

# **SCHOOL DESIGN**

## **An Ophthalmological Perspective**

### **1. Introduction**

The development of a new school for children with multiple disabilities and visual and hearing dual sensory impairment presents particular challenges in design, equipment and staffing. The environment of the school should ideally allow children to be as independent as possible. The design of the school needs to take into account the sensory and central processing functions of the children so that the impediments caused by these limitations are minimised. Such an approach is likely to lead to enhanced learning with fewer resources and should therefore prove both beneficial for the children and cost efficient.

This paper provides a preliminary set of ideas from the perspective of an ophthalmologist who looks after these children.

### **2. Summary**

The proposed design of the school is considered from the standpoint of how the visual disabilities of the children impact on learning, and how this impact can be minimised. The following issues are addressed.

- The children and their conditions
- Building design considerations
- Equipment
- Staffing considerations

### **3. The children and their conditions: their relevance to the design of the building**

The children can be divided into various groupings

- Diagnostic grouping
- Severity of disability
- Age grouping

#### **3.1 Diagnosis**

The diagnosis has a direct bearing on the design of the school.

- Children with damage to the brain comprise the majority. Survival rates of children receiving intensive care have increased. It is likely that the proportion and numbers of such children will increase owing to increased survival of both very premature infants and children with disorders (such as meningitis) affecting the brain, vision and hearing.
- Children with visual impairment only due to disorders affecting the eyes and /or the optic nerves have intact brain function and any building design matching the needs of those whose vision is due to damage to the brain will function well for such children. There are however specific requirements for specific disorders, and these are considered below.

- Children with dual sensory impairment due to eye and ear disorders but with intact brain function comprise a minority, but their requirements are different.

### **3.1.1 Children with damage to the brain**

Damage to the visual part of the brain leads to a number of specific deficits for which special provision is advisable.

Each of the deficits is considered below along with the potential design implications for the proposed school.

***A. Reduced clarity of vision, along with reduced contrast sensitivity*** is a problem for nearly all of the children.

Optimal colour contrast, and grey scale contrast within colour (eg light blue and navy blue comprise blue with white or black added respectively) are recommended for boundaries which need to be identified.

These include boundaries between:

Wall and floor

Wall and doorways

Wall and windows

Successive steps

Thus door frames, skirting board and window frames can be painted with dark colours assuming that the walls are painted with light colours.

All signage needs to be designed so that children with a clarity of vision of say 6/120 are able to see it, preferably half way between eye level for a standing and a seated child. Signage requires high contrast, wide letter separation and minimum content. Pictorial signage should ideally be three dimensional for tactile analysis as well. Each element of detail within the picture needs to be visible to all but the most visually impaired children.

#### Optimal lighting

It is our experience that many children with reduced visual acuity and impaired contrast sensitivity due to brain damage have considerable difficulties in darkened environments. This is because reduced lighting reduces clarity and can therefore impair access to information, (which can be more difficult and take longer) and can impair mobility.

To avoid glare, optimal natural lighting is shaded, for example by trees or north facing, as for art studios, with light reflecting colours on the walls.

Apart from exceptional circumstances (see below) artificial lighting throughout the school needs to be bright and diffuse.

Focal lighting can produce unwanted glare, but by producing shadows to enhance boundaries it can be used for specific purposes. For example direct

lighting obliquely from above can allow a glass to be seen on a table, or successive steps to be discriminated more easily (by those children who are mobile).

### ***B. Impairment in visual field***

The visual field is the area over which one can see. Impairment of visual field is common in this group of children. The area of absent visual field is analogous to the area behind you, except it impinges on the area where one expects there to be perception.

Absence of the lower visual field is common. When looking straight ahead the ground is not seen. The lower part of a page or computer screen is not seen. It is easier to go up stairs (because the stairs are seen) than to go down (because they are not). (It is no doubt important to have stairs, so that ambulant children learn how to cope with them. However, consideration should be given to reserving stairs for access to staff accommodation and for areas for mobility training.)

Children who are wheel chair mobile may tend to crash into low obstacles because they are not seen. Such obstacles need to be avoided. Classroom bins for example need to be tall.

Absence or impaired function of the visual field on the left or the right side (for both eyes) is also common.

We have seen some children with impaired vision on one side who are very frightened in symmetrical environments like long corridors with symmetrically placed doors. These children had brain damage which prevented one side of symmetrical environments from being seen. (Putting posters up on one wall to decrease the symmetry helped considerably.) Avoidance of long straight corridors in the design is recommended.

