Manual of Tactile Graphics

Foreword

Integration of the blind into the wider society has been gradually progressing through a great variety of channels. However, there is no doubt of the impulse given to integration by the various inventions which have given the blind access to sources of information and education, or given them greater knowledge of their environment - from the revolutionary discovery of Braille to the latest products of the new technologies.

Much remains to be done, however. The scope for drawing techniques which can communicate with the blind remains an experimental field still needing to be developed. Nonetheless, in the last few years, discussion and practice in this field has become steadily more widespread and more systematic. The debate is open and promises to produce important results in the future.

Precisely for this reason, I believe that the contents of the present manual - made possible through the generosity of the Lions Club of Roma Parioli - are of great interest. For the manual provides a description of the basic techniques of tactile drawing - which can then serve as the basis for informed debate among teachers and other experts. *Disegnare per le mani* has the great merit of being a comprehensive introduction to the techniques of tactile drawing which can serve as a reference point for investigators and practitioners.

Research and practice needs to be developed hand in hand in all aspects of the techniques of representing graphic reality to the blind or visually impaired. I am thinking here of the complex problematic of the psychological assumptions lying behind tactile graphics; of the general principles which should guide those designing the drawings; of the printing and production techniques (where we can expect rapid growth of new ideas and experimentation in the near future); of the areas where the techniques can be most suitably used; of standardization of the symbols used, and so on.

It is essential to increase the numbers of those - teachers and others - who use relief drawing, and to increase their level of knowledge and skill. Only in this way, will it be possible to have a meaningful debate over relief drawing, for otherwise discussion is bound to remain vague and woolly. This manual has just that aim of enlarging the circle of those who actually use what, in the past, have too often been techniques employed by isolated individuals improvising as best they could.

The more relief drawings that are produced, therefore, and the more skilled are the people who produce them, the more opportunities the blind will have to assess the real usefulness of the graphics they are offered. For, let us not forget, it is the blind who must be the final judges as to what genuinely expands the capacities of someone who has lost the use of their sight.

Tommaso Daniele

National President,
Italian Association of the Blind
(Unione Italiana Ciechi)

Preface

This manual gives a general outline of the techniques of tactile graphics for the blind and visually impaired. We try to show, in practical terms, how it is possible to use tactile drawing as a fundamental means by which the visually handicapped can get to know their environment.

Several books have been published on tactile graphics recently[1], a sign that an area which for a long time was neglected in psychological and educational theory and in the practice of teaching is now creating interest. Our book aims to give a more explicit and systematic account of the techniques, going beyond the excessively ad hoc approach which has often prevailed.

Two trends have made a more systematic approach to the subject possible. Firstly, more and more teachers and others in direct contact with the blind have been trying out various kinds of tactile graphics in various countries over the last few years. Secondly, research and discussion regarding the psychological implications of relief drawings has progressed, and has created the basis for a solid grounding for techniques which give the blind access to the world of pictures[2].

Our book rests partly on the practical experience we have acquired over the years, but also on discussions and collaboration with a large number of teachers and researchers in various European centres - especially the Cité des Sciences et de l'Industrie in Paris, and the Centre National d'Etudes et de Formation pour l'Enfance Inadaptée at Suresnes. This collaboration has recently focused on research into thresholds of perception, financed as part of the European Union programme "Horizon".

We therefore felt that it was time to present a brief synthesis of what has so far been achieved - results which constitute a fairly solid base which practitioners can stand on. We are well aware, however, that much work remains to be done. Indeed, one of the things we have tried to do in this manual is to separate discussion of the general characteristics of tactile graphics from other related subjects which, at the current stage of knowledge, are hazier. Among the most important of these areas, we might mention: - techniques for teaching visually impaired children to read tactile graphics and, more in general, techniques for teaching blind people who have no previous experience of drawing; the working out of specific techniques for particular types of drawing - such as geometry, technical design, drawings of nature or of architecture; the aesthetics of relief drawing; drawings by the blind themselves, and many other fields.

In all these areas research and experimentation will have to continue for many years. What we hope to do is to provide a preliminary framework which will encourage many more practitioners to get involved in these problems themselves, so that they will be able to accelerate the development of a form of communication which certainly holds great promise.

1 See, in particular, P. K. Edman, *Tactile Graphics,* New York, American Foundation for the Blind, 1992; and Y. Eriksson, *A Guide to the Production of Tactile Graphics on Swell Paper,* forhcoming, Swedish Library of Talking Books and Braille.

2 See, among others, Y. Hatwell, *Toucher l'espace: la main et sa perception tactile de l'espace,* Lille, Presse Universitaire de Lille, 1986; J. M. Kennedy, *Drawing and the Blind. Pictures to Touch,* New Haven and London, Yale University Press, 1993.

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In designing the drawings we have drawn on the following works:

C.Bessigneul, H.Corvest, J.C.Morice, F.Ragoucsy, *Des clés pour bâtir,* Paris 1991.

F.Levi, M.Rolli, R.Rolli, *Torino sottomano,* Turin 1988.

Parco del Gran Paradiso, *I sensi in gioco – Percorso naturalistico di Ceresole Reale,* Turin 1992.

Regione Autonoma Valle d'Aosta, *Percorso naturalistico di Bois de la Tour,* Sain Nicolas, Aosta 1991.

Note on the drawings in this book

The drawings in this book have the function of illustrating the points made in the text. It would be a mistake, therefore, to think that they could all be presented to a blind reader as they stand. For reasons of space, in fact, we have had to reduce some drawings to a scale which is suitable for a sighted person, but too small for someone using touch. It would not always be appropriate even just to enlarge these drawings (e.g. with a photocopier); for although this would make the overall dimensions of the drawing more suitable, it would also enlarge the lines, dots and planes which make up the drawing. These graphic elements should normally be kept to roughly the size they appear here.

Many of the drawings, however, are suitable to be translated into tactile form as they stand. These are figures 2, 3, 4, 6, 7, 8, 10, 11d, 12, 13, 16, 18, 20, 22, 23, 25, 27, 28, 29, 30, 32, 33, 34, 35, 36, 38, 39, 40, 41, 42, 44, 51, 52, 53, 54, 59, 62, 63, plus, of course, all the plates (from I to VI).

Chapter 1

Drawing in Relief

1.1. A little history

In the last two centuries or so much progress has been made in designing tools to help the blind to broaden their knowledge of their environment. Apart from Braille and more recent methods for transmitting words, gradually more appropriate reduced scale models came to be produced - models of household objects, buildings, animals, and many other things. It was only natural that a verbal description of the world should be supplemented by a more direct and unmediated approach which exploited to the full the great possibilities of touch.

After these models came maps and plans in relief. These are particularly well suited to represent the crinkled surface of the Earth. In the case of maps, of course, the function is not just to make the bulk of mountains and valleys tangible to someone who cannot see; for relief also makes it possible to pick out symbols which transmit a great deal of information - so it is possible for a blind reader to recognize the course of a road or a railway line, or the sign indicating the difference between a village and a town which is a provincial capital, and so on. More recently, these bas-relief or high relief techniques have been extended to areas other than geography and topography.

Representations of buildings and architecture, pictures for children, and various teaching aids have become accepted as standard informational and educational tools for the blind.

More recently still, a quite separate but very exciting technique has become widespread - tactile drawing. Here, the relief no longer directly corresponds to the shape or bulk of what is represented. Instead, it relies on tactile perceptions of points, lines, planes and other elements to make up a picture in the reader’s mind. In other words, tactile drawing communicates to the reader the essential form of objects - including their volume - and the relationship between one object and another, while remaining strictly at the level of two-dimensional representation.

Figure 1 shows three drawings of dwellings - a bungalow, a house and a block of flats (Please refer to the drawings in the Italian text.). These are drawings which have been especially designed - when produced in relief - to be read by blind people. At first glance, they may seem simplistic. But someone who is blind will not be "glancing" at these pictures, but touching them; and it is well known that, although the sense of touch has great potential, it is much less precise and discriminating than sight. In any case, simple though they may be, these drawings communicate more information rapidly and effectively than an oral description would. In addition, they can be produced far more easily and cheaply than three-dimensional scale models, or a series of images in bas-relief or high relief.

This does not mean that words, three-dimensional models or high relief representations have suddenly become obsolete. On the contrary. Each technique should be used when most appropriate, and when its potentialities can be exploited to the full. So we should not have any a priori preferences, but make a cool assessment of the limits and advantages of different techniques in any particular case.

This manual is based on an approach of this kind. We try to explain the differences between tactile drawing and other techniques of representation. We aim to give a clear, comprehensive guide showing how to produce effective drawings for someone who cannot see. For pictures designed on a piece of paper but intended to be perceived by touch need to follow criteria which are partially (though only partially) different from those of ordinary drawing. In the same way that draughtsmen need to learn techniques which transmit information efficiently for the eyes of their clients, anyone designing for the fingers of a blind person needs to adapt their techniques to the specific needs of their readers.

Whether draughtsmen are drawing for the eyes or for touch, they should never forget they are "translators" - that is to say, mediating between the surrounding world they are drawing and the public they are addressing on any particular occasion. They need to be skilled in picking out those elements of the object being represented which are most relevant, and then at "translating" those elements into a language which is as clear as possible. This implies keeping to a code which is: - easy to interpret; already familiar to the person receiving the message; always the same. Otherwise the information cannot be effectively communicated and confusion is inevitable.

This implies that it is always essential for designers of materials to identify with those who will be using them. In our case, of course, this means the blind. It is not easy to acquire this capacity to perceive the world as it is perceived by others, especially at the beginning; but nor is it extraordinarily difficult - it simply involves the capacity to become aware of, and imagine doing without, the habits one has acquired as a sighted person.

1.2. What tactile graphics are for

Among the many misconceptions which have bedeviled our understanding of blindness, one has been particularly persistent - the idea that the world of images is the domain solely of the sighted, and that the blind are inevitably confined exclusively to the world of words.

Research and experience do not support this misconception. Even someone who has been blind from birth is capable of perceiving patterns with a spatial dimension in a way which is not radically different from that of a sighted person. The most one can say is that the number of images a blind person can master may be much less numerous than those of a sighted person; for someone who is blind has to work much harder at collecting and memorizing images from the outside world. And they are likely to be much less complex images than those of someone who can see, since a blind person has less direct contact with reality.

We need, therefore, to reverse our reasoning. If the blind are short of images, we need to offer them more - not exclude them *a priori* from a world which is wrongly thought to be inaccessible to them. At the same time, we know that early training and continuous exercise of the mind are essential if we are to develop our capacities to the full. This is one more reason why we should multiply our efforts to compensate for the handicaps of blindness.

There would be no point, of course, in raising unrealistic hopes, and fostering the idea that a more systematic use of tactile drawing (or related techniques like high relief or three-dimensional scale models) could give sight to the blind. The aim is the more modest one of providing day-to-day help in the difficult task the blind face of coping better with the world which surrounds them.

