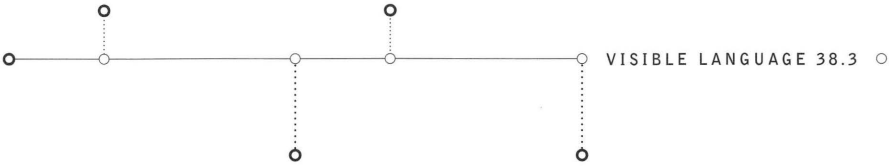
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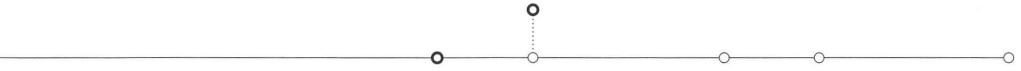

TOWARDS A READER-FRIENDLY FONT:

RATIONALE FOR DEVELOPING A TYPEFACE THAT IS FRIENDLY FOR BEGINNING READERS, PARTICULARLY THOSE LABELED DYSLEXIC

Larry D. Reid, Meta L. Reid & Audrey Bennett

ABSTRACT

A critical step toward becoming a fluent reader is learning to recognize, name and distinguish the letters of the alphabet. This difficult task is often a point of failure. The task, however, can be made easier and less prone to failure. This article, based on research by cognitive scientists, provides guides for how to design a font that will help children to learn to read. The article also summarizes the latest research that indicates that slowness in learning the initial steps toward fluent reading, for example, the ability to distinguish letters, has profound, lasting effects on the organization of the brain. Developers of fonts, therefore, can make a significant contribution to the intellectual development of our children by using their skills to design a lettering system, along the lines suggested here, that will be easier to learn.

INTRODUCTION

WE WANT ALL CHILDREN TO LEARN TO READ WELL. WE HAVE A NATIONAL goal that no child should be left behind. Unfortunately, reality falls far short of our aspirations. Developmental reading disorders, not explainable by mental retardation, by grossly inadequate schooling or by vision or hearing disorders, occur among about four percent of the children in the United States (American Psychiatric Association, 1994). Developmental dyslexia is not rare. Further, it is the most common problem among those referred to clinics specializing in learning disabilities. Also, we have many teenagers and adults who, although they can read, are not fluent, expert readers.

Many children who initially have problems learning to read eventually develop reading skills. Nevertheless, there is mounting evidence showing that initial failures in learning to read and write, at the times most children learn these skills, have profound, lasting effects. A consistent observation is that children who have difficulty learning to read in the first grade later have (e.g., in their senior years of high school) fewer academic, cognitive skills than their counterparts. Stanovich and his colleagues (1992, 1992) have data to indicate that part of the reason for the persistent deficit is related to

the observation that children who have difficulty learning to read do not like to read and eventually spend considerably less time reading than their counterparts. Our general knowledge of expertise indicates that the critical variable in becoming an expert is time on task. Evidently, the same general rule is applicable to becoming an expert reader. It is time on task that is the salient variable and, typically, children who are initially slow learners never spend sufficient time on task to become fluent readers.

In Portugal, in the past (circa 40 years ago), the first-born girl was kept out of school and at home to attend to younger children and hence failed to learn to read and write. Girls and boys born later were sent to school, at about six years of age, and learned to read and write. Castro-Calsas and Reis (2000) took advantage of this situation and modern technology, in order to study the cognitive and neural processes that follow from becoming literate. A conclusion that can be drawn from their work is that the processes that are learning to read and write are also processes that lead to a rather dramatic reorganization of the brain. They found, for example, that the major fiber tract connecting the two halves of the brain (corpus callosum) was smaller, at some segments, among illiterate adults than literate controls. So, children who do not become fluent readers and writers may, in fact, have different brain development than those who are fluent readers and writers. This difference, however, is not because of some inherent maturational process that was apt to occur regardless of the kind of education the child were to receive, but because the child did not learn and practice the skills inherent to fluent reading and writing.

Another line of research supports the conclusion that the acts of learning to read are sufficient to modify the structural features of brain. Recently, Simos et al. (2002) showed that 1) children with reading problems (i.e., showed dyslexia) had a different brain organization as manifest in patterns of electrical activity across certain cortical areas of brain and 2) intensive training in learning to read modified that pattern of activity so that it became very similar to that of reading children. These data complement those of Castro-Calsas and Reis (2000). The structure of the brain might be different between readers and non-readers, but that difference is not fixed.

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The complicated process of learning to read and write is not only a process to master, but also a process that sets into motion other processes that are critical to developing the brain for reading-fluency. We also surmise that such development is critical for the development of other cognitive skills. This perspective makes it imperative that we make the process of learning to read as easy and as failsafe as possible.

The research (Adams, 1990; Snow, 1998) is sufficient to draw some reasonably definitive conclusions regarding the first steps in learning to read and write. Bond and Dykstra (1967) found that the best predictor of those who will be reading at the end of the first grade of school is knowledge about letters. Meta analyses of the literature accumulated subsequently confirm that observation (Snow, 1998). Merely measuring how many letters a kindergartner can name successfully predicts future reading success. The next best predictor was ability to discriminate phonemes. Barker (2001, 424) commenting on these findings said, "These are not mutually exclusive skills. If the letters b and p are to be learned, the child has to hear the differences between these two sounds as well as recognize the differences in their letter shapes."

We generally do not remember how difficult it was to learn to read. What seems obvious to adults may not be so obvious to a child just learning about letters and words. As adults, for example, we often presume it is obvious that the spaces between groups of letters denote words. Research, however, has indicated that for many children that is not obvious. Meltzer and Herse (1969) printed sentences on long strips of paper while exaggerating the space between words. They then asked children to count the number of words and to cut with scissors between words. What seems obvious to readers did not seem obvious to nonreaders. Sometimes "words" were just a string of a few letters (short words are the words of the beginning books for children). Sometimes "words" were individual letters. Sometimes "words" were letters with a tall letter at the beginning of a string of letters. So, even what may appear to be obvious probably should be taught. We should plan on attending to everything that might be necessary to becoming a reader.

A prerequisite for learning to read is to be aware of text in print as something distinct from other features of the environment. The child needs to appreciate that print conveys information. This basic understanding can be accomplished by a parent reading to a child. There are, however, children who arrive at school without the experience to have gained this basic insight. So, the first step in learning to read is to gain something called print awareness (Adams, 1990), i.e., awareness that text in print is an important feature of the environment.

LETTER IDENTIFICATION IS CRITICAL

THE NEXT TASK FOR THE BEGINNING READER IS LETTER IDENTIFICATION. It is not easy to learn the names of the 26 letters of the English alphabet. They are symbols that are graphically abstract having no iconic significance. The child must learn that the name of the upper case letter is the same as the lower case letter even though they may not look alike. Then, there are the 10 digits of the numbering scheme. Also, one must learn about punctuation marks. After the names of the letters have been mastered, there is the chore of learning that these letters connote sounds. Of course, letter identification is critical to recognizing and spelling words, hence is critical to the entire process of gaining reading fluency.

After making the point that an initial step in learning to read is recognizing individual letters accurately, Adams (1990, 130) makes a second, related point that is relevant. She said, "... for the development of word recognition proficiency to proceed at its optimal rate, young readers must be able to recognize individual letters relatively quickly." Letter identification, that is, must be "over learned" and free of confusion and hesitation.

There are teachers who have tried to simplify the learning by not teaching the names of letters but labeling letters with sounds that they will eventually connote. Adams (1990, 351) reviewed the available evidence germane to assessing the success of this approach and decided that it was not particularly helpful. The main point of the discussion seemed to be that "there is, in itself, pedagogical power in having a label for a to-be-learned concept." The label becomes a focus of the many associations that will be used as the learning proceeds.

THE LEARNING PROCESS FOR LETTER IDENTIFICATION

BARKER (2001, 424) ECHOES ADAMS (1990) IN COMING TO THE conclusion that "no special cognitive mechanism facilitates the learning of the elements of the printed language." The learning of letters follows the same basic learning principles that characterize other instances of rote learning. There is no magic here, just practice under conditions that allow learning. There has to be attention given to elements such as contiguity, recency, frequency and similarity of stimuli. Consistency and predictability are highly salient. This learning, like other learning, is a product of both discrimination and generalization. The child must learn the invariants of letters across situations as well as learn the distinctive characteristics of the letters.

Given the importance of flawlessly learning the letters and the demand characteristics of that learning, what can the typographer do to make the learning easy rather than difficult? Can the art of lettering be brought to bear on issues of learning to be literate? We obviously believe that the answer to the latter question is yes.

TYPOGRAPHERS AND DESIGNERS OF WRITING SYSTEMS CAN MAKE A DIFFERENCE

A GOAL FOR TYPEFACE DESIGNERS MAY BE TO DESIGN FONTS THAT appeal to certain aesthetic standards. There is a marked tendency, for example, to use the same graphic elements over and over again in order to create visual consistency across the entire font. A consequence is that letters are often difficult to distinguish from one another, particularly for novice readers. The lower cases o, c and e of many fonts, particularly those used in material presented to beginning readers, are often designed from the same graphic element. If a child primarily attends to the left or right of letters or the bottom or tops, as they might initially, these letters will not be distinguishable.

To eliminate this potential source of confusion, we urge typeface designers to use their aesthetic expertise to design letters that are distinct. This will take creativity and a willingness to diverge from certain aesthetic standards in type design. A slight divergence from some rather arbitrary standards, however, seems a small price to pay for the benefit of helping children to learn to read. The goal should be to design letters that are distinct from one another and distinct

from numerals and punctuation marks. This will aid children in learning to name and distinguish letters and to use letters to form words. One can guess that it might even be critical for some children, because, for example, it is very confusing to perceive a shape and know it is an o and then be told it is a c and then later to perceive it is a c and be told it is an o and to have that happen time and time again for letter after letter. It is enough to frustrate almost anyone.

As mentioned, there is a necessity for some speed in letter identification. Such a requirement dictates that letters should be distinct and clearly legible. As will be discussed shortly, there is also the confusion that occurs with letters being tightly kerned (i.e., too close to one another) which can be remedied by skillful design.

The acts involved in learning to print are conducive to learning to identify letters and to learning that letters are elements of words. Given this circumstance, the typeface developed to be friendly to beginning readers should correspond to the templates that are used to teach children to print. Unfortunately, the templates used to teach printing do not correspond to the goal of having letters be distinct from one another. The resolution is to "morph" the two, i.e., the standards for the templates for printing can be modified slightly and the typeface can be slightly different from the templates. The goal is not necessarily to have perfect correspondence, but merely to have easy generalizations from one rendering of a letter to another. There should be positive transfer between learning to identify and name letters to learning to write letters by hand. Unfortunately, occasionally, the typeface used to teach reading presents the circumstance for negative transfer, i.e., the learning of one task interferes with the learning of the other.

We are advocating that the developed letters of a friendly font should be distinct from one another, but not widely different from templates used to teach writing. There should also be easy generalization, for a given letter, between upper and lower case letters. The circumstance with the letters c and x are nearly ideal. They are clearly different from one another. Between upper and lower case, they look alike, except in size. Further, the standards for these letters for printing and even cursive script are similar to the letters in most fonts.

Unfortunately, the differences between c and other letters, e.g., o and e, do not conform to the ideal of ability to distinguish them across letters, particularly in lower case. Further, uppercase E and lowercase e have a number of features that indicate that they are different from one another.

Notice that arranging it so that there is an easy generalization between upper and lower case letters considerably reduces the task faced by the beginning reader. It does not reduce the task by half (only some letters can be designed to be easily generalized from one case to the other), but does reduce the tasks considerably. The letter G presents a difficult design problem. There are as many as five forms of G, which are common in material usually presented to beginning readers, and each form is very different from the other. Devising a system in which each letter is distinct, but similar across cases, typeface and writing will indeed simplify the task and make it less confusing.

There is well-developed knowledge concerning the processes of visual perception and pattern recognition. We recognize shapes, including letters, by using feature identification. Further, we know that this process is a manifestation of the anatomy and physiology of the neural apparatus from the eye to the brain (Ashcraft, 2002). An implication of such specialization is that we should not change basic features of letters. Letters that are rounded should remain rounded because that roundness is a salient, basic feature. Other basic features include lines oriented vertically, horizontally and at forty-five degree angles. To be concrete, O, C and Q should not emerge as straight and angled lines, but should retain roundness while at the same time emerging as distinct.

As we inspected various fonts as potential candidates for use by beginning readers, we noticed that the spacing between letters presented many problems. For example, with some fonts, when the r was placed next to an n (i.e., rn), the result looked very much like m. Given this circumstance and its potential for confusion, it seems reasonable for a font for beginners to have distinct letters and when juxtaposed do not appear to be another letter of the alphabet. There may also be a need for graphic standards that dictate the type size, kerning and tracking of text set in a reader friendly font.

Though there may be some advantage to experienced readers to have ligatures like ffi appear as a unit as it does in some fonts (also, in some fonts ct and cl looks very much like d), there is almost no advantage to novice readers.

We understand that there is an extant body of thought indicating that fluent readers perceive the shape of a word rather than each separate letter and from that premise there may be some advantage to spacing letters close together (Bringhurst, 1992; Clair, 1999). There is considerable experimental evidence that can be brought to bear on this issue, which has been admirably reviewed by Adams (1990). Further, Adams conducted this review with the aid of a large panel of reading experts acting as advisors. A consensus emerged (also, see Snow, 1998). People read letters, but they get so good at it that among fluent readers it appears that they read words. Further, the goal remains for children to progress from nonreaders to fluent readers, which means they eventually have to process letters so efficiently that the percept is a word. The process, however, is processing letters. Further, since certain letters occur together more frequently than other combinations (i.e., there are spelling patterns), expert readers have the advantage of having learned this and that helps them to process letters more efficiently.

Knowing how people process letters to form words provides some guidelines for developing a font for beginners. We deduce that making the letters rather narrow will be an advantage. It will reduce some opportunities for confusion for beginning readers. It may even help experienced readers, but we found no strong evidence to bear on that issue. Expert readers have such a well-developed orthographic processing system, having so many associative nodules, that the slight differences in most commonly used fonts are probably not germane to efficient reading.

There is an alphabetic system, popular in Britain, which teaches reading by way of a "reformed," phonemically regularized alphabet. The system, the i/t/a curriculum (initial teaching alphabet), also uses marks to denote differences in vowel sounds. There is evidence that it is helpful to a number of children (Adams, 1990). Developing fonts using guidelines we are advocating here, however, can make some of the same gains. Further, the child will not have to unlearn

features to generalize to the common fonts used in most of our print media. The limited success of the i/t/a curriculum does indicate, however, that developing a font specifically for beginning readers will achieve some measure of success.

English has been labeled the language of dyslexia. Presumably, that is because so many words are spelled irregularly. It would be nice if that were not the case, but getting agreement to spell words more in accordance with the phonemes of their usual pronunciation is something that is beyond any of us. It is probably worth noting that ninety-seven percent of English words are spelled the way they are pronounced and many of the problem-words are partly phonetic. Nevertheless, designing narrow letters for a font has the advantage of potentially controlling more precisely the space between letters. Consequently, space can be narrowed to indicate digraphs, particularly those that always signify a given phoneme, e.g., qu and ph. If certain digraphs can be noted graphically, some of the confusion associated with irregular spelling can be reduced.

There is a consensus that lateral mirror images are a source of perceptual confusion. Recently, it was found that neurons of the inferotemporal cortex of the macaque-monkey brain responded equally well to b and d, indicating that there may be underdeveloped neuronal apparatus for making the visual distinction between mirror images (Rollenhagen & Olson, 2000). There are a couple of related ideas concerning the difficulty of perceiving the difference between mirror images. One is related to the fact that there has not been either phylogenic or ontogenetic pressure to perceive mirror images. To use the words of Rollenhagen and Olson (2000, 1506): "a tiger is equally threatening when seen in right or left profile." Their data, derived from recording relevant neurons, indicate a lack of specialization of neuronal machinery for making such a distinction. The other idea is related to the general bilateral symmetry of the central nervous system's visual apparatus. Left hemisphere neurons activated by a b must be linked to right hemisphere neurons activated by a d. Given the possibility for confusion, particularly among those whose neural apparatus are just developing and who have limited experience at detecting mirror images, it seems that we should just avoid making letters that are mirror images of one another.

There are clearly things we can do to make learning to read easier. We can make, for example, periods (full stops) more compelling than commas (half stops). Yet, in font after font, used in children's readers, the comma is commanding and the period is rather diminutive.

Eventually a child must respond correctly to the invariants of the thousands of slightly different ways each letter is presented. There has to be generalization from the letters used initially to those used eventually. The relevant rules of learning, however, are uncontroversial. Learning is slowed, retarded, when different stimuli call for the same response and the same response is to be elicited by different stimuli. It is most efficient to learn the response to some consistent stimulus and then generalization will almost automatically occur to similar stimuli. A child that learns to identify letters using one writing system, and learns that very well, is not apt to have much difficulty generalizing that learning to different fonts. The converse is not the case, however. Presenting many variants of a letter, with the hope of achieving generalization across fonts, is apt to be merely confusing and retard substantial learning.

We call for the development of a font that has distinctive letters, that is clearly legible, that has few or no mirror images, that eases generalization across upper and lower case and eases generalization from what is asked to be printed by the beginning reader and what is asked to be read. There should also be some consistency, when possible, from cursive script and the emergent font and some consistency from what is apt to appear on a computer screen and what is being presented to a beginning reader. This asks a lot. Yet, there is more. There is another criterion. The emergent font has to be clearly recognizable by expert readers. Further, the emergent font for beginning readers cannot appear peculiar, i.e., it has to generalize eventually to the other fonts of the print world. It should be different, but not too different. Of course, it should be as beautiful as its functionality will allow.

We have recommended a number of design characteristics that we deduce will be friendly to beginning readers and dyslexics. We have deliberately not provided any specific examples about how a particular letter ought to look. Our recommendations are derived from the expanding literature of cognitive science, typography and type design;

and, consequently, are subject to the same changes as the changing content of the science itself. We believe, however, that there is a sufficiently well-developed body of extant knowledge (Adams, 1990) to confidently conclude that by attending to the font presented to beginning readers that considerable progress can be made in helping our children. The talents of a number of designers all trying to devise a friendly font is apt to be the best way to get designs to meet the goal of having a friendly font for beginning readers.

Those interested in the art of lettering have often focused, recently, in making letters unique and attention attracting thereby achieving a goal of advertising. Those neuropsychologists interested in learning disorders, particularly dyslexia, have focused, recently, on classification and diagnosis of the disorders (Kolb, 1996). Until recently, the reading specialists have been focused on what has been called "the reading wars" (Snow, 1998) (incidentally, the polemic war is over and the decision has been made to let experimental science determine the value of various ways of teaching reading). With very few exceptions, e.g. (Sassoon, 2002), there seems to be a lack of focus on lettering for beginning readers by either developers of fonts, neuropsychologists or reading specialists. Obviously, by now, one of the goals of this essay has been to advertise the possibility of a font that is friendly for beginning readers and dyslexics. A number of neuropsychologists and other specialists might argue that, although such an enterprise is O.K., it will have only a marginal impact on the incidence of disorders of learning to read. Recall, however, the possibility that the differences in brain they might observe may be a result of failure to become literate rather than the cause of dyslexia. Also, meta analysis of the literature (van Ijzendoorn et al, 1994) on non word reading deficits (an index of phonological deficit which, in turn, indicates a poor central nervous system processing unit) in relationship to developmental dyslexia came to the conclusion that nonword reading deficits were common among those with developmental dyslexia, but only accounted for fifteen percent of the variance of the presenting problems. As the authors acknowledged, the occurrence of this deficit is statistically significant but leaves plenty of room for alternative explanations and approaches to the problem. They noted that some of the unexplained variance

in children's reading ability could easily be related to poor initial comprehension of basics such as letter identification. Because fonts have not been deliberately designed to be friendly for beginners, those who would complain that such an endeavor will have little impact have little basis for their conclusion.

