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The Journal of Typographic Research
Volume IV, Number 1, Winter 1970

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Published quarterly (Winter, Spring, Summer, and Fall) by the Journal,
c/o The Cleveland Museum of Art, Cleveland, Ohio, USA 44106.

Dr. Merald E. Wrolstad, *Editor and Publisher*
c/o The Cleveland Museum of Art, Cleveland, Ohio, USA 44106.

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The Journal of Typographic Research is devoted to critical investigation and experimentation that contribute to a better understanding of the role letterforms play in the communication process. "Typography" is interpreted in the broadest possible sense, encompassing any use or reproduction of letterforms and related symbols within our own and other language systems—and including their origins, historic development and special applications. It is the Journal's purpose, first to identify and encourage letterform research internationally, and second to pursue the natural association of experimental work in all research areas concerned with our *visible language*. Research on letterform problems is flourishing in

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Quarterly for one year	$11.00	£4. 12. 0
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Index
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An Investigation of the Design and Performance of Traffic Control Devices

John Lees and Melvin Farman

This paper reports on a study (performed for the United States Bureau of Public Roads) involving a comparative analysis of the design elements of the major highway sign systems of the world. Shape, color, symbols, pictographs, and verbal messages were studied through design exercises, laboratory investigations, and road tests. The study—carried out by a multi-disciplinary team of psychologists, engineers, and graphic designers—also included extensive reviews of existing research on highway signs, traffic control devices, and the design of signs. The introduction examines the history of highway sign development and regulation as well as a discussion of an automobile driver's processing of information.

When man first began to move around his earth, he was guided by nature; paths and trails often followed the contours of the land. Warning signs were provided by animal tracks or rushing water, by smells and sounds. There was no need for regulation by man.

Imperial Rome provided road signs for travelers. Under Caesar Augustus, the 29 major military highways which led from the city to the outposts of the empire were provided with milestones for their first 100 miles. A law establishing compulsory measurement of these routes was enacted in 183 B.C. It took almost 200 years for a standard milestone to come into general use. Neither travel nor road signs changed significantly during the next 18 centuries.

In the early days of turnpikes between settlements and cities, road signs were the responsibility of private individuals, as were many of the major roads. Some roads had signs, others did not. If the signs on one road resembled those on any other, it was likely to be a coincidence.

Early Developments in the United States
The principal highway between New York and Philadelphia was spotted with milestones as early as 1745. These markers were set at

two-mile intervals and at intersections with other public roads. The introduction of regular stagecoach travel over established routes helped to encourage the development of maps showing mileage between two points on these roads. The best of these were produced by the U.S. Post Office Department.

In the second quarter of the nineteenth century, the steam railway became an important means of overland transportation, and highway use diminished considerably. Traffic control problems peculiar to railroads caused the evolution of a special set of railroad signs and signals. These signs had little to do with highway traffic problems and were of little concern to the highway traveler.

Near the end of the nineteenth century the bicycle became very popular and bicyclists, with their boundless energy, began to agitate for better roads and better bicycle paths. New communities and expanding populations in the cities increased commercial and social interaction and encouraged the development of statewide road systems.

With the advent of the automobile, problems which for centuries had been benign and almost academic became complex and urgent. Local networks of roads were integrated into statewide systems and then into interstate connections. Route numbers and names evolved slowly, but signs were sparse and inconsistent.

Private sources provided help. Automobile clubs and highway associations (formed to promote the use and improvement of specific roads) often provided signs for those roads which were of interest to them. The Automobile Club of California put signs on the principal highways within 250 miles of San Francisco in 1907. Earlier, in 1905, the Buffalo Automobile Club had provided signs for its section of New York State. Other private organizations with interests in highway travel also stepped into the void. The B.F. Goodrich Company marked railroad crossings with warning signs and formed a touring service which marked routes and issued route books and maps. Goodrich sign crews—working out of New York, Chicago, and San Francisco—erected thousands of signs each year between 1910 and 1920. Rand McNally Company, the Chicago map maker, not only promoted the marking of highways but also paid people to do the work. These markings consisted of a system of colored bands on telephone poles; where there were no

telephone poles, other posts or structures along the roadside were used. The color code was then picked up on the maps.

Although these commercial interests and the numerous road associations did much to provide orientation for many travelers, their multiplicity also fostered confusion and chaos. There was a wide range of sizes, colors, and shapes of signs along main roads. Often, long stretches of major highways had many different route designations. Even more confusing was the fact that the same road or route sometimes had several different locations. A road promoter, for example, might enlist local support from parallel communities near a proposed north–south route. If these communities were a number of miles apart, two roads would be built, one through each town, both with exactly the same name and designation. Even the experienced driver often found himself miles away from where he thought he was.

The state of Wisconsin was a leader in the organization of principal roads within the state. In 1918 Wisconsin's roads were marked according to a systematic plan, and maps were prepared with roads identified by number. Wisconsin also led in determining the physical form of the sign itself. Most early signs and route markers were painted on telephone poles or affixed or painted to structures along the roadside. (Companies owning the poles objected to anything but paint on the poles since signs would interfere with pole climbers.) Paint wore out quickly; poles, culverts, or bridge railings were often poorly located for driver visibility. Wisconsin became the first state to use baked enamel markers on sheet metal, supported on relatively light standards.

Many other states followed Wisconsin's lead and within a few years developed and implemented numbering systems and a few standard warning signs for their own highways. The obvious next phase was interstate control to overcome the confusions caused by the separate state systems. In 1924 the American Association of State Highway Officials urged the creation of a comprehensive interstate route system, the development of a "uniform scheme for designating such routes," and recommended adoption of uniform signing practices. At the time, the Bureau of Public Roads was a part of the U.S. Department of Agriculture, and the Secretary of Agriculture appointed a board to do the job.

The Board's recommendations were accepted and a manual for rural highways was published in 1927. A manual for urban streets was published in 1929 by the National Conference on Street and Highway Safety. In 1935 the two manuals were combined to form the first *Manual on Uniform Traffic Control Devices*. This Manual has been revised through the years, most recently in 1960.

Early Developments in Europe

Modern European signs also have roots in the activities of private entrepreneurs and motor clubs. In 1909 the Convention on the International Circulation of Motor Vehicles was held in Paris. It resulted in four road signs depicting typical road dangers of the times —bump, curve, road crossing, and flat or level-grade railroad crossing. Many European countries ratified the Convention; however, signs were not governmental responsibility and were installed by private organizations with the help of commercial sponsors such as automobile and tire manufacturers. These commercial sponsors felt obliged to advertise on the signs so that many were badly cluttered. Many of the signs were verbal and could be read only by those who understood the national language.

In 1926 the Convention Relative to Motor Traffic described a uniform system of signs. A very modest system containing only six signs specified pictorial conventions for uneven pavements and curves; it also adopted the triangular shape as the international standard for danger signs. As in America, these signs were intended for rural situations and did not include urban regulatory signs.

The League of Nations. The Traffic Committee of the League of Nations developed a set of urban regulatory signs in 1928. In 1931 the Convention for the Unification of Road Signs was adopted in Geneva. Under this Convention, the number of road signs rose from six to twenty-six and signs were divided into three categories: danger signs, signs giving definite instructions, and signs giving indications only. In 1939 a committee of the League of Nations recommended further refinements of the international road sign system, but the Second World War prevented implementation.

The United Nations. After the Second World War the United Nations developed a new "protocol on road signs," which was adopted in 1949. It specified more than 50 traffic signs and was signed by about 30 nations. In the early 1950's a United Nations group of experts was formed to study the problem further and to recommend an international system which would take into account all other systems in the world. Their report was published in 1953. It did not, however, generate the reception which had been hoped for and ten years later only two European nations had subscribed to it. The 1949 protocol, therefore, remains the basis for most European sign systems today.

Early Developments in Great Britain

The British Motor Car Act of 1903 included the authority for the erection of warning signs by local authorities; these were specified in 1904. They consisted of shape specifications only, with one exception: prohibitory signs were to be indicated by a red disc. Speed limit signs were to be incorporated in circles, warning signs were to be indicated by triangles, and all others by diamond shapes. The signs were to be 18 inches in diameter, their lowest point was to be not less than 8 feet from the ground, and they were to be located approximately 50 yards from that to which they referred. Beyond these specifications, local authorities were free to act on their own.

British standards evolved through national acts and circulars in 1909, 1920, 1921, and 1923. Three years after the 1926 convention in Paris, Britain ratified the agreement on road signs and, for the only time in its history, formally adhered to an international agreement on roadside traffic signs. Certain of the signs included in the 1931 Geneva convention were adopted by Great Britain but it did not support the convention generally and continued its own way with a national committee in 1933.

Many British road sign were uprooted in 1940 because of the fear of invasion. A new committee was formed and issued its report in 1944. It did not recommend any radical departures, however, and the signs which were installed after the war were very much like those which had preceded them.

In December, 1961, a committee headed by Sir Walter Worboys was appointed by the Ministry of Transport to review traffic signs on all-purpose roads, including those in urban areas, and to recommend what changes should be made. The committee issued its report in 1963. The implementation of its recommendations began in 1964 and is expected to end in about 1972. The present British system, among the most modern in the world today, is based primarily on the signs contained in the 1949 U.N. Protocol.

Other Systems

All other sign systems in use through the world today were essentially developed from the systems we have already cited. In Africa, for example, conferences were held in Johannesburg in 1937 and again in 1950, and the sign systems are essentially based on those included in the Geneva Protocols of 1926 and 1931. In the Western hemisphere, most signs are based on the U.S. system. The Canadian and Mexican systems, which will be described in the next section, were initially developed following the U.S. or U.N. pattern.

Today's Systems—Comparison and Contrast

Each sign system has its own peculiarities and no two are exactly alike. They have, however, essentially polarized around two basic philosophies. One of these is best represented by the U.S. system.

The U.S. system relies heavily on the use of verbal messages to transmit information. Over the years a small, but significant, body of pictographic images have become part of the system. Certainly this trend is continuing. Nevertheless, there seems to have been a general aversion to using visual shorthand, except in what would appear to be the "safest" of situations.

Canada has followed the U.S. system to a great extent. Innovations have been added or borrowed from other systems in certain situations. The Canadians use pictographic images for regulatory signing. During their introductory period, however, supplementary plates were used containing verbal messages. Sometimes the verbal message and the visual image differ. Verbally, for example, a sign will say "No Left Turn," while visually illustrating the fact that traffic can proceed straight ahead or turn right. In other words, the verbal message is prohibitory while the visual message is permissive.

The Mexican system is closely allied to the recommendations of the

U.N.-1953 group of experts. Mexican warning signs are usually purely pictographic; regulatory pictographs are partially supported verbally.

Most European countries use systems based on the U.N. protocols of 1949. The recommendation of the U.N. group which met in 1952 and 1953 are principally used in Mexico and the Middle East. Most African nations use a related system based on the League of Nations' Geneva protocols of 1931, and modified at international conventions in Johannesburg. This highly visual system reflects the diversity of African languages and also, in the limited number of signs, the relative simplicity of Africa's traffic control problems.

The current British system is much more extensive and precise than those of the other nations of the world, particularly in its delineation of guide signs. The system accommodates a differentiation among signs for motorways, primary and secondary roads. Color coding is used for visual differentiation, and specific map-type signs are included for a wide variety of highway configurations and junction situations. Still in the process of installation, the British system is the first to be devised with the continuing assistance and consultation of a graphic designer.

Regulatory Signs

In the U.S. system regulatory signs are considered a single category. In other systems, they are divided into two categories: mandatory and prohibitory. Most U.S. regulatory signs are rectangular, whereas other systems use circular forms. In the Canadian system there is often a compromise: the circular form is retained within a rectangular shape and the pictograph and verbal legend are included on the same plate. The octagonal red STOP sign is the only octagonal sign in the U.S. system and, in fact, the only octagonal sign in any sign system. It is, at present, also the only *red* sign in the U.S. sign system (although the proposed introduction of the abstract NO ENTRY and the red YIELD signs may change this).

In our tests, and in other tests of shape, the observers were more apt to confuse the octagon and the circle, than the circle and the diamond. This raises the possibility of making the American STOP sign circular. This step would have no effect on its visibility, practically no effect on its uniqueness in the American system, and would make the sign somewhat more compatible with the other STOP signs of the world. Whether such a change would be worth the effort required is doubtful. (It should be noted that the diamond-shape railroad sign, an accompanying change, has been independently proposed.)

The European and British STOP signs incorporate the triangle within the circle. This arrangement presents several weaknesses. When the legend "Stop" is included within the triangle, it must of necessity be small and therefore difficult to read. When the legend breaks through the legs of the triangle, as it does in the British stop sign, the triangle loses its shape and serves almost no function. The yellow United Nations 1953 STOP sign is based on the octagonal U.S. sign. The legend is superimposed on a pictographic image for an intersection with a major roadway. The meaning of the pictograph is lost, however, in the confusion with the verbal legend and the overall sign shape, diminishing the effectiveness of the sign.

Closely related in function to the STOP sign is the YIELD sign, which requires that a driver be prepared to stop before entering a stream of traffic. Here the systems of the world are consistent in their selection of the triangle, vertex down. Note that in European and British systems the triangular form is also used in STOP signs.

Another sign which is closely related in function to both the STOP and YIELD signs is the NO ENTRY sign. Again, the driver must stop. In the European and British systems, the abstract NO ENTRY sign picks up the circular shape of the STOP sign. The U.N.-1953 system reverts to a more pictographic form with the red diagonal bar slashed across the red STRAIGHT AHEAD arrow. In the U.S. system, the verbal DO NOT ENTER sign is completely inconsistent with both the STOP and the YIELD signs.

The obvious inconsistencies among these three signs in the U.S. system pose several problems. Although each of the signs should elicit approximately similar responses from the driver, the signs differ in shape and color. The proposed introduction of the abstract NO ENTRY sign into this country would be a significant improvement. In fact, the abstract NO ENTRY sign is quite close in its visual characteristics to the STOP sign and is therefore quite compatible with it. The proposed use of red for the YIELD sign is another useful step toward visual consistency.

Whereas the European and British systems rely on circular shape for all regulatory signs, the United States and the rest of North America use the rectangular shape. A rectangle is a more efficient field for a verbal message than a circle and so the basic shape difference may be considered as a reflection of the verbal-legend versus pictograph dichotomy. It is also an efficient shape for pictographs and so, any change to a pictographic system would not necessarily mean a change in shape.

Although the U.S. relies on verbal messages in regulatory signing, the Canadians increasingly use pictographic images for regulatory signing. In their newer signs, they have combined the European pictograph and circle with the North American rectangle and verbal legend. From a visual point of view, the use of the circular color border is questionable. It restricts the size of the pictograph and confuses the use of shape. Perhaps a strong border following the shape of the sign, which would permit a larger image without diminishing color coding, would be preferable.

Color is not utilized in U.S. regulatory signs as it is in all other systems. Although the significance of color has yet to be determined precisely, we should question its absence in the U.S. system of regulatory signs. (Color is, of course, used in urban parking signs, but its use is obscured by the clutter on these signs and by their lack of consistency with any other regulatory signs.)

Red is internationally used as a prohibitory color. The bold red border has been familiar to European drivers since the inception of formalized sign systems and is well-understood. To provide added emphasis, the United Nations group of experts incorporated the diagonal red bar across the pictographic image to indicate prohibition in their system. Thus even the most naive driver (who may look at the red border as a decorative element) should be brought to attention by this red bar. The bar also aids those individuals who experience difficulty in red-green discrimination. Although prohibitory signs are not treated as a distinct classification in the U.S. system, nevertheless a number of control signs for moving traffic are prohibitory in nature, and might be made more efficient with the careful use of color. These black-on-white rectangular signs do not transmit any sense of strength or urgency from a visual point of view. They must rely totally on verbal legend for communication, since their shape or color tells the driver nothing. The U.S. system is, through recently proposed changes, moving toward wider and more efficient use of color. There persists, however, the indecision as to whether color should be allied with sign category or sign message. Thus, yellow is used for warning signs, red for stop signs, and orange (proposed) for construction warning signs.

Warning Signs

The U.S. diamond shape provides a convenient field for pictographic images and for very brief verbal legends. Research has shown that the black on yellow is a highly effective color combination (for visibility) and the United Nations' group of experts recommendation of the U.S. shape and color for warning signs recognized this effectiveness. U.S. warning signs have long used pictographic images for curves and intersections. They have relied primarily on verbal legends for most road hazards, however. Other systems of the world have historically used the triangle as a warning sign. The triangle provides a distinctive shape and was probably much more effective when it was used as an abstract form to indicate danger in the very early highway systems. The triangle does not efficiently accommodate pictographic images or legends. The diamond is much more efficient as a visual field and at least equally distinctive as a unique shape. There would seem to be little justification for the U.S. system to consider conversion to a triangular format. The argument for increased reliance on pictographs, however, is valid and should be heeded.

Guide Signs

In the very early days of sign systems, only broad specifications were enumerated by conventions or government bodies. Local jurisdictions were left to their own devices insofar as basic sign design was concerned. With the passage of time and increased sophistication, all systems have become much more specific about regulatory and warning signs. The British, however, have carried this detail into guide signs.

The U.S. system treats route markings rather carefully; in contrast, direction signs are very broadly brushed. Without a comprehensive point of view, U.S. guide signs have proliferated without adding to the effectiveness of the system. Problems involving guide signs

are problems of content and of design. This was well-recognized in the most-specific British system. We do not necessarily agree with all that the British have done, or with the extent to which they have specified signs, but we do feel that much of what they have done has at least conceptual application in this country.

The British have carried the specification of map-type signs to an extreme. The manual provides a specification for almost every given situation. The specifications also provide for primary and secondary roads as well as motorways, all of which are indicated by various color codings. Accommodations are also included for route numbers, which are again color-coded. The American manual seems to be the only one which does not specify directional and destination signs which include route numbers and other information on a single plate. Such signs are specified by both the Mexican and the Canadian manuals and, although they do not have map-type signs, they are both somewhat more specific in their description of guide signs, and somewhat more sophisticated in their sensitivity to driver information needs.

Driver Processing of Information

In the early days of automobiling, the "task" for the driver was often more physical than mental, and human performance requirements were based on the strength necessary to operate the starting handle, the tiller, and the wheel brake. Sixty years of motor vehicle and highway development have gradually but completely changed this situation. The physical demands of the driving process now fall within the capabilities of almost all of the non-bedridden population. Investigators of the driving process commonly regard the driver as primarily an information processor with secondary physical capabilities used to interact with the vehicle controls and the environment. The driver's need for information is based on the tasks he must perform; these include lane holding, car following, vigilance for hazards, and the monitoring of gages and controls of his vehicle.

Although the *output* of such a sensor-processor-actor system can be measured and understood, it is difficult to specify what the *input* is that results in the observed output. Attempts have been made by several investigators to determine those elements in the complex visual world of road, traffic, and traffic controls that elicit the driver's responses. Recent research has concentrated on the total visual information the driver takes in through the windshield as he observed the roadway ahead, and has led to a model of how information flows into the driver and is processed.

In this model a certain information density is postulated for the roadway, so many bits per unit distance. A section of road with many curves or traffic control devices has a high information density. The faster one traveled a portion of the road, the more bits per unit time must be processed. The model then describes the requirements for visual sampling of a road, where the minimum sampling rate is related to the information density of the road and to the velocity at which it is traversed.