Let us look now at what kind of information tactile drawing is able to transmit. First of all, it provides information about aspects of reality which could not otherwise be grasped except via verbal descriptions - which are often inevitably vague and misleading.

So tactile images can provide indispensable information, for example, regarding anything which is too large for a blind person to put their arms round - whether this is the Statue of Liberty (fig. 2), or a geographical territory (fig. 3).

The same applies to small objects which cannot be touched - such as a butterfly (fig. 4), clouds, steam from a train, fire or snowflakes.

But relief drawings can provide the blind with means of understanding and orienting themselves towards those "taken-for-granted" objects of everyday life which we tend to forget the blind may not be familiar with (fig. 5).

Other objects may be intrinsically difficult to grasp - and may be rendered visible by drawings of varying degrees of realism. This applies, for example, to internal organs like the stomach (fig. 6).

Another major area is that of abstract images like geometrical shapes, graphs and charts, diagrams, patterns, etc. (fig. 7).

Lastly, we might mention symbols. These have great utility in themselves, but in addition they are important because they can help blind people become accustomed to the world of drawing and its conventions (fig. 8).

All these kinds of information are normally inaccessible to the blind; yet tactile graphics make them part of the blind's experience.

This could imply a much richer and more complex mental world for the blind. For example, it could be possible to transmit the idea that anything in the physical world - a woman's face for instance (fig. 9) - may be viewed from a number of points of view. This is by no means a trivial discovery for someone who has to rely on touch, and for whom the idea of "point of view" does not have immediate, intuitive meaning.

We might expect tactile drawing to encourage greater flexibility in cognitive processes, too. For example, it should make it easier for a blind person to move from a whole to its parts and back again; whereas normally, someone who is blind is forced to adopt a very close-up approach, and in very many cases this means perceiving just part of an object at a time. Fig. 10 shows how different it is to be able to consider a candelabra as a whole rather than as a series of individual parts.

1.3. Some basic principles of tactile graphics

Anyone designing relief graphics is designing for a reader's fingers. It is essential to bear in mind the specific nature of tactile perception. Certain general principles are worth listing.

Firstly: the sense of touch is much less able to discriminate than sight. Fine detail cannot be perceived via touch, and lines or points too close to one another will be perceived as joined, lines which are very short will be missed, and so on. This means that it is necessary to draw very simply, just capturing the essential. It is no good thinking it is possible to transmit the same amount of information contained in an ordinary picture for sighted people of the same dimensions. On the contrary, a tactile drawing which is too rich in detail will just confuse and discourage the reader.

Secondly: it is obviously not possible to perceive colour or variations in lighting through touch. So shading of all kinds must be eliminated from tactile drawings - and any reference to colour, of course. This does not mean that shading and colour may not be added to a relief drawing afterwards. As will be explained, some techniques allow for this - letting the partially sighted use both their sense of touch and their residual vision.

Thirdly: although recent research has shown that even those who have been blind from birth are capable of grasping perspective, this entails overcoming considerable difficulties. It should be clear, therefore, that attempts to communicate the third dimension via perspective techniques cannot normally be incorporated into tactile drawings. Other techniques need to be used to give an idea of bulk and depth. We explain below that techniques like orthographic projections are more efficient for someone who is orienting himself via touch.

If we bear these three principles in mind, it should be clear that tactile drawing has to make do with a much more restricted range of graphical resources than ordinary drawing. Consider, for example, fig. 11a. This is a typical picture designed for a sighted person. Translating this kind of picture into a tactile drawing produces badly confused and misleading drawings (such as figs. 11b and 11c). Anyone drawing for the blind has to be prepared to give up their "sighted" point of view, and keep to the restrictions imposed by the medium. So it is only the extreme simplicity of the drawing in fig. 11d that is really suitable for the hands of a blind person.

In other words, someone using tactile graphics needs to be highly circumspect in using the resources familiar in traditional drawing, and needs to follow strict guidelines like those given in this manual. In addition, however, it is important to have a clear idea of the codes of tactile drawing in order to be able to help someone who is blind learn the principles which are necessary to understand a tactile drawing. The learning period is not long, but we should not expect blind persons - particularly children of school or pre-school age - to grasp a simple drawing as quickly as a sighted person would. Any blind person has to pass through a period of apprenticeship before they will be able to interpret a tactile drawing properly, and before they are able to decide adequately whether the technique is useful for them. Even when this brief apprenticeship period has been completed, while reading any individual drawing a blind person needs time and patience and, above all - this is really crucial - adequate verbal support.

None of this detracts from the communicative efficiency of relief drawing, nor from the fact that it performs functions which words and other means cannot. But a precise awareness of the limits of tactile graphics and of the special characteristics of the medium are essential if we are to make best use of the techniques available.

1.4. How the fingertips explore a tactile drawing

To explore a tactile picture, the reader runs the fingers of both hands rapidly back and forth over the surfaces of the picture. The perceptions acquired gradually come together to form mental images which become progressively more detailed and complex.

Since the mental image builds up gradually, it is not possible for a reader to have even a rough overall idea of the picture, or what it represents, at the beginning. A little time is required before any significant understanding is obtained.

On the other hand, it would be wrong to think of the process of exploring a picture as a simple linear accumulation of information, or as a mechanical succession of procedures which is the same for every picture. The working of the fingertips is very complex and changes greatly from one situation to another. It depends, for example, on the shape of the image and on how complex it is; on the experience of the reader, and on other personal characteristics; on how much the reader wants to get out of any particular picture; on the time the reader thinks s/he has available to read the picture; on the provisional understanding of the drawing which has already been acquired; on the outside help available, and so on.

Each situation is therefore unique. Notwithstanding this, some general principles remain constant, and these need to be borne in mind. The first is that only when the fingers are in movement can they feel relief - once they stop moving, their capacity for perception decreases rapidly. For this reason, readers may run their fingertips over the same area of a drawing several times, perhaps approaching it from different directions, or moving at different speeds. This means that the surface of a tactile drawing - both the raised parts and the base - should be as smooth and as pleasant to touch as possible.

A second principle is that, in general, effective readers alternate between an overall survey of a picture and an exploration of details. They have realized that a step forward on one of these dimensions can make possible a step forward in the other. To take the example of the picture in fig. 12, it is the detail of the two fingers pointing upwards which shows that the picture is a representation of a hand; but it is only the vertical position of the arm, and the fact that the two other fingers and the thumb are folded inwards which shows that the index finger and forefinger are extended in a victory sign. In general, it is true that identifying a part is a good clue to the whole, but that a clearer sense of an image's overall meaning is also a good key to guessing details.

It should be noted, however, that although both orientations are important - recognizing overall meaning in order to interpret details, and analyzing details in order to get a better idea of the whole - it is the first which is more crucial. It is only when a reader has a clearer overall conception of an image that s/he will be able to reduce the range of possibilities and have a good chance of identifying details. In fig. 12, the identification of the V-shape formed by the two fingers could, on its own, outside of the context of a hand and arm, have an enormous variety of meanings. For this reason, especially at the beginning, readers' fingers usually seek out the overall pattern of a drawing, the general outlines, so as to be able to form a preliminary idea of what it represents.

This implies that it is necessary to give a reader - alongside the drawing itself, a written explanation which describes what it is. This helps to overcome initial disorientation. Words can provide crucial initial clues and frameworks of interpretation - and thus give pictures the chance to perform their specific function and communicate what words would never be able to.

1.5. Who this handbook is for

This manual deals with tactile graphics as a technique for communicating information about the physical environment to the blind. We are therefore writing primarily for sighted people designing pictures for the blind. We will not deal with, for example, the drawings produced by the blind themselves - notwithstanding the evident interest of this subject.

In addition, we should specify that when we talk of the blind, we have in mind primarily persons who are completely sightless - either because they have been blind from birth or because subsequent accident or disease has left them without any residual sight. Tactile drawings should be designed primarily for people who are in the worst situation regarding powers of sight. This does not imply, naturally, that tactile graphics may not be fruitfully used by partially sighted people who use touch as an additional medium.

Finally, it is important to emphasize that the approach to tactile drawing should vary in accordance with the age and especially with the degree of experience readers have of visual representation. This guidebook will not deal with this question to any significant extent, since it merits separate discussion. We just try to outline the general characteristics of tactile drawing. Subsequently, those who are interested will be able to go on and acquire more specific skills and techniques - e.g. those especially suitable for readers with a particular level of education or general knowledge; or those techniques most appropriate for those who are accustomed to adapting themselves to blindness, and to using tools like Braille, as against those who have become blind recently and who tend to resist using tools specifically for the blind.

It has already been stressed that any person needs some training before being able to interpret images. In this, the blind are no different in principle from the sighted - who may be accustomed to "seeing" the surrounding world, but who still need to learn to "look" and to "read" the images which surround them. How training for tactile images ought to be organized is an undeveloped area. It will be necessary to work out methods for training child or adult readers to imagine the real objects which pictures represent, or to master the elements of relief drawing. We repeat that this introductory manual only aims to provide a base from which it is possible to start.

Chapter 2

How to Simplify Pictures

Before starting to draw, it is essential to carefully analyze the things which are to be represented, so as to choose which elements should be kept in the picture, and which left aside. Once again, any form of representation, whether it is for the blind or the sighted, always involves making difficult and often painful choices, for many details will have to be cut. Many details which seemed so important when one starts to draw will, in the final analysis, be recognized as dispensable.

Drawing in relief is no exception to this general principle. Indeed, because tactile drawing does without so many of the refinements of ordinary visual drawing or painting - doing without perspective, shading or colour - it demands particularly drastic preliminary selection of the elements to be represented.

So we may say that the first rule anyone producing relief drawings has to keep to is that a large amount of information needs to be eliminated. This does not mean, however, producing pictures which are vague or over-general.

The picture of Turin cathedral shown in fig. 13 gives an overall idea of the kind of simplification which must be obtained in drawing the front of a church.

It is not easy - indeed, it is probably impossible - to give clear criteria which would apply to all situations to indicate what are the most important elements to pick out in a drawing. In general, it may be said that someone preparing a drawing should aim at a simplicity which captures the essence. This means that the draughtsman must always try to get to the deep sense of whatever is being represented.

Take a couple more examples - another architectural one (the Eiffel Tower in fig. 14), and a topographical one (the map of the town centre of Turin in fig. 15). In the picture of the Eiffel Tower what comes out clearly, apart from the shape, is the criss-crossing pattern of the metal structure; although this is simplified, it comes over clearly. In the map of the centre of Turin, the overall pattern formed by the principal streets is simplified and emphasized; this creates a pattern which is easily recognized and memorized, but at the same time specific to Turin, so not over-general.

