Research with users: colour design and lighting for public transport, prison and health care environments

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Abstract
The Colour Design Research Centre at South Bank University is involved in research, consultancy and the application of colour design and lighting focused on specifier and user needs, from products to environments. Current projects are in the transport, prison and hospital sectors. The EPSRC/ DTLR LINK funded project (2001-2003) entitled Inclusive Transport Environments: Colour Design, Lighting and Visual Impairment, is being conducted jointly with the Research Group for Inclusive Environments at the University of Reading. The project examines issues concerning colour design and lighting in future multi-modal public transport environments for visually impaired and elderly users. The Home Office, Construction Unit project on safer custody in prison is currently working on six prison sites throughout the country. The NHS Estates Research and Development Project (2002-2003) entitled Colour Design and Lighting for Hospital Environments is being carried out with BRE (Building Research Establishment). The Disability Discrimination Act 1995 (DDA) is applicable to service providers (Prophet, 1998) yet few practitioners understand the complexity of colours’ role in making environments truly accessible. Current field studies with visually impaired people have revealed that colour can affect acuity. (Dalke H et al., 2002) For visually impaired people with macular disease for example, red is sometimes perceived as black. Colour is aesthetic, practical and an inherent property of materials and therefore an inseparable component in design. Materials like glass, steel, applied colour such as paint or powder coating, present colour contrast design problems for developers of buildings. The widespread use today of monochromatic schemes and highly reflective surfaces is known to be problematic for visually impaired people. Older environments are similarly complex due to levels of ‘visual noise’. Research to establish some mechanisms from the complexity of these environments and to understand how colour design affects people who occupy different types of environments.
Public transport

Future inter-modal public transport environments should encourage independent living, ensure social inclusion, and accessibility. In public transport environments, functionality of the space in terms of wayfinding and orientation constitutes major importance as well as safety and comfort. A survey by the Royal National Institute for the Blind (Bruce, McKennell and Walker, 1991) established that about 1 million people in the UK have some form of visual impairment affecting central, peripheral vision, or the whole visual field. In addition to this number, there are about 1.97 million people who have some significant loss of vision, but not sufficient to be considered for being registered as visually impaired. The objectives of the research are:

- To enhance the performance of transport environments.
- Encourage inter-modal travel for VIPs.
- Produce safe and inclusive multi-modal transport for all.

The team conducted site audits en route from the Elephant and Castle tube station to Paddington Main Line, through to Heathrow Terminal 3 on the Heathrow Express. These sites provided generic scenes applicable to future multi-modal transport environments. Issues for the visually impaired were:

- Environments were without visual clues to orientation – alighting from tube with no directional signage visible.
- Extreme light to dark adaptation areas – from outside stations into low-level lighting on concourse.
- Decision points at key route junctions poorly light and below standard signage for accessible wayfinding.
- Use of poor colour design application – markings on road or link pathways indistinguishable.
- Ticket machines with poor interface design – red text on black difficult for people with Macular Disease.
- Monitors fail to be legible for a majority – height, angle, location and text.
- High levels of visual noise – mixture of overpowering retailing lighting and lack of clarity or space for public information.
- Monochromaticity and highly reflective materials – glazing and shiny steel present a multitude of problems for some visually impaired users of transport environments.
- Back-lit signage can be easier to see but also more difficult to use – visually impaired people may find light produces glare.
- Dangerous edges and boundaries are not always sufficiently defined – they need to be clearly marked with contrasting detail for VIPs.
- Manifestations on glazing is often neglected or badly designed – coloured motifs are not visible against backgrounds.
- Retail design is more effective at creating an impact on transport sites than public information providers.

A pilot-questionnaire was designed and tested with 100 visually impaired people with Macular Disease. Fifteen hundred questionnaires were then distributed nationally containing 56 questions about travelling using public transport. They covered issues including vision, confidence, ambience, functionality and problems encountered. A pilot real world test followed of task performances of a representative sample of visually impaired and elderly users. The early pilot real world tests were carried out at Paddington Station, London, then Gatwick Airport, South Terminal. Volunteers identified from the questionnaire were given two trial tasks to complete.
• Task 1 was static, a panorama test undertaken at arrival point from the tube below ground, onto the Railtrack concourse. The volunteers described every visible or usable piece of signage, information, objects and landmarks perceived from that stationary position, rotating around 360 degrees.

• Task 2, a mobile test at a selected inter-modal transfer point on the station was navigation between two defined points on the station. The volunteers were again asked to describe in detail their sightings.

Paddington Station was selected for complexity and visual noise found on many transport environment sites. Results have been measured, plotted, and collated. Disadvantages of this field research outside a laboratory setting were:
• Familiarity and recognition of certain signage.
• The changing daylight conditions, a major uncontrollable variable. Night time tests are being planned.
• Visual complexity from advertising to lighting, competing in the environment.
• ‘Organic’ developments of sites creating optical chaos.

Some conclusive positive results were:
• Liking for the light mat floor across the concourse. Traveller’s shoes on site test days were mostly dark and contrasted on the concourse floor.
• Ability to detect key symbols e.g. telephone kiosk and Transport for London
• Diagonals of escalator handrails and reflective steel were seen
• Lights showing between the treads on the escalators.