Were the driver to get a glimpse of the road only at fixed intervals, he would develop uncertainty about details not discernible at his last observation, and about where his car is on the road. If the intervals between observations (snapshots) were very long, then the accumulated uncertainty and the amount of information to be absorbed on the next observation would be greater. If the short observation time itself were to remain fixed, the driver would be unable to absorb the amount of information required, and would be forced to reduce the rate at which he must process the information. This would mean reducing his speed, so that the information rate, the product of information density and speed, is reduced in proportion. In this way the driver finds a limiting speed related to his information processing capabilities. It should be noted in passing that an experimental technique, based on this visual sampling, was employed in some experiments described later in this paper.

The sampling process just described is quite appropriate to the "normal" task of driving. Instead of the external imposition of visual sampling, this sampling process is controlled internally. Man is a sampler of the constant stream of signals reaching his central processor from his senses. Although some selective attention is apparent at the sensor level (e.g., focusing the eyes on a sign), the control resides with the central information processor which runs all the time, and switches (attends) to sensor inputs one at a time. This sampling is conditional; that is, it is based on previous inputs. If the information coming in through a few sensors does not occupy the central processor full time, man finds other things to do with the

excess input capacity. If there are few signs and curves on a particular road, then the driver turns on the radio or looks at the distant scenery. He may, in fact, daydream or tend to sleepiness in order to lower the effective full-load capacity of the processor. If he does reduce his excess capacity, he also increases his probability of missing a sign or signal that is important.

When the task is challenging, the effective capacity is expanded, but too much attentional demand at once will also lead to overload and missing important sensor inputs. As the driver comes to the advance exit sign, his effective processing capacity starts to reach the limit; he stops attending to the scenery or the radio and switches this attentional capacity to the traffic control signs. Road geometry and unusual traffic flow patterns near the exit can also impose enormous increases in attentional demand. If this occurs, the central processor will be overloaded, and important information will not get processed. A sign which meets all ordinary requirements of legibility at distance (or for exposure time calculated from vehicle speed) may not be "readable" at all. Alternatively, drivers who do "read" the sign may have vehicle control problems. Thus they may spoil the smooth flow of traffic, or even cause collisions.

This view of information processing and its critical role in the driving task leads to several observations about the design and use of traffic control devices.

Where attentional demand of the driving task is low (as on rural expressways), the driver needs advance warning to trigger the build-up to greater information-processing capacity. The driver cannot remain vigilant for guide signing, for example, if the frequency of occurrence of such signs has been very low. If the attentional demand of guide signing had been made more uniform along the road, the difficulties with the build-up time could be avoided. Since the attentional switching (at any effective information processing capacity) is conditioned by the previous inputs, a maximum interval between guide signs could be established. This interval might be one minute or ten minutes driving time, and would depend on the size of the related information processing task at the next critical decision point.

Where attentional demand of the driving task is quite high (as on urban expressways) the driver needs signing that presents the necessary information in a way that mixes in as few irrelevant cues as possible. Such irrelevant cues can come from inconsistencies in layout, design, or presentation. If the messages "Metropolis," "Utopia," and "Exit 29" appear on one sign, then they all should appear on every sign that can convey that information. Scrambling the order in which these three messages appear, using different background or alphabet styles, or changing the layout from centered to justified-left on succeeding signs introduces a great deal of irrelevant information. This information, which is just "noise" must be sensed and processed before it can be separated out and discarded. This processing often imposes attentional loading on the driver under conditions where he can least afford it. The steps necessary to reduce this irrelevant information should be as much a part of uniformity of traffic control devices as the regulation of shape and color.

Relating Signs to the Driving Task

Traffic control devices are used to tell the driver something that the road does not tell him, solely to increase the probability of correct vehicle response. Optimizing the process of communication alone is likely to be suboptimization for the system; the vehicle and the driving task itself should be considered. As discussed in the previous section, the driving task involves maneuvering the vehicle on the road as a result of decisions which are usually based on the processing of visual cues. Putting signs on a road often puts some lead, or prediction, in the system. If this is the case, we should take advantage of the fact that the goal is strictly one of vehicle response. Signs do not talk directly to the vehicle yet, so at present it seems appropriate that signs tell the driver what vehicle control actions he needs, and with what probability.

What do traffic control devices tell him now? Sometimes they tell him what the vehicle must do, or can do; sometimes they tell him what he must expect, or can expect. Often signs combine these unconsciously, forcing on the driver an additional information processing task to select the appropriate response. This need not be the case; design elements of signs could explicitly carry such information as (a) the probability, (b) the action required, or (c) the intended reader.

Probability cues would be useful in warning signs, for example. Warning signs direct the attention of the driver to two kinds of things. One kind, indicated by a BUMP or a curve warning sign is an event that is *certain* to happen. The driver *must* make the appropriate response to keep the car on the road. The second kind, indicated by a TRUCK CROSSING or FALLING ROCK sign is an event with a probability that is usually small, but not zero. There may be a truck or a rock in the road, and the driver may have to take appropriate evasive action, but usually he does not, and no specific action is always appropriate. A highly recognizable design element of the sign, rather than the entire message, could be used to make the distinction between certain events, and those of various low probabilities. Research may indicate the desirability of making additional distinctions among events of differing probability.

The second distinction, according to intended action, is a logical forerunner to the automated highway. Such a highway communicates vehicle control commands directly to the vehicle. At present, the signs speak for the highway, and address the driver. Transmitting information in order to elicit the appropriate vehicle response might be done more efficiently by encoding the message in a way related more directly to the vehicle control actions desired. The message set is not large; the driver controls the vehicle through few inputs. The feet control the longitudinal behavior (and signaling) and the hands control the lateral behavior (and signaling).

STOP signs; YIELD signs; maximum, minimum, or advisory SPEED LIMIT signs all ask the driver to use his foot on the brake or accelerator pedal: these signs could share a common design element. Following the previous argument, the STOP sign and the YIELD sign would contain different probability messages, however. Such signs as route markers and trail blazers, LEFT TURN ONLY, or curve warning require turning the steering wheel, and would be distinguished by a second action message.

The third distinction, according to intended user, arises from the observation that not all signs are for all people. To require the driver of a passenger car to process the information on a sign, only to find that the message is relevant only to trucks, bicycles, or motorcycles dilutes the expected value of all signs. Development of a series of signs intended for a single class of users has two benefits:

it reaches the intended audience more effectively, and it allows the remainder of the road users to concentrate on signs of utility to themselves.

THE EXPERIMENTS

Shape

Each of the world's highway sign systems uses certain shapes for specific or general types of signs. In the American system, for example, the octagon is reserved for the stop sign while the equilateral triangle, with one point downward, is reserved for the yield sign. The diamond shape is used for warning signs, and rectangular shapes are used for regulatory and guide signs. In regulatory signs, the longer dimension is vertical; in guide signs that dimension is generally horizontal. The circle, which is used extensively in other systems, is used only for advanced warning of railroad crossings and for civil defense evacuation route markers.

In the laboratory, 14 shapes were tested (Fig. 1). Approximately 30 observers were used, each for at least ten daily sessions. Each session lasted two hours in which each subject was exposed to 80 tachistoscopic stimulus presentations. (Exposure durations used were: .015, .020, .025, and .030 seconds.) Each stimulus presentation was preceded and followed in time by masking fields of visual noise of slightly higher energy.

Each observer was asked to tell which of the shapes occured on a given trial and to attach a numerical confidence rating of from one to four. They were provided with an answer sheet to record responses, as well as with copies of all of the shapes being tested. They were required to answer on each and every trial.

Results. The shapes which were found to be most distinctive and recognizable from the set in both positive and negative were those with the most accute angles; triangle, pennant, and trapezoid. Figures with more obtuse angles: octagon, pentagon, square, and diamond, as well as the circle, did not fare as well. When the data was analyzed according to negative and positive presentations, the superiority of the positive (black figure on white images) was quite clear and held true for every shape.

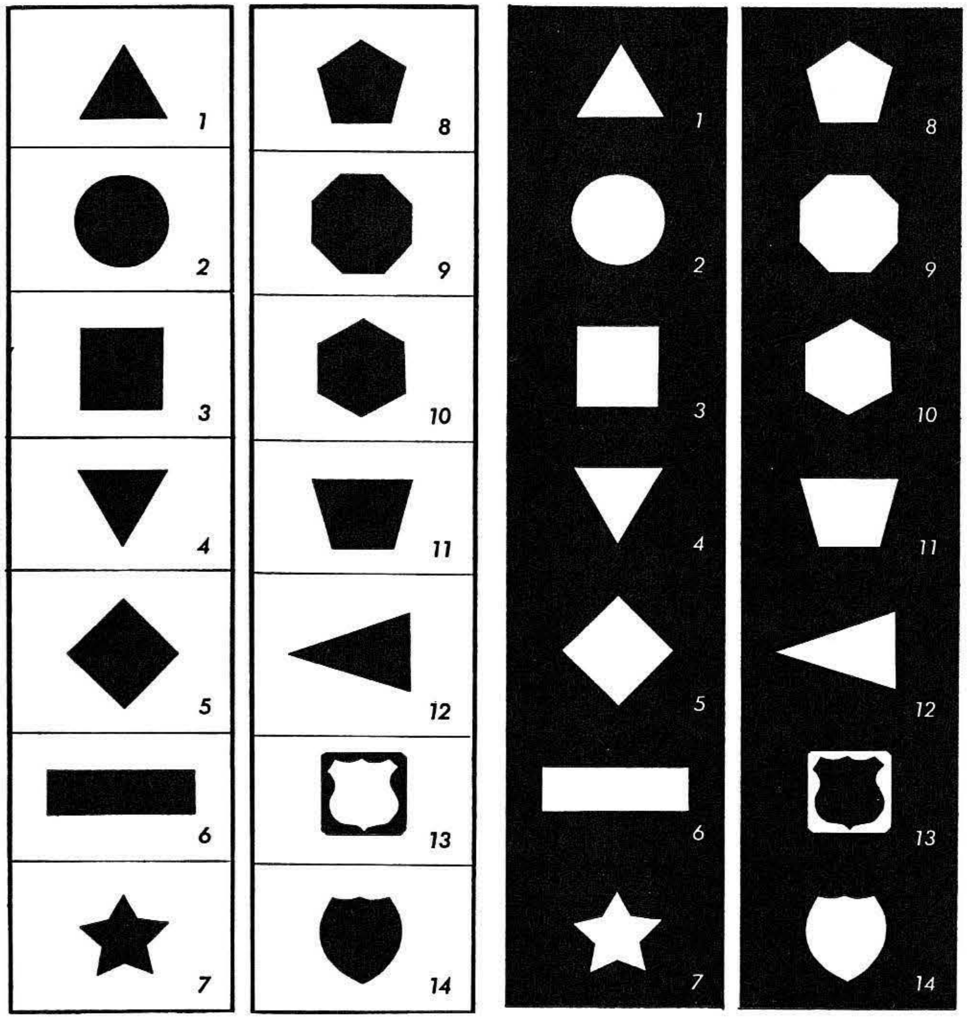


Figure 1. The shapes tested, in positive and negative image.

Arrows
Arrows are, of course, quite significant in traffic control devices. A number of different arrows are used in the various systems and variations of these systems. Seven were chosen for study (Fig. 2). Again, stimuli were presented tachistoscopically. Each presentation consisted of one of the seven arrow types oriented in one of the basic cardinal directions: up, down, right, or left. The observers were instructed to indicate the directions in which the arrow pointed, and, again, to rate their confidence in their decision on a four-point numerical scale ranging from "very sure" to "very unsure." Exposure durations were varied.

Results. Arrow type 1 proved to be clearly superior to all others. Visually, it carries directional information not only in its arrow head, but also through its tapered shaft, so that the necessary processing of the figure by the observer is reduced. The experiments also indicated that vertically oriented arrows were easier to recognize than those which were horizontal.

Recognition of Shape in Colored Shapes
Color plays a very important part in all sign systems. In this set of experiments the recognition of shape as a function of color was tested. Ten of the 14 shapes used in the shape tests (Fig. 1) were selected for testing and observers were exposed to groups of 30 randomly selected colored shapes in red, yellow, blue, and green (the colors most often used in various sign systems.) Observers were asked which of the ten shapes occurred on a given trial and to rate the confidence in their answer.

Results. The researchers found that the introduction of color effects no drastic changes in the recognition of shape.

The previous set of experiments were repeated with one exception: Observers were asked to identify color rather than shape.

Results. The tests indicated a high recognizability factor for yellow at brief exposure durations (15 mila seconds), quickly declining at longer exposure durations, and increasing again at even longer durations. The recognizability of red, blue, and green was very consistent. The limitations of the project precluded pursuing the

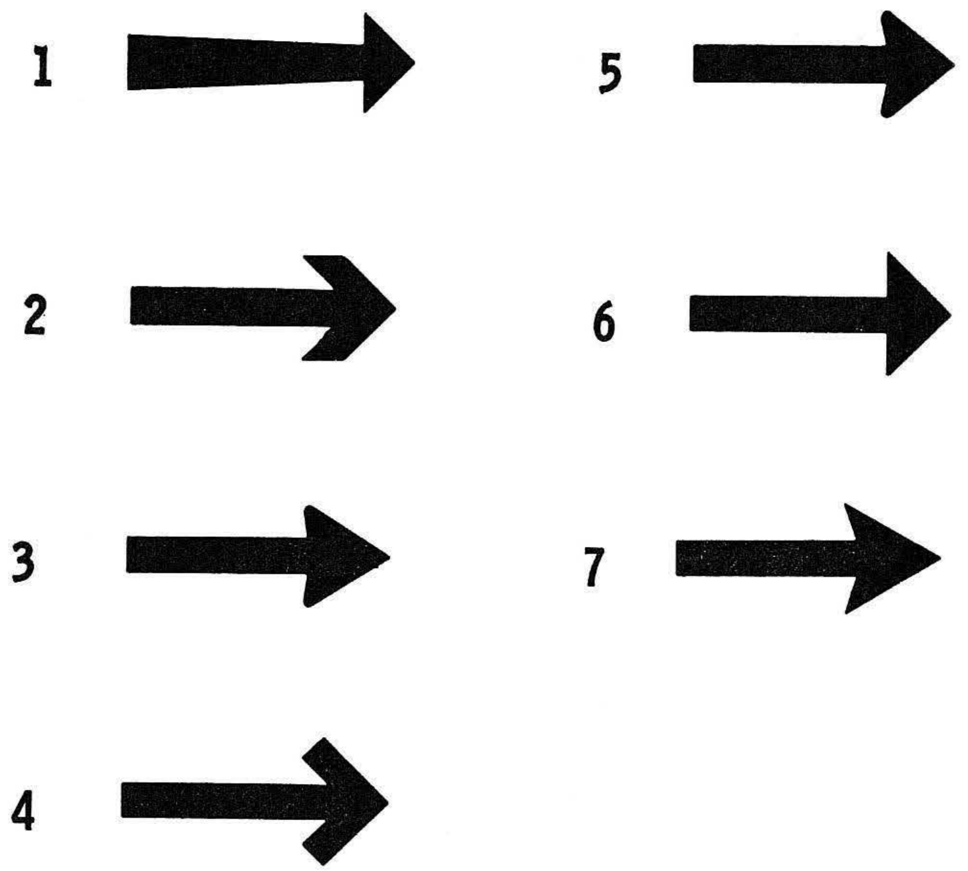


Figure 2. The directional arrows tested.

unusual reactions to yellow. It should be remembered that observers had to choose from a finite set of alternatives. It is possible that in very brief exposures, when the observers saw "nothing," knowing that it had to be one of the four, they chose yellow as the most likely alternative.

Guide Signs

Directional and informational signs are very important elements of every sign system. The researchers classified two major ways of "reading" signs: searching and discovering. In a search situation, the observer approaches a choice point with a well defined destination in mind. Expecting to find that destination on the sign, he searches through the words on the sign to find what he is seeking. In a "discovery" situation, the observer either has no well defined destination or does not expect to find it on the sign. He must then "discover" which destination names go with what directions, and then, finding the destination most properly related to his ultimate destination, he will know how to proceed.

Searching for a Destination. Three destination names on a set of guide signs were used in this series of experiments (Fig. 3). One destination went to the right, one to the left, and the third straight ahead. Any of the three destinations could appear in any of the positions of travel. Arrows indicating the directions were located all to the left of destination names, all to the right, or scattered. Signs were either positive or negative. Observers were tested at varying exposures which were basically longer than those used in previous tests, since the task was more complex.

Results. Several conclusions could be drawn from the data. Arrow placement to the right of the destination name is inferior to placement to the left or staggered presentation, the later two having about the same measure of supperiority. Positive presentations (black legend on a white background) produced better results than negative variations. The tests also indicated that the middle position of the sign is best in terms of being most easily and efficiently processed. Yet another analysis indicated that the straight ahead direction fared best in terms of identification, although this might be attributed to the fact that in the signs being tested, two of the arrows were horizontal while only one was vertical.

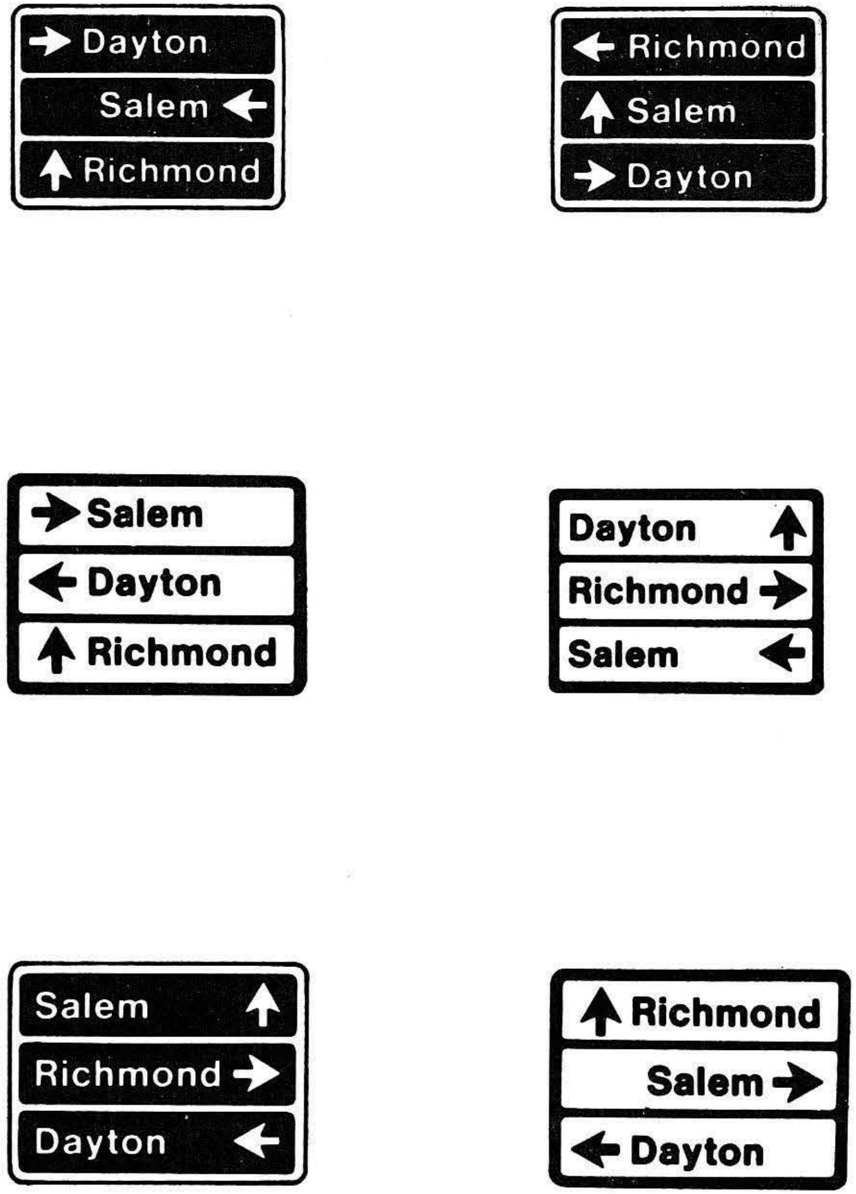


Figure 3. Specimen guide signs used in testing search for a destination.