Developing a font that is friendly to beginning readers, particularly those who might have dyslexia, takes design skills and knowledge of the chores of learning to read. If a child learns to read, the child will be exposed to completely new worlds, one of which will be the artistry of lettering. The artistry of lettering, however, for someone who has had trouble learning the letters is apt to be a source of grief rather than a source of pleasure. Let us move toward the time when everyone appreciates the art of lettering. Recall, no prevention is too early when dealing with our children.

Adams, M. J. 1990. *Beginning to Read: Thinking and Learning about Print*. Cambridge, MA: MIT Press.

American Psychiatric Association. 1994. *Diagnostic and Statistical Manual of Mental Disorders,* (4th ed) Washington, DC: American Psychiatric Association.

Ashcraft, M. H. 2002. *Cognition* (3rd edition). Upper Saddle River, NJ: Prentice Hall.

Barker, L.M. 2001. *Learning and Behavior* (3rd ed). Upper Saddle River, NJ: Prentice Hall.

Bond, G.L. & R. Dykstra, 1967. Cooperative research program in 1st grade reading instruction. Reading Research Quarterly, 2, 5-142.

Bringhurst, R. 1992. *The Elements of Typographic Style*. Point Roberts, WA: Hartley & Marks Publishers.

Castro-Caldas, A. & A.Reis, 2000. Neurobiological substrates of illiteracy. *The Neuroscientist,* 6, 475-482.

Clair, K. 1999. *A typographic workbook: A primer of history, techniques, and artistry.* New York, NY: John Wiley and Sons.

Kolb, B. & I.Q. Whishaw, 1996. *Fundamentals of human neuropsychology* (4th ed) New York: Freeman & Co.

Meltzer, N. S. & R. Herse, 1969. Boundaries of written words as seen by 1st graders. *Journal Reading Behavior* 1, 3-14.

Rollenhagen, J. E., & C. R. Olson, 2000. Mirror-image confusion in single neurons of the macaque inferotemporal cortex. *Science,* 287, 1506-1508.

Sassoon, R. 2002. Downloaded from *http://www.clubtype.co.uk/sassoonintro.html* on Jan.3, 2003.

Simos P. G., J. M. Fletcher, E. Bergman, L. I. Breier, B. R. Foorman, E. M. Castillo, R. N. Davis, M. Fitzgerald & A. C. Papanicolaou. 2002. Dyslexia-specific brain activation profile becomes normal following successful remedial training. *Neurology* 58, 1203-13.

Snow C. E., M. S. Burns & P. Griffin 1998. *Preventing reading difficulties in young children.* Washington, DC: National Academy Press.

Stanovich K. E. 1994. Annotation: Does dyslexia exist? *Journal Child. Psychol Psychiatry* 55,579-95.

Stanovich. K. E. & A. E. Cunningham 1992. Studying the consequences of literacy within a literate society: The cognitive correlates of print exposure. *Memory & Cognition* 20,51-68.

van Ijzendoorn, M.H. & A.G. Bus, 1994. Metaanalytic confirmation of the nonword reading deficit in developmental dyslexia. *Reading Research Quarterly,* 29, 267-275.

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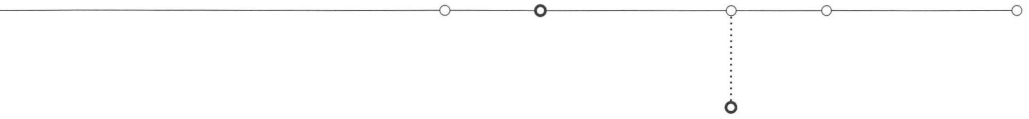

LEFT-HANDEDNESS:

A WRITING HANDICAP?

Ian Peachey

ABSTRACT

Left-handedness is often seen as a disadvantage when it comes to writing and left-handers are often seen as 'problem' writers. However, the difficulties many left-handers face do not stem from their left-handedness, but from the left-to-right writing movement of the Western writing culture. This article investigates left-handed writing technique and tries to determine, through both research and direct observation, the extent to which the theory regarding left-handed writing technique corresponds to the techniques used in practice.

The main focus of the investigation is an observational study. Participants were asked to copy out a series of simple sentences while photographs were taken to document their writing technique. The results of this study are then discussed in the context of handwriting manuals and specific left-handed writing guides. The fundamental aspects of writing technique – such as penhold, pengrip and paper position – are all dealt with in turn, together with the effect of the resulting written trace.

It is concluded that despite the range of literature available on left-handed writing, a 'right' and 'wrong' attitude still tends to prevail, which is in contrast to the variety of writing techniques seen in this investigation. Left-handedness is not a writing handicap and it is through more liberal and tolerant attitudes that this notion will be eradicated.

INTRODUCTION

THE ACT OF HANDWRITING, UNLIKE MOST OTHER ACTIVITIES, IS ALMOST entirely focused on one side of the body. While the non-writing side may be involved in subsidiary tasks, such as steadying the paper, the main job of writing is carried out by just one-half of the body, and in particular one arm and hand.

Left-handed writers are often cast in a negative light, as if their left-handedness is some kind of handicap. While the prejudices and discrimination that they faced in the 18th and 19th centuries have long since ended, left-handers are still seen as 'problem' writers in need of special attention, whether it be in the form of classroom layout, specially adapted pens and grips or alternative methods of teaching.

Contrary to popular opinion, the difficulties that many left-handed writers face do not stem from their left-handedness. Instead, these problems arise from the nature of writing and in particular the direction in which we write. In the Western handwriting culture, we write from left-to-right across the page and from top-to-bottom. This left-to-right movement is an 'arbitrary evolution' in our culture, and not necessarily fundamental to the act of writing. A right-to-left movement – which is much more natural for a left-hander – occurs in a number of other alphabets, such as Hebrew and Arabic (Sassoon, 1995:67).

However, it is the left-to-right movement that causes the most problems for left-handers. Not only do they have to try to push the pen across the page, but they have to try to push it across the body midline, which can result in problems with paper position, pengrip, an inability to see the writing and cramped body postures – all before the resulting written trace has even been considered.

Despite these difficulties, neither the left-hander nor the writing culture is at fault. It is their relative incompatibility that is the problem. The extent to which the theory regarding appropriate left-handed writing techniques corresponds to the techniques used in practice needs to be established, and where necessary, suggestions made for how the theory can be improved.

OBSERVATIONAL STUDY

TO TRY TO BETTER UNDERSTAND SOME OF THE VARIETY OF DIFFERENT techniques used by left-handers when writing, an observational study was undertaken. No specific hypothesis was tested, since the investigation was exploratory and gathered qualitative data. It aimed to survey a range of left-handed writing techniques, without any specific ideas about the outcomes.

Task

PARTICIPANTS WERE ASKED TO COPY OUT A SERIES OF 14 SIMPLE SENTENCES and photographs were taken to document their writing technique. The sentences were presented to participants on an ISO A5 (210 x 148 millimetres) piece of card.

In addition to these 14 sentences, three pangrams (sentences containing every letter of the alphabet) were reproduced on another

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piece of card. These pangrams were used to ensure that participants wrote every letter of the alphabet, and at least three versions of every letter were produced.

Since participants' attention would be constantly switching between the printed cards and their own written trace, the sentences were grouped in pairs. The pairing was entirely random and the pairs were presented in no particular order. All text was set in Swift Roman 11 point.

Participants

FIFTEEN PARTICIPANTS WERE TESTED, NINE LEFT-HANDERS AND SIX RIGHT-handers. The right-handed participants were necessary so that a comparison could be made with the left-handers, particularly in terms of patterns of writing technique and in the written trace produced. Seven participants were female, and eight were male. All came from a design/typographic background, and as all participants were over eighteen years of age it was assumed that the written trace they produced was their fully developed adult hand.

Procedure

PARTICIPANTS SAT IN A STANDARD OFFICE-STYLE CHAIR AT A SINGLE DESK. On the desk were the two cards containing the text to be copied and a pad of plain A3 paper. The A3 pad was available for participants to lean on if required. Participants were given a choice of either lined or unlined paper to write on and were given one sheet of the chosen paper on which to copy the text. More paper was available if required. Participants were also given a choice of writing tool. As the investigation was looking at natural handwriting technique, it was necessary to make the situation as normal and relaxed as possible. Participants were therefore given the choice of using either their own writing tool or choosing one from a selection provided. This selection consisted of a fountain pen, a roller-ball, a biro and an HB pencil.

No order was specified, for either of the two different tasks or the order in which the 14 sentences were to be reproduced. Similarly, no presentation style was specified. It was stressed that participants take as much time as was necessary in order to complete the task. During the test, three photographs were taken to document writing technique: one from the front, one from the side and a close-up of the writer's hand.

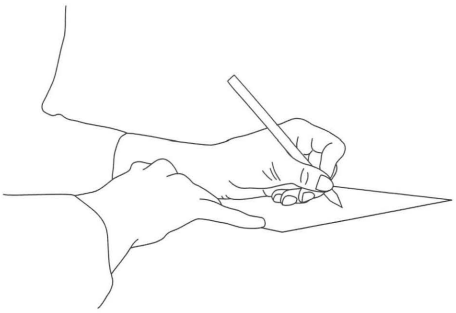


FIGURE 1:
The dynamic tripod grip (All illustrations are drawn from photographic documentation of the observation.)

A brief pilot study was carried out prior to the main study, to ensure that the procedure was clear to participants and the method of recording results was satisfactory. Testing was done on an individual basis and was carried out in a quiet environment away from other aural or visual distractions.

Discussion of results

THE RESULTS OF THE OBSERVATIONAL STUDY NEED TO BE INTERPRETED AND explained in the context of the relevant literature. The study aimed to compare the theory regarding the appropriate writing technique for a left-hander with the techniques used in practice.

PENHOLD

Tripod penhold

FOR MANY YEARS THERE HAS ONLY BEEN ONE ACCEPTED PENHOLD, THE dynamic tripod grip (SEE FIGURE 1). It is achieved by resting the writing tool on the 'distal phalanx' (last bone) of the middle finger and controlling it via the pad of the thumb and forefinger (Alston & Taylor, 1987,29). The tripod grip's evolution as the model penhold for writing seems to have happened without much question. This may be because it is the arrangement of fingers that offers the finest motor control over the writing tool. It may however, have been accepted as the model because it is the most commonly observed penhold.

Like any model, there are likely to be exceptions to the use of the dynamic tripod grip. However, a study conducted by Thomas (1997,48) of 218 school children aged between seven and nine found less than fifteen percent of children (fewer than thirty-two) using a tripod grip. This suggests that in the whole spectrum of writing penholds, the tripod grip has less prevalence than was previously

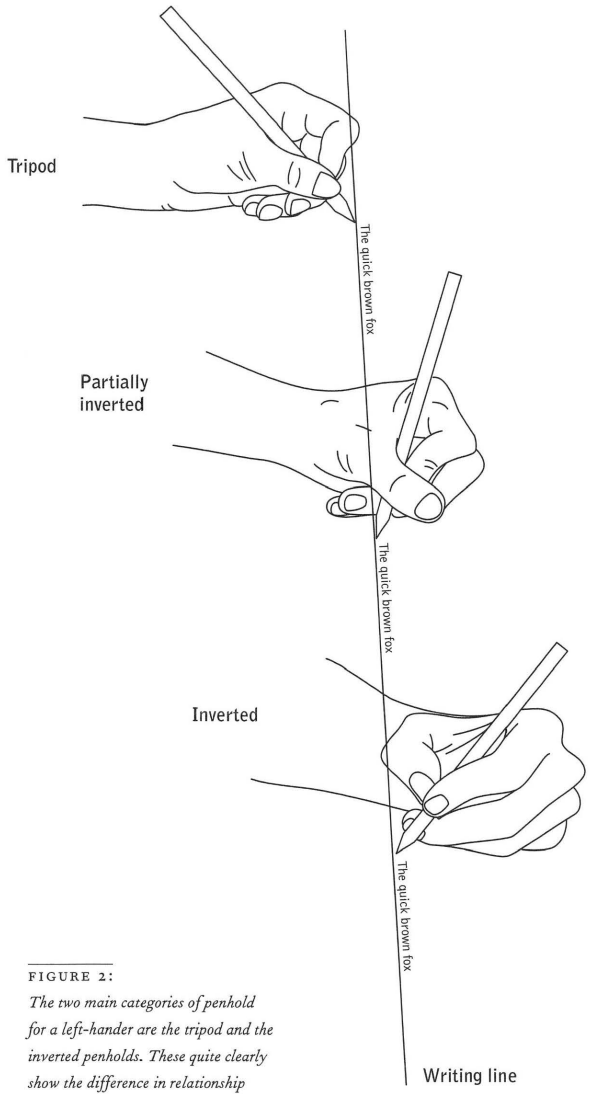


FIGURE 2:
The two main categories of penhold for a left-hander are the tripod and the inverted penholds. These quite clearly show the difference in relationship between the writing hand/tool and the writing line. The partially inverted penhold is somewhat of a hybrid, as it is neither a traditional tripod nor is it fully inverted. Hence writing becomes smudged and the pen tends to dig into the paper when using this penhold.

thought. The results of Thomas' study may reflect the age of the participants, and the fact that many would not have fully developed their adult hand. The question remains as to what factor(s) determine the evolution of a writer's penhold, be they right- or left-handed.

In order to move from left-to-right across the page, the right-hander *pulls* the writing tool – the left-hander has to *push* it. This fundamental difference between right- and left-handed writing demonstrates that handwriting technique is not just a matter of the way the pen is held. Arm posture and the position of the paper relative to the writer are also important. Both of these factors however, are determined by the way the writing tool is held.

Left-handed penholds

ALSTON (1989,15) IDENTIFIES TWO CATEGORIES OF LEFT-HANDER AS:

1. *Those who rotate the paper clockwise, hold the pencil pointing towards the top of the paper and generally adopt a position that is the mirror image of right-handed writers.*
2. *Those who rotate the paper anticlockwise, placing the pencil towards the body and generally adopt a hooked writing position (Inverted Hand Posture).*

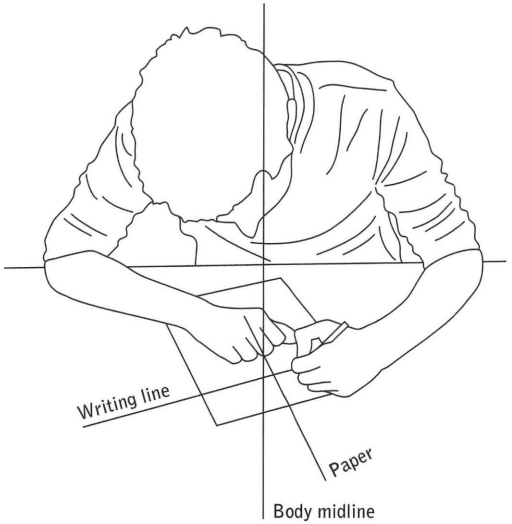


FIGURE 3:
The inverted penhold. The paper is rotated anticlockwise and the writing tool is placed pointing towards the body.

Among the left-handed writers observed in the study, many individual and characteristic writing traits were demonstrated. However, the penholds fell broadly into the two categories described above: those where the pen is held below the line of writing (as in the traditional tripod penhold), and those where the pen is held above the line of writing (an 'inverted' penhold).

In this group, far more fell into the first category than was expected. While it was anticipated that an inverted penhold would be less common, only two of the nine left-handers tested used such a penhold.

However, it must be remembered that only a small number of writers was studied. To reliably estimate the frequency of an inverted penhold among left-handed writers, far greater numbers would need to be tested. In his paper 'The relative efficiency of the various approaches to writing with the left hand,' Enstrom (1962,573) attempted to do this. Left-handed writers, numbering 1,103, were each classified and evaluated for the efficiency of their writing technique. Although Enstrom identified the two main groups of left-handed writer – those with the hand above the writing line and those with the hand below – he did not provide an exact breakdown of how many fell into each group. Despite this, he concluded that writing techniques that adopted non-inverted penholds were the most desirable.

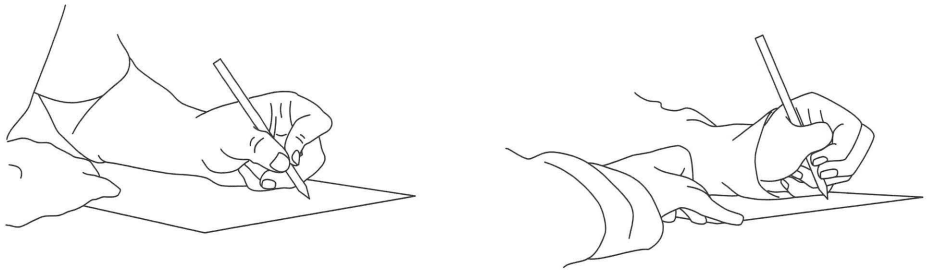


FIGURE 4A
A difference in pengrip.

Clark (1974,33) argues that 'there is nothing normal about [the inverted writing] position.' She claims it develops in left-handed children due to the unsuitable nature of anything demonstrated by schoolteachers or right-handed classmates. In order to write successfully, a left-hander must develop a penhold that gives them sufficient control over the writing tool, yet allows them to see what they are writing. They therefore grip the writing tool at the same distance from the point as does the right-hander, but curve their hand slightly to enable them to see under it (Clark, 1974,33). Hence the penhold can be termed 'partially inverted,' as it is neither a traditional tripod nor is it a fully inverted penhold, but somewhere between the two.

This method is convenient while a pencil is being used to write with, but it becomes unsuitable once a pen is used. The nib of a pen does not move across the surface of the paper as easily as a pencil (it may even poke into the paper if an italic nib is used), and the writing is smudged by the writer's hand. To overcome this, the writer 'completes the hook, placing his hand above the writing' (Clark,1974,33) (SEE FIGURE 2).

The main reasons for Clark (1974,33) not endorsing an inverted penhold as acceptable for a left-hander seem to be speed and neatness:

> *It is difficult to achieve neat writing by [the inverted] technique and since it is also a continual strain on the hand anyone adopting it will readily become fatigued if required to do much writing.*

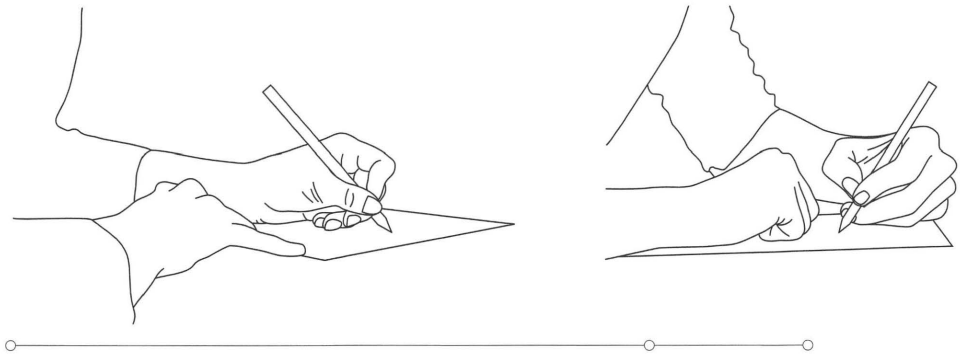


FIGURE 4B
A difference in penhold.

In Handwriting: theory, research and practice, Alston and Taylor (1987,58) quote Thurber as advocating the use of an inverted penhold, saying that it should not be corrected. Enstrom (1962,573) went as far as identifying fifteen different techniques that were used by left-handed writers, nine of which used an inverted penhold. Of these nine techniques only one was recommended by Enstrom, and then only with some reservation. Although very aware of the drawbacks, he was conscious of the fact that many left-handers use an inverted penhold, and so rather than dismissing it, he tried to establish some parameters for using it successfully. Enstrom (1962,577) concluded that when using the inverted penhold, the paper should be turned to the left, facilitating a flowing, rhythmic movement. FIGURE 3 shows a participant from the study demonstrating an inverted penhold and using the paper position described by Enstrom.