However the quality of signage declined during the research phase – renewed signage was less legible. On impact and visibility on site, the retail sector beats public utility most of the time.

An expanding ageing population faces difficulties in wayfinding and accessibility. Use of colour design, lighting and contrast are ways of increasing the clarity of visual cues and information provided in transport environments, beneficial for visually impaired people, elderly and all.

Prisons
Safer custody, the prevention of suicide or self-harm, is an important issue. The aim of this work is to provide colour design solutions to problems found within long-term restricted living environments such as prisons. A sense of well-being is vital to maintain a healthy frame of mind. Quantifying these ‘beneficial’ uses of colour in prisons has been the subject of much trial and error. Constraints to developing any interior schemes for prisons are practical. The frequency of refinishing and storage of various paint colours present the biggest problems to institutions. Prisons environments are required to be secure and robust with a need for economy in construction. Opportunities for the colour designer to create any meaningful improvement in the visual environment are limited. Colour, and related visual aspects such as lighting design and surface texture, is one of the few variables that can be controlled to alleviate an otherwise harsh, monochrome environment. Generic solutions to the use of colour design and lighting can be found.

The influence of colour, design and lighting essentially affects the feelings of the occupants of buildings, influencing attitudes and behaviour. The extent of this is debatable, but negative effects of a poor quality visual environment are apparent as seen in the:
- Poor planning increasing sensory deprivation.
- Visual monotony and boredom which engenders vandalism.
- Maintenance and the physical appearance of a building affecting occupant’s morale and tension.

Response to colour is subconscious. (Mahnke FH, 1996). A lack of light may have a detrimental effect upon people’s emotional state. A lack of variety in colour, lighting and even surface texture may either depress occupants or lead to under-stimulation, alienation and aggressive behaviour in isolation. (Fairweather I and S McConville, 2000). Variation in location and lux levels of artificial lighting provide visual interest while sunlight, seasonal and time variations should penetrate the building. Hue or saturation variation in colour or a variety in texture, has a positive effect on mood and behaviour. (Kwallack N, 1996)

Most prison sites visited to date are shades of the ubiquitous yellow and blue with furniture, the only other potential for visual interest within the cells, of little relief, bar the inmates personal belongings. Occupants may suffer from sensory deprivation due to the uniform visual appearance of the environment. The lack of stimuli contrasts with the outside world that the inmates have inhabited. Attempts to alleviate the paucity of the environment with images have been difficult as a consensus on visual material has not been easy to obtain. The duration of the prisoner’s physical confinement contributes to this deprivation by inaccessibility to other spaces and changing visual environment. (Fairweather I and S McConville, 2000)

Improvements in the use of colour and lighting together, are important in countering sensory deprivation and encouraging a sense of well-being. The approach to the use of colour however cannot always be formulaic. Orientation, location, building, and its use is in some sense unique so an effective design specification responds to these variables. Vary colour shade or hue and luminaire position or lux level, and a radical effect on a prison environment is achieved. Uniform application of a single colour, or improvements in only a quantitative or qualitative measure of lighting performance, are less effective.

Natural light and the view from windows are important factors in safer custody and have psychological effects on people particularly light changes from early morning to late afternoon. Windows are a factor influencing ambience and not only let light in, but also play a critical role in the way light is transferred into the interior. The outside grounds surrounding windows or doors are also part of the colour design scheme as lighter paving can throw up more reflected light. Small cells with Northern facing aspects will be difficult to lighten and dark materials intensify the potential gloom. Lighting and colour should always be considered simultaneously. Utilising sources of natural light where benefits can be gained in the quality and directionality of daylight. The use of daylight and artificial lighting sources should be integrated so as to achieve good colour rendering. Artificial lighting can provide variety in terms of location on ceiling or walls to create a varied and stimulating environment.

One recently completed wing on a site is currently newly occupied. We were asked to provide a colour finishes schedule for this wing, a First Night Induction Unit. A colour scheme was developed to enhance quality materials retained in the original building, hard wood ceiling, steel handrails, terrazzo stairs and landing and terra cotta floor tiles. The colour scheme provided contrasting hue differences between the living environments and the association or recreation areas to achieve visual stimulation. Window walls of cells were pale to alleviate strong contrast between daylight through the window and the gloom of an unlit wall. Sanitary fitting colours were different
from the furniture, table and bed to provide a psychological divide between these areas. Post occupancy evaluation of all projects are currently being undertaken to analyse and assess the impact of colour design and lighting on inmates and staff.

**Hospitals**

The aim is to establish principles of colour design and lighting in the creation of inclusive, pleasant, ambient hospital environments focusing on generic areas of hospitals. Guidance produced will suggest colour and lighting strategies and techniques for general, circulation and care areas in an illustrated report based on expert audits, site surveys, and consolidation of previous knowledge about healthcare environments. Much of the refurbishment of healthcare environments often involves non-professional decision-makers who require this guidance.

