

A Schema for the Study of Graphic Language (Tutorial Paper)

Michael Twyman

This paper presents a schema that attempts to embrace all graphic language. The essence of the schema is shown in a matrix which presents a number of theoretical possibilities in terms of approaches to graphic language. One axis of the matrix describes the methods of configuration of graphic language, using such terms as pure linear, linear interrupted, list, linear branching, matrix, non-linear directed, non-linear open. The other axis describes the modes of symbolization of graphic language, using four somewhat crude categories: verbal/numerical, pictorial and verbal/numerical, pictorial, schematic. Numerous examples are shown to clarify terms and the underlying concepts they describe. It is emphasized that the matrix is a device for directing thinking, rather than a means of defining graphic language.

The paper is written from the standpoint of a practising graphic designer. The matrix is used to illustrate the wide range of approaches open to us in graphic language and the effect this is assumed to have on reading/viewing strategies and cognitive processes. It is suggested that the matrix is useful in focusing attention on two fundamental questions that ought always to be asked when deciding how a graphic message should be communicated: What should be the mode of symbolization and what should be the method of configuration? Legibility and related research is briefly reviewed in order to establish what light it throws on these questions; with a few notable exceptions it is found wanting. It is suggested that there is a need for more research that crosses the boundaries of the cells of the matrix.

This paper is not the culmination of a sustained programme of research and brings no firm evidence to bear on any aspect of graphic language. It is the contribution of a graphic designer who has had the opportunity of associating with research workers concerned with the evaluation of graphic language, and is written as a tutorial paper to stimulate thought and discussion. It is an attempt to define the scope of graphic language and to show relationships between different approaches to it that have been, and can be, used. Throughout the paper, the totality of graphic language and its specifically graphic variables are emphasized. Though the approach may appear to be somewhat theoretical, it is intended that it should have practical implications.

For the purpose of this paper "graphic designer" means someone who plans graphic language; "graphic" means drawn or otherwise made visible in response to conscious decisions, and "language" means a vehicle of communication. The graphic designer is usually seen as someone who operates between those with messages to transmit and those to whom they have to be communicated; in this respect he is the graphic equivalent of the radio producer. The graphic designer may not always be a professional however and, whether lay or professional, he may on occasions be the originator of the message. It should be stressed therefore that the term graphic designer is used here to refer to anyone who plans graphic language.

While all of us use graphic language as originators and consumers, very few of us are aware of how it should be planned so that it can be most effective. In this respect, as in many others, graphic language differs from oral language, which is either not consciously planned at all - as in most conversational situations - or is planned by those who engage in public speaking with a reasonable understanding of what they are doing. Our experience of planning graphic language - unless we have special problems, such as those presented by the preparation of a table for a scientific paper or a hand-made notice for a jumble sale - probably ended at school when we learned how to organize a letter, address an envelope, or set out a sum in mathematics. Most of those who use graphic means of communication professionally in everyday situations involving continuous prose merely pass on their problems to their typist who does the planning for them. In more complex areas of graphic communication, particularly when the message is non-linear, the originator has less control over the graphic presentation of his message and frequently relies on a specialist draughtsman, cartographer, or typographer. This is a situation that has few parallels in oral language.

Outline of Objectives

The principal objective of this paper is to demonstrate by means of a schema the wide range of approaches open to us in graphic language. The proposed schema, which is presented in the form of a matrix, draws attention to the different modes and configurations of graphic language and is firmly rooted in practical applications. It is relevant to consider a schema of this kind - though not necessarily the one proposed - for both practical and theoretical reasons. In practical terms it is important because a schema which presents graphic language as a whole has the value of drawing attention to the variety of approaches available when using graphic language and defines those areas where decisions have to be made. All this is made necessary because our training and experience, whether primarily verbal, numerical, or visual, tends

to predispose us towards particular approaches to graphic communication. In more theoretical terms, the overall pattern presented by the schema enables us to see points of connection between different areas of graphic language that are normally seen as discrete and that our traditional attitudes and terminology encourage us to keep separate.

The secondary objectives of this paper stem directly from the first. The matrix will be used as a means of identifying, in a very general way, those approaches to graphic language that are most commonly adopted. It will also be used to consider the extent to which legibility and related research has responded to the real needs of those making decisions about graphic language.

The schema does not pretend to be watertight, and some of the boundaries between the cells of the matrix are drawn subjectively. The fact that some kinds of graphic language do not fit perfectly within the matrix serves only to highlight the subtlety and flexibility of graphic language. This should not invalidate the schema itself, which is intended as a device for directing our thinking and not as an end in itself.

Fragmentation of the Study of Graphic Language

Over the last few years I have attempted to develop approaches to the description of graphic language. In this respect I have taken a leaf out of the book of linguistic scientists, many of whom believe that description is a necessary prelude to understanding. Certain aspects of graphic language have, of course, been extremely well covered from a descriptive standpoint. The characters of the Latin alphabet, for instance, have been minutely studied: there are numerous classification systems designed to accommodate thousands of different styles of letter forms (most of which are not even noticed by the layman), and a precise language has been developed to describe the various parts of letters and their related characters. All this can perhaps be compared with phonetics as a branch of linguistics. There is also a vast literature which focuses on the iconography of that part of graphic language we call art, and traces subtle stylistic influences of one artist or school on another. This activity might be seen, at least in some respects, as akin to literary criticism.

These two aspects of graphic language have been chosen to highlight the diversity of the field and of the activities of those who work within it. Those who study letter forms in the manner described above are likely to be practising typographers or historians of printing; those who study the iconography of paintings are likely to be art historians. Though related to one another in that both are concerned with forms of graphic language, the two disciplines hardly interact. To a large degree the same must be said of other fields of scholarship concerned with graphic language within a theoretical framework, such as semiology, psychology, topology, anthropology, palaeography, linguistic science, and cartography.

The Matrix

The proposed schema is based on the matrix (Figure 1) which presents a number of theoretical possibilities in terms of approaches to graphic language. The column headings describe what have been called methods of configuration, by which is meant the graphic organization or structure of a message

Method of configuration

	Pure linear	Linear interrupted	List	Linear branching	Matrix	Non-linear directed viewing	Non-linear most options open
Verbal/numerical	1	2	3	4	5	6	7
Pictorial & verbal/numerical	8	9	10	11	12	13	14
Pictorial	15	16	17	18	19	20	21
Schematic	22	23	24	25	26	27	28

Mode of symbolization

Figure 1. The matrix.

which influences and perhaps determines the "searching," "reading," and "looking" strategies adopted by the user. There is no accepted terminology in this field, apart from the headings "list," "linear branching," and "matrix," which will be readily understood. The division between the two headings to the extreme right of the matrix, "non-linear directed viewing" and "non-linear most options open" (shortened henceforth to "non-linear directed" and "non-linear open") is highly subjective and is therefore indicated by a dotted line. In reality the two categories, which are shown as discrete items in the matrix, form a continuum. There are elements of linear reading in some of the "nonlinear directed" categories, but the heading serves to emphasize that the principal searching strategy is non-linear. The most important general characteristic presented by the column headings is that they show a transition from pure linearity on the left to extreme non-linearity on the right.

Column headings have been limited to major categories since the main aim of this paper is to concentrate attention on a few central issues. It would not have been difficult to subdivide some of these major categories. For instance, the heading called "linear interrupted" could be further divided according to whether all reading was in the same direction (i.e., left to right, or right to left), or whether it was to be done boustrophedon (as the ox ploughs). Within each of these categories the interruption of the linear flow may be made on the following grounds:

- 1) semantically (with the lines broken only after linguistic units, the smallest such unit being the word)
- 2) quasi-semantically (with the lines broken only between words or within words according to etymology)
- 3) partially semantically (with the lines broken between words or within words either phonetically or arbitrarily)
- 4) mechanically (with words broken at the most convenient point, regardless of meaning).

Even within these four categories there are different ways in which these line endings may be achieved, and most of these can be found in everyday use. It is clear, however, that little is to be gained by producing a matrix of such complexity that it would be understood only by its originator or those prepared to spend an inordinate amount of time studying it.

The row headings describe the modes of symbolization. This is a fairly crude breakdown of modes, especially in relation to those sections that relate to pictorial language. The subject is one that has attracted considerable attention from semiologists over the last few decades, particularly in relation to iconic and symbolic images, but such issues are not central to the theme of this paper, which is more concerned with the relation between mode of symbolization and method of configuration. It should be said that it is more difficult to establish a distinction between pictorial and schematic modes than between the other categories on this axis; for this reason the division between them is indicated by a dotted line. A number of additional headings could also have been introduced on the axis of the matrix. A "numerical" mode might have been included as a separate category from "verbal/numerical"; in addition, it might have been valuable to introduce a combined "schematic and verbal/numerical" category and to distinguish between discrete pictorial symbols and unified synoptic pictures. However, it was felt that such additions

to the matrix would have blurred an important issue – the conflict in reading/viewing strategies that arises from the linearity of the verbal mode and the non-linearity of both the pictorial and schematic modes.

In other respects, too, emphasis has been placed on ease of understanding. Most obviously the matrix, as presented, takes no account of sequences in time as seen in film and television; nor even of the interrupted sequences in time presented by pages of a book or sets of slides. Such approaches could have been accommodated by adding a third dimension to the matrix, but at the expense of clarity. Similarly, a number of the graphic variables isolated by Bertin (1967) – such as size, tone, texture, colour, and shape – are not specifically catered for. These can, and should, be considered in relation to all the combinations of modes of symbolization and methods of configuration presented in the matrix.

The Cells of the Matrix

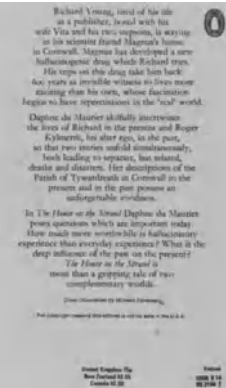
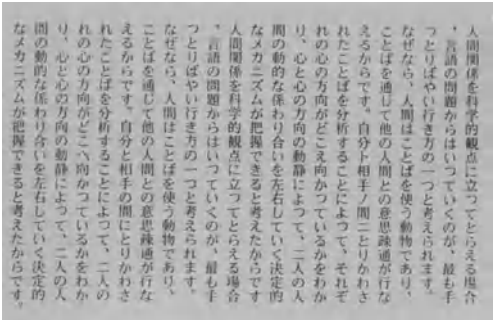
The cells of the matrix have been numbered for ease of reference, even though this approach reinforces one particular reading strategy at the expense of others. These numbers have been included in parentheses in the text of this paper where relevant.

