Considerations in Using Colour in a Care Home

1. INTRODUCTION

To perceive colour we require light to be reflected from the surface of objects and where light is minimal, colour is greyed out and the form of objects is less clear. Where a strategy has been employed, considering colour contrast alone to delineate two or more objects o r surfaces, the strategy can be undermined if the tonal relationships of the specified colours are inappropriate.

Persons with standard vision and cognition negotiate the environment without taking particular attention of the abilities they are using. Persons with reduced visual ability (i.e. the partially sighted) become more aware of the limitations of their sight, and of the difficulty of performing daily tasks i.e. making decisions about where to go or being hampered in locating objects to perform tasks.

When reduced cognition is added to the equation the situation becomes more complex and visual ability plays a vital role. Where vision is also reduced (in addition to cognition) then, the nature of the environment assumes paramount importance. Tonal contrast, in aged care accommodation, assumes significance where visual abilities and cognition are reduced and when light is minimal.
Therefore, when specifying colour in aged care, there are a number of independent variables, which should be considered: visual ability; colour vision & perception; tonal contrast; the prevailing light conditions and the affect these have on the dependent variable, the wayfinding process. Each of these will be briefly canvassed in turn to demonstrate their interdependence.

2. WAYFINDING

Golledge (1999) refers to wayfinding as the cognitive and behavioural abilities of humans to find a way from an origin to a destination. It is a purposive, directed and motivated activity.

Human travel takes place either freely in an unstructured natural environment, along paths delineated by repetitive travel, or along natural or artificial ways e.g. streams, roads, or tracks, and in an interior environment, along halls and corridors etc.

For successful travel it is necessary to:

1. Identify an origin and destination
2. Determine angles
3. Identify segment lengths
4. Identify directions of movement
5. Recognise en-route and distant landmarks
6. Embed the route to be taken into a larger frame

Most human wayfinding uses natural skills and abilities, and memory-based spatial knowledge, known as a cognitive map.

Cognitive maps are the internal representation of perceived environmental features or objects and the spatial relations among them. Difficulties experienced in mentally integrating different routes and their associated features into networked structures helps to explain why cognitive maps may be fragmented, distorted, and irregular.

The term, cognitive map, implies deliberate and motivated encoding of environmental information so that it can be used to determine where a person is, at any point in time. It is commonly agreed that cognitive maps consist of:

- Points – landmarks and reference nodes
- Lines – routes, paths and tracks
- Areas – regions, neighbourhoods, and topographical containment or exclusion
- Surfaces – three dimensional characteristics of features or places (e.g. density)

3. VISUAL ABILITY

When selecting colours for aged care accommodation, specifiers should be mindful that they are specifying for a group of people, the majority of whom will have some degree of reduced vision. Colour is being specified for people with partial sight which, refers to a permanent condition of diminished visual performance.
Visual impairment indicates a limitation in one or more of the basic vision functions. It is strongly related to ageing and, the incidence of visual impairment grows nearly exponentially with age (Julian, W. & Verriest G., 1997). Selective disruption to basic visual capacities in Alzheimer's Disease has been reported (Cronin-Golomb, 1995) together with an unspecified decrease in colour vision (M. Pache et al, 2003).

Some of the principal visual abilities, which are diminished through normal ageing, include the following: acuity, accommodation, the visual field, light sensitivity and colour sensitivity (Cristarella, 1977).

Acuity is the capacity to discriminate the fine detail of objects in the visual field.

Accommodation is the ability to focus on objects at varying distances. The reduction in acuity and accommodation inhibits a person's ability to focus on both near and far objects, diminishing the capacity to perform tasks of daily living.

Our **visual field** is roughly oval in shape and extends 180 degrees laterally and 150 degrees vertically. The visual field is sharp, clear and detailed at the centre but progressively vaguer and less detailed toward its boundaries. A gradual narrowing of the visual field occurs with increasing age. The change is gradual up to age 55, and after 60, the narrowing of the field is marked and accelerated.

Light sensitivity is the ability to adapt to varying degrees of light. With increasing age, there is a need for increased illumination to perform tasks and three visual functions are associated with light sensitivity: brightness contrast, dark adaptation and recovery from glare.

Brightness contrast, which is also known as brightness discrimination, applies to the relation between neighboring regions of a visual field, which are differently illuminated.