Let us try and give more precise guidelines. The first rule to bear in mind is that any drawing should make the overall shape clear; so the borders of objects should be as clear as possible. This is not always easy to achieve. Fig. 16 shows a tree with foliage which presents a very ragged outline; in this case, too close adherence to the real shape would produce an over-detailed and confusing image which could not be properly distinguished by the fingertips. The relief drawing suggested in fig. 16 simplifies the outline adequately.

Obviously, objects should normally be presented whole; objects which are half hidden by others are difficult to recognize and tend to cause confusion.

When very complicated shapes and lines need to be represented, an attempt should be made to simplify them; consider the case of a highly indented coastline, or very irregular boundaries between states on a map. Once again, some stylization is necessary (fig. 17).

In many cases the border of an object cannot be precisely defined - as when a shape is very irregular or very dispersed. In this type of case, it would be a distortion to base a drawing on an outline. It is better to try and capture the various elements which make up the object by portraying its internal structure.

An example is given in fig. 18, where a representation of a pine tree reduced to a simple triangle is contrasted with an attempt to convey the overall structure of the same tree, albeit in simplified form.

An approach which conveys an outline of an object does not, of course, exclude one which communicates an inner structure. Many effective drawings combine the two approaches.

Someone designing a tactile drawing needs to give an idea not just of the overall shape and structure of an object, but also a precise idea of essential details. Here it is necessary to choose among the almost infinite possibilities. It is a useful guide to think of the "unique" features which mark out an object as specifically that object. For example, in the description of a historic building, a drawing of a window should contain the essential features of the architectural style of the building in question. Fig. 19 portrays a window of Palazzo Carignano in Turin, bringing out the distinctive form of the decoration, which recalls the headdress of an American Indian chief. The principle is similarly illustrated in fig. 20, which emphasizes a particular shape of nose as the most distinctive trait of a particular individual's face.

Sometimes the most distinctive detail of an object will be very small. In this case, it may be represented separately on a larger scale.

Since it is necessary to simplify the images of tactile drawings in order to avoid giving too much confusing information, it will normally be necessary to eliminate background, and all the information that contains. So in the drawing, the background becomes smooth and anonymous. However this makes it far more difficult to convey the specificity of situations, and of objects whose meaning depend on their surrounding context.

It is a very different matter to see a boat against the background of a raging sea, and to see the same boat completely divorced from any context. The lack of background in tactile drawings is, therefore, a very serious limitation to the technique's communicative capacity. For this very reason, it is essential to think hard about how the information lost can be transmitted by other means.

As we have already said, tactile drawing does not make use of perspective since this does not fit in well with the approach blind people adopt to reading a picture. This has two consequences. The first - which will be discussed later - is that other techniques must be adopted to convey the third dimension. The second consequence - which is more directly relevant here - is that without perspective it is much more difficult to convey continuity in space, and distances and relationships between objects.

For example, unlike in an ordinary drawing for sighted people, in a relief drawing the different sizes of objects relative to each other no longer give an idea of the distance between them. When fig. 21 is explored by touch rather than by sight, the connection between the pedestrian and the car tends to be completely lost. The car, which is smaller than the woman, is not "seen" as an approaching danger for the pedestrian; a reader might even interpret it as a miniature model in the picture by chance. In any case, the pedestrian and the car tend to be perceived as essentially separate from each other.

This is, therefore, another intrinsic limitation of the medium of tactile drawing, and of the simplification of images which it requires. This limitation can to some extent be overcome by an explanatory text accompanying the drawing.

Very often drawing pictures which will be reproduced in relief involves removing features which make an object aesthetically pleasing to the eye. Of course, sometimes simplicity can be synonymous with beauty. And we certainly do not wish to assert that aesthetic criteria should necessarily be ignored in drawings for the blind. However, normally the prime function of tactile graphics is to convey "useful" information regarding the characteristics of this or that object and its relationship to other objects.

In this manual, we do not deal with the aesthetic aspect of relief graphics (while recognizing the importance of the subject). We simply wish to point out that when an image is simplified, this tends in any case to accentuate its "functional" side. An object like the telephone, for example, (fig. 22) tends to lose its peculiarities and become a stylized image which will be roughly the same in all pictures, for this makes it easier to recognize by touch.

This does not mean that it is impossible to draw telephones of all shapes and fashions. But the demands of simplification impose limits to the extent to which the variety - and hence also the beauty - of objects in the external world can be effectively conveyed in tactile drawings. It is as well to be aware of this when making decisions as to how to go about drawing a particular object.

Finally, simplified drawings designed for reproduction in relief tend to give an idea of the world as being a good deal more orderly than it is in reality. This may mislead a blind reader.

Take, for example, a jug and glasses placed irregularly on a surface. In a simplified drawing for a reproduction in tactile form, these will be neatly lined up and separated from each other so that they can be easily recognized by touch (fig. 23). This rearrangement abolishes most of the casualness of the original positioning in space.

After having analyzed these various aspects of simplification of drawings, we can restate in more precise form the point we started out from - the comment that it is by no means easy to find the right balance between images which are too detailed and carry too much information, and those which are too skimpy and oversimplified.

Given the greatly reduced range of resources which it has at its disposal, tactile drawing faces (even more sharply than drawing for the sighted) an acute dilemma. On the one hand, there is the risk of drawing an object in so general a form that it loses all its distinctive features. So a chair of a distinctive style (fig. 24) may be transformed into a completely anonymous object (fig. 25). On the other hand, there is the risk that - in circumstances where it is more essential to portray a chair in general - a failure to pick out the essential may lead to a drawing which is weighted down with superfluous detail (fig. 26). It is not easy to know how to simplify the innumerable types and shapes of chair which exist in the world, and choose a form which is adequate for particular circumstances. In some cases, an image like fig. 27, without too much detail, but not too easily confused with other types of artefact, may be the most appropriate.

Chapter 3

Choosing Appropriate Graphics

3.1. Format

At least three essential criteria need to be borne in mind when choosing the format for a tactile drawing.

Firstly, a size should be chosen which allows a reader to "see" the overall shape of whatever is being represented in its entirety easily. This means a size which more or less corresponds to the span of the hands placed side by side.

Secondly, make sure the edges of the sheet of paper on which a tactile drawing is printed provide useful guidelines to the boundaries of the picture.

Thirdly, for the sake of simplicity and so as to keep printing costs down, try and keep to standard sizes used in the printing industry.

An A4 format (210 x 297 mm.) meets these three criteria, and is commonly used for tactile drawings. The rectangular form allows the reader to perceive clearly the difference between the horizontal and vertical, and as far as size goes, it corresponds roughly to the span of the hands with the fingers spread out.

Much larger sizes than A4 tend to be counter-productive. The hands tend to get lost on the drawing: if the hands are too distant from each other, it becomes impossible to know where one hand is relative to the other, or relative to the edges of the paper. In addition, a large sheet is liable to have too much information on it, and this will be difficult to assimilate all at once.

Confusion may also be created if readers are presented with drawings in formats which are continually changing.

3.2. Scale

Any representation in relief of a real object must keep strictly to the scale which has been decided on. The proportions between different parts of the object must also be respected, naturally, and the proportions between different objects in the same picture.

The scale for a drawing should be decided bearing three factors in mind. The first is the format of the paper. As we have said, it is better to keep the format constant, which means that the scale has to be smaller or larger, according to the real size of the object or objects represented. A butterfly will have to be enlarged, an elephant scaled down.

Secondly, it must be possible for the fingertips to feel those features of the picture which are considered most interesting. This will usually include the outline of the overall shape - the profile of an apple, a house, etc. - and the details thought to be most relevant - the stalk, the chimney, etc. If a detail would be too small to be easily perceived by touch, it can be drawn separately on a larger scale.

Thirdly it should be remembered that, in general, the smaller a drawing is, the quicker it will be recognized. This applies especially to the overall shape - the outline of a house, a car, a household object, etc. The smaller the drawing is - provided that the essential features can be easily picked out by the fingertips - the fewer movements the fingers have to make over the paper and the quicker the reader will grasp the sense of the image.

The scale needs to be clearly indicated on every drawing. The most effective symbol for indicating scale consists of a 5 cm. line broken into five equal segments (fig. 28). Any segment then represents a given distance, according to the scale adopted: e.g. 1 = 1m., 1 = 10m., 1 = 100m., and so on. This scale symbol should be placed in the bottom left of the sheet of paper. It may be positioned either horizontally or vertically, depending on how the object or objects represented are oriented on the paper.

Sometimes, especially in pictures for children, other scale symbols are used, which may be more immediately comprehensible. The stylized figure of a man (fig. 29) is often used to indicate the size of a building; a life-sized (1:1) drawing of a coin may be used to show the size of an insect (fig. 30), and so on.

In more complex series of drawings - for example those in an architectural guide to a city - there may be a final sheet at the end of the series which sets different buildings alongside each other in order to provide a more direct comparison of comparative size (fig. 31).

Having stated the above rules and guidelines regarding the scale of drawings, we are forced to admit at once that there is one important and frequent exception. It is often impossible to make all the parts of a tactile drawing conform strictly to the same scale. The lines which make up a drawing must not be thinner than a certain minimum, otherwise they cannot be perceived by touch. In the same way, in order to make sure that details kept within the main drawing can be easily perceived by a reader's fingers, they may need to be drawn on a slightly larger scale.

3.3. Layout of a page

The sheet of paper, with its fixed edges and its centre, makes up a system of coordinates by which readers can orient themselves, and a drawing has to be carefully located within this space. First of all, however, it is necessary to decide which way up the sheet of paper is to be read. In the case of A4 format, it is preferable as a rule to use it sideways, with the long side as the base - since the two hands, placed side by side, in a natural position, with the fingers spread out, fit the paper better this way.

However, this rule should not be adhered to rigidly. Many drawings inevitably extend upwards and downwards more than horizontally. It will therefore be necessary for the reader to rotate the page through 90 degrees. Every drawing, therefore, should include an arrow in relief showing which way is up (see plate 1). This arrow should be placed in the bottom right corner of the page.

The page number should always be placed in the upper right hand corner of the sheet.

If the drawing or graphic has a title, it is essential to begin this in the top left corner of the page; this arrangement makes the best and most regular usage of the space available on the page.

The drawing itself may occupy the whole page, except for a margin of at least one centimetre along all four edges of the sheet. These margins are necessary for two reasons. Printing techniques often produce imprecise or blurred results at the edges of a page. In addition, since a tactile drawing consists of images raised in relief, it can only be properly perceived when it protrudes above a smooth, flat background extending on all four sides around the raised parts.

In some circumstances, it may be helpful to the reader to indicate ground level with a line. However, this is only appropriate when the ground is an essential part of the representation - as is the case, for example, in a drawing of a building - and when it will not lead to possible confusion.