The examples chosen to fill the cells of the matrix are mainly from this century and from those parts of the world using the roman alphabet. However, the matrix has validity in relation to other linguistic conventions and other periods of time, and culturally and historically based approaches to it would probably prove fruitful.

It is important to emphasize that each cell of the matrix offers a relatively wide range of graphic possibilities. The most effective way of presenting the essential characteristics of each cell would be to show numerous examples, but clearly a printed paper does not lend itself to this approach. There is the danger, in showing a single example, or even a limited number of examples, that this might lead to the formulation of a narrow set of definitions for the cells. It should be said therefore that the prime reason for presenting the matrix is neither to define nor confine graphic language. The examples shown here should be considered with these comments in mind; they are presented in list form in the numbered sequence of the cells of the matrix, together with a brief commentary.



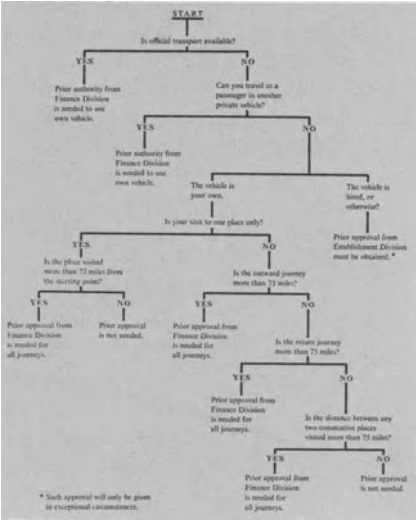
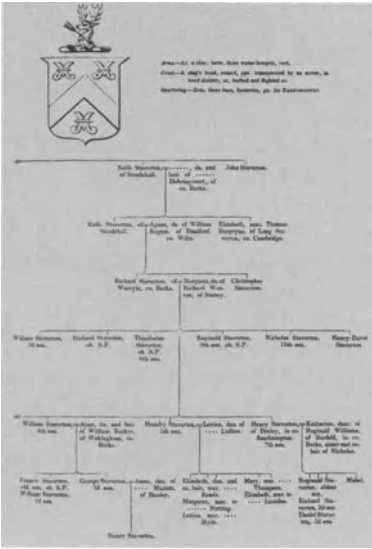
Cell 1. These examples come as close to pure linearity as a limited two-dimensional format will allow. On the left is the Phaistos disc (Minoan, c.1700BC) and on the right a recent handwritten letter. Both examples read from the outside to the centre.



Cell 2. In practice, linear flow of text is nearly always interrupted, as in the Codex Sinaiticus from the fourth century AD (left). The reasons for this practice are various (ergonomic, perceptual, practical) and apply throughout the world whether the direction of reading is left to right, right to left, or top to bottom (centre). Normally, line breaks do not relate to semantic units. Lines are usually more or less of the same length within a single passage of text, but linear interrupted text may take other forms (right). The methods used to make sequences of lines conform to predetermined arrays are too numerous to describe here.



Cell 3. Lists differ from 2 above in that the items presented on each line form discrete semantic units. On the left is the order of the coronation procession of George IV, 1821. On the right is a restaurant guide in which entries are distinguished from one another by occupying separate lines, though each entry consists of two parts which are distinguished from one another typographically.



Cell 4. On the left is a traditional family tree of 1833, with many branches; on the right is an algorithm, which is binary.

	FIRST DIVISION									
	P	W	D	A	W	L	F	A	Pts	
Leeds	12	5	0	13	4	3	2	5	16	20
Arsenal	13	6	1	0	21	2	3	2	6	11 18
Man. C	12	3	3	0	12	4	3	2	5	4 17
Spurs	13	4	1	1	9	4	2	4	11	6 10
Cryst P	13	5	0	2	10	5	2	2	3	5 4 17
Chelsea	13	3	3	0	11	5	3	2	5	5 16
Wolves	12	3	2	1	13	3	3	2	3	14 16
L'pool	12	4	2	0	12	2	1	3	2	3 4 15
Stoke	13	3	3	0	13	1	0	2	4	5 15 13
Cov C	13	4	1	2	6	3	2	2	3	6 8 13
New U	13	1	4	1	8	6	3	3	9	10 13
S'hampton	13	2	1	1	8	3	1	4	5	10 12
Everton	12	2	2	1	9	6	2	1	4	9 15 12
Derby	13	3	1	3	11	9	1	2	3	7 11 11
WBA	13	3	3	1	13	9	0	2	4	9 21 11
Man. U	13	2	3	2	6	4	1	2	3	7 14 11
Not't F	13	2	2	1	12	6	0	8	4	1 12 11
B'ham	13	2	1	1	8	3	1	2	4	5 10 12
Ipswich	13	3	2	2	11	7	0	1	5	1 8 9
W Ham	13	1	4	2	9	10	0	3	3	6 11 9
B'pool	13	1	3	2	6	9	1	1	5	4 14 8
Burnley	13	0	2	5	4	12	9	2	4	2 10

[illegible]

Cell 5. Both these matrices would be described as tables: the football league table (left) is primarily numerical, the page from a company report (right) is primarily verbal.

dresses from 1 to 2000 coats
 from 10¢, girls' suits from 25¢
 skirts overcoats from 41¢, gauds
 from 10¢, 1000s from 10¢, 1000s
 hundreds of other bargains at
 The Tractor Shop, 4701 N. 1st
 St., Minneapolis 12, 1000s
 TYPEWRITERS, Undermanned, manual
 modern, 1000s, 1000s, 1000s
 CYCLE TYRES, 25 by 1 1/2, 26 by 1 1/2
 27, 28, 29, 30, 31, 32, 33, 34, 35, 36, 37, 38, 39, 40, 41, 42, 43, 44, 45, 46, 47, 48, 49, 50, 51, 52, 53, 54, 55, 56, 57, 58, 59, 60, 61, 62, 63, 64, 65, 66, 67, 68, 69, 70, 71, 72, 73, 74, 75, 76, 77, 78, 79, 80, 81, 82, 83, 84, 85, 86, 87, 88, 89, 90, 91, 92, 93, 94, 95, 96, 97, 98, 99, 100, 101, 102, 103, 104, 105, 106, 107, 108, 109, 110, 111, 112, 113, 114, 115, 116, 117, 118, 119, 120, 121, 122, 123, 124, 125, 126, 127, 128, 129, 130, 131, 132, 133, 134, 135, 136, 137, 138, 139, 140, 141, 142, 143, 144, 145, 146, 147, 148, 149, 150, 151, 152, 153, 154, 155, 156, 157, 158, 159, 160, 161, 162, 163, 164, 165, 166, 167, 168, 169, 170, 171, 172, 173, 174, 175, 176, 177, 178, 179, 180, 181, 182, 183, 184, 185, 186, 187, 188, 189, 190, 191, 192, 193, 194, 195, 196, 197, 198, 199, 200, 201, 202, 203, 204, 205, 206, 207, 208, 209, 210, 211, 212, 213, 214, 215, 216, 217, 218, 219, 220, 221, 222, 223, 224, 225, 226, 227, 228, 229, 230, 231, 232, 233, 234, 235, 236, 237, 238, 239, 240, 241, 242, 243, 244, 245, 246, 247, 248, 249, 250, 251, 252, 253, 254, 255, 256, 257, 258, 259, 260, 261, 262, 263, 264, 265, 266, 267, 268, 269, 270, 271, 272, 273, 274, 275, 276, 277, 278, 279, 280, 281, 282, 283, 284, 285, 286, 287, 288, 289, 290, 291, 292, 293, 294, 295, 296, 297, 298, 299, 300, 301, 302, 303, 304, 305, 306, 307, 308, 309, 310, 311, 312, 313, 314, 315, 316, 317, 318, 319, 320, 321, 322, 323, 324, 325, 326, 327, 328, 329, 330, 331, 332, 333, 334, 335, 336, 337, 338, 339, 340, 341, 342, 343, 344, 345, 346, 347, 348, 349, 350, 351, 352, 353, 354, 355, 356, 357, 358, 359, 360, 361, 362, 363, 364, 365, 366, 367, 368, 369, 370, 371, 372, 373, 374, 375, 376, 377, 378, 379, 380, 381, 382, 383, 384, 385, 386, 387, 388, 389, 390, 391, 392, 393, 394, 395, 396, 397, 398, 399, 400, 401, 402, 403, 404, 405, 406, 407, 408, 409, 410, 411, 412, 413, 414, 415, 416, 417, 418, 419, 420, 421, 422, 423, 424, 425, 426, 427, 428, 429, 430, 431, 432, 433, 434, 435, 436, 437, 438, 439, 440, 441, 442, 443, 444, 445, 446, 447, 448, 449, 450, 451, 452, 453, 454, 455, 456, 457, 458, 459, 460, 461, 462, 463, 464, 465, 466, 467, 468, 469, 470, 471, 472, 473, 474, 475, 476, 477, 478, 479, 480, 481, 482, 483, 484, 485, 486, 487, 488, 489, 490, 491, 492, 493, 494, 495, 496, 497, 498, 499, 500, 501, 502, 503, 504, 505, 506, 507, 508, 509, 510, 511, 512, 513, 514, 515, 516, 517, 518, 519, 520, 521, 522, 523, 524, 525, 526, 527, 528, 529, 530, 531, 532, 533, 534, 535, 536, 537, 538, 539, 540, 541, 542, 543, 544, 545, 546, 547, 548, 549, 550, 551, 552, 553, 554, 555, 556, 557, 558, 559, 560, 561, 562, 563, 564, 565, 566, 567, 568, 569, 570, 571, 572, 573, 574, 575, 576, 577, 578, 579, 580, 581, 582, 583, 584, 585, 586, 587, 588, 589, 590, 591, 592, 593, 594, 595, 596, 597, 598, 599, 600, 601, 602, 603, 604, 605, 606, 607, 608, 609, 610, 611, 612, 613, 614, 615, 616, 617, 618, 619, 620, 621, 622, 623, 624, 625, 626, 627, 628, 629, 630, 631, 632, 633, 634, 635, 636, 637, 638, 639, 640, 641, 642, 643, 644, 645, 646, 647, 648, 649, 650, 651, 652, 653, 654, 655, 656, 657, 658, 659, 660, 661, 662, 663, 664, 665, 666, 667, 668, 669, 670, 671, 672, 673, 674, 675, 676, 677, 678, 679, 680, 681, 682, 683, 684, 685, 686, 687, 688, 689, 690, 691, 692, 693, 694, 695, 696, 697, 698, 699, 700, 701, 702, 703, 704, 705, 706, 707, 708, 709, 710, 711, 712, 713, 714, 715, 716, 717, 718, 719, 720, 721, 722, 723, 724, 725, 726, 727, 728, 729, 730, 731, 732, 733, 734, 735, 736, 737, 738, 739, 740, 741, 742, 743, 744, 745, 746, 747, 748, 749, 750, 751, 752, 753, 754, 755, 756, 757, 758, 759, 760, 761, 762, 763, 764, 765, 766, 767, 768, 769, 770, 771, 772, 773, 774, 775, 776, 777, 778, 779, 780, 781, 782, 783, 784, 785, 786, 787, 788, 789, 790, 791, 792, 793, 794, 795, 796, 797, 798, 799, 800, 801, 802, 803, 804, 805, 806, 807, 808, 809, 810, 811, 812, 813, 814, 815, 816, 817, 818, 819, 820,

