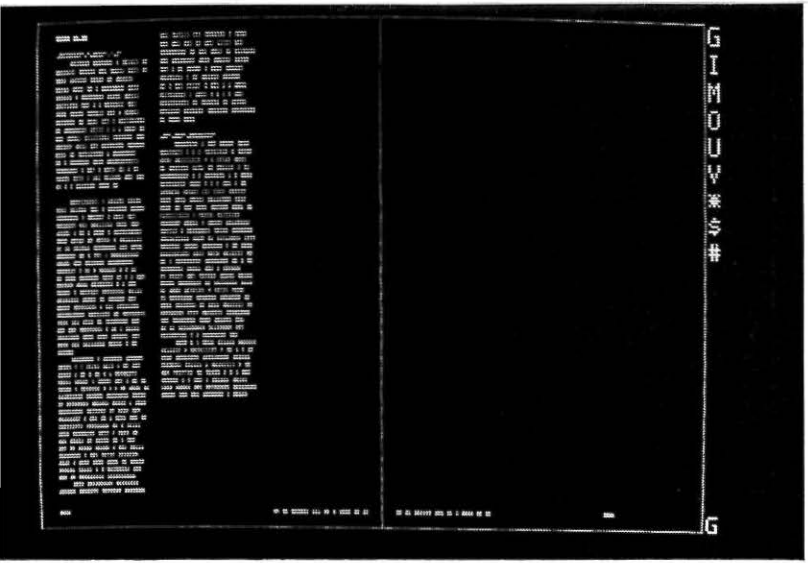


Figure 5. Another type mass is placed. Automatic checks prevent its extending beyond the top and bottom margins or its overlapping material already on the page.

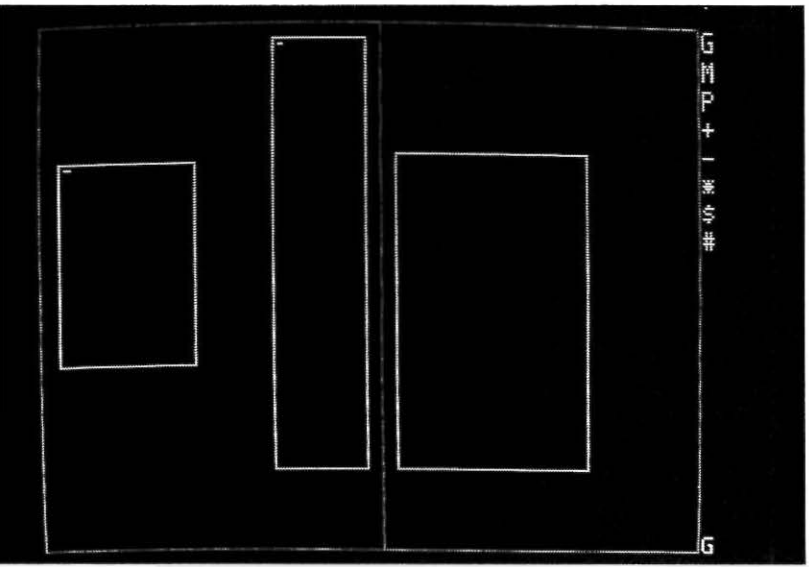


Figure 6. The designer now decides to switch to the viewing board to select an illustration. Here he may add the grid again when determining the sizes and proportions of illustrations symbolized by outlines. Moving a tracking dot to within an illustration's borders, he signals with a push button that this illustration is required. This is only one of many ways in which illustrations might be sized and proportioned; it is meant only as an example. Variations in procedure could be easily programmed.

Figure 7. The viewing board disappears and one of the actual illustrations which has been coded and stored in the memory of the computer is instantly brought to the screen as a "half-tone" image. The present coarse version has only four levels of brightness but indicates that even this low resolution image conveys much information about the "look" of the illustration. It is also possible that the illustration might appear on a higher resolution screen, since it might not have to change in the rapid, interactive way in which the page design changes. In the present system the designer can determine which portions of the illustration are to appear on the page by moving about the image four dots representing the corners of the final illustration.

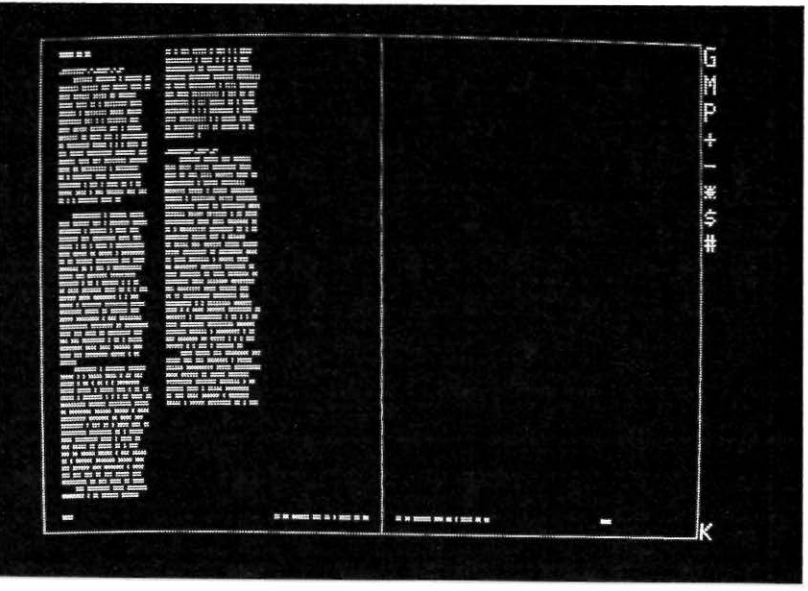


Figure 8. When the desired portion of the illustration has been selected, the four movable dots then appear on the two-page spread and can be positioned. If the illustration is keyed to a particular section of text, flashing dots in the text columns make this apparent to designer.

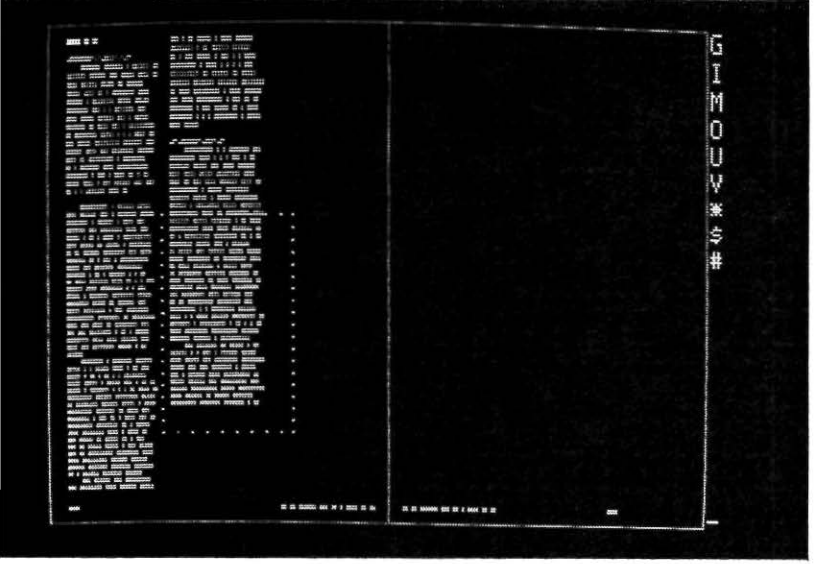


Figure 9. In this example, the designer decides that the last portion of the most recently added text will be in the way of the desired location of the illustration. Therefore, he interrupts his present activity, signals the computer to enter an erasing mode, and indicates the type to be erased by describing a variable outline.

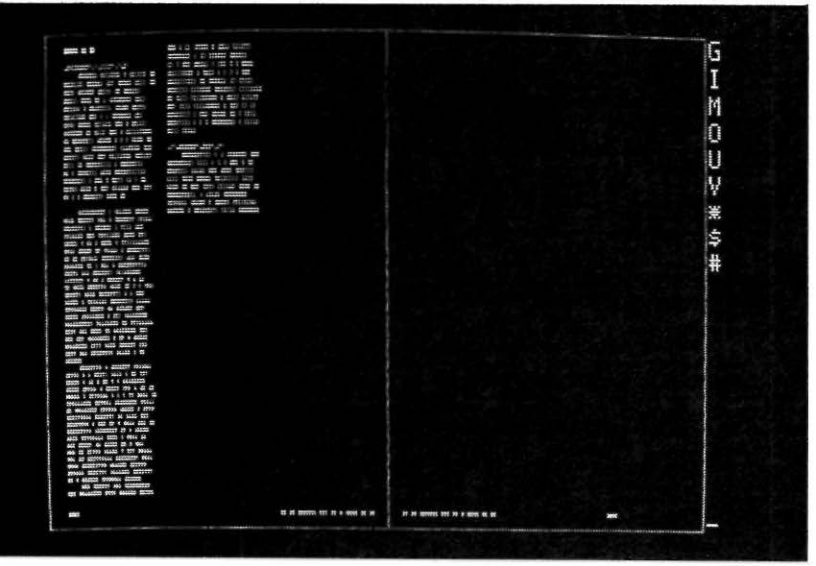


Figure 10. At the push of a button the desired number of lines disappear from the screen and the computer backs up its location in the file of text information. The next time text is added, the same paragraph lengths and headlines will appear (the dummy text sub-routine which simulates the presence of a text-editing program coupled to this system generates new word lengths).

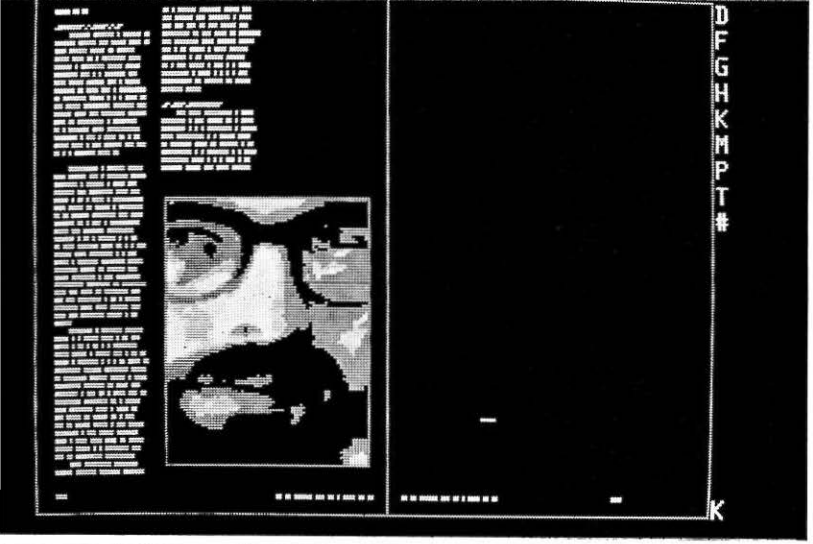


Figure 11. After re-selecting an illustration (the same one or another in the computer's store of illustrations), the four corner positions are fixed, and the illustration appears on the screen. In this particular program it is assumed that the display might be intended for eventual reversed display viewing on a screen; thus it appears as a positive image. A simple programming alteration could prescribe that a negative version of the illustration would appear at this point in the procedure.

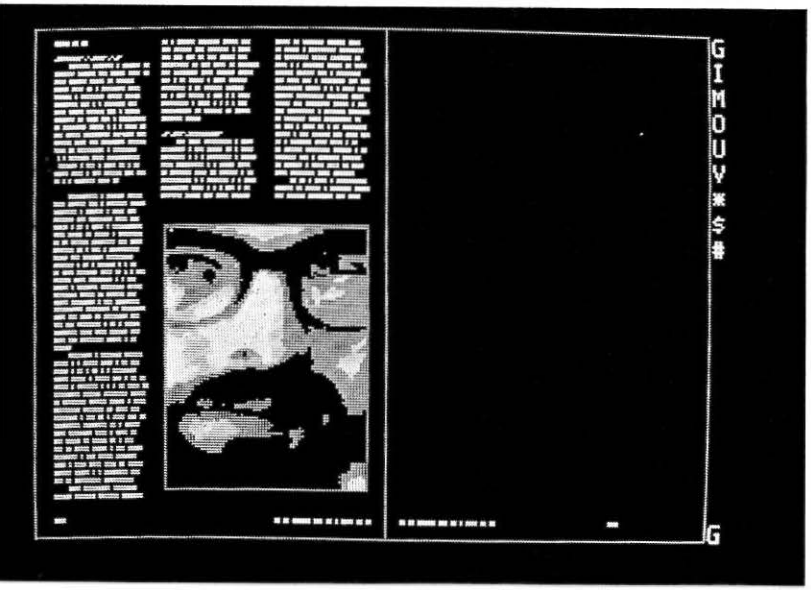


Figure 12. Additional text, beginning with the most recently erased material, is added, and the left page is completed. In the present situation it is assumed that the illustrations are explained directly in the main text. A programming alteration would allow the designer to draw upon two or more sources of text material (e.g., captions and footnotes) and to add these independently to the screen.

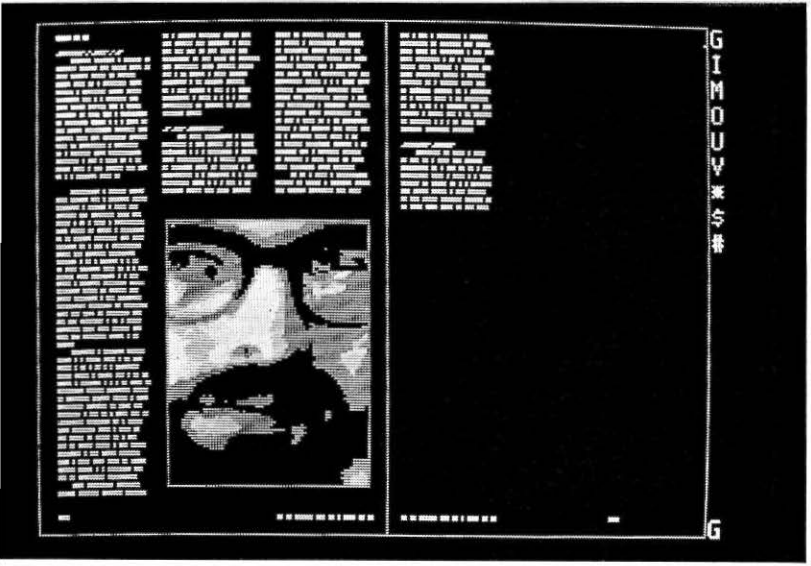


Figure 13. A text mass is begun on the right page, and the designer decides to move this to another location. Any text material, from a single line to a column, and any complete illustration may be moved.

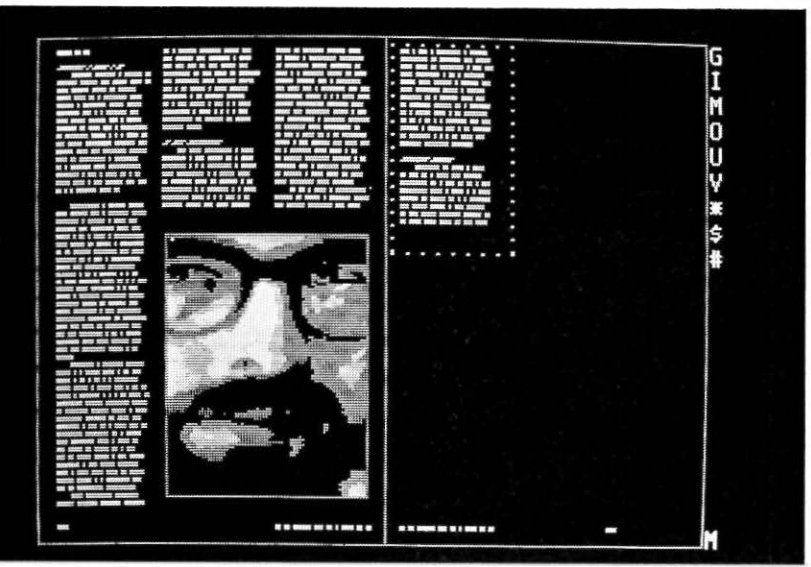


Figure 14. The area to be moved is designated by a variable outline.

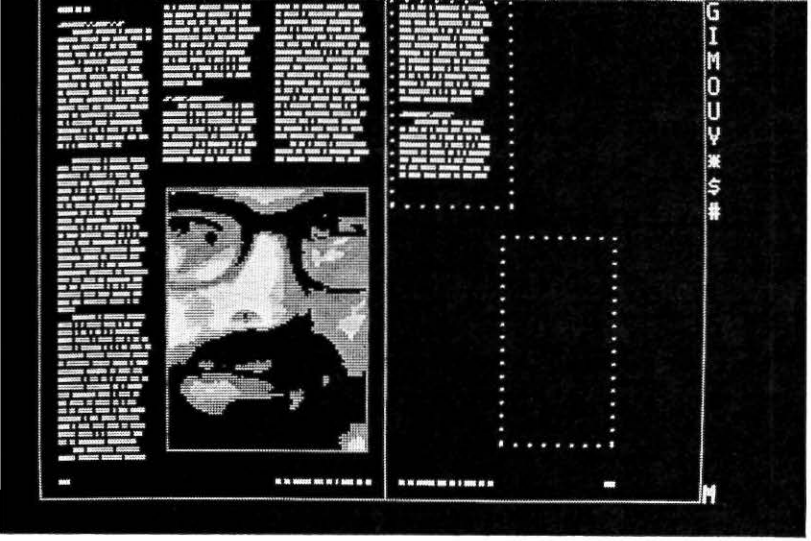


Figure 15. An identical, moveable outline may now be shifted anywhere on the page. Automatic checks prevent graphic elements from being placed on top of other elements. In this program no "bleeding" of illustrations is allowed, but simple program alterations would include this possibility.

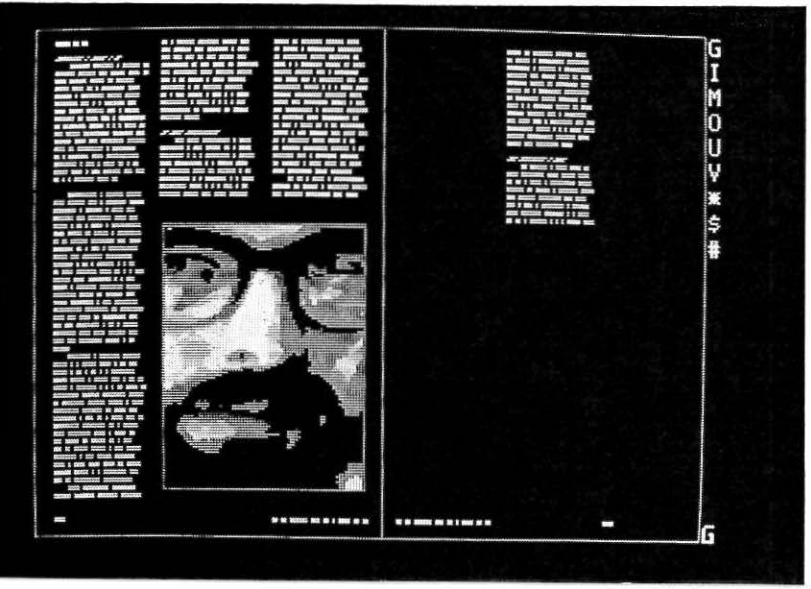


Figure 16. When the new position is decided, the movement option is executed, and the new locations for the characters are recorded.

Figure 17. Other illustrations and text are added, subtracted, or moved about the display until a tentative version is completed.