3.4. Dots, lines and planes

3.4.1. The significance of relief

In general, it is the features raised in relief which we want to attract readers' attention to. Normally, therefore, it is the objects being represented which stick out clearly from their background.

This does not mean, however, that, in tactile graphics, the height of relief has any necessary relation to the height or depth or volume of the object represented. Nor, vice versa, does it mean that an absence of relief indicates empty space surrounding an object. The kind of relief drawing described in this manual differs from the various high relief techniques which have traditionally been used with the blind precisely on this point: there is no relationship between relief and volume. It is perhaps worth reiterating that high relief and tactile drawing are two completely separate techniques of representation. Both are important and have their uses, but each has its own special characteristics.

In tactile graphics, the main function of relief is to render the dots, lines and planes which make up a drawing perceivable to touch. These dots, lines and planes, and the way they are combined together, draw very different things in different pictures, depending on what we want to represent, and on the way which has been chosen to represent it.

Take the example of a town plan drawn to a relatively small scale (fig. 32). Normally, the streets will be indicated in relief, but not the buildings. This means that the raised parts in the map correspond to something which in ordinary life is usually perceived as empty space and as an absence of buildings or other constructions. In the map, the streets are indicated in relief because they are seen as important and we want to focus readers' attention on them.

On the other hand, when a map is drawn to a very large scale, as a plan of a park might be (fig. 33), and the aim is no longer to focus readers' attention on the route but, say, on the location of the benches and of the trees in an avenue, the approach changes. In this case, relief is used for symbols which indicate benches and trees, while the road becomes background, empty space - an empty space which is, however, bordered by the surrounding outlines which show where the edges of the avenue are, and in which direction it runs.

This, then, is what relief is used for in a tactile drawing. Now let us move on to the various signs - the dots, lines and planes - which any relief drawing is made up of. We will consider the possible uses of each of these fundamental elements of a relief drawing, remembering that they will always only be felt, not seen - a fact which makes many signs used in drawing for sighted people impracticable.

Only a clear awareness of the limits and constraints imposed by the fact that perception is solely through touch makes it possible to use tactile graphics effectively and to the full.

3.4.2. Dots in relief

The dot of the Braille alphabet (plates II and III) is the smallest dot which it is practical to use in a relief drawing, unless the dots serve simply to trace a line (i.e. a dotted line) or to fill in a hatched space. In these cases it is possible to use finer dots because what counts is the effect of a number of dots next to each other in a line or covering a surface.

However, Braille dots should never be used in a tactile drawing except for any writing it may contain - otherwise readers may try to interpret what they imagine to be mysterious or incomprehensible letters or groups of letters.

For this reason, if a drawing requires individual dots, these should be larger than the Braille dot, or in any case not of a kind to be confused with the latter.

The distance between dots, and the way they are grouped together in a drawing, also must not cause confusion with Braille. Braille of course has fixed patterns and fixed dimensions - so keep away from these.

If it is too big, a dot ceases to be a dot and becomes a plane, thus changing its communicative function. However the point where a dot stops being a dot is not only a question of size - and thus a problem which could be solved just by avoiding dots larger than a certain number of millimetres in diameter. For it depends also on context, and on the meaning which that context gives a dot or a plane. For example, in a geometrical figure a dot at the centre of a circle will still be the centre of a circle even if it is large. Whereas the dots which are drawn on the side of a ship to represent the portholes are likely to lose their meaning if they become too large.

3.4.3. Lines in relief

Beneath a certain threshold a line in relief is difficult to perceive. This threshold is roughly 0.5 mm. of width.

Relief lines must not be brought too close to one another, otherwise the fingers will perceive a single line instead of two separate lines. This minimum distance is around 2 mm.

These are, however, only rough thresholds. There are several reasons for this. The ease with which a line can be perceived does not only depend on its width, but also on the height of the relief, on how much resistance it offers to the fingers passing along it (some printing techniques give stickier lines than others), and on its shape in cross-section. So a relief line with rounded edges is less effective than one with sharper, more "aggressive" edges, which sticks up more brusquely from the paper. In addition, the effects of width, height, resistance and shape in cross-section all vary with different printing techniques - so someone designing a tactile drawing has to think of what will be most suitable for the reproduction technique being used. All this means that anyone designing drawings to be reproduced in tactile form needs to obtain some practice in the particular reproduction technique chosen.

As we have said, there is a minimum threshold under which a line cannot be readily perceived. But there is also a maximum threshold. A line which is too wide ceases to be a line and becomes a flat surface - so changing its communicative function. This is especially important in lines like those representing major roads on a map, where, if the line is too large, the finger has difficulty in following the direction of the line because it cannot feel both edges of the line at the same time. Obviously there are many other occasions in which it is important for a reader to be able to follow a line’s direction easily.

Dashed and dotted lines are more easily perceived by the fingertips than continuous lines because by stimulating the fingertips they continually recall the reader’s attention to their presence. For this reason, dotted lines in particular may be drawn thinner than a continuous line, and still remain easy to perceive.

A number of printing techniques make it possible to create lines of differing heights. As we have already said, these differing heights do not necessarily tell us anything about the height or size of the objects represented. Different heights constitute instead an added means which someone designing a drawing can use to communicate information.

In general, a line in relief can be used in at least three ways:

- as an "object". So a simple line may be used to represent something which is roughly linear in shape, or which is at any rate thin and long (fig. 34).
- as a border. In this case the line creates an outline around an area (fig. 35). We will return to this point when we deal with areas in relief.
- as an element in a pattern. Here however it must be remembered that the visual experience of hatching and contrasts of light and shade as a means of representing variations in lighting, shadows and differences in depth cannot be communicated by tactile drawing. In a relief drawing, hatching is only used to fill in different areas which need to be distinguished from each other because they have special characteristics or significance (fig. 36).

However a line in relief is used, irregularities which are so small that they would be difficult to perceive need to be eliminated. An irregular outline certainly should remain recognizably similar to the original, but its elements must be easily identifiable by touch (fig. 37).

Sometimes even irregularities which are easy to perceive, but are too frequent, need to be eliminated (fig. 38). The objective should be to simplify the outline so that it is easier for the reader to reconstruct the shape in his mind. If the outline is too complex, this process takes a long time and is frustrating.

In other cases, when an important curve is not readily discernible because it is only slightly curved in reality, or when a sloping line is only slightly oblique, it may be necessary to exaggerate so as to make the curve or the slope easy to perceive, and avoid uncertainty.

It is not always easy for the fingertips to distinguish a wavy line from a jagged line. Especially if the finger runs along the top of a line rather than sideways along the edge, it does not always manage to tell the difference between saw-like points and wavy curves. This is due to the rounded configuration of the fingertip. Once again, it is necessary to exaggerate the shapes to avoid confusion.

When two or more lines in relief meet, they should not meet completely - otherwise the fingers perceive a kind of knot. A small gap should be left at the joint. However, this must be so small that it is not noticed.

3.4.4. Planes in relief

To make sure that planes or surfaces in relief can be easily perceived, they must have a clearly identifiable shape and their outline should normally be closed on all sides.

In general, an outline in relief will not be enough, on its own, to give the impression of a plane. At least when the space enclosed by the outline is fairly large, the most effective way to communicate the idea that it is a solid surface is to fill in the outline with the relief equivalent of hatching. This can be quite light, just so long as it is distinguishable from the smooth background. Fig. 39 compares three possible ways of representing a solid surface - via a simple outline, a raised solid surface, and an outline filled in with dots as hatching.

When an outline is filled in with "hatching", there should be a gap of at least 2mm. between the outline and the dots or lines inside. Otherwise, the outline may not stand out clearly enough. If there is a very clear distinction between a particularly bold outline and very fine-grained hatching, a little less than 2mm. may be sufficient.

Various kinds of hatching may be used. Plate V gives some of those which are easiest to perceive.

Any particular type of hatching in a tactile drawing signifies something different from other types of hatching. So on a town plan, for example, all the squares with trees might be represented by one kind of dot, all the car-parks by dots of another type, and so on.

When the area enclosed by an outline is small, use fine-grained hatching. If you use large dots, lines or squares you will be forced to place them close together, and the fingertips may perceive them as a continuous raised surface.

It is important to bear in mind the relationship between the direction of hatching and the shape of an area which is filled in. For example, it would be misleading to fill in a long, thin area like that in fig. 40 with hatching that ran parallel to the long sides of the area. This would be likely to accentuate one dimension of the area at the expense of the others, and the shape would be difficult to perceive.

The shape of very small areas cannot be readily distinguished by touch. For example, a circle 5mm. across is not easy to distinguish from a 5x5mm. square. The minimum size threshold which it is practicable to employ depends partly on the thickness of the line used to draw the outline, and on how it is filled in (whether the whole surface is raised above the background or whether the outline is filled in with dots, etc.).

Planes which are too large also cause problems. Fingertips tend to get lost on large surfaces - they lose contact with the outline and cannot recognize the overall shape. This is especially true for smooth surfaces which are completely raised, rather than filled in with hatching; here the fingertips may even forget that they are on a raised area rather than on the background to the picture. In general, a plane is easy to perceive only when its boundaries can be touched fairly readily.

As between two lines, a minimum distance must be left between two planes placed next to each other, to stop them being perceived as one continuous area. As in the case of lines, this minimum gap is about 2mm. As with lines, the exact distance will depend on factors like the thickness of the line used to trace the outline, the shape of its cross-section, etc. - but also on the shape of the outline of one plane relative to another. So if one plane fits into another, like a mortise, the gap between the two areas will have to be larger than 2mm. (fig. 41).

At the same time, do not go too far in the opposite direction, and separate raised surfaces too much from one another. In tactile drawing, even distances which seem small to the eye may have the effect of separating areas from each other. So the reader may get the impression that the things represented by these areas are much further apart than they actually are. Remember it takes much longer for the fingers to build up an overall image, and therefore it is much more difficult for them to form an idea of the spatial relationship between the various components of a drawing.

As usual in tactile drawing, the height of a surface in relief has no necessary relation to the height or bulk of what is being represented.

Smooth, flat surfaces not raised in relief communicate different information when they are outside an object or when they are enclosed by relief. Surfaces of the first kind constitute part of the background to a picture, those of the second kind take on a meaning which varies with the context. They may represent a window, for example, a label on a notebook, or any number of other things (see fig. 42).

3.4.5. Relief of different heights

As we explain in a later chapter, with some printing techniques, it is possible to produce relief of differing heights on the same drawing.

We have already stated many times that one of the defining characteristics of relief drawing is that there is no necessary relationship between any differences in the degree to which relief protrudes from its background and the height or bulk of things in the real world represented in the drawing. This does not reduce the potential of relief drawing, but greatly increases it - for it widens the range of graphical resources at a draughtsman's disposal. Dots, lines and planes which are more prominent than others - in terms of how much they stick out from the background as well as in terms of width and length - make it possible to differentiate much more the elements which make up a drawing.

