Measurement for a more visible world: colour contrast and visual impairment

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Abstract

Visual contrast between adjacent surfaces is a requirement of Building Regulations Part M, 2004, the Disability Discrimination Act (DDA) 2004, for the design of inclusive environments, and products and services for Visually Impaired People (VIP). There are nearly 3 million people in the UK who have some form of low vision. Despite guidelines, standards and regulations, there is no 'tool' to help contractors, architects, designers and access consultants evaluate what exactly constitutes 'good colour contrast' in their projects. No definitive advice exists on how to achieve effective contrast specification for materials. Currently contrast assessment may be too complex a process for access personnel to devote time and resources to. Existing colour measurement technology (spectrophotometry) is too expensive (circa £4 - 8,000) and over-specified (multiple colour spaces) for simple and easy contrast evaluation.

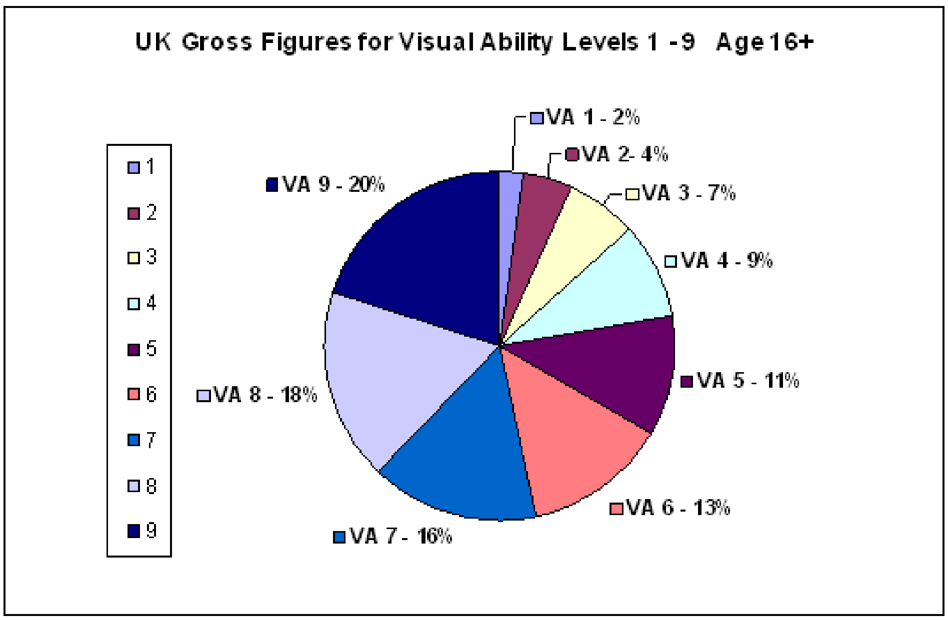
Although it has been known for some time that adequate contrast is essential for the perception of the world for people with low vision[1], until recently the mechanisms for the provision of those interventions for the agencies that require that information - the methods for achieving success - have not been fully mapped out. Research has been carried out over the past four years that developed from useful observations on an EPSRC/Link research project[2]. The detailed measurements of 380 objects (seen by VIPs) and their environs – namely the light reflectance value (LRV), size, distance and lux – on 'real world' sites were collated and analysed. This work resulted in the creation of a first generation algorithm colour contrast prediction model for software, and firmware to be used in a tool microchip.

This colour contrast model - developed by Dalke, Conduit and Conduit for the benefit of improved visual acuity for the visually impaired population, enables the architect, designer or access consultant and developers of the built environment to predict whether a VIP is able to see an object, text or element of a building before design and installation.

The model required beta-testing in the lab and observations conducted on what occurs in a complex near 'real world' setting; the presentation of this paper will describe the positive verification of the model with a test; this was carried out with 10 participants. The results from the lab tests will also demonstrate the differences between the perception of backgrounds and objects of varying grayscales by the visually impaired participants.

Background

One of the five key factors of the colour contrast model, in both contrast assessment and specification, is the profile of the visually impaired population (Fig 1). Exact figures on the size of the VIP categories of visual ability are difficult to obtain; however it is likely that only around 2% of the registered VIP population (classified as severely impaired or blind) have no ability *'to see any light at all that may be coming through a window'*, and 4% may just be able to perceive light (Fig 2). From data gathered it can be seen that the vast majority of the visually impaired population – 94% - have varying increasing levels of residual vision from V3 to V9; V10 being full vision. Consistent and accurate use of colour contrast for product or environmental design would be efficacious for this community and others. It should be noted that experts in the field recognize that the number of registered VIPs does not fully reflect the actual scale of low vision in the UK. Many people with poor visual acuity fail to present themselves to either GPs or opticians for early diagnosis so statistics on the visually impaired population are thought to be much larger than the figures recorded.