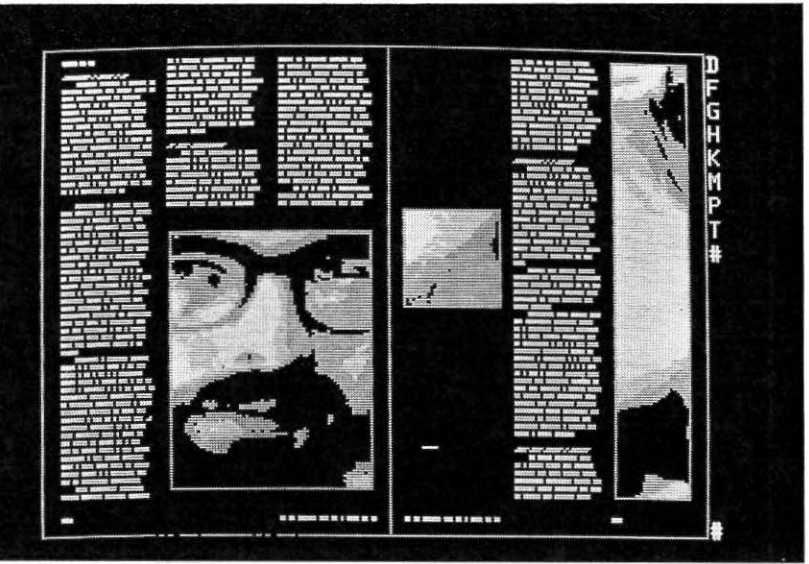


Figure 18. The page composition may be changed continuously until a satisfactory version is achieved.

Figure 19. The designer may again check a black on white version of the display. (In other circumstances the illustrations could appear as positive images.)

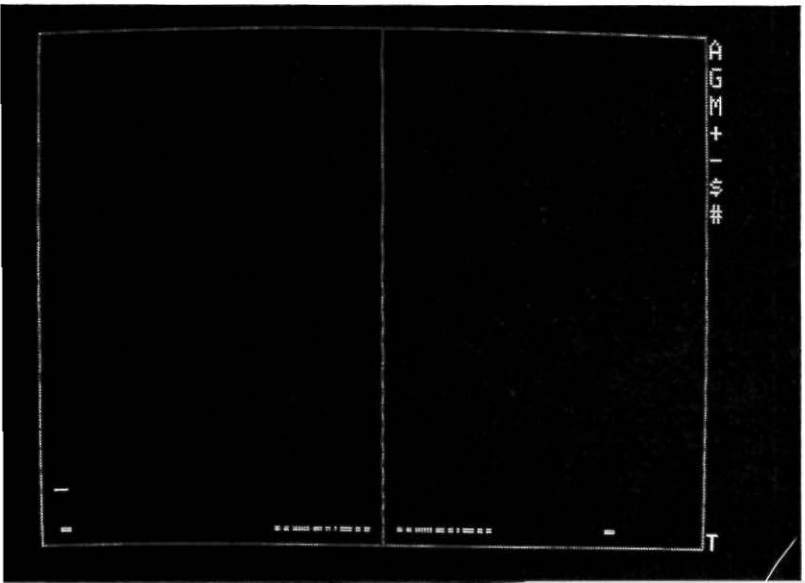


Figure 20. Finally, the designer sends the completed spread to the computer's memory, then calls up a new two-page spread or recalls an old one. The present system does not have the ability to move material directly from one spread to another, but it suggests how in a more sophisticated system, the designer could quickly move from spread to spread, working out a tentative sequence of pages, then returning to make final decisions about text placement, the number and size of illustrations, etc. The present program devised by the author, who is a practicing graphic designer, is intended primarily to indicate possibilities rather than to provide immediately a commercially useful system.

The Letter Names of the Latin Alphabet

Arthur E. Gordon

Contemporary and earlier studies of the Latin language have failed to present and discuss adequately the letter names of the Latin alphabet—in contrast, for example, with the Greek alpha, beta, gamma, etc. Several theories, and their derivation, about the letter names are presented. The ancient evidence—from the third/second century B.C. to the seventh century A.D.—is rather scant and not always clear. While the names of the vowels and of all the consonants except the continuants (F, L, M, N, R, S, X) seem certain, the names of these continuants seem to have undergone changes in the course of history and to be clear only towards the end of antiquity (from the fourth century A.D. on).

It seems strange that beginning Latin books (in English at least), while they have something to say about the *sounds* of Latin, have little or nothing to say about the *names* of the letters of the alphabet—the A B C's, so to speak. Nor in fact do Sturtevant (1920), Kent (1945), Palmer (1954), and Allen (1965) in their valuable books on the pronunciation of Greek and Latin or the sounds of Latin. Nor did my own schooling in Latin ever include any instruction on this—one would think—rather elementary matter, in marked contrast to one's experience in Greek, where we begin at once with alpha, beta, gamma, etc., and it becomes fun to learn the names of all the letters along with the wonderful shapes of the new alphabet.

Nevertheless, at least some of the old standard Latin grammars in English have statements about the letter names: for example, Roby (1881), Gildersleeve & Lodge (1894), Lane (1903), Allen & Greenough (1903), Burton (1911), Postgate (1918), but not—so far as I can discover—Lindsay (1894 and 1915), Harkness (1898), Hale & Buck (1903), Bennett (1895, ed. 3 1918; 1907), or Elmer (1928). The former group, in fact, is in essential agreement about the letter names. Including only the 21 letters of Cicero's, Augustus', and Quintilian's alphabet (to which were later added the letters Y and Z),

the agreed names are as follows: ah, bay, kay, day, eh, ef, gay, hah, ee, kah, el, em, en, o, pay, koo, air (or er), es, tay, oo, and ex (or ix). Besides noting that the sound indicated by -ay is only approximate, "the true sound" being "that of the French e in fête", Lane (1898) is alone in adding that the above names "are those employed by Roman grammarians," although he doesn't specify which ones and he gives no references or bibliography.

Nor did Buck, when he came to write his own Comparative Grammar of Greek and Latin (1933), give any supporting evidence or references for his three paragraphs on "the Roman names of the letters", which nevertheless are worth quoting in full (p. 76):

The Greek names as a whole were not retained in Italy. They were replaced, perhaps first among the Etruscans, by monosyllabic names representing the simple sound of the letters in the case of the vowels, or, for the consonants, the sound supported by a vowel, usually *e*, following the stops, preceding the others.

For the vowels this was merely an extension of what was also the Greek practice in the names of ε, ο, and υ. The Greek name πεῖ gave the *pe*, and this, supported by the first syllable of βῆτα and δέλτα, was followed by *be*, *ce*, *de*, *te*, and the late *ge*; while *ka* accords with the first syllable of κάππα and the prevailing use of *k* before *a*; and *qu* both with the normal Etruscan and the prevailing use of *q* before *u*.

The letters for the continuous sounds—that is the nasals, liquids, and fricatives—were perhaps at first, like the vowels, named by their sounds, that is with syllabic *m*, *n*, *l*, etc., which appear to have been frequent in Etruscan. But the attested Latin names are with a preceding supporting *e*, as *em*, *en*, *el*, *er*, *ef*, *es*. The name of the *x*, namely *ix*, shows inversion of the Greek name in its late form ξῖ, probably due to the fact that no Latin word begins with *x*. The *h* was often called "aspirationis nota" (because of the Greek ῾), but the name *ha* is attested. [He then speaks of Y and Z.]

His table of Latin names gives the following: a, be, ce, de, e, ef, ge, ha, i, ka, el, em, en, o, pe, qu, er, es, te, u, ix, plus y (no pronunciation indicated) and zeta.

I repeat: Buck gives no supporting evidence for this statement, although he implies having used some testimony, and Lane mentions "Roman grammarians" without further details in his very brief statement on the letter names. What then is the evidence?—apart from what might be deduced from the generally monosyllabic unanimity in the letter names of English and the other Western

European alphabets. Even Buck leaves it doubtful whether he accepted or rejected some of the ancient evidence. No publication—at least since 1882—contains a concise statement of the history of the letter names together with all the supporting evidence and the modern literature on the subject; hence this paper.

The evidence is by no means simple or straightforward in character which is probably the reason why no publication does justice to the complexity of the evidence, at least of some of it. (Manu Leumann, for example, in his 1963 *Lateinische Laut- und Formenlehre* [in the big *Handbuch der Altertumswissenschaft* series] simply refers to two modern writers without even summarizing their studies or discussing the matter.) The evidence I have found ranges from Plautus (3d/2d c. B.C.) to Isidore of Seville (7th c.) and perhaps even beyond, and thus spans a period of 800 years or more. With the exception of a little evidence from Plautus, Lucilius (2d c. B.C.), and Varro (d. 28 or 27 B.C.) (Lucilius and Varro at second-hand), all the evidence dates from the time of the Empire or later, and comes mostly from Roman grammarians (one writing in verse, which I sometimes don't fully understand) but also from Quintilian (quoting Lucilius), the anonymous *Carmina Priapea*, the poet Ausonius (the "Moselle" poet), the encyclopaedist Isidore, and a scrap of papyrus from Egypt.

In summary, it seems to me that until we get to Varro we can be sure of nothing about the names of the Latin consonants, and even the testimony about Varro is not perfectly satisfactory. In the light of Plautus' ā and Lucilius' ā and ē, and of Terentianus Maurus' and Pompeius' long vowel-names, we can hardly doubt that from the beginning each of the five vowels had a monosyllabic name consisting of the "long" sound of the vowel itself, ā ē ī ō ū. But whether before Varro the name of each consonant consisted of the mere sound of the consonant followed by a short neutral or obscure vowel-sound, schwa (as in Sanskrit), which might be held long in verse if the meter demanded it (as perhaps in Lucilius for the names of C and D, and possibly L), or by some other vowel-sound, most likely a long E, it seems impossible to decide from the evidence available. Any relation between the earliest Latin names and the Etruscan names remains entirely hypothetical, therefore dubious, though it must be admitted that, if the Etruscans gave the Romans the symbols of the Greek alphabet, or at least as many of them as the Romans needed, they

must have given them also some sort of nomenclature for the symbols, whether the original Greek names (which in that case the Romans, in due course, reshaped) or the Etruscan (which were presumably based on the Greek). But we simply do not know what the Etruscan names were, though both Hammarström (1920) and Einarson (1967) construct Etruscan nomenclatures from the Greek and what they know or conjecture of the Latin.

For this reason, it seems to me, Sommer's (1914) surmise and Hammarström's theory that the Latin names were borrowed from the Etruscans—rather than being (as Schulze [1904] had thought) an essentially independent, Roman, creation based on the Greek model —makes no advance for us. As Hammarström himself admitted, "the method of phoneticizing the names of the semi-vowels" (i.e., giving them sonant/syllabic names—f̩, l̩, m̩, etc.), which he concluded the Romans had borrowed from the Etruscans, was "senseless from the point of view of the Latin language and Latin orthography." The semivowels were the key letters for Hammarström; he had accepted Schulze's theory that until after Donatus (4th cent. A.D.) the Romans had only "phoneticized" the names of the semivowels (*lautieren* as opposed to *buchstabieren*), and he then found in the later Etruscan consonant-clusters—which always, with few exceptions, contained one of the semivowels L, M, N, R—evidence that these semivowels were already "syllable-forming" in Etruscan, and therefore concluded that the Romans borrowed from the Etruscans the names not only of the semivowels but of the whole alphabet except B, D, O, and X.

Even though quoted by a late, and now anonymous, writer and rejected by Schulze, we should accept as authentic the evidence about Varro, that he "says that the [names of the] semivowels should begin with E and [the names of the] mutes end in E," with as much confidence as we accept the same writer's several other quotations from Varro as well as his very numerous quotations from other Roman writers, which a glance at Keil's apparatus criticus (Vol. 4, 1864) shows substantially confirmed by their own independent manuscript tradition; Marx's (1905) answer to Schulze's rejection seems fully justified. But questions remain: What does the Varro evidence mean? What is its value? *Debere esse* is the crux. Is Varro trying to *reform* the names of the semivowels and mutes? Or is he merely being

didactic—laying down the law, so to speak? From a reading of his *De lingua Latina*, which contains very many examples of *debere*, *oportere*, and the passive periphrastic (along with many milder forms of expression, such as *puto*, *arbitror*, *opinor*, *credo*), especially in Books VIII–IX after he has left his etymologies behind, I conclude that *debere* and the like are common expressions of Varro's and that in our disputed passage *debere* is perfectly in character but, in the lack of a larger context, is neutral in its implication as to whether Varro is trying to *correct* current practice or is only *confirming* it. It is not impossible that there was some leeway or variation in the names of some of the letters—semivowels? mutes?—just as there is still in English with respect to the name of Z, both "zee" and "zed" being still in use (formerly also "izerd" or "izzard"). I conclude that for Varro the names of the semivowels and mutes are as indicated by the anonymous grammarian; that presumably this nomenclature represents what may be called standard usage, but that *perhaps* there was some variation in the names of some letters, most likely the semivowels, less likely the mutes. In view of Varro's great authority, it is possible also that his nomenclature was influential for the future. In any event, the slight, roughly datable evidence that we have between him and Terentianus Maurus (2nd cent. A.D.)—in the *Carmina Priapea* (about A.D. 14–138?)—confirms the long-syllable character of the names of C, D, and P.

Given the inadequacy of the earlier evidence, the reason for what seems to be the great change—if it was a change—indicated by Terentianus Maurus can only be conjectured. One wishes that Terentianus—having said so much, so clearly, about his inability to put the names of the semivowels into verse because (as we would put it) their names did not constitute syllables in the Graeco-Roman sense—had said more, had spoken of the history of the subject, of Varro's system, and of the origins of the new system—of which he certainly gives no hint of being himself the founder. Donatus and the other fourth-century writers until we get to Servius simply number, list, and describe the vowels, semivowels, and mutes, but do not give them names. Servius marks a return to Varro's names for the semivowels; from then on, with the exception of Ausonius (A.D. 390) (who omits them from his list of Latin letter-names, but—unlike Terentianus—gives no explanation), whenever a writer gives names

to the consonants he follows Varro's nomenclature (except for the addition, in the Antinoë papyrus [4th/5th c.], of a second syllable to the names of the semivowels, presumably for the use of Greek speakers learning Latin in Egypt). And this Varronian nomenclature, completed by the "long" names of the five vowels and supported by the authority of Servius, Priscian (early 6th c.), and to some extent Isidore, plus a number of lesser-known or now unknown writers, is what was handed on to Middle-Age and modern Europe.

In imitation, and attempted improvement, of Buck's statement of the truth about the letter names of the Latin alphabet, I would summarize my findings as follows. The Greek names were not retained in Italy. They were replaced—perhaps first among the Etruscans—by metrically long, monosyllabic, names representing the simple sound of the letters in the case of the vowels (ā, ē, ī, ō, ū) or, for the consonants, the sound supported by a vowel, usually ē, following the stops and H (ā after H and K, ū after Q), but (eventually, at least) preceding the others. The letters for the continuous sounds, or semivowels (F, L, M, N, R, S, X—the nasals, liquids, and fricatives) were *perhaps* at first, like the vowels, named by their sounds, that is with syllabic *f*, *l*, *m*, etc., of which especially *l*, *m*, *n*, *r* appear frequently in later Etruscan writing. The evidence for syllabic L, R, and S appears in Lucilius, for syllabic M perhaps already in Plautus. But the names attested by Varro and again by the Vergil commentator Servius and from then on into the Middle Ages are with a preceding supporting E, as *ef*, *el*, *em*, *en*, *er*, *es*, *ex* (later *ix*). Yet between Varro and Servius the evidence presented by Terentianus Maurus is unmistakably of syllabic *f*, *l*, *m*, etc., while Ausonius by failing to mention the semivowels seems to concur in this nomenclature.

The weakness of this statement lies in the character of the Republican evidence—Plautus, Lucilius, Varro—for the semivowels: Plautus' one word *amo*, Lucilius' few lines (quoted at second-hand; needing emendation; and commented on—the lines for R and S—by the one who quotes them, though with some lack of clarity), and Varro's one sentence (again at second-hand and out of context). Furthermore, if the statement is essentially true, the pattern it presents—*a b a b*—is, so far as I know, anomalous and unique; no Roman writer from beginning to end seems to note the fluctuation.

Perhaps, therefore, I lack some of the facts or have not interpreted them correctly.

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Professor Gordon's article is based on a paper read to the meeting of the Archaeological Institute of America in New York City, December, 1970. The complete monograph has been submitted for publication in the *University of California Publications: Classical Studies.*

Steps toward Handwriting Analysis and Recognition

Makoto Yasuhara

In order to introduce to the field of human handwriting recognition formal concepts which correspond to those of the analysis by synthesis method in speech analysis, a dynamic model of handwriting process is proposed. Discussion to support the proposed scheme is presented both from the theoretical and from the experimental points of view.

1. *Introduction*

Undoubtedly, writing and speech play the most important roles in human communications. These two forms of verbal behavior have appreciable similarities as well as differences. Although their physical appearances are different—and although different sets of muscles are used in the execution or articulation of the appropriate gestures, the problems they present in the higher levels of language processing seem to be the same. That is, at some level of the language processing in the brain, both must relate to the same grammatical structures of the language in question. Thus, processes corresponding to the production or perception of handwriting and to those of speech may be in a one-to-one relation at that level. So, many of the problems concerning speech processing would probably be related closely to the corresponding problems concerning visual language processing.

In this paper, an active method for handwriting analysis and recognition is proposed, which corresponds to the so-called analysis by synthesis method (henceforce abbreviated to A-b-S) in speech research.

K. N. Stevens (1960) first proposed A-b-S method as a guiding principle of his speech analysis and recognition. This is one of the typical and practical techniques that execute the idea of active analysis. The first attempt to apply A-b-S scheme to handwriting and pattern recognition was made by M. Eden (1962) at MIT. He

considered two alternative models of the description of cursive script. One was based on a set of defined primitive stroke segments analogous to the distinctive feature in speech analysis; the other was based on a sinusoidal model of practiced writing. However, neither of these models can be considered to simulate the actual human handwriting.

2. *Synthetic Model of Handwriting*

2.1 Van der Gon's Model

Cursive handwriting may be considered as a highly skilled process which is executed by means of a rapid sequence of motion. As early as 1917 Lashley studied such processes, including the principle of position feedback. Although this principle doubtlessly works in guiding some human movements to a certain extent, it is well-known that it does not apply to quick and well-practiced movements. Thus Lashley (1961) concluded that in these cases, an effector mechanism can be primed to discharge at a given intensity or for a given duration, independent of any sensory control. According to the above background, Denier van der Gon postulated the following assumptions:

(1) The effects of position feedback can be neglected for cursive handwriting.

(2) The timing of muscle contraction determines the shape of the pattern to be generated; the magnitude of the applied muscular force does not play an important role.

Van der Gon proposed a simple model of the human handwriting process, in which the hand-pen couple was assumed as a mass point that moved according to the following simple equations,

$$\left.\begin{aligned} \ddot{x} + R_x\dot{x} &= F_x(t) \\ \ddot{y} + R_y\dot{y} &= F_y(t) \end{aligned}\right\} \quad (1)$$

where R_x and R_y represent time invariant model parameters. The handwriting patterns are considered as the resultant loci of the movement of a equivalent mass point.