Take an example. We might want to represent a flat, patterned surface (say ceramic tiles or a painted window), where the decoration consisted of complicated geometric figures - some of which were more prominent than others (see fig. 43). It would be very useful here to use relief of different heights to distinguish between various elements of the pattern. Since a painted pattern of this kind is completely flat in reality, it is clear that the height of relief in the tactile drawing is in no way functioning to represent height or volume.

Having said this, it has to be admitted that the distinction between tactile drawing and bas-relief is not quite as sharp as we have implied. As we have said, there are intermediate printing techniques - like thermoform and gaufrage - which can be used to produce drawings in relief with different heights of relief, and also to produce bas-reliefs of varying heights. But another reason why the distinction cannot be made absolute is that although blind people's tactile knowledge of the size of objects can be partially transcended by training in the abstraction inherent in drawing, this direct tactile experience of objects cannot and should not ever be contradicted.

This means that while relief of differing heights is often used in tactile drawing to signal differences which have nothing to do with the real volume of the things represented - as in the example mentioned above - in cases where the objects represented in a drawing do have volume, if relief of differing heights is employed, this must not send messages which contradict the real volumes involved. For example, in a bird's eye view of a building which, in the real world, has parts which project up into the air to a different degree, if relief of different heights is used to distinguish the various sections of the building, this must take account of the relative heights of those parts. It would be quite wrong in this kind of circumstance to represent a part of the building which was lower in reality with relief that projected further from the background (fig. 44).

It should be emphasized, in any case, that higher relief on its own is not enough to distinguish one plane from another, or from the background of a picture. If you want to bring out the difference between one plane and another you need to add some kind of texturing (unless you are drawing a window, empty space, etc.). In cases like fig. 44, each part of the building needs to be differentiated by a different type of hatching: giving different heights of relief to different surfaces would not on its own be enough. The fingertips need to be able to tell clearly all the time when they are on one type of surface and when on another type. Otherwise they would tend to confuse one smooth plane with another, and with the background.

Chapter 4

Introducing the Third Dimension

As we have said several times already, in relief drawing, the height or size of the relief does not have the function of representing the volume of objects in the real world. Its purpose is simply to make dots, lines and planes perceivable to readers' fingers. But in that case, how can we represent the depth of objects? How can we introduce the third dimension in a way that is precise, clearly understandable and compatible with the simplified images of tactile drawing?

Anyone who is drawing for sighted people has a number of ways of representing the volume of objects. The main methods are perspective, axonometric projection and orthographic projection (plans, sections and elevations - giving a bird's eye view, a side view and a front view). Which of these methods is most suitable in a tactile drawing?

There is no doubt that perspective is the technique which allows an artist to create a drawing which is closest to reality as it appears to our eyes. However, the retreating lines of perspective - converging together on some distant point behind the picture - distort the objects represented significantly. The eye soon becomes used to looking at perspective drawings, and corrects for these foreshortening distortions. But matters are much more difficult for someone exploring a picture by touch, since the innumerable oblique lines and angles in a perspective drawing are difficult to interpret. Even a shape as simple as a cube becomes difficult to interpret for readers who have to feel their way around the lines which represent the sides or top of the cube (fig. 45). It is far from simple for a blind reader to "see" square faces in the irregular rhomboids used in the drawing to depict the faces of the cube which are not head-on to the observer.

Fig. 46 gives two different kinds of axonometric projection of a cube. Unlike perspective techniques, isometric and other axonometric projections give a precise representation of the dimensions of an object. Like perspective techniques, however, they also introduce distortions - making them difficult to interpret by touch.

4.1. Orthographic projection

This leaves us with plans, sections and elevations, technically known as orthographic projection - the type of top view, side view or front view given e.g. in fig. 50 or fig. 51. What is orthographic projection? A full explanation can be found in a manual of drawing - here we will just give a summary explanation and a few examples.

In an orthographic projection, the imaginary observer is situated at an infinite distance from the object and in an orthographic - i.e. right-angled - position to the surface being drawn. The projection lines coming from the object are parallel to each other and perpendicular to the plane which is being projected (i.e., the plan, the section or elevation). Orthographic projection gives an undistorted view of the object seen from the side, from the front, etc. - there is no foreshortening and dimensions are exact. Each view of the object (each plane or elevation) is drawn at right angles to another view (another plane).

4.2. How to introduce the blind to orthographic projection

The most effective method for the visually impaired to master orthographic projections consists of a series of gradual steps. The blind reader's hand needs to be guided over the surfaces of an object - the front, the side and the top - then shown how these correspond to front, side and top elevations stuck onto the inner surfaces of an open box we call a "projectometer".

The "projectometer" (fig. 47) is a simple cardboard model - a sort of cut away box - made up of three planes at right angles to each other. In fig. 47, the upright, vertical plane at the back of this open box is labelled P.V., the horizontal plane P.O., and the lateral plane at the side P.L. (front elevation, plan, and side elevation or section).

To use the projectometer, you take an object which can easily be recognized by touch - such as a cube - and place it in the "projectometer".

Now imagine that the object (in our case, the cube) projects images of its three types of face (front, side and top views) onto the sides of the projectometer. To illustrate this, you need to put reproductions of the three faces of the object onto pieces of cardboard, and stick these onto the walls of the projectometer. These pieces of cardboard obviously need to be the same dimensions as the faces of the cube, and easily distinguishable by touch. On the vertical plane (P.V. in fig. 47) of the projectometer you now have an orthographic projection of the front view of the cube; on the lateral plane (P.L.), a projection of the side view; and on the horizontal plane (P.O.), the plan.

You can then unfold the projectometer onto a flat surface. The three projections (front elevation, side elevation or section, and plan) thus lie side by side in positions which allows their relationship to each other to be understood (fig. 48). The same operation can then be performed with gradually more complex objects. Each time, the blind person must be allowed to feel the faces of the object, then to touch the images of these faces "projected" onto the sides of the projectometer.

4.3. The usefulness of orthographic projection in relief drawing

Orthographic projection constitutes a set of rules which are easy for a blind person to grasp; and the technique makes it possible to present different points of view of an object. Depth and the third dimension can be introduced as essential aspects not just of the outside world, but also of drawing. Orthographic projection is well suited to relief drawing for at least two crucial reasons. The first is that the point of view, contained in orthographic projection, of an observer situated at an imaginary, infinitely distant point is the most similar to the "point of view" which blind people's fingertips - in immediate contact with objects - have.

The second reason is that orthographic projection makes it possible to gain a precise idea of the relationships between the dimensions and bulk of different parts of an object. The blind person only has to consult the scale printed beside the drawing to be able to measure the exact dimensions.

The choice of how many elevations to present to a reader (front, side, plan, etc.) will depend on the information you want to communicate. Sometimes one view will be enough, as in the case of a coin (fig. 49). Sometimes at least two are needed, as with a drawing of a computer (fig. 50). In other cases, all three viewpoints are needed, as with a cow (fig. 51). In still other cases, a front projection may be supplemented by another projection of part of the object - for example, in a drawing of a church like fig. 52, the front elevation may be supplemented by a plan of the portico entrance. In some cases, it may be necessary to have up to six projections. A car, for example, might require five elevations: the two sides are likely to be the same, but the views from the front and back, top and bottom will all be different.

These different viewpoints may be presented on the same sheet or on separate sheets one after another. Naturally, if they are on the same sheet, it is easier to bring out the relationships between the different viewpoints: the fingertips can move easily from a feature on one view to the same feature on a different view and back again, building up an idea of the object's overall form in this way. Sometimes it may be useful to accompany a drawing projected from one point of view (say the front) with smaller scale projections of the three main elevations (plan, front and side) (see fig. 53).

If different elevations are drawn on separate sheets, do not introduce sudden changes in scale.

Chapter 5

Sequences of Drawings

In many cases, it is a good idea to divide the description of a complex object into a sequence of drawings. Graphical description of a car, an insect, a part of the human body, a town, or perhaps even just the front of a building are all best split up into a number of simpler pictures. We have already mentioned a couple of reasons why it may be preferable to use a sequence of drawings: it may be useful to describe especially important details on a larger scale separately from the drawing of the whole object; and it may be very helpful to give more than one viewpoint or elevation. More in general, the highly simplified nature of tactile graphics often makes it necessary to present readers with a series of drawings: tactile graphics reduces images to their bare bones and cuts out a great deal of information.

However, when you do decide to split an image into a sequence of simpler or more partial images, you must make sure the successive drawings are in a logical order. The connection between the various drawings must be as simple and clear as possible - otherwise the reader will get lost. In particular:

- be careful about the orientation of the various drawings in space - so about which way is up, which way is north, etc. So a sequence of topographical drawings (figs. 55,56,57 and 58) should all be oriented in the same direction on the compass. A sequence of sheets of a map of a park, or a plan of a school or some other building, should likewise all be oriented in the same direction - with, for example the entrance, or some other especially prominent point always at the bottom, at the top, etc.
- if you use drawings in different scales, do not make the jump from one scale to another too drastic.
- make the link as clear as possible between the front view of an object, the side view and the bird's eye view.

Three kinds of sequence follow a logic which is right for a visually impaired person.

- First, we may have series of drawings which keep the same scale and the same basic pattern, but which differ in certain elements. One kind of such sequence is shown in fig. 54, representing movement and change over time. Other examples might be different versions of the same map, giving different information. It would often be confusing to include all this information on the same drawing.
- Second, a series of drawings may be arranged in the sequence in which a blind reader is liable to explore the object in question. This may mean ordering the various drawings in accordance with the parts seen (and touched) as one moves through a building (for example). In other cases, it means conforming to the sequence which someone follows when using the object. Many blind people approach things from their own, utilitarian point of view, and tend to categorize things in terms of the relevance and relationship they have to themselves. This means they often have an "egocentric" viewpoint on the objects which surround them, memorizing most clearly the aspects which directly affect them. This needs to be borne in mind when planning the best order for a sequence of pictures.
- Third, you need to compensate for blind people's tendency to start from analysis of details to build up an idea of overall form. This means arranging sequences of drawings in the opposite direction - starting with the whole and proceeding to the parts. This rule cannot be observed too rigidly, however. For the real problem is not so much that the blind tend instinctively to go from the particular to the general, but rather that they have difficulty in moving

back and forth in the two directions - from details to an overall viewpoint and vice versa.

These three criteria imply that it will often be useful to zoom in on objects - so giving an overall view in the first drawing, since this is the view which would be most difficult for blind readers to grasp on their own, and then proceeding to more and more detailed views. If necessary, however, take a step in the other direction, and go from the particular to the more general. In any case, make sure the transition is gradual - do not ask readers to make huge leaps between pictures which are too different from each other.