Absence of the upper visual field is rare but is sometimes seen in this group of children. Information such as signage needs to be at eye level.

***C. Impaired simultaneous perception*** of varying degree is present in a large proportion of the children. Such impairment applies to all elements of perception including hearing. The back of the brain at the top, (the posterior parietal lobes) is responsible for handling incoming information. We all become overloaded when there is too much information to handle, but children with cerebral palsy and impaired vision usually have considerable difficulty handling crowded information, whether it is crowded in time (information, whether it is visual or auditory, is presented too rapidly) or in space (there is too much information crowded into the visual scene). This has major implications for the design of the building if educational strategies for these children are to be optimised.

- Background clutter and decoration needs to be minimised. (Many of the children we have seen are easily distressed if there is a lot of visual distraction or background noise, but they are much more relaxed and receptive if they are in a non crowded quiet calm environment.)
- Equipment in the classrooms needs to be kept out of sight, behind plain curtains or inside adjacent store rooms. (This will also enhance mobility.)
- Large north facing large windows with low walls beneath them, to allow children to determine the positions of the windows and not bump into them (say 700 - 800 mm to be seen by children with lower field impairment, but not to obstruct the line of sight for wheel chair users) which look out onto grass and trees warrant consideration. Doors that open out onto this environment (with free wheelchair access) could be considered. This visual background has a significant calming effect in our experience.
- Contrary to the norm for main stream schools, too much decoration on the walls can have an adverse effect. For some children it causes distraction, for others it causes distress and for another group it impairs access to the information being presented because there is too much visual information to handle.
- The acoustics of the rooms need to be considered. Acoustic damping of the floors, the ceiling and the walls is required to reduce echoes for this population, and for the population of children with reduced hearing. It should not be possible to hear distracting sound from:
  - Adjacent accommodation
  - Central heating systems
  - Ventilation systems
  - Outside
- Sensory rooms have been found empirically to lead to significant improvement in attention for the most severely impaired children. This is because they have profound impairment of simultaneous perception and can only handle a very small amount of visual and auditory information at once. The use of darkness and focal lighting combined with focal sound sources provides the elimination of extraneous sights and sounds, which is required. If such a room or rooms are to be incorporated into the design considerable thought should be given as to their optimal design. (A lot of equipment, which has limited educational value is on the market and is over priced. Custom designed equipment could well prove cheaper. This area warrants further research.)
- Electronic white boards may well provide the magnification and simplification, combined with the simple interaction required to enhance the teaching of these children.

***D. Impaired visually guided movement*** is a common accompaniment of impaired simultaneous perception. The visual scene is interpreted in the mind. The messages concerning the 'coordinates' of where things are in visual space are then passed to the limbs. In addition to impaired movement many of the children have inaccurate movement of the limbs and body in 3D space because

their coordinates are not so finely spaced as able bodied children. Enlargement of objects to be handled by the children will allow them to be rewarded by success. This applies for example to door, cupboard and drawer handles. These therefore need to be large and must contrast in colour / contrast from the background object they are attached to.

**E. Impaired orientation** is another problem that many children have. In order to know where we are going we have to remember where we have been before and to map this information in our minds. Many children with brain damage and impaired vision due to brain damage also have problems with orientation. These problems are manifest in four situations.

- Route finding can be very difficult and affected children get lost very easily. Both objects and sounds of reference along commonly used routes can help considerably. Children can then learn the sequence of objects and / or sounds which is needed for a specific route. (Setting the sequence to a song can help considerably.)
- Orientation within a room can be lost. It is logical to design the rooms that they will progress through classrooms with similar layouts, avoiding mirror image designs.
- Orientation with respect to what is in which drawer, and in which cupboard can be impaired. Clear systematic labelling of drawers and cupboards in classrooms, using three dimensional images warrants consideration.
- Orientation in immediate personal space can be a problem. For some children, labelling of place mats with a picture of a knife, fork and spoon for example can prove helpful. The same concept could be considered in such special cases for work stations. Consistency of design is important.

**F. Impaired recognition** is less common but affects a significant proportion of children. We are able to recognise what we are looking at because our minds contain a complete store of images. We compare what we are looking at with our image store. If it matches the picture in the image store recognition takes place. If it does not we learn about it for the first time. This concept applies to people's faces and to objects. The image store is at the back of the brain at the bottom (the temporal lobes). If the temporal lobes are damaged this can cause impaired recognition. For such children objects of reference may provide limited information. Reinforcing the stimulus with a matching sound of reference is again warranted. This can be done by providing different acoustic characters to different spaces. Such an approach of course applies to all children whose vision is so poor that they are unable to use vision for recognition.