If the handwriting produced by such a penhold is of a good quality, and can be produced quickly and without excessive fatigue, then perhaps the penhold should not be discouraged. It may not be conventional, but then writing from left-to-right seems to be a conventionally right-sided exercise. When researching penhold, Sassoon (1993,35) emphasized that "different body proportions and personal pressures, when allied to the many differences in size, shape and points of modern writing implements provide such a multiplicity of factors that it is better to suggest a variety of penholds for experimentation."

PENGRIP

CARE MUST BE TAKEN WHEN DISCUSSING THE WAY A WRITING TOOL IS HELD, in particular in making clear the distinction between a penhold and a pengrip. So far we have looked at the dynamic tripod as a way of gripping the pen, and have seen it working above and below the line of writing. In both of these instances the way the writing tool is held is referred to in the literature studied as a penhold ('non-inverted' when it is below the line of writing, and 'inverted' when it is above the line of writing). However, when the arrangement of fingers used to grasp the writing tool is discussed, the term pengrip is more commonly used (e.g., Sassoon, 1995).

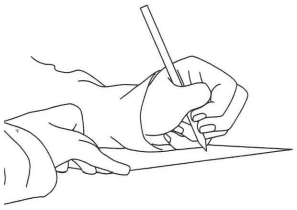


FIGURE 5A
The left-handed pengrip that deviated the most from the tripod model.

Thus the distinction is clear – penhold is used when talking about the relationship between the writing hand/tool and the writing line, and pengrip is used when discussing the relationship between the writer's hand and the writing tool. One is an internal relationship, concerning how the writing tool relates to the writer's hand, and the other is an external relationship, concerning how the writer's hand relates to the paper (SEE FIGURES 4A AND 4B).

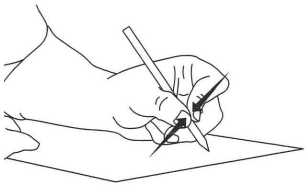
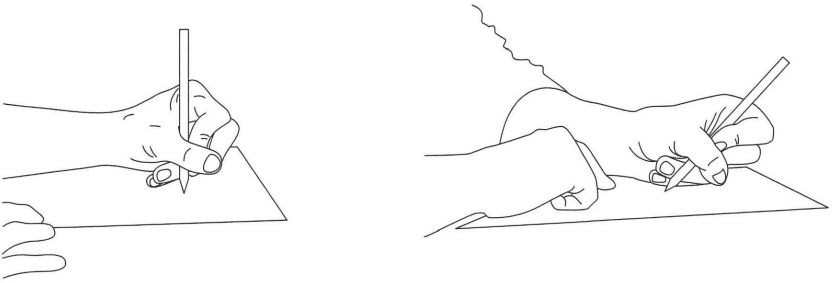


FIGURE 5B
The opposing forces provided by the pads of the index finger and thumb in the traditional tripod pengrip.

Of the left-handed participants in the study, only one demonstrated a grip that was a complete departure from the dynamic tripod (SEE FIGURE 5A). The most obvious difference between this pengrip and a traditional left-handed tripod grip is that the thumb curves round in front of the writing tool, and tucks in behind the index and middle finger. The fine motor control achieved by the opposing pads of index finger and thumb in the traditional tripod grip (FIGURE 5B) must now be provided from somewhere else.

FIGURE 6
Two more unconventional left-handed pengrips.



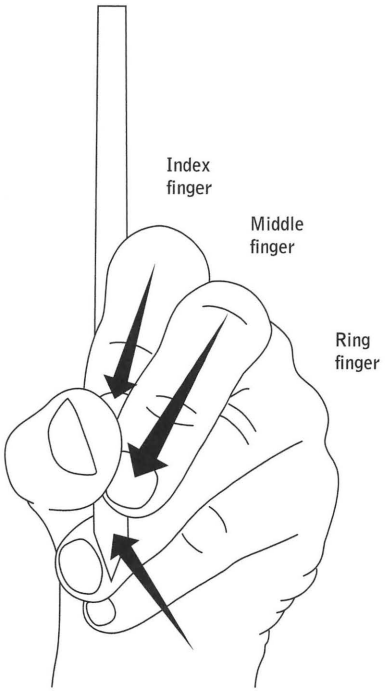


FIGURE 7A

An unconventional left-handed pengrip, viewed from underneath. The forces provided by the index and middle fingers are opposed by that of the ring finger.

Forces in a pengrip

IF TWO SIMILAR KINDS OF PENGRIP FROM THE STUDY ARE CONSIDERED – both deviating substantially from the dynamic tripod – a common feature emerges. Instead of resting on the distal phalanx of the middle finger, the writing tool rests against the distal phalanx of the ring finger (FIGURE 6). The pads of the index and middle fingers are both placed on top of the writing tool, providing a movement force in one direction, and the top of the ring finger provides a movement force in the opposite direction.

FIGURE 7A shows the first of the two pengrips from FIGURE 6, but viewed from underneath. The pen can be clearly seen resting against the distal phalanx of the ring finger, with the index and middle fingers positioned on top. The opposing forces supplied by these three digits provide the writer with most of the control they need, but the thumb is still required to complete the grip. This is because the index/middle fingers and the ring finger do not work directly against each other, but rather at a slight angle to one another. This

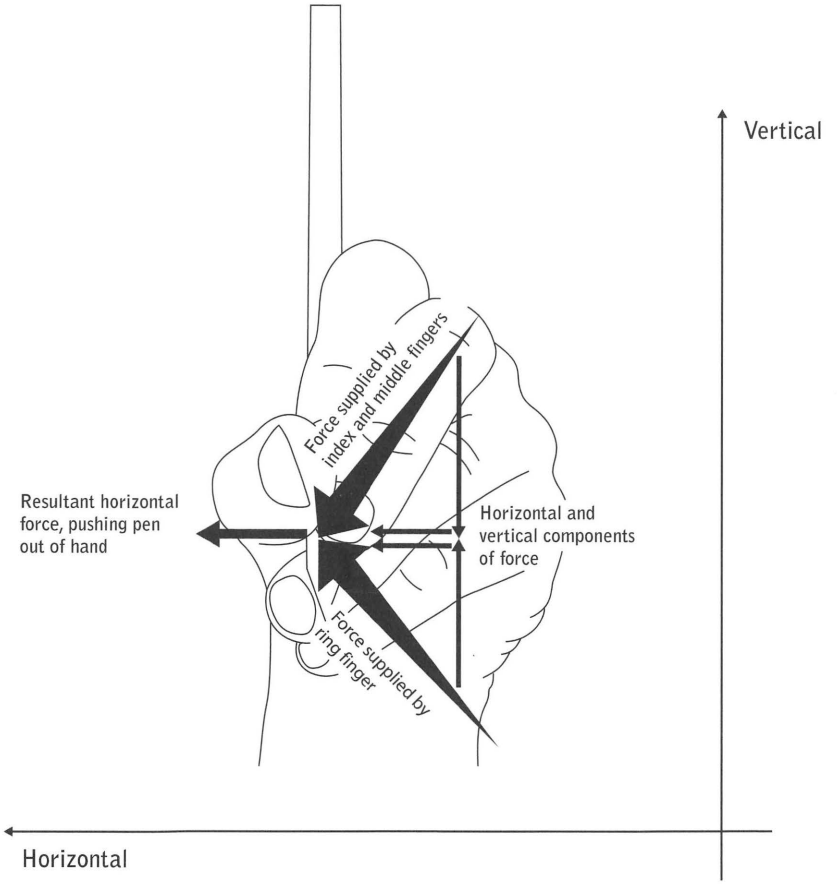


FIGURE 7B

The forces applied by the fingers of the writing hand can be broken down into their horizontal and vertical components. The vertical components work directly against each other, but the horizontal components are all in one direction. They have no opposition and the resultant force pushes the pen out of the writer's grasp.

creates a small resultant force in a direction perpendicular to the pen, forcing it slightly out of the writer's hand (SEE FIGURE 7B).

To overcome this, the thumb is curved around in front of the pen and across the index finger, providing a counter force. Used in this way, the thumb provides the same function as the distal phalanx of the middle finger in the tripod grip – that of keeping the pen within the grasp of the digits providing the movement forces (SEE FIGURE 7C).

This analysis of the forces in a writer's pengrip is based entirely upon observation of participants within the study and personal experience of writing left-handed. Nothing in the literature studied discusses in any length the forces connected with a writer's pengrip. Although it is difficult to draw any solid conclusions from observation alone,

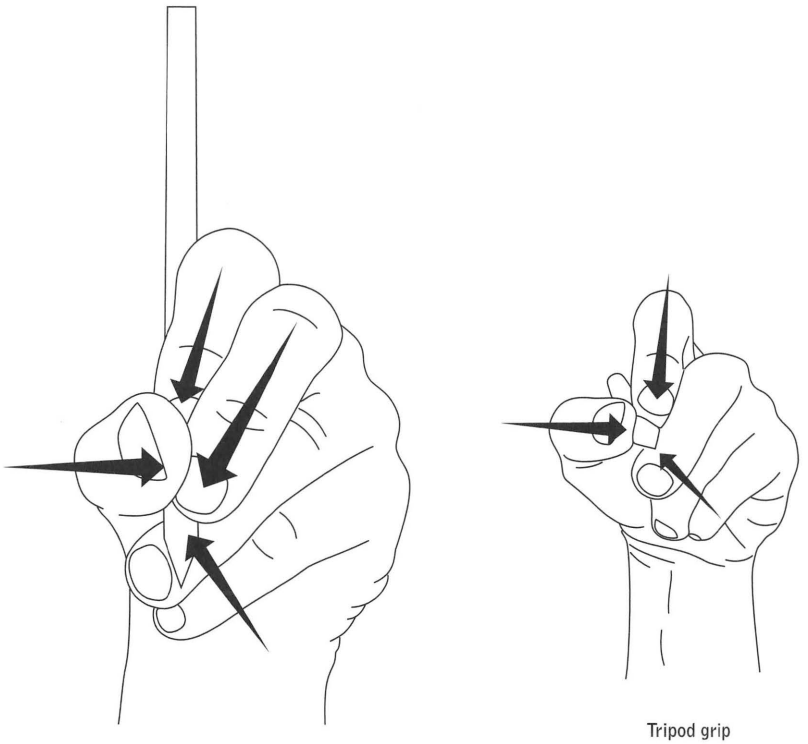


FIGURE 7C
The additional force supplied when the thumb is curled round in front of the index finger keeps the pen within the writer's grasp. In comparison with the same view of a left-handed tripod grip, the overall force directions are quite similar. The main difference is that four fingers are directly involved in controlling the pen, rather than three.

consideration of the forces involved offers another explanation for the occurrence of unconventional pengrips, and why some left-handers find them more comfortable than the traditional tripod grip.

Relationship between pengrip and penhold

IF WE CONSIDER THE PENHOLDS IN FIGURES 5A AND 6 AGAIN, IT IS WORTH noting that one is non-inverted, one is partially inverted and one is fully inverted. For both the partially inverted and fully inverted penholds the thumb comes across the top of the index finger. Yet for the non-inverted penhold it is tucked underneath the index finger. This may be coincidental, or it may be an indication of how the relationship between pengrip and penhold works.

Tucking the thumb underneath the index finger forces the pen back into the web between thumb and index finger. Thus the angle of the pen, and the way it points away from the writers' body, classify the penhold as being non-inverted. Placing the thumb in front of

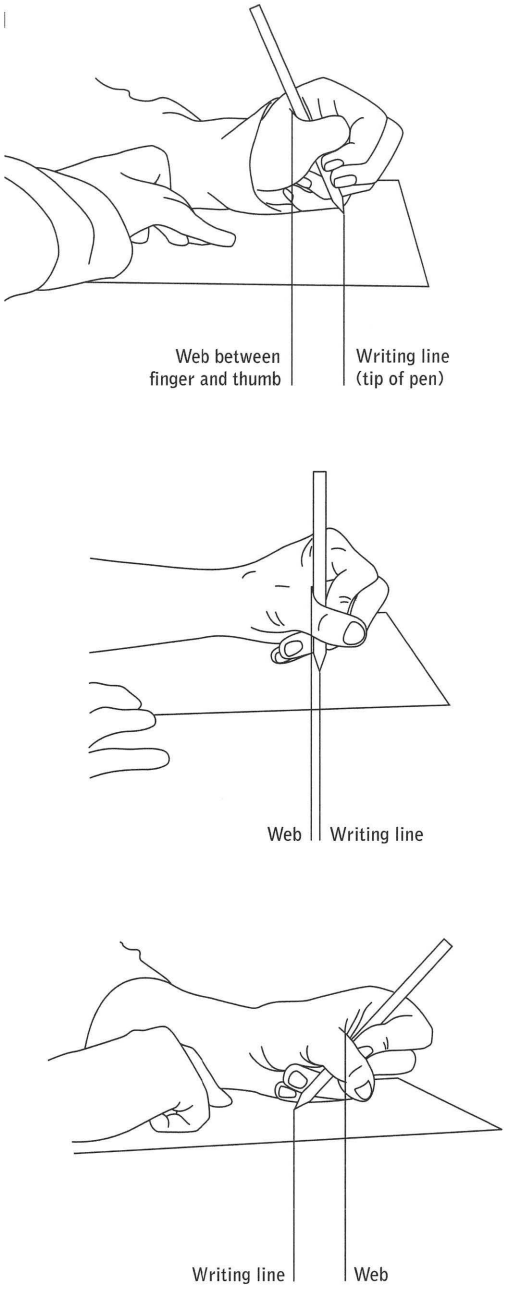


FIGURE 8
How the penhold changes as the pengrip changes. As the thumb moves from being underneath the index finger to being in front of, and then across the index finger, the penhold becomes inverted.

the index finger brings the web between index finger and thumb forward, so that it is almost directly above the tip of the pen. The penhold then develops into one that is partially inverted. If the thumb is brought further round in front of the index finger, so that it is almost touching the middle finger, the web between finger and thumb is brought even further forward, so that it is in front of the tip of the pen. The penhold is then fully inverted (SEE FIGURE 8).

This pattern may not be typical, but it provides more examples of the variety of writing techniques employed by left-handers, and emphasizes the impracticality of trying to impose a model writing technique.

Relationship between pengrip and written trace

BACKWARD SLANTING HANDWRITING IS OFTEN linked with left-handedness, usually in the context of describing a left-hander's writing as messy and untidy. However, a backward slant may be the result of the nature of left-handed writing. Sassoon (1986,9) recognizes the link between the way the writing tool is held and the resulting slant of the written trace:

> *When you alter your hand or finger position the slant of your writing can change. Alternatively, if you want to change the slant of your writing play around with your penhold.*

The two left-handed writers in the study who used similar inverted penholds held their writing tool in different ways. The first used a traditional tripod grip, and the second used an unconventional pengrip,

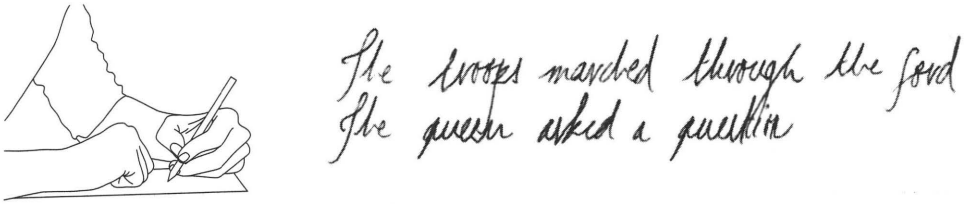


FIGURE 9A
The tripod grip with an inverted penhold and the written trace it produced.

where the thumb comes across in front of the index finger and the writing tool is controlled via the first three fingers of the left hand.

Both of the written traces produced by these penholds had a slant to them. The writer who used a tripod grip had a slight forward slope to their writing (FIGURE 9A), and the writer who used the unconventional pengrip produced the handwriting with a backward slope to it (FIGURE 9B).

The variation in pengrip may account for the difference in writing slant. The handwriting, in FIGURE 9A, was produced by a writer who had a 'textbook' inverted penhold and tripod pengrip. The wrist twists round so that the pen comes down from above the line of writing, allowing a forward letter slant to be made easily. The writing hand turns into the body slightly, so that it is at an angle to the forearm (FIGURE 10A). The writer of the handwriting in FIGURE 9B, which had a backward slant, theoretically does use an inverted penhold, since the hand sits above the writing line and the pen points back towards the body. However, the nature of the pengrip is such that the writing hand turns away from the body, so that it is parallel

FIGURE 9B
An unconventional grip with inverted penhold and the resulting written trace.

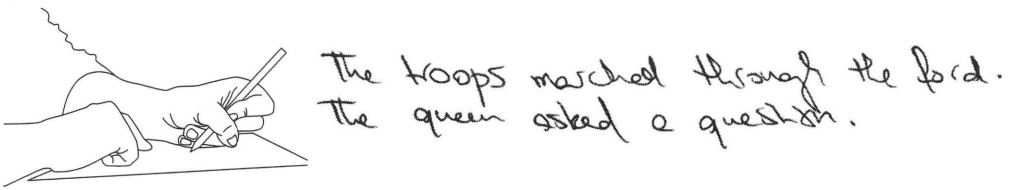


FIGURE 10A
With the traditional inverted penhold and tripod pengrip, the writing hand is at an angle to the forearm.

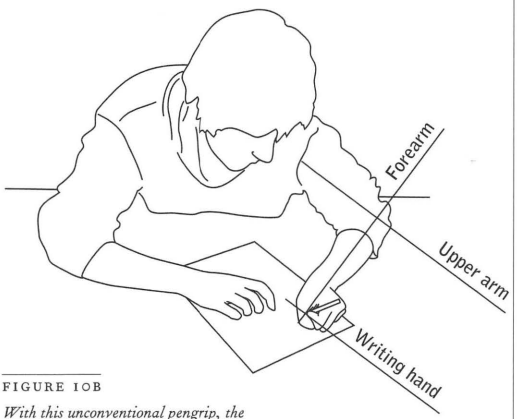


FIGURE 10B
With this unconventional pengrip, the writing hand turns away from the body so that it becomes parallel with the upper arm.

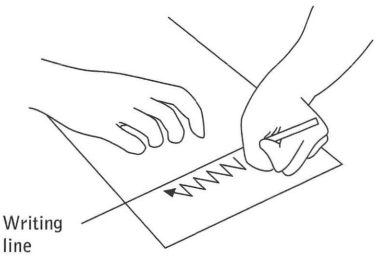


FIGURE 10C
The up and down movement of writing is at a slight angle to the paper.

with the upper arm (FIGURE 10B). With the wrist now parallel to the upper arm, the up and down movement of writing is at a slight angle to the paper, and causes the backward slant evident in the written trace (FIGURES 10C–E).

PAPER POSITION

LEFT-HANDERS ARE OFTEN TOLD THAT THEY need to rotate their paper clockwise – the opposite of what is recommended for a right-hander. This suggestion is made by, among others, a fact sheet on writing provided by the Left-Handed Club.[1] It advises writers to rotate the paper clockwise 'up to a maximum of 45 degrees.' However, as has been seen, this is unsuitable for the left-hander who adopts the inverted penhold. If forced to rotate their paper clockwise, they will have to arch their arm even more to enable them to reach the top of the paper (FIGURE 11).

As discussed earlier, Enstrom (1962,577) concluded that when using an inverted penhold the paper should be rotated anticlockwise. This re-emphasizes the point that penhold and paper position are not independent of one another, and need to work together in order to establish a comfortable writing technique.

A better recommendation for paper position is made by Sassoon (1990,14), who advocates placement of the paper in relation to the body midline. Regardless of whether a left-hander rotates their paper clockwise or anticlockwise, the paper should be positioned to the left of the body midline. If it is central to the writer, or positioned

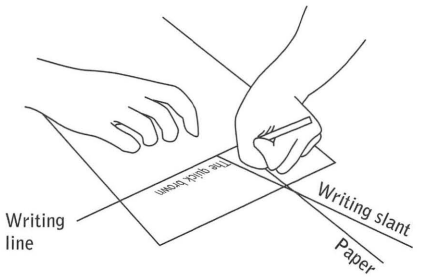


FIGURE 10D
Letterforms are thus created at this angle.

