Applied Ergonomics 47 (2015) 253–258

Contents lists available at ScienceDirect

Applied Ergonomics

journal homepage: www.elsevier.com/locate/apergo

Subjective responses to display bezel characteristics

Peter A. Howarth*, Simon G. Hodder

Environmental Ergonomics Research Centre, Loughborough Design School, Loughborough University, LE11 3TU, United Kingdom

ARTICLE INFO

Article history:
Received 30 May 2013
Accepted 5 October 2014
Available online

Keywords:
FPDs
Bezel
Gloss
Glare

ABSTRACT

High quality flat panel computer displays (FPDs) with high resolution screens are now commonplace, and black, grey, white, beige and silver surrounds ('bezels'), matt or glossy, are in widespread use. It has been suggested that bezels with high reflectance, or with a high gloss, could cause eyestrain, and we have investigated this issue. Twenty office workers (unaware of the study purpose) used six different FPDs, for a week each, at their own desk. These displays were identical apart from the bezel colour (black, white or silver) and shininess (matt or glossy). Participants completed questionnaires about their visual comfort at the end of each week, and were fully debriefed in lunch-time focus groups at the end of the study. For the white and the silver bezels, the glossiness of the bezel was not an issue of concern. The participants were significantly less content with the glossy black surround than with the matt black surround, and in general the glossy black bezel was the least-liked of all those used. With the possible exception of this surround, there was no evidence of significantly increased visual discomfort, indicative of eyestrain, as a result of high or low bezel reflectance, or of high glossiness.

1. Introduction

Flat panel displays (FPDs[1]) with high resolution screens are now common in the workplace. As with tablets, style has played an important role in the marketplace, and black, grey, white, beige and silver surrounds ('bezels'), matt or glossy, are common. However, concerns linger that some of these could be detrimental from an ergonomic viewpoint, leading to eyestrain for the user.

The question of whether bezel characteristics adversely affect people is important because there are moves to limit their design,[2] which are based on concerns about the health and safety of people using the display. This is despite the fact that there is little scientific evidence to indicate why, or how, reflectance or glossiness could actually affect users. In 2003 the Swedish Confederation of Professional Employees (TCO) stated (Overödder and Rudling 2003a) that "If a dark frame is used with flat displays in common office lighting, the display-to-frame contrast can cause eye strain". TCO concluded, presumably on the basis of their own studies, that "black frames can be a problem due to excessive contrast .." and that "… white frames are considered a problem due to excessively high reflectance" (Overödder and Rudling, 2003b). No data were published to substantiate these claims at the time, although a subsequent study performed at TCO (Beländ and Andrén, 2007) indicated that higher gloss bezels were less acceptable than those with lower gloss, with the reflections in the higher gloss frame being 'disturbing'. The suggestion has been made that poorly-designed bezels could contribute to so-called "computer vision syndrome" (Yan et al., 2008) and potentially this could, to some degree, affect millions of people at work.

Other studies to date (Soderston et al., 2003, Hunter et al., 2003, Howarth and Hodder, 2004, Sheedy et al., 2005, Hisatake et al., 2011) present the opposite view and indicate that the bezel characteristics do not affect either performance or comfort. However, these studies can all be criticised (as can that of Beländ and Andrén, 2007) on the grounds that they were laboratory studies of restricted time and scope, and did not examine the effect of bezel colour or gloss during normal work. The current study avoids this pitfall as it examined participants using a number of different displays for a week at a time in their own workplace.

We provide evidence here that office workers, rather than test panel subjects, were not disturbed by either the glossiness of the surround, or its colour (black, white or silver) with the possible

* Corresponding author. Tel.: +44 1509223040.
E-mail address: p.a.howarth@lboro.ac.uk (P.A. Howarth).

[1] In this paper we use the following terms with these specific meanings: **Display**: the complete piece of hardware which makes up a computer monitor, including the screen and the case **Screen**: the active part of a display device **Cathode Ray Tube (CRT):** the complete display device using this screen technology **Flat Panel Display (FPD):** the complete display device incorporating Flat Panel technology **Bezel**: the portion of the display immediately adjacent to the screen.

[2] ISO/TC 159/SC4/WG2.

http://dx.doi.org/10.1016/j.apergo.2014.10.005
0003-6870/

exception of a glossy black bezel. Also, importantly, there was no evidence of a difference in visual discomfort between the different conditions.

2. Methods

2.1. Conditions

The study was run over a four month period, during the mid and late summer of 2003. Twenty participants, none of whom were aware of the study purpose, each sat at their own desk with one of the six FPDs replacing their own VDU for a full week. At the end of the week they completed a questionnaire about the display and the screen, and the display was then changed. In order to ensure that there were no order effects, participants were presented with the FPDs in a pseudo-random order, designed to ensure that, as far as was practicable, each FPD was viewed the same number of times before and after every other FPD. Before starting the study, participants rated the VDU that they normally used, which in all cases was a CRT. This initial step was designed to familiarize the participants with the questionnaire and the procedure, and to ensure that primacy effects did not affect the FPD assessments.

2.2. Participants

All participants were secretarial, managerial, or research staff of Loughborough University, from either the Department of Human Sciences or the English Language Study Unit. They ranged in age from 20 to 59. Seven were male and 13 were female, and all used computers extensively during their daily routine.

2.3. Displays

The Flat Panel Displays were all 17 inch LCD monitors manufactured by Samsung, each with a resolution of 1280*1024. The manufacturer produces low-gloss silver or black bezels, and to extend the study we purchased extra displays which were then painted white. One display of each bezel colour (white, black, silver) was painted with clear varnish to provide a glossy appearance. All displays were driven by the participants' own PC using MS Windows. All of the screens appeared to be identical, the only difference between the displays being the colour and glossiness of the bezel. Participants were instructed to adjust the display when they received it, and to set it to their own preference. Fig. 1 shows the two silver FPD's, illustrating the difference in the bezel glossiness.

Gloss was measured using a Minolta Multi-Gloss 268, serial #192646, at a measurement angle of 60°, and reflectance was measured using a Minolta LS-110, serial # 79123002 and a standard white reflectance comparison sheet (see Table 1).

2.4. Questionnaire

The questionnaire contained twenty-nine questions, of which only seven were relevant here:

1. How irritated and disturbed visually did you usually feel when looking at the screen?
2. How legible did you consider the text to be?
3. How much visual discomfort did you experience during the trial?
4. Was the level of discomfort greater than or less than that which you usually experience with screen work?
5. How content were you with the visual appearance of the complete monitor which you have been using?

Fig. 1. The two silver FPDs used in the experiment are shown, illustrating the difference in bezel glossiness.

6. How pleasant did you find the glossiness of the bezel?
7. How disturbing did you find the glossiness of the bezel?

For each of the first five of the above questions participants were presented with a horizontal line, anchored by descriptive end points (e.g. completely content; not at all content). This approach mirrors that used by Schenkman et al. (1999) although some questions were phrased slightly differently to make them more intuitively understandable. For the sixth question, participants had to choose one of five categories for their response, and for the seventh question they had to choose one of four categories. These last two questions, about glossiness, were embedded amongst a number of superfluous questions, included to disguise the importance of gloss to the study (e.g. "How disturbing did you find reflections from the furniture"). This 'masking' was designed to

Table 1
FPD bezel gloss and reflectance values.

FPD	Gloss (60°)	Reflectance (%)
White glossy (WG)	88.8	92
White matt (WM)	4.5	92
Black glossy (BG)	87.6	5.4
Black matt (BM)	6.8	5.4
Silver glossy (SG)	85.7	67
Silver matt (SM)	7.2	67