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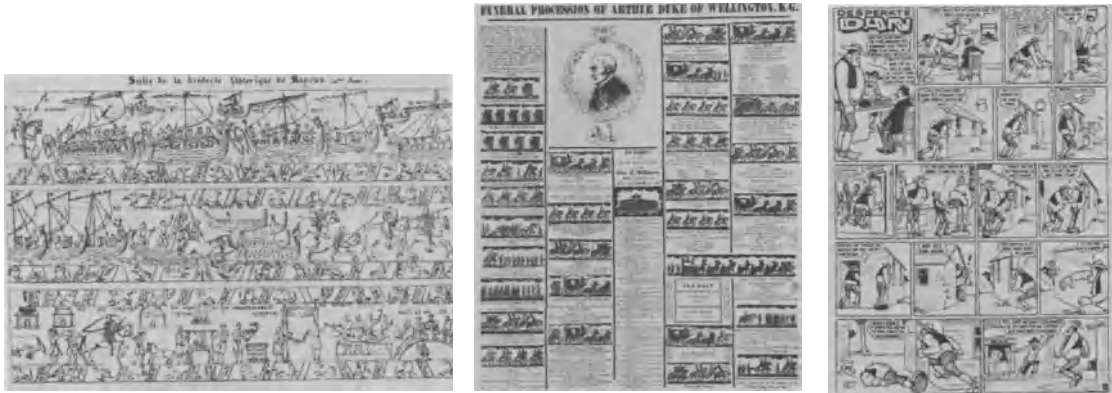
Cell 6. The boundary between Cells 6 and 7 is subjectively drawn. "Non-linear directed" has traditionally been the language of advertising. Examples shown range from a consistent method of directing the viewing (left), where it is assumed that the bold headings will be scanned vertically as a first operation, to others (centre and right) where it is most unlikely that reading strategies will bear much relation to those adopted in relation to "linear interrupted" language.



Cell 7. In the "non-linear open" configuration, verbal language usually breaks down in terms of precise communication. In concrete poetry however it may take on other dimensions of meaning.



Cell 8. The Bayeux Tapestry is probably the nearest approach to a "pure linear" image in this mode that can be found. It is not purely linear, however, as the verbal image is divided into discrete units and the picture is not a continuous narrative.

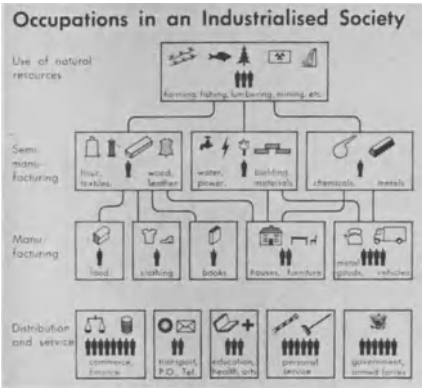


Cell 9. When presented in book form the Bayeux Tapestry (left) is usually divided into units of equal length as in traditional text setting. The broadsheet of the funeral procession of the Duke of Wellington in 1852 (centre) shows a division of pictorial and verbal information into hunks to form five columns. A well tried application of the linear interrupted configuration in this mode is the comic strip (right), where the interruptions to the story are usually made on the basis of what will fit into the line.

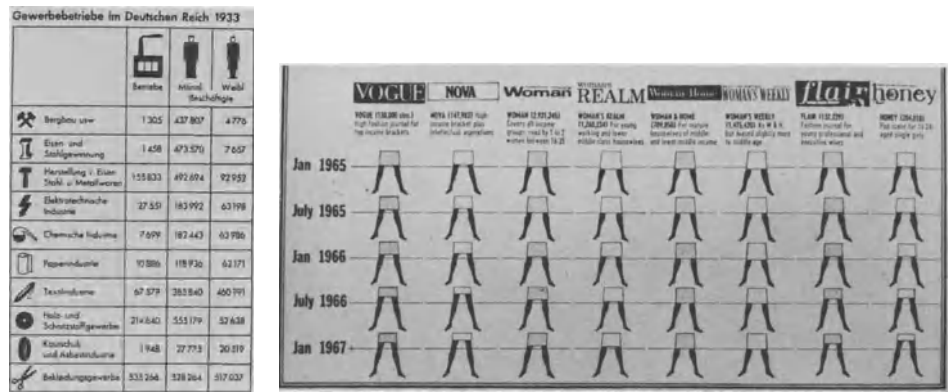
	car	} figures in these columns are charges per night	E
	adult		Etr
	caravan		exch
	tent		FDM
	swimming (see L, P, R, S, and <->)		GC
	grass		h
	sand		junc
	stone		km
	little shade		L
	partly shaded		LC
	mainly shaded		lt
	shower (cold only)		m
	shower (hot and cold)		N
	shop (see <->)		n/c
	café		P
	restaurant (see <->)		Pi
	electric points for razors		
	electric points for caravans		

	One small camera and/or a pair of binoculars
	Een kleine camera en/of een verrekijker
	One overcoat or wrap
	Een overjas of mantel
	One blanket
	Een deken
	One umbrella or walking-stick
	Een parapluie of wandelstok

Cell 10. Combinations of pictures and words are found in list form in such things as keys to maps and guides (left) and travel regulations (right).



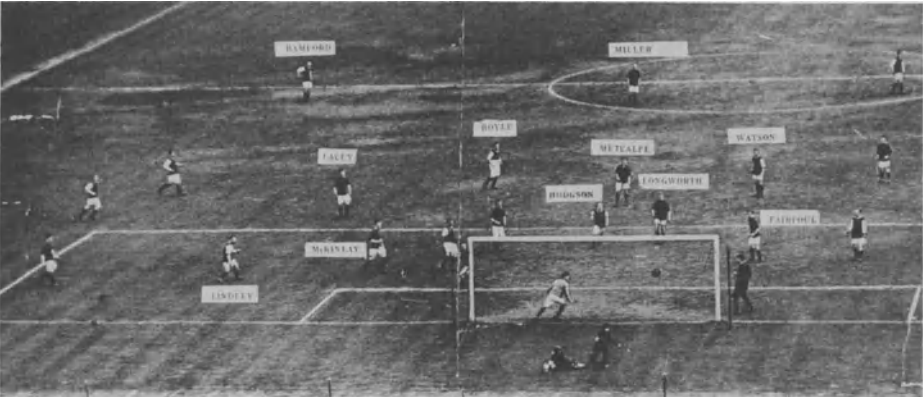
Cell 11. This is an unusual example of a multiple tree presented in the combined "pictorial & verbal/numerical" mode.



Cell 12. In the example on the left pictures are used as column and row headings to identify the numerical information in the cells of the matrix. In the example on the right, prepared for the Sunday Times, the actual content of the matrix is presented in pictorial terms and the user "reads off" the information by assessing the length of the miniskirts.



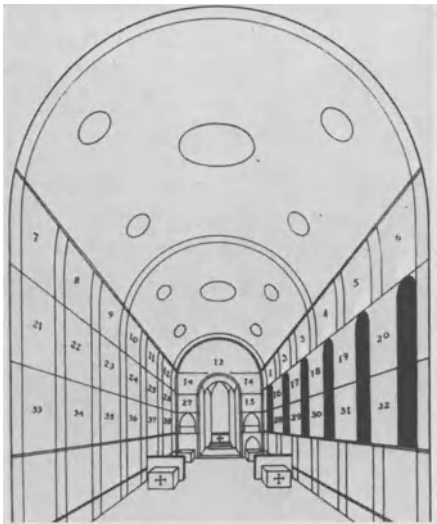
Cell 13. In the exhibition catalogue (left) the user's viewing is directed in a number of ways: horizontally along the row of pictures; horizontally from one column of text to another; and vertically so that each picture is read in conjunction with the passage of text beneath it. This scheme of organization is a rational one that has some of the characteristics of a matrix, whereas the directed viewing associated with advertising (centre) and popular journalism (right) is more intuitive and open to a wider range of reading/viewing strategies.



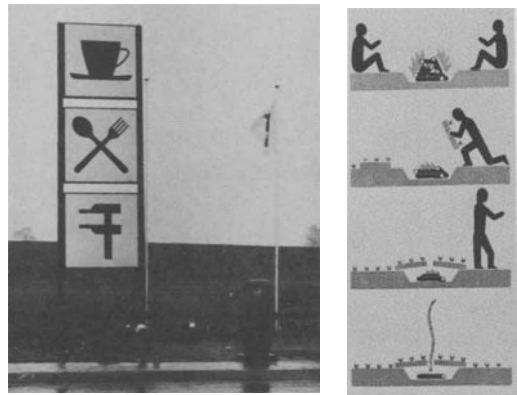
Cell 14. This early example of football reporting is probably as near as one can get to a graphic image in this mode, in which most options of viewing and reading are left open.



