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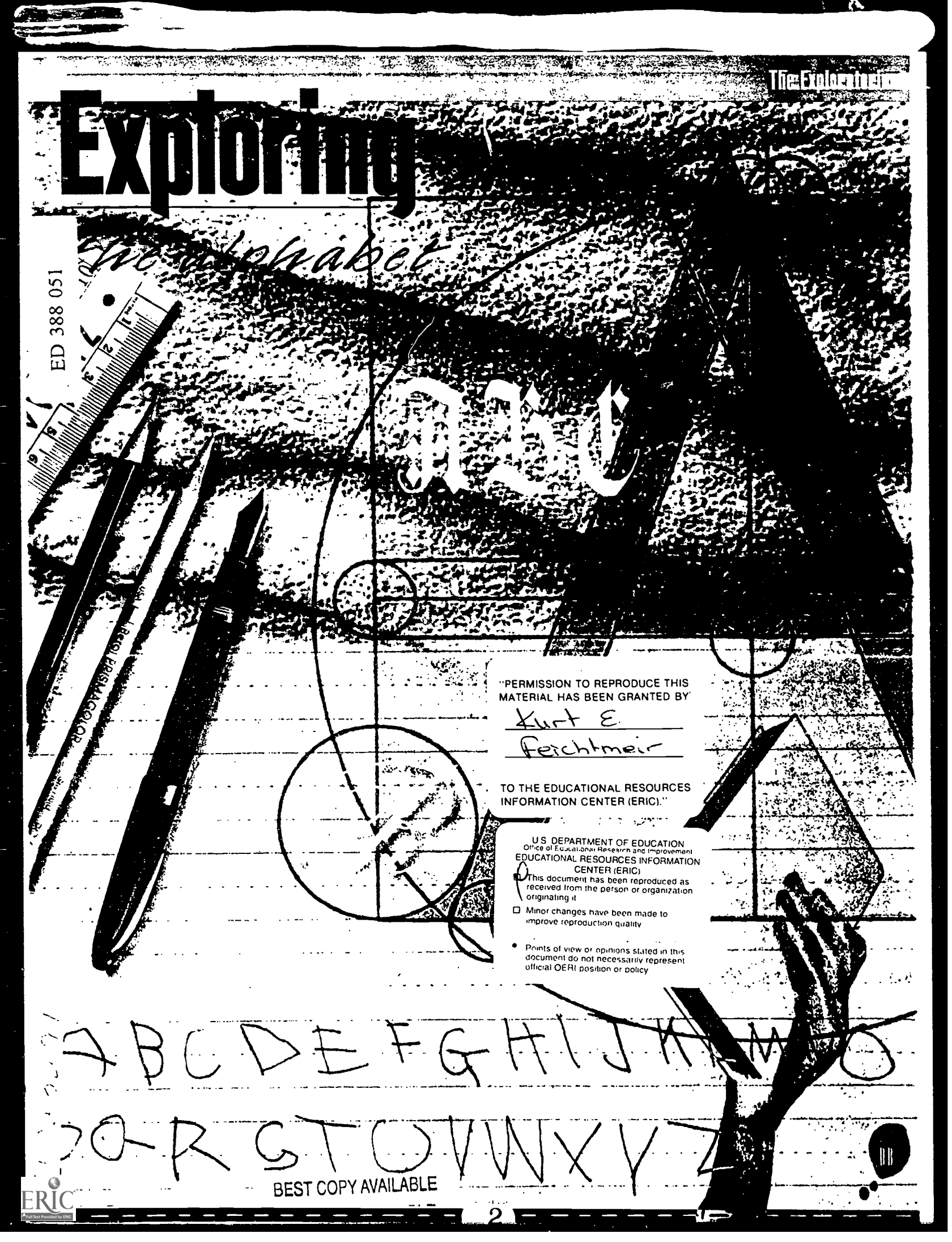
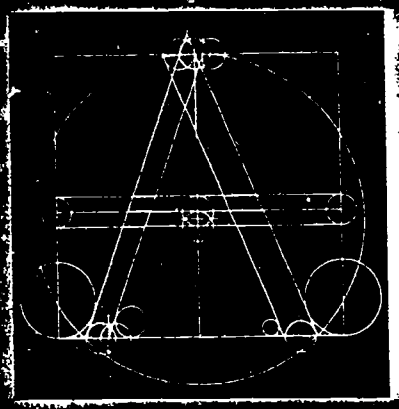
ABSTRACT

This issue of "Exploring," is devoted primarily to examination of alphabets and the languages they represent. Major articles include: "Shrinking the Alphabet" (Pat Murphy), a comparison of alphabet composition for different languages; "The Puzzle of Linear B" (Paul Doherty), a history of archaeologists' deciphering of an early form of written language; "Letters Take Shape" (Judith Brand), a comparison of letter forms and print through history and across cultures; "How Do You Spell That" (Richard Brooks), an exploration of spelling and linguistic consistency. Games, lists of further reading for most articles, regular features of the magazine (letters, reviews, and museum news), and a large wall poster (not included here) chronicling the evolution of the modern Roman alphabet are also included. (MSE)

Exploring the Alphabet





Exploring

Vol. 19, No. 2, Summer 1995

This issue [illegible]
Walter [illegible]
July 9, 19[illegible]
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Exploring is a magazine of science, art, and human perception, produced by the Exploratorium. *Exploring* communicates ideas that museum exhibits can't easily demonstrate, extending the museum beyond its physical walls. Each issue concentrates on a single topic, examining it from a variety of viewpoints. This focus allows us to investigate and discuss interconnections between apparently unrelated phenomena, revealing the essential unity of nature.

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From The Director

Dear Friends:

People have produced a number of different alphabets to record the world's languages, some of which you'll learn about in this issue of *Exploring*. But I'd like to call attention to a very special alphabet, one that is important to all of us regardless of which languages we speak. It's an alphabet of just four letters—*A, C, G,* and *T*—and it represents the language of DNA, the chemical language of life.

This language shapes physical characteristics such as your eye color and height, and it also influences your susceptibility to certain diseases. In every cell, A, C, G, and T (which stand for the chemicals adenine, cytosine, guanine, and thymine) form a seemingly endless string of 3 billion letters. What finally gives meaning to this combination of chemical building blocks is the precise order of the letters along the string. A, C, G, and T form about 100,000 *paragraphs*, or genes, which are compiled in 24 *volumes*, or chromosomes. This genetic information is like a huge, personalized encyclopedia—one that is present in all the cells of your body.

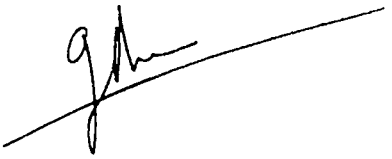
You can explore all the conundrums that surround the language of life and the genetics of human beings in the Exploratorium's current exhibition, *Diving into the Gene Pool*. You can investigate the basic chemistry of DNA and learn how our cells transcribe, translate, and proofread our genetic code as they go about their task of synthesizing proteins. At other exhibits, you can find out how DNA fingerprinting works, or how geneticists determine the order of the four letters in DNA.

Diving into the Gene Pool also emphasizes some of the ethical, social, and legal issues surrounding the current genetic revolution. Would you want to know whether you were susceptible to a particular disease if there were no cure available? Could you be excluded from health insurance or life insurance on the basis of a genetic test?

Of course, the Exploratorium cannot provide answers to all the emerging questions, but we invite you to contribute to the dialogue in the "Points of View" section of *Diving into the Gene Pool*. Consider the case studies provided, read the talk-back board to find out other people's viewpoints, and then add your own. If you have access to the Internet, you can also subscribe* to the ETHEX listserver, an on-line discussion of these ethical issues, developed by the Exploratorium in collaboration with the International Bioethics Institute.

I look forward to seeing you at the exhibition.

Sincerely,



Goéry Delacôte
Executive Director

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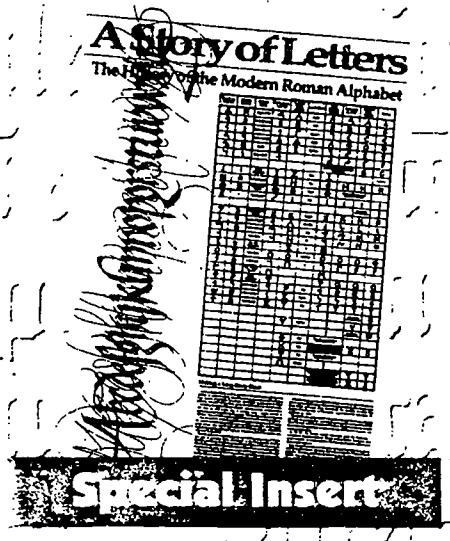
To: `listproc@exploratorium.edu`
From: [your name and E-mail address]
Subject: [leave blank]
Body of message: subscribe ethex [your name]

BE CAREFUL! The experiments in this publication were designed with safety and success in mind. But even the simplest activity or the most common materials can be harmful when mishandled or misused. Use common sense whenever you're exploring or experimenting.

the alphabet

Exploring Magazine, Summer 1995



The Puzzle of Linear B
by Paul Doherty
A hundred years ago, archaeologists discovered tablets bearing an unknown language. Here are the clues that helped solve this mystery.

Letters Take Shape
by Judith Brand
Square and curved, thick and thin, elaborate and streamlined—the style of letters has changed throughout history, from the time of the Romans to the age of the computer.

How Do You Spell That Sound?
by Richard Brooks
Find out why pronouncing words both common and unfamiliar may not help you put them in writing.

Try This!
Abecedarian Amusements
by Ellen Klages
Challenge yourself with these alphabet games.

A Story of Letters:
The History of the Modern Roman Alphabet
Beginning with the first known alphabet—the Phoenician of 1100 B.C.—the poster in this issue traces the major changes leading to the letters we use today.