Dark adaptation describes the process, whereby an individual gain increased sensitivity, by remaining for an interval in the dark. For example, when a person passes from strong sunlight into a dimly illuminated room, objects are not seen at first – with time however, outlines become more discernible i.e. they first

begin to perceive tonal contrast and then colour contrast. Older persons display dysfunction in dark adaptation.

The third visual function is **recovery from glare**. A glare source is described as an object that reflects excessive light back into an individual's eyes and is the result of too much or the wrong type of light. Glare makes it difficult to attend to a visual task. With increasing age the ability to recover from glare decreases.

The next issue to consider is **colour sensitivity**, which refers to the ability to discriminate colours. There is a decline in colour discrimination with age. A steady decline occurs after 30 years of age, with the ability to discriminate between blue, green or violet showing a marked decline: less deficit is demonstrated in red-green discrimination. With increasing age, colour is purported to have lessinfluence on perception of an object than its form. The colours of objects themselves are said to be not as important as is the contrast between the colours of objects and the background colours, i.e. what is called colour contrast differentiation or more correctly, tonal contrast differentiation.

The final visual function is **visual memory**. In visual memory, images are received and stored by the brain in pictorial form. In general, visual memory is more efficient than linguistic memory at all ages - at least four times the amount of visual material can be remembered than verbal material: this ability decreases with age. Accordingly, the greater the degree of colour and luminance (tonal) contrast that is provided, the more efficient will be the visual memory.

Summary

- A combination of the reduction in the visual field, acuity and accommodation, limits the information that a person receives from the environment.
- Increasing sensitivity to light has a direct effect on a person's capacity to deal with reduced ability in acuity, accommodation and reduction of the visual field.
- Reduction in visual memory has particular implications for persons with cognitive deficits – cueing in the environment assumes importance and by extension, Luminance (tonal) contrast also assumes greater importance.

4. COLOUR VISION & PERCEPTION

Colour vision is only partially understood by researchers. Whilst research continues into this complex area, there appears to be general agreement on certain aspects of the subject. Colour vision, or the intensity of colour sensation, depends on many variables, including, but not limited to (Colour and Illumination, IES, 1990);

Colour Perception

As stated previously, the visual field of an individual is roughly oval in shape and extends 180 degrees laterally and 150 degrees vertically (Cristarella, 1977). The field is sharp and clear at the centre, but progressively more vague and less detailed towards its boundaries and, a gradual narrowing of the field occurs with increasing age.

The perception of colour does not take place over the whole field of vision (Diffrient, 1981). Only **white** can be seen in the peripheral areas. Moving in from the peripheral vision 20º-30º, we begin to discern **yellow**. Moving closer to the standard line of sight (vision straight forward) we begin to see **blue**, then **red**. Finally **green** can be discerned within a 40º cone.

Therefore, because the field of vision of the elderly decreases with age, the colours red and green appear to assume greater importance. Whilst some elderly may have difficulty in discerning some colours, because of a reduction in the visual field and colour discrimination, all colours in the spectrum can still be used, as long as appropriate luminance (tonal) contrast is employed.

The Blue Mountains Eye Study confirms the reduction in various visual abilities in the elderly (Wang, J. J., Mitchell, P., Smith, W., Cumming, R. G., & Attebo, K., 1999). Unfortunately, that study was not able to include testing for colour vision nor did it investigate the perception of colour in the participants.

Cooper (1994) stated that knowledge about the appropriate use of colour (in long-term care) is clearly still incomplete, and more research is needed, particularly on the application of colour to influence function. However, progress is being made.

Wijk and Sivik (1995) conducted experiments to call attention to some aspects of colour and the possibilities of using it as an orientation aid for people in dementia facilities. The experiments tested for four aspects of colour: **naming, discrimination, preference and memory.**

The experiments were conducted because one of the authors noticed in her clinical work that persons with Alzheimer's disease seemed to react to the colours in the environment to a remarkable degree. The question was "*to what extent are various aspects of the colour sense affected by the concomitant cognitive deterioration's of Alzheimer's Disease?*"

This study indicated that persons with Alzheimer's, when compared to people without cognitive impairment of corresponding age, have their colour sense intact regarding:

- Colour identification and memory of common colour names.
- The ability to discriminate between various kinds of rather small colour differences.
- Retention of a general preference order, i.e. those colours that they liked and those that they disliked.

Just as for 'healthy' people, colours and luminance (tonal) contrast in the environment can be both guiding when correctly used, and confusing when misused. The results, the authors stated, would serve as a basis for further studies concerning the visual perception of people with dementia.