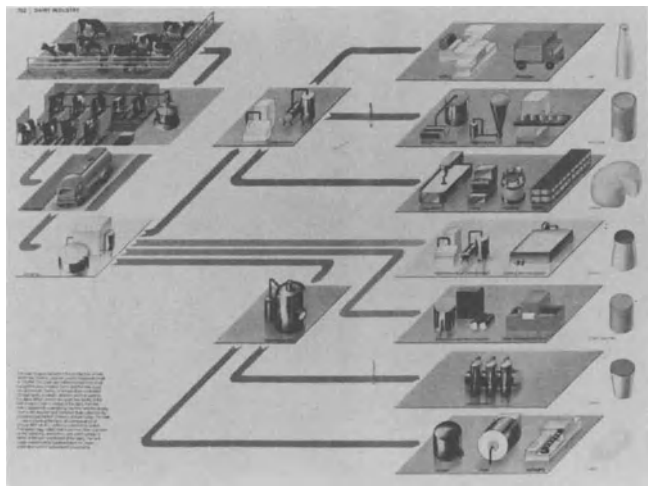
Cell 15. The story in relief sculpture spiralling up Trajan's Column of 112AD in Rome (left), and panoramic views of coastlines and rivers (right) are examples of the linear presentation of pictures.



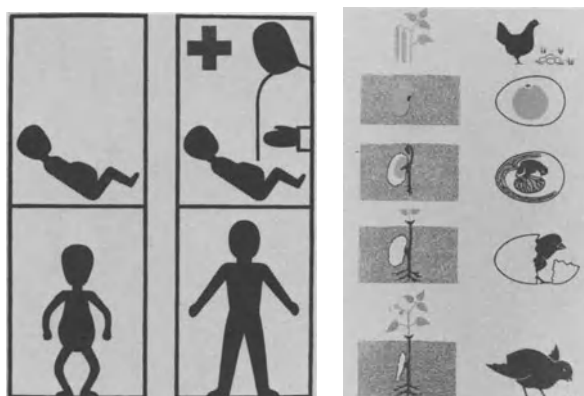
Cell 16. Wall paintings and mosaics have traditionally been presented in series of discrete scenes. The individual scenes of Giotto's fresco cycle in the Scrovegni Chapel, Padua (left and centre) of the early fourteenth century have been arranged, in so far as the structure of the building will allow, in much the same way as one reads text. A closer parallel with the "verbal/-numerical" mode is provided by the illustration of the funeral procession of Lord Nelson, 1806 (right) in which the rows of pictures have been "justified" by putting variable amounts of space between the pictorial units.



Cell 17. Amongst the simplest pictorial lists are arrays of symbols designed to facilitate international travel (left). A more complicated example is provided by the sequence of pictures (right), each of which represents a separate stage in the narrative.



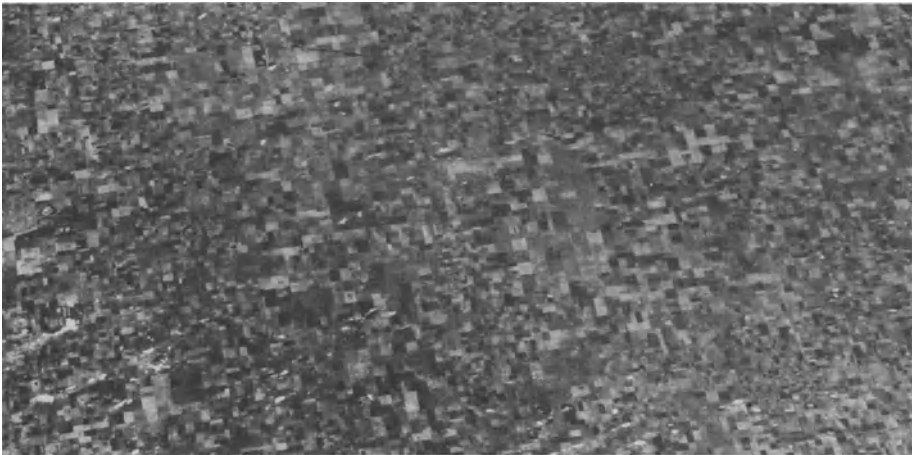
Cell 18. This pictorial tree from a recently published pictorial encyclopaedia illustrates the structure of the dairy industry. The original is colour coded.



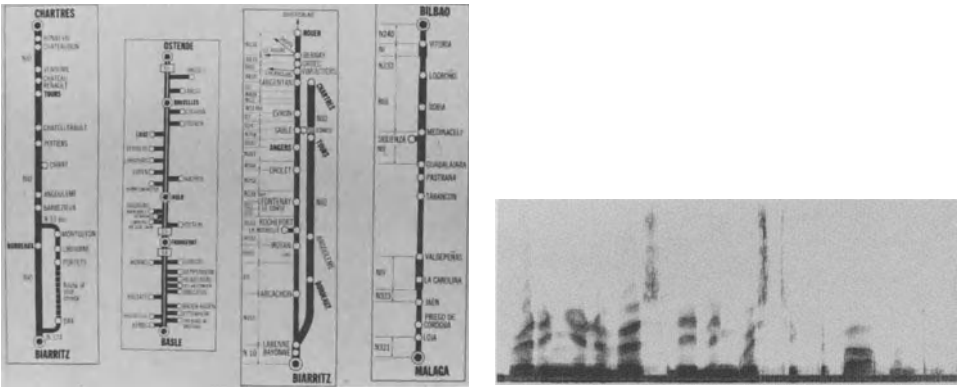
Cell 19. Matrices are rarely presented in the pictorial mode. In the example on the left the viewer has to deduce the headings from the content of the pictures (Column headings: no medical man / medical man. Row headings: swollen stomach / after swollen stomach). The example on the right shows the parallel life cycles of a bean and a chicken.



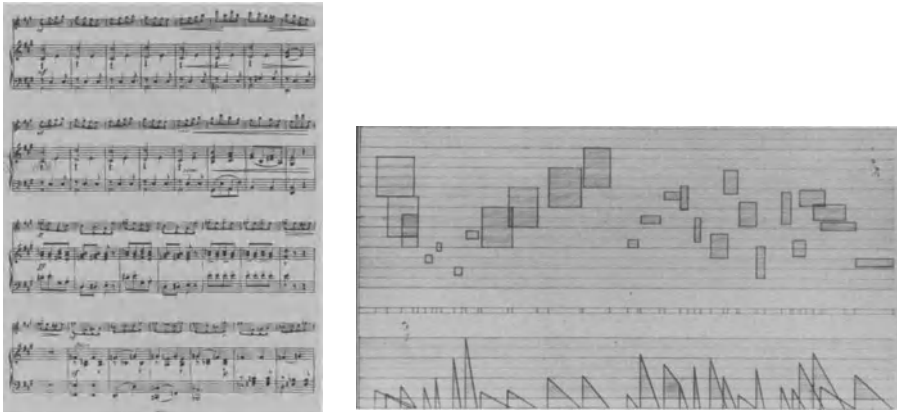
Cell 20. Most consciously-designed pictures fall into the category of "non-linear directed," since it is usually the intention of an artist or photographer to say something in visual terms. The difficulty lies in determining whether viewers do respond to images in the intended manner. It has been assumed that this perspective projection of the Great Exhibition building of 1851 provides a strong directive force in viewing.



Cell 21. For the reasons given in relation to cell 20, it is almost impossible to find an example of "non-linear open" in this mode. Even when a photograph is taken more or less at random there will be aspects in the organization of the image that influence our viewing. The example given is an aerial photograph.

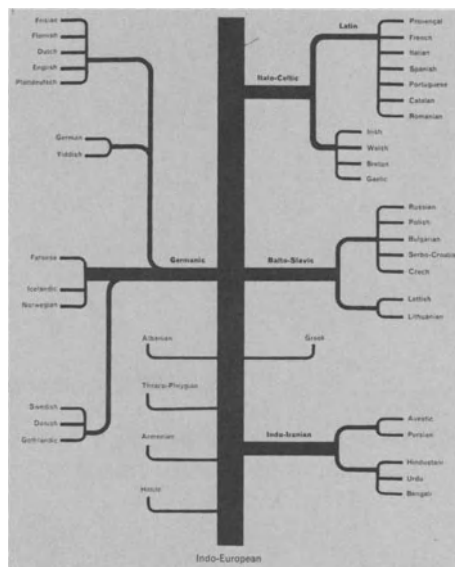


Cell 22. Route maps (left) and traces from graph plotters such as the spectrogram (right) provide well used examples of pure linear schematic language.

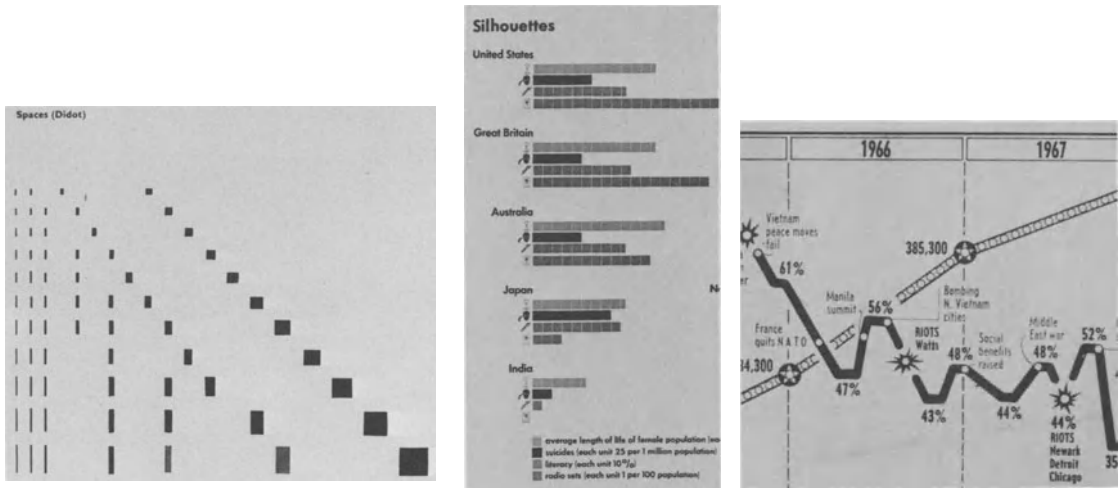


Cell 23. Traditional musical notation (left) and, more obviously, modern form of notation (right) follow the "linear interrupted" method of configuration.