Consider the examples taken from a street-plan to the centre of Turin (figs. 55-58). These pictures zoom in gradually, so each is on a larger scale than the previous one; but at the same time, the link between one drawing and another is clear. The first drawing here (fig. 55) is a map of north west Italy oriented according to the points of the compass (for non-Italian readers, the first map might be of Italy as a whole, or of Europe). The next drawing (fig. 56) shows the location of Turin at the intersection of the river Po and two smaller rivers. Then the reader moves to a schematic plan of the centre of the city (fig. 57), and finally to a more detailed description of the street pattern of a part of the centre (fig. 58).

Finally, note that at least two types of images can function as reference points to orient readers. In a long and complex sequence of drawings, it may be helpful to have, as a reference point or base, a picture which is half-way between an overall view (which is necessarily very general) and drawings of details (which are necessarily fragmentary). In the sequence of representations of Turin (figs. 55-58), fig. 57 might be a suitable, intermediate picture. This could act as a base or reference point to which one could return periodically. This could help readers to make the transition in the two directions necessary - from the general to the particular, and from the particular to the general. The simpler this base image is, and the more distinctive - in other words, the more it captures the essence of what is being represented - the more it will become fixed in a reader's mind and the better it will act as a guide to understanding.

The second type of picture which is especially suited to the way blind people approach drawings is a simplified overall view of the thing represented, drawn on a very small scale, so that it can be recognized very quickly. This might be a stylized Arc de Triomphe, for example, or a simplified picture of the Mole Antonelliana in Turin (fig. 59). These representations may exaggerate certain features a little in order to bring out the most distinctive aspects of the object. This kind of stylized image can help to guide readers through a sequence of pictures and make the transition from one drawing to another smoothly. And it can also constitute a memorable image which will form part of a gallery of images in a blind person's mind - so that a distinctive image of one building, etc. can be remembered, compared with others, etc.

Chapter 6

Graphical Signs and Icons

Graphical signs and icons in relief drawing need to be simple, clear and easily perceivable by touch. It must be possible to recognize them immediately and automatically.

These conventional symbols - i.e. signs which have the same meaning every time they appear (at least in a given context) - cannot be very numerous. Tactile drawing has limited graphical resources at its disposal, so it would not be advisable to use up too many of these with new icons and signs.

Two signs which have a fixed meaning in any drawing - and therefore must not be used for any other purpose - are:

- the arrowhead telling the reader which way a drawing should be oriented (which way is up) (fig. 60).
- the sign showing the scale of a building or other object in a drawing (fig. 61).

There are also a number of graphical signs and icons which are easy to recognize by touch, and which can be used with different meanings in different pictures. Table V gives a selection.

In the future, it is possible that some of these signs may be given a standardized significance, so as to make recognition easier. As we have said, it is not advisable to have too many conventional signs. It is to be hoped that each field - e.g. technical drawing, geometry, topography, etc. - will work out a small number of fixed signs which always have the same meaning in that field. Where possible, the conventional signs and icons should be similar to those used for sighted people.

Tactile drawing is too new, however, to have had time to establish this kind of standardization. As more and more people use tactile drawings, standardization will gradually come.

Chapter 7

Accompanying Text

A pattern of dots, lines and planes as stylized and simplified as a tactile drawing tends to be intrinsically ambiguous. Especially the first time the fingers run over the picture, both the shape as a whole and any detail may legitimately be interpreted in any one of several ways. Only an accompanying explanation can cut down this ambiguity significantly. A text may tell readers right from the beginning whether the rectangle in relief they have under their fingertips represents a plan of a terrace, a piece of paper or a side view of a brick.

All drawings therefore need to be accompanied by a text - texts should in no way be thought of as optional extras. Of course, the object of relief drawing is to communicate as much information to the reader as quickly and directly as possible. But this does not imply that tactile drawings need be independent of textual support - that would only force readers to make major (and unnecessary) efforts of interpretation. Indeed, neglecting accompanying text reduces the potential of tactile drawing as one element in an overall system of communication.

Text needs to be designed for the specific purpose of being a supplement to drawing. It is not enough, therefore, to take a text written for some other purpose, and for sighted people, and simply reproduce it in a drawing.

The first aim of a text accompanying a drawing must be to help the fingers to explore the drawing in the most economical and efficient way possible. For example, the most effective approach to a drawing of the facade of a building is to start from ground level and proceed upwards, tracing the outline of the building, then the most significant features, then finally less important detail.

The text should point out the most important relationships between different parts of the picture and make the reader aware of what are the most important parts. It is better to use text for these purposes rather than devices like frames highlighting a particular feature, arrows, or lines linking one part of a picture to another - for these devices would complicate things significantly for someone exploring the drawing with their fingers.

Text can also warn the reader of any simplifications or exaggerations which it has been necessary to introduce into a drawing in order to make it more comprehensible - e.g. features which may even be essential parts of an object, but which could not be drawn in that particular drawing, parts of an object drawn to a different scale on the same sheet of paper, etc.

Words may also be able to tell the reader about effects due to lighting, colour and other aspects of the visual experience which cannot be communicated by tactile drawing. The aim of relief drawing is to help blind people "see" aspects of the world which surrounds them; but this does not imply that we should pretend that the capacity for perception they acquire through tactile drawing reproduces the experience of actual sight. Language can be used to describe aspects of the surrounding world which cannot be grasped - including aspects which may appear most alien to the experience of the blind.

Finally, the accompanying text should try to communicate the overall experience a sighted person obtains from the thing or situation represented in the drawing. This needs to be a description which is accessible to a blind person, and needs to refer as closely as possible to the type of message which can be perceived through a tactile picture. Once again, what this kind of general description does is to compensate for blind people’s difficulty in constructing images which give a general idea of the whole, without being too generic. So images which are not just either a mass of uncoordinated details or excessively vague.

Texts may be presented in Braille or on a cassette. Cassettes are preferable because they do not require use of the fingers and so can be listened to at the same time as exploring the drawing.

Since the connection between drawing and text is so close, text can even be included on the drawing itself - as in an ordinary diagram or illustration for the sighted. So although it is important to avoid overcrowding a drawing with information, words of explanation, letters and symbols may be included. These may refer the reader to a key, an explanatory note, etc. (fig. 62 - 63).

Writing on the drawing must be in Braille. This applies to numbers too. For references to a key, it is better to use letters than numbers, which take up more space because of the number sign.

Whenever possible, a text in Braille on a drawing should be positioned horizontally (i.e. horizontally when the picture is the right way up). This makes it easier to read and avoids confusion in the interpretation of Braille letters which have an oblique configuration, like "i" and "e".

It should be remembered that only a proportion - and not an enormous proportion - of blind people can read Braille. This implies that the use of text on drawings themselves needs to be sparing. However, letters and numbers used by sighted people are very difficult to recognize in relief - so they cannot be used as a substitute for Braille. Braille letters and numbers are much easier to identify and recognize, even for someone who is not used to Braille.

Chapter 8

Printing and Reproduction Techniques

8.1 Choosing between different methods

Over the years, more and more techniques have become available for reproducing drawings in relief, and it is not always easy to choose the technique which is best suited to particular needs. This chapter tries to give readers some guidance to the various methods and products on the market. But first of all, what criteria should be borne in mind when making the decision?

A first group of criteria concern the quality of relief and the ease with which it can be perceived. More precisely, the following factors need to be considered:

Height of relief

Individuals vary in the lowest relief they are able to perceive - the variation is between 0.4 and 0.6 mm. However, the height of relief cannot be considered independently of other features below.

"Aggressiveness" of relief

This is shape of the relief in cross-section, that is to say the extent to which the side wall of relief sticks up vertically against the rest of the paper, plastic, etc. on which the drawing is printed. A profile which is sagging and rounded is less easy to perceive; a more upright profile is easier to distinguish from the background because the fingertips bump up against it more sharply. In other words, the height of relief is a bit like the prominence of a line in a drawing for the sighted; whereas the "aggressiveness" of its profile is rather like the contrast between that line and its background.

Resistance to the fingers

Some surfaces are too rubbery for the fingers to pass over quickly. Others are too hard and unpleasantly sharp under the fingers. The relief must be able to communicate precise information without impeding the passage of the fingertips or creating distracting sensations.

Adherence to the base

The relief must be firmly attached to the paper, plastic, etc. which forms the base of the drawing, so that fingers passing rapidly and continually over it do not cause it to gradually peel off.

Durability

Resistance to wear, and the length of time which a drawing reproduced with a particular technique lasts, also need to be taken into consideration.

Pleasantness to the touch

This criterion is much more subjective than the others and varies from one reader to another. However, it is a criterion which must in no way be neglected. A reader who finds a drawing unpleasant to touch will not explore it properly, and thus will not be able to understand it properly.

A second group of criteria concern the limits imposed by particular methods of reproduction. The most important are as follows:

Number of copies wanted

Some techniques are more suitable for making just a few copies, others are only worthwhile when a larger number of copies are being made.

Whether you want drawings on both sides of a sheet

In many methods the back of every drawing has to be left blank. These methods may make books containing a large number of drawings excessively bulky.

Whether you want relief drawings accompanied by visible drawings

Not all techniques print pictures which are suitable for the blind, the sighted and the partially sighted, for they do not all produce drawings which make the relief visible. Some techniques do make the relief visible, however. Better still, some techniques make it possible to spray ink on top of the most prominent and suitable lines and shapes of an ordinary drawing for sighted people. In this way, the fine detail of the original drawing remains for the eyes, but the relief of the relief drawing superimposed on top means that the structure can be perceived by a blind reader.

Need for complex equipment and skilled personnel

The equipment needed for a given printing method may be elaborate or simple, costly or cheap, and easily accessible or not. Similarly, different methods require different degrees of skill in the person operating it.

Production costs

Here, it is necessary to consider the costs of the equipment, costs of materials (special inks, paper, electricity, etc.), labour costs, etc.

Time needed

Each technique has its time scale for how long it takes to print per copy.

8.2. Methods available

There are numerous methods for reproducing drawings in relief of this or that aspect of the surrounding world. In the last few years especially, teachers of blind and partially sighted children have experimented with various approaches intended to widen their pupils' acquaintance with the world which surrounds them and also to develop the sensibility of the faculty of touch. Techniques of collage, for example, have become more sophisticated - using various types of paper, cloth and a variety of other materials which stimulate curiosity.

However, we do not intend to deal with this area in this manual. In this chapter, we will only describe techniques which can be used to reproduce more than one copy of a relief drawing. We will describe both techniques which are widely used at the time of writing, and those which we believe to be most useful and effective. Rather than try to be comprehensive and describe the whole field superficially, we have tried to concentrate on the main techniques suited specifically for relief drawing or tactile graphics in the strict sense employed throughout this manual.