Departments

First Word

by Pat Murphy

When the Exploratorium staff began talking about this issue of *Exploring* magazine, Judith Brand, the magazine's production editor (soon to be editor), described an unfortunate game of Scrabble. When Judith was visiting Norway, she and her traveling companions decided to play a game with the hotel's Scrabble set one rainy afternoon. They drew their tiles and settled down to play—but soon discovered that they couldn't. The game just didn't work. Player after player was stumped. They could make a few short words—like *dog* or *cat*—but not long ones.

That seemed strange to me. Scrabble is Scrabble, right? You choose letters and make words. What's the problem?

On the lid of the Scrabble game box, you'll find a list of the letters of the alphabet. Beside each letter, you'll see the number of points you earn for using that letter and the number of tiles printed with that letter. Joe Edley (two-time National Scrabble Champion) of the National Scrabble Association was kind enough to provide us with the same information from Scrabble games designed for use in various languages. When we compared the letter lists for English and Norwegian (opposite page), we found the problem. Take a look, and you'll see what I mean.

If you're an English speaker playing with a Scrabble game made for Norway, you'll quickly find yourself running short of *E*s and *I*s and *O*s. In general, you'll be low on vowels—there are forty-four vowels in the English version, but only thirty-four in the Norwegian, even if you count the *Æ* and the *Å*s and *Ø*s. You may not miss the *Q* or *X* or *Z*, letters that don't appear in the Norwegian game. But what are you going to do with those extra *K*s and *F*s and *J*s?

It turns out that the distribution of letter tiles in a Scrabble set—which always seemed somewhat arbitrary to me—isn't arbitrary at all. Before deciding how many copies of each letter to include in the game, the inventor of Scrabble, an out-of-work architect named Alfred Mosher, painstakingly analyzed English word structure. Obviously some letters appeared more frequently than others—but which ones?

To figure out the relative frequency with which letters were used in English words, Mosher examined the front page of the *New York Times* and counted how many times each letter of the alphabet appeared. Armed with this information, he decided how many tiles with each letter to include in the game—and the appropriate value to assign to each letter. That's why the English language version provides twelve *E*s, each worth only one point, but only one *Q*, which is worth ten points. Mosher included many *I*s so that players could make words ending in *-ing* and *-ion*.

That brings us back to that troublesome Norwegian Scrabble game. Though English and Norwegian more or less share an alphabet, Norwegian words use some letters more frequently than English—and some less frequently. Trying to spell out English words using the distribution of letters appropriate to Norwegian is, as Judith discovered, a difficult proposition. Imagine playing after all the *E*s have run out.

That would be a challenge, but I'm confident that it can be done. Why am I so sure? Well, playing Scrabble without *E*s is not so different from the creation of a lipogram, a piece of writing in which the author has disallowed the use of one or more letters.

For centuries, writers have been creating works that lack letters. Perhaps the most diligent

If you're an English speaker playing with a Scrabble game made for Norway, you'll quickly find yourself running short of *E*s and *I*s and *O*s. It turns out that the distribution of letter tiles in a Scrabble set isn't arbitrary at all.

of the Greek lipogram writers was Tryphiodorus, a poet of the fifth century B.C. Tryphiodorus wrote a twenty-four-volume epic poem on the adventures of Odysseus. In the first book, titled *Alpha*, he omitted the Greek letter alpha. In the second book, titled *Beta*, he did without that letter. One by one, he excluded every letter of the Greek alphabet. Latin writer Fulgentius followed Tryphiodorus's lead and wrote a book with twenty-three chapters. Each left out one letter of the Latin alphabet.

In more recent times, A. Ross Eckler is noted for creating lipogrammatic versions of "Mary Had a Little Lamb." Here's "Polly Owned One Little Sheep," his version of the poem omitting the letter *A*.

Polly owned one little sheep.
Its fleece shone white like snow.
Every region where Polly went
The sheep did surely go:
He followed her to school one time,
Which broke the rigid rule:
The children frolicked in their room
To see the sheep in school.

He has also done versions of the poem that omit the letters *S, H, T,* and *E*. And as a finale, he wrote one version that uses only half the letters of the alphabet: *A, C, D, E, H, I, L, M, N, P, R, S,* and *T*.

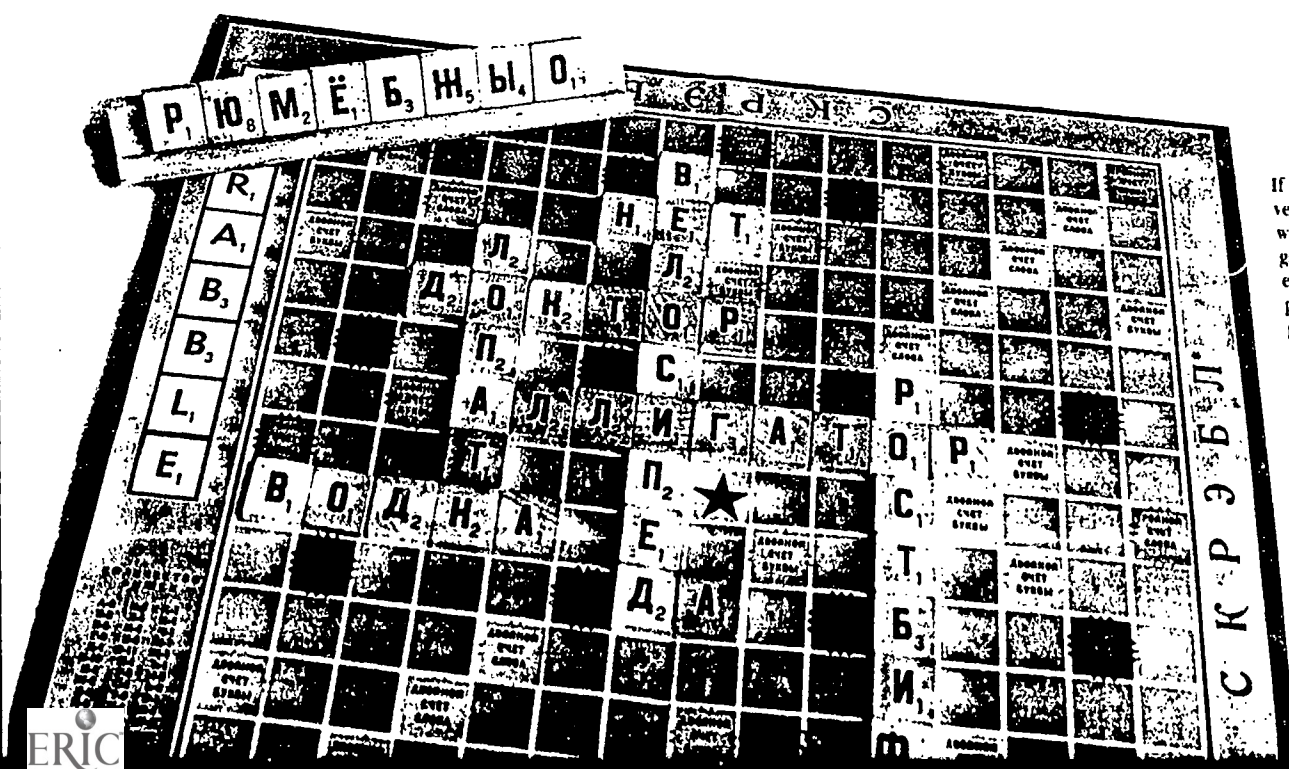
But Eckler's work pales to insignificance beside *A Void*, a recently published novel written in French by Georges Perec and translated by Gilbert Adair. The entire novel, a detective story about the disappearance of a character named Anton Vowl, omits the letter *E*. As James Kincaid wrote in a *New York Times* review of the book: "Imagine having virtually no past tense; no definite article; few personal pronouns; no here, there, where, when; no be; no elephant; no eye, ear, nose, elbow; no yes; no love; no sex!"

Perec and his translator manage the task quite handily, and for that, I salute them. If you want to get a feeling for the magnitude of their feat, try rewriting "Mary Had a Little Lamb" or some other simple verse without any *H*s. (You'll find Eckler's version on page 14.)

If you give up halfway through, join the club. Though I'm a professional writer, reputed to be good with words, this sort of endeavor is beyond me. The effort of rewriting "Mary Had a Little Lamb" without any *H*s made me cranky and frustrated. I could probably do without *Z* or *Q* or even *J*, but that's where I draw the line.

I love the letters of the English alphabet, every last one of them. If I ever find myself in Norway on a rainy afternoon, challenged to a game of Scrabble on a Norwegian set, I will smile and abdicate graciously while murmuring softly about how I simply can't do without the *X*. ●