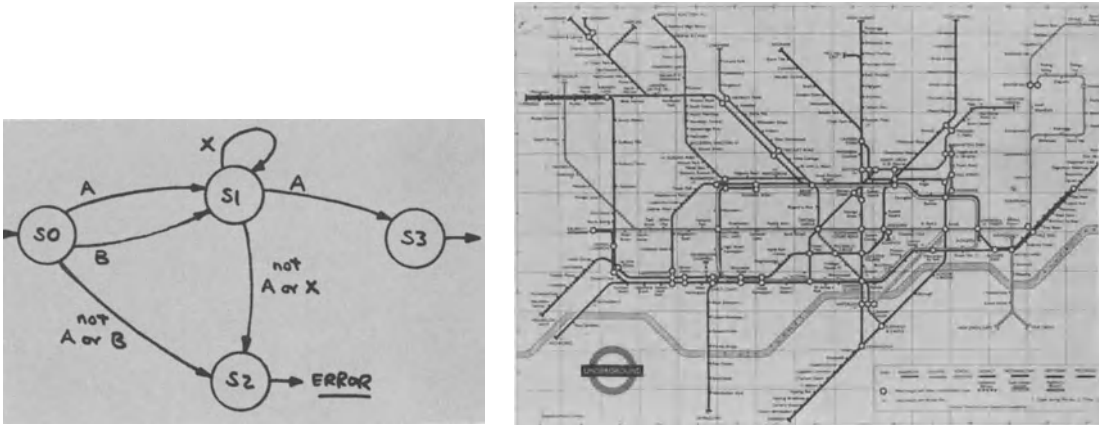
Cell 24. No example has yet been found for this cell.



Cell 25. This schematic display of the relationship of the languages of the world follows a tree structure. The thickness of the lines relates to the evolutionary position of the languages shown.



Cell 26. The example on the left presents the range of spacing units available in letterpress printing using the Didot system. As with the set of bar charts (centre) it requires the user to make searches about two axes. Line graphs (right) fall into this cell because they represent schematically the plotting of points on a matrix.



Cell 27. Most network diagrams fall into the "non-linear directed" category because only certain routes in them are regarded as legal. On the left is a network diagram by Wiseman and Linden (this volume). Some maps take the form of network diagrams: the London underground diagram, originally designed in 1933 (right), is perhaps the most influential network diagram ever produced.

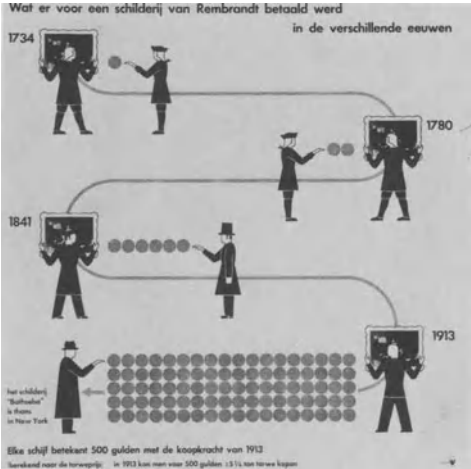


Cell 28. Surface maps, such as this detail of a Canadian city, differ from network diagrams in that they leave most options open to the user. Some element of direction is provided for the user by such devices as colour coding and categories of labelling.

The following items have been provided as a visual footnote to the examples shown above in order to emphasize that the schema presented in this paper is a device for directing thinking about graphic language rather than a schema for the language itself. While there are many variants of graphic language that do not fit precisely within a single cell of the matrix, most such variants can be accommodated by it in that they combine the characteristics of a number of cells.

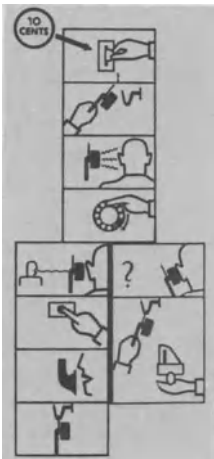
Abraham Mrs V.E. 11 Midcroft Slough.....	Farnham Cam 3601	Aczel Michael	
Abrahamson A. 15 Longwater Rd. Fitchamstead	Evesley 2677	Aczel Dr T. St.	
Abrautic Societies Ltd. 17 London Rd.....	Alcal 23923	Adach Eli 44	
Abrey G.A. 105 Vine Rd.....	Farnham Cam 4409	Adage Engines	
Abrey & Gerrard Ltd. Eng.		Adair C. 156 H	
Abrey M. Glenquiff Alwarp Baitley.....	206 Bedford Av. Trading En. Slough 32727	Adair D. 19 Sw	
Abrey M.J. 30 Southdown Rd. Emsler Gn.....	Maidenhead 20037	Adair Ian. The J	
Abrey D.E.F. Gerts. 19 The Broadway.....	Reading 471416	Adair J. 100 Bc	
Abraham A.M. & Sons St. Caversham.....	Thatcham 3302	Adair J.S. 16 C	
Abraham D.W.A. 17 Hammary La. Tishburn.....	Reading 471756	Adair J.R. 29 C	
Abraham E.W. 25 Baysley Rd.....	Reading 26247	Adair Maj P.R.	
Abraham E.P. 2 Little Range Cott. Serley Av.....	Reading 85961	Adair R.M. 11	
Abraham Owen G. The Millinery Arms.....	Rotherfield Greys 400	Adam Brian. 30	
Abraham Peter F. 20 Northumberland Rd.....	Reading 32141	Adam D.J. 14 J	
Abraham R.B. Yalham Fur Rd. Tishburn.....	Reading 76053	Adam E.W. 301	
Abraham R.W. 33 Th. John Rd.....	Wallingford 3561	Adam H. 31 Fr	
Abraham R.W.		Adam House Li	
Abby Cor.Lytton Av. Chalton St. Piner.....	Sarnsley X 36158	Adam J. Timba	
Abraham S.		Adam J.C. 8 St	
2 Stamford Carrs. Highmoor, Henley.....	Rotherfield Greys 522	Adam J.E. 37 F	
Abraham R.I. 42 Cromwell Rd.....	Maidenhead 22028	Adam M.J. 5 N	
Aburrow Brian G.		Adam Peter.....	
3, Eastwood Ct. Eastwood Rd. Wootley.....	Wootley Pl. 1212	Adams Laid	
Aburrow L. Laid. 50 Western Elm. Av.....	Reading 52929	(Gons. Res)	
Academy Hair Fashion.		Adam P. Faby	
126 Ainslie Rd. Wokingham.....	W. Farley 4595	Adam Mav. S.J.	
Accounting, Bookkeeping & Stationery Services.....	Reading 44580	Adam W.F.	
Accounting & Secretarial Services.....	38 Duke Rd. Crawthorne 2560	Adam W.S.	
131 Stoke Poges La. Slough.....	32223	Adam W.L. 10	
ACCURACY Ltd. Telemarketing Injection Moulders, Factory 1 Welbeck Rd. Welbeck Rd.....	Maidenhead 24396	Adamson Karen	
Aep Car Hire & Taxi Service.....		Adamson & Wre	
71 Kings Rd.....	Reading 560411	Adamson J.M.	
	Reading 562143	Adams & Smith	
		Adams A. Gaur	

Display 29. This detail from a telephone directory shows a sequence of lines composed of three discrete items in terms of content (name, address, number). However, only two distinctions are made typographically (the number is distinguished from the other two items by space and by the fact that part of it appears in bold type). This is not a simple list, but further typographic distinctions would have to be made for it to be considered a matrix.

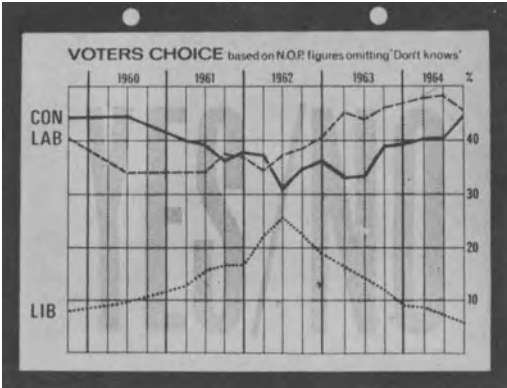


But when a boy leaves school
and is set to study
if botany be a branch of his studies,
he will find that the word for
of the Chinese *Tsia* or *Tcha, Cha*.
he will find that there are three
kinds of tea belonging to the natural family
of *Camellia*, or green tea; *Thea Bohea*,
which gives us
the black tea; and *Thea Assamensis*,
which gives us
the tea of the risk of being blacked, if

Displays 30 and 31. The pictorial chart (left) is particularly complex in its characteristics. It shows the growth in value of Rembrandt's paintings from top to bottom. In one sense it is purely linear in that viewing is directed in boustrophedon manner (as the ox ploughs) along a single drawn line; but there is a change in the orientation of the image on alternate rows as in some boustrophedon printing (right). Does this make it "purely linear" or "linear interrupted"? In any event, each row displays only one semantic unit, so that the chart has some of the characteristics of a list.



Display 32. This chart can be seen as a cross between a pictorial list and a binary branching tree. It is a very simple example of its kind, but the possibilities for the development of this approach are obvious.



Displays 33 and 34. Many examples of everyday language we are presented with combine different modes of symbolization and methods of configuration. The example on the left combines a simple statement in the verbal mode with a more complex message stated schematically. The example on the right is a map within which discrete units of information are presented in matrix configurations.

from Study 1. However, because of the inclusion of a larger number of passages, it was necessary to use a somewhat more complicated order of

The passages consisted of six excerpts from the Davis Reading Test.⁴ Six orders of presentation were used. These orders were arranged so that each passage appeared in each possible position (i.e., first, second, third, etc.) at least once. Within each order of presentation, half the passages were typed with proportional spacing and half with standard spacing, in counterbalanced order.

A total of 198 men and women were asked. As in Study I, the sampling procedure consisted of recruiting adult passers-by from a suburban shopping center. The demographic characteristics of the final sample are shown in Table IV.