Discovering a Destination. In the "search" test, observers had been given a list of destination names and required to respond with the associated direction of travel. In this series of tests, the observers were given the direction of travel and asked to discover the name of the destination presumed to be lying in the target direction.

Results. In these tests, data generally paralleled results of the "search" series of tests. Arrow placement to the right of the destination proved inferior to placement to the left or staggered; staggered presentations were slightly superior to placement to the left. As the previous series of tests, positive legends on negative backgrounds were far superior to their negative counterparts. Again too, "best performance" was associated with the middle position on the sign, and the "straight ahead" direction was most easily discovered.

Pictographs

The study did not undertake to compare pictographs to verbal legends. It did, however, attempt to discover which of a large set of pictographs were most easily recognizable from amongst that set. A set of 44 commonly used pictographs were used as stimulus (Fig. 4). Observers were given a list of intended meanings as a set of response alternatives.

In a second set of pictographic experiments, observers were asked to respond to each stimulus in their own words. The results were sorted into four catagories: strictly correct, generally correct, irrelevant, and contradictory. It is interesting to note that although the pictograph depicting "children crossing" was difficult to recognize, its meaning was most clear. The results of both series of pictographic tests were plotted as indicated in Figure 5.

According to this classification scheme, the best pictographs are falling rocks, slippery road, signal ahead, airplane, cattle crossing, pedestrian crossing, sheep, horn, noise, horse, elephant, and children crossing.

The worst, according to this classification scheme are: gas pump, no passing, police hat, youth hostel, fork and spoon, hump bridge, tent, wrench, dip, tar, riverbank, first aid, bus, telephone, and trailer.

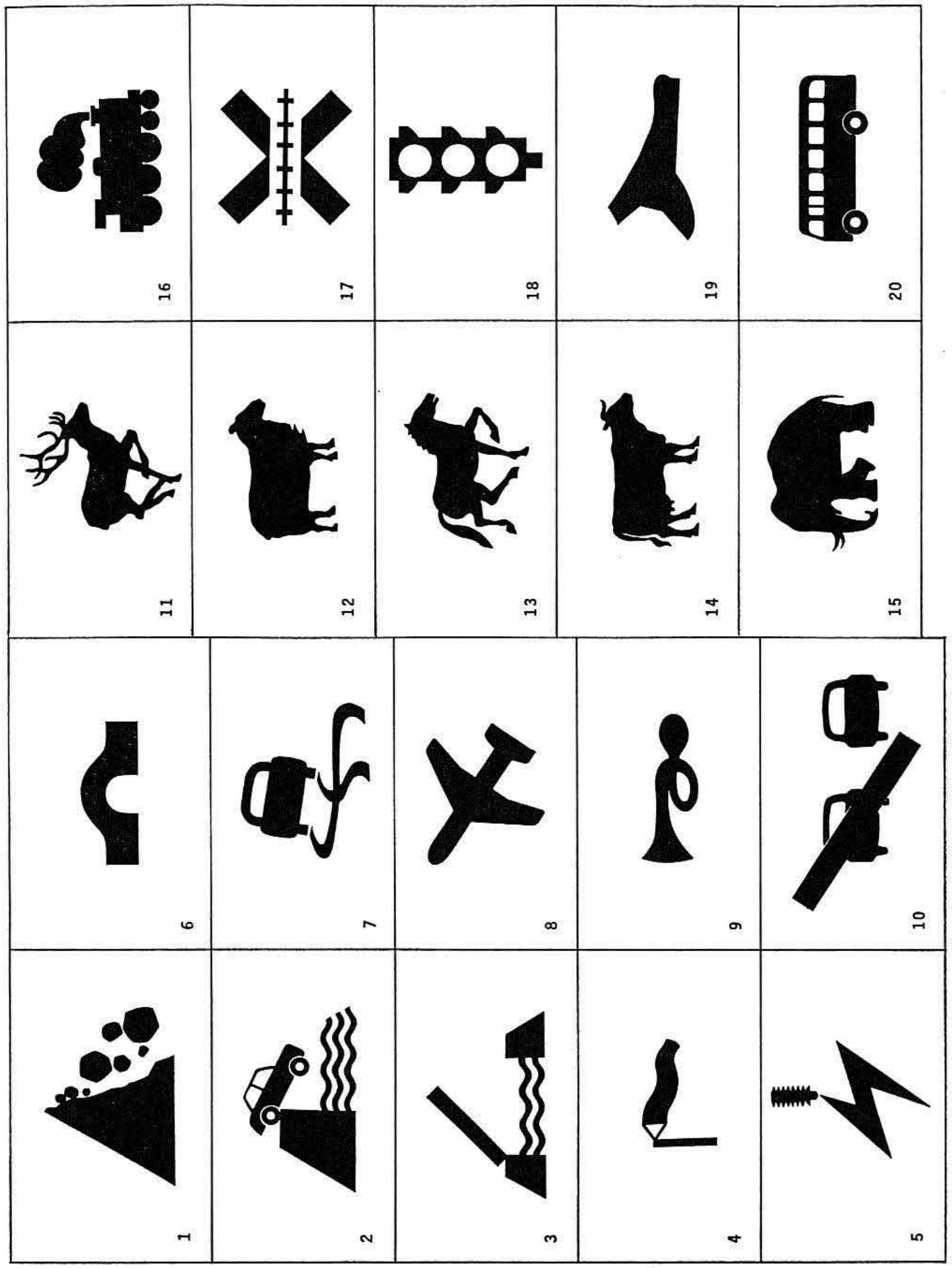
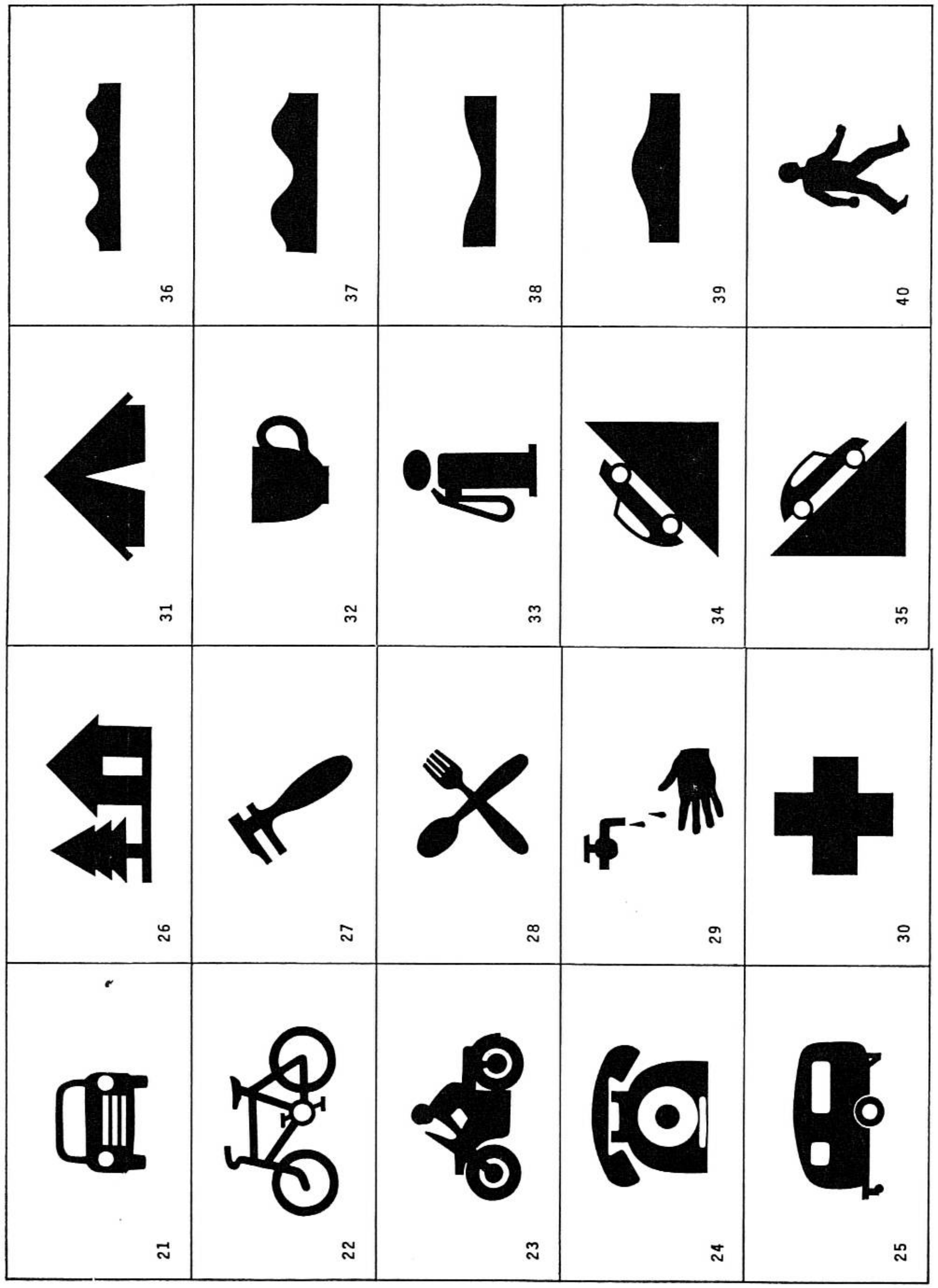


Figure 4. The set of commonly-used pictographs tested.



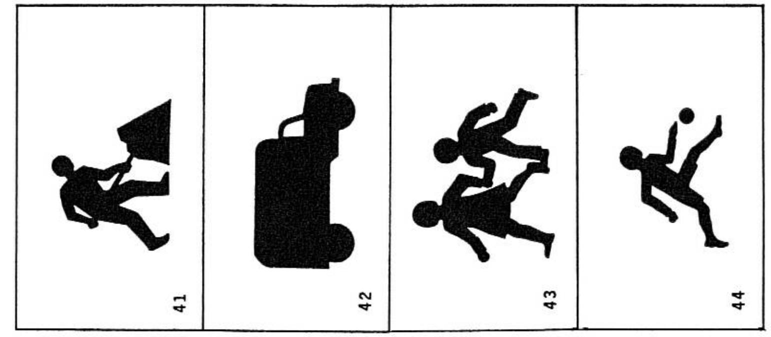
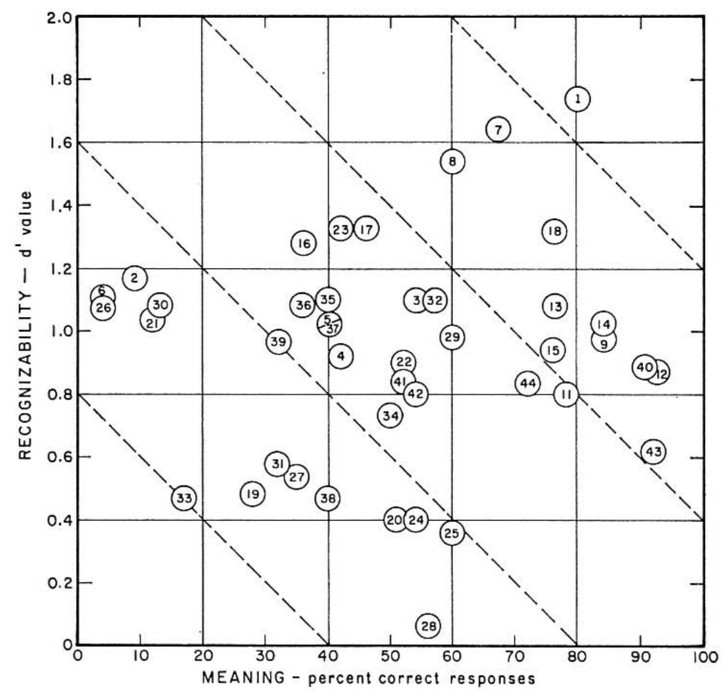


Figure 5. Combined rating scheme for the results of pictograph experiments. Numbers correspond to pictographs shown in Figure 4. Each pictograph, identified by number, is located on a grid by two co-ordinates, one its recognizability, the other its meaning transmissibility. The closer to the upper right-hand corner a pictograph lies, the better; the worst lies closest to the lower left-hand corner. A series of parallel lines of negative slope can be used to separate the pictographs according to quality. The actual slope chosen determines the weighting of meaning relative to recognizability. The steeper the slope, the more heavily recognizability is weighted.



Selected Signs in the Laboratory

All of the experiments mentioned previously dealt with basic design elements in their simplest and purest forms. Tests were carried to another level with a series of experiments involving ten selected signs chosen from those used in American and other systems (Fig. 6). These signs were tested in the laboratory and on a special test road.

In the laboratory, each observer was provided with a sheet containing all signs to be used in the experiment. After each exposure, they were asked to identify which of the ten signs had been flashed. As in all previous tests they were also asked to rate their choice in terms of confidence.

The same signs were tested on a test road using a car which was in as many ways as practically possible an "average" full-size American car. The track itself was an auto racing track in New Hampshire which is considered a good example of the narrow, winding, hilly country road that places considerable demands on the average driver.

A translucent screen, mounted on a helmet, was used to interrupt driver vision in the road tests. The vision interruption apparatus markedly reduces the amount of visual information a driver can process per unit time and provides a level of visual noise. Visual information processing tests will set his maximum speed everywhere on the road, making possible closer control and permitting a greater number of stimulus display locations in a relatively short length of test track.

The test signs were of standard sizes mounted at standard heights above the roadway. Observers were asked to memorize the signs prior to testing and then as they approached them on the track, to identify them to a researcher sitting in the car.

Results. The relative recognizability of individual signs varied between laboratory tests and road tests. Dividing them into three general categories, we find the following:

Recognizability Category	*Road Tests*	*Laboratory Tests*
Upper	Signs #3, 6, 9	Signs #2, 7, 10
Middle	Signs #1, 5, 7	Signs #1, 3, 8
Lower	Signs #2, 4, 8, 10	Signs #4, 5, 6, 9

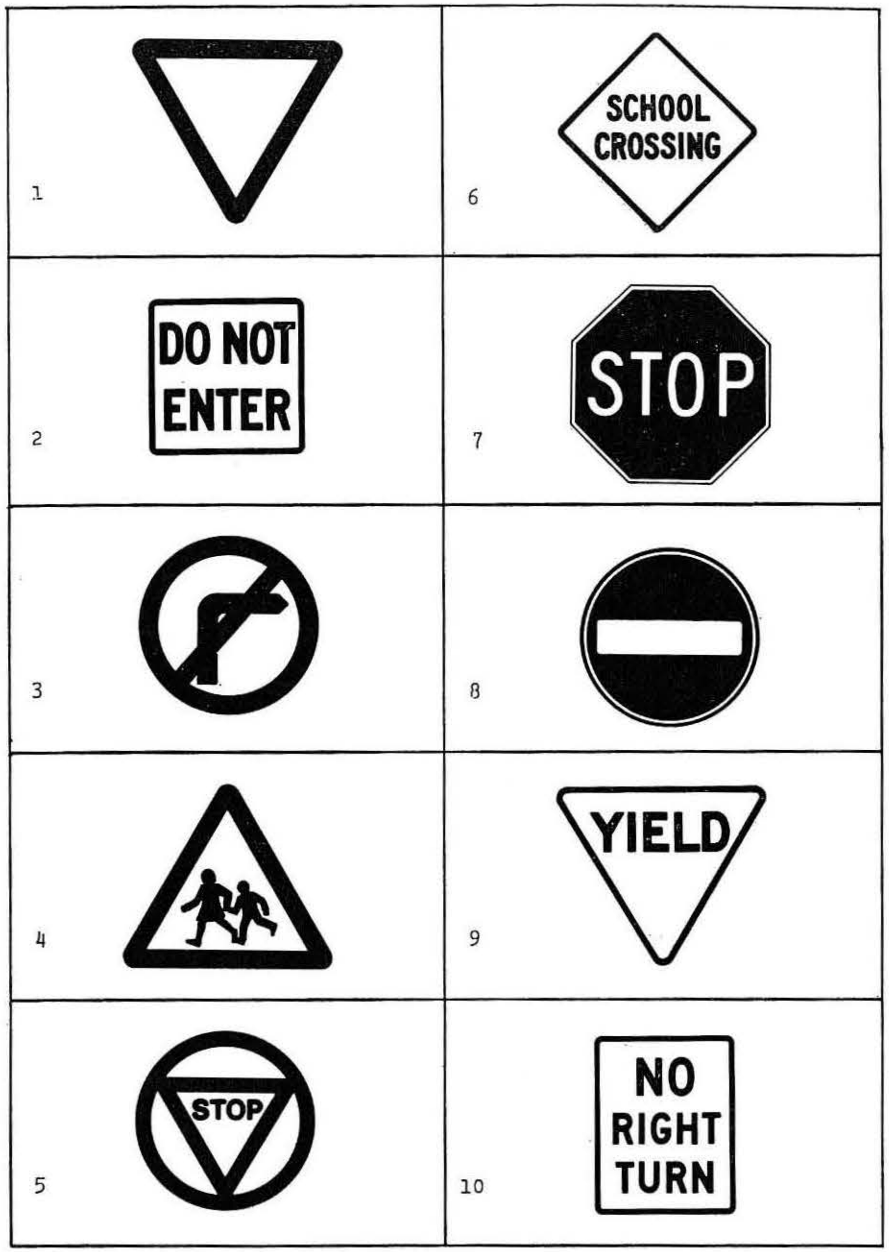


Figure 6. Signs used in the laboratory and road tests. Signs 1, 3, 4, and 5 have red borders; signs 7 and 8 are solid red; signs 6 and 9 have overall yellow backgrounds.

Conclusions
The program went far beyond testing of basic elements and signs. It included a broad literature search and a number of design experiments and explorations. These efforts, and the specific tests we have mentioned, led to a number of broad conclusions, raised many questions, and suggested a number of avenues for further exploration.

Warning Signs. Of the colors and shapes used in various systems for warning signs, there seems little doubt that the yellow diamond is less efficient carrying a verbal message than it would be were it to contain pictographs. At the same time, the diamond is a much more efficient shape for pictographs than is the triangle, which is currently used in most foreign systems.

Regulatory Signs. American regulatory signs are often cramped and awkward. The vertically oriented rectangular shape has many layout limitations. Were verbal legends replaced by pictographs, however, the problems would be greatly diminished, since the rectangle is in adequate shape for containing pictographs. Pictographs could never completely replace words, however, and there will always be a need for some word signs. The problems of alphabet are considerable enough to deserve a special section of the report, and these are included below.