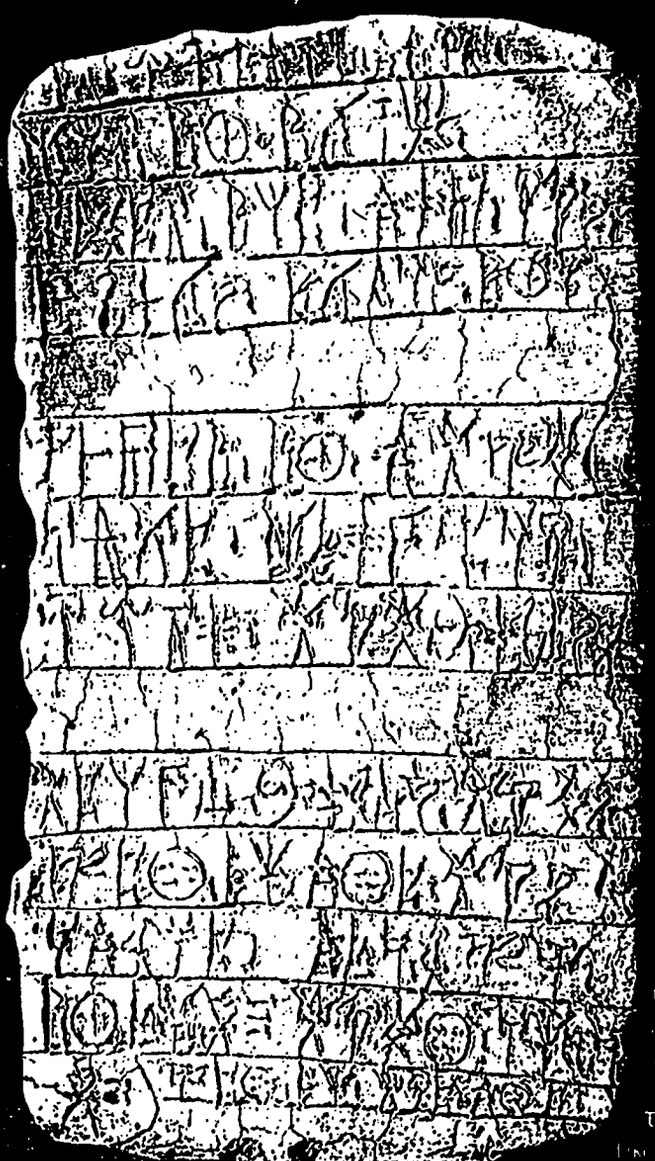
	English Scrabble		Norwegian Scrabble	
A	1 point	9 tiles	1 point	7 tiles
B	3 points	2 tiles	4 points	3 tiles
C	3 points	2 tiles	10 points	1 tile
D	2 points	4 tiles	1 point	5 tiles
E	1 point	12 tiles	1 point	9 tiles
F	4 points	2 tiles	2 points	4 tiles
G	2 points	3 tiles	2 points	4 tiles
H	4 points	2 tiles	3 points	3 tiles
I	1 point	9 tiles	1 point	5 tiles
J	8 points	1 tile	4 points	2 tiles
K	5 points	1 tile	2 points	4 tiles
L	1 point	4 tiles	1 point	5 tiles
M	3 points	2 tiles	2 points	3 tiles
N	1 point	6 tiles	1 point	6 tiles
O	1 point	8 tiles	2 points	4 tiles
P	3 points	2 tiles	4 points	2 tiles
Q	10 points	1 tile	none	
R	1 point	6 tiles	1 point	6 tiles
S	1 point	4 tiles	1 point	6 tiles
T	1 point	6 tiles	1 point	6 tiles
U	1 point	4 tiles	4 points	3 tiles
V	4 points	2 tiles	4 points	3 tiles
W	4 points	2 tiles	8 points	1 tile
X	8 points	1 tile	none	
Y	4 points	2 tiles	6 points	1 tile
Z	10 points	1 tile	none	
Æ	none		6 points	1 tile
Ø	none		5 points	2 tiles
Å	none		4 points	2 tiles



If you're used to the English version of Scrabble, playing with a Russian Scrabble game, like the one here, is even more frustrating than playing with a Norwegian game. See if you can find these words that use the Cyrillic alphabet: *doctor, velociped (bicycle), rostbif (roast beef), vodka, alligator, da (yes),* and *nyet (no).*

THE PUZZLE OF LINEAR B

By Paul Doherty



The decipherment of linear B allowed archaeologists to read firsthand accounts of Bronze Age life. In this tablet, the Minoans describe how they defended the Greek coast at Pylos.

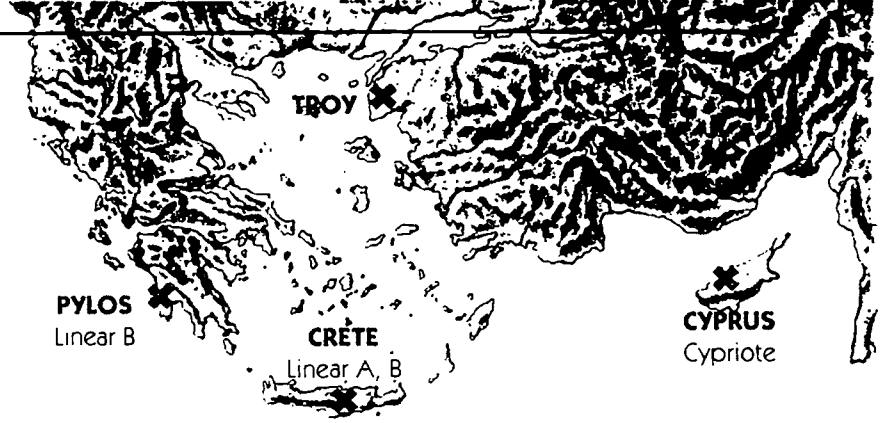
1

FROM SYMBOLS TO SYLLABLES

A LINK TO ANCIENT HISTORY

Linear A, which shares some characters with linear B and Cypriote, has yet to be deciphered.

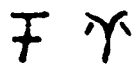
LINEAR A	LINEAR B	CYPRIOTE
?	SA	SA
?	PA	PA
?	PO	PO
?	TO	TO



languages. Assuming that linear B followed the same pattern as Cypriote, he looked for symbols for vowels and for consonants followed by vowels. He then examined how frequently linear B characters occurred in words. Analysis of the beginnings of words indicated that symbols resembling a double axe, a throne, and a capital A with an extra bar might be vowels.

The pattern of vowels and consonants in Cypriote script provided a clue crucial to the interpretation of linear B.

Ventris was particularly interested in word endings. Emmett Bennett had determined that the vertical columns of symbols on some tablets were numbers. In deciphering these symbols, he theorized that the two characters alongside the numerical totals at the bottom of most columns were probably the linear B word for *total*. Ventris noted that two words marked the numerical totals. Both had the same initial character, but the word on tablets with drawings of men used an ending character different from the ending on tablets with pictures of women. Knowing that Latin, Spanish, and French nouns have endings that indicate gender, Ventris believed that the two linear B endings also indicated gender.



Two symbols, for *to* and *sa*, spell one form of the linear B word for *total*.

Another clue was that some words appeared often on the tablets from Crete but were absent from those found at Pylos. Ventris guessed that these words were the names of towns and that the most common ones mentioned were Knossos and its harbor, Amnisos, names that survive today. If the characters representing these two towns were *ko no so* and *a mi ni so*, the double-headed axe was indeed the vowel *a*.

In linear B as in Cypriote, there was no way to represent a lone consonant like the final *s* of *Knossos* or to represent two consonants in a row. Vowels were added between consonants, and the *s* at the end was dropped. The character for *so* in *A mi ni so* also appeared at the end of one of the words for *total*. Therefore, the linear B words for *total* became *toso* and *tosa*, the phonetic spellings of the masculine and feminine forms of the Greek words for *total*. Knowing the symbols for *to*, *sa*, and *so* enabled Ventris to figure out other words. He then announced to the world that linear B was ancient Greek written with a different alphabet.

After Ventris published his decipherment in 1952, Blegen released a previously unpublished linear B tablet. The so-called Tripod Tablet bore drawings of various containers and included a tripod. Next to the tripod was a word which, according to Ventris's decipherment, translated to *ti ri po*. It is a word that English has borrowed from the Greek.

In the best tradition of science, analysis of data led to a theory that then explained new discoveries. Linear B was a script for writing late Bronze Age Greek and was in use at the time of the Trojan War, around 1240 B.C. Its decipherment never proved that Carl Blegen had found the palace of King Nestor. More important, however, the deciphered script allows us to read one of the earliest forms of the Greek language, from over 3,200 years ago.

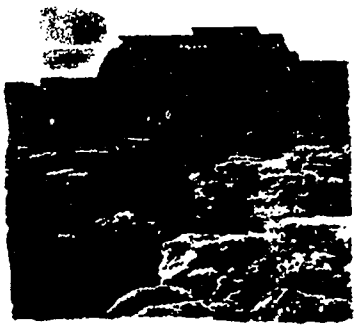
What do the tablets say?

On the tablets, the Minoans wrote detailed accounts, inventories, and lists, such as the following:

- Koldos the shepherd holds a lease from the village: 48 liters of wheat;
- one pair of wheels bound with bronze, unfit for service;
- to the mistress of the labyrinth, one amphora of honey.

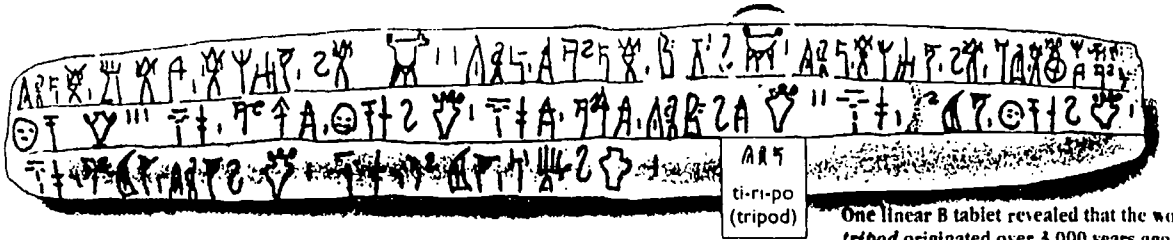
The last example is particularly interesting since the palace of Knossos is associated with King Minos, who, according to legend, kept the Minotaur imprisoned in a labyrinthine maze. The Minoan civilization is named for King Minos.

No one yet knows why linear B disappeared. Archaeologists figured out one reason why examples of the script are rare. Normally made of unbaked clay, the tablets were intended as a temporary medium. The Minoans would break up the tablets, mix the pieces with water, and shape new tablets. Perhaps the contents were copied onto paper before the clay was reused.



Archaeologist Arthur Evans first discovered linear B tablets at the palace of Knossos on the isle of Crete in 1900.

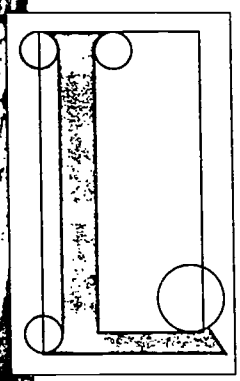
If you are intrigued by this story, you might take a crack at another script, linear A. Tablets written in linear A are found throughout Crete, not just in and around palaces. Linear A shares ten characters with linear B, but it has never been deciphered. The puzzle awaits. ●



One linear B tablet revealed that the word *tripod* originated over 3,000 years ago.