2.2 Refined Model of Handwriting

In order to have more refined and generalized discussions on the dynamics of human handwriting movement, consider the process

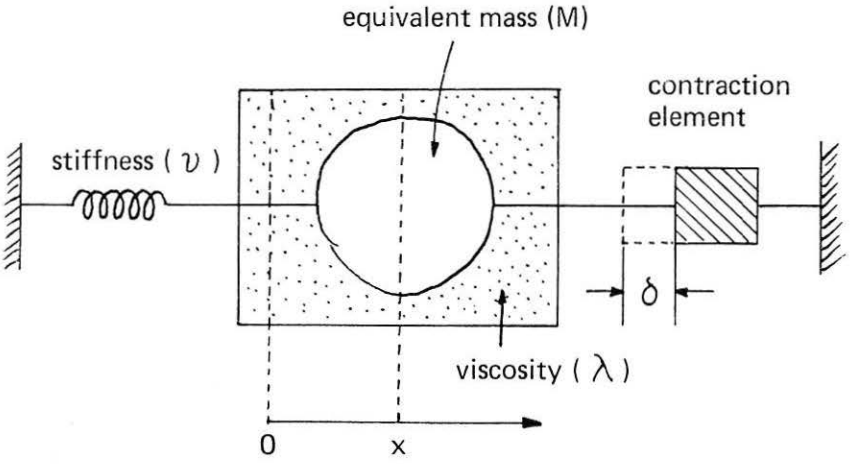


Figure 1. Schematic illustration of the dynamic model of the human handwriting process.

schematized in Figure 1, in which the effects of stiffness, internal friction of muscle, and friction force between the surface of paper and a pencil point are taken into account. The motion of a mass point, when the muscle contracts by δ, is expressed by the following dynamic equations,

$$\left.\begin{aligned} \ddot{x} + r_x\dot{x} + n_x x &= h_x\delta_x = F_x(t) \\ \ddot{y} + r_y\dot{y} + n_y y &= h_y\delta_y = F_y(t) \end{aligned}\right\} \quad (2)$$

where,

$$\left.\begin{aligned} F_x(t) &= f_x(t)/M, F_y(t) = f_y(t)/M \\ r_x &= 1_x + m_x p(t)/v \\ r_y &= 1_y + m_y p(t)/v \end{aligned}\right\} \quad (3)$$

$1_x = \lambda_x/M,\ 1_y = \lambda_y/M$	viscosity coeff. of muscle
$m_x = \mu_x/M,\ m_y = \mu_y/M$	friction coeff.
$n_x = \gamma_x/M,\ n_y = \gamma_y/M$	stiffness coeff. of muscle
$v = (\dot{x}^2 + \dot{y}^2)^{1/2}$	writing speed
$p(t)$	writing pressure
M	equivalent mass

If the writing pressure $p(t)$ and the writing speed v are time-invariant, eqs. (3) become

$$\left.\begin{aligned} r_x &= 1_x + m_x P/V = R_x \\ r_y &= 1_y + m_y P/V = R_y \end{aligned}\right\} \quad (4)$$

Consequently, the normalized effective viscosities R_x, R_y are proved to be time-invariant. And further, by neglecting the stiffness term of the muscle which is actually considered to be of less importance compared with the effective viscosity term, eqs. (2) become

$$\ddot{x} + R_x\dot{x} = F_x(t)$$
$$\ddot{y} + R_y\dot{y} = F_y(t)$$

These are exactly identical to the model proposed by Van der Gon. It is clear, therefore, that the tacit assumptions have been introduced in Van der Gon's model, that the speed and pressure of a pencil point during handwriting movements are time-independent and the stiffness term of muscle is small enough to be neglected compared with the effective viscosity term.

Although our understanding of the physiology of the actual human handwriting process is not complete, we can understand some of operations required in human handwriting process, and a limited model of handwriting can be simulated—as demonstrated in the Appendix.

3. *Handwriting Analysis and Recognition*

In this section, the formal concepts of the active analysis of handwriting—analyzer-synthesizer model—are introduced to the field of human handwriting analysis and recognition with reference to the actual human handwriting process.

3.1 General Description of Handwriting Analyzer

The block diagram shown in Figure 2 illustrates the basic structure involved in the handwriting analyzer to be described. The first stage of the analyzer accepts the handwritten specimen to be analyzed as its input and provides the physiological descriptions (or equivalents) that are necessary to generate the input handwritten specimen. At the next stage, a description in terms of strokes is derived, into which

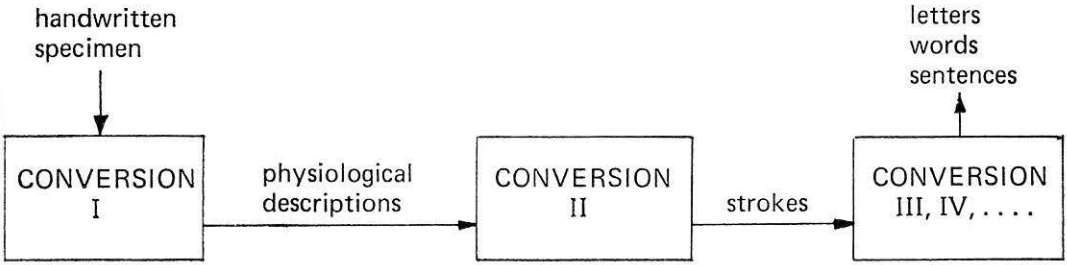


Figure 2. Block diagram illustrating several stages of analysis in the handwriting analyzer.

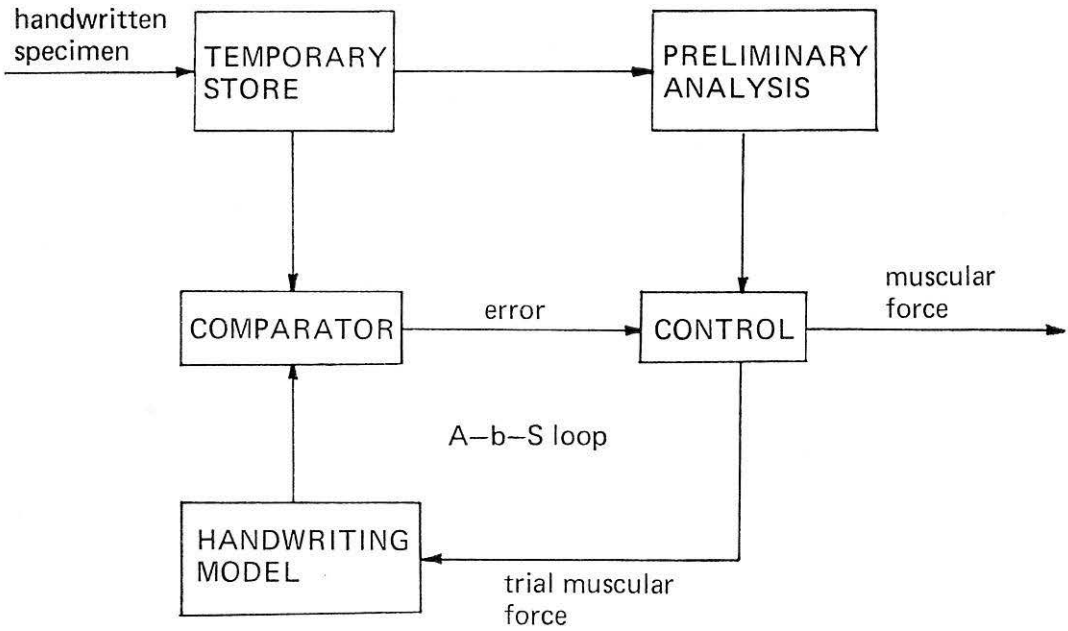


Figure 3. Block diagram of an analysis-by-synthesis procedure for extracting muscular force signals from an input handwritten specimen.

handwritten specimens are segmented (Appendix), and in the higher stages the sequence of strokes is converted into letters, words and sentences. In this paper, we shall engage principally in the conversion of handwritten specimen into a sequence of strokes. We shall note here that the method of analysis at each stage can be described as "active" rather than "passive"; that is, the analysis is performed by synthesis according to stored rules and by comparison of the synthesized signals with the input signals to be analyzed.

3.2 Conversion to Physiological Descriptions

Before describing the details of Conversion I in Figure 2, there must be some comments on the signal representation at the output of this stage.

We consider two levels, called roughly "muscular" and "neurophysiological." The representations at the muscular level are in terms of the actual muscular forces applied to hand-pen couple to generate a sequence of strokes. We expressed these as $F_x(t)$, $F_y(t)$ in the previous section. When discussing effects of a writing pressure, we must add the muscular force $F_z(t)$ to cause a pen-point pressure $p(t)$. The second and perhaps more fundamental representation, termed neurophysiological, should specify in some sense the neural control signals that must be transmitted to the motor unit of muscles to cause them to generate the prescribed force.

In order to simplify the discussion, we shall refer to the representations at this stage simply as "physiological descriptions."

The detailed structure of the first stage "Conversion I" in Figure 2 is shown in Figure 3. It is the block diagram of analysis-by-synthesis procedure for extracting muscular force signals from a handwritten specimen. The input specimen, which may be placed in temporary storage, is compared in the comparator with signals synthesized by the model. Instructions as to the muscular forces to be tried are transferred to the model by the control component, which bases its decisions on the results of a preliminary analysis of the input specimen and on the output of the comparator for previous trials. When the best match is obtained in the comparator, the control component reads out the muscular force which, through the model, produced that match.

As mentioned above, the function of the model is to synthesize

handwriting specimens from the physiological descriptions. The model must, furthermore, be able to simulate the handwriting by not just one but by a number of writers. Thus part of physiological descriptions must include the characteristics that are unique to a particular writer and that are relatively invariant in the particular handwriting material.

To program completely a machine to perform all these functions is clearly beyond our capabilities at present. But the model proposed in the previous section has been confirmed to be effective as shown by experimental studies (Appendix).

3.3 Conversion to a Sequence of Strokes

Since the active analysis procedure seems to have certain attractive features when applied to extracting the so-called physiological description, it is reasonable to examine whether the same general approach can be applied to a higher analysis stage in the analyzer; that is, the conversion of physiological descriptions to representations in terms of a sequence of discrete symbols—strokes.

Figure 4 shows the internal operations that would be involved in the analysis stage labeled "Conversion II" in Figure 2, if the method shown in Figure 3 were extended to this level of analysis. The "model" stores various rules that relate a sequence of strokes to physiological descriptions. The box labeled "control" determines the order in which different sequences of strokes are selected and converted to physiological descriptions for comparison with input data. The output is the sequence of strokes that produces a minimum error at the comparator.

Once the handwriting specimen has been decoded into a sequence of strokes, these strokes must be converted to letters and grouped into words and sentences in the later stages. We shall not be concerned here with this transformation into letters, words, and sentences.

3.4 Two-stage Scheme for Handwriting Analysis

The components discussed in Figures 3 and 4 are shown connected together in Figure 5. To begin with, assume that we have a sequence of strokes. If the output of the handwriting synthesizer is restricted to a particular writer's handwriting, the rules stored in the box labeled "Model II" would provide the conversion from stroke

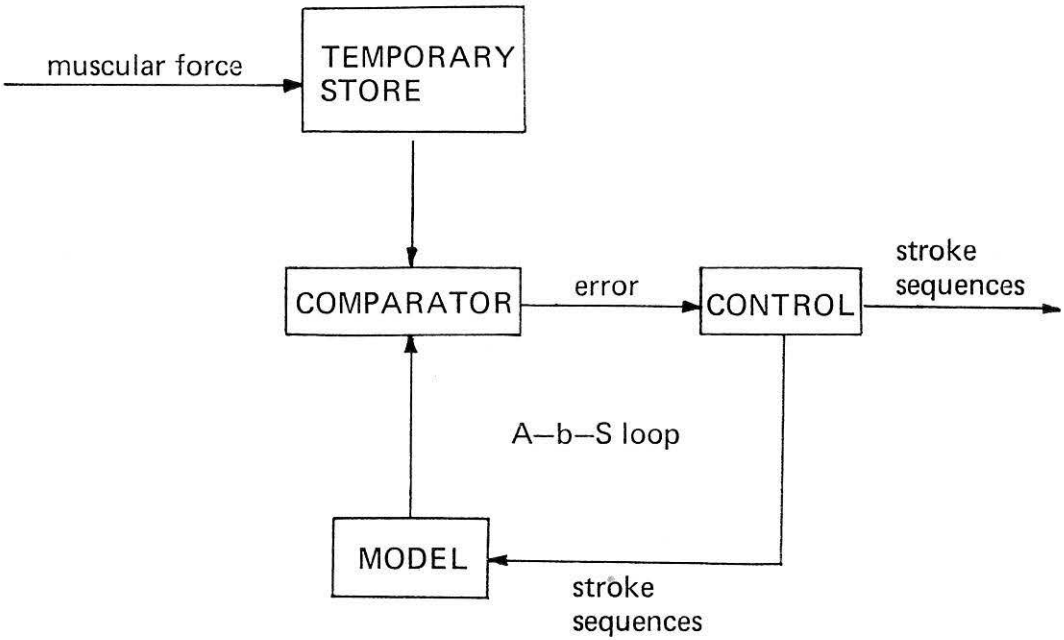


Figure 4. Block diagram of an analysis-by-synthesis procedure for extracting a stroke sequence from an input muscular force.

sequence to a muscular force description for that writer. Thus conversion to the muscular force description is accomplished by the Model II of Figure 5. This model is used both for analysis and for synthesis. If the handwriting output of the synthesizer is connected to the input of the analyzer, the over-all A-b-S loop may be completed. Such a feedback loop would permit comparison of derived muscular forces with those actually used. Thus adjustment of computations in Model II could minimize the difference between these two measures.

Figure 5 may be viewed as a proposed model of a complete analyzer-synthesizer model for human handwriting analysis and recognition.

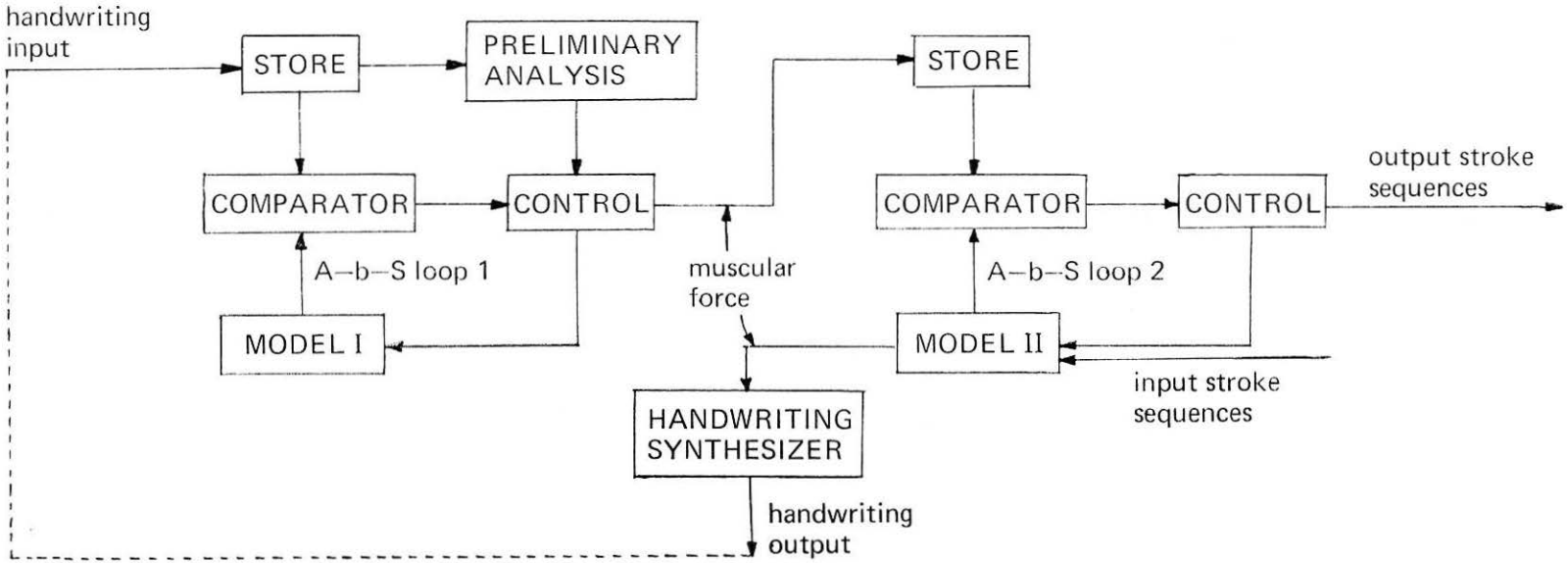


Figure 5. Block diagram of a two-stage scheme for handwriting analysis—overall system block diagram of the proposed handwriting analyzer.

Concluding Remarks

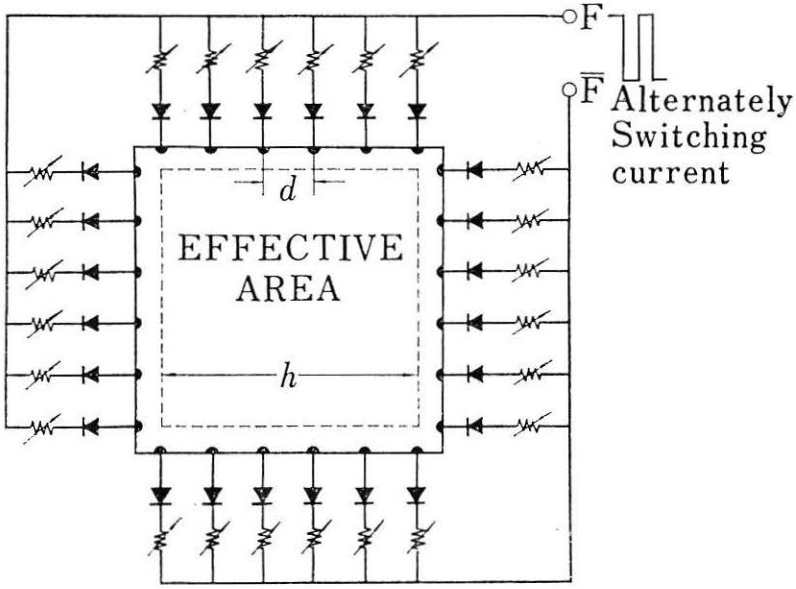
We have proposed herein an approach to the design of certain portions of a machine for the analysis and recognition of handwriting. The main features of the proposed system are the following:

(1) Between the handwritten specimen and the stroke output, we have two stages of conversion. The descriptions at the output of the first stage have been termed "physiological descriptions" which may take one of two forms termed "muscular" and "neurophysiological."

(2) At each stage of conversion, the analysis is performed by the active synthesis of signals which are compared with the input patterns that are under analysis.

(3) The analyzer-synthesizer system (Figure 5) has certain properties in common with the actual human handwriting process.

Figure 6. The principle of an X-Y position transducer.



APPENDIX

1. Handwriting Analyzer

We must, first of all, measure the displacement, velocity, acceleration of handwriting movements, and the writing pressure of the pencil point using a device for transforming X–Y coordinates and a pressure of a pencil point into electrical signals as functions of time. The handwriting analyzer generates such signals, and these signals can be connected to X, Y, and Z axes of a cathode ray tube display as well as to an input channel of a computer.

The principle for picking up this information with the stylus is illustrated in Figure 6. The writing plate consists of a square of uniform resistive material fed with equal magnitude current. The contacts are identically shaped and equally spaced along the four edges. A uniform horizontal and vertical current flow is established alternately by switching the operational mode of the respective contact sets. Because the contact separation (d) is small compared with the writing plate width (h), there will be a uniform potential gradient between mutually faced contact sets, except for local deformations in the vicinity of the edges. Thus, the time variant analogue samples of X–Y coordinates are generated by placing or moving the stylus over the resistive surface. A durable, highly transparent stannic oxide (SnO_2) coating on a carefully polished plate of glass shows no physical or chemical deterioration after several months of use. The stylus used is a soft lead pencil which can move freely over the coating. The writing plate is held up at the four corners by pressure sensitive gauges—strain gauges of non-contact type—and the signals from them are correlated. The multiplexer and analogue to the digital converter convert simultaneously three channels of analogue signals, corresponding to X–Y coordinates of the stylus and the writing pressure Z, respectively, into eleven bits of digital samples at a sampling rate of 400Hz.

Figure 7 shows the system block diagram. Figure 8 shows the electrical potential distribution generated over the resistive surface. Figure 9 shows an example transferred to the computer, intending to represent the Japanese letter "ru." The intensity of the pencil-point pressure is also shown in the figure by the printed numerics. Figure 10 represents some examples of the measured writing pressure wave forms.