For patients, staff and visitors, the primary considerations are a sense of well-being, the minimising of stress factors and an improved environment. The impact of colour and lighting on peoples’ perceptions and responses to the environment are well documented (Birren F, 1978) and can impact on patient well-being and recovery rates, improving the quality and overall experience of patients, staff and visitors (Mahnke F, 1997). (Ulrich R, 2002). Country of our time, BBC Radio 4. An enhanced visual environment has produced improved patient recovery rates by around 10%. These improvements include the use of appropriate colour in interior design, views or even pictures of natural scenes, display of art works, the provision of sunlight and of attractive views out (Ulrich R, 2002).

The patient requires a quality environment with accessibility, clear signage and easy wayfinding. Patients like to be seen by staff and have visibility of staff or key facilities and be connected to the world outside to watch life going on as ‘normal’ (Ulrich R, 2002). For young children the floor and shapes, colour and texture are more important. They experience fear and boredom, which can be assuaged through careful tactile design. For staff, the quality of the environment is vital for morale, recruitment and staff retention. Many staff have been involved in refurbishment design, some funded in London by the King’s Fund. Staff confidence in the environment transmits to the patients.

Colour design issues identified as a priority are:

- Wayfinding and signage.
- Colour coding and zoning.
- Visual impairment and colour contrast.
- Skin-tone and lighting.
- Interiors and materials.
- Design management and guidance.

Research has shown how people search and navigate spaces, experiencing problems with accessibility, safety and wayfinding. (Dalke H, 1998). These issues are particularly important for those, who may require longer understanding visual information, and are lacking confidence. Colour can improve the definition of the environment, reinforcing hierarchy of prominent features, contribute to intuitive wayfinding, sensory acuity and cognitive understanding of building form. 55% of people used cues other than signage to navigate, for example coloured glass windows. Colour application in coding can be misguided and strategies for zoning, contrast or colour coding are inconsistent. Two-thirds of all coding systems are misunderstood and not checked for colour vision impairment. Employing a few colours, for example coding on floor boundaries, is very simple and effective. Ease of navigation and wayfinding
will promote faster, effortless access, thereby reducing labour, frustration and wasted time.

Healthcare environments need to improve accessibility for all. Main considerations for a colour design specification for the needs of visually impaired people are:

- Surfaces textures and materials
- Colour and contrast
- Tonal detail
- Balance between daylight and nighttime illumination.

Polished or shiny surfaces cause glare and glass should be suitably marked to avoid accidents. Tonal contrast is important for definition of walls from floors, doors or obstacles and shadow detail in the buildings’ structure from decorative mouldings or window recesses may make interiors conspicuous.

Visual noise can be a major problem in hospitals increasing stress levels; this may come from clutter of equipment or communication of information. The assimilation of information is more easily achieved with less visual distraction. Clear space is important to achieve maximum take up of communication material. High levels of ‘visual noise’ within the building, can lead to confusion for a new visitor.

The ambience of a building is judged from how faces appear. Colour and skin tone is appraised against coloured backgrounds under colour rendering qualities of a light source. Convalescing patients warm coloured lamps, which are flattering to most skin-tones. The lighting of toilet facilities requires care, as this is often where patients see themselves for the first time after medical treatments.

Corridors, to take one generic area studied, are ideal for any wayfinding colour strategy on landmarks, walls, dado rails, doors or flooring and can form colour coding or zoning. A single colour in a corridor, especially a long monotonous one, can desensitise and produce feelings of claustrophobia. Ceilings are crucial to ambience especially in long, straight corridors and can create visual disorientation. Curved corridors provide visual interest but can make it more difficult to orientate oneself without a view. Lighting areas of accented colour on walls is a way of assisting orientation and highly polished floors can produce extensive glare with artificial lighting. If a patterned carpet is used then the designs need to be examined in situ with the correct luminaire to check for uneven pattern repeats or the unpleasant results of optical colour mixing.

The most important element of a building is the window. Window treatments ‘manage’ daylight by filtering light through different types of blinds or sheer translucent fabrics. The material and colour of blinds or fabrics can create surprising colour effects that reflect off walls or bed-linen nearby. Wooden blinds can reflect a warmer light into the room.

Textiles are used for bedding, linens, curtains, screens, cushions and upholstery. For patients textiles are important in creating a feeling of comfort and cleanliness. Less institutional bed-linen would improve patient morale. Staff would appreciate better quality sheets so they can provide an attractive, modern environment for their patients. Curtains are a staple component of hospitals and ‘homely’ floral textile designs dominate the environment. They soften the environment visually and acoustically and by tradition form the divisions of interior space. Curtain linings usually face the patient so woven and reversible, or finer fabrics that have some degree of translucency to allow light to filter through, are preferable.

Furniture adds to the overall impression of an environment, is a fairly permanent part of the building so colour choice for materials used in upholstery should be
practical as well as aesthetic. A technically tough man-made material is appropriate as it can be wipe able or waterproof.

In conclusion, these three projects should show the part colour plays in spatial cognition, provision of information, 'ambience', a sense of well-being and affecting factors of sensory deprivation. Experience has already shown that colour research has been carried out in the past by single disciplines; our aim has been to provide results from multi-disciplinary research teams to assist the take-up of results for a wider application for the benefit of all users.

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