Guide Signs. The problems of alphabet use are very apparent on guide signs as well as regulatory signs. In addition, the American system has many problems dealing with basic layout arrangement of elements on the sign and the make-up of these elements themselves. For example, there are the rather awkward route shields used on many signs and the lack of map-type or diagramatic signs which have proven quite successful in other highway systems.

A great deal of research has been done on legibility and lettering in highway signs. Many factors are known to have effects: letter width, stroke width, spacing between letters, proximity of borders and other lettering, contrast between colors, brightness between lettering and background, and general level of brightness all affect legibility. These factors interact with each other to affect legibility in different ways then each does individually. As a result, the

conclusions reached in studies of individual elements have varied with those reached when factors were studied in combination.

For example, one researcher found that the optimum relationship for stroke width to letter height was 1 : 8 for black letters on a white background and 1 : 13 for white letters on a black background. Another found ratios of as low as 1 : 4 for black letters on the white background. In the alphabets specified as U.S. Standards, the stroke width varies in conjunction with the letter width (the ratio of the U.S. series E, for example, is 1 : 6, which is the same as the ratio used by the Ministry of Transport in England.) No accommodation is made for variations if the lettering is to be used in the negative, however.

It has been found that the legibility of signs can be improved by increasing the spacing between letters. One study found, for example, that in certain American signs maximum legibility was obtained when the length of a place name was 40% larger than it would be with normal letter spacing. However, given the same amount of space, increasing the letter size results in a significantly greater increase in legibility. So, although letter spacing is mportant, letter size remains the overriding factor.

The legibility of lettering of a given size can also be improved by increasing the space between the message and the edge of the sign. Again, however, this is less than the increase obtained when the letter size is increased and the border width is reduced. It has been found that the border width need be no wider than the stroke width for black letters on a white background. The British Ministry of Transport has found that optimum legibility results from the use of space equal to about two stroke widths between names, and between the message and the border of the sign.

The question of whether to use upper- and/or lower-case letters is another one involving legibility. It has been claimed that lower-case lettering (with initial capitals) is better than all capitals in direction signing, because the ascenders and descenders of some lower-case letters (such as b and y) give a characteristic shape to a name, which in turn facilitates recognition. The British Road Research Laboratory has carried out a number of experiments involving upper- and lower-case comparisons and have found that the differences between good examples of upper- and lower-case lettering are negligible. In these experiments, signs of equal area were used, with the x-height of the lower-case letters being approximately three quarters of the height of the upper-case letters.

Legibility may also be related to the details of the lettering design itself. The Road Research Laboratory has suggested for example, that serifed letters might be more legible than the sans-serif letters normally used for traffic signs. Their work indicates that the advantage in using serifed letters, if any, is small. It may be possible, however, to increase this advantage by emphasizing the distinguishing features of the letters, for example, by exaggerating the horizontal bar to a G to distinguish it from a C. It is doubtful that this could be done in any way that would aesthetically be acceptable, however.

The American Alphabets

We have indicated the American system has many weaknesses and has made little use of existing research. For example, the *Manual on Uniform Traffic Control Devices* states that better legibility can be obtained using relatively wide spacing between letters, than by using wider or taller letters with cramped spacing. As explained previously, this is not always true.

The specifications for spacing given for standard alphabets are quite complex and unnecessarily confusing. A better system would be to determine spacing by the use of the body or block on which letter is mounted. This is a method by which spacing is determined in the *British Traffic Signs Manual* and provides a much simplified means of setting up words correctly.

The relationship of the lower-case alphabets to the upper-case alphabets in the U.S. system is also poor. Specific lower-case alphabets should be designed for each upper-case alphabet. (Currently the American system contains several alphabets in upper-case of varying widths, and one lower-case alphabet to be used with all of them.) The American standards also need work on word spacing, interlinear spacing, and the use of upper- and lower-case alphabets.

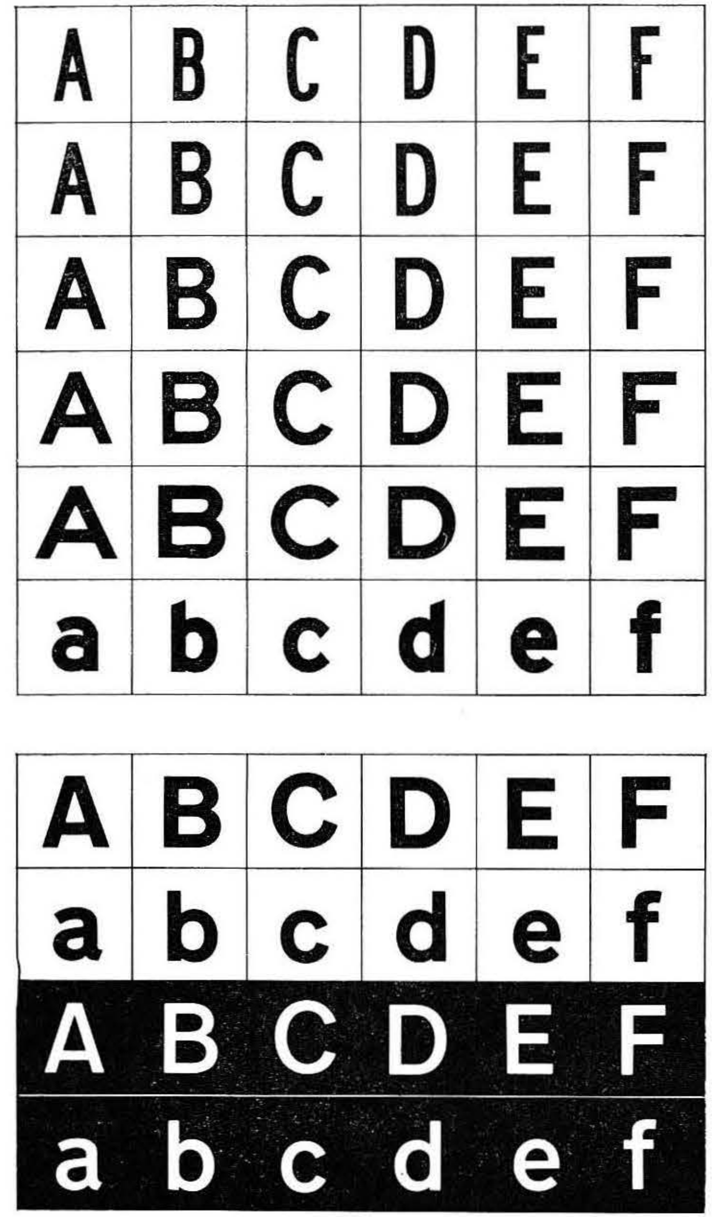


Figure 7. *Top*: Examples of standardized American highway alphabets from the *Manual on Uniform Traffic Control Devices*. *Bottom*: Examples of standardized United Kingdom transport alphabets from the *British Traffic Signs Manual*.

Design Review

As should be clear from the bulk and the content of this report, and from the work of other investigators in the area, the problems of traffic control device design are many and complex. Nor do they all admit of solution at the present time.

What is clear at the present time is that there is the need for uniform design review procedures. These should be performance-oriented, and include not only proposed new designs but continuing re-evaluation of existing designs. Ideally, the procedures would be simple, inexpensive, and implementable at a relatively local level—using state universities and local consultants, for example. In all likelihood, this would not be feasible for some time, and does not in itself provide the national uniformity necessary. An alternative is to provide centralized, or centrally controlled and managed, facilities for continuing performance review of proposed designs. Such a function would be appropriate for the National Traffic Safety Research Center. Interested parties would then be encouraged to submit problems and propose solutions for evaluation. This policy would ensure that evaluations were rendered within the framework of the then-current system of uniform traffic control devices. As we have emphasized, this total systems viewpoint is necessary in order to avoid proliferating designs which, while independently effective for regional problems, conflict with the current overall system.

This paper has been excerpted from *An Investigation of the Design and Performance of Traffic Control Devices* (Document No. PB-182-534) which gives complete statistical information for the experiments plus an extensive bibliography of related research. The complete report also contains a detailed graphic design discussion of the problems of signs in the urban environment. Copies are $3.00 from the Clearinghouse for Federal Scientific and Technical Information, 5285 Port Royal Road, Springfield, Virginia USA 22151.

Ligature Design for Contemporary Technology

Joseph S. Scorsone

Computer-aided composition has eliminated restrictions on the number of characters that can be stored practically in a font of printing type. A system of 27 ligatures was designed as an addition to both sans-serif and roman fonts. The development of the ligatures in News Gothic and Century Schoolbook typefaces is discussed and illustrated.

In a recent article, Aaron Burns (1968) writes of a new age of typography—a photo-electronic era which is about to revolutionize the present system of type composing. The computer, he points out, can be programmed to solve problems of letter spacing which, since the invention of movable type, were complicated by the walls of metal around each letter. Without this limitation, type can be set extremely close, which may contribute to its legibility as well as its aesthetic quality.

This new photo-electronic technology not only helps solve problems of spacing but also a problem Gutenberg faced when he attempted to cut his first alphabet. Gutenberg's first job case consisted of 290 different letters, ligatures, and abbreviations (Zapf, 1968). His first letters were fashioned after those of the medieval scribes; he copied many of the ligatures they employed in order to create a printed page indistinguishable from the hand-drawn manuscript. As the technology of printing evolved, the size of the printer's type case decreased because it was neither practical nor economical to have such a large assortment of ligatures. The ligatures in use today which have survived this evolution are ff, fi, fl, ffi, ffl, æ, and œ. With photo-electronic technology, the size of the font is no longer a problem since an infinite number of letters and ligatures can be stored in the memory of the computer.

The purpose of this study has been to design a system of ligatures (1) that would be compatible with an existing sans-serif and roman alphabet, (2) that could be used along with the normal 26-character alphabet without prior learning on the part of the reader, and (3) that would not be confused with other letter combinations and could be recognized easily when used in a word.

It has been argued that words are read not by recognition of individual letters but by their visual shape (Paterson and Tinker, 1940). The use of the ligatures may increase legibility since the shape of the word would be reinforced by uniting the letters into a more distinct visual form. And space taken up by the printed matter could be greatly reduced (and, thereby, cost also), since a normal page of text contains over two hundred of the proposed ligatures.

Selection of Bigrams and Words

Before the ligatures could be designed, it was necessary to determine what two-letter combinations (bigrams) would be employed as ligatures. The ligatures are composed of bigrams and words according to their rate of frequency in the English language. The bigrams in List 1 have the highest rate of occurence in normal English text and are listed in the order of their frequency. List 2 contains the most common doubled letter in English (Pratt, 1939).

List 1

th	on	of	as	le	de	we	ng	ut	si	nc	em
he	at	ti	to	nt	ea	ve	ma	us	la	so	ac
an	nd	ed	ar	re	ne	ta	ce	be	ad	ll	im
re	st	or	ou	se	ro	tr	ra	un	li	ur	pr
er	es	ti	is	ha	om	co	ic	ch	rt	el	ot
in	en	hi	it	al	io	me	ns	wa	ca	rs	wi
ec											

List 2

ll	ff	mm	ee	rr	gg	ss	nn	dd	oo	pp	aa
tt	cc	bb									

Twenty-four bigrams were selected from these lists to be used as ligatures; "at," "of," and "the" were selected from a list of most common English words (Pratt, 1939). These word ligatures would not

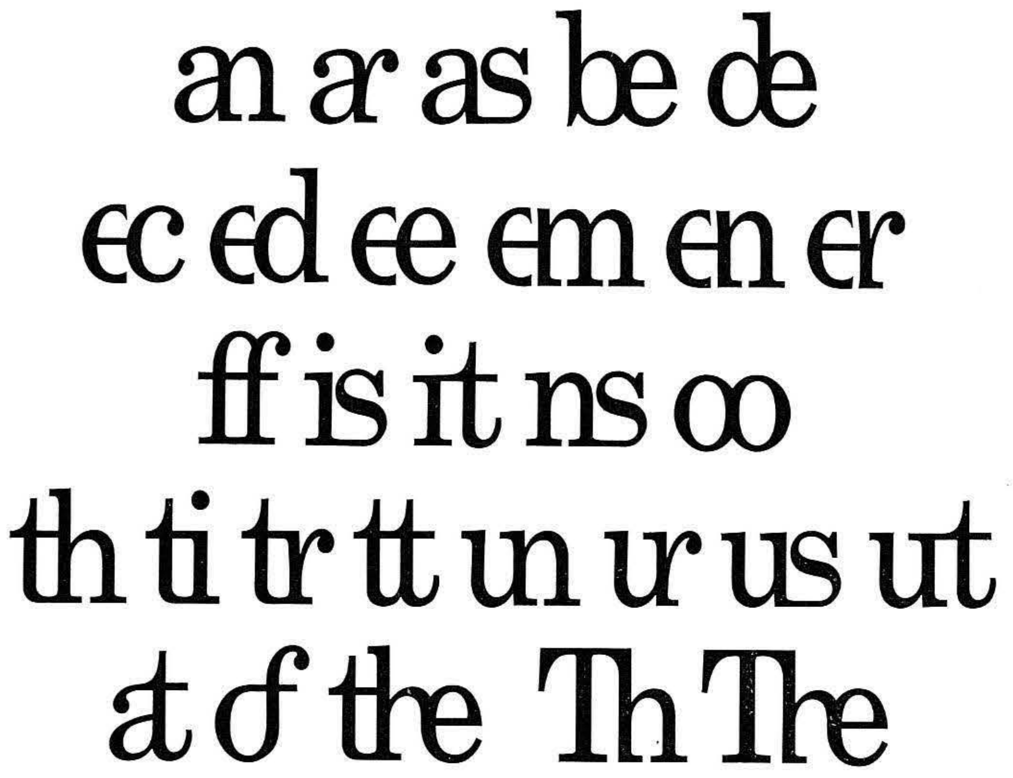


Figure 2. Roman ligatures to be used with Century Schoolbook.

recognition when united with other letters in a ligature. Another reason was the symmetrical distribution of thick and thin strokes on the letter o. This characteristic made a natural transition in the of ligature, since the thin stroke of both letters meet horizontally and the thick strokes coincide vertically. If the thick and thin strokes were distributed asymmetrically, there would have been an awkward juxtaposition between the weights of the two letters.

The ligatures can be easily adapted to most sans-serif alphabets without many alterations to the existing letter design. Adaptation to many of the existing roman alphabets would require major alterations, since there is greater variation in the design of the roman type families.

Designing the Sans-serif Ligatures

The initial task in designing a system of ligatures was to determine the most important elements of each letter combination; what elements could be discarded and what elements had to be retained. Numerous drawings of each pair of letters, in every conceivable combination, either stressed or eliminated certain features of each bigram. It was discovered that certain ligatures worked well as words but not within words, i.e., at, of, and the. They were retained only as word ligatures.

I tried not to deviate from the established weight of the sans-serif letter. To avoid concentration of black which would appear spotty when the ligatures were set in a paragraph, certain elements were eliminated from the letters; for example, the top of the vertical stem of the letters n and r in the an and ar ligatures, the bottom stem on the d in the de ligature, and the interior forms of both the at and the of ligatures had to be adjusted.

When one shape or stroke becomes an integral part of both letters in the ligature, you establish a "multiplicity of read." This phenomena can be seen in the an, ar, be, de, oo, un, at, of, and the ligatures. When this "multiplicity of read" could not be accomplished without destroying the recognition of the ligature, the letters were joined together eliminating much of the space between them, creating one distinct form out of the bigram.

Bigrams beginning with the letter e made it necessary to use two different styles. If the traditional e form were used at the beginning,

be used within other words but only by themselves. Only those letter combinations which could logically be united into a ligature were used. Not all bigrams can be joined together without destroying their legibility. Every letter has a side which is more important for its recognition. The letter a, for instance, has its most important elements on the left, while the letter r has its most important elements on the right. When a bigram is united into a ligature, parts of both letters are obliterated. In designing the ligatures it was important to retain the elements of each letter which were essential for recognition; most of the bigrams from the frequency lists could not be united without destroying these elements. For example, if the bigram re was united as a ligature, the right and most important side of the letter r would be lost.

The 27 bigrams and words which proved to be adaptable to ligature formation are contained in List 3; see also Figures 1 and 2.

List 3

Bigrams						*Words*
an	em	th	ar	en	ti	at
as	er	tr	be	ff	tt	of
de	is	un	ec	it	ur	the
ed	ns	us	ee	oo	ut	

Selection of Typefaces

The selection of the sans-serif alphabet was more arbitrary than the selection of the roman alphabet. Although many sans-serif alphabets could have been used, News Gothic was selected mainly because of the length of the stem on the lower-case r. On two of the ligatures which employed the letter r (ar and ur) the stem on the r had to be long enough to be recognized. This was especially true in the ar ligature, since the top of the vertical stroke of the r was removed.

The selection of Century Schoolbook for the roman counterpart was made for many reasons; e.g., it has horizontal square serifs. This characteristic makes the connection of two letters appear more natural than with a typeface having pointed diagonal serifs. As in the selection of the sans-serif type, the lower-case r was a factor in the selection of Century Schoolbook. This particular r has a long thin stem terminating in a large ball, which gives it excellent

an ar as be de
ec ed ee em en er
ff is it ns oo
th ti tr tt un ur us ut
at of the Th The

Figure 1. Sans-serif ligatures to be used with News Gothic.

Typography is the art of visual communication.
It has one fundamental duty before it and
that is to transmit ideas in writing. No
argument or consideration can absolve
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Figure 7. Roman ligatures used in a paragraph.

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Figure 8. A paragraph employing roman ligatures reduced to a normal text size.

On the whole, the roman ligatures appear to be superior to the sans-serif counterpart. The roman alphabet, with its serifs and thick and thin weight distribution, supplies more cues to the identity of the individual letters than the more simplified sans-serif characters. An example of this can be seen if we compare the roman ar ligature with the sans serif. The roman ligature has a very distinctive ball on the stem of the r as well as a serif at the bottom to establish recognition. The sans-serif ar ligature has only the stem of the r which has few distinctive characteristics.

The Technical Process

The ligatures were drawn $5\frac{1}{2}$ inches high and were photographically reduced to a standard 60-point type height or approximately $\frac{1}{2}$ inch. The ligatures were then juxtaposed with printed individual letters to make paragraphs, and then reduced to a normal text height of 10–11 points.

Ultimate use of this system of ligatures would require a computer and a photocomposition machine. The programming would have to be determined in conjunction with professional computer personnel.

REFERENCES

Baudin, F. "Typography: Evolution and Revolution." *The Journal of Typographic Research*, 1 : 4, 1967, pp. 373–386.

Burns, Aaron. "Typography 1978." *Print*, 17 : 3, 1968, pp. 34–41.

Cheetham, D. "Case for Research." *Design*, 195, 1965, pp. 48–51.

Cheetham, D., and Grimbly, B. "Design Analysis: Typeface." *Design*, 186, 1964, pp. 61–71.

Emans, Robert. "Context Clues as an Aid to the Reader." *The Journal of Typographic Research*, 2 : 4, 1968, pp. 369–373.

Neisser, Ulric. *Cognitive Psychology*. New York: Appleton-Century-Crofts, 1966.

Paterson, Donald G., and Tinker, Miles A. *How to Make Type Readable*. New York: Harper and Brothers, 1940.

Pratt, Fletcher. *Secret and Urgent*. Garden City, N.Y.: Blueribbon Books, 1939.

Ruder, Emil. *Typographie*. Switzerland: Arthur Niggli, 1967.