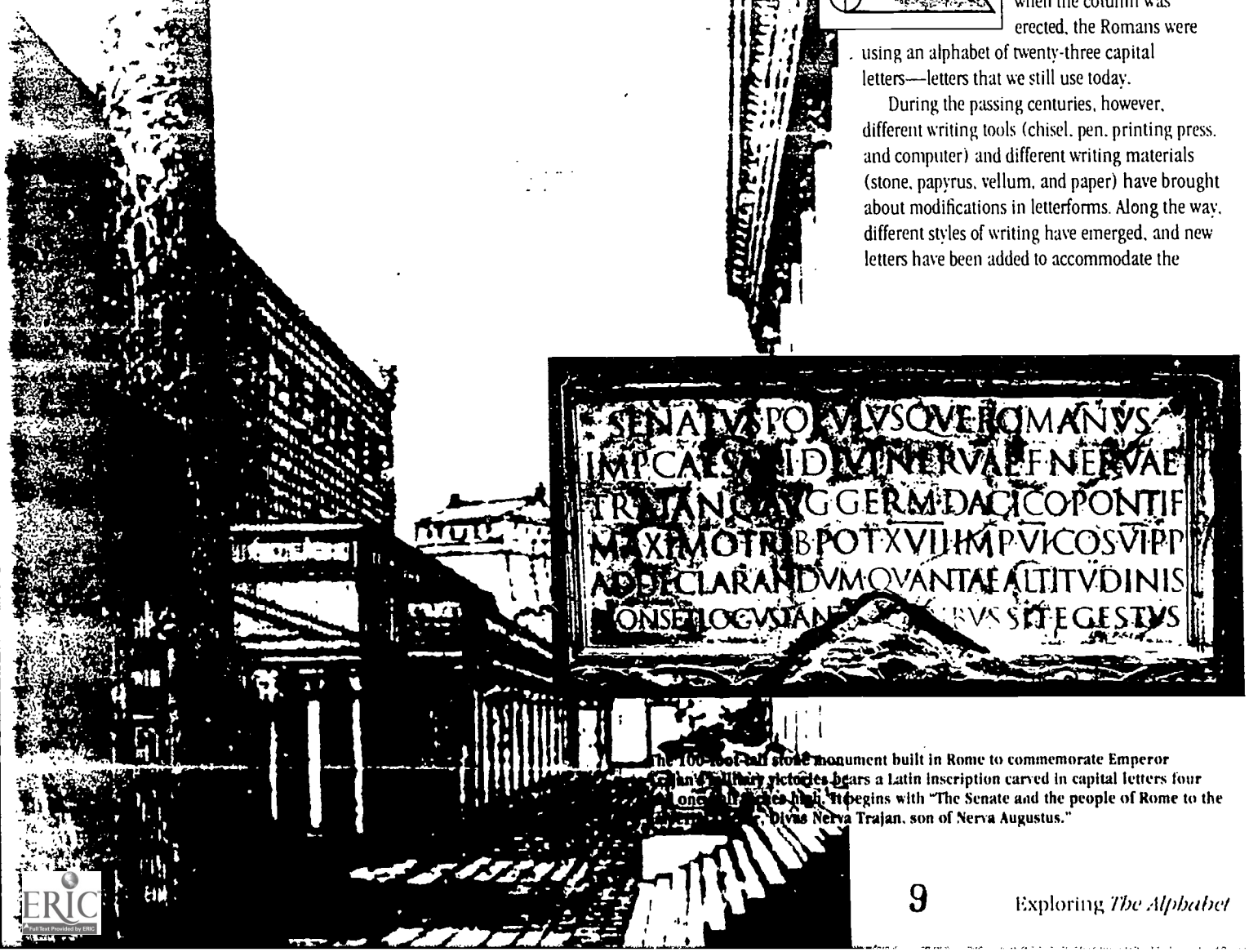
LETTERS TAKE SHAPE

by Judith Brand

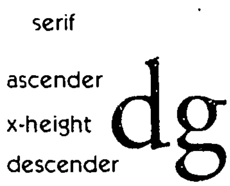


LOOK FOR A MOMENT at the inscription from the Trajan Column shown below. You will recognize the letters even though you may not be able to read the Latin words. By the first century A.D., when the column was erected, the Romans were using an alphabet of twenty-three capital letters—letters that we still use today.

During the passing centuries, however, different writing tools (chisel, pen, printing press, and computer) and different writing materials (stone, papyrus, vellum, and paper) have brought about modifications in letterforms. Along the way, different styles of writing have emerged, and new letters have been added to accommodate the



The 100-foot-tall stone monument built in Rome to commemorate Emperor Trajan's military victories bears a Latin inscription carved in capital letters four inches high. It begins with "The Senate and the people of Rome to the Divus Nerva Trajan, son of Nerva Augustus."



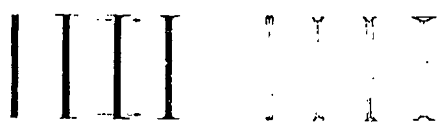
distinctive sounds of various languages.

The elegant *lapidary*, or stone-cut, capitals on the Trajan Column, probably drawn first with a stiff brush, were incised with a flat-edged chisel. Although these letters contain beautiful curves, there seems to have been a preference for angles, which are more easily cut. The thin lines perpendicular to the ends of the

SQUARE CAPITALS

strokes—called *serifs*—are a visually pleasing way to finish a stroke with a chisel.

The formal manuscripts of the Roman period were written with a reed pen on papyrus, in *square capitals* resembling the lapidary letters. These capitals, time-consuming to write, required several strokes per letter. But the result was a manuscript of considerable dignity, thought suitable for important works such as the poems of Virgil. Various other letterforms were also employed by the Romans, depending on the writer's purpose. Informal writing, for example, was done in an early *cursive*, a flowing writing in which the pen rarely leaves the page between letters. Unlike today's informal writing, however, this was a cursive of all capital letters.



Historians debate whether serifs originated as a way of refining the stroke of a letter written with brush and ink (left) or of finishing a stroke carved in stone with a chisel (right).

By the fourth century, the Romans were using letters that were rounder and lacked serifs. These letters, called *uncials*, were easily formed by reed or quill pens and could be written more quickly

roman half-uncial

than the square capitals. But not quickly enough. As scribes hurried to fulfill the increased demand for their products, a fundamental change evolved.

New letterforms called *semiuncials*, or *half-uncials* were developed, some of which had elements that ascended above or descended below the average character height. Today we call these *lowercase* letters. The Bible and other religious works were copied in uncial and semi-uncial writing. The Romans also developed a second form of cursive writing, called *minuscule cursive*, which incorporated lowercase letters as well.

After the collapse of the western Roman Empire in the fifth century, scribes continued to use uncials and semiuncials for formal manu-

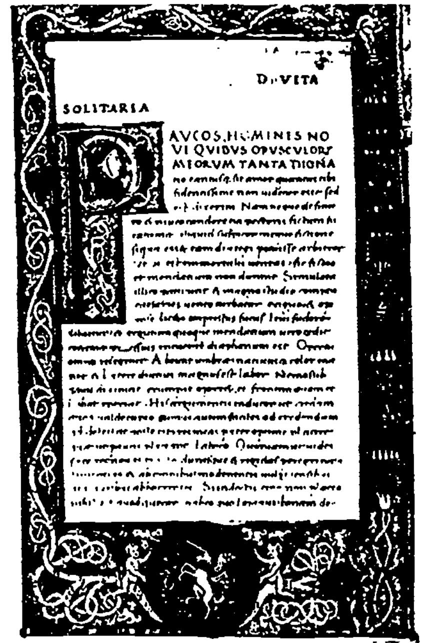
carolingian minuscule

scripts. Cursive writing, however, began to vary from region to region, resulting in what are called *national hands*. Italian, Merovingian in France, Visigothic in Spain, Germanic, and Insular, or Anglo-Irish. These national hands would later influence early forms of type in various parts of Europe.

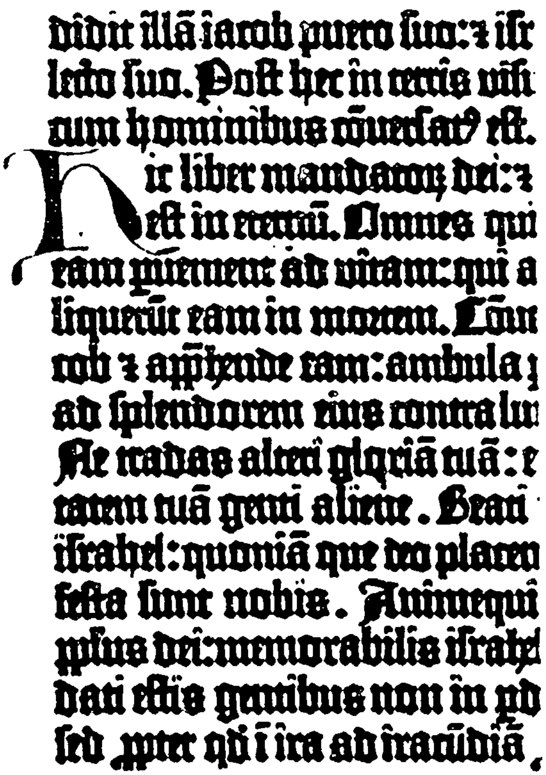
According to type scholar Daniel Berkeley Updike, the emergence of these national hands from Roman cursive is analogous to the evolution of the Romance languages from Latin. Without the strong central authority of the empire, both the spoken language and the writing style developed distinct regional characteristics.

gothic textura quadrata

Charlemagne, who became king of the Franks in 768 and later ruled much of Western Europe, was a patron of learning. He wanted to preserve the important works of the past, and he set exacting standards for both scholarship and calligraphy. His scribes, who studied the Roman semiuncial writing, created a lowercase alphabet known as the *Caroline*, or *Carolingian*.



Fourteenth-century scribes revived the readable, elegant Carolingian minuscule for works such as Petrarch's *De Vita Solitaria* of 1345 (above). In the 42-line Bible (below), Gutenberg used movable type to replicate the manuscript hand of the mid-1400s.



minuscule—praised by calligraphers for its grace and clarity.