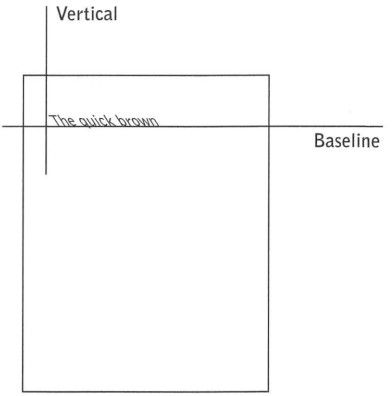


FIGURE 10E
The resulting written trace.

to the right of the body midline, then the writing arm is forced across the body, which "causes a cramped writing position and obscures the writer's view of the point of the implement." Sassoon (1990,14) concludes that for those who hold the pen above the line of writing, adopting an inverted penhold, the paper should be rotated anticlockwise, as for a right-hander. For those who hold the pen below the line of writing, the paper should be rotated clockwise.

Clark (1974,33) recognizes another method of writing adopted by the left-hander, where the paper is positioned to the left of the body midline, but is rotated clockwise to the extent that it is almost at a right angle to the body of the writer. The left-hander then writes "down towards the body in an attempt to acquire a comfortable position." FIGURES 12A AND 12B show a participant from the study using this writing technique.

The pushing action associated with left-handed writing seems to be the main problem in trying to find a comfortable writing technique. Sassoon (1990,80) comments that "the left-handed action often involves more pushing than is desirable for a relaxed handwriting." The solution shown in FIGURES 12A&B – of rotating the paper to such an extent that the movement pattern of the writing arm is more similar to that of a right-hander – is only viable for some left-

1 Left-Handers Club factsheet: handwriting.
URL: http://www.anythingleft-handed.co.uk/library/ALH_handwritingfactsheet.pdf
[13 November 2002]

FIGURE 11
A left-hander, who uses an inverted penhold, trying to write with the paper rotated clockwise.

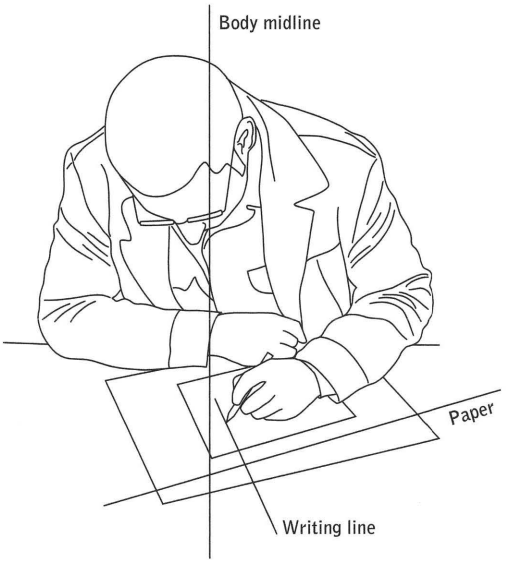


FIGURE 12A
The paper is rotated clockwise so that it is almost at a right angle to the body midline. The writer then adopts a tripod grip, holding their hand below the line of writing.

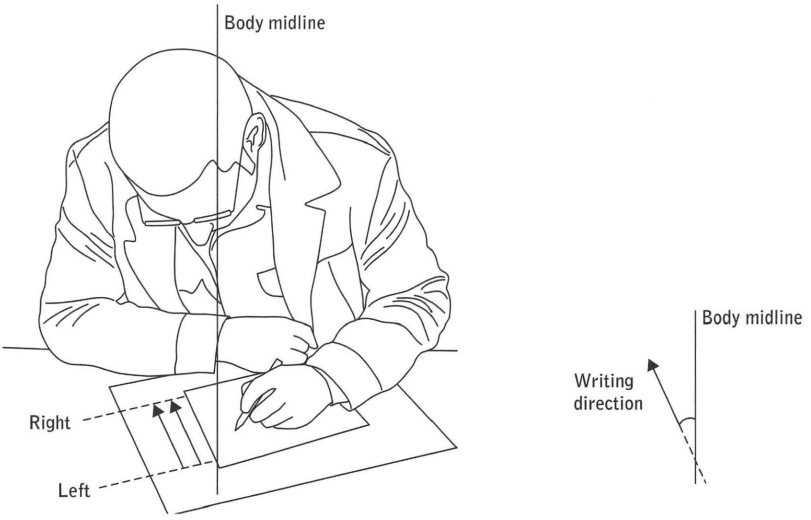


FIGURE 12B

When the paper is rotated to such an extent, it could be argued that the hand is no longer below the line of writing, but alongside it. The writing direction is almost parallel to the body midline, so in order to write from left to right across the page, the writer moves their arm up and down relative to the body midline. This avoids the need to push the pen across the paper and stops the writing arm from becoming cramped into the side of the body. The left-hander writes by pulling their left hand towards them, then pushing it away from them when the end of a line is reached. This pattern of pulling and pushing is similar to a right-hander – pulling the pen when writing, and pushing it when returning to the beginning of a new line.

handers. Those who use an inverted penhold or unconventional pengrip may find such a paper position very awkward and uncomfortable (FIGURE 12C).

Paper position relative to body midline

ALL OF THE WRITERS STUDIED PLACED THE PAPER TO THE LEFT OF THEIR body midline, but to varying extents. FIGURE 13 shows the participant who placed their paper the furthest from their body midline.

The extent to which the paper is to the left of the body midline can be approximated by looking at the nearest and furthest the writing hand gets to the body midline. In FIGURE 13, the writer is using a non-inverted penhold. The closest the writing hand gets to the body midline is still clearly on the left side of the writer's body. By comparison, in FIGURE 14 – where the same penhold and paper rotation are used – the writing arm is much closer to the side of the body, and the writing hand is slightly to the right of the body midline when it is at the end of a line. This is because the paper is positioned almost centrally to the body midline. The writing arm thus begins to get cramped into the side of the body.

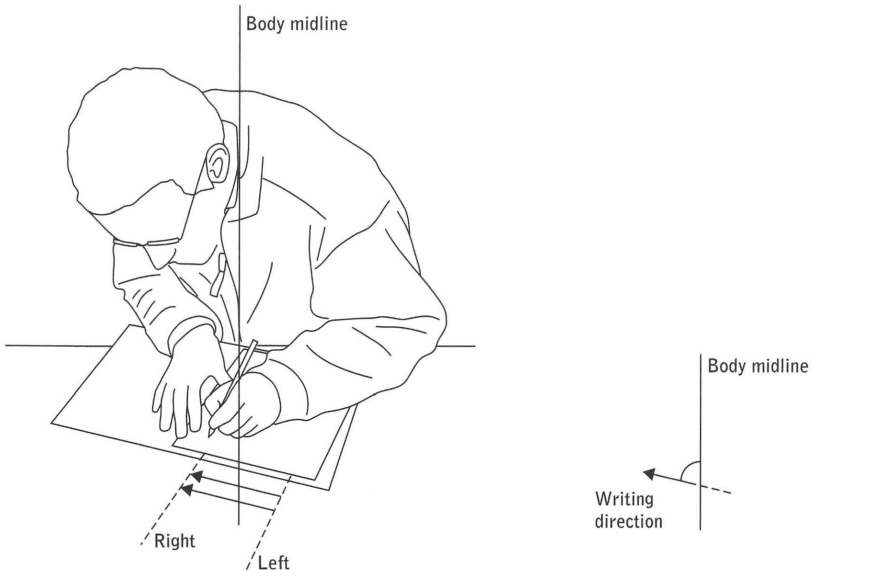


FIGURE 12C

By contrast, for a left-hander who rotates their paper to a far lesser degree, the writing direction and body midline are almost perpendicular. Thus the writing arm moves from left to right, relative to the body midline, and can become cramped into the side of the body.

Paper position relative to writing slant

WHEN THE WRITING TECHNIQUE USED IN FIGURE 13 IS STUDIED IN conjunction with the written trace it produces, a reasonable argument can be made for why there is a large distance between paper and body midline.

If the paper position is studied in more detail, it becomes clear that the writing hand is not only below the writing line, but in front of the writing as well (FIGURE 15A). The writer still uses a tripod pengrip and a non-inverted penhold, but through a combination of paper position/rotation and hand position, they imitate the writing movement of a right-hander, where the hand is below and in front of the writing.

This imitation of a right-hander's posture can lead to the left-hander's writing becoming cramped into the side of the body (Alston & Taylor, 1987,85). The writer in FIGURE 15A however, has overcome this problem by positioning the paper a sufficient distance away from the body midline so that the writing arm only comes into the side of the body when it is at the end of a line.

The angle at which the paper has been rotated, no more than forty-five degrees clockwise, is conventional for a left-hander with a non-inverted penhold. This angle, together with the distance between writing hand and body midline are the primary reasons for the letter

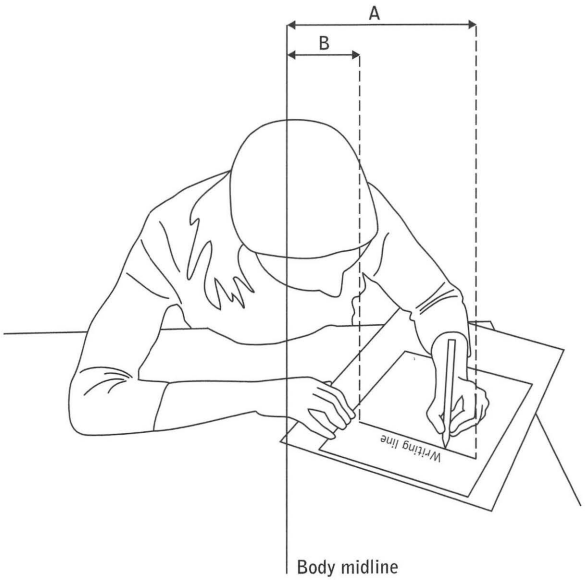


FIGURE 13
The left-handed participant who placed their paper the furthest from their body midline. As the hand moves along the writing line, and moves from the furthest point from the body midline (A), to the closest (B), the writing arm gradually moves up to the side of the body.

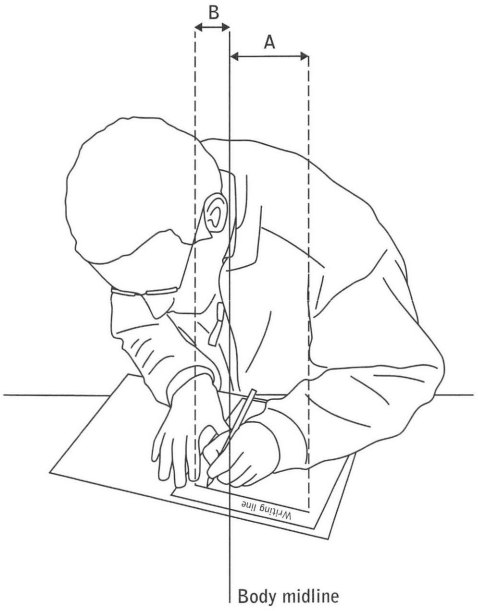


FIGURE 14
The left-handed participant who placed the paper the closest to their body midline. As the hand moves along the writing line, it crosses the body midline. Hence the distance between the midline and the hand at the start of a line (A) is measured in the opposite direction to the distance between midline and hand at the end of a line (B). The writing arm thus remains close to the side of the body throughout.

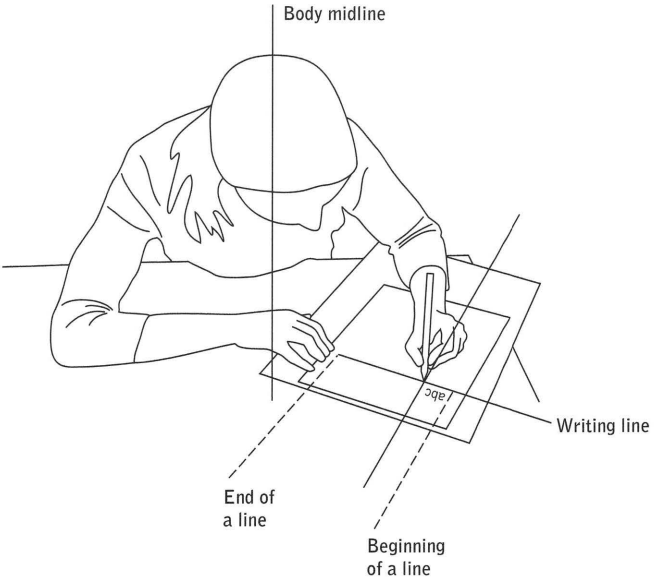


FIGURE 15A
The writing hand is below and in front of the writing, and the paper is a sufficient distance from the body midline so that the writing arm does not become cramped into the side of the body.

FIGURE 15B
The resulting slant in the written trace.

slant found in the written trace (FIGURE 15B). With the paper at this distance, the writing hand and forearm can remain aligned, and with the paper at that angle, the up and down movement of writing can be made by moving the writing hand from left-to-right (relative to the forearm – SEE FIGURE 15C).

The fingers of the writing hand can remain almost static, since a lot of the writing movement is made by the whole hand, without disrupting the left-to-right flow of the arm moving along the writing line. The pattern of moving from left-to-right to form the main strokes of letters means that the writing hand and the written trace are at right angles to each other (FIGURE 15D), and the written trace is at an angle of forty-five degrees to the paper (FIGURE 15E).

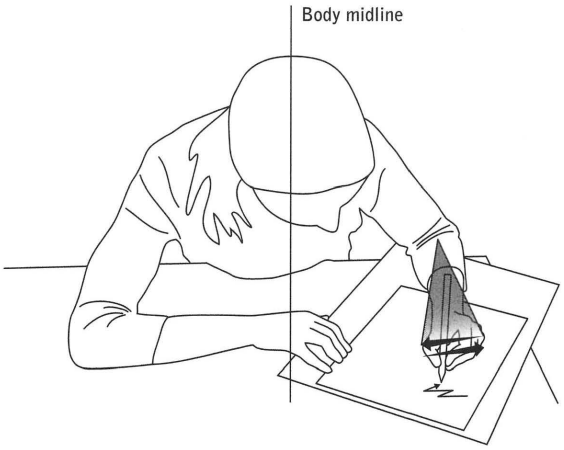


FIGURE 15C
The up and down movement of writing is made by moving the writing hand from left to right (relative to the forearm).

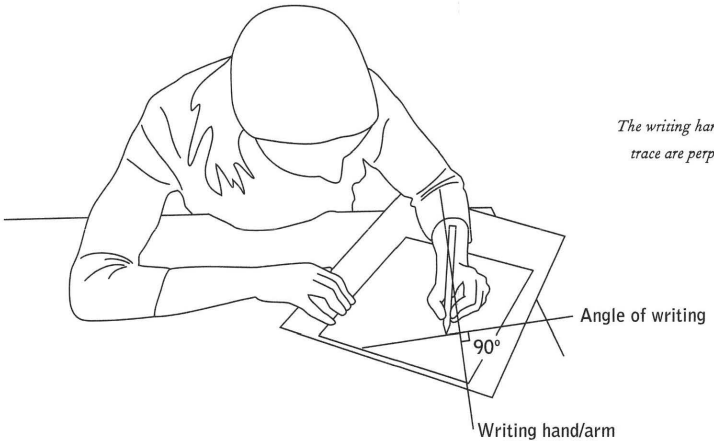


FIGURE 15D
The writing hand/arm and the written trace are perpendicular to each other.

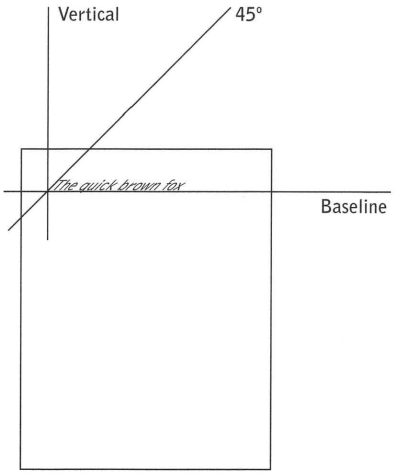


FIGURE 15E
The written trace is at an angle of 45 degrees to the paper.

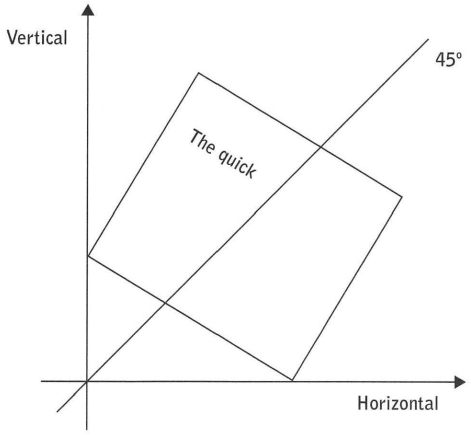


FIGURE 15F
The reverse of a standard right-handed writing technique. Based on an illustration in Enstrom (1962:574).

The technique used by the writer in FIGURES 15A–E is an amalgamation of two different techniques recognized by Enstrom (1962,575) as being used by left-handers who adopt a non-inverted penhold. The first of these two techniques (FIGURE 15F) is the reverse of a standard right-handed writing technique, in that the paper is rotated no more than forty-five degrees clockwise and the hand is below and in front of the writing (AS IN FIGURE 15A). The second of

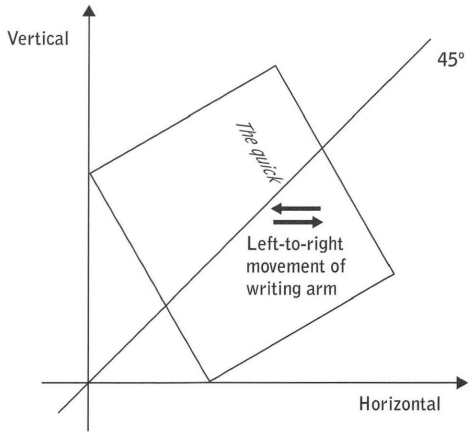


FIGURE 15G
The paper is rotated more than 45 degrees, so that the letter slant is created by a left to right movement. Based on an illustration in Enstrom (1962:574).

these techniques (FIGURE 15G) has the paper rotated more than 45 degrees, so that the forward slant of the written trace is created by a left-to-right movement of the writing arm (AS IN FIGURE 15C).

The writer in FIGURES 15A–E uses a mixture of these two techniques because of the distance between paper and body midline. With the paper that far to the left of the midline, it only has to be rotated to the extent of FIGURE 15F to allow the writer to use the writing movement of FIGURE 15G.

CONCLUSION

ENSTROM (1962) AND CLARK (1974) SUGGEST THAT THERE IS VERY MUCH a 'right' and 'wrong' technique for writing, particularly where the 'problem' of left-handedness is concerned. This attitude is inflexible, since it is impossible to expect everyone to write in exactly the same way. Left-handedness is not a writing handicap, but a factor that needs to be considered when learning to write, alongside paper position, chair height and choice of writing tool. Writers, in particular left-handed writers, are very resourceful, and where a handwriting model does not allow them enough flexibility, they will rely on their own ingenuity. This attitude was evident among much of Rosemary Sassoon's writing, (e.g. Sassoon, 1993), and among the small number of left-handed writers studied, where a variety of writing technique was observed.

Penhold, pengrip and paper postion/rotation are all inter-related, and are all determinants of the resulting written trace. The examples illustrate this relationship, as the effect on writing slant was discussed first in the context of pengrip and then in the context of paper position. More research of this nature, together with a willingness to accept and consider a much wider range of possible writing techniques and approaches, will hopefully eradicate the outdated notion that left-handedness is a writing impediment.

REFERENCES

Alston, J. & J. Taylor. 1987. *Handwriting: theory, research and practice.* London: Croom Held.

Alston, J. 1989. *Writing left-handed: a guide for parents and teachers of left-handed children.* Manchester: Sinistral Books for the Centre for Left-Handed Studies.

Clark, M.M. 1974. *Teaching Left-handed Children.* Sevenoaks: Hodder & Stoughton.

Enstrom, E.A. 1962. The relative efficiency of various approaches to writing with the left hand. *Journal of Educational Research.* 55.10, 573–577.