Characteristic	Men	Women	Characteristic	Men	Women
----------------	-----	-------	----------------	-----	-------

Age	Age 16-19 years	Age 20-24 years	Age 25-29 years	Age 30-34 years	Age 35-39 years	Age 40-44 years	Age 45-49 years	Age 50-54 years	Age 55-59 years	Age 60-64 years	Age 65-69 years	Age 70-74 years	Age 75-79 years	Age 80-84 years	Age 85-89 years	Age 90-94 years	Age 95-99 years	Age 100 years	Age 101 years	Age 102 years	Age 103 years	Age 104 years	Age 105 years	Age 106 years	Age 107 years	Age 108 years	Age 109 years	Age 110 years	Age 111 years	Age 112 years	Age 113 years	Age 114 years	Age 115 years	Age 116 years	Age 117 years	Age 118 years	Age 119 years	Age 120 years	Age 121 years	Age 122 years	Age 123 years	Age 124 years	Age 125 years	Age 126 years	Age 127 years	Age 128 years	Age 129 years	Age 130 years	Age 131 years	Age 132 years	Age 133 years	Age 134 years	Age 135 years	Age 136 years	Age 137 years	Age 138 years	Age 139 years	Age 140 years	Age 141 years	Age 142 years	Age 143 years	Age 144 years	Age 145 years	Age 146 years	Age 147 years	Age 148 years	Age 149 years	Age 150 years	Age 151 years	Age 152 years	Age 153 years	Age 154 years	Age 155 years	Age 156 years	Age 157 years	Age 158 years	Age 159 years	Age 160 years	Age 161 years	Age 162 years	Age 163 years	Age 164 years	Age 165 years	Age 166 years	Age 167 years	Age 168 years	Age 169 years	Age 170 years	Age 171 years	Age 172 years	Age 173 years	Age 174 years	Age 175 years	Age 176 years	Age 177 years	Age 178 years	Age 179 years	Age 180 years	Age 181 years	Age 182 years	Age 183 years	Age 184 years	Age 185 years	Age 186 years	Age 187 years	Age 188 years	Age 189 years	Age 190 years	Age 191 years	Age 192 years	Age 193 years	Age 194 years	Age 195 years	Age 196 years	Age 197 years	Age 198 years	Age 199 years	Age 200 years																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																					
16-19 years	27	46	71	100	130	160	190	220	250	280	310	340	370	400	430	460	490	520	550	580	610	640	670	700	730	760	790	820	850	880	910	940	970	1000	1030	1060	1090	1120	1150	1180	1210	1240	1270	1300	1330	1360	1390	1420	1450	1480	1510	1540	1570	1600	1630	1660	1690	1720	1750	1780	1810	1840	1870	1900	1930	1960	1990	2020	2050	2080	2110	2140	2170	2200	2230	2260	2290	2320	2350	2380	2410	2440	2470	2500	2530	2560	2590	2620	2650	2680	2710	2740	2770	2800	2830	2860	2890	2920	2950	2980	3010	3040	3070	3100	3130	3160	3190	3220	3250	3280	3310	3340	3370	3400	3430	3460	3490	3520	3550	3580	3610	3640	3670	3700	3730	3760	3790	3820	3850	3880	3910	3940	3970	4000	4030	4060	4090	4120	4150	4180	4210	4240	4270	4300	4330	4360	4390	4420	4450	4480	4510	4540	4570	4600	4630	4660	4690	4720	4750	4780	4810	4840	4870	4900	4930	4960	4990	5020	5050	5080	5110	5140	5170	5200	5230	5260	5290	5320	5350	5380	5410	5440	5470	5500	5530	5560	5590	5620	5650	5680	5710	5740	5770	5800	5830	5860	5890	5920	5950	5980	6010	6040	6070	6100	6130	6160	6190	6220	6250	6280	6310	6340	6370	6400	6430	6460	6490	6520	6550	6580	6610	6640	6670	6700	6730	6760	6790	6820	6850	6880	6910	6940	6970	7000	7030	7060	7090	7120	7150	7180	7210	7240	7270	7300	7330	7360	7390	7420	7450	7480	7510	7540	7570	7600	7630	7660	7690	7720	7750	7780	7810	7840	7870	7900	7930	7960	7990	8020	8050	8080	8110	8140	8170	8200	8230	8260	8290	8320	8350	8380	8410	8440	8470	8500	8530	8560	8590	8620	8650	8680	8710	8740	8770	8800	8830	8860	8890	8920	8950	8980	9010	9040	9070	9100	9130	9160	9190	9220	9250	9280	9310	9340	9370	9400	9430	9460	9490	9520	9550	9580	9610	9640	9670	9700	9730	9760	9790	9820	9850	9880	9910	9940	9970	10000																																																																																																																																																																																																																																																																																																																																													
20-24 years	19	32	47	62	77	92	107	122	137	152	167	182	197	212	227	242	257	272	287	302	317	332	347	362	377	392	407	422	437	452	467	482	497	512	527	542	557	572	587	602	617	632	647	662	677	692	707	722	737	752	767	782	797	812	827	842	857	872	887	902	917	932	947	962	977	992	1007	1022	1037	1052	1067	1082	1097	1112	1127	1142	1157	1172	1187	1202	1217	1232	1247	1262	1277	1292	1307	1322	1337	1352	1367	1382	1397	1412	1427	1442	1457	1472	1487	1502	1517	1532	1547	1562	1577	1592	1607	1622	1637	1652	1667	1682	1697	1712	1727	1742	1757	1772	1787	1802	1817	1832	1847	1862	1877	1892	1907	1922	1937	1952	1967	1982	1997	2012	2027	2042	2057	2072	2087	2102	2117	2132	2147	2162	2177	2192	2207	2222	2237	2252	2267	2282	2297	2312	2327	2342	2357	2372	2387	2402	2417	2432	2447	2462	2477	2492	2507	2522	2537	2552	2567	2582	2597	2612	2627	2642	2657	2672	2687	2702	2717	2732	2747	2762	2777	2792	2807	2822	2837	2852	2867	2882	2897	2912	2927	2942	2957	2972	2987	3002	3017	3032	3047	3062	3077	3092	3107	3122	3137	3152	3167	3182	3197	3212	3227	3242	3257	3272	3287	3302	3317	3332	3347	3362	3377	3392	3407	3422	3437	3452	3467	3482	3497	3512	3527	3542	3557	3572	3587	3602	3617	3632	3647	3662	3677	3692	3707	3722	3737	3752	3767	3782	3797	3812	3827	3842	3857	3872	3887	3902	3917	3932	3947	3962	3977	3992	4007	4022	4037	4052	4067	4082	4097	4112	4127	4142	4157	4172	4187	4202	4217	4232	4247	4262	4277	4292	4307	4322	4337	4352	4367	4382	4397	4412	4427	4442	4457	4472	4487	4502	4517	4532	4547	4562	4577	4592	4607	4622	4637	4652	4667	4682	4697	4712	4727	4742	4757	4772	4787	4802	4817	4832	4847	4862	4877	4892	4907	4922	4937	4952	4967	4982	4997	5012	5027	5042	5057	5072	5087	5102	5117	5132	5147	5162	5177	5192	5207	5222	5237	5252	5267	5282	5297	5312	5327	5342	5357	5372	5387	5402	5417	5432	5447	5462	5477	5492	5507	5522	5537	5552	5567	5582	5597	5612	5627	5642	5657	5672	5687	5702	5717	5732	5747	5762	5777	5792	5807	5822	5837	5852	5867	5882	5897	5912	5927	5942	5957	5972	5987	6002	6017	6032	6047	6062	6077	6092	6107	6122	6137	6152	6167	6182	6197	6212	6227	6242	6257	6272	6287	6302	6317	6332	6347	6362	6377	6392	6407	6422	6437	6452	6467	6482	6497	6512	6527	6542	6557	6572	6587	6602	6617	6632	6647	6662	6677	6692	6707	6722	6737	6752	6767	6782	6797	6812	6827	6842	6857	6872	6887	6902	6917	6932	6947	6962	6977	6992	7007	7022	7037	7052	7067	7082	7097	7112	7127	7142	7157	7172	7187	7202	7217	7232	7247	7262	7277	7292	7307	7322	7337	7352	7367	7382	7397	7412	7427	7442	7457	7472	7487	7502	7517	7532	7547	7562	7577	7592	7607	7622	7637	7652	7667	7682	7697	7712	7727	7742	7757	7772	7787	7802	7817	7832	7847	7862	7877	7892	7907	7922	7937	7952	7967	7982	7997	8012	8027	8042	8057	8072	8087	8102	8117	8132	8147	8162	8177	8192	8207	8222	8237	8252	8267	8282	8297	8312	8327	8342	8357	8372	8387	8402	8417	8432	8447	8462	8477	8492	8507	8522	8537	8552	8567	8582	8597	8612	8627	8642	8657	8672	8687	8702	8717	8732	8747	8762	8777	8792	8807	8822	8837	8852	8867	8882	8897	8912	8927	8942	8957	8972	8987	9002	9017	9032	9047	9062	9077	9092	9107	9122	9137	9152	9167	9182	9197	9212	9227	9242	9257	9272	9287	9302	9317	9332	9347	9362	9377	9392	9407	9422	9437	9452	9467	9482	9497	9512	9527	9542	9557	9572	9587	9602	9617	9632	9647	9662	9677	9692	9707	9722	9737	9752	9767	9782	9797	9812	9827	9842	9857	9872	9887	9902	9917	9932	9947	9962	9977	9992	10000
25-29 years	13	22	33	44	55	66	77	88	99	110	121	132	143	154	165	176	187	198	209	220	231	242	253	264	275	286	297	308	319	330	341	352	363	374	385	396	407	418	429	440	451	462	473	484	495	506	517	528	539	550	561	572	583	594	605	616	627	638	649	660	671	682	693	704	715	726	737	748	759	770	781	792	803	814	825	836	847	858	869	880	891	902	913	924	935	946	957	968	979	990	1000																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																
30-34 years	10	19	28	37	46	55	64	73	82	91	100	109	118	127	136	145	154	163	172	181	190	199	208	217	226	235	244	253	262	271	280	289	298	307	316	325	334	343	352	361	370	379	388	397	406	415	424	433	442	451	460	469	478	487	496	505	514	523	532	541	550	559	568	577	586	595	604	613	622	631	640	649	658	667	676	685	694	703	712	721	730	739	748	757	766	775	784	793	802	811	820	829	838	847	856	865	874	883	892	901	910	919	928	937	946	955	964	973	982	991	1000																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																												
35-39 years	8	15	22	30	38	46	54	62	70	78	86	94	102	110	118	126	134	142	150	158	166	174	182	190	198	206	214	222	230	238	246	254	262	270	278	286	294	302	310	318	326	334	342	350	358	366	374	382	390	398	406	414	422	430	438	446	454	462	470	478</																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																															

In both studies, the sampling procedures produced fairly heterogeneous groups of adult subjects. However, there were some significant differences in the demographic composition of the two samples. The

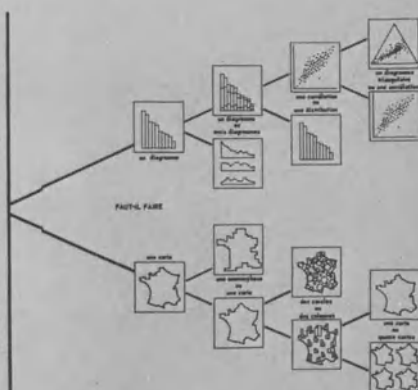
In Study II, one of the easy passages ("Finland") and one of the hard passages ("Landscape"): From Study I were only again. Two passages were added which were judged to be even easier than "Finland" – "Wald" (360 words, Form I-9, 11 questions), and "Johanna" (253 words, Form I-7, 7 questions). Two others were added which were judged to be even harder than "Landscape" – "Thick" (354 words, Form 2-A, 16 questions), and "Landscape" (236 words, Form I-3, 10 questions).