In an effort to gain some knowledge of muscular force during writing movements, some electromyographic (EMG) records of muscle activities in the forearm are also taken. The equipment used can record two channels of EMG's simultaneously. A pair of surface electrodes is placed on the dorsal part of the forearm, that is, directly over the muscle, flexor

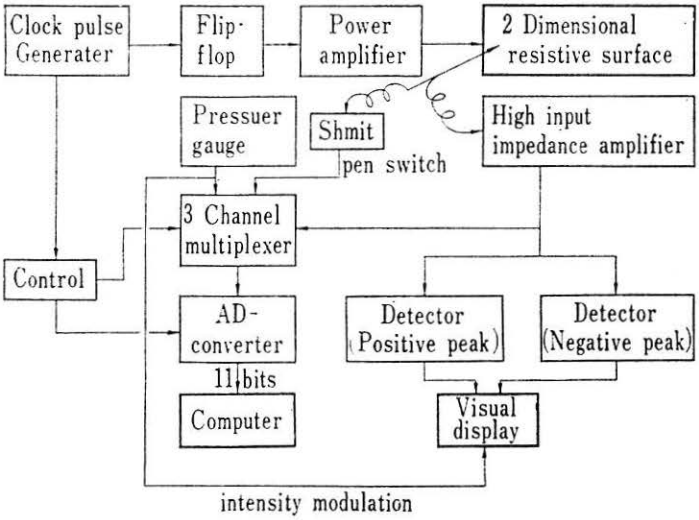
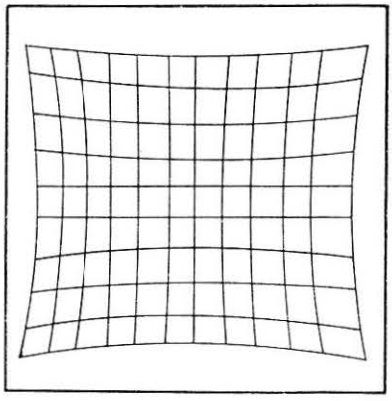


Figure 7. The system block diagram of handwriting analyzer.



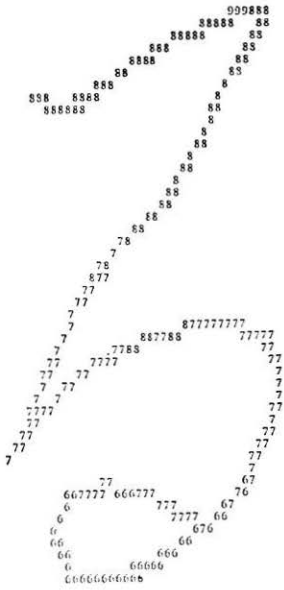


Figure 8. The electrical potential distribution generated over the resistive surface (120 mm × 120 mm). The central part is selected to use.

Figure 9. Japanese letter "ru" which is transferred to the computer, representing the writing pressure by the printed numerics.

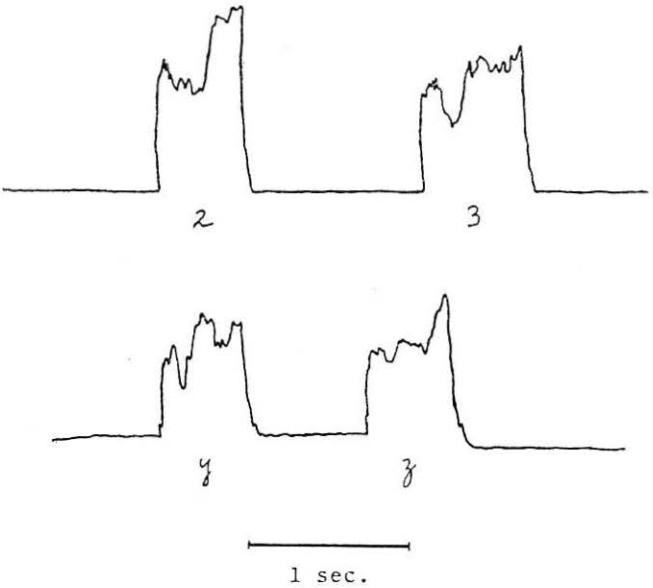


Figure 10. Some examples of characters and their measured waveforms of writing pressure.

carpi unlaris (EMG 1); the other is placed over the muscle, extensor carpi ulnaris (EMG 2). Figure 11 shows one of the records of the observed left-right displacement $x(t)$ and pressure waveform $P(t)$ of a pencil point together with two channels of the corresponding EMG's for subject Y (a 29-year-old male).

Case A. First of all, in order to estimate the optimum value of parameter R_x appearing in the Van der Gon's model eqs. (1), we define the approximation error $\epsilon_A(R_x)$ as follows,

$$\epsilon_A(R_x) = 1/T \int_T \{F_x{}^A(t, R_x) - M_x(t)\}^2 \, dt \qquad \text{(I-1)}$$

where,

$$F_x{}^A(t, R_x) = \ddot{x} + R_x \dot{x}$$

and $M_x(t)$ is derived from the corresponding EMG's. By minimizing ϵ_A with respect to R_x, we can estimate the optimum value R_x^* which is considered to be the intended parameter value. Thus $R_x^* = 18\ [T^{-1}]$, $\epsilon_A^* = 2.5 \times 10^{-2}$ were obtained for the data shown in Figure 11.

Figure 11. Simple repetitive right-left wrist motion.

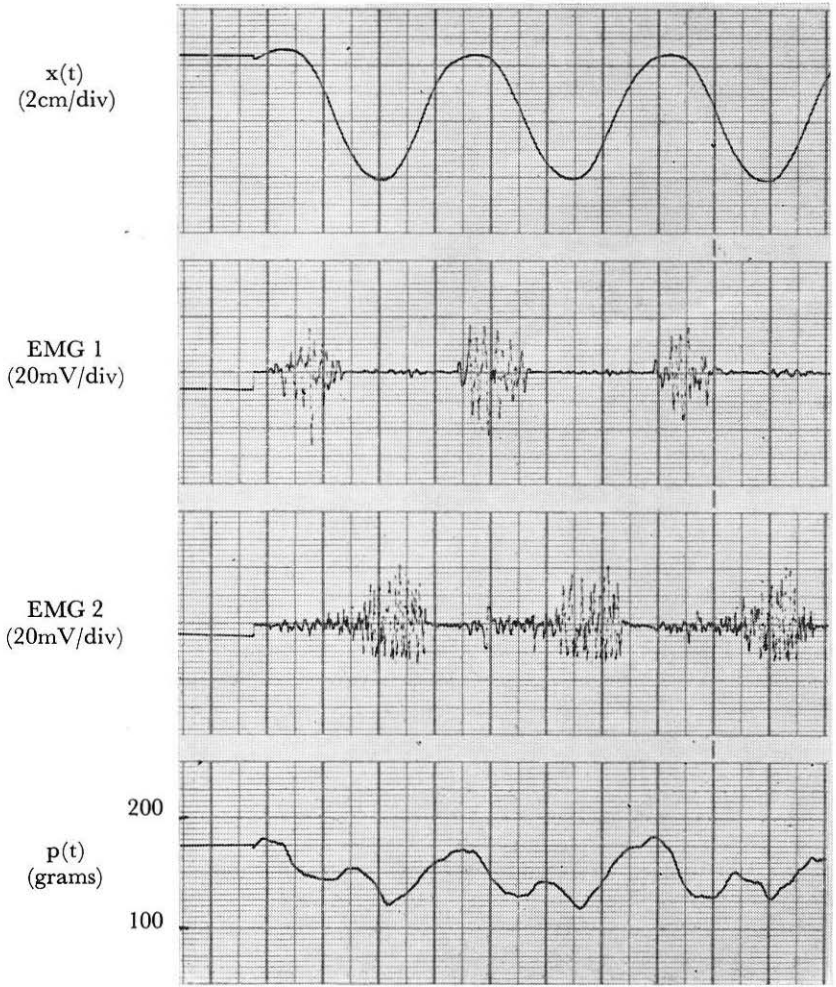
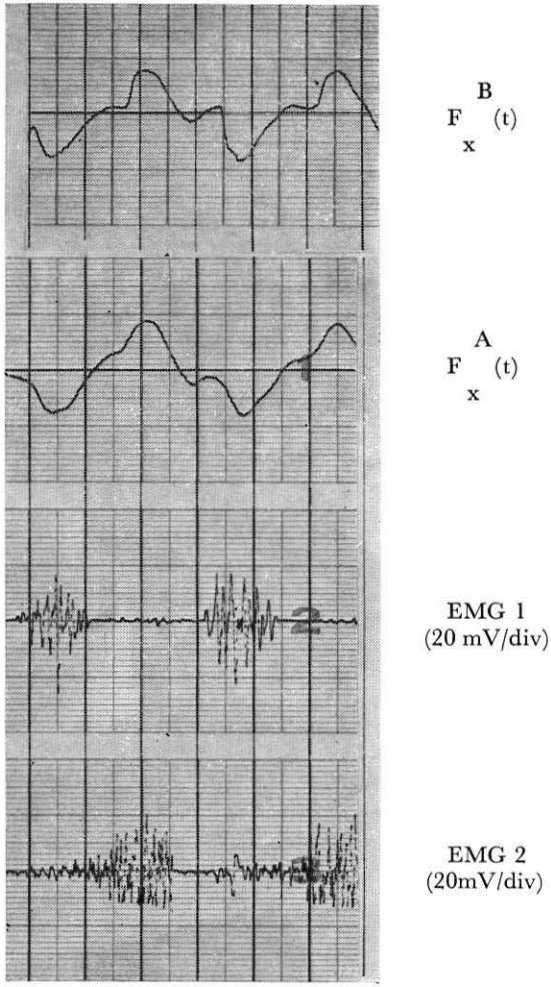


Figure 12. Estimated force waveforms for Case A and for Case B, together with the corresponding EMG signals.



Case B. In order to evaluate the effects on handwriting movements of a pencil-point pressure, consider the following model,

$$\left.\begin{aligned} &\ddot{x} + m_x p(t)/v\,\dot{x} = F_x(t) \\ &\ddot{y} + m_y p(t)/v\,\dot{y} = F_y(t) \\ &v^2 = \dot{x}^2 + \dot{y}^2 \end{aligned}\right\} \quad \text{(I–2)}$$

which are derived from eqs. (2) by neglecting both the stiffness and viscosity terms of the muscle. In the case of simple left-right motions, eqs. (I–2) become

$$\ddot{x} \pm m_x p(t) = F_x{}^B(t, m_x) \qquad \dot{x} \gtrless o$$

since $\quad v = |\dot{x}|.$

By minimizing the expression

$$\epsilon_B(m_x) = 1/T \int_T \{F_x{}^B(t, m_x) - M_x(t)\}^2\, dt \qquad \text{(I–3)}$$

$m_x^* = 2 \times 10^{-3}\,[M^{-1}]$, $\epsilon_B^* = 1.3 \times 10^{-2}$ were obtained for the same data as in Case A.

Figure 12 shows the finally estimated waveforms of muscular force $F_x{}^A(t)$ and $F_x{}^B(t)$ together with the corresponding EMG signals. It may be recognized, as a whole, that although the estimated muscular force waveforms have rather good correspondence with EMG patterns for both cases, the fine structures differ between the two. The difference between ϵ_A^* and ϵ_B^* for Case A and for Case B tells fluently the fact that the effects on handwriting movements of the writing pressure are not so small to be ignored. This will be discussed again in the synthetic studies.

II. *Synthetic Studies of Handwriting*

It is easy to say that handwriting signals are continuous time functions themselves. But, handwriting signals are composed of a sequence of strokes that are digital time segments. The stroke is defined as the time eliminated locus of a pencil-point movement caused by a muscle contraction.

Figure 13 shows the muscular force waveforms calculated from,

$$F_x(t) = \ddot{x} + m_x p(t)/v\,\dot{x}$$

where $m_x = 2 \times 10^{-3}$ for subject Y writing the Japanese character "ふ", together with the corresponding EMG's. It might safely be assumed from the inspections of these data that the muscular contraction causes the force with an exponential increase and decrease in amplitude. The introduction of this assumption makes it possible to determine uniquely

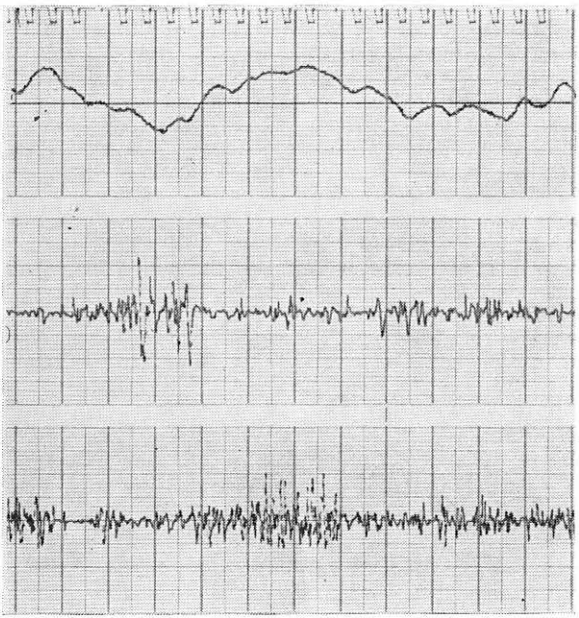


Figure 13. Muscular force waveforms calculated for writing the Japanese character "mi," together with the corresponding EMG's.

the force function by only giving the contraction timings τ_i's of muscle, at which handwriting signals are divided into a sequence of stroke segments.

Subjects are asked to write a certain Japanese letter "hiragana" without any constraints, and the samples of $(x$–$y)$ position and pressure of a pencil point during handwriting are transferred to the computer.

First of all, from the data obtained by above processes, a rough guess of timings

$$\boldsymbol{\tau}_x^0\,(\tau_{x0}^0, \tau_{x1}^0, \tau_{x2}^0, \ldots.), \boldsymbol{\tau}_y^0\,(\tau_{y0}^0, \tau_{y1}^0, \tau_{y2}^0, \ldots.),$$

which are considered to correspond to those of muscle contractions, is made by extracting zero crossing timings of $F_x(t), F_y(t)$ calculated from,

$$\left.\begin{aligned} F_x(t) &= \ddot{x} + m_x p(t)/_v \dot{x} \\ F_y(t) &= \ddot{y} + m_y p(t)/_v \dot{y} \end{aligned}\right\} \qquad \text{(II–1)}$$

which are the copies of eqs. (I–1) and the parameters m_x, m_y are assumed pre-known for each subject.

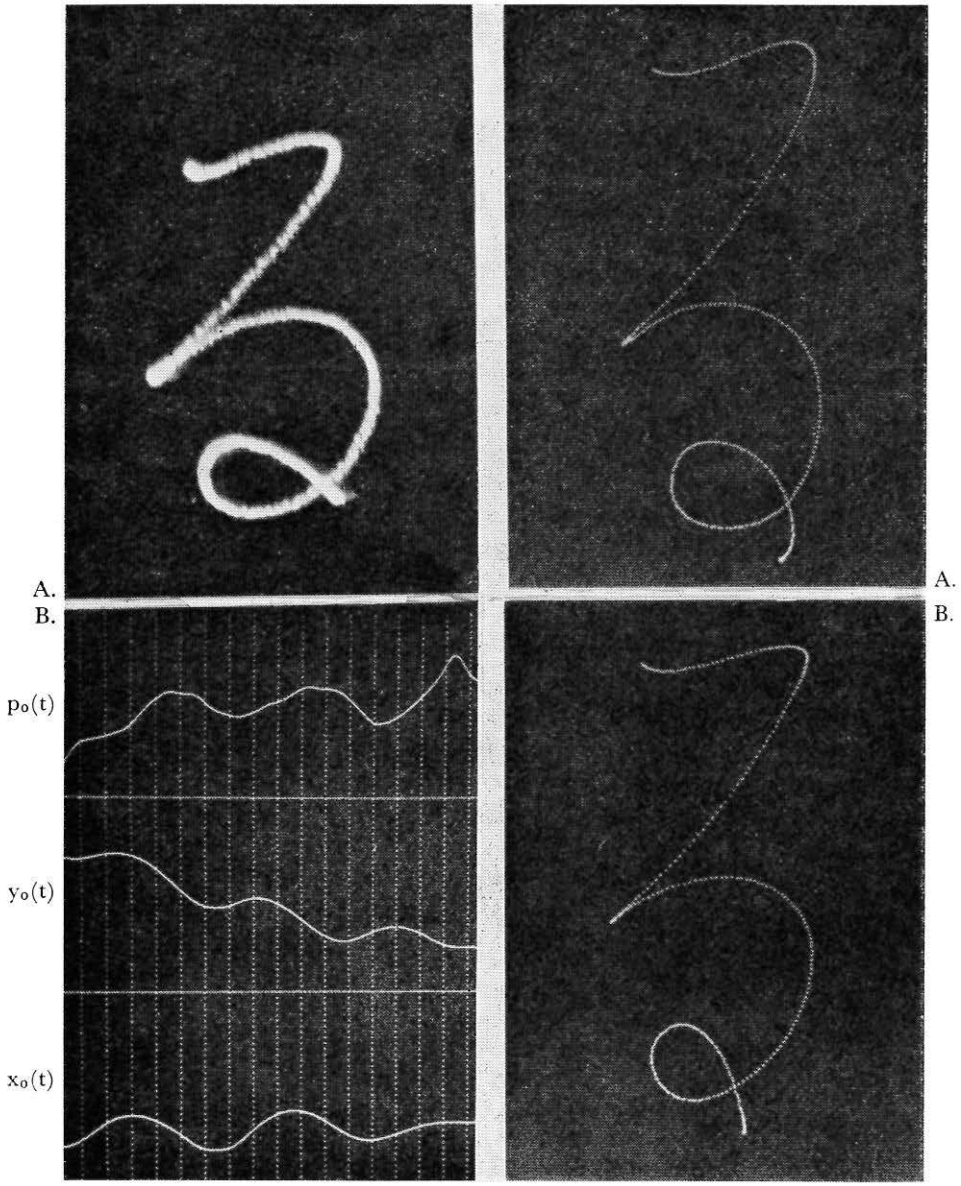


Figure 14. A. Original handwriting sample that the synthesized output is supposed to match. B. Estimated force waveforms for the original sample.

Figure 15. Synthesized patterns: The writing speed and pressure are assumed constant in Case A, but not in Case B. The normalized approximation error $\mathcal{J}^*$'s $(\mathcal{J}_x^* + \mathcal{J}_y^*)$ were $\mathcal{J}_A^* = 1.21 \times 10^{-3}$ and $\mathcal{J}_B^* = 0.72 \times 10^{-3}$ respectively.