An important characteristic of this alphabet was that, in general, each letter stood alone. There were few *ligatures*, or letter combinations that are joined together and written as one character, such as the "fi" ligature still used in type. The Caroline minuscule is a direct ancestor of the lowercase script and type forms that we use today, and the treatment of the letters as separate units explains why this alphabet was easily adaptable to type.

The Caroline minuscule spread throughout Western Europe, but it was followed by a second wave of national hands. By the thirteenth century, writing styles that employed narrow, heavy letters had emerged. These manuscript styles are known by a variety of names, the most descriptive of which is *black letter*, because the black color of these heavy letters overpowered the light background on which they were written.

These black-letter hands are also known as *Gothic*—a term introduced by the Italian humanists of the fifteenth century. The humanists, who revived Carolingian writing along with their study of classical Latin texts, used *Gothic* as a term of derision; to them, the black-letter forms were barbarous, so they named them after the barbaric Goths who had invaded Rome in the fifth century.

St. Gregory the Great, known as an avid writer, appears on a carved ivory relief with three equally diligent scribes. The small panel decorated a German church service book from the tenth century.

Et Salomon ex pſona
ıtionẽ conſtitui: & dnũ
ı ſua. In principio ante

Type designed and printed by Nicolas Jenson in the fifteenth century.

The Gothic hand began as a condensed form of the Caroline minuscule, probably as a space saving device, and evolved into narrow, pointed letters. This formal style was popular when printing was developed in Europe—it was the hand imitated in the Bible printed in about 1455 and attributed to Johannes Gutenberg.

Most of us have been taught that Gutenberg invented the printing press. Printing from movable type was developed in Asia considerably earlier, although printing was probably invented independently in Europe. Gutenberg's Bible is of such high quality, however, that it is unlikely to have been the first European attempt at printing. Scholars theorize that printing in the Netherlands may have preceded Gutenberg's efforts. Gutenberg will never lose his place in history, though; he is still credited with inventing a machine that cast type in quantity, enabling the production of books for the "mass market" of the time.

Gutenberg's motivations are interesting to consider. He was apparently trying to create a facsimile of the manuscript page. He designed a large number of ligatures, for instance, which would have been unnecessary except to emulate the writing of a calligrapher. Most likely he saw himself competing with the calligrapher to produce a faster, cheaper product, rather than practicing a new art.

P ontibus ut crebris poſſint conſiſter
P andere ad æſtuum ſolem, ſi forte.
S parſerit, aut præceps Neptuno im
H æc circum caſiæ uirides, et olenta

Sixteenth-century type designed by Aldus Manutius.

As printing continued to follow the precedents of handwriting, new types were modeled on the humanist hand of the Renaissance—a style of type we call *roman*. Working in Venice in the late 1400s, the French printer Nicolas Jenson produced remarkably beautiful roman type that was successful in its own time and is still used as a model today. In 1500, a humanistic cursive was translated into type by the influential Italian printer Aldus Manutius. This type was called *Aldine* after its creator, but we know it as *italic*—the name used by the early imitators of Aldus's work.

We think of italic type as a subset of roman, and we often use it for emphasis within roman type. But in the sixteenth century—the age of the italic, particularly in Italy—entire books were set in these types. The narrow width of italic letters resulted in smaller, less expensive books that could reach a wider readership.

From Jenson's time until our own, a great variety of roman typefaces have been created. They're grouped into classes based on characteristics such as the way the serifs are formed and the variation between the thick and thin parts of the letters. Some of the changes in typefaces were due to technology—improvements in the printing press and the availability of different kinds of paper made more delicate lines possible, for example.

Garamond
Baskerville
Bodoni

Old style, transitional, and modern typefaces.

Old style, the style of the first roman types, most closely resembles letters written with a pen. There's a gradual transition from thick to thin strokes and not much overall difference in thickness. *Transitional* types, introduced in the eighteenth century and designed for a smoother

paper, have more contrast between thick and thin strokes, with the thin strokes much finer than those of old style types. The strokes of *modern* types, developed in the late eighteenth and early nineteenth centuries, change abruptly between thick and thin and have even more contrast. The

Helvetica

serifs are perfectly straight, and the resemblance to pen-written letters is distant.

Typefaces from these three classes of roman type are all in use today. If you have a computer, you may find Garamond (old style), Baskerville (transitional), and Bodoni (modern) on the font menu. Try printing a document in each of these faces and see whether you can discern the differences among them.

The twentieth century is the century of the sans serif typeface, with Helvetica being the prime example. *Sans serif* type—type without serifs and usually with strokes of equal weight—was developed in the early nineteenth century, probably from the lettering used by sign painters.

TEKTON

Ex Ponto

According to type designer Sumner Stone, sans serif type has been embraced in our time by industry and corporate culture because it is untraditional, functional, impersonal, and universal. It is the type of subway signs and highway signs and of the ubiquitous office memo.

Although the sans serif letterform clearly occupies a place of major importance, many people who work with type feel that it isn't effective in small sizes and is unsuitable for long passages of text. Others argue that serif and sans serif typefaces are equally legible, and that we're simply more accustomed to serif type from reading books and newspapers. The results from studies are inconclusive — but it's something to think about when you choose a typeface for your next report or other document.

The twentieth century is also the age of the computer — a tool that lets millions of people select typefaces for themselves and allows many

Poetica
TRAJAN

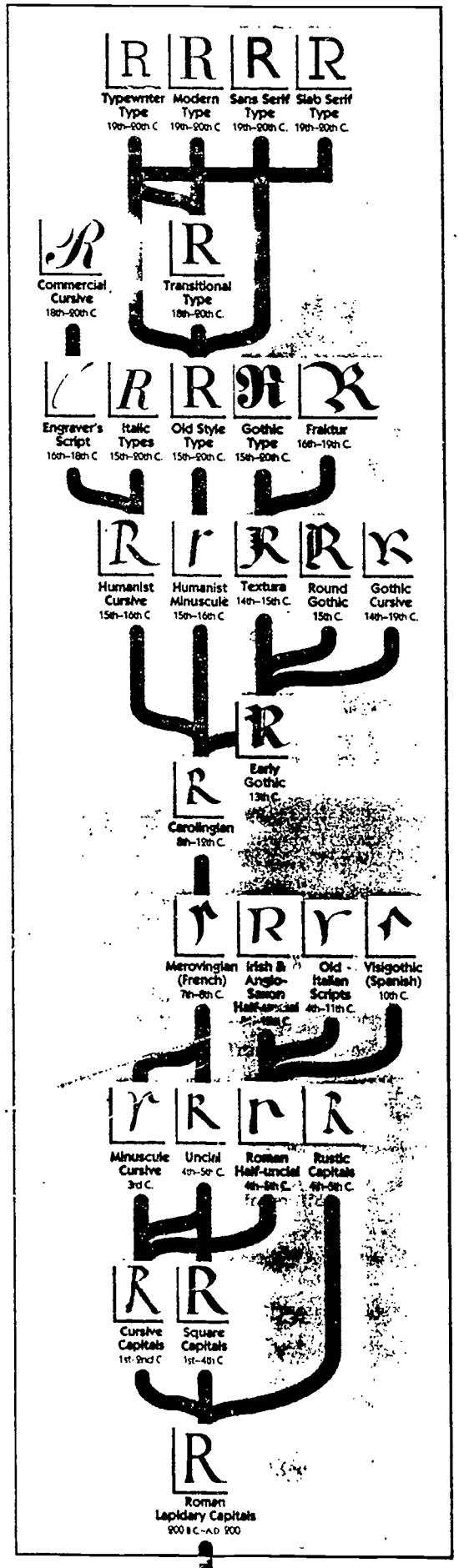
more people to design type than in the past. An explosion of activity has led to the creation of many new typefaces—there may be as many as 20,000 to choose from today.

Some of the current experimentation with type design is based on forms of handwriting. A typeface called Tekton, for instance, is based on the lettering style used by architects. There are a number of new script typefaces such as Ex Ponto. It's even possible to have a personal font designed based on your handwriting. (See *Tools & Toys*, page 14.) Next year's holiday letter from Cousin Emma may be created on her computer with characters based on her own illegible scrawl.

Other contemporary type designers look to the past, seeking inspiration from earlier type forms and from calligraphy. The typeface used in *Exploring* is a condensed form of Garamond, a recent revival of a typeface designed in sixteenth-century France by Claude Garamond. The Bodoni illustrated on the opposite page is a 1994 design based directly on type created by Giambattista Bodoni in the eighteenth century. A typeface called Poetica, issued in 1992, recalls Italian calligraphy from the sixteenth century. A new typeface based on the famous Jenson roman will be released soon. There is even a new capital-letter typeface called Trajan, based on the lapidary letters of ancient Rome.

Graphic designers, as well as many other people with personal computers, have access to an almost endless variety of typefaces—typefaces that can be formal or fanciful, strong or delicate, plain or dramatic; typefaces that can evoke any historical period, set any mood. Typography can provide a visual interpretation of content, enhancing a writer's work. But if it's mismatched with the writer's ideas, typography can mislead or confuse the reader.

The next time you pick up a book or an advertising brochure, or perhaps as you glance through this magazine, take a look at the typefaces used and how the type is arranged on the page. Think about what the type suggests concerning the material you are about to read. Then find out if those visual promises are fulfilled.



How Do You Spell That Sound?

You can do whatcha want, but don't step on my blue suedy shoes!

by Richard Brooks

When I was, oh, eightish, I asked my dad to buy me a pair of the "sweedy shoes" that I had seen in his mail-order catalog.

He looked puzzled after I posed the question. Knowing that his hearing was less than perfect, I repeated my request a tad louder and pointed to the picture of the "sweedy shoes." "You mean *suede?*" he said. "Yeah," I replied halfheartedly and somewhat embarrassed, as I began to focus more on the weird word than on the snappy footwear I coveted.