Scheid, K. G. "Computer Printing—What Role for the Designer." *Print*, 20, 1966, pp. 19–23.

"Typesetting by Computer—A New Challenge to the Designer." *Design*, 212, 1966, pp. 40–45.

Updike, D. B. *Printing Types: Their History, Forms, and Use*. Cambridge: Harvard University Press, 1922.

Zapf, Hermann. "Changes in Letterforms Due to Technical Developments." *The Journal of Typographic Research*, 2 : 4, 1968, pp. 351–368.

Type Design for the Computer Age

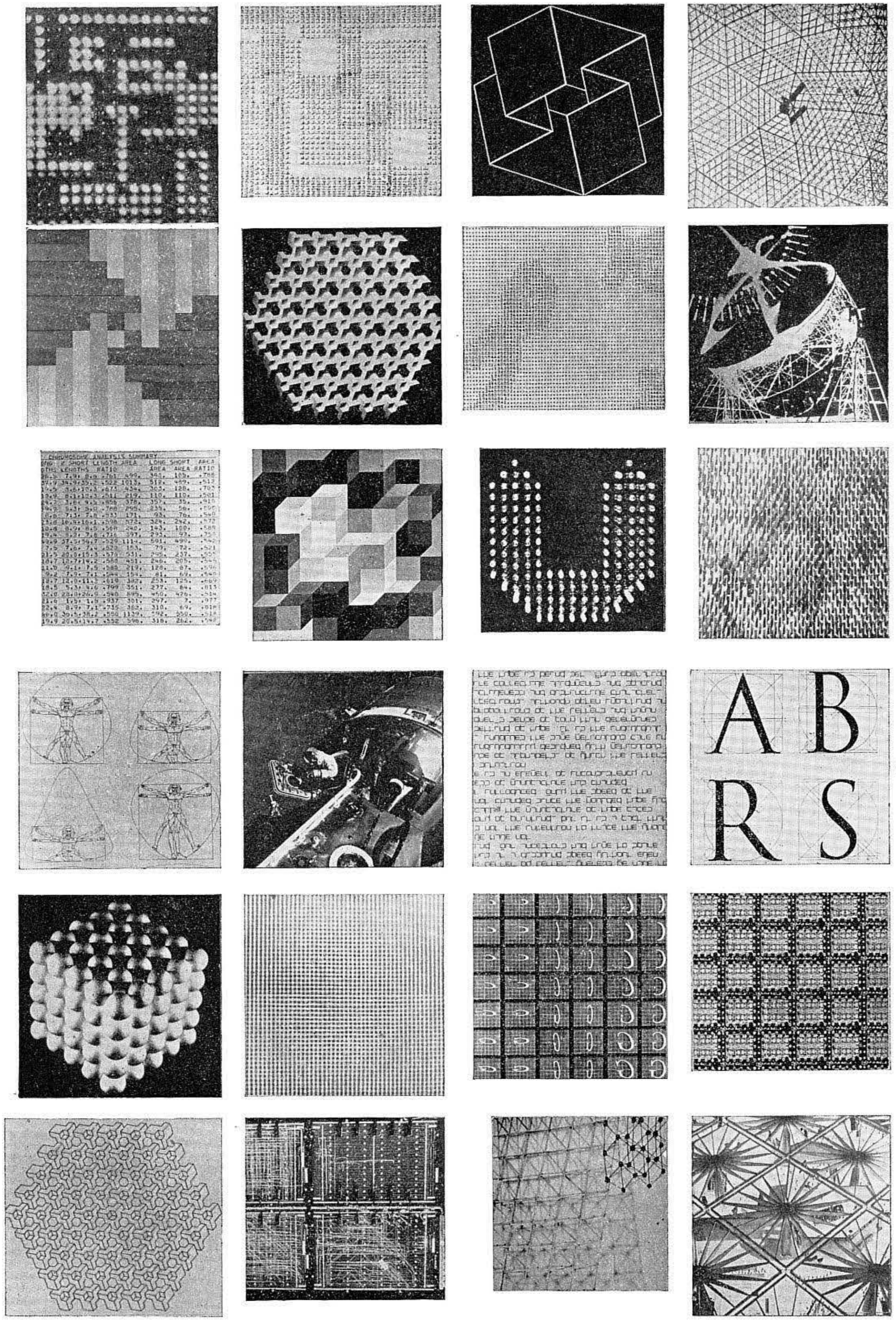
Wim Crouwel

Although typography has always reflected the cultural pattern of its period, today's typefaces and typographic design are a reflection of the past, not of contemporary society. We must think in terms of our electronic media and contemporary forms of expression. A suggested approach for designing today's typography—based on a cell or unit system—is discussed and illustrated.

Leonardo da Vinci may not have been an important type designer; he was, in any case, one of the first who tried to bring letter-types into the framework of a construction. Many after him have repeatedly tried, with more or less success, to analyze the highly individual signs that letters are into a number of basic forms. In da Vinci's case it was clearly the constructor who felt the need to reduce things to simple principles; more-over, his constructions were inspired by his being a sensitive artist.

This attempt—to reproduce constructionally what the human hand created with care and devotion—never had many actual consequences for the evolution of type. Clearly, man's productivity could easily meet the existing demands, and the individual who looked a bit further stayed alone; economically there was no need.

Now, however, we have reached a period—the second half of the twentieth century—in which economic necessity has created machines capable of reproducing characters at a speed of several 1000 per second. In 1969 Leonardo da Vinci would have been able to contribute much to the development of the typesetting machine and especially to the evolution of types for it. We can assume that da Vinci, who reflected the trend of his time with extreme sensitivity, would have evolved a highly appropriate type, a type that would not be anachronistic to the space craft in which the first men landed on the moon.



For the moment I shall ignore the fact that computers and CRT setting systems came into existence as a result of military needs. And I only mentioned Leonardo da Vinci (who also designed horrible war-machines) to indicate that typographical development has always been closely related to a period—its techniques, its economics, its art, and its culture.
As there were the Phoenicians with imprinted clay tablets,
the Romans with their inscriptions in marble,
the men of the Middle Ages with illustrated parchment,
the men of the Renaissance with soft lead type,
and the Classicist with type engraved in steel;
each period with the type conforming to its need and reflecting a total cultural pattern.

We do not conform to this tendency today; our type is generally anachronistic, out of touch with our particular time. Today, for example, we should soon be able to project letters into space with the help of laser beams. We have for too long seen the typographical character as a form in itself. We have for too long practised the writing down of these beautiful characters: in school, in our handwriting; in art school, in calligraphy and letter-drawing. We have been so intent upon copying something from the past that we have forgotten to think of our own time. We are so dazzled by the beauty of the characters with which we have to do every day that we cannot bring ourselves to regard them objectively. Writing by hand is fortunately a vanishing skill. In the future it will serve only for making rapid abstract notes, which will be of no value except to the writer, and undecipherable except by him. For true communicative purposes its role is finished.

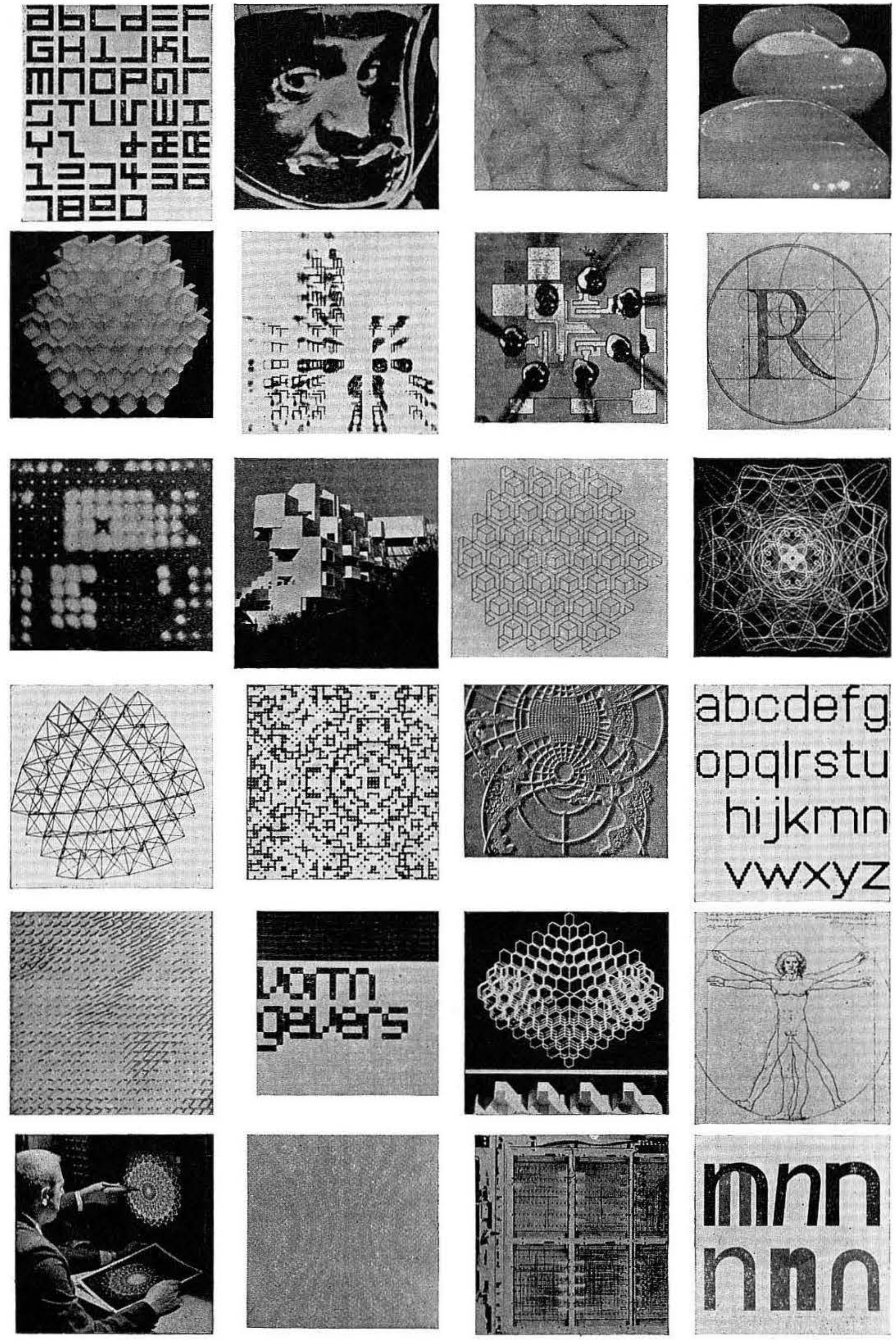
The letter-type for our time will, therefore, certainly not be based on the written or drawn examples of the past. The type which will now come into existence will be determined by the contemporary man who is familiar with the computer and knows how to live with it. Likewise, this type will be determined by the art of the present time, with its rapidly changing character in which aesthetic values are given a totally different interpretation. The type will be determined by the contemporary cultural pattern of which we have as yet only a partial view, but which each of us senses, and in which we participate; a period with a tremendous urge for renewal.

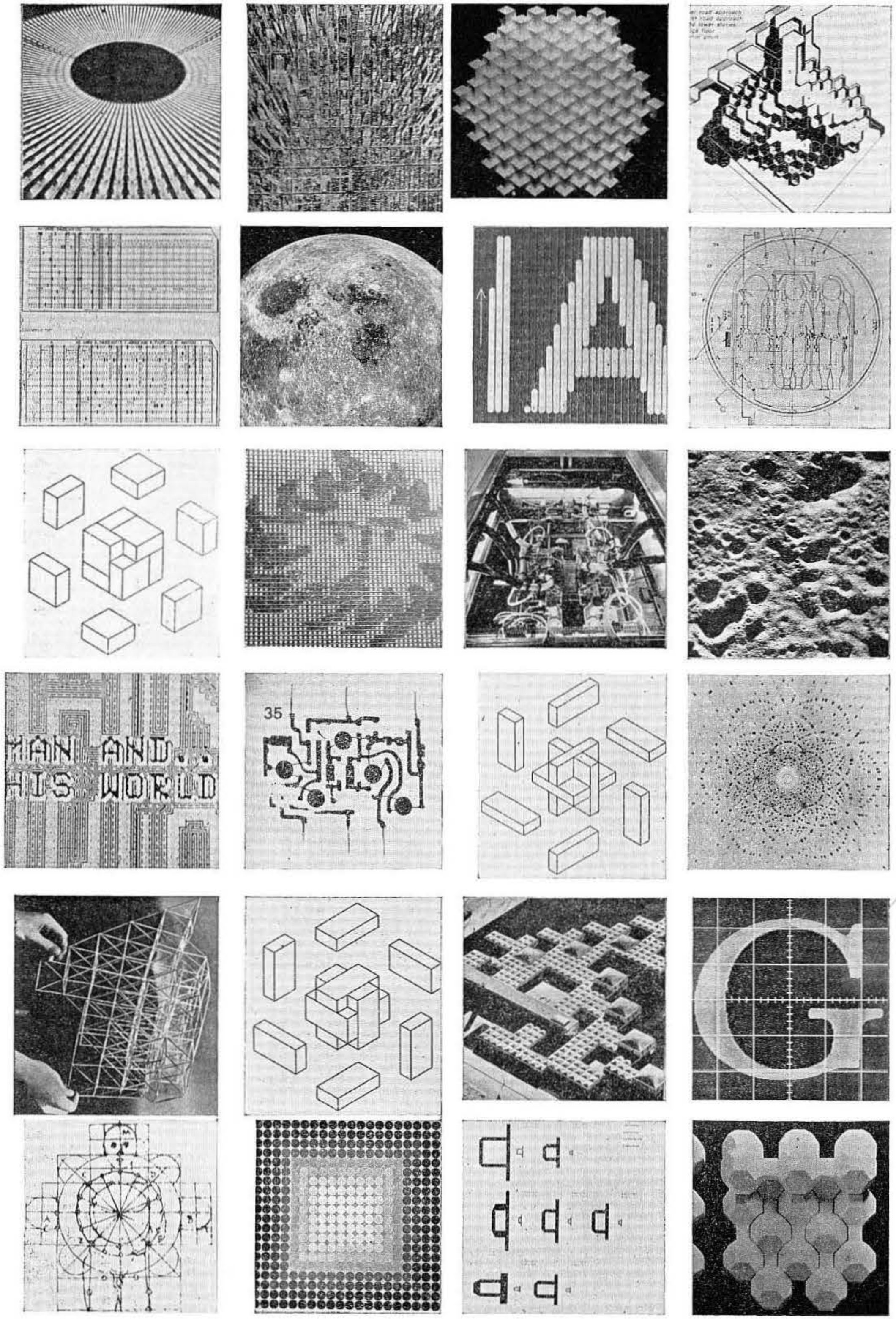
Our computers work according to the very simple system of yes or no, 1 or 2. The memory of a computer is an assembly of cells, charged positively or negatively. This assembly of cells, so similar to the composition of organisms and to the structure of our entire society, could be a new starting point for the development of new characters. I do not know whether this ought to be letters or pictograms; in principle I speak of communication symbols. Symbols in every form can be constructed with these cells and even spatial symbols are possible. The computer does not have a merely two-dimensional "output," but a three-dimensional possibility. The cells may be strung together in certain patterns; this pattern construction determines the form of the symbol.

In our present arsenal of forms one finds many corresponding expressions—the clearest in contemporary architecture—all based on the principle of many small units, together shaping the form. For example: the honey-comb, certain architectural studies by Conrad Wachsmann, the geodesic domes of Buckminster Fuller, and Habitat at the Montreal Expo. No matter which computer-aided system one applies, the cell principle seems to me a correct starting point, just as was the papyrus stamp, the goose quill, or the engraver's tool.

Although the cell form is important for the arrangement of patterns, I use the expression "dots" as an example for convenience sake. If we compose a classical letterform with these dots, you will notice that there is something happening. The letter cannot be dotted, cannot be screened; that is incompatible with its appearance. In principle nothing is changed when one takes 400 dots to the cm. instead of 20. Apparently everything is in order, but the screening has been done. It remains a concealed affront! It is against the classical letterform.

One can compare this to another example. In the nineteenth century when cast iron was discovered, we were proud of the fact that we could imitate everything in cast iron, indistinguishable to the naked eye from the original article. By means of this, beautiful wood carvings and sculpture were copied for architectural purposes. We soon saw that this was the wrong approach. In the same way we will doubtless stop the reproduction of Bodoni and Garamond on the supersonic machines. *It is an error!*





The assembly of cells which is so marvellously adapted to the computer principle, will have to lead to a specific sign language. Taking into account the uniformity of the cells, an equilateral form is perhaps the most desirable for these signs—an enlarged cellform, as it were. It is also desirable in view of a variable typography. Every conceivable combination in all directions can then be achieved. I would like to adopt some sort of vocabulary agreement to facilitate understanding.

Together the cells form the signs, I would call these *nuclei*; together these nuclei form words or concepts, I would call these *units*; these units form the *communication*. A communication is an assembly of units, and a unit is an assembly of nuclei. Giving form to a communication is therefore typography. Typography, according to this system of nuclei, will be very clearly defined. The construction of this typography could be much freer, could even be developed in the third dimension; while, on the other hand, the form would appear far more systematic and harmonious than in traditional typography. It will probably lead to equilateral two- or three-dimensional sizes if we assume that the cellform determines the form of the nucleus, the nuclear forms determine the forms of the units, and the forms of the units determine the form of the communication. The increase or decrease in size of a specific type sign, a specific nucleus, means that a greater or smaller number of cells is involved.