Cronin-Golomb (1995) reported selective disruption to basic visual capacities in Alzheimer's Disease e.g., in depth perception and contrast sensitivity, and a specific deficit in colour discrimination, with confusion in distinguishing between blue and green hues. It is suggested that difficulties in activities of daily living may be attributable to specific visual dysfunction e.g., problems in spatial orientation and locomotion may be related to deficient depth perception.

Additionally, a later study reported an unspecified decrease in colour vision (Pache et al, 2003) with the proviso that persons with dementia had some difficulty undertaking the various tasks when assessing their colour vision deficiencies.

Wijk, H., Berg. S., Sivik, L. & Steen. B. (1999), continued their research, and found that:

1. Discrimination ability was significantly better in the yellow and red area and for tonal variations.
2. Cognitive decline had a significant impact on naming mixed colours and using elaborate colour names.
3. Severity of dementia did not affect the preference rank order of colours.
4. No significant sex differences were found regarding the perceptual ability of colour discrimination.

Their general conclusions were that the ability to discriminate colour is affected, with most errors in the blue and green area; the naming of colours shows a cognitive decline and those preferences for colour are stable despite the disease. The authors make two further points:

1. The basic knowledge of how people with Alzheimer's Disease recognise and prefer colours is a prerequisite in a conscious colour design.
2. There is still a lack of studies on how dementia affects aspects of colour perception.

Summing up, persons with dementia retain certain colour perception abilities despite their condition:

1. The ability to name and remember common colours (red, blue green, purple etc).
2. The ability to discriminate Luminance (tonal) differences.
3. Higher ability in discriminating between red & yellow, as opposed to green and blue.
4. The ability to indicate colour preference.

5. LIGHTING

Light is essential for the perception of colour. There must be a coloured surface from which light is reflected into the eye. The difference in wavelengths of light contained within this reflected light and their relative power will influence the perceived colour (Bright, K., Cook, G. & Harris, J., 1997).

Sight is the most important sense for acquiring information; therefore, disturbance or disruption of the visual system will lead to negotiation difficulties (Julian & Verriest, 1997). People with partial sight (low vision) receive distorted or disturbed visual pictures. This means that individuals have to make inferences about visual information. Incorrect inferences can lead to incorrect behavioural responses and can be made by there being too little, too much or the wrong type of light in the environment. The available light determines the degree of success in undertaking daily activities as well as influencing the safety and independence of the residents of aged care facilities.

There are three basic objectives of a lighting system (AS1680.1: 1990):

(i) to facilitate the performance of visual tasks
(ii) to aid in the creation of an appropriate visual environment
(iii) to ensure the safety of people in the interior

A safe and comfortable visual environment depends mainly on:

(i) avoidance of excessive illuminance variations

(ii) absence of direct glare from lamps, luminaires or windows

(iii) an appropriate luminance distribution on interior surfaces

(iv) use of 'suitable' colours on the main interior surfaces

(v) use of light sources with suitable colour characteristics i.e. light sources which achieve true colour rendition.

The recommendations of AS1680.1:1990 presume that the occupants of any interior have normal or near normal vision. Whilst AS1680.1 recognises that 'some' people have reduced vision, it states that "it is more economical and efficient to ensure that the occupants (of an interior) have normal or near vision, rather than over-design the lighting system'. AS1680.2.0:1990 details recommended illuminances for various environments. Noticeably missing from this standard are recommendations for nursing homes, hostels and domestic- type interiors such as retirement living. The absence of any lighting standard for environments inhabited by the elderly and/or those with partial sight has been noted by two authors, Coulson (1997) and, Julian and Verriest (1997).

AS/NZS1680.0:1998 is the first standard to alert designers to the needs of persons with impaired vision. Under Appendix A. lighting for the Partially Sighted (Informative), it briefly canvasses The Causes of Low Vision; How People are Affected and The Role of Lighting. However, it does not provide specific guidelines as to the specification of light fittings which deliver light levels in an appropriate manner. The absence of specific lighting design guidance has also been noted by Bright, Cook & Harris (1997).

The point about lighting, is that if it is installed inexpertly i.e. lux levels too high or low, incorrect colour rendition or inappropriate designs of the light fittings, then strategies based solely on colour contrast are at risk. Luminance (tonal) contrast strategies assume significance.