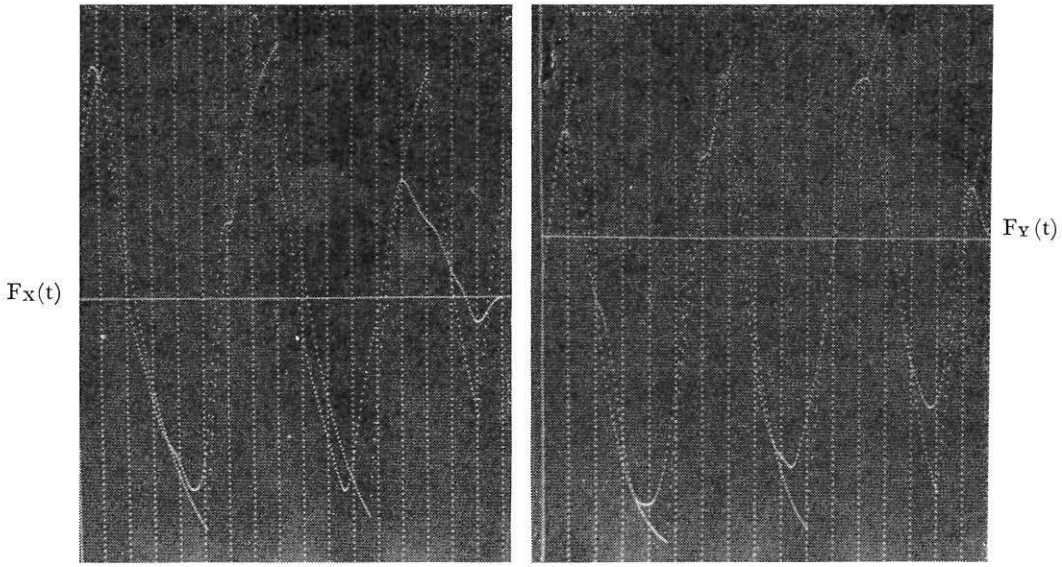
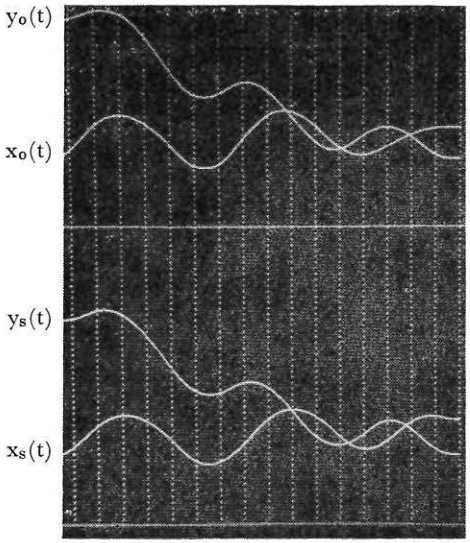


Figure 16. (A) Finally extracted force waveforms (cf. Figure 14B, estimated force waveforms for the original sample). (B) Original and synthesized *x–y* displacement waveforms, both of which correspond to the Case B in Figure 15.



Now, let $x_s(t), y_s(t)$ be the synthesized position functions by the proposed model of handwriting. The integral functional $\mathcal{J}_d$ $(d = x, y)$ is introduced which evaluates the distance between the actual handwriting and the synthesized handwriting as follows;

$$\mathcal{J}_d(\tau_d) = 1/T \int_T [\{d(t, \tau_d) - d_s(t)\}^2 + \{\dot{d}(t, \tau_d) - \dot{d}_s(t)\}^2] dt \qquad \text{(II-2)}$$

Our concern here is to find the optimum timing τ_d^* which minimizes the functional $\mathcal{J}_d$. Iterations of A-b-S algorithms can be executed by setting previously guessed τ_d^0 as a initial value of τ_d. Thus, the optimally estimated value τ_d^* will be obtained and its corresponding force function $F_d^*(t)$ will also be calculated.

Figure 14A is the original handwriting that the synthesized output is supposed to match. Figure 15 shows the synthesized patterns in which the writing speed and pressure are assumed constant in Case A, but not in Case B. The synthesis in Case A is quite successful except for the tail of "3" where the remarkably high writing pressure is observed (Fig. 14B). Further it was found that the last stroke on the tail of "3" could not be made to have the same shape as the sample without changing other parts so that they failed to agree with the sample. On the other hand, the example shown in Figure 15B, for which the independent variation of the pressure are provided, is found to be matched quite well.

These reveal that the constant pressure model is not completely compatible with an arbitrary sample of cursive script; that is, the writing pressure plays an important role in the actual human handwriting.

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The Calligraphy of Ch'an and Zen Monks

Jan Fontein and Money L. Hickman

Although a dependence on words and letters was avoided in the concepts of their sect, the Ch'an and Zen monks produced a prodigious amount of written material, in book form and in handwritten documents. Believed to express the total personality of the writer, the art of calligraphy (*bokuseki*) acquired a kind of mystique. The highly personal calligraphy was not as strong an influence in China as in Japan, where it established the standard for excellence and was extensively emulated in secular society. Representative examples are shown and discussed.

It may well seem paradoxical that a sect which attached so much importance to the concept of a "special transmission outside the scriptures," with "no dependence upon words and letters," should have produced a monumental amount of written materials during the course of its development. Included among the prolific output of its Chinese and Japanese monk-writers and chroniclers are sermons, tracts, hymns, the "Recorded Sayings" of a large number of patriarchs and eminent ecclesiastics, compendious biographies, and *kōan* collections, as well as an impressive quantity of writings in seemingly secular forms of literature, such as diaries and poetry. It must be noted, however, that this history of literary accomplishment did not develop without occasional antiscriptural activities. Liang K'ai's painting of a patriarch tearing up a *sūtra* (Fig. 1) provides graphic evidence of this sentiment, which seems to have developed from time to time among certain monks who feared that the spiritual vitality of the sect would decline if the revered sermons, sayings, or apothegms of the masters were set down in written form. This type of concern probably accounts for the action of Ta-hui, who suppressed and burned the famous collection of *kōan* known as the *Green Cliff Record* (*Pi-yen-lu*), a composite work of Hsüeh-t'ou Chung-hsien (980–1052) and Ta-hui's highly respected teacher, Yüan-wu K'o-ch'in (1063–1135). Yüan-wu had lectured to his students on the one hundred

"cases" of Hsüeh-t'ou which are included in this work. He seems to have had no intention of compiling his lectures, but the monks wrote them down and they were later published as commentaries to the one hundred cases. Ta-hui may even have felt that he was actually carrying out the master's wishes in destroying the work. Good fortune prevailed, however, for the work existed in other copies, and it became one of the most frequently used *kōan* compilations in later times. The case of Tê-shan (780–865), famous for his rough treatment of students, provides another example of this antiscriptural tendency. He devoted himself diligently to the study of the *Diamond Sūtra*, but when he attained *Satori*, he burned all his patiently accumulated notes and commentaries on the *sūtra*, proclaiming that all philosophical speculation was meaningless.

Despite these destructive aberrations, however, which seem to be characteristic of the Chinese parent sect rather than the Japanese offspring, the amount of written material that has been preserved,

Figure 1. *The Sixth Patriarch Tearing up a Sūtra*. Liang K'ai (active first half of the 13th century). Hanging scroll, ink on paper, 73 × 31.7 cm. Collection of Mitsui Takanaru, Tokyo.

In brushwork of great dynamic force, the artist has conjured up a scene which recalls the early days of Ch'an Buddhism, when the "strange words and extraordinary behavior" of the founding fathers of the Ch'an branches still determined the course of the sect. The general significance of a patriarch ripping a *sūtra* into shreds is evident, and similar episodes occasionally are described in Ch'an texts. It is known, for example, that the T'ang priest Tê-shan Hsüan-chien (died 865) burned all his *sūtras* after he had attained Enlightenment.

This painting traditionally is identified as a representation of the Sixth Patriarch, Hui-nêng. However, none of the many biographies of this patriarch shed any light on the episode which is depicted here. Yet there is one good reason for connecting this representation with him. In the Ch'an biographies of Hui-nêng, the sect's ideal of independence from scriptural sources is emphasized by a proud and defiant display of the illiteracy of the patriarch. As he was incapable of reading, the stimulus for his initial resolve had to come verbally, and it only occurred when he overheard a monk reciting the *Vajracchedikā-sūtra*. Similarly, the poem which earned him the succession to the patriarchate had to be written on a wall for him by another monk. In the *Platform Sūtra* every opportunity is used to emphasize Hui-nêng's militant illiteracy. His disdain for the written word must have made him an outcast in a society which traditionally revered literary accomplishment. Even though specific references to the dramatic scene in this painting are lacking in Hui-nêng's biographies, it would seem to be in complete accord with the basic attitude and behavior of the Sixth Patriarch.

both in book form and in handwritten documents, is nothing short of prodigious. The corpus of printed editions of Ch'an religious literature that has been transmitted down to the present in both China and Japan is impressive in its variety and size, but actual specimens of the writings of Ch'an priests can only be seen today in Japan.

The calligraphy of Ch'an and Zen monks is generally referred to in Japan as *bokuseki*, an elegant term which, translated literally, means "ink traces" or "ink vestiges". In China the term (pronounced mo-chi) seems to have been used as early as the Six Dynasties period, but it did not become a popular term until Sung times, when it seems to have been only one of several synonyms for "calligraphy." Japanese Zen monks who travelled to China during Sung times adopted the term and applied it in a more specific, restricted sense to the hand-written documents or calligraphy of Ch'an or Zen monks. The term is already used in this sense in the *Butsunichi-an Kubutsu Mokuroku*, the catalogue of calligraphy and paintings of the Butsunichi-an, a sub-temple of the Engakuji in Kamakura, compiled in 1365.

The unique master-student relationship in Ch'an-Zen is an out-growth of the central preoccupation of the sect—the direct, personal transmission of certain intuitively comprehended truths from the teacher to his successor or follower. The tradition that Bodhidharma's bowl and robe were handed down in succession to the patriarchs who followed him represents the symbolic expression of this arcane, perhaps on occasion ineffable, transmission. When the sect had become considerably larger and more institutionalized in later times, the desire for some tangible evidence of this transmission resulted in the practice, described above, of the master's presenting a *chinsō* of himself (usually with an inscription by him above) to the zealous student in recognition of both his advanced stage of religious accomplishment and his acceptance in the master's line. Alternatively, the master might write out a document in his distinctive calligraphic style and give it to the disciple, accomplishing the same purpose. In either case, the essential requirement was that the object of certification, whether painted or written, was received directly and personally from the master's own hand.

While the greatest reverence was focused on the particular calligraphic documents which attested to the religious accomplish-

ments of the student and confirmed his position in the authentic line of the master, it is also clear that there was a deep sense of respect, if not awe, for all of the writings of eminent church figures, contemporary as well as past. This feeling of veneration was twofold, for it applied not only to the religious content of the writings, but also to the calligraphy itself, the direct product of the master's personality, with its individuality, strength, and profundity of expression. Believed to express the total personality of the writer, the art of calligraphy acquired a kind of mystique, inspired in part by religious circumstance, but more largely as a result of its high level of aesthetic accomplishment.

The oldest piece of calligraphy from the hand of a Ch'an monk preserved in Japan is a letter written by Tao-ch'ien, a man who was awarded a high ecclesiastical title by the Sung Emperor Chê-tsung (reigned 1086–1101), and who seems to have associated with many of the scholars and literati of the period, including Su Tung-p'o. He achieved fame for his talents in composing poetry, but it is also apparent that he was a superlative calligrapher. His style owes something to that of Wang Hsi-chih (Fig. 2) but he seems to have been influenced by Su Tung-p'o's manner in his later years.

However, the Ch'an calligraphy that has been most admired in Japan is not of the orthodox type represented by Tao-ch'ien's example, but belongs rather to more personal, unconventional types like the famous example by Yüan-wu (1063–1135) in the Tokyo National Museum. Yüan-wu belonged to the Yang-chi branch of the Lin-chi (Japanese: Rinzai) school of Ch'an, which became the dominant branch in Japan, and exercised the strongest influence on the evolution of calligraphy in later times. The works of Yüan-wu's pupils such as Sung-yüan and Ta-hui (who destroyed the *Pi-yen-lu*) are highly respected and continue the master's stylistic tradition.

In China, where the weight of established tradition in calligraphic expression was quite strong, the unconventional, highly personal calligraphy of Ch'an monks does not often seem to have been well received very far beyond their own religious circles, and it eventually declined. In Japan, however, where Zen exercised a dominating influence on the evolution of culture during much of the "medieval" period, the calligraphy of Zen monks established the standard for excellence, and was extensively emulated in secular society.

Figure 2. *Wang Hsi-chih Writing on a Fan.* Attributed to Josetsu (active early 15th century). Fan-shaped album leaf, mounted as a hanging scroll, ink and slight colors on paper with mica ground, 98.3 × 21. 8 cm. Agency for Cultural Affairs, Tokyo. *Registered Important Cultural Property.*

Wang Hsi-chih Writing on a Fan, although painted by such famous Ch'an artists as Liang K'ai and Josetsu, is strictly speaking not a Zen theme. It illustrates an anecdote about the famous Chinese calligrapher Wang Hsi-chih (321–379). Once, when Wang saw a woman selling bamboo fans, he took them from her and wrote a five-character phrase on each one. The illiterate woman was angry because she thought that Wang had ruined her merchandise. Wang predicted that she would be able to sell all the fans for a good price because of the high market value of his calligraphy. When the woman promptly sold out her stock, she went to Wang and asked him to write phrases on more fans, but he merely laughed and did not respond to her request.

There is some evidence, however, that the attitudes of Ch'an monks, and perhaps even something of their calligraphic style, exercised a degree of influence on certain of the literati who associated with Ch'an monks during the Northern Sung period. Thus Su Tung-p'o, who studied Ch'an under two noted masters, seems to express the individualized spirit of the Ch'an practitioners in his statement: "While it cannot be said that my calligraphy is very accomplished, I have produced my own new ideas, and the fact that I am not treading in the footsteps of men of the past is the most pleasant thing of all to me!" Again, the pronouncement of his close friend Huang T'ing-chien (who was a diligent devotee of Ch'an practices): "In my calligraphy there is no basic method!" reflects the original, eccentric quality of Ch'an.

There are many fine specimens of *bokuseki* in private and public collections in Japan, but the largest number of pieces are preserved in Zen temples, particularly in Kyoto, where the main headquarters of the Rinzai school are located. The Tōfukuji has a superlative group of early examples, particularly those from the hand of the great Ch'an prelate Wu-chun Shih-fan which were brought back personally from China by Ben'en Enni in 1241, or sent to him slightly later in honor of the founding of the Jōtenji in Hakata (Fig. 3). Wu-chun's style, although vigorous and dynamic, is rather more orthodox than that of most Sung monks, and shows a strong inclination to emulate the style of his somewhat younger contemporary Chang Chi-chih

This humorous incident, which illustrates the true gentleman's lack of concern for financial gain, has been painted by Josetsu in a sensitive and delicate manner. Very appropriately, he chose the fan format to illustrate this anecdote. Each detail of the figures is meticulously painted with a fine, pointed brush. Wang Hsi-chih is shown seated on a garden seat under a tree. The tree trunk is painted in the manner of the Ma-Hsia school of the Southern Sung dynasty, but the branches of the tree have been sketchily indicated by closely spaced dabs from a dry brush. Wang is assisted by two child attendants, one of whom holds the ink stone.

On the left, written on a separate piece of paper, which has been pasted onto the fan, is a four-line verse by the monk Daigaku Shūsū (1345–1423):

In the world a fan can easily be sold for a thousand cash,
But in Shan-yin [where Wang lived] even one character in his handwriting is difficult to obtain.
His elegant distinction is ineradicable.
It is even visible in this painting.

Figure 3. *Calligraphy Presented to the Jōtenji.*
Wu-chun Shih-fan (1177–1249).
Hanging scroll, ink on paper,
196.7 × 44.0 cm.
Tōfukuji, Kyoto
Registered Important Cultural Property

Wu-chun was overjoyed when he heard of his disciple Enni's prodigious activity, and he took up his brush and wrote out a number of calligraphic plaques for the new temple. It is not clear just when or where the illustrated piece was displayed. It has no reference to any building, and may have been hung in whatever place was appropriate on felicitous occassions. It reads "Bestowed at Imperial Order, (the) Jōten Zen temple." Because of the term "Bestowed at Imperial Order," a conventional phrase often used to preface the name of a temple which had received sanction or support from the throne in China, it is possible that the "Jōten Zen temple" is the name of a temple or compound on Mount Ching which still existed during the thirteenth century. The practice of using Chinese temple names for those of the same religious lineage in Japan was certainly common enough to support this supposition. The present manner in which the characters are mounted, in vertical sequence, may not represent the original arrangement. Each character is written on a separate piece of paper, and although the paper is all of the same sort, it is not clear whether Wu-chun originally wrote them on independent sheets, or whether they might initially have been executed horizontally on a single sheet and separated at some later time. The fact that each has a seal imprint reading "Fumon-in" (the name of a sub-temple in the Tōfukuji), an imprint which appears on all the Wu-chun pieces, indicates that they were probably in separate sheets sometime early in their history. At the bottom left is Wu-chun's seal: "Fo-chien Ch'an-shih."

Wu-chun's calligraphic style is vital and direct in its impact, and depend on a strong, unembellished line, devoid of artistic eccentricities. His characters are written in a deliberate, preconceived manner, and are constructed tectonically so that each stroke has its own independent strength, but also interlocks organically with the total composition.

(Fig. 4). Lan-ch'i Tao-lung, the founder of the Kenchōji in Kamakura (Fig. 5), and Fêng Tzŭ-chên (Fig. 6) also exhibit an indebtedness to Chang's influential style in their writing.

The *bokuseki* collection in the Daitokuji in Kyoto is one of the finest in existence. Not only is it extensive in numbers and high in quality, but it also includes a variety of pieces which span a considerable period of time, and a general idea of the main currents, styles, and developments of Ch'an-Zen calligraphy from early Southern Sung times up to the Edo period can be acquired through a study of this collection alone. The oldest example is from the hand of Mi-an Hsien-chieh (1107–1186), one of the most influential prelates of the first half of the Southern Sung dynasty, whose later line includes names such as Sung-yüan, Hsü-t'ang, Wü-chun, Tao-lung and I-shan. It is not surprising that the Daitokuji has the most important corpus of calligraphy by its founder, Daitō Kokushi (Shūho Myōchō, 1282–1337) or examples of works of his teacher Nampo Jōmyō (1235–1309), who studied in China under Hsü-t'ang Chih-yü (1185–1269) and returned to Japan with works by his master. Daitō's style represents the fusion of his own strength of expression with the calligraphic manner of Huang T'ing-chien, one of the most widely emulated master of the Northern Sung period. T'ing-chien's characters have an incisive though elegant quality which is reproduced in Daitō's works, but with the addition of a slightly eccentric flavor. Daitō reached the height of his career during his fifties, when he devoted himself to educating and advising his many disciples. He wrote a large number of *hōgo* (essays or tracts interpreting the teachings of the Buddha, often with advice on methods for attaining Enlightenment) during this period, which he presented to his students. The manner in which he expressed his opinions through sermons and explanatory discourses and tried to elucidate the methods and means for achieving *Satori* show a clear resemblance to certain practices followed by the Ch'an master Chung-fêng Ming-pên, who had a number of Japanese students. Daitō revered Chung-fêng and must have been familiar with his "Recorded Sayings," which were brought back to Japan.