Sassoon, R. 1986. *Helping your handwriting: pupil's book.* Leeds: Arnold-Wheaton.

Sassoon, R. 1990. *Handwriting: a new perspective.* Cheltenham: Stanley Thornes Ltd.

Sassoon, R. 1993. *The art and science of handwriting.* Oxford: Intellect Books.

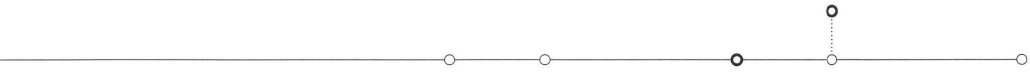
Sassoon, R. 1995. *The practical guide to children's handwriting,* revised ed. London: Hodder & Stoughton.

Thomas, S. 1997. The grip characteristics of pre-schoolers. *Handwriting Review.* 11, 48–56.

Thurber, D.N. 1987. *D'Nealian Handwriting,* second ed. Northbrook, IL: Scott, Foresman, Glenview. Cited by Alston, J. & Taylor, J. 1987. *Handwriting: theory, research and practice.* London: Croom Held.

AUTHOR NOTE

IAN PEACHEY obtained a first class BA (Hons) in Typography & Graphic Communication from the University of Reading in July 2003. Within his course he focused upon the handling of complex information, the placement of images relative to text, and designing to form part of a series. This article is an edited extract from 'Left-handedness: a writing handicap?' the dissertation submitted by Ian in partial fulfilment of his degree



THINKING ON PAPER:

HINDU-ARABIC NUMERALS IN EUROPEAN TYPOGRAPHY

Liz C. Throop

ABSTRACT

Western typography involves the 26 letters, punctuation marks and numerals as a whole "expanded alphabet." Between the 11th and 16th centuries the hindu-arabic numerals entered that alphabet, causing greater numeracy, much like the growth in literacy during that period. Europeans had to overcome ignorance and prejudice toward a foreign number system, but also had to adapt the numerals' visual forms to fit in with their existing alphabet. Westerners were at last able to work out calculations "on paper," which helped Europe move from a primarily oral to modern graphical culture. While the numerals we use today remain residually "foreign" in some ways, their introduction is a significant part of the history of Western typography.

INTRODUCTION

THE PRACTICE OF TYPOGRAPHY INVOLVES WORKING WITH THE 26 LETTERS, punctuation marks and numerals more or less as a whole "expanded alphabet," yet most histories of typography focus on the letters with little or no mention of the hindu-arabic numerals. The origination of the numerals in India and their migration to Arabic cultures has been dealt with extensively elsewhere. What follows is an account of how these characters became part of our writing system after repeated introductions; how they were adapted to fit in with our written letterforms; and how their incorporation played a part in the transition from the primarily oral culture of medieval Europe to modern graphical culture.

IMPERFECT NUMBER SYSTEMS

PRIOR TO THE RENAISSANCE, EUROPEANS USED SEVERAL SEPARATE SYSTEMS to count and do calculations. A farmer might have counted his sheep by carving notches in a wooden tally stick using a system of marks specific to his family or region. A merchant might have counted on his fingers, toes and other body parts to do addition and subtraction. A monk might have calculated the dates of upcoming Easter celebrations by moving stones on a counting board (a table that served as a sort of abacus) while another monk transcribed the dates

onto parchment using roman numerals. These various methods were adequate for counting and recording simple operations, but none of the systems lent themselves to working out extended calculations "on paper." Those few who could do calculations on the counting board constituted a powerful elite, and the vast majority of Europeans could have been described as innumerate.

1 Ifrah, Georges. 2000. The Universal History of Numbers from Prehistory to the Invention of Computers. David Bellos, E. F. Harding, Sophie Wood and Ian Monk, translators. New York: Wiley, 577.

Georges Ifrah describes the arithmetical state of Europe as late as the 15th and 16th centuries:

> *A wealthy German merchant, seeking to provide his son with a good business education, consulted a learned man as to which European institution offered the best training. 'If you only want him to be able to cope with addition and subtraction,' the expert replied, 'then any French or German university will do. But if you are intent on your son going on to multiplication and division – assuming that he has sufficient gifts – then you will have to send him to Italy.'*
>
> *It has to be said that arithmetical operations were not in everyone's grasp: they constituted an obscure and complex art, the specialist preserve of a privileged caste, whose members had been through a long and rigorous training which had allowed them the mysterious and infinitely complicated use of the classical (Roman) counter-abacus.*
>
> *A student of those days needed several years of hard work as well as a long voyage to master the intricacies of multiplication and division – something not far short of a Ph.D. curriculum, in today's terms. The great respect in which such scholars were held provides a measure of the difficulty of the operational techniques. Specialists would take several hours of painstaking work to perform a multiplication that a child could now do in a few minutes. And tradesmen who wanted to know the total of the week's or the month's takings were obliged to employ the services of such counting specialists.*[1]

THE ROMAN NUMERAL SYSTEM

ROMAN NUMERALS WERE USEFUL TO PRE-RENAISSANCE EUROPEANS FOR basic notations, but proved problematic for denoting large numbers. A key issue was the variation in the notation of large numbers. For instance, MM might have been used to express two thousand or a million (1,000 + 1,000 or 1,000 x 1,000, respectively). Another problem was that the link between the amount of a roman numeral and its length is weak: for example 1,001 can be expressed as MI, but 888, a smaller number, is written DCCCLXXXVIII. Long

Georgia State University
Visible Language 38.3
Throop, 290-303

strings of characters can be hard to read, making calculations difficult.[2] (If in doubt about this, try dividing MCXXIV by MCVIX without converting to hindu-arabic numerals first.)

Shifting from written records to a counting table and back to written records was cumbersome and introduced many opportunities for error.

The difficulties involved in working with numbers had effects similar to those of widespread illiteracy. Ifrah notes that prior to the dissemination of the hindu-arabic numerals, "professional arithmeticians, who practiced their art on the abacus, constituted a powerful caste, enjoying the protection of the Church. They were inclined to keep the secrets of their art to themselves; they necessarily saw algorism (the Arabic number system), which brought arithmetic within everyone's grasp, as a threat to their livelihood."[3]

We can only imagine the frustrations of European merchants, who could not even calculate whether they were operating at a profit or a loss, trying to meet the growing demand for silk and spices which they purchased from Indian and Arab merchants – many of whom were, presumably, mathematically adept.

INITIAL DIFFICULTIES

THE HINDU-ARABIC NUMBERS ORIGINATED IN INDIA AROUND THE FIFTH century AD and probably migrated into Arabic cultures through merchant traders in the eighth century. Early introductions of the hindu-arabic numerals into Europe were not successful. Important scholars promoted the system because they had heard it was a superior system that made calculations much easier, but they failed to make use of the system's key advantage – the zero.

Additionally, the written forms of the numerals themselves proved problematic. Europeans were very inconsistent in the visual orientation of the symbols. During the tenth century, European mathematicians began using the hindu-arabic forms by placing the figures on "apices," which were markers that were set on counting boards to do calculations. These boards operated like abacuses, in which small disks stand in for the thing being counted. "The rotation, or different orientations, of the individual number symbols and apices may be due to the fact that the counters were customarily placed on the counting board in a particular manner in one monastery and differently in another."[4]

2 Guedj, Denis. 1996.
Numbers: The Universal Language. Lory Frankel, translator. New York: Abrams, 49.

3 Ifrah,
The Universal History of Numbers, 588.

4 Menninger, Karl. 1969.
Number Words and Number Symbols: A Cultural History of Numbers. Paul Broneer, translator. Cambridge, MA: M.I.T. Press, 327.

5 Hill, Sir George Francis. 1915.
The development of Arabic numerals in Europe, exhibited in sixty-four tables. London: Oxford UP's Clarendon Press.

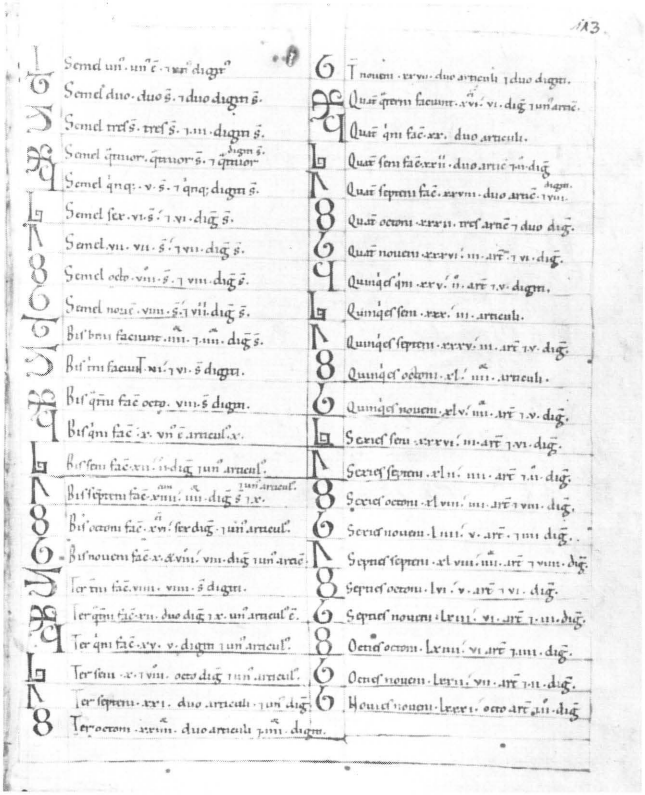


FIGURE 1

An 11th century multiplication table using arabic and roman numerals, drawn up by a Pater Othlo at the St. Emmeran Monastery at Ratisbon. The first nine symbols reading vertically down the left column are 1 through 9, respectively. (From Bayerische Staatsbibliothek, München)

In an 11th century multiplication table from Ratisbon, serifs have been added to the characters, making them looking generally "roman," but the numerals 1 and 8 alone are familiar to the modern reader (SEE FIGURE 1). Alas, the 9 has been rotated so it looks to us like a 6, and the 6 is squared off, looking more like the letter L. It is hard to see the connection between 2, 3, 4, 5, 7 and our present-day numerals or to their hindu-arabic antecedents.

Some typographic histories give brief mention of the numerals by showing "the style" of numerals in pre-Renaissance Europe. But if we compare the Ratisbon example to those from Hill's *The development of Arabic numerals in Europe*,[5] we see that there was in fact no general style at this period, but instead a variety of forms (SEE FIGURE 2).

FIGURE 2

A few early examples of hindu-arabic numerals in Europe, from the work by G. F. Hill. Numeral sources for this figure follow: A. 976 AD, from the manuscript Codex Vigilanus, written in the monastery of Albelda, Spain. Perhaps the form of the 5 is related to the roman numeral "V;" B. c. 1200, from a manuscript; C. c.1350, from an English manuscript; D. probably 1400 to 1450, from an English manuscript; E. 1342, from an astrolabe in the British Museum; F. 1490, from a brass astrolabe; figures stamped; G. 1488, from a woodcut in Augsburg Boethius, German; H. c. 1400, French Astrolabe; I. c. 1400, French or Italian Astrolabe; J. 1400s, Spanish Astrolabe.

Ifrah notes,

> *Styles obviously varied from one region to another, from one school to another, even from one engraver to another, in a period that had no concept of standardization. Indeed, what we can see happening in these examples is the adaptation of the Ghubar forms of the Arabic numeral to the very different styles of writing practiced in different parts of Europe. So in Italy we see numerals assimilated to the round shapes and wide openings of Italic script, in England to the narrower and more angular shapes of English script, in Germany to the thicker and squarer writing style of German script, and in France and Spain we see them being shaped in harmony with the dominant styles of Carolingian script.*[6]

Given the ambiguous orientation of the forms and the fact that standardization was not understood or valued at that time, we can understand why early introductions of this number system were met with skepticism.

In the 12th century, mercantilism and literacy were expanding, and trade and the crusades had increased contact with Arab cultures. Muhammad al'Khuwarizmi's *Book of Restoration and Equalization* was translated into Latin, thus re-introducing the numerals to Europe. Rather than marks for apices, the numerals, complete with zero, were promoted as a way to solve equations through written calculations.

This second introduction of hindu-arabic numerals was roughly

6 Ifrah,
The Universal History of Numbers, 586.

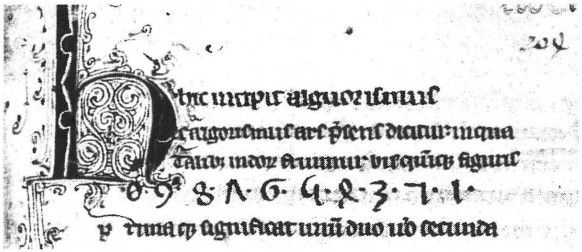


FIGURE 3
Detail from Albrecht Durer's engraving "Melancholia." (Photographic reproduction by the Bibliothèque Nationale de France).

coincidental to the introduction of paper into Europe. While calculations were at first written temporarily on a dusted or waxed tablet, the ability to "think on paper" that came with the availability of paper allowed calculations to be recorded, reviewed and checked later for accuracy. Anyone who has tried to reconcile a check register with their bank statement understands how important this is.

The "new numbers" were more than just new symbols in an expanded alphabet. They represented a whole organized system of counting, calculating and recording that had been well developed in India and the Arabic cultures. Europeans were aware that this system had many advantages, but apparently were unsure what features of the hindu-arabic system to keep and what to discard. Arabs wrote right to left, and some Europeans scholars kept this practice. Many Europeans were introduced to the "new numerals" through such texts as Alexandre de Villedieu's 13th century text *Carmen de algorismo* which begins

> *Here are the new indian numerals*
>
> *0 9 8 7 6 5 4 3 2 1...*[7]

In this manner, the number 268 would be expressed, roughly, as 862. For this reason alone one can imagine why the system again met with confusion and resistance. Other objections largely centered

7 Guedj,
Numbers: The Universal Language, 53. "The Carmen de algorismo, or Poem on Algorism, by Alexandre de Villedieu, played a major role in the spread of the new arithmetic in Europe, especially in the French universities, among the earliest to teach mathematics."

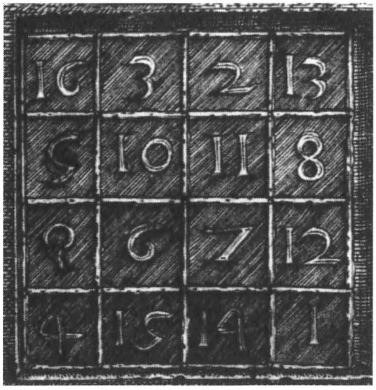


FIGURE 4
From The Carmen de Algorismo of 1240 by the Norman monk Alexander de Villedieu.
(From Hessische Landesbibliothek, Darmstadt)

around the suspicion and confusion about the number zero, for which Europeans had no frame of reference other than its derivation from non-Christian cultures.

Further, there was concern that the new figures could be altered. This is no small point. A letter of the alphabet that is ambiguous in form is usually saved by its context within a word, and that word within a sentence. Numerals however, often lack such clues, and a written inventory might be read as 71 bushels instead of 11, or changed from 33 bushels to 83 bushels without raising suspicions.

European scribes had developed safeguards against the alteration of roman numerals, such as writing all the characters with a single pen-stroke, "like the links in a chain." The last character in a roman numeral was typically finished in a downstroke rather than an upstroke - the "i" being written as a "j." Menninger notes a pervasive preference for roman numerals in court documents, and recounts that the City Council of Florence in 1299 made it illegal to write amounts of money in hindu-arabic numerals: "...the old figures alone are used because they cannot be falsified as easily as those of the new art of computation, of which one can with ease make one out of another, such as turning the zero into a 6 or 9, and similarly many others can also be falsified."[8]

In the 15th Century, there was a third wave of interest in hindu-arabic numerals in Europe, growing out of the growing dependence on mercantilism. Merchants were more focused on the practicality of the new number system than in their suspicions about foreign cultures. Some merchants had traded with the Arabs and Indians who had been using this system for centuries, and they desperately needed

8 Menninger,
Number Words and Number Symbols, 426, 427.

FIGURE 5
Adobe® Garamond "Old-style" numerals from expert set.

to calculate sums in order to run their businesses. Block books and some of the earliest books printed with moveable type were devoted to instruction in using the "new numerals." Growth in "numeracy" kept pace with the explosion in literacy going on at that time.[9] Europeans were at last able to calculate with the new numbers, but scribes and typographers had to grapple with a new and essentially foreign set of marks.

ADAPTATION OF FORMS TO WESTERN AESTHETIC

IN ALBRECHT DURER'S ENGRAVING OF 1514, "MELANCHOLIA," (FIGURE 3) we see hindu-arabic numerals arranged in a magic square. Durer was scientifically minded and a superlative draftsman, yet his numerals of 1514 seem awkward to us today. The stroke widths seem uncontrolled, the 7 is much too wide; the 4 and the 5 both seem off balance. In fact, Durer was attempting to be faithful to the fluid, horizontal strokes of Arabic script and yet squeeze the characters into a grid – literally in terms of the outline of the magic square and more generally in terms of the imaginary grid applied to Western type from the ancient Greek period onwards. In fact, 11 years later Durer wrote *On the Just Shaping of Letters*, diagramming harmonious proportions for letters based on analytical grids.[10]

Those who developed letterforms for moveable type shared Durer's concept of a rigidly oriented grid. They did so in part because it was necessary to the mechanics of typographic composition to draw each character within the space of a rectangular metal block. Although early type looked somewhat like hand-drawn brushstrokes, it was, in fact, created by the carving of metal punches. Through this

9 Menninger,
Number Words and Number Symbols, 334, 335. Menninger describes the Bamberg block-printed book of 1470, a printed Italian textbook of arithmetic of 1478, and a printed German textbook of 1482 devoted exclusively to the new art of written computations with numerals. Menninger observes that the printing press made not only the hindu-arabic numerals, but the counting board more accessible to wide audiences during this period. "Such text books show not only that computations were made, but also by what methods and how the counting board was set up. These books of computations, which were among the first popular printed works, appeared in large numbers in all countries in the 16th century."

10 Durer, Albrecht. 1965.
On the Just Shaping of Letters. R. T. Nichol, translator. New York: Dover.

practice, early type designers were able to bring a level of precision and regularity to new letter and numeral forms that had previously been unachievable. They were able to recreate the "new numbers" in forms consistent with emerging humanist and gothic typefaces by adding serifs, modulating the stroke with vertical or oblique stress and even by creating italic versions of the numerals.

Earl M. Herrick, in a discussion of typography in general, describes a process he calls "Trajanicizing" in which letter forms as diverse as Armenian, Thai and Cherokee have, at various times, been redrawn using a limited set of straight lines and regular curves, given serifs, given vertical or oblique stress and formed into an "upper case" and "lower case" set.[11] Ratisbon's example from the 11th century reflects some of these characteristics, notably serifs and regularity of form (FIGURE 1). Impulses toward "Trajanicizing" accelerated as designers recreated forms for the new metal type.

Allan Haley notes that:

> *Claude Garamond is generally credited with creating the first typeface whose numerals were specifically designed to reflect the subtleties of its letterforms. Except for a few stylistic variations, Garamond's figures set the standard for numeral design for the next two hundred years. Garamond intended his numerals to be set as part of text copy and designed them to have the same proportions as lowercase letters. Because of this, they do not align with the baseline and the cap line or ascender line of a given typeface, as do the numerals in most fonts today.*[12]

Interestingly, this standardization of hindu-arabic numerals within roman typefaces would seem to be a major achievement, yet is not listed with Garamond's most significant achievements in most references to him.

Today in faces such as Adobe Garamond we have a choice of "old style" numerals with ascenders and descenders and bodies generally as high as lower-case letters, or alternate "lining" figures that align with the capital letters. [13]

In Garamond's old-style numerals the 3, 4, 5, 7 and 9 are configured as descenders and the 6 and 8 as ascenders. Yet one may observe many variations in popular typefaces today, such as 5 as an ascender or all the odd numbers as descenders and the even ones as

11 Herrick, Earl M. 1999.
"Toward Disambiguating the Term 'Roman.'" Visible Language 33.2, 104 – 126.

12 Haley, Allan. 1995.
Alphabet: The History, Evolution, and Design of Letters We Use Today. New York: Watson-Guptill, 104, 105.