6. LUMINANCE (Tonal) CONTRAST

Tone is the lightness or darkness of a colour. It is an integral part of colour, and every colour can be classified as a certain tone. Tone creates relationships between elements i.e. tonal contrast. Tonal Contrast is also known as Luminance Contrast. Luminance Contrast is commonly defined as the luminance difference between a task detail and its background (Bright, K., Cook, G. & Harris, J., 1997). Where Luminance Contrast (tone) is minimal or non-existent between two colours, the boundaries of elements can become blurred and unrecognisable.

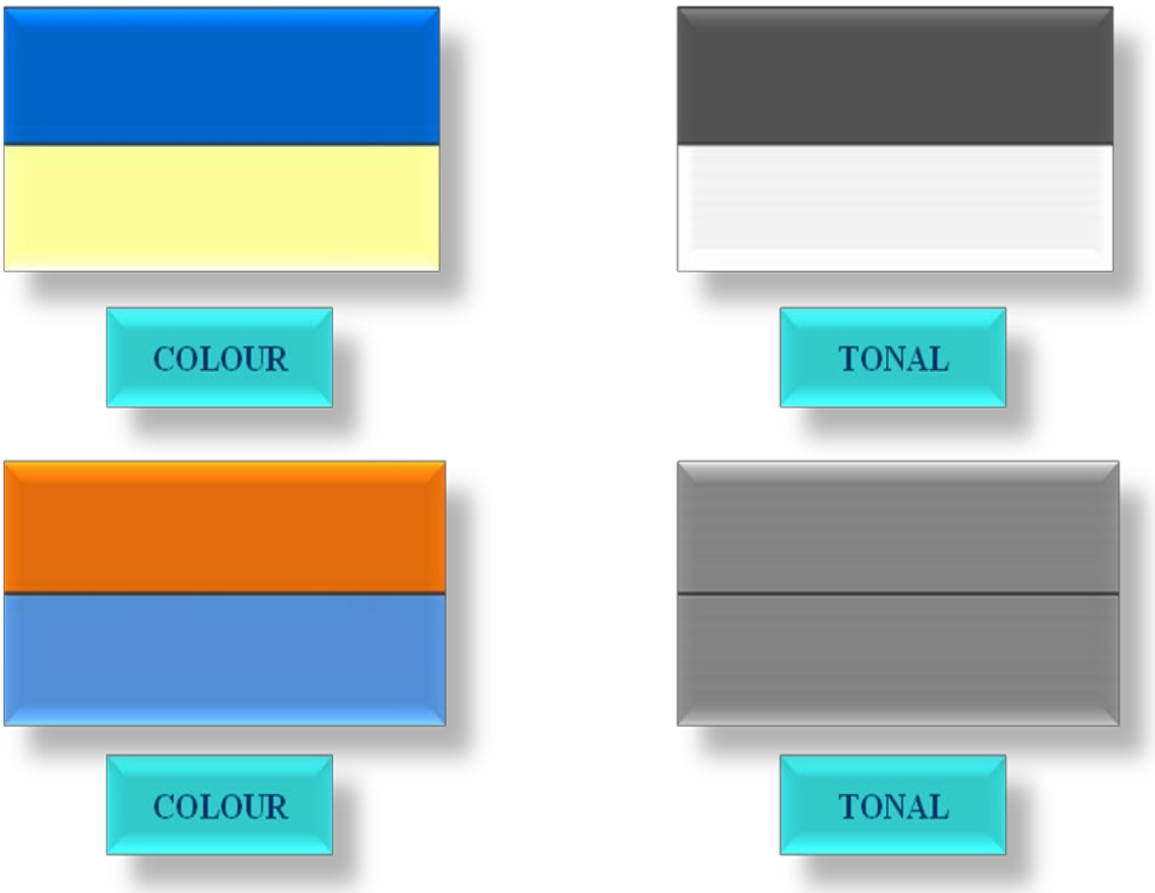
Professional Artists begin with a tonal layout when commencing a painting. Depending upon the artist's preference, the tonal layout can be composed of greys, blues or browns. After tonal relationships has been established then judgements are made as to the colours to be applied which represent the 'tonal decisions'. The artist mixes the selected colour and then visually compares the tone of the mixture with the relevant tone on the tonal layout, and when satisfied applies the colour. This process is reliant on the visual judgement of the artist.

For an interior to function effectively, particularly in Aged Care, a similar approach should be adopted, i.e. decisions should be made about where maximum or minimum tonal contrast is required and then appropriate colours should be specified to achieve the desired strategy.