**G. Impaired visual memory** is common. From the standpoint of being able to recognise which room is which, colour coding could be considered. Other memory cues can be used to enhance the objects and sounds of reference.

### **3.1.3 Children with profound visual impairment due to eye and optic nerve disorders**

Children with profound visual impairment due to eye and optic nerve disorders will have their needs met by the design considerations for those whose visual impairment is due to damage to the brain. Additional issues to consider include: Lighting considerations. A number of conditions give rise to photophobia if there is direct light shining on the eyes. The design considerations discussed in this paper takes into account the orientation of the classrooms in such a way that they are akin to art studios and face in a direction that avoids direct sunshine during the school day (primarily South facing in New Zealand). Trailing walls can prove very helpful.

### **3.1.3 Children with dual sensory impairment due to eye and ear disorders**

Although these children have intact brain function, the lack of sensory input during early development leads to many problems similar to those outlined above. The design features considered above are equally appropriate for this group of children.

This author is not qualified to address the provisions needed for hearing impaired children. However, the comments made above considering the acoustic characteristics of the building no doubt apply.

## **3.2 Severity of disability**

### **3.2.1 Severe disability**

Children with profound visual impairment or complete blindness comprise those who are mobile and those who are confined to a wheelchair.

The mobile children may gain greater independence by having a wall mounted (or central passageway) hand rail both for guidance and for support. Some children have weakness down one or other side of the body. Support rails therefore need to be mounted on both sides of the corridor to allow such children to be mobile in both directions.

Children who are confined to a wheelchair need to be able to move or be moved freely both within the building and outside.

### **3.2.2 Moderate disability**

The environment described above for the specific visual disabilities and for those with severe disability will meet the needs of the other children with moderate disabilities.

## **3.3 Age grouping**

### **3.3.1 Infants and young children**

The critical period for the development of vision, hearing, intellect and social development is the first seven years of life. There is considerable evidence in the world literature that the fundamental building blocks for development are laid down in early life. The earlier intervention is implemented to compensate for and circumvent disorders which impair access to, and interpretation of information,

the more effective it is likely to be. Moreover, the costs of education and long term care are likely to be significantly minimised by early intervention.

The construction of a centre of excellence for training parents and for teaching infants and young children, both in the school and on a peripatetic basis warrants serious consideration. A toy and equipment 'library' warrants consideration.

### **3.3.2 Older children**

As in schools for the able bodied furniture and toilets will no doubt be designed according to the size of the children.

## **4. Building design considerations**

Taking into account the issues described above the overall design of the school envisaged by this author is as follows.

- The building would be built on level ground.
- The class rooms would face from east through to South west (for New Zealand). In order to avoid direct sunshine during school hours.
- The class rooms would have large windows looking out onto a paved area and playground, beyond which there would be a calm scene of parkland and trees. Each room would have direct access to the play ground, and could have its own specialised outdoor equipment if required.
- There would be limited decoration throughout the school.
- Classrooms would be small with small numbers of pupils in each one. (An open plan design is not acceptable.)
- There would be rooms for physiotherapy, occupational therapy and vision and hearing assessment, in addition to a communal hall.
- The decoration, lighting and acoustic design of the building should take into account the issues addressed above.
- Staff accommodation could comprise an upper storey. This would provide staircases for mobility training.

## **5. Equipment**

We all have thresholds for perception and action. The design of the building, the decoration, the signage and the equipment provided should all take into account the fact that the thresholds for perception (primarily touch, hearing and vision) are reduced for all the children in the school. Everything which is designed to allow the children access to information, mobility and communication must be clear simple and bold to fall within the perceptual thresholds of all but the most severely disabled.

## **6. Staffing considerations**

The building of a new school presents opportunities to review working practises. From the medical standpoint the children to be catered for in this new environment need a holistic approach in which education is one element.

Functional vision needs to be assessed on a regular basis in order to determine the visual thresholds for access to information and optimal curriculum delivery matched to its visibility for each child.

Occupational therapy, mobility training, physiotherapy, sign language training and all other needs are no doubt best addressed by team working in which all workers know a significant amount about each others expertise and continue to implement a holistic approach.

## **7. Conclusion**

This document represents the personal views of the author. It comprises a suggested outline for the future design of this special school, based on the perspective gained by the author who has worked with these children for over ten years.