Several of the abbots who succeeded Daitō at the Daitokuji, such as Tettō and Kasō, were also accomplished calligraphers, but the most dynamic hand in this line during the middle of the Muromachi period belonged to Ikkyū Sōjun (1394–1481, Fig. 7). The larger part

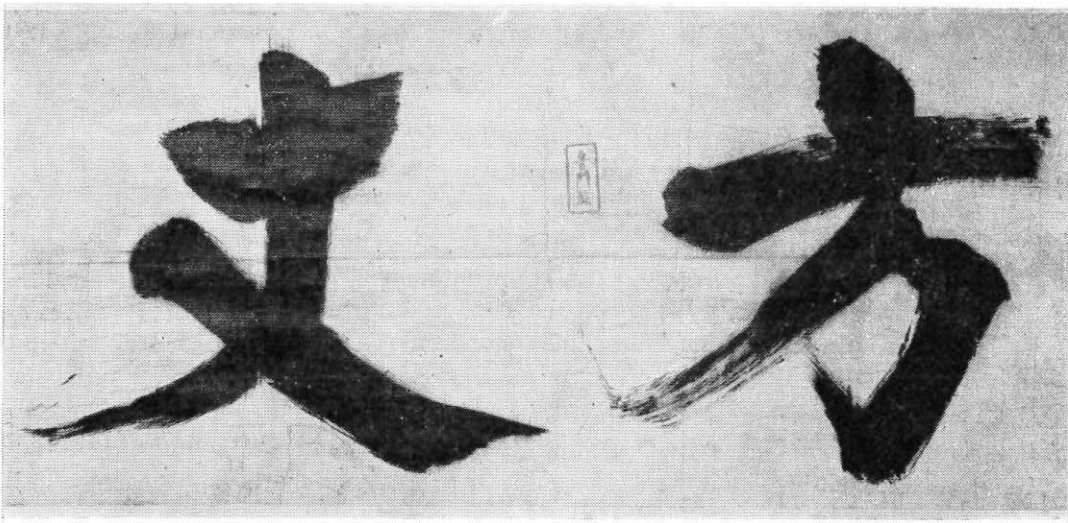

Figure 4. *Fang-chang* ("*The Abbot's Quarters*"). Chang Chi-chih (1186–1266). Framed and mounted as a panel, ink on paper, 45.2 × 126 cm. Tōfukuji, Kyoto. *Registered Important Cultural Property.*

Chang Chi-chih was an official of the Southern Sung dynasty. His career as a mandarin was not one of particular distinction. As a calligrapher, however, his fame spread far beyond the borders of his homeland. The Jurchen, who occupied the northern half of China, as well as the Japanese, who heard about him from travelling Zen monks, eagerly sought to acquire specimens of his handwriting.

Chang was a deeply religious Buddhist and copied the *Vajracchedikā-sūtra* as an act of devotion several times during his lifetime, and he is also known for his copies of poems by the T'ang poet Tu Fu, written both in small and large characters.

This fine piece of calligraphy, consisting of the characters *Fang-chang* ("The Abbot's Quarters"), is one of a set of eight examples written with two characters referring to locations in a temple. An incised wooden plaque based on this piece of calligraphy is still in use at the Daitokuji, Kyoto. The words *fang-chang* are an abbreviation for "a room of ten square (*fang*) feet (*chang*)." This expression originally applied to the residence of Vimalakīrti but was used, from T'ang times on, for the abbot's quarters at a Ch'an temple.

The bold characters, which combine strength with elegance, are characteristic of Chang's robust style which continued the traditions of the Northern Sung schools of Huang T'ing-chien and Su Shih. In spite of the close resemblance to other works by Chang's hand, especially the fragment of a poem by Tu Fu in the Chisaku-in, Kyoto, this piece is thought by some to be the work of one of Chang's numerous followers rather than by the great artist himself.

Between the two characters is a seal which reads: "Fumon-in." This is the name of one of the sub-temples of the Tōfukuji. The eight-piece set is believed to have been brought back from China in 1241 by the monk Ben'en (1201–1208), who subsequently founded the Tōfukuji, the temple where these pieces are still preserved.

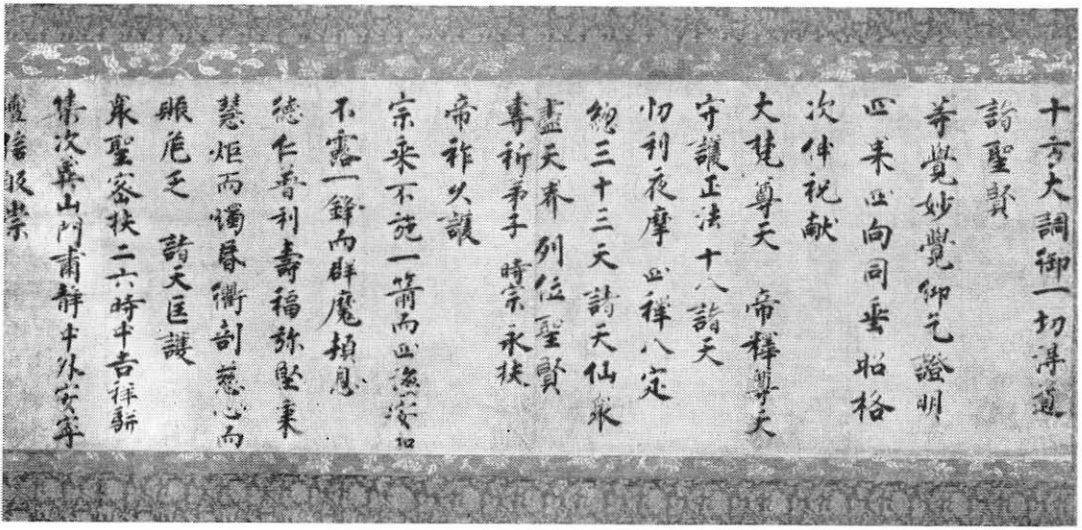

Figure 5. *Buddhist Hymn.* Lan-ch'i Tao-lung (1212–1278). Part of a handscroll, now mounted as a hanging scroll, ink on paper, 32.5 × 95.2 cm. Tokiwayama Bunko, Kamakura. *Registered Important Cultural Property.*

This piece of calligraphy from the master's hand contains the text of a Buddhist hymn which Lan-ch'i Tao-lung composed himself. Abbots of Zen monasteries often led their monks in chanting such hymns. The text may be translated as follows:

Great Buddhas of the Ten Directions, and all of you holy saints who have attained the Path, all who have attained Undifferentiating and Subtle Perception, we reverently raise our heads and beg you to bear witness.

May those who have attained the Four Fruitions, and those who have attained the Four Stages of Sanctity all favor us with their luminosity and extend to us their blessings. . . .

We especially pray that our disciple Tokimune may always support the Imperial Throne, and protect, for many years, the doctrine of our sect; that the land within the Four Seas may live in peace and harmony without even one arrow being shot; that the host of demons may bow their heads and desist without so much as a tip of a lance having to be bared. . . .

Lan-ch'i Tao-lung has written these characters in a bold, vigorous style that is reminiscent of that of the great calligrapher Chang Chi-chih (Fig. 4). "That the host of demons may bow their heads" supposedly refers to the Mongols, who first threatened to invade Japan in 1274. At that time, the Imperial Court was holding continuous services to pray for the safety of the country, and Lan-ch'i Tao-lung may well have led his priests in chanting invocations such as this hymn.

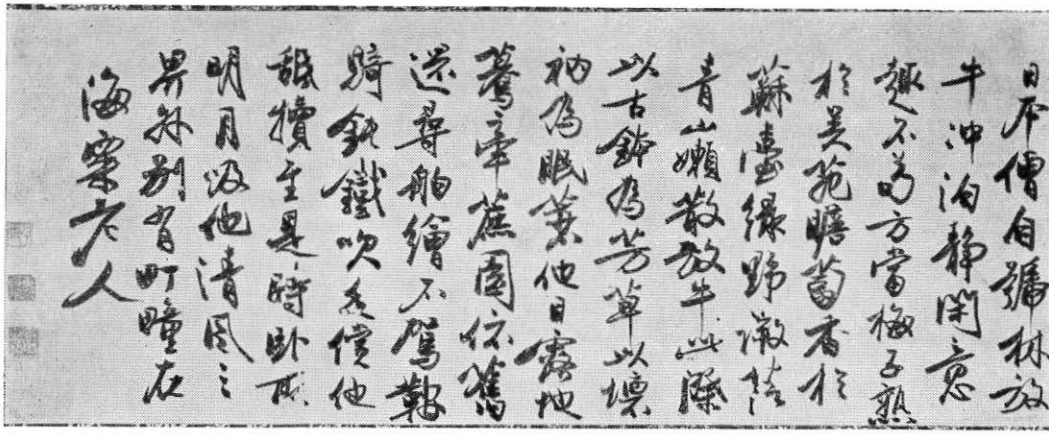

Figure 6. *Encomium for Hōgyū Kōrin.* Fêng Tzu-chên (1257–post-1327). Hanging scroll, ink on paper, 33.4 × 88.7 cm. Collection of Ueno Yasuyuki, Tokyo.

Fêng Tzú-chên, a native of Yu-hsien (Hunan province), served as a minor official in the Mongol administration. He was a man of literary talent, but his greatest distinction was not in the field of literature, but in calligraphy. He shared this distinction with the Northern Sung calligrapher and art connoisseur Mi Fu (1052–1107) on whose work he is said to have modeled his style. It still retains much of the typical Sung flavor and somewhat resembles the work of Chang Chi-chih (1186–1263), the favorite calligrapher of the Japanese during the previous generation. Although Fêng's calligraphy did not go unnoticed in China and was appreciated by such eminent arbiters of the arts as Chao Mêng-fu, it was among the Japanese that his work was admired most, and several Zen monks studying in China are known to have asked him for specimens of his calligraphy.

Hōgyū Kōrin, the Zen monk to whom this calligraphy is dedicated, was a pupil of Shōgun Sentai, the abbot of the Hōkanji in Kyoto. In 1318 he left for China where he stayed for seven years. It was during Hōgyū's residence in China that Fêng Tzŭ-chên's calligraphy was written. It reads in part:

The Japanese monk who calls himself Lin Fang-niu [Japanese: Hōgyū] is a man of agreeable, relaxed disposition, whose thoughts, and intentions are never ill-considered. The plums are now ripening in the Garden of Wu, and the gardenias spread their fragrance at the [Ku] Su Terrace; the verdant fields disappear in the far distance, while the green mountains lie scattered in the panorama before us. Now, Fang-niu has taken the old alms bowl to gather fragrant herbs, and he has made his ragged cassock into a sleeping cloak [i.e., he is leading a life of exemplary frugality]. . . .

The text, written in running script of perfect balance and great elegance, is a polished example of expedient prose, written at the request of the recipient. What it lacks in inspiration is largely compensated for by the refinement of the literary style. Its somewhat perfunctory character has been expertly hidden behind a façade of bookish allusions. Evidently, Fêng was frequently approached for such pieces of calligraphy, and he acquitted himself of his task with polite promptness.

of Ikkyü's life was devoted to combating the religious shortcomings of Zen during this period—a growing spiritual debilitation, complacency, and worldly ostentation. His great strength of character and sense of conviction stand out in his calligraphy, which is renowned for its uniqueness and vitality.

The Daitokuji produced few calligraphers of note during the last century of the Muromachi period, a time marked by wars and instability. During the Momoyama period, however, there was a renewed interest in calligraphy. This development took place in large part as a result of the rapid growth of interest in the Tea Ceremony, in which hanging scrolls with appropriate phrases played an essential part. The Daitokuji was the chief monastic center for the Tea Ceremony during Momoyama times, and Sen no Rikyü, who established the main canons for the ceremony which are still followed, was closely associated with the temple and is buried there. Thus there was considerable demand for the calligraphy of Daitokuji monks such as Shun'oku Sōen and Kokei Sōchin, who produced small works with the characters written in a precise, spare manner.

During the second quarter of the seventeenth century, Daitokuji masters such as Kōgetsu Sōkan (Fig. 8) and Takuan Sōhō (Fig. 9) returned to a larger, more dynamic mode of calligraphic expression in an attempt to realize more fully the aesthetic potentialities of the hanging scroll format. Both men favored short, direct phrases which could be rendered in a single line, often consisting of only two or three characters, and usually containing some reference to Zen. Kōgetsu's association with the Tea Ceremony was of a very intimate nature, for his father had been a Tea Master, and Kōgetsu studied with Kobori Enshū, the famous garden designer and arbiter of taste, who was also a fellow student at the Daitokuji. The Daitokuji continued to provide support and inspiration for the Tea Ceremony and related calligraphic forms of expression during the following centuries, and it remains a center for these activities at the present day.

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Figure 7. *Calligraphy Dedicated to a Dead Sparrow: "Sonrin."*
Ikkyū Sōjun (1394–1481), dated 1453.
Hanging scroll, ink on paper,
78.8 × 24.5 cm.
Hatakeyama Collection, Tokyo.

Ikkyū emerges as a strong individualist, full of inner conviction and self-confidence, quick to speak his mind. At the same time, however, there is abundant evidence of Ikkyū's concern for the spiritual welfare of his fellow man (as in his diligent efforts to propagate Zen teachings to those of limited education through the use of simplified, popular language) as well as his deep compassion for all life—a fundamental Zen ideal. This compassion is movingly revealed in the content of this piece of calligraphy, written when Ikkyū was sixty-one. He has composed a kind of requiem dedicated to a dead sparrow.

I once raised a young sparrow that I loved dearly.
One day it died suddenly, and I felt an intense sense of grief.
So I buried it with all the ceremonies proper for a man.
At first I had called it Jaku-jisha ("Attendant Sparrow"),
But I later changed this to Shaku-jisha ("Sākyamuni's Attendant").
Finally, I gave it the Buddhist sobriquet Sonrin ("Honored Forest"),
And I attest to this in this *gāthā:*
His bright gold body, sixteen feet long [lying between]
The twin sāl trees on the morning of his final nirvāna,
Liberated, free of the heretical cycle of samsāra,
Spring of a thousand mountains, ten thousand trees, and a hundred flowers.
1453, eighth month, nineteenth day,
Kyōunshi Sōjun

Ikkyū's calligraphic style is unique. Although certain features of the styles of his lineal predecessors Kidō and Daitō may be discerned in his calligraphy, these are more

likely to have been the result of his keen familiarity with and respect for documents from their hands than of a desire to emulate them. Ikkyū's large characters, like the *Sonrin* here, are written in a straightforward, bold manner and show a preoccupation with the compositional possibilities of the character forms. His ingenuity is apparent in the first two strokes in the upper character, which are intended to suggest two seated sparrows. The smaller characters below, written with greater speed, reveal a fine sense of interrelated continuity and rhythm.

Figure 8. *Calligraphy:* "*Tea and Rice.*"
Kōgetsu Sōkan (1574–1643).
Hanging scroll, ink on paper,
125.4 × 25.9 cm.
Collection of Nemoto Kenzō, Tokyo.

Kōgetsu Sōkan was the son of a noted tea master, Tsuda Sōkyū (died 1591), who served Oda Nobunaga and Toyotomi Hideyoshi, the most powerful military figures of the period.

Calligraphic skills had been highly regarded at the Daitokuji since its founding by Daitō Kokushi. The greatest artist that this tradition produced was Ikkyū Sōjun (Fig. 7), and Takuan Sōhō and Kōgetsu Sōkan were the central figures in the renaissance of this tradition. In contrast to the refined and supple style of Takuan, the work of Kōgetsu is rough and has a strong impact.

The calligraphy reads "When I happen upon tea, I drink tea; when I encounter rice, I eat rice." The motto is an expression of the relaxed and carefree attitude of the enlightened tea devotee who takes life as it comes. It is written in the bold, impulsive manner which is the hall-mark of this artist. He allows his thick brush to dry, so that the last characters written with it have a thinner scratchy appearance, and their basic structure is clearly revealed. They contrast with the solid, pitch-black forms of the characters that were done first, just after the brush had been dipped into the ink.

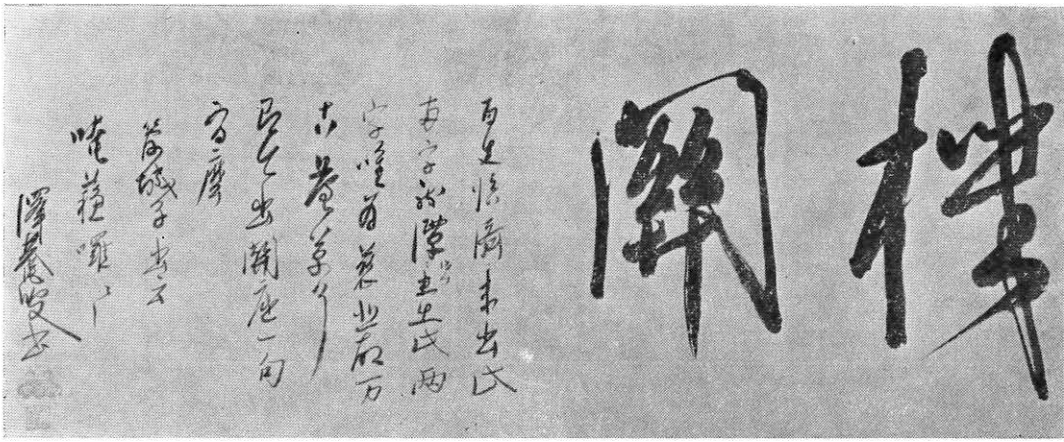

Figure 9. *Calligraphy: "Kikan."* Takuan Sōhō (1573–1645).
Hanging scroll, ink on paper, 32.8 × 83.5 cm.
Collection of Hosokawa Moritatsu, Tokyo.

Takuan Sōhō, the son of a *samurai* from Tajima (present-day Hyōgo Prefecture), studied Zen at the Daitokuji under Shun'oku Shuon (1529–1611), who was also the teacher of Kōgetsu (see Fig. 8) and the tea masters Kobori Enshū and Furuta Oribe. Like many other Zen priests of his time, Takuan occasionally painted. His great fame, however, rests upon his calligraphy. He especially liked the horizontal format, writing one or two characters in bold script on the right and adding an explanation or verse in smaller script on the left. The most famous of his works of this type is the calligraphic piece *Dream*, in which the word is followed by a poem. It is Takuan's last work, written as he lay dying, a brush in his hand.

The example shown here with the Zen term *kikan* conforms to the general layout and style of Takuan's *Dream*. The large characters are written in a dynamic running script, whereas the explanation is written in *sōsho* ("cursive" script). The stylistic resemblance of *Kikan* to Takuan's last work, suggests that this piece of calligraphy was executed in the monk's later years.

Kikan (literally, "mechanism") is a technical term used specifically to denote the so-called "interlocking of differentiation." Once the Zen adept has achieved *kensho*, that is, insight into his own real nature, he has passed the first stage of Enlightenment. From there, he has to proceed to a phase in which he must grasp the idea of differentiation. This is done, step by step, through the study of *kōan* that deal especially with the aspect of the Zen truth. Such *kōan* are therefore called *kikan-kōan*. In his explanation Takuan traces the idea of *kikan* to the Chinese Ch'an masters Lung-t'an Ch'ung-hsin and his pupil Tê-shan Hsüan-chien (ca. 781–865).

Experiments with Unjustified Text

James Hartley and Peter Burnhill

Three separate experiments are described in which various settings of unjustified text are compared: (1) passages with line endings determined by syntactic considerations were compared with passages set in a standard unjustified form; (2) passages with approximately one-third of the lines ending with hyphenated words were compared with the same standards; (3) unjustified double-column formats of different widths were compared with each other. No significant differences in reading speed were found in any of the three experiments, although a significant sex difference was found in Experiment 3 when a scanning method was used. No significant differences were found in comprehension scores. Attitudes expressed by students in Experiments 1 and 3 tended to favor the shorter lines with more uneven endings.

If the reader examines any textbook in front of him, he will most probably observe that the right-hand margin of the text is straight: that the lines of type are forced—by variable word spacing and by the use of hyphens—into what printers call "justified" text. An alternative strategy to this procedure is that adopted in the presentation of this article, that is, to provide equal spacing between the words, and consequently to produce line lengths that are irregular—or "unjustified" text.

The argument of this paper is that there is, in fact, little—apart from tradition—to justify justified text. When a typographical sign (say a lower-case roman s) of a particular sort (set, font) is repeated in the context of a meaningful sequence of signs, we expect the dimensional attributes of the sign to be consistent at every appearance. If it does not appear so (say in proof reading), we replace it by a sign of the correct sort. In a sentence the particular sign we use to group signs meaningfully is, by convention, the *absence* of a mark; and we call this "not-mark" sign a word space. We could replace this not-mark sign by a particular sign; and, if we did so, we would expect it

to be dimensionally consistent at every appearance. If it was not, we would replace it by a sign of the correct sort. The fact that we prefer to use a "not-mark" sign does not change the need for particular signs to be dimensionally consistent.