Source : Dalke et al 2008, Grundy E.[3], Douglas, G.[4]

Fig 1 UK Gross figures for visual ability levels V1 – 9 Age 16+

- 3 million people in the UK population live with some form of low vision
- 6% of the VIP population has a VA level of around V1 and V2, the most severely sight impaired (blind).
- 94% of the visually impaired population registered as blind or partially sighted may have good residual or useful fields of vision.

- V1 – Cannot tell by the light where the windows are
- V2 – Cannot see the shapes of furniture in a room
- V3 – Cannot see well enough to recognise a friend if close to his/her face
- V4 – Cannot see well enough to recognise a friend who is at arm's length away
- V5 – Cannot see well enough to read a newspaper headline
- V6 – Cannot see well enough to read a large print book
- V7 – Cannot see well enough to recognise a friend across a room
- V8 – Has difficulty recognising a friend across the road
- V9 – Has difficulty reading ordinary newspaper print
- V10 – Full vision ability

Source : http://www-edc.eng.cam.ac.uk/betterdesign/usercap/vision/vision11.html

Fig 2 Visual ability categories; the ability level is measured with any desired vision aids.

Results

Colour contrast model predictions were checked with VIP participants and shown to be robust when compared with data generated in the beta lab tests. The results showed a consistent trend across ten participants; there was a difference between perceptions of patches on the light background/patch sets and dark background/patch sets. As can be seen in (Table 1), where there is an LRV difference of 22 points in all sets, the distances at which the patches were observed were greater and more successful when the darker shade combinations were used. Dark background and patch sets scored considerably higher visibility at 1155 metres total distance with participants, whereas the reverse lighter combinations, scored much less at 680 metres (Table 1). Although both sets had a 22 points difference between background and objects, the lighter the background and patch set the closer proximity needed to see the contrast difference.

Two objectives of the study were achieved. Firstly, the utility of the prediction software was rigorously tested and the accuracy of the software established against the beta test results. Secondly, the 'real world' lab tests demonstrated that a contrast of 22 of dark objects on dark backgrounds were visible at a greater distance (63%) than a contrast 22 of light objects on light backgrounds (37%) by as much as 26% over a 10 metre test course.

Table 1 Testing of 5% and 27% LRV and 71% and 93% LRV patches and backgrounds (both with contrast difference of 22). The results for greatest distances from which the patches were seen was 1155 metres (63%) for darker backgrounds and patches; and a greatest distances total of 680 (37%) for light backgrounds and patches. All testing of backgrounds and patches were with 22 contrast difference between backgrounds and the patches.

Participant. Ref No	**8**	**3**	**9**	**7**	**6**	**10**	**1**	**2**	**5**	**11**		TOTAL
Visual Ability (VA) 2 -10	**2**	**2**	**2**	**3**	**4**	**5**	**6**	**6**	**8**	**10**		
Object size 15cm												
RESULTS All with contrast difference of 22 over a 10 metre course												
Dark 5%/27% (22)												
Background/Patch Distance seen	0.5	1	2.5	7	8.5	8	9.5	1.5	9.5	10		**580 metres**
Dark 27%/5% (22)												
Background/Patch Distance seen	1	1	3.5	5.5	5	6.5	10	6	9	10		**575 metres**
Difference between reversal	.5	0	1	1.5	3.5	1.5	.5	4.5	.5	0	**13.5**	**1155 metres**
								Distances seen dark sets				**63%**
Light 71%/93% (22)												
Background/Patch Distance seen	0.5	0	1.5	5	5	3.5	4	4	10	10		**340 metres**
Light 93%/71% (22)												
Background/Patch Distance seen	3	1.5	3	3.5	1.5	0.5	3	4	7	10		**340 metres**
Difference between reversal	2.5	1.5	1.5	1.5	1	3	1	0	3	0	**15**	**680 metres**
								Distances seen light sets				**37.00%**

References

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Keywords: Colour contrast, Light Reflectance Value, Inclusive Design, Visual Impairment, Visual Acuity