13 Bringhurst, Robert. 1992.
The Elements of Typographic Style. Vancouver: Hartley & Marks, 44, 45, and 221. Bringhurst attributes the popularity of lining figures to the rise of retail trade in the 19th century. According to Bringhurst, old-style numerals are a sign of civilization, in that they keep numerals "on an equal footing with words." Presumably he is referring to how lining figures visually dominate upper and lower-case text, drawing attention to prices.

ascenders. Given the multiple introductions of the numeral forms into Western writing, it is not surprising that no one configuration is acknowledged as "the original" or as necessarily correct. Each attempt to align them with our alphabet has been subjective and even arbitrary. There is no single instantiation of the numerals that embodies their "real" form in the way that we look to Trajan's column, rightly or wrongly, as the archetype of our alphabet.

The incorporation of numerals into our expanded alphabet changed the overall visual form of texts. The act of "Trajanicizing" remains incomplete and the numerals, with their Arabic roots, allow the typographer and calligrapher opportunities for sweeping, expressive strokes on an otherwise regimented page.

Some typographers bemoan the current use of lining figures rather than the more graceful old style figures. But American penmanship classes from the 19th century until today have taught students that numerals should be consistent at either the full cap height or half that height. For instance, the Palmer method of penmanship, popular from the 1920s, taught students to write all numerals at a consistent height with very slight descenders on 7 and 9, and the subsequent Zaner-Bloser and recently popular D'Nealian handwriting methods teach children to write all numerals to align exactly.[14] It is not surprising that many designers choose typefaces whose numerals are consistent with how they have been taught to write. Even though ascenders and descenders are supposed to make characters more legible, old-style numerals are unusual enough today that readers may confuse the 0 with the letter "o," a 9 with a "g," and so on.

Ironically, two of the figures whose forms changed the least when adapted to our writing system now prove to be the most problematic. The 0 (zero) has long been confused with the letter O, and the 1 (one) with the letter l, but the sudden importance of alphanumeric web addresses, and the computer's intolerance for misspelling, have made these confusions particularly grievous. Dirk Wendt's 1969 article "O or 0?"[15] anticipated some of these problems, but they are far from solved.

14 Sassi, Paula A. 1989.
Better handwriting in 30 days: developing a more attractive, readable script for business, school, and personal satisfaction. Los Angeles: J.P. Tarcher; New York: St. Martin's, 17.

15 Wendt, Dirk. 1969.
"O or 0?." Visible Language 3.3, 241 – 48.

FINITE AND FLEXIBLE

THE NUMERAL SYSTEM THAT THE ARABS ADOPTED FROM INDIA WAS AN enormous improvement upon roman numerals and the many other systems Europeans had used for counting and calculating prior to the 13th century. This was because of the system's elegance: all possible numbers can be expressed with just ten symbols. As in the Western alphabet, there is an efficiency and economy of means effected by recombination of just a few constituent parts.

Many accounts of the history of typography mention the superiority of phonetically-based alphabets over ideographic writing systems, noting how much easier it is to learn the 26 symbols in our alphabet than the 9,000 to 80,000 used in Chinese. David Diringer effuses:

> *The alphabet is the last, the most highly developed, the most convenient and the most easily adaptable system of writing. Alphabetic writing is now universally employed by civilized peoples; its use is acquired in childhood with ease. There is an enormous advantage, obviously, in the use of letters which represent single sounds rather than ideas or syllables. No sinologist knows all the 80,000 or so Chinese symbols, but it is also far from easy to master the 9,000 or so symbols actually employed by Chinese scholars. How far simpler is it to use 22 or 24 or 26 signs only! ... Thanks to the simplicity of the alphabet, writing has become very common; it is no longer a more or less exclusive domain of the priestly or other privileged classes, as it was in Egypt, or Mesopotamia, or China.*[16]

The limited number of characters used in the Western alphabet is often cited as creating the perfect setting for the birth of typography in Europe, as well. For instance, De Vinne notes that moveable type was invented by the Chinese and Koreans earlier than by Gutenberg, but moveable type was not widely used in those cultures for centuries because it would have involved casting too many characters.[17]

Our alphabet has benefited by reduction to just a few different letters but similarly by the simplification of its visual forms into those made with just a few strokes. The Greeks and Romans adapted the Phoenician alphabet by reducing it to regular marks of uniform proportions. These limited constituent shapes (lines, curves, verticals, horizontals and serifs) are combined and recombined to create all the letter forms in the alphabet – each letter easily

16 Diringer, David. 1968.
The Alphabet: a Key to the History of Mankind. 3rd ed., vol. 1. New York: Funk & Wagnalls, 13.

17 DeVinne, Theodore Low. 1969.
The Invention of Printing. [1876] Detroit: Gale Research Co., 116 – 118.

distinguished from the next yet together forming a visually unified whole.[18] The introduction of the hindu-arabic numeral system, based on the infinite recombination of a few component symbols, fit in with an emerging European worldview in which all things could be built from, or broken down into, repeatable parts. Ironically, despite the "Trajanicizing" mentioned earlier, calligraphers and type designers still struggle to visually incorporate hindu-arabic numerals into this limited system of marks. According to calligrapher Jacqueline Svaren, "The numerals are surprisingly difficult [to render]. This is due, in part at least, to the subtle differences between the well-made figures & those we have done incorrectly for so long. Another reason is the basic difference in rhythm. These symbols are not Western – as are our letterforms. Rather, they are Eastern, from India, via Arabia."[19]

INTERRELATIONSHIP BETWEEN LETTERS AND NUMERALS

THE NUMERALS ENTERED OUR CULTURE OVER A PERIOD OF TIME THAT coincided with complex intellectual upheavals in Europe. The upswings in mercantilism, travel, paper production, literacy, mass production of texts and tolerance of "non-Christian" ideas all played parts in making the numerals both accessible and necessary. It was a time when printed books, block books and manuscripts existed side by side and when gothic and humanist letters were written on the same page. At roughly the time Gutenberg's press was putting scribes out of business, hindu-arabic numerals were being disseminated across Europe through the printed books that Gutenberg spawned.

As book publishing grew, numerals made the organization of texts more clear, enabling bible verses to be located, legal codes to be made uniform and conflicting texts to be reconciled. Eisenstein notes, "The use of arabic numbers for pagination suggests how the most inconspicuous innovation could have weighty consequences – in this case, more accurate indexing, annotation and cross-referencing resulted."[20] In short, conventional "literacy" was enhanced in a variety of ways by readers' familiarity with hindu-arabic numerals.

The broad impact of hindu-arabic numerals was that they gave Europeans a much greater ability to manipulate numbers, which

18 Carter, Rob, Ben Day, Phillip B. Meggs. 1993. Typographic Design: Form and Communication 2nd ed. New York: Van Nostrand Reinhold, 30, 31. "Letterform combinations from the Times Roman Bold font demonstrate visual similarities that bring wholeness to typography. Letterforms share similar parts. A repetition of curves, verticals, horizontals, and serifs are combined to bring variety and unity to typographic designs using this typeface. All well-designed fonts of type display this principle of repetition with the variety that is found in Times Roman Bold."

19 Svaren, Jacqueline. 1975. Written Letters: 22 Alphabets for Calligraphers. Freeport, ME: Bond Wheelwright Co., 45.

20 Eisenstein, Elizabeth. 1979. The Printing Press as an Agent of Change, vol. 1. Cambridge: Cambridge University Press, 106.

in turn helped to propel Western culture toward its ever-growing preoccupation with written data. This shift from haptic and oral traditions to a fixed scribal activity described by Marshall McLuhan in *The Gutenberg Galaxy*[21] had an important numerical component. Europeans' tendency to "think on paper" depended, in part, on becoming comfortable with writing, as well as calculating with the numerals.

In short, the introduction of hindu-arabic numerals enabled Europeans to make calculations but also made the culture more "graphical." Europeans had to overcome their ignorance and prejudice toward a foreign number system and their confusion about how to write and print hindu-arabic numerals in order to incorporate these characters into their overall writing system. While the numerals we use today remain residually "foreign" in some ways, their incorporation into our writing system is a significant part of the history of Western typography.

21 McLuhan, Herbert Marshall. 1962.
The Gutenberg Galaxy: The Making of Typographic Man. Toronto: University of Toronto Press.

REFERENCES

Campbell, Jeremy. 1982. *Grammatical Man: Information, Entropy, Language and Life*. New York: Simon and Schuster.

Flegg, Graham, editor. 1989. *Numbers Through the Ages*. London: MacMillan Education.

Gazalé, Midhat. 2000. *Number: From Ahmes to Cantor*. New Jersey: Princeton University Press.

Ong, Walter J. 1982. *Orality and Literacy: the Technologizing of the Word*. London: Methuen.

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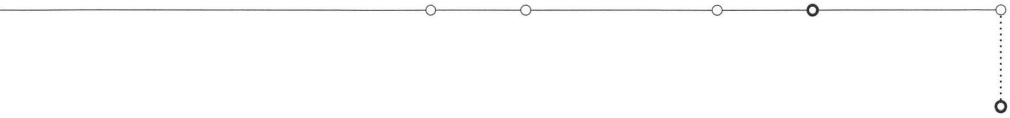

THE MUTAMATHIL TYPE STYLE

TOWARDS FREE, TECHNOLOGICALLY-FRIENDLY 'ARABETIC'[1] TYPES

Saad Abulhab

ABSTRACT

Efforts to adapt various Arabetic scripts to the machine are as old as the field of typography, but most of these efforts concentrated primarily on forcing the machine to duplicate the Arabetic handwritten forms. Others have practically advocated divorce from the calligraphic tradition rather than enrichment or reform. One reason why the few modern attempts to typographically solve the technology-induced Arabetic script problems has failed is that new typeforms (or many times just a theoretical calligraphy style) was presented as replacement for the traditional ones rather than as optional working types. New "controversial" typeforms should be made widely available for users to experience and judge, rather than be dismissed based on unsupported claims or verdicts by a few influential individuals. Through the open design of the Mutamathil type style, the past restrictive, calligraphy-based, Arabetic typography is overcome and a more progressive development path is established. This is an open system that produces Unicode compliant, technology-oriented, fonts to work side-by-side to the traditional ones. Such fonts not only work with current Arabetic applications, but also facilitate future creative ones.

INTRODUCTION

TYPOGRAPHY IS THE ART OF AUTOMATED CALLIGRAPHY, HOWEVER IT MUST adhere to the key principles behind automation, which are mass production and its underlying economic goal. Despite its roots in and association with the art of calligraphy, typography has emerged as an independent field. A type designer can begin with calligraphy, but should use it as a design base only when it facilitates automation. Due to this key goal of serving automation, type design and its application as typography is closely linked with other fields of technology and industry. It is a field combining both art and science, like architecture. Type (or typefaces or fonts) and their designs are at the heart of the field of typography. Fonts were originally developed as metallic letter sets of particular calligraphic design, which were appropriate for the early stages of mechanized paper printing

processes. Modern day fonts are systems of software-based digital fonts, which can facilitate many visual representations aside from the printed one.

Historically, typography emerged in Europe as "the demand for more speed than the scribes could provide made some means of more rapid production necessary."[2] It evolved during the Industrial Revolution into an industrial field governing the process of mass production of Latin-based written forms. To serve this process of automation, these written forms were eventually altered and standardized in their overall appearance. The early, wood engraved, block type and the first movable type attempted to duplicate various handwriting forms.[3] But they gradually moved beyond their handwritten models when it became apparent that letters' shapes were easier to cut and print individually.[4] "In the early days of the craft, when printing was beautiful, writing was the model; whereas today printing is held superior to writing."[5] Consequently, the new model or standard type paved the way for the many changes that occurred during the following centuries. Handwritten texts of old manuscripts and engraved block books that contained mostly connected letters were replaced by texts composed of individual letters. The number of necessary base letters and shapes needed to represent the previous calligraphic varieties became fixed and normalized. The visual appearance of several letters was altered to accommodate the limitations of the machinery. Ligatures, one shape representing two or more conjoined letters, either disappeared or became infrequently used. In some cases, an accented letter was either transformed into an independent letter or was replaced by two existing letters. The fixed set of independent characters on a typical Latin typewriter or keyboard today summarizes these revolutionary changes. Current printed or visual Latin forms vaguely resemble the old ones. It is a challenge to read an old English or German book from a few centuries ago! Similar changes also affected the written forms of other non-Latin languages in Europe like Russian and Greek.

The history of human writing offers many examples of how a nation's writing can change dramatically over the years. Adaptation to new needs was almost always the primary driving force behind

1 'Arabetic': a new word, is a more descriptive and inclusive adjective than 'Arabic' when referring to various scripts using Arabic letters and their related applications or embodiments.

2 Goudy, Frederic W. 1940. Typologia: Studies in Type Design and Type Making. Berkeley: University of California Press, chapter 2.

3 Goudy, Typologia, chapter 3.

4 Goudy, Typologia, chapter 5.

5 Goudy, Typologia, chapter 3.

Baruch College, SUNY
Visible Language, 38.3
Abulhab, 306-333

6 Ghulam, Yusuf Muhammad. 1982.
The Art of Arabic Calligraphy. Review copy.

most of these transformations. The handwritten texts of one thousand year old Arabic manuscripts differ greatly from the printed texts of modern books. Many Arabic letters today do not even resemble the old ones.[6] For many languages, the number or definition of letters have changed, too; and changes did not necessarily occur over very long time periods. The Japanese and Chinese languages, which not so long ago were oriented right-to-left, top to bottom in writing order, are now read from left-to-right. Hebrew, in its transformation from an ancient language to a modern one, has experienced writing reform as well. Historically, the need for adaptation has rarely transformed a language writing form overnight and it has rarely caused it to disappear. But modern adaptation to industry and technology has shortened the time period for transformation. It has also threatened or sometimes forced many non-Latin writing forms to become either secondary or to disappear. The extreme and unnecessary abandonment of the Ottoman Arabic based letters in modern Turkey is a good example. It was justified, at least partially, as a reform step adapting to modernity and technology, and as a key factor in improving literacy. Instead, it was a costly surrender to technology as well as an abandonment of the goals of adaptation, literacy and reform. Among other results, it permanently denied the Turkish people the ability to read thousands of their historical texts. For years, it even denied them the ability to effectively read or write their language. In contrast, a few decades ago, real adaptation occurred in Germany, when they replaced its historically rooted letterforms with current, commonly used Roman ones.

As with many other fields, the emergence of computers has transformed typography significantly. Software and font design have changed the ways in which we read or write the old printed forms. Digitization has quickly gained dominance; just visit the World Wide Web. Globalization has emerged as a major challenge to typography. Today, the text writing and rendering of any language must rapidly adapt to creative, flexible and economical type designs. Because early computers were originally designed to handle Latin letters, the subsequent progress of non-Latin typography became even more dependent on non-native, external factors. Internally,

for example, most software programs and systems display text in a left-to-right order and are designed to render characters in isolated forms. Therefore, to adapt to an emerging technology, while strictly following the rules of an old calligraphy, non-Latin languages needed a greater investment to develop software and acquire the technical expertise in order to accommodate to the limitations of the dominant Latin-based technology. Most of the non-Latin typography handled on today's computers, became captives of the Latin software producers who gladly charged very high fees to tweak their systems to generate these nonstandard scripts. Unlike the natural and healthy evolution of Latin typography and its machine-friendly writing forms, non-Latin typographic progress concentrated primarily on how to alter the machine to duplicate old, detailed and ill-suited calligraphy rules; thus maintaining old writing forms. One can point out many expensive attempts, both successful and unsuccessful, to accommodate Chinese, Arabic, Hebrew or other scripts on computers. In a way, many non-Latin languages missed a golden opportunity to truly reform their writing system.

7 The Unicode Consortium.
The Unicode Standards Version 1.0.

The distorted evolution of non-Latin typography finally settled down with the introduction of the Unicode standards sponsored by major software companies like Microsoft and Adobe. This was, without a doubt, a major step in conquering the "technical anarchy" that dominated the development of non-Latin software and typography. The result was that non-Latin type design and development became less expensive and more standardized. Mainstream type editors and other tools finally started to accommodate these complicated scripts. Thanks to the Unicode standards, one can read in many languages on the Internet today. But imposing these standards has potentially affected the evolution of non-Latin typography in a negative way. For many languages, it could reinforce and sustain their unevolved, calligraphy-oriented letterforms. For example, the Unicode standards finalized a fixed number of basic required characters to render a given language. It endorsed the process of glyph (shape) substitution to represent characters as a minimum rule of design for certain languages. It imposed either right-to-left or left-to-right letter ordering as a native direction requirement for other languages.[7] Most of these rules were

rooted in the distorted evolution of many non-Latin types during their struggle to adapt to the Latin-geared machinery. Although the Unicode compliant technology today is not so restrictive toward non-Latin text, it is still not as friendly with it as it is with Latin text, which has reshaped itself historically to embrace technical change. It would be a mistake for non-Latin typography to settle forever on all of the rules imposed by the current Unicode standards. The machine must not be forced to duplicate all and every detail of the old calligraphy. Typography is about transforming calligraphy to adapt to the machine as much as it is about altering the machine in the service of calligraphy. Since most of the available and affordable technology is Latin based, non-Latin typography ought to adapt to it rather than reinventing the wheel. This fact is especially important in developing countries where adaptation can save many endangered writing forms from extinction. But despite some of its negative effects, the Unicode standards can be employed today as a primary tool to correct the path of the calligraphically obsessed past of non-Latin typography.

8 Hudson, John. 2000.
"Windows Glyph Processing." Microsoft Typography. http://www.microsoft.com/typography/default.asp

THE ARABETIC TYPOGRAPHY

NOWHERE WAS THE PREVIOUSLY MENTIONED DISTORTED EVOLUTION OF non-Latin typography clearer than in the case of the calligraphy-oriented Arabetic typography. Arabetic scripts include all scripts or writing forms utilizing the original Arabic alphabet or an alphabet related to it through the addition or subtraction of a few derived letters and glyphs. Among these scripts are Arabic, Urdu, Persian, Baluchi, Kashmiri, Kazakh, Sindhi, Pashto, Lahnda, Kurdish, Dargwa, Uyghur, Turkic, Berber, Old Malay, Old Hausa, Adighe and Inguish. The Unicode standards combined all these scripts into one script group referred to as "Extended Arabic." It was classified further, along with a few other scripts like Hebrew, as a complex script. "The term 'complex script' refers to any writing system that requires some degree of character reordering and/or glyph processing to display, print or edit."[8]

Main problems of the Arabetic typography

BEFORE DETAILING VARIOUS PROPOSALS AND DESIGNS, IT IS ESSENTIAL to first examine the technological problems of the Arabic-based scripts and the methods and solutions currently supported by the

Unicode standards to visually display them. To type, render or otherwise represent the Arabic language digitally, mechanically or in ways other than by common handwriting, a minimum of 44 basic Unicode characters is required. Extended Arabic, used by more than twenty-one other distinct non-Arabic languages (e.g., Urdu, Persian and Kurdish) necessitated the addition of 96 other basic characters, mostly derived from the original Arabic letters. Included with the basic characters are nine diacritics and several ligatures. Diacritics, not used extensively by modern Arabic, are placed on top or below a character altering its shape when viewed within a fixed frame. Therefore, a total of at least 140 distinct basic Unicode characters are needed in order to accommodate all the written forms that are based on the extended Arabic character set as defined by the Unicode standards version 1.0.[9]

In reality, each of the base Unicode characters above is an abstract representation of a letter, diacritic or ligature, which can appear in any of several different forms called glyphs.[10] In its isolated form, each character is represented by a distinctive glyph. But within Arabetic texts, each character must change its shape, either significantly or slightly, depending on its position in a word. Ligatures that belong to the basic character set (e.g., Waw with Hamza above) also change their shapes based on their positions and are treated by computers as if they were normal letters. Other ligatures, like the Lam-Alif ligature, which are formed by replacing two or more basic glyphs by one glyph, are not included in the basic set. They, too, change shapes depending on their positions within words. Therefore, an average of two to five glyphs are needed for each character/ligature when typing or displaying any Arabetic script. Diacritics complicate this picture further since they produce additional shapes upon their placement. Since each letter/ligature does not have one uniform shape in all positions, the number of glyphs needed is not constant. In contrast, English is always represented by 26 letters and 52 glyphs. Producing a font for the extended Arabic set today minimally requires the design of 500-600 glyphs, depending on type or calligraphy style, compared to less than 200 glyphs to cover all Latin scripts. This also means that articles of manufacture with Arabetic lettering embodied within (e.g., printers,

9 Abulhab, Saad D. 2004.
US Patent 6,704,116. Also, US Design Patent 435,584.
10 The Unicode Consortium.
The Unicode Standards Version 1.0.

hand held devices, computer software, stamping devices or fonts) need to store a large number of glyphs. To this is added the need to manage the problem of constant glyph change, which introduces labor-intensive glyph definition tables and complex programming processes.