A. Le problème graphique

Si vous n'êtes pas d'accord, le débat peut être réglé au maximum des décisions de la commission parlementaire et, s'il y a lieu, au parlement. Mais il ne faut pas oublier que les applications de l'édifice de Chomsky, qui ont été faites, ont été faites. Et il y a eu des résultats. Les résultats ont été les suivants : le rapport, comme sur les habilités acquises, ne nous a pas permis de nous en servir. Le rapport, comme sur les habilités acquises, ne nous a pas permis de nous en servir. Le rapport, comme sur les habilités acquises, ne nous a pas permis de nous en servir.

CENT CONSTRUCTIONS
POUR UNE INFORMATION

10 L'indicateur se qualifie
 Population active, en Taux, en 1964
 11 par département
 12 population active
 13 non grand secteur d'emploi
 14 principal (agriculture)
 15 secondaire (industrie)
 16 tertiaire (commerce, services)
 17 Le calcul permet de comparer l'indicateur et de
 18 le valuer par rapport à la population active par département.
 19 L'indicateur est calculé par département de chaque secteur
 20 par 100 personnes actives.
 21 L'indicateur permet de comparer la possibilité de trouver
 22 des emplois et des carrières.



the matrix in relation to such factors as ease and cost of production, user capabilities, interests, and training, and the effectiveness of various approaches in connection with specific learning tasks. In order to make valid decisions without running special tests, a designer would need to know what empirical research reveals about the effectiveness of different approaches to graphic language in various circumstances. The matrix might therefore be considered as a useful aid for reviewing empirical research in the field of graphic language.

Some of the approaches to the matrix mentioned above need to be considered in relation to one another; a few of them have been isolated for convenience and will be touched on in the following sections of this paper.

Specialist and Non-Specialist

A discussion of this topic should be based on a carefully controlled investigation. No such investigation has been undertaken and the comments made in this section are therefore highly subjective. All the same, it can be said with some confidence that the approaches to graphic language that fall into the "verbal/numerical, linear interrupted" cell (2) are the norm for both specialist and non-specialist adults; and this applies to the origination of a message as well as to its consumption. Such approaches have obvious advantages over most others in terms of ease and speed of production. What is more, teaching of graphic language is concentrated almost universally in cell 2 of the matrix. Approaches to graphic language that fall into this cell are so bounded by conventions that they are perhaps the only ones most originators feel they have more or less under their control from conception through to production. There is little to be gained from dwelling on these approaches to graphic language, except in order to compare them with approaches falling within other cells of the matrix.

Many approaches to graphic language appear to have been developed for special situations. Outside the "verbal/numerical, linear interrupted" cell (2) there is a much weaker relationship between the language of the specialist and the non-specialist on the one hand, and the originator and the consumer on the other. Thus algorithms (4) appear to be nearly always specialist in origination and mainly specialist in terms of consumption, but are used only rarely by non-specialists either as originators or consumers (even though research has shown that they can be highly effective under certain circumstances). Tables (5) and maps (27, 28) tend to be specialist in origination, though they are often intended for non-specialist consumption and in some cases, such as football league tables (where the nature of the information is usually understood), they appear to present few problems to the user. Even a casual survey of papers in particular branches of science and technology makes it clear that specialists in these fields frequently abandon both the "verbal/numerical" mode of symbolization and the "linear interrupted" method of configuration. At the other end of the complexity scale, stories for the entertainment of young children and poor readers frequently take the form of comic strips (9) which make use of the combined "pictorial and verbal/-numerical" mode of symbolization along with the "linear interrupted" method of configuration. The fact that there are common words in English for a approaches to graphic language which fall into some cells of the matrix, such

as family tree (4), table (5), strip cartoon (9), and map (27, 28) is in itself testimony to the accepted use of such approaches in non-specialist situations.

It would also be of interest to consider the distribution within the matrix of those cells of graphic language that are most commonly used. But how does one determine common use? As a rough and ready way of doing so, it is proposed that a further matrix might be considered within each cell of the master matrix to record a positive or negative response according to originator/consumer and specialist/non-specialist use (Figure 2). The dotted line indicates that no clear line of demarcation exists between specialist and non-specialist and, following the definition of specialist given previously, it is possible to record the same response in both specialist and non-specialist cells on the same axis.

	Specialist	Non-specialist
Originator		
Consumer		

Figure 2. Matrix according to use.



















The writer's own subjective analysis of common use on this basis is included in Figure 3 simply as a discussion point. Those cells marked ■ received three or more positive responses; those marked □ received one or two. Such an analysis reveals a clear clustering of commonly used cells at the top left and bottom right of the matrix, and this reflects the association of the verbal mode with linearity and the pictorial and schematic modes with non-linearity.

It is perhaps surprising that the cells of the matrix that accommodate those approaches to graphic language that can be described by common words (family tree, table, strip cartoon, and map) are widely scattered in relation to both axes of the matrix. One is forced to consider why this should be so and, in particular, why some cells of the matrix appear to be used so much less than others. Has there been a process of design gestation that has led to the promotion and survival of appropriate combinations of mode of symbolization and method of configuration at the expense of others, or have certain combinations never been seriously considered?

The Evolution of Graphic Language

This is not the place to consider the historical evolution of graphic language in any serious way, but the matrix makes clear what many would claim is self-evident: that language in the pictorial and schematic modes has tended

Method of configuration

	Pure linear	Linear interrupted	List	Linear branching	Matrix	Non-linear directed viewing	Non-linear most options open
Verbal/numerical	1	2 	3 	4 	5 	6 	7
Pictorial & verbal/numerical	8	9 	10 	11	12 	13 	14
Pictorial	15	16 	17 	18	19	20 	21 
Schematic	22 	23 	24	25	26 	27 	28 

Mode of symbolization

Figure 3. Presumed common use of kinds of graphics.

to develop in non-linear ways, while language in the "verbal/numerical" mode has developed in linear ways. The relationship between oral and graphic verbal language accounts to a large degree for the linearity of the latter, but the technology of printing has undoubtedly helped to reinforce it. The ease of production of graphic language using the prefabricated and modular characters of printing type has been a powerful force in maintaining the dominance of the verbal mode and, consequently, graphic linearity. The constraints of ergonomics (book size), perception (line length), and the method of production have led to the linearity of graphic language being interrupted at regular, and usually non-semantically determined, points.

Nowadays it is largely the typewriter that determines the initial configuration of graphic language. One very reputable book published recently on the subject of typing for print (Westwood, 1976) even advises the originators of graphic language against the use of tables for simple information on the grounds that they are expensive to set. If production difficulties are to be a deterrent in such cases, when the organization of the language can be done on a machine using repeatable units, how much greater the production difficulties are going to be when the originator wishes to use modes of symbolization that involve purpose-made marks in addition to individual planning. It is hardly surprising that the approaches to graphic language most widely used are those involving the verbal mode of symbolization and linear methods of configuration.

Pictures almost certainly pre-date graphic verbal language as vehicles for graphic communication of ideas and information and, along with geometry and cartography, are major exceptions to the dominance of linearity in the early days of graphic communication. Tables too were in use before printing was invented, and so were scientific and concept diagrams. All the same, it was not until the work of Priestley and Playfair in the late eighteenth century that non-linear methods began to be widely used in relation to problems of communication in fields such as history and economics, which had hitherto been treated in predominantly linear ways. The movement towards non-linear pictorial or schematic modes of presenting information gained momentum in the nineteenth century, in the inter-war years of this century, and again in the 1960s. The general trend, taking a long-term view from the Renaissance, has been a shift from linear to non-linear methods of configuration.

The Teaching of Graphic Language

It makes little sense to consider the general issue of graphic design options and the evaluation of graphic language without some consideration of the teaching of graphic language, for the simple reason that nearly all language relies on the learning of conventions. Yet formal teaching of graphic language appears to be limited, at least in so far as general needs are concerned, to the "verbal/numerical" mode of symbolization and the "linear interrupted" method of configuration. In practice, literacy means the ability to write (originate) and read (consume) linear verbal language.

Children may be taught to draw simple maps (though rarely to originate them) and to read more complex ones; they may also be taught to organize such things as equations and calculations in non-linear ways. In recent years young children have been taught how to produce simple line graphs, bar charts, and pie charts from data they have acquired themselves. At a later

stage in their education, those specialising in certain fields may well learn the particular approaches to graphic language that are held to be appropriate to their speciality. On the whole, however, it is true to say that children are not taught to read the wide range of graphic language they will be confronted with in later life. Still less of course are children taught to originate information in anything like the range of approaches to graphic language presented in the matrix. The issue of when to use one approach rather than another hardly arises as far as the lay designer is concerned. What is more, when it comes to a comparison of the effectiveness of different approaches to the presentation of information, the long-term consequences of the dominance of one approach to graphic language cannot be calculated.