This episode shook my confidence in reading and spelling. I had trusted that spelling the words I said and pronouncing the words I saw written down would be relatively straightforward. Little did I know then about all the complexities and subtleties that make up the story of spelling. *Suede* is only one of many words in the English language that is not spelled the way it sounds.

Shortages and Redundancies One of the main reasons for the discrepancies between spelling and sound in the English language is the alphabet itself. When the relative merits of different alphabets are discussed, an alphabet is commonly considered the most efficient when it has one and only one letter for each sound in the language.

This sound-to-letter correspondence means that there is no ambiguity or redundancy in the spelling of a word. *Step* is a good example of a word in which every sound is represented by a single letter. When you pronounce it, you can hear four sounds that correspond to the four letters.

Compare this with the word *thought*. Say the word aloud so you can hear the different sounds. The letters *th* stand for the first sound, *ough* the second, and *t* the last. Seven letters are used to represent these three sounds.

Latin used an adaptation of the Etruscan alphabet from about the seventh century B.C. This Latin alphabet, also called the Roman alphabet, had twenty letters that represented the sounds of its fifteen consonants and its five vowels. Although it lacked a strict one-to-one correspondence of letters and sounds, it was quite close. When Latin speakers started borrowing words from Greek, they adopted Greek letters to stand for some of the sounds previously unheard in Latin. By the time the English language adapted the Roman alphabet, before the sixth century A.D., it had twenty-three letters. Three more—*j*, *u*, and *w*—were added to the alphabet between the late sixth and late fifteenth centuries.

Standard American English—the English we hear spoken on TV—has twenty-four consonant sounds represented by twenty-one letters and twelve basic vowel sounds represented by five letters. With an alphabet of twenty-six letters, English is short of the ideal one-to-one sound-to-letter correspondence. Because of this shortage of letters, some sounds have to be represented with *digraphs*, two letters that function as a single letter. *Ch*, *gh*, and *th*, for example, act as single units when they are part of the same syllable. In words like *church*, *rough*, *thigh*, and *thy*, these digraphs serve as single sounds distinct from the

sounds of the individual letters that make up the digraph.

The alphabet also has redundant letters—that is, some sounds can be represented with more than one letter. For example, *circle* and *syrup* have the same initial sound represented by different letters. Other letters represent more than one sound, like the *g* in *gothic* and *gentle*. All of this helps create confusion and inconsistency.

Standardization to the Rescue Our linguistic forebears did not set out to create spelling inconsistencies. Centuries ago, English words were spelled much as they sounded. The word *knight* has been spelled much like this for the last thousand years, and each letter was meant to be pronounced. Since all letters in a word were uttered, there were no silent letters, like the *p* in *psychology* or the *b* in *debt*. Manuscripts of the time were handwritten, and the dialects of the writers were reflected in their transcriptions. Whether they were writing in their best formal Latin or in the vernacular, they spelled the words the way that they pronounced them. This practice preserved regional dialects and provided a generally accurate record of the pronunciation of the times.

The beginning of printing in England, in 1476, marked the beginning of the discrepancy between spelling and pronunciation. When printers started committing words to type, they initially tried to follow the spellings in medieval manuscripts, even though the pronunciation of words had changed substantially since the Middle Ages. Some printers had scholarly pretensions and tried to correct the medieval treatments of words. Other printers, who weren't native speakers of the English language, were simply dreadful spellers.

Many of the printers' ways of spelling, regardless of linguistic consistency, were preserved for many years to come. An example is the word *fault*. It was once spelled *faute* and was pronounced the same as *fought*. Because it was thought to be related to the word *false*, the letter *l* was inserted. Hundreds of years later, this *l* was pronounced.

London had a notable effect on the English language we use today because the earliest presses were located there. The prestige associated with learning from books made the London dialect of the fifteenth century worth emulating. If the earliest printing presses had been located elsewhere in England, the look and sound of the language might be very different.

Printing presses helped increase levels of literacy. Not only were more books available, but they were published in English as well as in Latin. As part of the new Renaissance passion for learnedness, English scholars enriched their discourse with fine Continental embellishment, chiefly words borrowed from Latin and Greek.

As this pattern continued to engage the elite, words borrowed from other languages entered the English language mainstream and began to influence the spelling of native English words.

A Linguistic Melting Pot Rules of English spelling have to be fairly ornate to handle the inventory of sounds that have come into the English language from a great variety of sources—from Germanic languages, such as Old English and Scandinavian; from Romance languages, such as Latin and Norman French; from Greek; and from other languages in Europe and elsewhere in the world. Borrowed words, the standard source for new sounds in a language, were initially adopted whole. Both their spelling and their pronunciation were essentially kept intact.

With continued use, the pronunciation of these borrowed words, or *loan words*, conformed to the prevailing rules for English words, or the sounds of these words were incorporated into the English language—but their spelling continued with little change. One example is the sound represented by the letter *s* in the word *measure* and by the second *g* in *garage*, which came to the English language from French. Initially this sound was heard only in the particular words that English borrowed from French. Later the sound was adopted for other words that weren't French in origin, such as *cashmere*.

Words from other languages will continue to enrich the English language. The easiest ones to assimilate are simple to spell in their native language, such as *enchilada* from Spanish. Or they can be transcribed phonetically into the Roman alphabet, such as *hibachi* from Japanese. Of course, words aren't borrowed simply because they're easy to assimilate. As our contacts with people around the globe increase, we will need to borrow words—including those that are difficult to pronounce and frustrating to spell—that reflect our shared knowledge and experiences. ●

The Mad Chaw Party

Derivation of selected words used in this passage from **Alice's Adventures in Wonderland** ***reveal the diverse borrowings that have entered the English language.***

"Have some wine," the March Hare said in an encouraging tone.

Alice looked all round the table, but there was nothing on it but tea. "I don't see any wine," she remarked.

"There isn't any," said the March Hare.

"Then it wasn't very civil of you to offer it," said Alice angrily.

"It wasn't very civil of you to sit down without being invited," said the March Hare.

March: From the Old French *marz*, derived from the Latin term *Mensis Martis*—the "Month of Mars," who was the god of war. During March, amorous male hares cavort through the English countryside—hence the expression "mad as a March hare."

Encourage: From the Old French *encoragier*, literally "to hearten or give courage to," from the Latin *cor*, meaning "heart."

Alice: From the Middle English *Alys*, the Old French *Aliz*, and the Old High German *Adalheidis*. There is also *Alicia*, a modern invention based on Latin.

Table: From the Latin *tabula*, meaning "board" as well as "table." In the English expression "room and board," *board* refers to meals.

Tea: From *t'e*, in the Chinese dialect of Xiamen, a derivation also reflected in the French *thé*, the Spanish *té*, and the German *Tee*. All but forgotten is *chaw*, the seventeenth-century English word for the same beverage, from Mandarin *cb'a*.

Very: From the Middle English *verai*, which came from the French *vrai* and the Latin *verus*. Each means "true." Usually the short everyday words in English are Anglo-Saxon in origin, but here one of the most common words is exposed as an immigrant from the Mediterranean.

Civil: From the Latin *civis*, meaning "city." The March Hare, whose name indicates rural beginnings, may hardly be the one to point out breaches in civility. ●

by Ruth Brown

In English, we read the letters in a word from left to right. But some words—like *mom, peep, Hannah,* and *rotator*—read the same backward as they do forward. These words are called *palindromes,* from the Greek word *palindromos,* which means "running back again." Sentences—even groups of sentences—can also be palindromes. In a palindromic sentence, the words themselves aren't necessarily palindromes; instead, the entire construction can be read backward or forward.

Most palindromic phrases don't make much sense, but you might be able to come up with rationales for some of these:

- *Eva, can I stab bats in a cave?*
- *Was it Eliot's toilet I saw?*
- *Ten animals I slam in a net.*
- *Tarzan raised Desi Arnaz' rat.*
- *Straw? No, too stupid a fad. I put soot on warts!*
- *No devil. No garden. One dragon lived on.*

Early dictionaries were sometimes little more than collections of difficult words. (After all, why would anyone need a dictionary for the easy ones?) As a result, they've become valuable sources for rare words and linguistic curiosities. An infamous entry from a 1930 dictionary was the word *dord,* which (according to the book) meant "density." Later editions of the same dictionary omitted the word. What happened to it? Apparently, a compiler of the 1930 edition had made an unfortunate mistake. The folder in which he had collected instances of both *D* and *d* being used as abbreviations for the word *density* was marked "D or d"—hence *dord* made its surprising appearance.

For archaeologists, one of the first steps in deciphering an ancient inscription is figuring out which way to read it. This isn't always a simple task. Even English, which is customarily read from left to right, is sometimes read from top to bottom (on the spine of a book, for instance), or even in a circle (on the edge of a coin or the inside of a seal). Modern Arabic, like ancient Egyptian, reads from right to left. Traditional Japanese is read from top to bottom; some ancient Greek texts are read from bottom to top.

Other languages switch back and forth. Linguists call this characteristic *boustrophedon,* which means "ox turning" in Greek. It refers to the way an ox plows a field, going first in one direction, and then turning and going in the opposite direction. Some early Greek boustrophedons read from left to right with the letters facing in one direction, and then, on the next line, from right to left with the letters facing in the opposite direction. Wooden tablets found on Easter Island in the 1960s display an interesting form of boustrophedon. The reader reads across one line, then flips the tablet upside down to read the next line.