Justifying the text, therefore, causes unco-ordinated word spaces, whereas unjustified text is the result of co-ordinating the sign system. It might be more appropriate to think of justified and unjustified text as "unco-ordinated" and "co-ordinated" word space systems. If we accept the argument for the standardization of the interval between words in the context of a sentence and if we agree that not-marks are signs of a particular sort, we can go on to examine the implications of the argument for the joints which occur between other groups of signs in the hierarchical structure of the language. Alternatively, of course, we are free to continue the irrational practice of unco-ordinated spacing.

Unjustified text is now becoming common where cheap and rapid printing is required—in reports of conference proceedings, and in newspapers. Evers (1968) reports—with reference to *Rotterdamsch Niewsblad*, a Dutch evening newspaper—that there have been "considerable savings in the composing room, a production benefit of 13.5% in the perforating department, and (less clearcut and to a less extent) appreciable savings in the casting department." Spencer's (1969) textbook, *The Visible Word*, provides an illustration of the technique, together with a review of typographical research. Zachrisson (1965) cites evidence to show that unjustified text is read as quickly as justified text (Hultgren, 1954; Powers, 1962), and he suggests that unjustified text is read more quickly by less proficient readers. Other investigators have reported similar findings of no significant difference between the two typesettings (Davenport and Smith, 1965; Wiggins, 1967; Fabrizio, *et al.*, 1967). Becker, *et al.* (1970) found no differences between the preferences of American college students for justified or unjustified setting, although this finding contradicts that of Ruthenbeck (1965).

If it is accepted that unjustified text is read as quickly as justified text, then future questions will concern themselves with whether some methods of setting unjustified type might lead to more efficient reading than others. The experiments to be reported in this paper examine three issues. The first of these is a comparison study between

standard unjustified text and text where line length is determined by grammatical constraints. The second experiment compares standard unjustified text with text where approximately 33% of the lines end with a hyphenated word. The third experiment examines the effects of unjustified double-column formats with different overall widths. Table I illustrates samples from the experimental texts.

Experiment One

The aim of this experiment, in the light of recent work in psycholinguistics which has shown that syntactical units are important in the understanding of sentences (e.g., Miller, 1962; Miller & McKean, 1964; Fodor & Bever, 1965; Epstein, 1967; Anglin & Miller, 1968), was to see if a grammatical determination of line length would speed up, or slow down, reading speed; and whether or not comprehension would be affected. Two passages of approximately equal length (2500 words) and difficulty were obtained; these were scripts of two Radio Three broadcasts prepared by the same author (McInnes, 1965 and 1969). Two versions of each passage were typed out and duplicated (Table I): (i) the standard—Example 1; and (ii) the experimental—Example 2—similarly produced but with line lengths determined by grammatical constraints. In brief, lines stopped between syntactic units rather than within them. (This procedure was easily done—reflecting the fact that secretaries can intuitively recognise syntactical units although they may have forgotten all about "grammar.") Following each passage—in order to test comprehension—were appended a series of questions, demanding short written answers. These questions related to material covered in the first five pages of the passage (which was approximately seven foolscap pages long). A total of eight marks was available for each test.

Procedure. The experiment was carried out in a group setting with volunteer students, following a first-year psychology lecture. A standard balanced experimental design was employed by allocating students at random into four conditions:

Condition 1. Passage A, Standard	followed by Passage B, Experimental
Condition 2. Passage A, Experimental	followed by Passage B, Standard
Condition 3. Passage B, Standard	followed by Passage A, Experimental
Condition 4. Passage B, Experimental	followed by Passage A, Standard

TABLE I. Examples of materials used in the experiments.

Example 1. (The standard)

Moreover, not only have so many historians concentrated their attentions on individual sects, but increasingly they have tended to study these sects from one particular standpoint - from a sociological point of view. The differing sects are seen as representing differing social groups or social movements, the theology of the sect being an ideological

Example 2. (Grammatically terminated lines)

Moreover, not only have so many historians concentrated
their attentions on individual sects, but increasingly they have tended
to study these sects from one particular standpoint -
from a sociological point of view. The differing sects are seen
as representing differing social groups or social movements,
the theology of the sect being an ideological superstructure,

Example 3. (Moderate hyphenation)

Moreover, not only have so many historians concentrated their attentions on individual sects, but increasingly they have tended to study these sects from one particular standpoint - from a sociological point of view. The differing sects are seen as representing differing social groups or social movements, the theology of the sect being an ideological superstructure,

Each student was provided with the two passages fastened together. The instructions given were as follows:

"When I say 'Start' I want you to read the first passage in front of you *as naturally as possible*. There are a few simple questions to answer at the end of the passage, only four or five, and they are not

Example 4.

have worked on the period. Each individual sect has found its chronicler who has explored its theology and examined its history in loving detail. George Yule, for example, has written on the Independents, Brailsford on the Levellers, Braithwaite on the Quakers, and so on.

Moreover, not only have so many historians concentrated their attentions on individual sects, but increasingly they have tended to study these sects from one particular standpoint – from a sociological point of view. The differing sects are seen as representing differing social groups or social movements, the theology of the sect being an ideological superstructure, a rationalization of the group's economic aims. For example, Norman Cohn in his brilliant and

are in danger of missing, or at any rate obscuring the main point. The central feature of seventeenth-century religious history is, indeed, not so much what was happening to the individual sects, that is to religions in the plural, but rather what was happening to Christianity as a whole – in other words to religion in the singular. And, in order to understand what was going on in this second sphere, it is essential to glance briefly at the place of religion in medieval socity.

In the Middle Ages religion formed a total backcloth to all human activity. Every aspect of life was simply a projection, an extension of religion. Art for example. The greatest artistic achievement of the Middle Ages was in the building of cathedrals. Music

Example 5.

the period. Each individual sect has found its chronicler who has explored its theology and examined its history in loving detail. George Yule, for example, has written on the Independents, Brailsford on the Levellers, Braithwaite on the Quakers, and so on.

Moreover, not only have so many historians concentrated their attentions on individual sects, but increasingly they have tended to study these sects from one particular standpoint – from a sociological point of view. The differing sects are seen as representing differing social groups or social movements, the theology of the sect being an ideological superstructure, a rationalization of the group's economic aims. For example, Norman Cohn in his brilliant and learned book *The Pursuit of the Millennium* has argued, that Anabaptism was the religion of the displaced peasantry and the disoriented urban poor. These groups, Cohn maintains, rootless and cast out from traditional society, found identity in the total solution of a revolutionary chiliasm. A still more striking instance of this sociological approach is the Tawney-Weber thesis. Both R. H. Tawney and Max Weber

What is true in the sphere of art is true in all other spheres in the Middle Ages. Economic relations were governed by the Christian ideal of the just price. Kings were also priests. They were given divine powers at their coronation. Churchmen played a key role in government. Religion in the Middle Ages was totalitarian. It compromised every aspect of life.

The profound thing which happened to religion in the seventeenth century was that it ceased to occupy this position of being a total backcloth to all human activity. Gradually, religion disengaged itself from the world around it and retracted into its own compartment. From being everything it became only a part of life, separated off and distinct from other parts of life. It was in the seventeenth century that men ceased to believe in the idea of the just price. In the seventeenth century, too, one can discern religion without withdrawing from the sphere of art. Music ceases to be simply polyphony; the first operas were performed in England in the Commonwealth period. The typical medieval poem was a didactic poem. It was designed to justify the ways of God to man. On the surface *Paradise Lost* seems to be well within this

difficult to do. Try to read the passage as though you were reading a novel. I shall tell you when to stop after a certain amount of time." The students were stopped after seven minutes and were asked to mark clearly on the passage how far they had read. They were then allowed as much time as they liked to complete the test questions.

This procedure was then repeated for the second passage. After completing the second test, the students were asked to indicate on the back of the last test sheet their sex and their answers to the following questions, which were given orally: 1. Which passage did you prefer to read, A or B? 2. [After being shown the differences between the layout of the passages] Which layout do you prefer, 1 or 2? 3. Why? State the reason for your choice. The aim of questions 2 and 3 was to ascertain directly what the students thought about the layouts, whereas that of question 1 was to ascertain *indirectly* whether the layout had had any effect on expressed preferences.

Results. The main results of the experiment are shown in Table II, and speak for themselves. There was no significant difference between the number of words read in either version of the passages, there was no significant difference between the comprehensions scores, and there was no significant difference between the results obtained by either sex.

In response to question 1, the experimental versions of the passages were preferred to the standards, but this difference was not significant. In answer to question 2, 12 subjects preferred the standard versions of the passages, 19 the experimental versions, but 18 expressed no preference. Quite marked and contrasting statements were made in response to question 3: e.g., a subject preferring the standard passage wrote, "For appearance, this is much more acceptable"; a subject preferring the experimental passage wrote, "A sheet of evenly-spaced writing puts me off at the very beginning."

Discussion. One of the consequences of using grammatical constraints to determine line lengths was that, although the mean line lengths were the same, the experimental passage had a much more uneven right-hand margin than had the standard (see Table I). Indeed, if the experiment had produced statistically significant differences, a second experiment would have been needed to determine whether or not it was the uneven line length rather than the grammatical constraints that had caused the differences. This second experiment, however, was not necessary. It can be concluded, therefore, that these subjects were not restricted by a wide variety of line length in unjustified text, or by grammatical considerations.

TABLE II. The means and standard deviations obtained by the two groups on two measures: (i) number of words read and (ii) comprehension score.

		Standard Passage Unjustified Text		*Experimental Passage Syntactically Justified Text*	
		Number of Words read	*Comprehension Score*	*Number of Words read*	*Comprehension Score*
Men	$\bar{X}$	1855	4.44	1859	4.74
(N = 27)	sd	394	1.31	408	1.43
Women	$\bar{X}$	1812	4.27	1792	4.45
(N = 22)	sd	303	1.21	248	1.41
Total	$\bar{X}$	1836	4.37	1829	4.61
(N = 49)	sd	356	1.27	346	1.42

These findings are similar to those reported by Carver (1970). Carver's three experiments (published after the completion of our own) also examined the readability of text with line endings determined by syntactical considerations (and a double space between syntactic units). Carver also found—using a more sophisticated electromechanical device for recording reading speed—no significant differences between conventional typesetting and a variety of other settings of syntactically justified type.

Experiment Two

The aim of this experiment was to see if the presence of hyphens at the end of lines would slow down reading speed, and affect comprehension. In a pilot study conducted by some of the writers' students, it was found that with 100% hyphenation, reading speed was markedly slowed down for 8 out of 10 subjects (reading a single page of prose material). However, 100% hyphenation is rare and it looks very peculiar; it was thought that it would be better to experiment with a more usual amount. Accordingly, therefore, two versions of the passages utilized in Experiment One were prepared, (i) the standard, and (ii) the experimental—with approximately 33% of lines ending with hyphenated words (Table I, Example 3).

The procedure for this experiment was the same as that for Experiment One except that the reading time allowed was six minutes instead of seven. (Four subjects completed reading one of the passages with the latter time in Experiment One.) An additional

question was asked after the experiment in order to ascertain whether any of the subjects had noticed the difference between conditions. First- and third-year psychology students in laboratory classes were the subjects.

Results. The main results of this experiment are shown in Table III and, again, speak for themselves. There was no significant difference between the mean number of words read for either version of the passages, nor were there any differences in comprehension scores. As before, there were no significant differences between the results obtained by either sex.

Response to oral question 1 indicated that 33% hyphenation had no measurable effect upon preference. This finding was reflected in the responses to the additional oral question: not one subject reported having noted any difference between the standard and the experimental versions of the passages. However, in answer to question 2 (which to some extent was a leading one), 24 subjects preferred the standard, 10 the experimental, and 8 expressed no preference. (This difference was significant.) Again, marked and contrasting statements were made in response to question 3: e.g., a subject preferring the standard wrote, "It is easier to read words as whole units—I find hyphens confusing"; one subject, preferring the experimental version, wrote, "Hyphens allow speedy transferance from line to line and prevent you losing your train of thought."

TABLE III. The means and standard deviations obtained by the two groups on two measures: (i) number of words read, and (ii) comprehension score.

		Standard Passage Unjustified Text		*Experimental Passage 33% hyphenated*	
		Number of Words read	*Comprehension Score*	*Number of Words read*	*Comprehension Score*
Men	$\bar{X}$	1672	4.79	1582	5.11
(N = 19)	sd	347	1.20	348	1.62
Women	$\bar{X}$	1463	5.43	1525	5.26
(N = 23)	sd	306	1.17	299	1.39
Total	$\bar{X}$	1588	5.14	1551	5.19
(N = 42)	sd	341	1.23	323	1.50

Discussion. These results indicate that the proportion of hyphens used did not affect in any measurable way the reading speed or comprehension. This finding replicates that of Davenport and Smith (1965). The response to question 3 did suggest—although the subjects did not notice any difference between conditions when reading them—that when the standard and experimental passages were placed side by side they did prefer the overall appearance of the passages without hyphens.

It would seem valid to conclude from this experiment, therefore, that text without hyphenation is read as efficiently as text with a moderate amount, and that readers are unlikely to notice the difference. In view of the fact that hyphenation decisions, together with the extra key strokes required to put in hyphenation, can increase printers' setting time by as much as 25%, it would seem reasonable to suggest that printers might conveniently abandon such a practice. It is interesting to reflect at this point that computer programs are now being written which perpetuate the practice of hyphenation and justification.

Experiment Three (a)

The materials used in the experiments described so far have been typewritten cyclostyled sheets, and it may well be argued that students are used to a variety of layouts with such materials. In the following experiment, however, printed extracts from the passages were used.

Much research has been done with justified text on line length, and the relative merits of a single or two-column format (see Foster, 1970, for references), but as far as the authors are aware, these issues have not been examined with unjustified text. In this experiment two versions of extracts from the passages previously used were prepared and printed. In brief, one version utilised a two-column format with short line lengths (approximately 50 mm. each) and the other version utilised longer line lengths (approximately 85 mm. each). Both passages were printed in each version (Table I, Examples 4 and 5). In more technical detail, each text was printed in letterpress, Monotype Baskerville, Series 169, 9-point 9 set, cast on a 10-point body. New paragraphs were shown by a one-line space, with no indentation. Word space was standard throughout at 4 units of

set. One version of the text had maximum permissible line lengths of 13 pica ems, the other 20 pica ems—both had an inter-column space of 1 pica em. Line length was determined by the rule that breaks would occur at the point when no more words could be fitted by the machine compositor to the line without hyphenation.

The differences in line length in this experiment were not just arbitrarily chosen. Both measures can be used with a standard A4 (210 mm. × 297 mm.) page size, although the length of 13 ems is more usual in a three-column structure. The relationship can be seen more clearly in that three columns of 13 ems with 1 em inter-column space produces an information area 41 ems wide (approximately 173 mm.) and that two columns of 20 ems each with 1 em inter-column space also totals 41 ems.

The experiment followed the same general pattern as before, except that in this experiment the reading time allowed was $2\frac{1}{2}$ minutes, and no test questions were asked. Subjects were informed that there would be no test questions, and that simply "natural reading speed" was being assessed. Following the experiment the standard questions were repeated. In this experiment College of Education students were used as subjects.

Results. The main results of this experiment are shown in Table IV, and like the others, largely speak for themselves. There was no significant difference between the mean number of words read for either version of the passages, nor was there any significant differences between the results obtained by either sex.

Experiment Three (b)

It has been argued in previous research that reading speed over such a short period of time is not a particularly sensitive measure to use, and in particular that a *scanning* measure might be more appropriate (see Foster, 1970). Accordingly, therefore, the above experiment was repeated utilising such a method as described by Poulton (1967). Subjects were provided with the passages, and with lists of phrases from them, each phrase having a word omitted. Subjects' task was to scan the text for target phrases and write in the missing word on the response sheet. Phrases were selected from successive parts of the text at approximately equal intervals, thus the more the subjects

TABLE IV. The means and standard deviations obtained for the double-column format with different line lengths, using two measures; (i) reading speed and (ii) scanning score.

		Double-Column Format with Short Line Length (Maximum possible, 13 ems)		*Double-Column Format with Long Line Length (Maximum possible, 20 ems)*	
		Number of Words Read	*Scanning Score*	*Number of Words Read*	*Scanning Score*
Men	$\bar{X}$	619	7.58	656	7.31
	sd	160	2.56	192	2.15
	N	10	19	10	19
Women	$\bar{X}$	588	10.36	584	9.86
	sd	87	2.44	151	2.00
	N	19	14	19	14
Total	$\bar{X}$	599	8.76	609	8.39
	sd	118	2.86	170	2.44
	N	29	33	29	33

read in the time available, the higher their scanning score. As before, each subject was allocated at random into one of the four experimental conditions. They were instructed that they were to scan the text and write in the missing words, and that they would be given a set period of time in which to do this ($2\frac{1}{2}$ minutes). It was emphasised that there would be no test questions afterwards, and that the phrases were in order. Following the completion of the scanning of the two passages, subjects were asked the standard questions. Subjects in this experiment were first-year psychology students attending a laboratory class.

Results. The results of this experiment are also shown in Table IV; again, they are clearcut. There was no significant difference between the mean scanning scores obtained for either version of the passages, but there were marked sex differences: the women students scoring significantly more than the men ($p<.01$ in both cases).

An analysis of responses to the standard questions given after these experiments indicated that within the subgroups of College of Education students and under-graduates, the results were substantially similar. Answers to question 1 (Which passage did you prefer, A or B?), the indirect preference measure, indicate that overall there

was a preference for the shorter line length, and this difference was significant. In answer to question 2 (Which layout do you prefer?), 37 subjects preferred the double-column format with the short lines, 24 the longer lines, and one expressed no preference. It is perhaps worth observing at this point that the undergraduates were more disposed towards the shorter line lengths than were the College of Education students. Again, marked and contrasting statements were made in response to question 3, although, generally speaking, the short lines were preferred because they were "easier to read." Some subjects commented that scanning was easier with short lines, "Your eyes only need to go in one direction: down"; although, of course, opposite views were expressed, "With longer lines I could scan more in the same time."

Discussion. The main finding in these two related experiments was that line length did not affect reading speed—when measured by word counts, or by scanning. It is difficult to relate this finding to previous research, for such research has used justified text. An inspection of Examples 4 and 5, Table I, show the unjustified settings produced quite irregular line lengths. Burt (1959) using justified text, reported that (for 10-point type) line lengths shorter than 20 ems retarded reading speed, although these findings contradicted those of Paterson and Tinker (1940). Poulton (1959) found that single-column arrangements were read more rapidly than double-column ones, but he altered the type-sizes in producing the different versions of his passages. Foster (1970) showed, using the same type size, that a double-column justified format (line lengths of 17 picas) was read more quickly than a single-column justified format (line length 36 picas).

Foster (1970) measured the differences found in his experiment by the scanning method. It is not clear from the results obtained in our experiment that scanning is a more sensitive measure than reading speed. Clearly, overall, there was no measurable difference produced by the reading speed or the scanning measure, yet there was a sex difference with the scan procedure which was not found with reading speed. It would seem, then, either that scanning is more sensitive or that it is setting subjects a different task, one which is susceptible to sex differences. No previous investigation, to our

knowledge, has reported sex differences with the scanning measure, and few of them say whether or not they used one sex or both for their subjects.

Concluding Remarks

These experiments taken together would seem to indicate that unjustified text is robust: that is, it can be quite markedly manipulated without affecting reading speed or comprehension. Furthermore, the attitudes expressed have tended to favor the shorter and the more uneven lines.

Such conclusions are, of course, over-generalizations from limited studies. In the first two experiments the passages were typed rather than printed, and students (well used to a variety of typing styles) were employed as subjects. Furthermore, the conditions of the experiments were all kept very simple. Typography is remarkable for its number of variables—all of which interact—i.e. size and style of type, spacing between words and lines, line length, etc. Systematic research, varying one or two features at a time, ignores this complexity. Looking to the future, one needs to consider the relationships between the content of the material, its typesetting, and methods of assessing efficiency. Short lines may be a more appropriate way of setting—and scanning a more appropriate measure to use—when the material is more disconnected than that used in the experiments described, and when speedy retrieval of information (e.g., from a catalogue) is the prime requirement rather than comprehension.