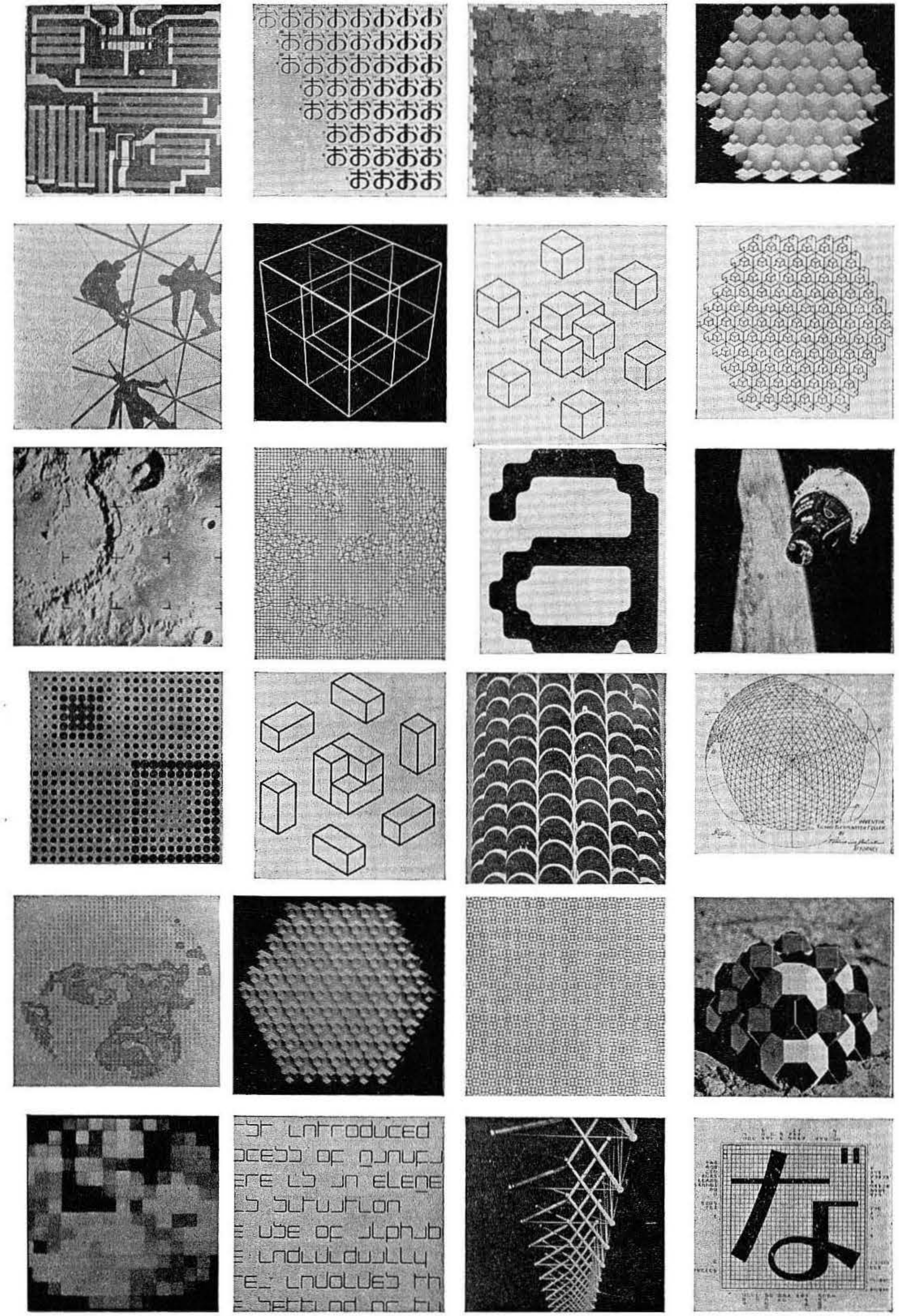
A result of this is that a freely-drawn curved line changes its shape in principle with every increase or decrease in size. Again I say "in principle" because with 400 cells per centimeter, this could not be observed by the naked eye. The fact remains, however, that there is an unacceptable change of the sign in every size, while the meaning remains unchanged. This would mean that all straight lines of 90° or 45° could serve as the basis for the construction of the nuclei. These directions do not change and are the most regular in the cell construction. Straight lines with other angles—such as 60° or 30°—could possibly also be considered.

A lettertype was designed two years ago as a basis for discussion along these lines in which a correspondence between reproductions of types and of illustrations was effected. After all, illustrations have for many years been reproduced by means of the multiplication of dots, even though in this case different dot sizes are used. An illustration could just as well be reproduced by same-sized dots, only a far greater density than has been possible so far, is needed. It is a matter of the refinement of printing techniques. It would be ideal when illustrations and type could be handled in the same way. The typographer would then have innumerable possibilities at his disposal, and complete integration of illustration and text could be realized.

For the "total" typography, which then becomes possible and which might even assume spatial dimensions, simple grids would have to be constructed. These grids may be compared to the structure in architecture, in which housing units can be placed as required. A grid is the invisible network of lines into which signs and illustrations are placed as required. And since the computer is able to carry out spatial calculation, this typography could also achieve an extra dimension, which very soon would also be completely visible from all sides in space. Just as holography is already showing.

The laser beam in typography. I wonder if we could then still maintain the term typography.

This article is based on a speech by Wim Crouwel at the Eleventh Congress of the Association Typographique Internationale held at Prague, Czechoslovakia, June, 1969.



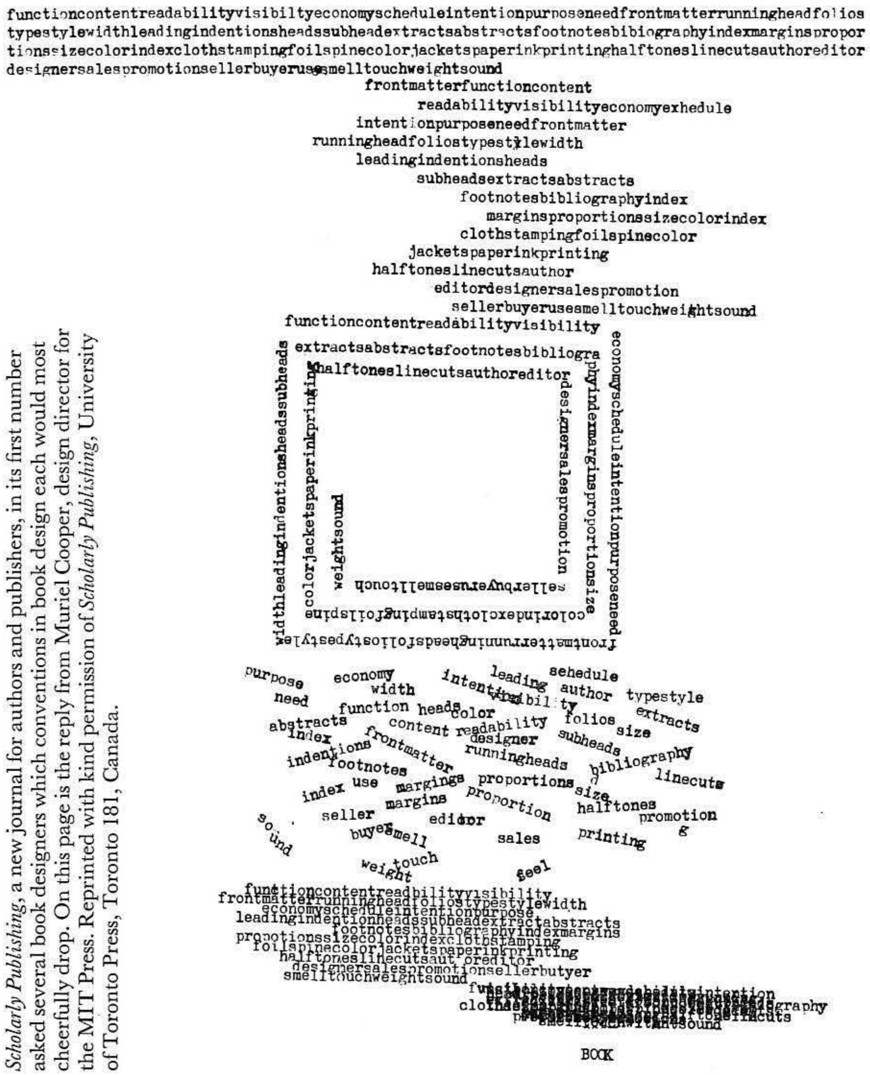
I would drop the convention of thinking in conventions instead of functions.....

I would drop the convention of thinking in detail rather than in wholes......

I would drop the convention of replacing thinking with rote and calling it tradition .....

I would drop the convention of mocking the past by idolizing it....

I would drop the convention of denying today to preserve the past.....



Scholarly Publishing, a new journal for authors and publishers, in its first number asked several book designers which conventions in book design each would most cheerfully drop. On this page is the reply from Muriel Cooper, design director for the MIT Press. Reprinted with kind permission of *Scholarly Publishing*, University of Toronto Press, Toronto 181, Canada.

Reader Preferences for Typeface and Leading

D. Becker, J. Heinrich, R. von Sichowsky, and D. Wendt

This paper investigates the influence of typeface and leading on perceived appealingness of a printed page. Eighty subjects judged the attractiveness of 48 typographic designs, varying in typeface (Garamond, Bodoni Antiqua, Bodoni Kursiv, Akzidenz Grotesk), in justified vs. unjustified composition, and in leading (0, 1, 2, 3, 4, and 5 points). Judgments were made by rank ordering subsets of six specimens. A scaling procedure (comparative judgment) was applied to the data and gave scale values for each design. There was no significant difference between mean scale values for justified and unjustified composition, but different typefaces required different amounts of leading to allow most appealing composition.

Various experiments have investigated the influence of leading and font style on legibility of printed text; for reviews of such studies, see Tinker 1963 or Zachrisson 1965. Some experiments have shown that objective criteria of legibility are correlated to reader's judgment of legibility (e.g., Pyke 1926, Tinker and Paterson 1942, Ovink 1938, Burt 1955, 1959). However, only a little research has been done until now on the attractiveness of typographic design for its own sake. Typographic design may be considered just as the "package" of a printed message, but it may be "the package that sells," and, as such, not at all unimportant. This is not only because, in the overwhelming flood of printed materials which comes on our desks, printed pieces have to "compete" with each other; what looks intuitively most appealing to us (other factors being equal) has best chances to get read first. It is also because an attractive design may be read more deliberately, with less fatigue, and faster just because of its higher motivational appeal.

This study was planned to explore the effect of two typographic factors on the perceived appeal of a printed page: typeface and leading. The questions were: what typeface (among a choice) looks most attractive; what amount of leading makes a page, printed in a given font, most attractive; and what combination of typeface and leading is most effective?

Four typefaces were under investigation: Garamond, Bodoni Antiqua, Akzidenz Grotesk, and Bodoni Kursiv (Fig. 1). Printed pages, containing the same text, were composed in a 10-point font of each of these four typefaces: (1) with no leading; (2) with 1-, 2-, 3-, 4-, and 5-point leading; and (3) one of each in justified composition (line length 20 picas), and one in unjustified composition (average line length also 20 picas). This made a total of $4 \times 6 \times 2 = 48$ different stimuli. Subjects in this experiment were 80 students from the Hochschule für Bildende Künste (art school), from various faculties of the Universität Hamburg, and some from the upper grades of Hamburg high schools (corresponding in age to American college sophomores).

In the first part of the experiment each subject received eight series of six pages each with instructions to rank order each series with respect to their attractiveness or appealingness for reading. Each series contained six different amounts of leading, in the same font, justified or unjustified composition. Subjects were told to choose intuitively the "best" and "worst" design first, and then to look for the "best" and "worst" among the remainder, until they arrived at a complete rank order for the set of six stimuli. From these rank orderings, we inferred pairwise preferences, accumulated them over subjects, and analyzed the obtained data pair comparison matrices under assumption of Case V of Thurstone's Law of Comparative Judgment. Table I displays the results of these scaling procedures.

In the second part of the experiment, the same stimuli were used to explore preferences for various combinations of font style, leading, and justified or unjustified composition. However, since 48 stimuli would have been too many to be evaluated by a subject, the whole set was reduced to the 1-, 3-, and 5-point leading items; making a total of $4 \times 3 \times 2 = 24$ stimuli. Out of these we formed eight combinations of four subsets of six stimuli each. These combinations were arranged in such a way that each of the 24 stimuli was, at least once, combined with each other stimulus in the same subset, and each combination contained each stimulus just once. Each combination of four subsets was given to the subjects, under instruction to rank order the stimuli of each of the four subsets with respect to their

BODONI
abcdefghijklmnopqrstuvwxyz

BODONI-KURSIV
abcdefghijklmnopqrstuvwxyz

AKZIDENZ-GROTESK
abcdefghijklmnopqrstuvwxyz

GARAMOND
abcdefghijklmnopqrstuvwxyz

Figure 1. The four typefaces used in the experiments.

TABLE I. *Appealingness scale values for various amounts of leading (comparisons made within each line).*

Typographic Design	*Leading in points*					
	0	1	2	3	4	5
Garamond justified	0	10.9	12.4	11.2	10.5	4.7
Garamond unjustified	0	12.2	15.5	15.8	8.6	2.3
Bodoni Antiqua justified	0	13.5	14.9	14.2	9.3	4.0
Bodoni Antiqua unjustified	0	8.6	13.6	13.2	7.2	4.1
Akzidenz Grotesk justified	0	9.5	17.7	20.6	17.0	12.0
Akzidenz Grotesk unjustified	0	11.8	17.6	19.0	16.0	10.2
Bodoni Kursiv justified	0	8.1	14.1	14.2	10.1	6.0
Bodoni Kursiv unjustified	0	9.4	13.7	13.9	9.3	5.4

appealingness, as in the first part of the experiment. Inferring pair comparisons from these rank orderings gives us a 24 × 24 pair comparison matrix, with at least ten judgments in each cell (and more in some cells, because the subsets of stimuli had to overlap in order to make sure that every subject saw the whole set, as a constant frame of reference). An analysis of this data matrix under assumption of Case V of Thurstone's Law of Comparative Judgment resulted in the scale values reproduced in Table II. (For better convenience and avoidance of negative numbers, the lowest scale value was added to all figures, and they were multiplied by ten.)

An inspection of the results in Tables I and II reveals that the different typefaces need different amounts of leading to be considered most attractive by readers. The highest scale value was obtained with 2-point leading for Bodoni Antiqua both justified and unjustified, and for Garamond justified, and with 3-point leading for Garamond unjustified (although the differences from the scale values with 2-point leading are negligibly small); whereas Bodoni Kursiv (italic) and Akzidenz Grotesk (sans serif) required 3-point leading both for justified as for unjustified composition. This result was partly expected: the hypothesis was that Akzidenz Grotesk would require more leading since it lacks the bottom line of serifs, and has shorter ascender and descender heights.

Differences between typefaces, and between justified and unjustified composition, cannot be interpreted in Table I since each of its rows is based on a different set of data. They can, however, in Table II which shows that there are rather strong preferences for the roman types Garamond and Bodoni Antiqua over Akzidenz Grotesk (sans serif) and Bodoni Kursiv (italic). Three-point leading is judged best in all typefaces except for Akzidenz Grotesk where even 5-point leading is considered slightly better than 3-point (which contradicts the results from the first part of the experiment, Table I, and may be due to sampling error). The differences between scale values for different typefaces, and for different amounts of leading proved significant at the .001 level in an analysis of variance, the interaction of these two factors was significant at the .05 level.

We cannot draw too strong conclusions from this experiment. The number of subjects was small—most of the inferred pair preferences in the second part based only on ten subjects—and it is hard to say

TABLE II. *Appealingness scale values for various combinations of typeface, composition, and leading (overall comparisons).*

Typographic Design		*Leading in points* 1		3		5		*Row average*	
Garamond	justified	10.9		15.2		11.1		12.4	
			10.2		15.9		11.2		12.4
	unjustified	9.5		16.6		11.2		12.4	
Bodoni Antiqua	justified	11.6		11.1		10.4		11.0	
			8.9		12.5		10.3		10.5
	unjustified	6.2		13.9		10.1		10.1	
Akzidenz Grotesk	justified	0		7.9		8.8		5.5	
			0.8		9.3		9.9		6.6
	unjustified	1.5		10.6		10.9		7.8	
Bodoni Kursiv	justified	1.4		5.7		5.5		4.2	
			1.8		6.3		5.7		4.6
	unjustified	2.2		6.8		5.9		5.0	
Column average			7.2		14.6		11.3		

justified: 8.3

unjustified: 8.8

how far our findings can be generalized for other typefaces and situations. What is left to summarize is: (1) different typefaces need different amounts of leading to allow the composition of most appealing printed pages; (2) sans-serifs and italics may need one point more leading than roman types; (3) unjustified composition requires neither more nor less leading than justified composition, and (4) neither of these two styles of composition is considered more attractive than the other.

REFERENCES

Burt, C. A psychological study of typography. *Brit. J. Statistical Psychology*, 1955, *8*, 29–57. [Also, Cambridge (Engl.): University Press, 1959].

Gerstner, K. *Programme entwerfen*. Teufen (Switzerland), 1963.

Guildford, J. P. *Psychometric methods*. New York: McGraw-Hill 1954.

Ovink, G. W. *Legibility, atmosphere and forms of printing types*. Leiden: Sigthoff, 1938.

Pyke, L. R. *The legibility of print*. Medical Research Council, Special Reports, 1926, 110.

Pyke, L. R. *Reports of the Commission on the Legibility of Type*. London: H.M. Stationery Office, 1926.

Tinker, M. *Legibility of print*. Ames: Iowa State Univ. Press, 1963.

Tinker, M. Reader preference and typography. *J. Appl. Psychol.*, 1942, *26*, 38–40.

Zachrisson, B. *Studies in the legibility of printed text*. Stockholm-Göteborg-Uppsala: Almquist & Wiksell, 1966.

Designing the Initial Teaching Alphabet in Five Typefaces

Arleigh Montague

Although use of i.t.a. (Initial Teaching Alphabet) in schools is growing, its use in printed materials is handicapped by inadequate adaptation to typeface designs. This study involved designing the i.t.a. alphabet for five well-known typefaces: Century Schoolbook, Baskerville, Melior, Helvetica, and Optima. The process is briefly described and the new alphabets are illustrated.

The Initial Teaching Alphabet, or i.t.a., is an interim alphabet designed to improve the learning of reading. Based on the phonetic alphabet, the i.t.a. consists of 44 symbols. This new alphabet was developed in England about ten years ago by Sir James Pitman and researched by the University of London Institute of Education in association with the National Foundation for Educational Research. The research work was carried out under the direction of Dr. John Downing; see also his report in this Journal, "Methodological Problems in Research on Simplified Alphabets and Regularized Writing-systems," April 1967, pp. 191–198. Sir Isaac Pitman, Sir James' grandfather and creator of the shorthand system which today is most used worldwide, had in the mid-nineteenth century developed the basis for the i.t.a. with an alphabet, called fonotypy, based on the phonetic alphabet which was tested in American schools between 1852 and 1860. Sir James in the middle of this century, with the help of the Monotype Corporation, went further to create i.t.a., an extended version of the roman alphabet which still claimed a phonetic base, but eliminated the learning of a completely new set of symbols when the child advanced to traditional orthography.

There are now 59 British, American, Canadian, and Australian publishing houses who have published literature or texts in the i.t.a. in fourteen beginning reading schemes. Yet among these can be found only three different faces of the alphabet: the original face, Monotype Ehrhardt, which is in the Caslon family another serif face, an improvement over the first, which seems also to be a member of the Caslon family; and one sans-serif face generally used in workbooks which is not uniform and may be a hand-lettered or constructed form since I have not been able to locate its source. In addition, the IBM, Imperial, Olympia, Remington Rand, and Smith-Corona typewriter companies are producing various sizes of the alphabet. Before i.t.a. will be used generally, it must be available in a variety of well-designed typefaces so that designers will consider using it.

Before beginning the selection of typefaces or actual character creation, the alphabet was examined in the original and most used typeface, Monotype Ehrhardt (Fig. 1). Of the 44 characters, 24 are retained from the regular 26-letter roman alphabet. The q and x are dropped because the sounds associated with these letters can be accomplished using other letters. Twenty "new" symbols complete the alphabet; of these, 14 are direct combinations of present letters, six are new characters.

There are many inconsistencies in the alphabet. Where letters were directly combined to form a new symbol, little or no visual correction was made to bring the thick and thin relationship of the face back into balance. In some cases the new letter form created by the juncture of two others, or the completely new symbol, was simply inconsistent to the basic alphabet itself.

There are no capital letters as separate symbols in i.t.a. Instead, capitals are enlarged lower-case letters which are placed with the body of the large letter centered vertically with the body of the regular lower-case letter, thus slightly below the line. And the "capital," because of its enlargement, is obviously more bold.

For my research five typefaces were chosen, each totally different from any other, but all recognized as good faces and in wide use in publications. The original i.t.a. is a serif face, and I felt that an emphasis on serif faces was necessary to demonstrate alternatives to the present face; I chose a schoolbook face now frequently used in non-i.t.a. books for children, Century Schoolbook. Baskerville was chosen because of its proven flexibility to style through the years.