Nor will we go into much detail about the technical details of particular methods. We will try instead to provide general guidelines to help you decide which technique is most suited to your needs. Apart from anything else, new methods are rapidly appearing, making others obsolete, so this is a changing field. Readers are advised to contact information centres regarding the latest products on the market. At present, information may be obtained from the following:

- Club Braille Italiano, at the Unione Italiana Ciechi, Vicenza branch or Rome headquarters
- Cellule Accessibilité de la Cité des Sciences et de l'Industrie, Paris
- Royal National Institute for the Blind, London

8.2.1. Pressing techniques

TECHNIQUES DERIVED FROM BRAILLE

The same techniques used to print Braille texts can be adapted to produce tactile drawings. Both Braille writing slates and computer printers can form lines and planes made up of sets of dots next to each other.

This is a technique which has long been used. It is useful because it makes it possible to insert drawings into texts written in Braille. The great limit of this method of producing tactile drawings is that the only graphical resource it has at its disposal is the dot - and, indeed, dots at fixed distances from each other.

THERMOFORM (vacuum forming method)

Here the picture is printed onto a sheet of plastic. A plastic sheet is placed on a master made of wood, metal carbon fibre or some other material, into which the drawing has been cut. The plastic is heated sufficiently to make it mould round the master; a powerful vacuum sucks the plastic into close contact with the master. When the plastic cools it is a relief copy of the master.

Thermoforming is a very versatile technique and for this reason it has become widely known throughout the world. It is suitable for printing a range of numbers of copies: simple hand machines can produce small numbers, while more expensive and more elaborate machines can run off large numbers. The precision of the relief produced varies with the quality of the master and the technique used to produce it. Masters may be cut by hand, with a machine, or through computerized equipment. Milling machines guided by a computer make it possible to produce proper dies - protruding outwards instead of being cut into the material of the master. Relief produced from masters of this type are easily the most precise.

Thermoform can also reproduce relief of different heights in the same drawing - from 0.5mm. to a few centimetres. This means that thermoform is often used by those producing bas-reliefs or high relief.

Thermoform's plastic moulds produce precise relief, especially from the more sophisticated machines. Unfortunately, plastic is normally felt to be much less pleasant to the touch than paper. In addition, when relief is relatively high it tends to bend under the fingers, and this reduces its capacity to transmit information with precision.

Costs of thermoform printing vary considerably. Equipment costs depend on the sophistication of the machine employed, and labour costs on the level of skill of the personnel needed to operate it. Choice will depend on the kind of drawing you want to produce. Only industrial procedures - using costly equipment - make it possible to print a picture in colour. On the other hand, very simple and quite cheap "home production" machines will produce quite acceptable relief. Costs per copy vary with the quantities produced - so costs per copy are lowest for long runs and increase quite sharply for short runs or for hand machines. The need to cut a master for every drawing means that there is an initial cost which has to be laid out each time; and the labour involved in the method is not insignificant, which inevitably has an effect on costs.

GAUFRAGE

In the pressing technique known by the French name of gaufrage, paper is compressed between a "male" master and a "female" mould. A pressure of several tons is exerted by an industrial press. The mould is made of synthetic fibre, and has the function of protecting the paper and ensuring that the edges of the relief do not tear under such great pressure.

The first step in gaufrage is to make a master - a die which is made by hand or, preferably, with a computer-aided procedure. The synthetic material of the mould is then moulded over this die. When the die and the mould are ready, production can begin. Pressing can take place on paper which has already been printed in black and white or colour; so pictures which are visible as well as perceivable by touch can be produced.

The precision of the relief produced depends on the quality of the die and on the ability of the paper used to take impressions and then keep them. With regard to the quality of the die, there has to be a delicate balance between a sharp die which will produce relief with a suitably "aggressive" profile and a die which will avoid tearing the paper. So gaufrage can produce relief at differing heights (even within the same picture) - including relief as high as a few millimetres; but where the relief is higher, the die will have to be less "aggressive", otherwise it will tear the paper. As for the paper, this has to be of the right thickness and rigidity. In assessing this, it must be remembered that gaufrage will itself make the paper more rigid, since the relief will create a sort of network of raised veins or tendons. Gaufrage is not capable of producing very fine lines or hatching. However, the overall results are of good quality.

The biggest drawback of gaufrage is that it requires industrial equipment and skilled workers to make the die, operate the heavy press, etc. It is not a technique which those working with the blind can think of using at home. This means that initial costs, in particular, are high (for cutting the die, etc.). Gaufrage is therefore only worthwhile when a large number of copies are being printed.

"MINOLTA" METHOD (microcapsule paper)

In this technique the relief is produced by the swelling of large numbers of tiny heat-sensitive capsules which have been laid onto the paper (first put on the market by Minolta). Cells which are covered by the black ink used to draw the dots, lines and surfaces of a drawing absorb heat and expand, while cells in the white background do not. The swelling of the relief is obtained by running the paper briefly through a small infra-red heater.

Microcapsule paper is very easy to use. First of all, draw a picture in black and white on normal paper, then photocopy this onto a sheet of microcapsule paper, using an ordinary photocopier. Most microcapsule paper is A4 format. A photocopy machine which produces too much heat is not suitable because it would cause the drawing to swell before putting it into the special heater, and this could produce uneven relief and a rough surface on all the paper. Immediately after photocopying, the sheet of microcapsule paper is run through the heater and the drawing is ready. Since it is the black areas which swell up, the drawing is as easy to see as to feel.

The height of relief cannot be varied with the Minolta method, but remains constant at about 1mm. The profile of the relief is somewhat rounded in profile, so not very "aggressive". Notwithstanding this, it is easy to perceive and pleasant to touch.

The greatest advantage of microcapsule paper, however, is the ease with which a drawing can be produced. The only equipment needed is a normal photocopier and an inexpensive heater, which is easy for anyone to use. The main effort is that of designing suitable graphics - after that, any reasonably careful person can produce a good relief reproduction.

A simple method like this is obviously suited to in house production and small numbers of copies. The paper is expensive and so cost per copy is high. As the process is all manual, production times per copy are also quite long when you have to make several copies. For these reasons, it is not suitable to use microcapsule method for more than a few dozen copies at most.

A final problem is that Minolta has stopped making the heaters, although it still produces the paper. Other firms do make similar heaters, but it may be difficult to find a supplier.

8.2.2. Ink-spraying methods

In the techniques we have described so far, the base on which a drawing is drawn - the paper, the sheet of plastic or the microcapsule paper - is modified to produce relief. The techniques we describe below, in contrast, are based on a different principle: they deposit special ink which builds up relief which can be felt by the fingers. The techniques normally use paper as a base.

GRAPHICMASTER AND SIMILAR PRINTERS

The Graphicmaster is an ink-jet printer controlled by an ordinary personal computer. The solid ink is heated and sprayed onto the paper. The printer passes over the drawing four times, building up a thick layer of ink which constitutes the relief.

This method produces very precise drawings - partly because the drawings themselves must be drawn on the computer. The relief obtained is no more than 0.4mm. in height but is not difficult to perceive since it has a good "aggressive" profile. Since the relief is made up of black ink, the drawing is, naturally, visible.

The Graphicmaster printer (now no longer produced) was a good deal more expensive than a Minolta-type heater for microcapsule paper - but it still remained within the reach of any school or organization. Its operation does not require special skills - except for those necessary for using a computer graphics programme.

To the initial cost of the printer, you have to add the cost of each copy; this is quite high, mainly because of the cost of the special ink. This cost per copy remains the same for each copy produced of course - there are no economies of scale. This is one reason the method cannot be used to produce large numbers of copies. The other reason is time: the printer takes several minutes to produce each copy.

The Graphicmaster was the first printer of its type. Other machines are gradually being developed and coming on the market. A printer called Graphtact has been developed in prototype in Canada, and should be on the market soon. Graphtact has a moving part which follows the patterns of the computer drawing and sprays a thick layer of quick-drying ink over the paper (preferably the type of paper used for Braille). It prints extremely accurate drawings, made up of relief of constant height which is clearly visible and pleasant to touch. At the time of writing, definite information is not available on the cost of the printer or the ink.

Production techniques making use of computer graphics are likely to become much more widely available in the future.

SILK SCREEN PRINTING

If you need to make larger numbers of copies, you will need to make use of more traditional methods, adapting these with the use of special inks to produce drawings in relief. Silk screening seems the most effective technique, and the one which sets the fewest limitations regarding the materials which can be employed. Silk screen printing works well both for small-scale production in-house, and for larger-scale runs contracted out to commercial firms.

In silk screening a special kind of fabric is stretched over a frame - which may be varied in size according to need. The drawing to be reproduced is transferred onto this fabric via a simple chemical process. Ink is then pressed through the fabric, and it passes only where the drawing is, not elsewhere. In this way, the drawing is reproduced onto a sheet of paper placed directly under the screen. The finer the texture of the fabric, the more precise the reproduction of the drawing will be.

Silk screen printing is a suitable method for reproducing large print runs, but is not too costly even for shorter runs. The main expense is the making of the master on the screen. Silk screening can also be used to print large sheets of paper, which can subsequently be cut up into smaller sheets. Pictures in more than one colour can be obtained by printing two or more times. Pictures can be printed onto a wide variety of materials apart from paper - including cardboard, plastic and metal.

It is preferable if the ink is applied to the screen mechanically, otherwise silk screening tends to produce imprecise images and blurred edges. The fabric of the screen needs to be fairly tightly woven so as to produce drawings as precise as possible; however, very tightly woven materials may not be practicable, because they do not let the special ink used to make relief pass through.

Let us now consider the inks used in silk screening for the reproduction of tactile pictures. At least three types are widely used:

- In the first procedure, the ink which passes through the screen is used just as a glue. Once the ink has been applied to the paper, minuscule globules of a heat-sensitive resin are scattered over the whole sheet. Those which fall on the drawing stick to the ink, and the rest are blown away. The paper then has to be passed under a heater to swell the resin globules which form the relief.

  This method is only really useful for long runs of at least several hundred copies, for it is a fairly complicated procedure involving several stages. The relief produced is acceptable in terms of height (about 0.5mm.), but is not particularly precise, nor adequately "aggressive" in profile. Apart from tending to be rather irregular and imprecise, the relief produced by the globules is not very pleasant to the touch. Production costs are reasonable.

- The second procedure uses heat-sensitive ink. Here, too, it is necessary to pass the paper through a heater to swell the ink. However, the method is simpler than that described in the previous paragraph, and there is not the problem of little bumps and inaccuracies in the relief caused by the globules fusing together in a slightly irregular way. Precision is therefore better, and the relief is easier to perceive. In addition, costs are a little lower. The relief produced is generally of good quality, although the profile tend to be too rounded, so accuracy and "aggressiveness" are not as good as they might be. Another problem is that the ink is not very hard-wearing and tends to peel off the paper after a time.