All Arabetic scripts are normally read and written from right-to-left. They are not easily written or read from left-to-right. But in some applications (e.g., the aviation field) training is provided to write them from left-to-right. Handwriting or reading any Arabetic script from right-to-left is easy when acquired from childhood. But articles manufactured to utilize Latin lettering (e.g., computer software and hardware) must be altered or redesigned to accommodate the right-to-left direction. Letters of embodied Arabetic words in various mediums (e.g., transparencies, microfiche, negatives, printed paper) look different depending on the direction of reading. Therefore, bi-directional reading of such composed texts is difficult when using the right-to-left traditional glyphs.[11] Numbers within Arabetic texts are ordered from left-to-right complicating further the rendering of these texts, because applications handling them must incorporate methods for bi-directional ordering not only right-to-left ordering.[12]

Unlike the glyphs of Latin letters, which can be written or displayed in both connected (cursive) and unconnected (isolated) forms, most glyphs of the Arabetic letters/ligatures must always appear connected within a word. A good number of these glyphs must join with others, both to their right and to their left. Some glyphs must join with the ones on their right but not with the ones on their left. Occasionally, glyphs must appear isolated within a word. And in rare cases (e.g., Ha used for a Hijri year) a glyph in its connecting form must appear isolated instead. Therefore, articles of manufacture designed to produce Arabetic letters have to employ additional complicated processes or methods to handle these puzzle-like letter-joining/non-joining possibilities. Also, many Arabetic scripts use an optional glyph "Tatweel," which is a straight horizontal line (like a dash), to justify texts or to create visual effects. Tatweel can form arbitrary word lengths. For this reason, applications that need fixed letter widths cannot handle traditional Arabetic fonts easily.

11 Abulhab, Saad D.
US Utility Patent 6,704,116.

12 Bishop, F. Avery, David Brown, David M. Meltzer. 1998.
"Supporting Multilanguage Text Layout and Complex Scripts with Windows NT 5.0." Microsoft System Journal. November. http://www.microsoft.com/msj/1198/multilang/multilang.aspx

Addressing these difficulties, programmers and Arabetic typographers introduced in the 1980's many complicated, but brilliant, computer system solutions. Most solutions were first handled by special additional software before being incorporated gradually into the operating systems. Endorsing the concept of the so-called "intelligent" fonts, the Unicode and Open Type standards later transferred many of these technical tasks (e.g., glyph substitution definitions) to the type designer.[13] In both cases, this became a burden resulting in larger, more complicated and expensive fonts and systems. In today's computers, Arabetic glyphs constantly change their look with every keystroke. Positioning a cursor to correct a misspelling is time consuming. Mixing right-to-left texts with left-to-right texts can be a nightmare. Such difficulties, in addition to being truly annoying, are very discouraging to new learners, putting the Arabetic scripts in a real disadvantage when competing globally.

13 Hudson, "Windows Glyph Processing."
14 AbiFares, Huda Smitshuijzen. 1998.
"Arabic Type: A Challenge for the 2nd Millennium." Baseline International Typographics: 26.
15 Sakkal, Mamoun. 1993.
"The Art of Arabic Calligraphy." Part 4: The Art of Arabic Calligraphy. http://sakkal.com.

Arabetic typographical solutions: a review

LIKE LATIN LETTERFORMS, ARABETIC LETTERFORMS ARE ROOTED IN the centuries old rich Arabetic calligraphy. Arabetic books were handwritten by calligraphers, prior to the emergence of mechanized printing. The earliest attempts to print Arabic letters using movable parts appeared at the beginning of the sixteenth century in Europe. Copper and lead type components to print today's most circulated Arabic Naskh type, are displayed in the Imprimerie Nationale in Paris.[14] Ironically, today's commonly used version of the Naskh calligraphy or type was refined by the Ottoman Turks in the 16th century and was adopted as their official writing form.[15] Unfamiliar with the Arabic script and its history, the Europeans who solved the earlier problems of the Arabetic typography concentrated on how to precisely duplicate various calligraphy styles on printed material. After all, typesetting with its static nature can more or less accommodate any written form. These early solutions deprived the Arabetic scripts of a true reform attempt, to rethink the obstacles of their strong calligraphy dependence in order to produce truly machine-friendly types. Later on, typewriters, facing these same ignored obstacles, came up with some relatively courageous and creative typographic solutions. Some letters were assigned fewer

Opening chapter of Koran in "unified" alphabet

FIGURE 1
An example of a previous attempt to simplify the Arabic writing. Sample text and the character set of the "Unified Arabic Alphabet" by Mr. Nasri Khattar. 1951. From "A Brief Survey of Proposals to Simplify Arabic Script" by Mamoun Sakkal, 2000.

رحلة الألف ميل تبدأ بخطوة واحدة
شهدت اللغة العربية دعوات إصلاح عديدة
تناول أكثرها الخط العربي

المرحلة الإنتقالية. توفر قراءة سلسة والوضوح المعتاد مع الأشكال التقليدية.

رحلة الألف ميل تبدأ بخطوة واحدة
شهدت اللغة العربية دعوات إصلاح عديدة تناول
أكثرها الخط العربي

المرحلة النهائية. بعد أن تكون العين قد تعودت على الأشكال الجديدة، تسهل
عليها قراءة هذه الأشكال منفصلة.

FIGURE 2
An example of previous attempts to simplify the Arabic writing. Sample text from the "Simplified Arabic Typeface" by Mr. Murad Boutros. 1993. From "A Brief Survey of Proposals to Simplify Arabic Script" by Mamoun Sakkal, 2000.

position-dependent shapes. But the typewriter failed to move the Arabetic scripts into the typographic age. With the emergence of computers, the few positive typewriter-based attempts at simplifying the Arabetic written forms, quickly evaporated. Arabetic typographers were again busy duplicating calligraphy to its fullest detail in their type designs.

Facing the challenges of typography in the early 1930's, the Academy of the Arabic Language in Cairo outlined a few proposals to simplify Arabic writing. These proposals included the reduction of the number of shapes per letter, the inclusion of Arabic accents as extra letters, the normalization of letterform sizes and the elimination of diacritic dots.[16] Many serious reform attempts to produce technology-friendly type systems surfaced in the past decades.[17,18] Some of these attempts were very creative, while others were artificial or arbitrary imitations of the Latin, Hebrew or Indic writing forms. FIGURES 1 and 2 show two samples of proposed type or calligraphy styles, that are truly outstanding. The first one, by the Lebanese architect and artist Nasri Khattar, was introduced in 1951 under the name of "al-Abjadiyah al-Muwahaddah" (or the unified Arabic alphabet.) The second one, by the Egyptian type designer, Murad Butrous, was introduced in 1993 under the name of "al-Khatt al-Arabi al-Mubassad" (or the simplified Arabic script.) Farsi type

16 AbiFares, "Arabic Type."
17 AbiFares, Huda Smitshuijzen. 2001. Arabic Typography: A Comprehensive Sourcebook. Saqi. Review copy.
18 Sakkal, Mamoun. A Brief Survey of Proposals to Simplify Arabic Script. 2000. http://sakkal.com. Review samples.

FIGURE 3
The Mutamathil type at different point sizes.

designers also made attempts to accommodate computer software. A completely different approach by Justin Majzub of England, detailed a method for chopping the Arabic letters into a fixed number of shapes, creating segments of characters to be reconstructed later to form any desired glyph.[19] The fixed number of segments presumably would make up a future keyboard or be used behind the scene as part of the internal processes involved in displaying Arabic glyphs. Mr. Majzub's creative approach was another attempt to force typography to duplicate calligraphy to its fullest details. Practically it failed to accomodate automation and its economic purpose.

19 Majzub, Justin H.V. 1993. US Patent 5,407,355.

FIGURE 4
The Mutamathil Mutlaq type at different point sizes.

Despite these serious efforts, the proposed designs left no major impact on contemporary Arabetic typography. The attempts to simplify Arabic writing generally failed to address several important issues. First, most solutions were introduced as alternatives to the traditional scripts, not as additional options. Also they did not advocate an open design principle by presenting solutions based on clear, defined and flexible design rules. Second, they ignored the derived Arabic characters used by many non-Arabic languages. Third, they continued to approach type design calligraphically without sufficient knowledge of the technical side of modern

تمثالان من أور

ظهرت التماثيل الصغيرة ومعظمها تماثيل نسائية في منطقة الشرق الأدنى منذ حوالي العام 7500 قبل الميلاد، وتساعد ملامحها المميزة علماء الآثار على معرفة الثقافات والشعوب المتعددة في المنطقة. ويعود التمثالان المصوران أعلاه إلى منطقة أور في جنوب العراق، ويرجع تاريخهما إلى العام 4500 قبل الميلاد، وهما نموذجان على الثقافة العبيدية التي تعود إلى ما قبل التاريخ.

ويعد هذان التمثالان إضافة إلى عدد آخر من التماثيل التي عثر عليها في المناطق المجاورة ما يسمى التماثيل "السحلية" وتلاحظ نظرا لمظهرها المشابه للزواحف. والذي يعود أساسا إلى شكل عيونها المشابه لحبوب القهوة وشكل رؤوسها المستطيلة، الذي من المحتمل أن يكون راجعا إلى القماط في فترة الرضاعة. كما تم استعمال القار لإظهار الشعر، وقد تشير الكريات الطينية أو العلامات المصبوغة على الكتف إلى الوشم أو إلى القرابين. وطول التمثال يقارب 13.6 سنتيمترا.

FIGURE 5

Computer generated sample of Arabic text illustrating Mutamathil type.

computer font design and generation. Most of these proposals were purely theoretical. They did not produce fonts that can be tested for clarity at different sizes, for example. Fourth, some of these designs truly violated the spirit of Arabic writing and ignored legibility. Also, many ignored addressing the vowel diacritics completely. Fifth, the required right-to-left ordering, which is technically the main challenge facing Arabic typography, was not addressed by any of these designs. Sixth, while some of them unnecessarily considered the removal of the crucial diacritic dots, all designs insisted on keeping the Lam-Alif and other ligatures. Finally, most designs either required letters to be connected or isolated instead of addressing both cases. And the few designs that suggested letter separation imposed equal spaces between all glyphs failing to include the important visual effects of the traditional letters joining/non-joining process.

تمثالان من أور

ظهرت التماثيل الصغيرة ومعظمها تماثيل نسائية في منطقة الشرق الأدنى منذ حوالي العام 7500 قبل الميلاد، وتساعد ملامحها المميزة علماء الآثار على معرفة الثقافات والشعوب المتعددة في المنطقة. ويعود التمثالان المحوران أعلاه إلى منطقة أور في جنوب العراق، ويرجع تاريخهما إلى العام 4500 قبل الميلاد، وهما نموذجان على الثقافة العبيدية التي تعود إلى ما قبل التاريخ.

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FIGURE 6

Computer generated sample of Arabic text illustrating our bi-directional Mutamathil Mutlaq type. (Compare to same text in figure 5.)

THE MUTAMATHIL TYPE STYLE

TO OVERCOME THE ABOVE-MENTIONED TECHNOLOGICAL PROBLEMS AND other obstacles facing the Arabetic scripts, a new style of type is outlined with its unique design principles; it is the "Mutamathil" (or unified and symmetric) type style. Briefly, this technology-oriented type style employs glyphs/characters representative of the extended Arabic characters; these are generally symmetric to facilitate bi-directional use, uniform to render a single glyph per letter and independent to compose non-cursive text strings. It utilizes the advantages produced by the Unicode standards, which have helped conquer the chaotic state of the Arabetic typography through the adoption of minimum design rules and procedures. Incorporating this type eliminates all major and unique obstacles faced by articles of manufacture utilizing the traditional Arabetic alphabets. It creates a font-only, software-independent character input/output system intended to facilitate the use of Arabetic lettering on articles designed for Latin lettering, with a slight or no alteration of such articles'

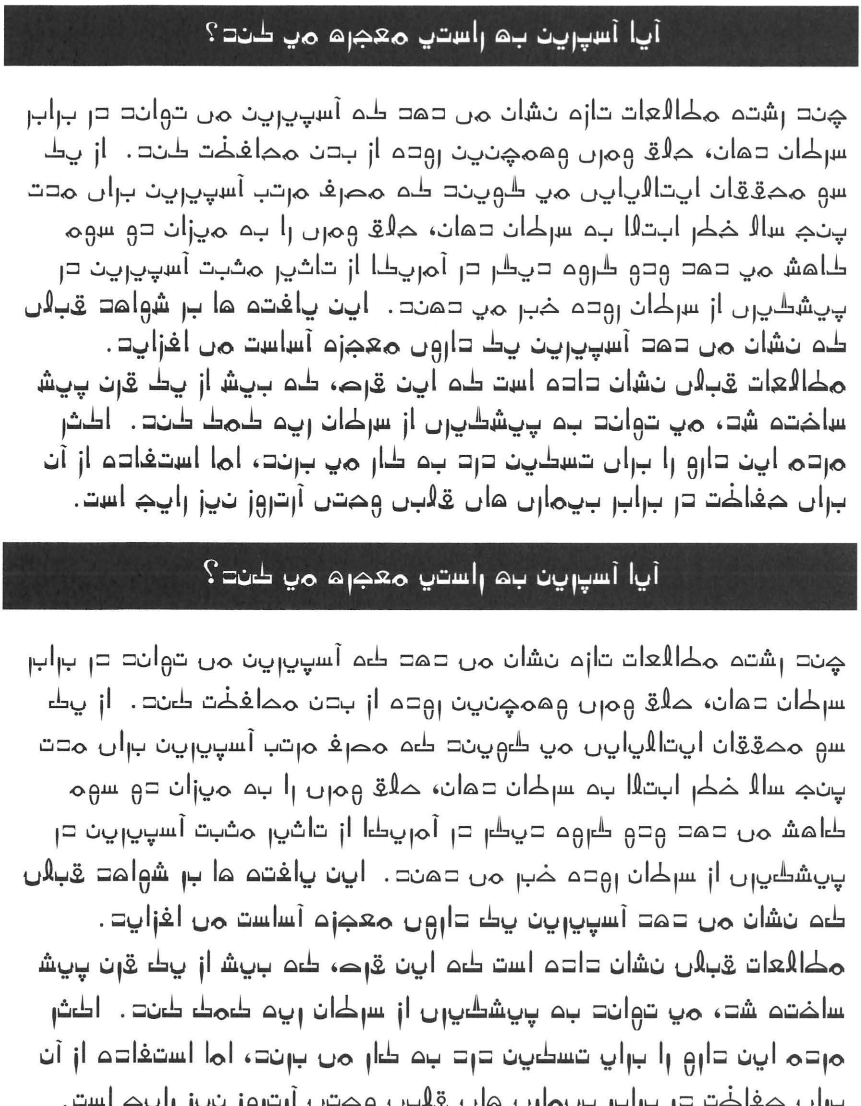

FIGURE 7
Computer generated samples of Farsi text in the Mutamathil type (above) and Mutamathil Mutlaq type (bottom).

FIGURE 8

Computer generated samples of Urdu text in the Mutamathil type (above) and Mutamathil Mutlaq type (bottom).

original design. Articles of manufacture with the embodiment of this new lettering (e.g., computer software and hardware, communication systems, image printing, translation software, Arabetic languages teaching tools) can be produced with significantly less complexity to deliver the extended Arabic texts in a form closely resembling their traditional ones. For samples of Mutamathil texts in Arabic, Farsi and Urdu (SEE FIGURES 3-8).

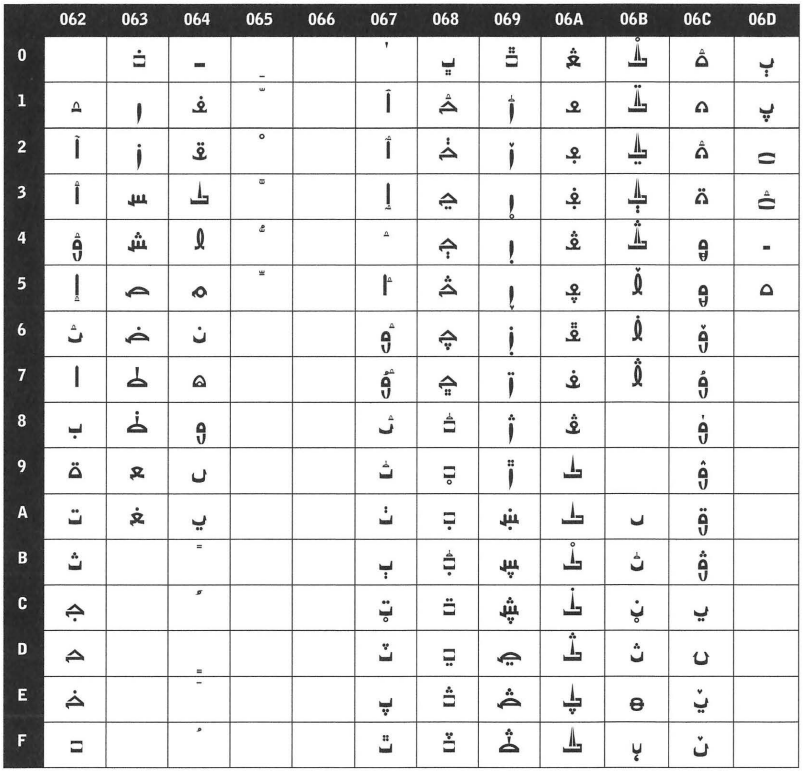

TABLE 1

Mutamathil type glyphs of the basic characters for the extended Arabic Unicode block, for right to left utilizations.

The reference TABLES 1, 2, and 3 include glyphs/Unicode characters of the two members of the proposed type style. Notice that the glyphs in each of these tables correspond, in a one-to-one relation, to all Arabetic characters both in their isolated and non-isolated forms. The design of the glyphs is based primarily on the Arabic Kufi type and calligraphy. They clearly resemble traditional Arabetic glyphs. The style or look and feel of these glyphs reflect the personal implementation vision of the design principles of the Mutamathil type as understood by this author; this is discussed later in the article. This style is limited by calligraphic and artistic experience and capability. TABLE 1 reveals the original glyphs for the Mutamathil type, which can only be employed for right-to-left applications. Compare these with the glyphs of TABLES 2 and 3, which are slightly altered ones of the same type style. These belong

	062	063	064	065	066	067	068	069	06A	06B	06C	06D
0		٠	ـ	ـ		'	ـ	ـ	ـ	ـ	ـ	ـ
1	ـ	ـ	ـ	ـ		ـ	ـ	ـ	ـ	ـ	ـ	ـ
2	ـ	ـ	ـ	ـ		ـ	ـ	ـ	ـ	ـ	ـ	ـ
3	ـ	ـ	ـ	ـ		ـ	ـ	ـ	ـ	ـ	ـ	ـ
4	ـ	ـ	ـ	ـ		ـ	ـ	ـ	ـ	ـ	ـ	-
5	ـ	ـ	ـ	ـ		ـ	ـ	ـ	ـ	ـ	ـ	ـ
6	ـ	ـ	ـ			ـ	ـ	ـ	ـ		ـ	
7	ـ	ـ	ـ			ـ	ـ	ـ	ـ		ـ	
8	ـ	ـ	ـ			ـ	ـ	ـ	ـ		ـ	
9	ـ	ـ	ـ			ـ	ـ	ـ	ـ		ـ	
A	ـ	ـ	ـ			ـ	ـ	ـ	ـ	ـ	ـ	
B	ـ		ـ			ـ	ـ	ـ	ـ	ـ	ـ	
C	ـ		ـ			ـ	ـ	ـ	ـ	ـ	ـ	
D	ـ		ـ			ـ	ـ	ـ	ـ	ـ	ـ	
E	ـ		ـ			ـ	ـ	ـ	ـ	ـ	ـ	
F	ـ		ـ			ـ	ـ	ـ	ـ	ـ	ـ	

TABLE 2

Mutamathil Mutlaq (directionless Mutamathil) type glyphs of the basic characters for the extended Arabic Unicode block, for right to left utilizations.

to the "Mutamathil Mutlaq" (directionless Mutamathil) type, which includes two differently encoded (same codes used in the tables only for comparison) sets of mostly identical glyphs that can be used for both right-to-left, and left-to-right applications.