Finally, it might be considered, in view of our introductory remarks, that researchers' and printers' concern over line endings is misplaced. Perhaps more attention should now be focused on general layout, relative to the kinds of material being printed, and, in particular, attention should be drawn to the relative position of the *beginning* of textual elements. It is indeed remarkable that, when our reading convention is from left ro right, we spend most of our time considering how to end rather than where to start.

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Book Review

E. Nicolette Gray, *Lettering as Drawing: The Moving Line* [volume 1] and *Contour and Silhouette* [volume 2]. London: Oxford University Press, 1970. 96 pages each with many black and white illustrations. 75 new pence. Paperbacks.

The three titles of the two books need further definition: the author's thesis is that western lettering has shown in the past abstract and expressionist qualities of line (essentially line, since we are the inheritors of a calligraphic culture) that can be drawn upon by both contemporary painters in the putting down of poetry, and for the wider uses of graphic designers. Amongst the 200 illustrations are all the qualities of master drawing—precise line in weight and direction, assurance of execution, interest in composition, and an expression of the literary or emotional content.

Let the author state her own case—"The object of this book is to provide a vocabulary as wide and as sensitive as possible upon which such artists can draw; a vocabulary which has both historic and formal ramifications. . . . We can take over letters which are no longer our own . . . reuse as shape or movement and forget its origin. The training of a generation of abstract art has given us this power. The modern artist has his own, new variations and expanding skills, but his lettering vocabulary is tiny." Drawing teaches one to look and understand, and calligraphy is a hard discipline allied to drawing; the case for calligraphy in the art school curriculum is unchallengeable—but what sort of calligraphy?

Books for Review
Publishers should send books and other materials for review in *Visible Language* to either of two addresses:
Europe—M. Fernand Baudin, c/o Visible Language,
64 rue du Village, Bonlez par Grez-Doiceau, Belgium.
All other publishers—Editor, Visible Language,
c/o The Cleveland Museum of Art, Cleveland, Ohio, USA 44106.

The need for a change in formal patterns for calligraphy has been long recognized. Whether there is a need for change of direction that other non-calligraphic lettering is already taking is more arguable. Mrs. Gray argues it does, linking Herbert Bayer and geometry—"too easily accessible" and can lead "to a uniformity far more rigid than that of the academic *trajan*" and "it arrives very quickly at total illegibility and so ceases to be lettering."

To my mind these are deficiencies in the letterer, they are not immutably the deficiencies of geometry—what's more total rigidity has nowhere been more apparent than in the work of the disciples of Edward Johnson (non-geometric) and illegibility is near at hand in the examples by Mrs. Gray's own students.

The strictures on illegibility are unevenly applied in this book—spectacular opening pages from seventh-, eighth-, and ninth-century manuscripts are given the greatest importance but they may well have appeared then as they do now—almost completely illegible. *However they were designed for times when there were a limited number of texts and the reader certainly knew the gist of them before he opened the book.* Early manuscripts were often just for looking and wondering at—not a good premise on which to build twentieth-century letterforms.

These two books, then, are best considered as an important exposition of the quandary of contemporary lettering—and it is not profitable to show us that much of the most imaginative lettering of the past is now and probably was then—unreadable. However, if the books are only about "Lettering as Drawings," then the passages on comparative legibility and reflections on literary content are irrelevant.

In the second volume, *Contour and Silhouette*, single letters are examined; this is done again within an historical context and then worked through to what is inherent in them for lettering today. But to dwell on capitals, as the author does when there are lower-case letters to explore, is to tie a letter designer's right hand behind his back.

The most fruitful line of exploration advocated in this second book is: think through gothic out towards its *art nouveau* manifestations. Certainly this is better than pseudo-*art nouveau*; but are not these styles now also alien to us? There are much more solid achievements to be made with roman lettering, *which is by no means worked out.*

Often contemporary lettering that is linked to historic forms looks anachronistic; for, in fact, many of the great varieties of letterform that were practised in the past have no continuing tradition—especially in English-speaking cultures.

Where contemporary examples of lettering do not hark back, the author's description of some modern work of the Letteristes too often comes

to mind—"not seen to have got much beyond the nihilist stage." But drawing on the past is the essential thesis of this book, and I think the value of study of the past as a main source of ideas needs to be questioned.

Necessity (the needs of today) *is the mother of invention; history is best read for its own sake.* This needs no further justification, especially here in these books where the historical examples are very, very splendid.

Colin Banks

Colin Banks is a principal of Banks and Miles, a design group in London currently engaged (amongst more general work) on the design of a new typeface for The Post Office and several display alphabets for photocomposition. He is a calligrapher; but one who has drawn faces for cathode ray tube high speed typesetting systems. He is a frequent contributor to this journal.

Correspondence

The editors welcome comments on articles, reviews, and letters that have appeared in past numbers. Communications should be addressed to the Editor, c/o The Cleveland Museum of Art, Cleveland, Ohio, USA 44106.

To the Editor:

The article, "Some Thoughts on the Use and Disuse of Diacritics" [Autumn 1970, pp. 317–326] by Louis Marck is an excellent piece of work —except for a gap in the author's information and understanding which I find incredible (and you, as editor, should have made some effort to define, if not fill, the gap).

Marck discusses the use of diacriticals in a feasibility-vacuum. His implication is that whether or not a publication uses such marks, and uses them correctly, is solely a matter of knowing what is correct and insisting that the printer come up with what is specified. For instance, he waxes scornful over *The New York Times* not carrying accented characters in its headlines.

Now, any good compositor equipped with a saw-trimmer, a jack-knife, a steady hand, and unlimited time can carpenter up almost any accented character (in display sizes of hand-set type); at a cost, maybe, of five to twenty dollars each. The point is that a font of display type, in the United States, does not normally include any accented characters, and improvising them is seldom practical.

In machine-set straight matter, the reality parameters are different. Every accented character requires a special matrix. A well-equipped book or publication printer will have at least the common ones for his work-horse fonts. Few, if any, printers will have *all* the mats that might be called for. If some are missing that are needed for a given job, the printer might be able to take his mats to an engraver and get simple graves, acutes, umlauts, etc., tooled into the mats. But if he needs accented full caps, in Linotype, he is in trouble (unless he can wait a few months to get them from the manufacturer). And if he is a purist about letterforms as well as diacriticals, he shouldn't be working with Linotype at all, since there is no space above a capital letter to add *anything*; hence, accented full caps are specially cut, with a smaller-than-normal letter.

You should know. That issue of JTR was Monotype-set; Monotype can carry leading at the top of the line, thus making room for accents, bars, whatever. Some of us can't often afford to use Monotype!

Photocomposition is something else again. Some processes employ "floating" accents that can be used like the "dead" keys on multilingual typewriters; some don't. But with photocomposition there is always the possible last resort of doctoring the camera copy with pen-and-ink.

It is a real contribution to have such a knowledgable article as Louis Marck's on the linguistics of diacriticals. But those who work with real type and real type images, need to know what is possible and what isn't.

Freeman Champney, Production Manager
Syracuse University Press
Syracuse, New York 13210

A Reply to Freeman Champney

The question of feasibility in the use of diacritics was dealt with in my article from a deliberately layman-like point of view. After all, we "consumers" of print far outnumber the "producers" who "work with real type." Mr. Champney seems to regard his "reality parameters" as somehow God-given and immutable. But, as in other fields, consumer demand for changes could very well force the producers to institute them. What is presently "impossible" would then become "possible," and "normal" U.S. "display" type would live up to its name. And the pronunciation of the name of a Venezuelan horse would not unaccountably change between the Derby and the Preakness. The trouble is that cold print is looked upon with a special kind of awe and that the progressive disregard of diacritics by the producers of print has made the average consumer less and less aware of what is being withheld from him. In some instances, such as that of the inverted circumflex, this lack of awareness has reached total ignorance, hence total lack of demand, hence all but total lack of supply. It is in recognition of this trend that I concluded my article with the evidently somewhat utopian international standardization/elimination alternative.

Professor Louis Marck
Department of Modern Languages
Polytechnic Institute of Brooklyn
Brooklyn, N.Y. 11201

To the Editor:

A French textbook that I am using for the first time has just rekindled one of my pet peeves of long standing: the absurd, the criminal, and definitely "internationally irresponsible" use of a lower-case italic *h* that is barely distinguishable from a *b*. Thus I couldn't stop myself from reading that the Légion d'Honneur was the "BIGBEST" French decoration. To me, this particular typeface (who is historically responsible for it??*) is literally a pain in the eye; when used in books on linguistics, and I have seen it so used—and in poorly printed ones at that and with Sanskrit examples (*bh*!)—it can become a catastrophe, and I for one would hound the printer until he uses an italic font having *h* instead of *b*. If this journal could mount a campaign resulting in the abolition of this typeface, future generations of readers would be in its debt.

Professor Louis Marck
Department of Modern Languages
Polytechnic Institute of Brooklyn
Brooklyn, New York 11201

* Editor's note: the examples we have inserted into Dr. Marck's letter are 14-point Monotype Garamond (Series 156 Italic). Does any reader wish to comment on the historical derivation of this form of the italic h, or possibly on the design considerations?

Résumé des Articles

Traduction: Fernand Baudin

Un prototype de mise en page par ordinateur *par Aaron Marcus*

Il existe déjà des programmes pour la composition et le titrage. Il est temps de songer à une mise en page programmée à l'usage des graphistes. L'article décrit un programme prototype conçu pour explorer les difficultés et les ressources de la mise en page par ordinateur. L'expérience porte essentiellement sur la représentation de la page par un écran à faible définition et sur les diverses possibilités d'intervention: ajouter, effacer, déplacer les blocs de textes et d'images. La mise en page ainsi obtenue aurait l'avantage d'être exprimée dans les mêmes termes que les programmes de composition existants.

Les noms des lettres dans l'alphabet latin *par Arthur E. Gordon*

Les noms des lettres de l'alphabet romain, par rapport au grec par exemple (alpha, bêta, gamma, etc.), n'ont encore fait l'objet d'aucune étude approfondie. L'article *rappelle* quelques théories et les conséquences qui en découlent. Le peu de documents vraiment anciens (II^e siècle av.-J.C.–VII^e A.D.) n'est guère probant et n'apporte pas de lumières suffisantes sur la question. Les noms des voyelles et des consonnes sont connus sauf les F,L,M,N,R,S,X dont les norms ont varié et ne se sont fixés qu'à partir du IV^e A.D.

Un projet d'écriture manuscrite pour lecture optique *par Makoto Yasuhara*

L'auteur propose un type d'écriture qui transposerait dans le domaine de la lecture optique des concepts formels correspondant à ceux qui interviennent dans l'analyse et la synthèse de la parole. Le projet est ensuite examiné du point de vue théorique et du point de vue pratique.

La calligraphie des moines Ch'an et Zen *par Jan Fontein et Money L. Hickman*

En dépit de leur défiance à l'égard de la parole et de l'écriture, les moines des sectes Ch'an et Zen ont produit une quantité énorme d'écrits sous forme de livres et de documents. Au point que l'art calligraphique où ils voyaient l'expression la plus complète de la personnalité du scripteur était presque devenu une mystique. Toutefois, les chinois mettaient moins l'accent sur l'aspect individuel alors que pour les Japonais c'était une question de prestige même dans la société laïque. Quelques spécimens sont reproduits et commentés.

Expériences de lectures sur des compositions non alignées à droite *par James Hartley et Peter Burnhill*

Trois séries d'expériences ont été faites avec des textes non alignés à droite: (1) des textes où les fins de lignes étaient déterminées par la syntaxe ont été comparés avec des textes non alignés ordinaires; (2) des textes dont un tiers environ des lignes étaient coupées ont été comparées avec les mêmes; (3) des mises en page sur deux

colonnes de justifications différentes mais toujours non alignées à droite ont été comparées entre elles. Aucune différence significative n'est apparue nulle part dans les vitesses de lecture. Toutefois, à l'examen, il s'est trouvé que les réactions aux spécimens de la série 3 variaient significativement selon le sexe. Dans les séries 1 et 3, les étudiants ont marqué une préférence pour des lignes courtes et assez irrégulières.

Kurzfassung der Beiträge

Übersetzung: Dirk Wendt

Prototyp eines automatisierten Seiten-Gestaltungs-Systems *von Aaron Marcus*

Der graphische Gestalter braucht ein automatisiertes Gestaltungs-System, das es ihm erlaubt, die Möglichkeiten der verfügbaren automatisierten Setz- und Umbruchsysteme auszunutzen. Dieser Aufsatz beschreibt ein Prototyp-System, das die Probleme und Möglichkeiten der Computer- Benutzung zur Seiten-Gestaltung untersuchen soll. Zwei Gesichtspunkte der Untersuchung sind die angemessene Darbietung graphischen Materials auf einem fernseh-bildschirmartigen Wiedergabegerät mit geringer Auflösung und die Entwicklung von Zwischenstufen. Die Möglichkeit zum Einfügen, Auslassen und Verschieben von Blöcken von symbolisierten Buchstaben und Darbietung auf dem Bildschirm hat den Vorteil, daß die computergeschaffene Form unmittelbar vereinbar mit den automatisierten Setzsystemen ist.

Die Buchstaben-Namen des lateinischen Alphabets *von Arthur E. Gordon*

Weder in gegenwärtigen noch in früheren Studien der lateinischen Sprache ist es gelungen, in angemessener Weise die Buchstaben-Namen des lateinischen Alphabets anzugeben und zu diskutieren—im Gegensatz beispielsweise zum griechischen Alpha, Beta, Gamma usw.
Verschiedene Theorien über die Buchstaben-Namen werden samt ihrer Herleitung dargestellt. Die Belege aus der Antike—vom dritten bis zweiten vorchristlichen Jahrhundert bis zum siebten nachchristlichen—sind ziemlich spärlich und nicht überall klar. Während die Namen der Vokale und aller Konsonanten mit Ausnahme der Dauerlaute (F, L, M, N, R, S, X) gesichert erscheinen, haben die Namen dieser Dauerlaute im Laufe der Geschichte anscheinend Veränderungen erfahren und sind nur bis zum Ende der Antike (vom Ende des 4. Jahrhunderts A.D. an) eindeutig.

Auf dem Wege zur Analyse und Erkennung von Handschriften *von Makoto Yasuhara*

Ein dynamisches Modell für den Vorgang des Schreibens mit der Hand wird vorgeschlagen, um in das Gebiet der Erkennung menschlicher Handschriften

formale Begriffe einzuführen, die denen der Methode der "Analyse durch Synthese" in der Sprachanalyse entsprechen. Das vorgeschlagene Schema wird sowohl unter dem theoretischen als auch unter dem experimentellen Gesichtspunkt diskutiert.

Die Kalligraphie der Ch'an und Zen-Mönche *von Jan Fontein und Money L. Hickman*

Die Ch'an und Zen-Mönche produzierten eine überwältigende Menge geschriebenen Materials in Buchform und in handgeschriebenen Dokumenten, obwohl in den Konzepten ihrer Sekte jede Abhängigkeit von Worten und Buchstaben vermieden wurde. Die Kunst der Kalligraphie—bokuseki—wurde zu einer Art Mystik, weil man glaubte, daß sie die ganze Persönlichkeit des Schreibers ausdrücken könnte. Die hochgradig persönliche Kalligraphie hatte in China keinen so starken Einfluß wie in Japan, wo sie einen hohen Stand erreichte und ausgiebig in der weltlichen Gesellschaft nachgeahmt wurde. Exemplarische Beispiele werden gezeigt und diskutiert.

Experimente mit Flattersatz *von James Hartley und Peter Burnhill*

Es werden drei Einzelexperimante beschrieben, in denen verschiedene Anordnungen von Flattersatz verglichen werden: (1) Textstücke mit Zeilenenden, die durch syntaktische Überlegungen bestimmt sind, wurden verglichen mit Textstücken im üblichen Flattersatz; (2) Textstücke, in denen etwa ein Drittel der Zeilen mit Worttrennungen endete, wurden verglichen mit demselben Standard-Flattersatz; (3) Doppelspalten-Umbrüche mit Flattersatz in verschiedenen Zeilenlängen wurden untereinander verglichen. In keinem dieser drei Experimente wurden signifikante Unterschiede gefunden, obwohl im Experiment 3 ein Unterschied zwischen den Geschlechtern bestand, wenn eine Schnell-Lese-Methode benutzt wurde. In den Verständnistests wurden keine Unterschiede gefunden. Meinungsäußerungen der Studenten in Exp. 1 und 3 zeigten Neigung zur Bevorzugung kürzerer Zeilen mit stärker verschiedenen Endungen.

This number of *Visible Language* has been composed in Monotype Baskerville types and produced by W. & J. Mackay & Company Ltd., of Chatham, England, on Bowater B20 Cartridge, 100 gm². The layout is based on the original design by Jack Stauffacher of the Greenwood Press, San Francisco.

The Authors

Aaron Marcus is an assistant professor at Princeton University (Princeton, N.J. 08540) in the School of Architecture and Urban Planning and in the Visual Arts Program. He holds a B.A. degree in physics from Princeton and B.F.A. and M.F.A. degrees from the Yale School of Art, department of graphic design. Mr. Marcus teaches basic design and graphic design at Princeton and is also a freelance graphic designer. He has been a visiting lecturer at the Yale School of Art and a consultant in computer graphics at Bell Telephone Laboratories, Murray Hill, N.J., where the work described in this article was recently completed.

Arthur E. Gordon (P.O. Box 97, Inverness, Calif. 94937) has from 1930 to 1970 been in the Department of Classics at the University of California, Berkeley; he will conduct a seminar on Latin epigraphy at Ohio State University this autumn. He is the recipient of many research fellowships and has been active in philological and paleographic groups. Dr. Gordon has published widely on Roman religion and especially on Latin epigraphy; e.g., *Album of Dated Latin Inscriptions* (with the cooperation of Joyce S. Gordon), 4 parts in 7 volumes, University of California Press, 1958–65.

Makoto Yasuhara is an instructor at the research laboratory of communication science at the University of Electro-Communications (14, Kojimacho, Chofushi, Tokyo, Japan). His research objectives are concerned with information and computer sciences, artificial intelligence. Dr. Yasuhara is a member of the Institute of Electronics and Communication Engineers of Japan, the Information Processing Society of Japan, and IEEE.

Jan Fontein was born in the Netherlands and studied Chinese, Japanese, and Southeast Asian archaeology at the University of Leyden. For many years he worked at the Museum of Asiatic Art in the Rijksmuseum in Amsterdam, first as an assistant and, after 1955, as its curator. In 1966 he joined the staff of the Museum of Fine Arts in Boston as the curator of the Department of Asiatic Art. Among his many publications is *The Pilgrimage of Sudhana* (The Hague, 1966).

Money L. Hickman holds the position Fellow for Research in Japanese Art at the Museum of Fine Arts in Boston, Mass. 02115. He has spent nine years in the Far East and studied at Berkeley, Kyoto, and Harvard. He is interested in the traditional art form of East Asia, particularly those of Japan.

James Hartley obtained his Ph.D. in 1964 from the University of Sheffield, England. Since that date he has worked extensively in the field of programmed learning and educational technology. During 1970–71, Dr. Hartley was visiting scholar at the Institute for Research in Human Abilities, Memorial University, Newfoundland, Canada. At present he is lecturer in psychology at the University of Keele, England.

Peter Burnhill is head of the Department of Visual Communication Design at Stafford College of Art and Design (The Oval, Stafford, England). He is a member of the Steering Committee of the independent Working Party on Typographic Teaching.