- The third method uses a quick-drying ink which itself makes up the relief, without being heated. This cuts out one phase of the production process, so this process is quite cheap - also because the materials added to the ink to thicken it are not particularly expensive. In addition, this method produces sharper edges than the rather rounded relief obtained with heat-sensitive materials. The ink adheres well to the paper and does not peel off easily. Relief of acceptable quality is produced, able to transmit the information in a drawing adequately. Only one height of relief can be obtained. The feel of the ink to the fingers can be adjusted by changing the composition of the substances added to the ink.

  This method is suitable for long and medium print runs. As with other kinds of silk screen printing, it is possible to print a relief version of a drawing over a more complex visual image for sighted people which has previously been printed on the same sheet by silk screening or by offset. Finally, as with all methods which spray ink onto the page rather than moulding the paper itself, it is possible to print on both sides of the page.

Chapter 9

Tools and Materials for Drawing

It would be a mistake to think that the field of graphics - including tactile graphics - was limited to the representation of material objects. Visual communication covers a field which includes symbols, company logos, signals, diagrams, geometric figures, technical drawings, and pictures of the most various aspects of the surrounding world - a geographical territory, a town, a building, the human body, plants, animals, and so on. Anyone designing a drawing has to know the techniques most suitable for each type of the very different types of visual representation. This applies also to the tools used.

This is not an ordinary manual of drawing, so we only cover techniques and materials essential for designing drawings to be reproduced in relief by one of the methods described in chapter 8. However, it should be pointed out that the very limitations of tactile drawing in many ways make it much easier than ordinary drawing. Anyone learning how to design tactile drawings will have to learn the principles given in this manual; however, the simplified nature of relief drawings mean that many of the more refined and complex skills demanded of someone drawing for the sighted are not necessary.

This means that even someone without any particular talent for ordinary drawing is perfectly capable of producing thoroughly acceptable tactile drawings. The only thing that is necessary is a willingness to pay attention to the needs of a blind reader, and what these imply in terms of techniques which can be used.

9.1. Tools and materials for drawing by hand

Paper

As we mentioned earlier, the most suitable format is A4 (210 x 297mm.), for the two hands fit into this space well. It is not surprising, therefore, that Minolta uses A4 format for its microcapsule paper.

Various kinds of paper can be useful for various purposes:

- squared paper, for making freehand sketches and outlines of the thing which is being drawn.
- millimetric paper of the type used by draughtsmen. This is useful when you are enlarging or reducing an object to scale and want to keep the dimensions right. It is also useful for diagrams.
- tracing paper for copying in ink the final version of drawings which have been drawn in pencil.

Pencils and propelling pencils

Pencils are graded according to the hardness of their lead. For drawing you need a selection of different leads for different purposes.

Metal or plastic propelling pencils are better than traditional wooden pencils, because the lead is always sharp and a lead of the same kind can be inserted when necessary. The type of propelling pencil which uses thin leads (0.3 o 0.5mm. in diameter) is especially suitable.

The best results are obtained with an HB or F lead for thicker lines, and an H or 2H for thin lines. The lead of a conventional wooden pencil must always be well sharpened.

Indian ink pens

These are used for inking in drawings which have been prepared in pencil. This kind of pen (Rapidograph) consists of a cylinder containing a reservoir of ink, and a nib, which can be unscrewed when you want to change to a finer or thicker one.

At least two nibs are essential for relief drawing:

- 1.0mm. for the drawing of the main outline of a shape, and for writing in Braille.
- 0.6mm. for less prominent lines, and for hatching.

Naturally, a wider variety of nibs allow you more scope in your drawing.

Squares

Squares for technical drawing (often made in transparent plastic) are usually of two types. Both types have a right angle at one corner, but one type has two 45-degree corners, the other has one 60-degree and one 30-degree corner. Two squares are often used together, to draw lines parallel to each other or at right angles to each other. Most squares have one side with a scale in millimetres, and the other two sides sloping downwards to make it easier to use an ink pen.

Rubbers

Draughtsmen usually use soft rubbers. However, any rubber which would dirty the paper must be avoided. There are also special rubbers for rubbing out Indian ink from tracing paper. However, this can also be scraped away just as satisfactorily with a razor blade.

Transfers

A useful device consists of the grid of lines printed on plastic tracing paper; these lines can be transferred to the drawing via the pressure of a pencil. Various transfers of this kind can be bought - you need to choose those which are most suitable for a tactile drawing.

Drawing board

Plastic drawing boards can easily be bought which have a ruler that slides along the sides of the board. Apart from holding the paper steady, therefore, a drawing board of this kind does much of the work of squares. It acts, therefore, as a smaller version of a professional draughtsman's drawing board.

Braille in pictures drawn by hand

Draw in the dots which Braille is composed of, going from left to right (not in reverse, as you would if you were punching Braille from behind).

When writing Braille, it is essential to use suitable tools: the Braille which emerges on the relief reproduction of your drawing will only be readable if you draw the dots accurately in the first place. The size of Braille dots, and the distance between them must never be altered.

This means that it is essential to make Braille dots with the special plastic or metal Braille writing slate. Instead of the stylus which comes with the slate, however, you will be using a 1mm. Rapidograph pen.

Place beside you a table of all the letters of the Braille alphabet; copy these attentively, being very careful to place the dots only in one of the six positions used for Braille dots (in the corners of the rectangular cells of the writing slate, or half way up the sides of the cell).

9.2. Drawing with a computer

To draw with a personal computer you need a mouse, and a printer capable of printing graphics, and also a graphics programme.

There are major advantages in using a computer for making drawings to be reproduced in relief.

- once you have learned to master the programme, drawing with a computer saves a lot of time, and makes it much easier to correct a drawing, enlarge it, etc.
- in the computer's memory you can store graphics which you use frequently in your relief drawings - particular types of line, hatching, symbols, icons, etc.

- in the same way, you can store images to be used in subsequent drawings. You can also make use of images other people have used and stored, and give your own images on diskette to others. A collection of images can thus be built up, and you can combine these in an infinite variety of ways. You can then use these images as they are, or modify them for your own needs.

There are now many "interactive" computer graphics programmes which are powerful and sophisticated, but also easy to learn. All interactive systems require a mouse - which is clicked to choose the commands, and is moved to draw the graphics. Most drawing programmes come with a store of ready-made images. Many of these can be modified slightly for drawings which are suitable to be reproduced in tactile form. It is also possible to store the fonts of Braille in your graphics programme; or these can be bought.

Touching to See

*by Peppino Ortoleva **

The purpose of *Disegnare per le mani* is to be a practical handbook. First and foremost you read it with your eyes; ultimately you use it with your hands, since its objective is to guide positive actions. The book starts off by stressing it is directed at a relatively specialist audience. When you read it carefully, however, this explicit and purposefully simple objective veils an underlying background of a host of theoretical problems that must involve anyone interested in communications.

1 Touch is a "realistic" sense *par excellence*. Together with taste, it is the only human faculty that cannot stand aloof from the object it feels. This of course means any quest for knowledge through touch becomes intrusive and susceptible of breaking all the essential rules of good manners governing physical contact between people. Since it cannot bear intermediaries, touch is the sense that seems the least able to stand apart from reality and create symbols. One the one hand, this makes it "truthful" by definition, as the distance between an object and its symbol *appears* to be a necessary premise for possibile lies, as confirmed by the story of the uncredulous Saint Thomas (which in no way means that touch cannot be misled just like any other of our senses). On the other hand, and perhaps for the very same reasons, it is far from suitable for exchanging messages. We certainly use our hands to learn, but this type of knowledge is not generally translatable into abstract terms and is hard to transfer between individuals except by means of long and difficult practices, such as apprenticeship for instance.

The brilliant invention of the Braille alphabet brought about a drastic change to this situation. It was the first time that touch was called upon to systematically "read" coded messages and replace sight, alphabetic culture's key sense. The invention of the Braille alphabet and the practically simultaneous invention of the Morse code of course enjoy a close and stimulating relationship. The alphabet was brought outside itself in both instances, so to say, and entrusted to unusual transmission channels, electrical in one case, manual in the other. The alphabets celebrated their triumphant power in both instances, since the new channels they used were accessible to hitherto excluded persons. This however perhaps signed the initial crumbling of an alphabetical culture, as the supremacy of sight appeared to be less unavoidable and all-pervasive.

Compared with the radical breakthrough brought about by Braille (that only affects a limited segment of society however, just as the Morse code is the professional alphabet of a limited category of people), the method the book describes is a continuation and a new breakthrough at one and the same time. It suggests using your hands not just to gain access to abstract and coded symbols but to achieve icons, visual signals by definition.

2 Braille might superficially be classed as a somehow "digital" code based on spaces and intervals, but *Disegnare per le mani* proposes an apparently more archaic "analogic" communication. In actual fact, the book does not propose the analogic reproduction of reality as a means for communicating (since the abstract character of representation is quite clear) but the translation into a tactile object of the whole of the many images that those with the gift of sight are becoming accustomed to take as part and parcel of the outside world - from public signals to graphs and from the small icons accompanying an increasing number of printed and televised verbal messages to the symbols that are an essential tool of communication between human beings and the computer.

The book raises an explicit request for access to the world of images for all those hitherto denied it and indirectly reminds us that the exchange of messages can no longer be limted to written texts alone but are dependant on this new form of pictography, an abstract icon writing based on descriptive symbols.

The book uses an unexpected approach guided by strict requirements to revise all modern pictography criteria governing the "readability" of images for transforming descriptive images into equivalent abstract words, to translate this iconsphere we are so immersed in unawares into a different language directed at blind users. *Disegnare per le mani* proposes new communication rules directed at touch, such as the "aggressiveness"of lines for instance, but also makes us reflect on many a rule for transforming images into symbols that are often used in visual communications out of pure "convenience".

3 On reading the book, I often wondered whether it was really to remain restricted to the limited sphere of cognitive and teaching aids for the blind, as might have seemed obvious, or whether it laid out a technique that would eventually elicit interest in other social environments both for pratical use and entertainment.

Touch is the new frontier of communications today. Research on virtual reality is directed at learning touch, after sight and hearing. The technique is directed at deceiving one's hands and consequent sense of balance and movement, to offer the most "realistic" and deceptive messages as can be conceived. Virtual reality continues its criticized and generally disappointing experiments, while touch becomes an essential part of communication by other means as well. Just think of videogames for instance. They can be literally defined as a tactile way to learning a world explored through subsequent touches, in "platform" games especially.

One might speculate whether the development of the new techniques described in this book and the general popularity of "tactile" communication forms is pure coincidence. *Disegnare per la mani* proposes a third way other than virtual reality and videogames of using touch to communicate. Not for deceptive or interactive "reading" in the modern meaning of the word, but for consciously

symbolical reading born of a painful need that could in the long run prove to be a pleasure and an experience to be added to those stimulated by other senses of ours.

* Translation: A. Cameron Curry