The Mutamathil type style proposes a technology-oriented, computer-friendly, minimal type style. A type capable of closing the gap between the Arabetic scripts on one hand, and both technology and other simpler world scripts on the other. The author is not advocating the abandonment of the daily newspaper types or common writing forms. Producing reasonably legible texts, the Mutamathil type is intended to fulfill the immediate prototype needs of the Arabetic scripts to ensure that they keep up with any emerging technology. Using this type, Farsi speakers, for example, would not need to romanize or transliterate Farsi words when communicating

	062	063	064	065	066	067	068	069	06A	06B	06C	06D
0		٠	ـ	ـٖ		ٗ	ٜ	٪	٦	٫	٬	٭
1	ٮ	١	٠	ـٗ		٘	ٝ	٫	٧	٭	٭	ٮ
2	ٰ	٢	٠	ـ٘		ٙ	ٞ	٬	٨	٭	٭	ٯ
3	ٱ	٣	٠	ـٙ		ٚ	ٟ	٭	٩	٭	٭	ٰ
4	ٲ	٤	٠	ـٚ		ٛ	٠	٭	٪	٭	٭	ٱ
5	ٳ	٥	٠	ـٛ		ٜ	١	٭	٫	٭	٭	ٲ
6	ٴ	٦	٠			ٝ	٢	٭	٬	٭	٭	
7	ٵ	٧	٠			ٞ	٣	٭	٭	٭	٭	
8	ٶ	٨	٠			ٟ	٤	٭	٭		٭	
9	ٷ	٩	٠			٠	٥	٭	٭		٭	
A	ٸ	٪	٠			١	٦	٭	٭	٭	٭	
B	ٹ		٠			٢	٧	٭	٭	٭	٭	
C	ٺ		٠			٣	٨	٭	٭	٭	٭	
D	ٻ		٠			٤	٩	٭	٭	٭	٭	
E	ټ		٠			٥	٪	٭	٭	٭	٭	
F	ٽ		٠			٦	٫	٭	٭	٭	٭	

TABLE 3

Mutamathil Mutlaq type glyphs of the basic characters for the extended Arabic Unicode block, for left to right utilizations.

with email or in chat rooms. Instead, they can write Farsi left-to-right utilizing our Mutamathil Mutlaq type. Also, learners of various Arabetic writing systems can use this simplified type as an introductory tool to read and write their languages. Through this design, a new step is taken in the same direction adopted by many open-minded modern type designers, who aimed to simplify and standardize Arabic-based scripts. The call to free the Arabic type forms from its restrictive calligraphy is similar to the highly successful calls of the twentieth century to free Arabic poetry from its restrictive historical rules. The call is not to abandon the traditional Arabetic calligraphy and fonts, but to enrich them by providing new flexible alternatives.

FIGURE 9
Computer generated sample Arabic writing of the Mutamathil type.

DESIGN PRINCIPLES OF THE MUTAMATHIL TYPE STYLE

GENERALLY, THE TYPE STYLE EMPLOYS GLYPH SYMMETRY AND UNIFORMITY as its design basis by representing each letter with a single glyph of unique, symmetrical and independent appearance, resembling one of the traditional glyphs of that letter. As a result, the approach creates new distinctive Arabetic alphabets or written forms. Keeping the symmetry and uniformity principles, a variety of fonts belonging to the same type style can be produced. Altering glyph design, partially or totally, through the application of systematic or geometric change on glyph symmetry, can also create new fonts that can be utilized for their new look, directional suitability or both (SEE FIGURES 9-11). The six major principles (or rules) used to achieve the design goals of this type style are explained below.

One glyph or shape per character

EVERY CHARACTER IN THE MUTAMATHIL TYPE IS REPRESENTED BY ONE shape or glyph, regardless of its position in the word. At the heart of the design is the elimination of the glyph forming process, which performs one-to-one, one-to-many or many-to-one glyph substitutions in order to display a traditional text. Since Arabetic computer characters include not only the officially accepted letters, but also a few other required ligatures and diacritics, the one glyph per character principle extends to them as well. The type eliminates

FIGURE 10

Two computer generated samples of Arabic writing in the Mutamathil Mutlaq type illustrating its bi-directional capability.

all glyph substitutions including the ones related to the Lam-Alif ligature. This Alif-Lam ligature elimination reduces further the number of required basic Unicode glyphs. And, as an additional benefit, it frees four assigned keys on a typical input device. In a keyboard, for instance, these free keys can be assigned for other basic letters or symbols. To be specific, this approach creates a new system wherein Arabetic alphabets are represented by a minimum number of around 140 glyphs, compared to the current minimum number of 500-600 glyphs now required depending on type. The number covers all extended Arabic letters, ligatures and diacritics as defined by the Unicode standards. It would be a fixed number independent of type or calligraphy.

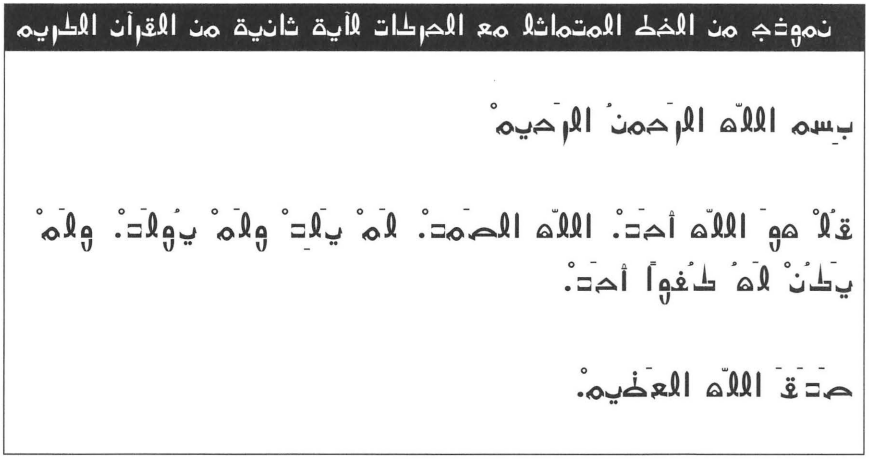

FIGURE 11
Computer generated sample of Arabic writing of the Mutamathil type illustrating diacritic insertions.

A glyph is generally symmetric around its vertical axis to facilitate bi-directionality

ONE GOAL OF THE TYPE STYLE IS TO END THE TRADITIONAL DEPENDENCE of the Arabetic texts on unidirectional character ordering. Every one of the glyphs is designed either exactly symmetric or semi-symmetric around its vertical axis. When flipped horizontally, every glyph maintains the distinctive features of the same glyph prior to flipping. Looked at individually from left-to-right or right-to-left, each glyph has its general characteristics preserved and is visually identical. Glyphs that do not natively have any form of symmetry, based on their positions in the traditional Arabetic word (e.g., Kaf, Dal), are first designed to be completely symmetric, but are then slightly altered to produce semi-symmetric glyphs resembling the traditional ones. The nature of this alteration determines whether they are going to be used in right-to-left or left-to-right applications. The Mutamathil type words, which are spelled the same but have their letters arranged in opposite order, would mirror each other. Reverse ordering a given word will produce a characteristically identical word when looking at it from the opposite direction. Therefore, it is possible to read a left-to-right ordered Mutamathil text without looking turned around as in the case of reading a horizontally flipped right-to-left ordered traditional Arabetic text. (SEE FIGURE 2). To display texts in either direction one needs to utilize two slightly different, direction specific, fonts. (COMPARE THE GLYPHS OF TABLES

Glyphs have independent forms to render non-cursive text

FREEING THE ARABETIC TEXTS OF THEIR REQUIRED, CALLIGRAPHY-inherited, cursive forms is another goal of the type style. Glyphs can be displayed slightly separated (isolated) or even connected within a word without loosing their visual characteristics. Therefore, words composed of these glyphs look basically the same in both cases. Also, the resulting spaces between glyphs when separated are not uniform or equal; extra space is added to the left or right (depending on the direction of writing) of both sides of the glyphs corresponding to the traditional Arabetic letters/ligatures, which either join from the right only, or do not join at all, with other letters/ligatures, in order to maintain the traditional visual effects of the non-joining appearance of these glyphs within our new non-cursive environment. This built-in glyph spacing static solution eliminates the need for additional system processes to handle the traditional problem of letter joining/non-joining. Specifically, extra space is added to the glyphs for Hamza, Dal, Ra, Alef, Waw and their derivatives. Diacritics can be inserted within the double space produced by two adjacent unconnected glyphs. Therefore a glyph would look the same when viewed within a frame before and after adding diacritics (SEE FIGURE 11). Combined diacritics, like "Shadda with Fatha" are treated by the type style as independent diacritics in order to end completely the need for glyph substitutions. For this reason, three diacritics are added, "Shadda with Fatha," "Shadda with Kesra" and "Shadda with Dammah," now assigned Unicode numbers FC60, FC61 and FC62, to the Unicode basic group of vowel diacritics under Unicode numbers 0653, 0654 and 0655. (SEE TABLES 1, 2 AND 3.) It is important to point out that the type does not eliminate the vowel diacritics, but like most other modern type, it discourages their excessive use.

Glyphs fit within specific boundary dimensions

WHEN ISOLATED IN A DESIGN FRAME, THE MAIN BODY PART OF ANY OF THE new glyphs fits uniformly between two horizontal and two vertical guidelines of specific x-y coordinate values. FIGURE 12 shows the seven horizontal guidelines, Y1 through Y6 and the X-axis, and the two vertical guidelines X1 and X2, which are used by the designs. The guidelines Y1, Y6, W and the Y-axis form a glyph design frame. Next to each horizontal guideline a group of Unicode names of Arabetic characters is indicated that use that guideline as one of

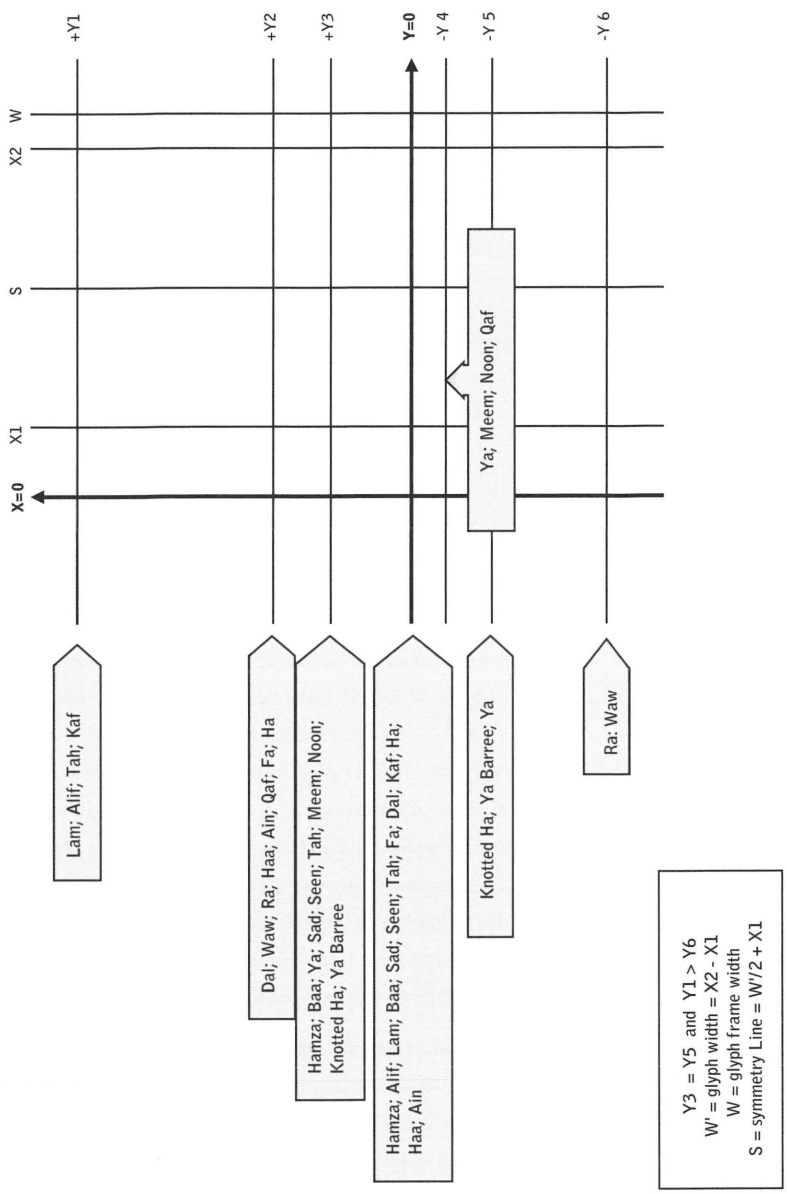

FIGURE 12

Design guidelines of the basic Arabetic glyphs for the Mutamathil type style.

Unicode Hex #	Unicode Name Description	Mutamathil Type Glyph
FEFB	Lam-Alif	
FEF5	Lam-Alif with Madda	
FEF7	Lam-Alif with Hamza above	
FEF9	Lam-Alif with Hamza below	
FEFF	Alif-Lam	
FDF2	Allah	

TABLE 4
Examples of possible added ligatures.

their boundaries. Font designers can determine the values of the Y variables. But these values should be chosen carefully to maintain the proportional sizes of all glyphs in a type. For most glyphs, X1 is set to equal (W-X2) in order to produce identical spaces around a glyph. Where W is the design frame width, which can be fixed or variable to produce fixed or variable width fonts. For specific glyphs (e.g., Dal, Ra) X1 is greater or less than (W-X2), depending on the location of the extra spaces added to achieve a desired directionality and to handle the join/non-join problem discussed previously. The placement location of dots or other diacritics above or below the main body of a glyph is not restricted by the guidelines. Also, each glyph has a line of symmetry S regardless of being completely symmetric or semi-symmetric.

Glyphs must resemble their traditional forms

EACH MUTAMATHIL GLYPH INCORPORATES THE VISUAL CHARACTERISTICS of a specific Arabetic glyph either in its isolated form or in one of its other varying forms within words, or both. Before designing the glyphs, special attention was given to the historical shape changes of the Arabic letters and their varied designs under major calligraphy schools. Attention to the statistical occurrences of various glyphs within texts was also a consideration. Therefore, all the glyphs are easily recognized as Arabetic glyphs and are readily distinguishable from each other.

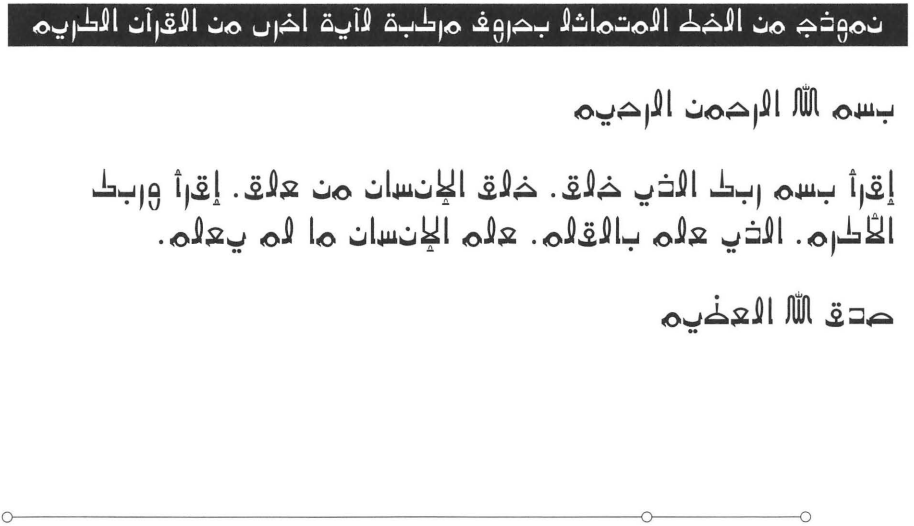

FIGURE 13

Related type must maintain the principles of design

THE MUTAMATHIL TYPE STYLE ADAPTS AN OPEN DESIGN APPROACH.

If, while altering or redesigning glyphs, the basic rules of the design are observed, similar new type is produced that will yield its exact functionality. A slight or total elimination of symmetry in either a few or all glyphs, when applied systematically and geometrically, produces a variety of direction-specific types. Keeping the uniform single glyph per character relation and completely eliminating symmetry produces glyphs similar to the position-specific traditional Arabetic glyphs (or their horizontal inversions). Again, the resulting types are either right-to-left or left-to-right implementations of the original type. Keeping the uniform single glyph per letter relation, while increasing or decreasing the number of basic characters, also produces closely related types. For example, two basic characters/glyphs for Urdu and Kurdish are added to the Unicode minimum set, in order to improve their legibility. (See the characters with Unicode numbers 06BF and 06CF shown in TABLES 1, 2 AND 3.) Additionally, one can add glyphs for some essential traditional Arabic ligatures (e.g., Lam-Alif) or new ones (e.g., Alif-Lam) to improve legibility or typing speed. Such added glyphs should observe general symmetry, and unless agreed upon universally, they should not be added to the basic required characters set, in order to keep the one-

glyph, per one-letter, per one-key relation (SEE TABLE 4 AND FIGURE 13). Finally, the Arabic glyph "Tatweel" can still be used with this type style without sacrificing legibility in most cases.

CONCLUSION

THE GOAL OF THIS TYPE STYLE IS TO MAKE THE ARABIC SCRIPT AND its derivatives more technology-friendly without eliminating most of their traditional characteristics. Effectively, distinctive Arabetic alphabets with a minimum constant number of characters with unique non-varying shapes are created, to simplify their handling as independent forms to render non-cursive strings and to facilitate bi-directional use via generally symmetric outlines. Each letter in the font has the visual characteristics of one of its traditional glyph variations. The look and feel of the Mutamathil glyphs are determined by the personal calligraphic and artistic experience and ability of the designer in his or her implementation of the design principles of this type style. The solution provides a platform-independent, font-only-based, character input/output system or method, eliminating many currently required processes. Unlike current Arabetic fonts, this font has a significantly smaller size. In the final result, articles utilizing this type style, such as computerized systems or language learning tools, can overcome many of the current obstacles related to application of Arabetic lettering.

AUTHOR NOTE

THE AUTHOR/DESIGNER, SAAD ABULHAB, was born in Sacramento, California, and grew up in Karbala and Baghdad, Iraq. Since 1992, he has designed several traditional Arabic fonts. Residing in the US since 1979, he is currently the Director of Technology at the Newman Library of Baruch College, the City University of New York. The Mutamathil type style, designed by the author in 1999, was awarded a US Design Patent in the year 2000 and US Utility Patent in 2003. Sixteen Mutamthil fonts and five optional Microsoft Windows keyboard drivers for Arabic, Urdu, Farsi, Pashto and Kurdish are available for evaluation purposes. Please email *contact@arabetics.com*.

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