For centuries, people have been searching for hidden meaning in the written word. By assigning numbers to letters of the alphabet and then analyzing the resulting mathematical patterns, people of many different beliefs and cultures have hoped to uncover deeper meanings than words themselves may reveal. Some look for concealed messages in the Bible; others search for prophecies and predictions. For the English alphabet, proponents of these beliefs usually number the letters consecutively: A=1, B=2, C=3, etc. Intriguing relationships such as these have been found:

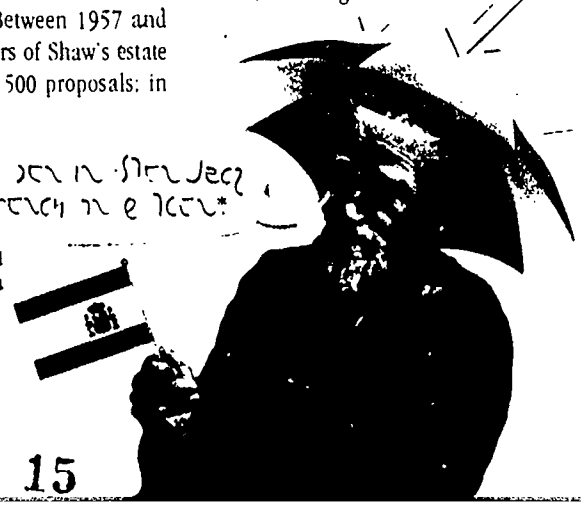
KEEP	11+5+5+16	=37
+OFF	15+6+6	=27
GRASS	7+18+1+19+19	=64

ARM + BEND = ELBOW
KING + CHAIR = THRONE
ALL + VOTE = DEMOCRACY

In his will, British playwright George Bernard Shaw (1856–1950) offered a prize for the creation of an alphabet based on the sounds of English words. Between 1957 and 1958, the executors of Shaw's estate gathered almost 500 proposals; in 1959, they put together the best of four different systems to create "Shaw's alphabet."

In accordance with Shaw's will, his play *Androcles and the Lion* became the new alphabet's showpiece. A special edition of the play printed the text in Shaw's alphabet next to the conventional alphabet to show off the new system's efficiency. Shaw, who felt that the traditional alphabet was not flexible enough to record all the sounds of the English language, expected his alphabet to become the primary writing system for the English-speaking world. Instead, Shaw's alphabet has become a linguistic curiosity, with one delightful feature: since it records the sound of the spoken word, anyone reading the original text out loud pronounces the words with a distinct British accent.

In these days of newspapers and computers, it's easy to take the written word for granted. But before the printing press, the laboriously copied documents created by monastic scribes were rare and priceless objects. In the twelfth century, stealing a manuscript was a serious crime. As one hand-copied medieval Bible warned: "If anyone take away this book, let him die the death; let him be fried in a pan; let the falling sickness and fever seize him; let him be broken on the wheel, and hanged. Amen." ●



*** If George Bernard Shaw's alphabet had prevailed, this is how we would be reading his famous line, "The rain in Spain falls mainly on the plain."**

Try This!

by Ellen Klages

Recreational Amusements

There are twenty-six letters in the English alphabet. Theoretically, they can be combined in any of 403,290,000,000,000,000,000,000,000 different ways. Most of these, however, just create nonsense. Here are some of the more practical and interesting combinations for you to play with. (Answers on page 14).

LETTER PERFECT

A pangram is a sentence that contains all twenty six letters of the alphabet. The best pangrams use the fewest letters; a perfect pangram contains twenty-six letters. As you can see from the examples below, as the number of letters decreases, so does the meaning of the sentence.

By Jove! My quick study of lexicography won a prize! (41 letters)

The five boxing wizards jump quickly. (31)

Quartz glyph job vex'd cwm finks. (26)
(*Cwm* is a Welsh word that means "valley.")

What's the shortest pangram *you* can make?

WORD PERFECT

If you find pangrams too confining, try creating a sentence or paragraph with twenty-six *words*—in alphabetical order, like this:

Able-bodied, conscientious dustmen emptying filthy garbage handle indescrib able junk. Kitchen leftovers make noxious odors, producing quite revolting stenches. This unwholesome vegetation won't xactly yield zeal.

(Extra challenge: Can you create one that uses a word that really begins with an *X*?)

❶ *What word contains twenty-six letters, but has only three syllables?*

❷ *What's unusual about the order of these numbers?*

8 5 4 9 1 7 6 10 3 2

KNOW I'VE SAID MY ZYXS

If you like secret messages, here's a simple way to use alphabetical order to create a code. Write down the alphabet in the regular order. Under it, write the alphabet in reverse—so it starts with *Z* and ends with *A*.

A B C D E F G H I J K L M N O P Q R S T U V W X Y Z
Z Y X W V U T S R Q P O N M L K J I H G F E D C B A

In this code, **A=Z**, **B=Y**, and so on.

The sentence **"THIS IS IN CODE"** would come out **"GSRH RH RM XLWV."**

❶ *Can you translate the sentence below, using the reverse-alphabet code?*

OVG'H ERHRG GSV VCKOLIZGLIRFN!

VOWEL PLAY

The twenty-six letters of the alphabet are divided into five vowels and twenty-one consonants (counting *y* as a consonant). Most words have a balance of both, but some words have unique vowel and consonant combinations.

❶ Two words in English contain all the vowels—*a, e, i, o, u*—in alphabetical order. Do you know what they are?

❷ What two words use all the vowels in *reverse* order?

❸ Most words have more consonants than vowels. Can you think of a fourteen-letter word that starts with a consonant, then alternates vowels and consonants?

❹ What one consonant can you use thirteen times to make the letters below into a sentence?

ARIMACINAROYLEISLESS
ARAVATINTHANAILINIOLO.

O SAY CAN U C?

❶ What do people have but men, women, and children don't?

❷ What happens twice in a moment, but only once in a month, and never in a thousand years?

❸ If you go to the end of the world, what do you find?

❹ How many peas are in a peck?

The first three riddles play with the fact that when we read words as units of meaning, we don't think of them as collections of letters. The last riddle works because the names of some letters of the alphabet sound like whole words—*p* (pea), *c* (sea, see), *t* (tea), *i* (eye).

D S-A S X-L-N

Letters that sound like words can also be used to create sentences that look like random letters—until you read them aloud.

O, I C U. (Oh, I see you.)
L-N S X-M-N-N U. (Ellen is examining you.)

Try to "translate" these three. Once you get the hang of these riddles, you may want to try to make up your own.

❶ D N-M-E S N J-L.

❷ I M N L-F I M N D-S.

❸ Y R U N T-S? X-U-L-E. I F N L-R-G.

*Translation of cartoon above:

Ask Us

by Mary K. Miller

Why does a shower curtain become attracted to you while you're taking a shower?

—*Matt W.*
Sent from cyberspace

I know the feeling. After a long workout at the gym, I look forward to a nice hot shower, and instead I often get a close encounter with a clammy shower curtain. I know it's not my magnetic personality attracting the curtain, so I've suspected it has something to do with airflow. Somehow, the outside air pushes against the shower curtain, which in turn pushes against my unsuspecting leg.

Jearl Walker, who for years wrote the Amateur Scientist column for *Scientific American*, investigated this curious bathroom phenomenon in the magazine's June 1988 issue. To study the air currents in and around his shower, he brought a lighted candle into the shower stall and watched the direction the flame was drawn toward by currents. In spite of the tendency for water to douse the candle, Walker reported that his experiment worked well. (Walker recommended that if you want to try this experiment, you should keep a second flaming candle outside the shower to relight a doused wick, but that you should take care not to let the unattended flame catch the bathroom on fire.)

From the telltale movements of the candle flame, Walker discovered that the patterns of airflow inside a hot shower are actually quite complex. Air immediately around the warm falling water is drawn, or *entrained*, into the spray. Some of this air heats up and rises to the top of the shower stall; the rest flows to the bottom of the stall. Air from outside the shower flows in from above and either side of the curtain to replace some, but not all, of the air trapped by the falling water. Inside the shower, there is less air available. This causes a region of lower pressure between the curtain and the water. The higher atmospheric pressure outside the shower pushes on the curtain, and before you know it, you're feeling the unwelcome caresses of a cold sheet of plastic.

Taking an especially hot shower only enhances the effect. Air heated by hot water draining from the floor of the shower flows along the outside of the curtain and gives it an extra push toward your leg.

Of course, you could partially solve this problem by taking a cold shower. If that doesn't appeal to you, you could attach weights or magnets to the bottom of the curtain or try plastering the wet plastic to the inside of the shower. That's usually enough to keep it from invading your space. ●

First Word
(from page 3)

Mary Owned a Little Lamb (without *Hs*)

Mary owned a little lamb
Its fleece was pale as snow
And ever place its mistress went
It certainly would go
It followed Mary to class one day
It broke a rigid law
It made some students giggle aloud
A lamb in class all saw

Abecedarian Amusements Answers
(from page 15)

Word Perfect
1 *alphabet*
2 They're arranged in alphabetical order: eight, five, four, nine, etc.

Now I've Said My ZYXs
1 LET'S VISIT THE EXPLORATORIUM

Vowel Play
1 *abstemious, facetious*
2 *unnoticeably, unsentimental*
3 *versimilitude*
4 *g* (A grimacing gargoyle is less aggravating than a giggling gigolo.) •

O Say Can U C?
1 The letter *p*
2 The letter *m*
3 The letter *d*
4 One

D S-A S X-L-N
1 The enemy is in tail!
2 I am an elf. I am in the forest.
3 Why are you in tears? Actually, I have an allergy.

Reviews & Resources

Tools & Toys

I was about three when I mastered the alphabet song. I've been told that I marched around my nursery school shouting "Elemenopee!" at the top of my lungs for several days. I thought I had a handle on this whole alphabet thing until Mikey Zuckov joined our second-grade class midyear. His mother was from Russia, and for show-and-tell he brought in a first-grade reader—in Cyrillic. I ran home with the astounding news that there was another alphabet, only to have my mom pull out the encyclopedia and show me that there were also Greek letters, and Hebrew, and Arabic. It was mind-boggling.

Fortunately for my seven-year-old brain, Mom didn't tell me about Egyptian hieroglyphics or Maya glyphs. But now I know a lot about these and other fascinating writing systems, thanks to the ***Reading the Past*** series ($9.95 per book, University of California Press). Each of these slim volumes covers a single alphabetic topic—runes, linear B, cuneiform—discussing history, archaeology, and linguistics. The books are illustrated with maps and photos that put the ancient languages into a vivid context.