The Evaluation of Graphic Language

The graphic designer (both lay and professional) concerned with deciding how to communicate a message effectively ought to ask himself two fundamental questions at the outset: What should be the mode of symbolization? What should be the method of configuration? The answers to these questions will not be arrived at easily and will be influenced by a number of factors: the nature of the message to be communicated, the people to whom it is directed, the effect it is intended to have, and practical considerations of cost, time, and means of production. Though such matters are often crucial in real situations, they are of interest in the context of this paper only in so far that it has to be accepted that they have a bearing on the two fundamental questions concerning graphic language mentioned above. The wider issue as to whether a communication problem should be solved by graphic or non-graphic means, or by a combination of both, though important, falls entirely outside the scope of this paper. The two axes of our matrix provide the graphic designer with a synopsis of possible answers to the questions concerning mode of symbolization and method of configuration. But where does he turn for help when making his decisions? It seems reasonable to look to the findings of empirical research for guidance.

A review of research literature with our matrix in mind reveals two interesting things. First, a large proportion of empirical research undertaken in the field of graphic communication falls within two cells of the matrix (2 and 20); second, other approaches to graphic language that have attracted attention have, in the main, been confined to isolated cells of the matrix. In other words, there has been little work that crosses cell boundaries either horizontally or vertically in order to compare the effectiveness of different modes of symbolization and different methods of configuration.

It was originally intended that this paper should include a survey of the literature of graphic communication as it relates to some of the central issues raised by the matrix. Since this paper was first planned, however, two publications have appeared that make a survey somewhat superfluous. An extensive bibliography of the subject has been compiled by Macdonald-Ross and Smith (1977), which includes general observations on the field it covers and perceptive comments on particular areas of research. The structure of the classification system adopted in the Macdonald-Ross and Smith bibliography has points in common with the matrix presented in this paper and the publication as a whole serves to underline the lack of research work that crosses the boundaries of the cells of the matrix. Wright (1977) has

reviewed part of the field recently in a wide-ranging paper on the presentation of technical information which offers some guidelines based on research findings. Another useful contribution that relates to various cells of the matrix is a collection of some 600 abstracts of papers relating to social graphics prepared by Feinberg and Franklin (1975).

The match between the matrix and empirical research in the field of graphic language is a tidy one in the sense that the bulk of research seems to fall within two areas of the matrix - those already identified as areas of greatest use. The largest single body of research relates to the "verbal/-numerical" mode and the "liner interrupted" configuration (cell 2). Work in this field has been reviewed in general terms by Tinker (1965), Spencer (1968), and Foster (1971, 1972), by Watts and Nisbet (1974) as it relates to children, and by Plata (1974) as it relates to newspapers. The findings of research workers in this field are readily accessible and there is little point in stating more here than that empirical research over the last century relating to this cell of the matrix has, by and large, confirmed the "horse sense" of many practising typographic designers and printers. Considerable work has also been undertaken in relation to the pictorial mode, specifically in relation to cell 20 of the matrix. The general field has been reviewed by Kennedy (1974). Much of the most interesting applied work has been concerned with two specific target areas - children and the developing countries. Watts and Nisbet (1974) and Smith, Watkins, and MacManaway (1970) reviewed the field in relation to children, and Hudson (1967) in relation to the developing countries.

Some other cells of the matrix that have attracted empirical research should be mentioned in passing. A few papers relating to cell 3 appeared early in this century, but of particular relevance to designers are two recent papers relating to bibliographical lists by Spencer, Reynolds, and Coe (1973, 1974). In recent years important and influential work has been done in relation to cell 4 on algorithms by Wason (1968), Jones (1968), Wright (1971), and Wright and Reid (1973). Cell 5 includes tables which have attracted a fair amount of attention over the last fifty years from, amongst others, Washburne (1927), Carter (1947, 1948a, 1948b), Tinker (1954, 1960), Feliciano, Powers, and Kearl (1963), and Hartley, Young, and Burnhill (1975). The programme of work in this field undertaken over the last ten years by Wright (1968, 1971, 1977), Wright and Fox (1969, 1970, 1972), Wright and Barnard (1975) makes a particularly important contribution to the evaluation of such approaches to graphic language. Cell 6 raises the issue of typographic cuing (a term used for particular ways of directing viewing), and the literature on this subject is reviewed by Foster elsewhere in this volume. Cell 9 includes what are commonly known as comic strips. Though they have considerable literature of their own (see Macdonald-Ross & Smith, 1977), they do not appear to have attracted empirical research workers. However, Holmes (1963) found a series of pictures presented in a linear configuration more effective than only two pictures, in experiments run with Kenyans. Cell 13 would include the work done by Spencer (1973) on labelling, which points to the value of keeping labels separate from technical drawings when the material is complex. Cell 26 has probably attracted more empirical research than any other cell of the matrix, apart from cells 2 and 20. Charts, graphs, and diagrams, many of which fall into this cell, have been evaluated from various standpoints

over the last fifty years, mainly in the USA. Research in this field has been reviewed by Feinberg and Franklin (1975) and Macdonald-Ross (1977). The findings of research workers in this area are somewhat conflicting, but work on one particular issue, a comparison of different kinds of charts and graphs, seems to be pointing to the superiority of bar charts, at least in certain circumstances. Cells 27 and 28 include network diagrams, maps, and plans. Research in the broad field of map design is not extensive and is reviewed by Phillips elsewhere in this volume.

Some, though very little, of the research referred to above crosses the boundaries of the cells of the matrix and thus helps to provide answers to our two fundamental questions: What should be the mode of symbolization and what should be the method of configuration? Research that specifically addresses itself to issues that cross the boundaries of the matrix is discussed in the following paragraphs.

As far as mode of symbolization is concerned, Dwyer (1972), Fuglesang (1973), and others have compared the effectiveness of different kinds of pictorial representations, such as photographs, masked out photographs, line drawings, shaded drawings, pictographs, and stick figures. But studies based on the rather crude differences between modes of symbolization as presented in our matrix have attracted little attention. Washburne (1972), in an experiment involving a comparison of fifteen approaches to the presentation of information which included different versions of text, tables, graphs, and charts, and Vernon (1946, 1950, 1952), in experiments involving a comparison of tables, graphs, and charts, studied, among other things, different modes of symbolization. Carter (1947, 1948a, 1948b) who compared the presentation of numerical data in tables and graphs, and Feliciano et al. (1962, 1963), who compared the effectiveness of text, tables, and graphs for statistical information, also crossed the boundaries of the cells of the matrix. The work of Walker, Nicolay, and Stearns (1965) on the responses of subjects to the largely verbal American road signs and symbolic signs similar to the international road signs, of Zeff (1965) and van Nes (1972) on digital and analogue time displays, and of Phillips, De Lucia, and Skelton (1975) in relation to digital and analogue presentation of relief on maps, are other examples of cross-modal research. More fundamental in this respect is the study by Magne and Parknäs (1963) in which the learning effect of pictorially and verbally presented information was assessed by running tests in different modes. Vernon (1951, 1952, 1953) and Smith and Watkins (1972) were concerned with establishing the part played by various kinds of illustrative matter (including pictures, graphs, and charts) when used with text; these experiments all included a comparison of illustrated and unillustrated material and in this respect can be regarded as cross-modal.

The question of method of configuration appears to have attracted even less attention from research workers than mode of symbolization, though it is a central one for typographic designers. The issue crops up incidentally in the work mentioned above on the comparative effectiveness of text and tables, both of which fall into the "verbal/numerical" mode but differ in their method of configuration. Papers by Coleman and Hahn (1966) and Carver (1970) on typographic "chunking" are also relevant to the issue of method of configuration.

The most interesting research in relation to method of configuration stems from work done in the 1960s more or less independently by P.C. Wason and B.N. Lewis, along with their colleagues, in developing ordinary language algorithms. Wason (1968) and Jones (1968) both provided evidence for the superiority of algorithms over certain kinds of prose. This line was followed up by Wright (1971) and Wright and Reid (1973), who compared the effectiveness of four different methods of presenting the same basic information. These methods are given below with the terminology of the matrix and the relevant cell number in parentheses:

- Prose (linear interrupted, 2),
- Short sentences (linear interrupted, 2),
- Logical tree (linear branching, 4),
- Table (matrix, 5).

It was found that prose was the least effective of the four in terms of both speed and accuracy, that the logical tree was the best when some uncertainty existed about the information presented, and that the table was the best when the user understood the problem beforehand. The conclusion was that the optimal configuration for verbal graphic language depends on the conditions of use. Such research, which was concerned with the effectiveness of different methods of configuration within the same mode of symbolization, closely matches the needs of graphic designers; yet it remains an isolated, or at least almost isolated, contribution of this kind.

It has to be said that the match between empirical research and those areas of graphic language that have been identified on a subjective basis as widely used, though described above as tidy, is not particularly helpful to the graphic designer. In practice there is a good chance that commonly used areas of graphic language work well, largely because they are commonly used (because of the craft design law - analogous to Darwinian theory - of the survival of the fittest). It is some of the less used areas of the matrix that call for the attention of research workers as far as the designer is concerned; and in particular there is a need for research that crosses the boundaries of the cells of the matrix.

Conclusion

The matrix presented as the focal point of this paper reveals something of the scope and flexibility of graphic language. But how flexible is the human response to graphic language? The matrix invites us to ask how the reader/viewer is expected to respond to the variety of graphic language he is bombarded with in everyday situations. Does he face up to images on a page or CRT in the same way that he responds to real-world situations with their multiplicity of visual stimuli? It is reasonable to assume that there is usually no great problem in identifying the mode of symbolization being used in graphic language; but how is the reader/viewer to determine the method of configuration of a graphic display of information? Various contributors to this volume have emphasized the importance of prediction in the reading process; but how does prediction apply when the rules of the game keep changing, or when there appear to be no rules? In any event, how does the reader/viewer develop an appropriate strategy for extracting information once he has identified the method of configuration? What problems are

presented by the apparent conflict between the linearity of the verbal mode and the non-linearity of the pictorial mode? This is a particularly important question since the two modes are being combined more regularly now, and at all levels of language, than at any time since the Middle Ages. What are the consequences of switching from one mode to another and one configuration to another on both eye movements and cognitive processes? Are there essential differences between absorbing information and ideas through discrete verbal statements (words, clauses, sentences), discrete pictorial symbols (pictographs, arrays of pictographs), and unified, synoptic pictures? How do all these questions relate to training in basic skills and working methods? Questions of this kind appear to be fundamental in relation to the processing of visible language. They can be formulated relatively easily; but how are they to be answered?

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