Melior was selected because its uniformity contributes to its legibility. In addition, it holds up visually in the wide range of type sizes used in educational publications and materials. Helvetica was

the choice for a sans-serif face because of its good visual correction and its wide popularity among designers. As an intermediate between serif and sans-serif, Optima was included.

Once the typeface choices were made, the procedure was briefly as follows: the faces were set in traditional alphabets in lower-case in the numbers of particular letters needed for combinations and generation. Also, several letters were "flopped" for this purpose. Through paste-up of these I arrived at general characters, or in some cases developed units to be used in formulation of characters at a later step. From this point the creation of characters was a process of making Kodalith negatives, contact prints from these, touching up at both stages, and repetition of this procedure many times enlarging the faces for easier manipulation and for more crisp final reductions. There were 21 symbols created for each alphabet (20 for Helvetica because its g conforms as it is to the i.t.a. form).

I could not pretend to correct all faults of the alphabet in the new typeface versions, for some of these inconsistencies are inherent with the nature of the letterform itself. Correction could not be made without creating and substituting a completely new symbol. In the forms where this was the case, correction was made to improve its appearance as a part of the face.

Once all characters were individually resolved, each was tested within a word or words in order to work out visual problems unforeseen when working with the symbols alone. Using words which contained one or more of the new characters, each of the new symbols was tested both in enlargement and in reduction. After making these corrections, I prepared clean photostats and turned the project over to the typesetter who photographically reduced the symbols to a point size commensurate with sizes in which the face is presently available. These were pasted up as full alphabets.

At this point i.t.a. became available in five new typefaces. At present these can be set photographically, and the design exists for development of the alphabet in other less expensive methods.

The new faces do not make allowance for capitals. Capitals under the i.t.a. system could be developed by redesigning each letter, enlarged but less bold than the same symbol actually enlarged. And the capitals should be placed on the base line of the regular type rather than vertically centered.

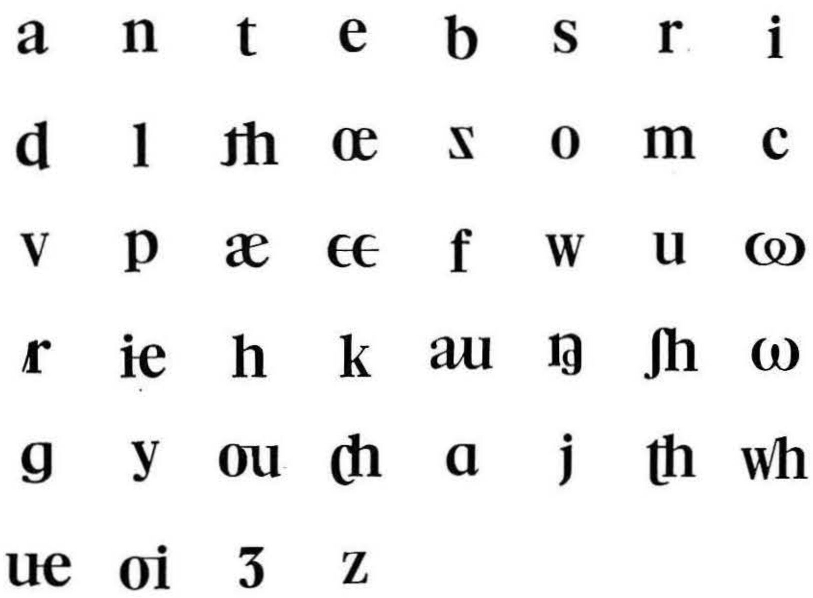


Figure 1. The original i.t.a. typeface, Ehrhardt.

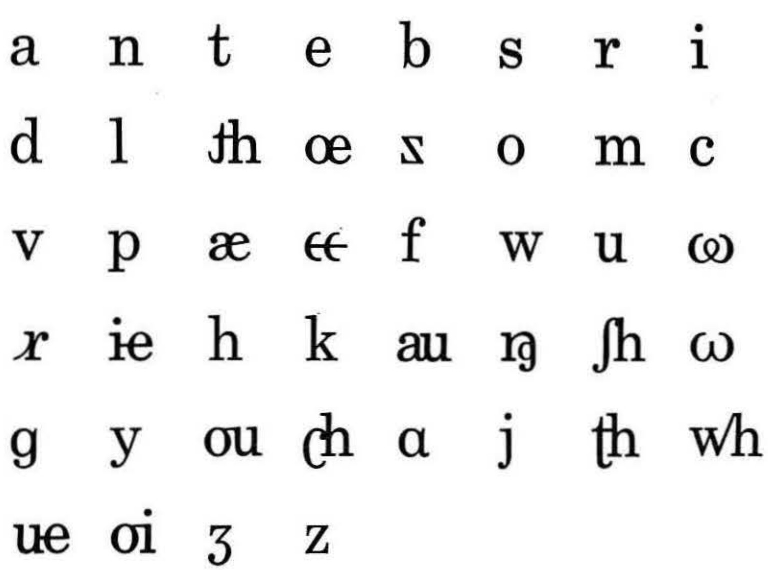


Figure 2. The i.t.a. alphabet based on Century Schoolbook.

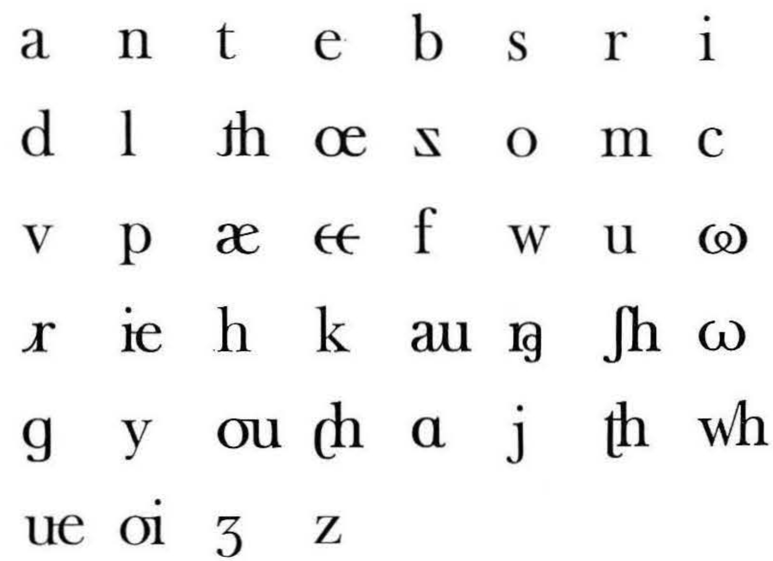


Figure 3. The i.t.a. alphabet based on Baskerville.

Figure 4. The i.t.a. alphabet based on Melior.

Figure 5. The i.t.a. alphabet based on Helvetica.

Figure 6. The i.t.a. alphabet based on Optima.

Speed-reading Made Easy

W. S. Brown

This paper advocates and illustrates an unusual typography, which promises to make speed reading easier, faster, and more reliable. It is suggested that computers be used to prepare text in this form.

Most normal readers move their eyes across the page from left to right once for each line of text. In this mode the brain is sometimes able to process the information more rapidly than the eyes are able to transmit it. As a result the mind may wander, and there may be a significant loss of comprehension.

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The key to speed-reading, as taught in certain popular courses, is to take in several lines of text during each pass across the page. When this is done, the words are not transmitted in the proper order, and therefore the brain must either rearrange them or understand them out of order. To achieve still greater speed, the eyes pass from left to right with a downward slope, and the omitted regions are picked up on the return. Normal readers who receive training in speed-reading are often able to improve their reading speeds by factors of four or five, with equal or greater comprehension.

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Poulton[1] contends that speed-reading is accomplished not by storing information faster, but by seeing it faster and storing less of it. In his view the skill is in selecting the appropriate information to store.

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Whatever the explanation for its effectiveness, speed-reading ought to be facilitated by any typography which permits the reader to absorb more words per fixation while reading them in their natural order. Many nonstandard typographies have been proposed,[2] including the vertical arrangement of words in columns as illustrated in the next sentence.

This is an example of vertical typography.

The present proposal is an apparently original compromise between the vertical and horizontal typographies.

—

A complete $8\frac{1}{2}$ inches by 11 inches page of conventional single-spaced typewritten text contains about four thirds as many words as a complete page of text in this form. However, in the former case the page consists of 48 lines of length $6\frac{1}{4}$ inches, while in the latter case it consists of 5 columns of length 8 inches. Thus the potential gain in words per fixation is a factor of

$$\frac{3}{4}\cdot\frac{48\cdot25/4}{5\cdot8}$$

or approximately 5.6.

—

To test whether this new typography really does improve visual efficiency, comparative studies of speed, comprehension, and eye motion will be required. The negative results of Coleman and Hahn[3] concerning vertical typography may or may not be relevant, but in either case they are inconclusive since experienced readers may require considerable unlearning to profit from the new typography, while beginning readers (children) may not be able to read more than one word per fixation, no matter what the typography.

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It is important to realize that the

possibility of using computers in the preparation of typed and printed documents has transformed the study of alternative typographies from an amusing diversion into an important practical undertaking. In many situations there are other potent reasons for involving the computer, and the advantages of speed-reading may well provide a decisive push in that direction.

—

Acknowledgment

The author wishes to thank Leon D. Harmon, Paul L. Richman, and Saul Sternberg for stimulating and very helpful discussions. He also thanks H. Wayne Gustafson, Ernest Z. Rothkopf, Saul Sternberg and Merald E. Wrolstad for calling his attention to the references.

1. E. C. Poulton, "Rapid Reading," *Journal of Documentation* (London). *19*, (1963) 168–172.

2. Herbert Spencer, *The Visible Word*, Hastings House, 1969.

3. E. B. Coleman and S. C. Hahn, "Failure to Improve Readability with a Vertical Typography," *Journal of Applied Psychology*. *50*, (1966) 435–436.

Legibility Research Abstracts

To facilitate and stimulate international research into legibility problems, the Legibility Research Committee of the Association Typographique Internationale[1] will start publication in 1970 of *Legibility Research Abstracts*. Legibility research will be broadly interpreted to mean scientific research which has examined the effects of the physical characteristics of a visual message and of the reading conditions upon the response of the reader to the message.

Legibility Research Abstracts will report on nearly 100 journals published throughout the world on subjects ranging from physiology, psychology, and education to optics, printing technology, and graphic design. It will also report on legibility research sponsored by government departments or private firms and institutions. A short bibliography will list new books which add to knowledge of this subject.

The editor will be Jeremy J. Foster, who will welcome any suggestions for the operation of this service; letters should be sent to him at the School of Advanced Studies, Manchester College of Art and Design, All Saints, Manchester 15, England. Mr. Foster will work with a steering committee presided over by Bror Zachrisson, Stockholm, and comprising John Dreyfus, Herbert Spencer, and Alison Shaw, all of London, and Merald Wrolstad, Cleveland.

Initially, *Legibility Research Abstracts* will be circulated as a supplement to *The Journal of Typographic Research* without charge. Separate subscription arrangements will be introduced in 1971 for readers who wish to continue this service, and for new subscribers who do not take the Journal.

1. Creation of the ATYPI Legibility Research Committee was described in this Journal: II (July 1968), 271–278.

Comment: Voice, Print, and Culture

Walter J. Ong

Man communicates through all his senses, and in ways so complicated that even at this late day many, and perhaps most, of them have never been adequately described. But in some mysterious fashion, among all forms of communication—through touch, taste, smell, sight, or what have you—communication through sound is paramount. Words have a primacy over all other forms of communication. No matter how familiar we are with an object or a process, we do not feel that we have full mastery of it until we can verbalize it to others. And we do not enter into full communication with another person without speech.

Speech is essentially a spoken and heard phenomenon, a matter of voice and ear, an event in the world of sound. Words are sounds. Written words are substitutes for sound and are only marks on a surface until they are converted to sound again, either in the imagination or by actual vocalization.

We know this, but we find it almost impossible to grasp its full implications. The spoken word has become entangled with writing and print. When we talk about words, we are seldom sure whether we mean spoken words or written words or printed words or all of these simultaneously.

We have to make a supreme effort today to establish a sense of vocalization as such. And yet, if we lack this sense, we cannot understand the development of communications systems in any real depth. For this reason, to get to the roots of our condition today, we must indulge in a little history.

Communication leading to technological culture has passed through three more or less clearly defined stages in the media by which the word is transmitted. The first is the spoken or the voice-and-ear stage, when all verbal communication was simply oral. The second is the chirographic-typographic stage or script-and-print stage, which begins with writing, most particularly the alphabet, and reaches its fullest development with the invention of movable alphabetic type. The third is the electronic stage, in which we at present live.

If man has been on earth for 500,000 years—a pretty good working figure—he has been in the first or oral stage of the word for almost his entire existence. Writing is new: the first scripts date from only around 3,500 B.C., less than 6,000 years ago, and the alphabet (which was invented only once) from around 1500 B.C. Alphabetic type is about 500 years old. We entered the third or electronic age not much more than 100 years ago with the telegraph. These are tiny denominations in a 500,000-year history of mankind.

It is common to view these stages in terms of the accumulation and diffusion of knowledge. A purely verbal culture could not accumulate its experience effectively at the conscious level. Certain of the new inventions, most notably writing, print, and finally electronic computers, make it possible to record knowledge, to "save" it. These same inventions as well as others, too, have implemented diffusion. In this view, our communications system is different from that of primitive man and better than his because we have a greater quantity of knowledge and can convey it more easily to a larger number of persons.

This is true, but such a view provides only a superficial understanding of the development of communications media. We know now that when changes in the media take place, the psychological structures or personality structures in a culture also change. Oral cultures are traditional and tribal. In them, knowledge develops slowly. Oral cultures must invest their efforts not in development of new knowledge but in retaining what knowledge is had. Without written records, knowledge threatens constantly to slip away. Words are always thought of as fleeting, vanishing—Homer calls them "winged words"—for they are thought of only as sounds, which of course is what words really are.

In an oral culture, there is no way to look up anything, when anyone was born or died, when a battle was fought, who won the battle, who is descended from whom. All one can do is ask someone, and if he does not know, someone else. Knowledge would go out of existence if bards did not constantly sing about it and if the people did not constantly pass around by word of mouth what they know. Proverbs and memory formulas are used by everyone. Thinking means speaking and listening to others speak. The result is a certain kind of personality structure, highly communal, externalized in a way, and conservative. Oral cultures have few if any original thinkers or discoverers. Everyone's thought must develop more or less with that of others. No one can get ahead of the tribe.

Writing, and particularly alphabetic writing, alters all this. Writing gradually changes man from a traditionalist, dominated by communal forces, to a more interiorly driven, reflective, and analytic individual. In an oral culture, the only way to "study" was to listen to someone who could talk. In a chirographic or writing culture, a manuscript culture, one could study all alone without any sound at all, with only a book. In this setting, individuals began to "think for themselves," and eventually original discoverers were developed—Aristotle, Duns Scotus, Galileo, Einstein, and all the others who learned by reading as well as by hearing.

But change was slow. Oral habits lingered long after the invention of writing. The ancient Greeks and Romans wrote a good deal, but they retained as their cultural ideal the orator or public speaker. Cicero spoke his orations first and wrote them afterwards. Into the Middle Ages, reading was commonly done aloud, even when one was reading to oneself. Although medieval universities used a great deal of writing in taking notes and preparing lectures, they did not use writing to test knowledge. Testing was done in an oral disputation or other oral trial. But if they were strongly oral still, the Middle Ages were also far more chirographic than classical antiquity, for their educational system had become largely a commentary on written books.

The aloneness of reading withdrew man from the world of sound into a world of silent space. Words remained indirectly sounds—one had to imagine what the words sounded like to understand reading but, deployed on the written page, writing itself made no noise. Withdrawal into the world of silent space was reinforced by the most remarkable writing system of all, the alphabet, the strange script which was so hard to invent that it was invented only once. There are many different non-alphabetic systems of writing, or scripts, often of independent origin. But there is only one alphabet. All the alphabets in the world are in fact adaptations of the original alphabet which appeared among the Semitic peoples around 1500 B.C. The alphabet undertakes to convert sound into space. Sound itself is not only perishable but always actually perishing. Sound exists only when it is going out of existence. When I pronounce the word "existence," by the time I get to the "-tence" the "exis-" is gone, and has to be gone. I can not stop a sound and still have a sound, as I might stop a moving picture projector and have a still picture on the screen. If I stop sound, all I have is its opposite, silence. The alphabet pretends that things are otherwise, that a word is present all at once. It pretends that a word can be chopped up into little pieces maneuverable in space. The letters in a word can even be written backwards and pronounced forwards. The alphabet seems to make sound independent of the one-directional movement of time.

The invention of the alphabet letterpress printing in mid-fifteenth century Europe is simply an extension or intensification of the invention of the alphabet itself. Alphabetic type commits the word to space even more than writing does. Writing makes words by creating marks on surfaces. Alphabetic print makes words out of pre-existing things—types, which are stored like nails or bricks in boxes—and made up into forms as bricks are made into houses.

The emergence of alphabetic typography was associated with a great intensification of spatial awareness in the European culture where alphabetic typography developed. The fifteenth and subsequent centuries mark the age of full linear perspective in painting, of maps and the concomitant sense of the earth's surface as a spatial expanse to be covered by exploration, of Copernican cosmology and Newtonian physics, which plotted the universe with charts more than ever before and reduced the old nature philosophy in the physical sciences to ineffectiveness. It was the age which made an issue of observation—that is, of the application of sight, exalting this one sense above all the others.

After the development of print in the mid-1400's, it took several hundred years for the invention to have its full effect in deadening the

original sound world where the word has its natural habitat. By the mid-1800's, the effect of typography was at its maximum. The old verbal culture had been highly personal, non-analytic, dramatic, oratorical, full of hostilities, some natural and others cultivated. The newer chirographic culture, matured by typography, and at long last relatively victorious, to a significant degree depersonalized the world, made "objectivity" an unquestionable ideal.

But twentieth-century man has to a degree left the "objective" world of space once more for new ventures in sound. Electronic communication has realigned the worlds of sound and sight and has brought the former into new prominence. Communication by letter and print is now supplemented and in many areas overwhelmed by the telegraph, telephone, radio, and television, which give sound a new ascendancy. We even catch fish by sonar. Significantly, the physical operations central to all these media, the movements of electrons, lie outside the range of sight.

The new electronic media have changed psychological structures once more. We are living not merely with more information but with information in a different state. Unlike earlier man, we are in constant touch with what is going on everywhere. We live in a world of global happenings. Books give access to what has already happened or else to abstractions and fixed truths. They do not give access to what is going on. Electronic media do. The man in touch with actuality today has constantly running through his head current happenings in Washington, Paris, Moscow, Rome, St. Louis, and any number of other places. All cultures are present within us today simultaneously—if they are not, we are to that extent today unrealized human beings. But our attention is caught not merely in all corners of space . . . it is likewise focused through time in ways unknown to earlier man. We know more history than any earlier age. We are still interiorized by writing. But in the interiorized consciousness of each one of us now, the whole world is jumping. Under such conditions, psychological structures have changed again.