For a simpler introduction to letters and symbols, I recommend a beautiful set of wooden Alphabet Cubes ($50.00). One face of each cube has a letter in the Roman (English) alphabet; four other faces have Cyrillic, Greek, Hebrew, and Arabic letters. The sixth side of each cube has part of a puzzle consisting of cuneiform characters. The whole set comes packaged in a wooden box with a handy chart and a minihistory of all five alphabets.

These blocks are nice to hold, but you can't tell the difference in the letters by touch—they're painted on. On my Read a Mat: Braille Alphabet

placemat ($4.29). I can actually feel the raised letters of the Braille alphabet. This washable plastic mat is divided into squares, each with a printed picture and a word—*Apple, Bird, Yo-yo, Zebra*—and also a raised letter and word in Braille.

To find out more about Braille and other alphabets, I read ***Writing: A Fact and Fun Book*** ($8.95, Addison-Wesley) by Amanda Lewis, illustrated by Heather Collins. Five chapters have pictures, examples, and diagrams about alphabets and symbols; pens, typewriters, and other writing tools; handwriting and calligraphy; books and printing; and reading and writing. It's a great book for kids, full of both information and activities: Chinese brush painting; making your own chalk, paper, or book, even analyzing your handwriting.

I decided not to analyze my handwriting—half the time I can barely decipher it. But that was before I got my own Personal Font ($99.95, Signature Software, Mac or Windows). The company sent me a form to fill out, asking me to write odd words like *oxyjobe, rybema,* and *kagrels* inside little blue boxes. The words cover just about any letter combination you can think of—including punctuation marks. So I filled the form out—as neatly as I could—and mailed it back. In just a few weeks,

This is an example of my handwriting created with Personal Font!

I got a computer disk in the mail. When I loaded it into my system and opened up my word-processing program, there was McGee, a font that's my very own handwriting. Now I can print out "handwritten" letters that people can actually read!

—Betsy McGee

Except for Personal Font, all of these items are available from the Exploratorium Store, where you can shop in person or order by phone at 1-800-359-9899. Prices and availability are subject to change. To order Personal Font (and many other handwriting fonts), contact Signature Software, 489 North Eighth Street, Hood River, OR 97031; 1-800-925-8840.

Related Reading

The Puzzle of Linear B by Paul Doherty

Reading the Past: Linear B and Related Scripts by John Chadwick. Berkeley: University of California Press, 1987. This short, readable account of the decipherment of linear B is complete with illustrations of linear B texts.

The Code Breakers by David Kahn. New York: MacMillan, 1967. One chapter describes the decipherment of many ancient texts, including linear B, with good examples of the deciphering process.

Letters Take Shape by Judith Brand

Medieval Calligraphy: Its History and Technique by Marc Drogin. Montclair, N.J.: Allanheld, Osmun & Co., 1980. Instructions for writing twelve different manuscript styles are provided, along with a concise, well-illustrated history of calligraphy from the Roman Square Capital through the Humanist Bookhand.

The Elements of Typographic Style by Robert Bringhurst. Vancouver: Hartley & Marks, 1992. Bringhurst clearly and elegantly explains the principles of typography and page layout and presents samples of many individual typefaces.

How Do You Spell That Sound?
by Richard Brooks

An Introduction to Language, Third Edition by Victoria Fromkin and Robert Rodman. New York: Holt, Rinehart and Winston, 1983. This beginning linguistics textbook makes for interesting reading. The clear, informal style is dosed with comic strip illustrations of a number of linguistic phenomena.

The Origins and Development of the English Language, Second Edition by Thomas Pyles. New York: Harcourt Brace Jovanovich, 1971. This standard text, though technical, is rewarding for the dedicated lay reader and a treasury of information.

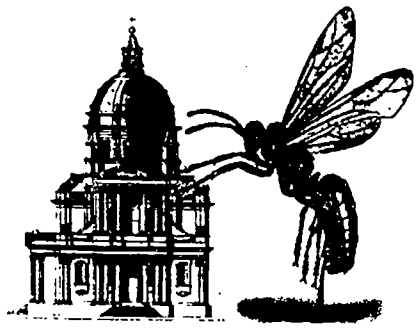
Try This! Abecedarian Amusements
by Ellen Klages

The Oxford Guide to Word Games by Tony Augarde. New York: Oxford University Press, 1984. Ways to play with words, letters, and language fill this interesting compendium.

From A to Zotamorf: The Dictionary of Palindromes by Stephen J. Chism. Morristown, N.J.: Word Ways Press, 1992. This amusing slim volume contains an alphabetical listing of every palindrome the author could uncover.

Credits & Acknowledgements

ILLUSTRATIONS are by David Barker unless otherwise noted. PAGE 3 AND PAGE 14: Poems from *An Almanac of Words at Play* by Willard R.P. Espy. New York: Clarkson Potter, 1975. PAGES 4–5: Photo and illustrations from the CD-ROM *Scientific American: Exploring Ancient Cities*. San Francisco: Sumeria, 1994. PAGES 6–9: Photos courtesy of the John M. Wing Foundation, the Newberry Library. Special thanks to Sumner Stone of Stone Type Foundry for his kind assistance, and to Fred Brady of Adobe Systems for generously supplying several of the typefaces illustrated in this article. Square capitals by Gary Crounse. Half-uncial, Carolingian minuscule, and Gothic lettering from *Medieval Calligraphy: Its History and Technique* by Marc Drogin. Montclair, N.J.: Allenheld, Osmun & Co., 1980. Type development time line adapted from *On Stone: The Art and Use of Typography on the Personal Computer* by Sumner Stone. San Francisco: Bedford Arts, 1991. PAGES 10–11. Thanks to Dr. Geoffrey Pullum for his wit, wisdom, and insight on all matters linguistic. PAGE 14: Illustration by Melissa Alexander. PAGE 16: Photo by Amy Snyder.



Next Issue

Why don't you ever see giant ants? How do moviemakers use tiny models to make realistic disasters on the big screen? What would happen to your house if it suddenly doubled in size? You'll find fascinating stories of size, scale, and structure in the next issue of *Exploring* magazine.

by Charlotte Moser

Partnerships in Education

When the Exploratorium's Life Sciences Department began to plan its current exhibition, *Diving into the Gene Pool*, in 1993, a key step to be included in the story of genetic research was the invention of a complicated device called the automated DNA sequencer.

This machine, manufactured in the mid-1980s by Applied Biosystems—a Bay Area biotechnology company that has since merged with Perkins-Elmer, a New Jersey–based firm—revolutionized the speed by which the human genome could be decoded. The discovery accelerated by decades the field of genetic research and its applications, the theme of the museum's *Diving into the Gene Pool* exhibition.

"We had this idea for an exhibit called *Cracking the Code* and approached Applied Biosystems for funding," recalls Charles Carlson, director of the museum's Life Sciences Department. The company's enthusiastic response delighted Carlson and his staff. Not only did Applied Biosystems contribute $32,000 to develop the interactive educational exhibit, but it entered an active partnership with the Exploratorium to develop the content of the *Cracking the Code* exhibit.

"André Marion, the company's founder and CEO, a longtime Exploratorium supporter, thought our exhibit was a wonderful idea," said Carlson. "He opened up his lab and sent out his R&D staff to help us develop the exhibit. As a result, we got a firsthand feel for how DNA is sequenced. The experience made a tremendous impact on our planning for the *Gene Pool* exhibition."

Successful partnerships like the one between the Exploratorium and Applied Biosystems go one step beyond the corporate contributions increasingly necessary to keep the museum's programs funded and its doors open. These collaborations are designed to allow each party to build upon the other's expertise.

"The partnership with Applied Biosystems resulted in our developing an important permanent exhibit for the Exploratorium," said Carlson. "Applied Biosystems, on the other hand, had an opportunity to develop an educational product and make a kind of payback to education."

As one of the few museums taking a leadership position nationally in science education reform, the Exploratorium provides unique pairings for corporations committed to community involvement, particularly in the field of education. Offering expertise in teaching hands-on science and access to schools involved with science education reform, the Exploratorium served as a testing ground for more than one high-tech corporation interested in making an educational impact.

Apple Computer, for instance, entered into a joint research project with the Exploratorium in 1992, following the donation of equipment from Apple's now-defunct San Francisco Multimedia Lab to the museum in 1990. That contribution led to the creation of the Center for Media and Communication, now one of the museum's core departments. It oversees such public programs as the Internet Station and the new Learning Studio.

Since then, as part of its Media Rich Collaborative Learning (MERICLE) project, Apple has worked continuously with the Exploratorium to develop science programs in a multimedia telecommunications project conducted in the Ross School District in Marin County. This spring, the Exploratorium provided a unique service for Hewlett-Packard. As part of its K-6 Hands-On Science Program, H-P's intensive education initiative, the company contracted with the School in the Exploratorium (SITE) to train thirty teachers from seven school districts in Northern California, Oregon, and Washington in the use of inquiry-based teaching in science education.

For two weeks, from April 30 to May 12, teachers from SITE conducted workshops in presenting theories of light and color with inquiry instruction. This is an area for which the Exploratorium has recently received a $5.5 million grant from the National Science Foundation.

"Children learn better through doing, but teachers must be trained in how to move away from textbook-driven instruction into teaching through hands-on exploration. Staff development to train teachers is critical in science education reform," explained Nancy Thomas, national contributions manager at Hewlett-Packard. H-P has sponsored the K-6 Hands-On Science Program for three years as part of the company's Corporate Citizenship objective. It now supports science education in twenty-five school districts throughout the country.

The Exploratorium has collaborative projects in the works with other computer companies. As part of the Science Learning Network, a national consortium of six science museums, the Exploratorium will work with Unisys to develop a new science education software program. Computer gifts and loans for special museum exhibitions, such as the *Multimedia Playground*, are often accompanied by staff assistance in addition to hardware loans. Quantum Corp., for instance, developed the exhibit *How Hard Disks Work*, which was used in the *Multimedia Playground*.

Such collaborative partnerships enrich the Exploratorium, the corporate culture of companies, and the community at large. For all parties concerned, the payback is knowing that something concrete has been done to make this a better world to live in.

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