In the publication Building Sight (Barker, P., Barrick, J. & Wilson R., 1995), examples of monochrome tonal layouts are provided to demonstrate appropriate tonal relationships in interiors for the partially

sighted. In the Australian Supplement to that publication (Mountain, 1995), it is advised that Luminance Contrast can be measured with the aid of light or lux meter. This testing method is relevant where the paint colours in an interior are existing or where a full mock-up of a proposed interior is constructed together with the relevant lighting.

The tonal relationship between colours is not necessarily obvious to the human eye when two colours are viewed together. The colour contrast and Luminance (tonal) difference between black and yellow is obvious, but it is possible to combine two colours which have evident colour contrast, but which will not necessarily provide for tonal contrast i.e. when viewed under diminished light conditions (greyed out). The tonal difference, or lack of it, is only apparent when the colours are viewed in grey-scale. Refer to the following examples.



The problems associated with the absence of tonal contrast were amply demonstrated when, in the first half of 2002, I was invited by Queensland University of Technology to write a Lecture and Tutorial for the Graduate Certificate in Designed Environments for Ageing, being given in the School of Design and Built Environment. The course was conducted on- line, so I never met any of the participants in the course.

The lecture was on Wayfinding Techniques and as I didn't come face to face with the participants, the Tutorial needed to be designed so that the material canvassed in the Lecture could be 'experienced' by the participants. I suggested that the participants undertake two wayfinding exercises:

1. Visit a large shopping centre with which they were unfamiliar, choose a destination, find their way and report their findings. I also suggested that the participants wear sunglasses during the exercise.

2. Select a number of familiar objects in their home, lay them out in a convenient location, view them over a period of approximately one hour at both sunrise and sunset and report their findings.

I recommended that the participants make a photographic record of their experiences together with a written record. The results of the two exercises were quite interesting.

Shopping Centre exercise - amongst other things, the participants found that:

1. They could not find adequate directions i.e. from available signage.
2. Glare was a major problem, both from roof lighting (daylight and direct sunlight) and artificial lighting (principally downlights). Depending on the intensity of the available light, the sunglasses worn by participants were variously a handicap or an aid.
3. There was minimal colour and/or luminance (tonal) contrast between surfaces i.e. floor/wall, furniture/floor which, would make it difficult for a partially sighted person to navigate the environment.
4. Patterned floors were generally finished in high contrasting materials which were both glaring and confusing for partially sighted persons.

Objects in the Home - the participants found that:

1. It was very difficult to identify objects in conditions of low levels of daylight (morning, evening & dull, cloudy days)
2. Objects which had a high reflectivity were the first ones able to be identified.
3. Objects with minimal luminance (tonal) contrast, within themselves or with adjacent objects, were the last to be recognised.

Note that in Point 3, I did not say 'objects with minimal colour contrast". As shown previously, elements in the environment can posses colour contrast, but not necessarily possess appropriate luminance (tonal) contrast for identification.

The photographic record submitted by the participants graphically illustrated the problems. The majority of participants submitted colour photographs which I viewed and printed out in monochrome. The monochrome pictures pointedly illustrated the tonal deficiencies (too much or too little) both in the shopping centre and home environments.

7. SUMMARY

When specifying colour in aged care, there are several independent variables, which should be considered: visual ability; colour vision & perception; luminance (tonal) contrast; the prevailing light conditions and the affect these have on the dependant variable, the Wayfinding process.

For those involved in the planning and design of aged care accommodation it should always be remembered that the primary tool used by residents in daily wayfinding tasks, is vision. And, most residents in residential aged care accommodation (including dementia facilities) will have some form of reduced visual ability. Where cognition is also reduced colour and luminance (tonal) contrast are significant elements in the design.

Therefore, colour contrast and more importantly luminance (tonal) contrast strategies should be addressed at the commencement of the design process. Colour contrast strategies assume standard colour vision and perception and are dependent on appropriate lighting. Luminance (tonal) contrast strategies recognise diminished visual ability and are less dependent on the prevailing light conditions, natural or artificial.

Questions need to be addressed in the initial stages of the process. How will luminance (tonal) contrast be used? Where is maximum luminance (tonal) contrast required and where is minimal luminance (tonal) contrast required? After those decisions have been made then appropriate colours can be selected and applied to achieve the desired strategies.

The final factor to consider is aesthetics. Following the professional artists' example, luminance (tonal) strategies should be designed first and then aesthetic expectations can be addressed.

meaningful care matters

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