A good deal of talk about the successive stages in the history of communications media suggests that each new stage wipes out the preceding ones. Nothing could be farther from the truth. In fact, a new stage often reinforces preceding ones at the very time it changes their significance by interacting with them. When man began to write, he did not stop speaking. Writing developed first in urban centers, where more talking was doubtless going on than in rural areas. By facilitating communication, writing doubtless further encouraged talking, for the classical addiction to oratory developed after writing in these same urban centers. But if speech was reinforced, at the same time it was no longer what it had been because, first, it no longer monopolized the field of verbal communication and, secondly, because it was now able to achieve a new kind of permanence in script. Gradually, speech began to be colored by modes of expression which could be worked out at first only in writing. The new medium did not wipe out the old but reinforced it and altered it at the same time.

Similarly, the invention of typography reinforced and altered writing. It reinforced writing by making universal literacy urgent as it had never been in a purely chirographic culture. It altered writing because writing no longer monopolized the field of visually stored verbal expression and because the new kind of commitment to space made indexing and other visual means of retrieval feasible on a scale which changed the sort of things being written about. Tabulation and "fact" finding and storage, for example, are favored by print. Writing and thinking for print produces different styles from writing and thinking for chirographic reproduction.

Now that we have entered the age of secondary electronic orality we can observe a certain reinforcement and transformation of print. First it is becoming increasingly imperative that a person be able to typewrite—that is to do a special kind of printing. Secondly, all of the products of our electronic age are not oral, for electronics have already given quite new forms to printing itself: one of the most typical products of the computer is, in fact, called a print-out. And those in touch with present developments assure us that ordinary typography is about to enter upon a new age more electronically controlled than ever before.

Nevertheless, there is some reason for the urge to overstate the effects of new media of communication by pretending that the new media simply wipe out those preceding them. The reason is that most persons consider a new medium to be simply added to the old, vastly underestimating the transformation of old media which the new bring about. Each of the successive new media discussed here interacts so vigorously with what went before that the effects of the earlier media are drastically reconstituted. When new media change psychological structures, the older media themselves operate in new ways.

Much of the malaise in society today, both in the developing countries and in more fully technologized ones, is due to the unfamiliar pressures set up by the new psychological structures. Our problem is understanding these pressures. This means that we must direct massive scholarly effort not only to the present but also to the past, for the problems of modern man are the problems of adjusting the past which is within him with the present which is also there and with the future which promises to be.

Walter J. Ong, S.J., professor of English at Saint Louis University (St. Louis, Mo. 63103), is known as a scholar in both the renaissance field and the field of contemporary culture. His latest book, *The Presence of the Word*, is an historical study of the development of verbal communication from oral cultures through writing and print to electronics. Dr. Ong has lectured widely and is the author of numerous articles in literary and scholarly periodicals.

This article is reprinted, with some additions, from the *Saint Louis University Magazine* and is taken in part from the first chapter of the author's book *In the Human Grain* (New York: Macmillan, 1967).

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Reading the Journal

A discussion of starting points in the issue of April 1969.

Gerrit Noordzij

"A report of the editor" deplores the lack of communication between research and design. It might be worth while to seek out the nature of this misunderstanding. Scientists say what design ought to be, the following notes say what research ought to be from a designer's point of view. By shaking some passages of articles in the same issue of April, 1969, I use the Journal as an intellectual battleground. I don't know if this is, as the editor says, scholarly research but it may be more palpable than a general contemplation.

Barbara S. Bartz: Type variation and the problem of cartographic type legibility.

Quotation: Perhaps the most common use of a type characteristic which might be considered a quality analogy is the very traditional use of italic type for labeling various classes of hydrographic features. There seems to be fairly general agreement that this type came to be used in this fashion because it looks wavy and more "flowing" than other forms of type (p. 132).

Comment: I inspected a collection of old and new atlases for an illustration of this traditional use, but in vain. Sometimes large wet area's are labeled with sloped flourished capitals, but that is not italic.

According to R. A. Skelton (*Decorative Printed Maps*, London, 1965), script in cartography has been chosen according to engraving conditions and fashions in handwriting, and he may be right. But the "easy to write, and exceptionable legible" (Mercator) italic is before all economic. No other script can contain nearly as much information in such a small space as italic. (Of course we cannot consider the ugly distorted letters on duplex-matrices of Linotype and Intertype.)

This is the reason why, since its introduction in cartography, italic has always been the prefered script to label cities, or, generally, localities which are too small to contain the description within their outlines. To get a word in italic, the letters must be crowded. A word in capitals is easily overcrowded. Capitals require generous spacing, which makes them the appropriate script for the names of countries, mountains, seas, and other vast areas. If the danger of confusion prescribes variations, they should be sought in inclination and color of the letters. Roman and italic offer no alternative for such situations.

The author declares that italic looks wavy and flowing by which it should be associated with water. In malicious people like me, such talk evokes associations with a dense fog.

Quotation: In cartographic literature, legibility is very often an Alice-in-wonderland word, which can mean whatever one decides it should mean. . . . Slogans substitute for fact [. . .] How prevalent such slogans are is illustrated in a 1964 article "Map design and typography." "Scientific investigation has shown sans serif to be the worst of all type styles for word recognition." This is a substitute for fact, but it is not a fact itself (p. 136).

Comment: Readability is likely to be a result of good design and adequate production, not of type, but of text. Not Times New Roman is readable or unreadable, but a newspaper or a book. What is good and adequate depends largely on training and habituation. It seems indeed to be the main conclusion which can be obtained from a comparison of different investigations in readability that readability is a subjective quality. Readability of a script (type) might prove to be something like "understandability "of a language.

Next to this subjective readability I could imagine some more objective legibility factors as, for instance, the balance between assimilation and differentiation of letterforms. According to such a measure, italic might be inferior to roman because different letters look less different in italic. For the same reason italic might be again superior to uncial, etc. Arabic script and Hebrew quadrat might prove to be inferior to Japanese or Latin writing because the units have their main accents in the direction of the writing line. If this comes true, it will not be in favor of sans-serif type. This suspection is a good reason to avoid sans serif. Notably in cartography sans serif is the worst of all

type styles and not only for word recognition: sans-serif D, O, I, 7 interfere with data printed in the same color. But where esthetics are prevailing, they substitute for clearness.

Quotation: Dawson pleads for a return to hand-lettering, and even concludes optimistically: ". . . and it may be that Captain Withycombe's dream of high quality freehand map lettering [. . .] will at least be partially realized in future Australian cartography." In the late 1960's such a remark appears almost medieval (p. 141).

Comment: "Medieval" conveys more of us than of the Middle Ages. Medieval people ate bread, slept in a bed, and made love. However, nobody will call such behavior medieval, because we still do the same things. He who calls a specific skill medieval, apologizes for the lack of that skill by suggesting that it should be obsolete. The quotation does not afflict handwriting in cartography, it only shows the author's incompetency on this subject.

Handwriting has advantages over typographic lettering. Form, construction, scale, and place of the letters can be adapted to the situation of each item. Typographic lettering is not flexible and it takes much more time. When the map with handwriting is printed, the typographic lettering is still to be corrected. Maps to illustrate recent developments in newspapers or on television depend on handwriting. Any doubt about these facts could be taken away by research, for which a preoccupied "medieval" is not a valid substitute.

If we could with reason call something medieval which has been devised in the Middle Ages, the word would not apply to handwriting but to typography. Medieval people are not to blame for it; they would never have tried to substitute handwriting by such a painstaking process if they would have had photography. Why should we stick to it?

Paul A. Kolers: Clues to a letter's recognition: implications for the design of characters.

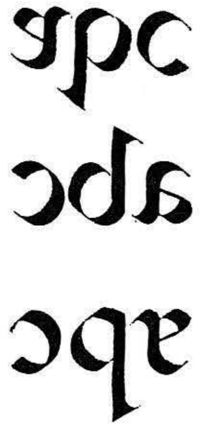
Quotation: The salient fact of the figures is that transformations which may be regarded as geometrically equivalent rotations in space are not equivalent for the reader.

I

and M

take far more time

than R.



[. . .] I do not have a complete explanation for this fact but have offered some conjectures elsewhere (pp. 150–153).

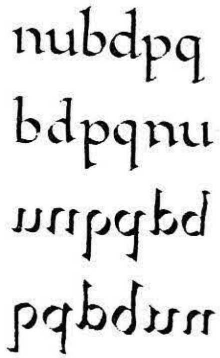
Comment: I wonder in how far the disorientation which slows down reading is due to the choice of the material. The humanistic minuscule (roman lower-case) which has been used for the reading experiments contains a number of letters with relations to each other which resemble the rotations of the experiments:

N

I

M

R



These "pseudowords" are absolutely illegible; they can be deciphered only. The peculiar typeface of the experiments (an extremely bad design by IBM) adds greatly to this chaotic effect by the absence of meaningful contrasts in the letters. As moreover a and reversed e have too much in common to be quickly distinguished in rotations, we can safely say that the majority of the characters as they occur in common English are disqualified for the experiments with reversed and rotated letters. Text in capitals may lead to quite different results. Some scepsis towards Kolers' conclusions is necessary.

Quotation: The conclusion seems clear that typefaces that emphasize bold downstrokes for the Roman alphabet, however elegant the letters esthetically, impede their smooth visual processing. As I have shown, the skilled reader needs to look more to the right than to the left; hence the typeface designer concerned to facilitate reading should emphasize the distinguishing marks of the letter rather than the informationnaly impoverished downstroke. Distinguishing marks appear on a letter's right (p. 164).

Comment: As I have shown, the skilled reader needs not to look more to the right than to the left. And the distinguishing marks are not on the right side of letters. The quoted statement may be true to some extent for capitals, though the "informationally impoverished downstroke" bears the only difference between D and O, D and P, X and K, V and Y, but the capital alphabet is not suited for reading at all.

Reading, understood as grasping words, depends on a writing system in which the word is a clear unity. Writing is designing the medium for reading. Design does not "impede the smooth visual processing" of the alphabet; design is its condition. Design which afflicts communication is bad design; it cannot be esthetically satisfying, but to illiterates.

Quotation: I am told that the designer of letters learns to make his down-strokes heavy and his upstrokes and curves light (p. 160).

Comment: The designer learns writing. Writing results in heavy downstrokes and light upstrokes. Generally this result is called letter. Curves and upstrokes tend to exclude each other: italic has upstrokes but no curves; "roman lower-case" has curves (generally bold, due to the technique of writing) but no essential upstrokes.

Writing is not a series of strokes, but space, divided into characteristic shapes by strokes. In our system of writing these shapes are arranged along horizontal lines. This is effectively done by downstrokes.

More than informationally impoverished, the downstroke might prove to be a pillar of visual communication, of the same importance as the horizontal brushstroke in Chinese writing.

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Résumé de Articles

Traduction: Fernand Baudin

La conception et la lisibilité des signaux routiers par *John Lees et Melvin Farman*
Ce rapport tire les conclusions d'une étude comparative (entreprise à la demande du U.S. Bureau of Public Roads) portant sur les principaux systèmes de signalisation connus dans le monde. Formes, couleurs, symboles, pictogrammes et inscriptions furent examinés en studio, en laboratoire et sur la route. L'enquête fut réalisée par une équipe qui comprenait des psychologues, des ingénieurs et des graphistes. Elle ne négligea pas les autres recherches en cours en ces mêmes matières. L'introduction fait un bref historique du développement de la signalisation routière et de sa réglementation; elle explique aussi les réactions du conducteur au volant de sa voiture.

Les ligatures et la technologie actuelle par *Joseph S. Scorsone*
La composition électronique supprime bien des restrictions quant au nombre des caractères qui peuvent entrer dans une fonte. C'est ainsi que 27 ligatures ont pu être ajoutées au News Gothic et au Century Schoolbook. L'article est illustré.

Le dessin des caractères dans l'ère électronique par *Wim Crouwel*
Autrefois, la typographie était toujours le reflet de la culture contemporaine. Aujourd'hui, elle reflète le passé et pas du tout notre société présente. Or, nous devons penser en termes d'ordinateurs et d'électronique. Comment? C'est ce que nous montre l'auteur, par la parole et par l'image.

Les préférences des lecteurs en matière de caractères et d'interlignes par *D. Becker, J. Heinrich, R. von Sichowsky, et D. Wendt*
L'article examine la part du caractère et de l'interligne dans l'attrait consciemment éprouvé à la vue d'une page imprimée. 80 sujets ont eu à juger 48 caractères tels que le Garamont, le Bodoni, l'Akzidenz Grotesk, romain et italique, en composition justifiée ou non, et interlignée 1, 2, 3, 4 et 5 pts. Ils eurent à exprimer leurs préférences sur 6 colonnes. Les résultats furent mis en parallèle et fournirent une échelle de valeurs pour chaque type de caractère et de présentation. Il n'y eut pas d'écart appréciable dans les préférences en matière de composition justifiée ou non. Mais il apparut clairement qu'il faut varier l'interligne selon le caractère adopté.

L'adaptation du Initial Teaching Alphabet par *Arleigh Montague*
L'usage de l'I.T.A. se répand dans l'enseignement primaire. Mais sa diffusion sous forme imprimée est encore entravée par une adaptation insuffisante des

caractères. C'est à quoi on a remédié dans cinq caractères bien connus : le Century Schoolbook, le Baskerville, le Melior, l'Helvetica et l'Optima.
Les résultats sont montrés et commentés.

Pour faciliter la lecture rapide par *W. S. Brown*
L'article propose et illustre une mise en page inhabituelle. Elle favoriserait une lecture plus rapide et plus sûre. L'auteur invite à programmer des ordinateurs pour ce genre de composition.

Kurzfassung der Beiträge

Übersetzung : Dirk Wendt

Eine Untersuchung über Entwurf und Brauchbarkeit von Vorrichtungen zur Verkehrsregelung von *John Lees und Melvin Farman*
Dieser Aufsatz berichtet von einer Studie (durchgeführt im Auftrage des *United States Bureau of Public Roads*), in welcher Vergleichsuntersuchungen zwischen den Entwurfselementen der wichtigsten Verkehrszeichen-Systeme der Welt vorgenommen wurden. Form, Farbe, Symbole, Bilddarstellungen und verbale Informationen wurden in Entwurfs-Übungen, Laboratoriums-Untersuchungen und in Straßentests untersucht. Die Studie—durchgeführt von einem interdisziplinären Team aus Psychologen, Ingenieuren und Graphikern—enthält auch ein ausführliches Literaturreferat bereits vorhandener Forschungsergebnisse über Verkehrszeichen. Die Einführung untersucht die Entwicklungsgeschichte von Verkehrszeichen und -vorschriften ebenso wie die Vorgänge der Informationsverarbeitung beim Autofahrer.

Entwurf von Ligaturen für die heutige Satztechnik von *Joseph S. Scorsone*
Die Satzherstellung mit Hilfe von Computern hat die Beschränkungen aufgehoben, die in der Begrenztheit des praktisch lagerbaren Vorrates eines Schriftschnittes begründet waren. Ein System von 27 Ligaturen als Zusatz zu Grotesk- und Antiqua-Schriften wurde entworfen. Die Entwicklung der Ligaturen in den Schriften *News Gothic* und *Century Schoolbook* wird gezeigt und diskutiert.

Schriftentwurf für das Computer-Zeitalter von *Wim Crouwel*
Obwohl die Typographie immer die kulturelle Struktur ihrer Zeit widergespiegelt hat, entsprechen die heutigen Schriften und typographischen Entwürfe der vergangenen, nicht der heutigen Gesellschaft. Wir müssen in Begriffen unserer elektronischen Medien und gegenwärtigen Ausdrucksformen denken. Ein Ansatz zum Entwurf in der heutigen Typographie—basierend auf einem untergelegten Zellen- oder Einheiten-System—wird vorgeschlagen und diskutiert.

Leser-Entscheidungen für Schriftart und Durchschuß von *D. Becker, J. Heinrich, R. von Sichowsky, und D. Wendt*
In diesem Aufsatz werden die Einflüsse von Schriftart und Durchschuß auf die empfundene Attraktivität einer gedruckten Seite untersucht. Achtzig Versuchspersonen beurteilten die Attraktivität von 48 typographischen Entwürfen, die in Schriftart (Garamond, Bodoni, Antiqua, Bodoni Kursiv, Akzidenz Grotesk), in Blocksatz vs. Flattersatz und im Durchschuß (0, 1, 2, 3, 4, 5 Punkt) variierten. Zur Beurteilung erstellten die Versuchspersonen Rangordnungen über Teilgruppen von je sechs Vorlagen. Auf die Daten wurde eine Skalierungs-Technik angewandt (Paarvergleich) und ergab Skalenwerte für sämtliche Vorlagen. Es ergab sich kein bedeutsamer Unterschied zwischen den mittleren Skalenwerten für Block- und Flattersatz, aber die verschiedenen Schriftarten erforderten unterschiedliche Durchschuß-Stärken, um den Satz möglichst attraktiv erscheinen zu lassen.

Entwürfe für das Lese-Anfänger-Alphabet in fünf Schriften von *Arleigh Montague*
Obwohl das Anfänger-Lesealphabet in den Schulen zunehmend verwendet wird, ist sein Gebrauch in Drucksachen durch unzureichende Anpassung an den üblichen Stil des Schriftentwurfs behindert. Diese Arbeit enthält Entwürfe für das Anfänger-Lesealphabet in fünf gut bekannten Schriften : *Century Schoolbook*, *Baskerville*, *Melior*, *Helvetica* und *Optima*. Der Vorgang wird kurz beschrieben, und die neuen Alphabete werden gezeigt.

Schnellesen—leicht gemacht von *W. S. Brown*
Dieser Aufsatz befürwortet und illustriert eine ungewöhnliche Typographie, die das schnelle Lesen leichter, schneller und zuverlässiger zu machen verspricht. Es wird angeregt, Computer zur Vorbereitung von Texten für diese Form zu verwenden.

This number of *The Journal of Typographic Research* has been composed in Monotype Baskerville types and produced by W. and J. Mackay & Company Ltd., of Chatham, England, on Bowater B20 Cartridge, Double Royal 84½ lb. The layout is based on the original design by Jack Stauffacher of the Greenwood Press, San Francisco.

Announcements

Colin Clair. *The Chronology of Printing*. 1969, 228 pages, index. $12.50.
Praeger Publishers, Inc., 111 Fourth Avenue, New York, N.Y. 10003.

A compendium of key facts in the history of printing, this book covers topics from the invention of printing, its practitioners and spread throughout Europe and the world, to the history of printing machinery, type founderies, type design and letterforms, technical processes, and book and newspaper illustration.

M. Faiman and J. Nievergelt (editors). *Pertinent Concepts in Computer Graphics*. 1969, 448 pages, 198 illustrations. $12.50.
University of Illinois Press, Urbana, Illinois 61801.

These 22 papers, comprising the proceedings of the 1969 second national conference on pertinent concepts in computer graphics, cover up-to-the-minute research on a broad class of interests ranging from devices through techniques (both hardware and software), systems, applications, and underlying principles.

Stanley Morison. *On Type Designs Past and Present*. 1962, 80 pages, 59 illustrations. $3.00.
John de Graff, Inc., 34 Oak Avenue, Tuckahoe, N.Y. 10707.

Concise history of the evolution of typography first published in 1926 and now reissued. English, French, German and American designs are discussed and there are more than 50 illustrations of typefaces.

Raymond Roberts. *Typographic Design*. 1966, 200 pages, 53 illustrations, bibliography and index. $7.50.
John de Graff, Inc., 34 Oak Avenue, Tuckahoe, N.Y. 10707.

A handbook of the choice of type in book production and advertising. A useful reference book for designers.

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The Authors

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