Improving school lighting for video display units

MARIE PARKER-JENKINS and WILLIAM PARKER-JENKINS*
University of Nottingham

INTRODUCTION
School lighting has in the past been relatively straightforward since the predominant occupation has been one of reading dark letters (print) on a light (paper) background. However, with the prolific installation of video display units (VDU’s) in schools and colleges, presently and anticipated in the future, the task now becomes one of reading light text on a dark screen. Thus the level and technique of lighting needs to be reassessed in order that VDU screen problems can be reduced or effectively eliminated. Problems arise not just from a bad or inefficient lighting system, but also from its interaction with the surrounding environment, i.e. wall surfaces, windows and furniture. Whether the terminals are installed in existing classrooms or designed for new ones, this article will allow the computer studies instructor to identify and implement the key characteristics which contribute to an efficient and comfortable VDU lighting installation.

VDU LIGHTING REQUIREMENTS
VDU’s require standard overhead lighting fixtures, but modified to provide a higher degree of lighting quality and control flexibility. The ambient room illumination should be sufficient for a student to perform ALL tasks, including viewing video-displayed text and any printed and written matter without strain. Generally, a mix of natural sunlight and INDIRECT fluorescent lighting is preferable, but fluorescent lighting only is an acceptable alternative. The main lighting issues which need to be addressed are: screen glare; VDU location/layout; lighting controls; environment and design recommendations.

GLARE
Natural and artificial light sources have the potential to produce glare in the VDU room. Direct room lighting causes glare on the VDU display, which can lead to student eyestrain and inefficiency. Glare can also originate from light reflection on desk surfaces, walls, internal windows, fabrics and graphics. The ‘mirror test’ can be used to detect sources of glare within a VDU area: hold a mirror in front of the VDU and scan it over the screen—any offending reflecting surface will then be clearly identified and corrective action can be taken. Standard

*Both authors have gained teaching experience in the United Kingdom, Bermuda and Canada.
classroom lighting will cause direct and indirect glare on the VDU screen, however, fitting grid type glare shields to lighting fixtures will alleviate direct illumination. If glare persists, the following pointers should be observed:

1. Drape windows (use finely-meshed plain bright drapes). Try to avoid blinds since they produce daylight striations.
2. Locate VDU screen normal (i.e. at 90°) to glare sources such as windows and fixtures.
3. Fit appropriate screen filter to minimize reflections (see section on optical filters).
4. Use specular parabolic louvre reflectors or baffles on direct (overhead) lighting or widespread beam (greater than 120°) on indirect lighting.
5. Locate fixtures out of the glare angle (45° from the horizontal).
6. If more than one student operates the VDU, then the screen may not be ideally positioned for all users. Screen platforms or tilt-turntables are available which allow the screen angle to be adjusted for minimum glare.

**Figure 1.** Recommended VDU station layout

**VDU LOCATION/LAYOUT**

VDU’s should not be placed in a location where the screen will receive direct natural or artificial light. If it cannot be shielded from direct overhead lighting,
re-orient the terminal such that the students line of viewing is parallel to the light source(s). Also equip the screen with a visor and an optical filter.

If feasible, do not place the VDU display screen against bright backgrounds such as windows or white walls, since when the students eyes move from text reading to surrounding areas in the room, they make muscular adjustments to accommodate brightness differences between the surfaces. Excessive brightness contrasts will ultimately lead to over-exertion of the eye muscles and cause eyestrain.

An acceptable VDU work station layout has the screen normal to the windows which are fitted with blinds, and parallel to the overhead lighting. The surrounding walls and floor should have a low reflectance value to prevent glare on the screen.

![Grid-type glare shields](image)

*Figure 2. Direct and reflected glare of a VDU*

**LIGHTING CONTROLS**

The illumination level in a VDU area can be varied easily and flexibly by installing manual or automatic controls. Individual light switches or dimmers have the advantages of low cost and simplicity, but they must be situated close to the VDU to be effective. Automatic controls featuring programmable controllers, timers, dimmers, people sensors and photocells allow for a more sophisticated lighting environment, but require a significant investment in equipment and installation labour.

**VDU ENVIRONMENT**

Environmental features other than lighting which must be addressed are noise, temperature and room decor. Ambient sound level should be minimized in order to eliminate distractions which may reduce student comfort. Particular noise sources which disturb concentration include: constantly ringing telephones...
typewriters; passing traffic; loud music; noisy heating, ventilating and air conditioning (HVAC) systems and the hard copy printer used with the computer.

Locate VDU's away from telephones and typewriting stations. To shield traffic noise, select a room away from the street or treat the room with carpeting and acoustical tiles on walls/ceiling. Printers can be remote from the VDU, but if it has to be close, a noise shield should be considered.

![Image of a computer workstation](image)

**Figure 3. Recommended ranges of reflectance for room surfaces**

- Ceiling reflectance: 60%
- General room illuminance: 300–500 lux
- Wall reflectance: 30–80%
- Task reflectance: Immaterial
- Floor reflectance: 20–30%

Adjusting ambient temperature for 20–22 °C and humidity for 30–40 per cent will eliminate 'air' problems and benefit student concentration and efficiency. These are also the recommended ranges for optimum computer operation.

All brightness within the surrounding space must be controlled. Walls, graphics and other surfaces should be diffused and have a light reflectance value of less than 50 per cent.

Decor which is 'non-intrusive' and does not include highly contrasting or drab colour such as dark green, brown and grey can be advantageous. Mixing, neutral tones including beige, pearl grey, light orange, etc. contributes strongly to a
comfortable working environment while minimizing reflected glare on the VDU screen.

VDU users should also avoid wearing white shirts or blouses because these reflect light onto the screen and obscure vision, thus making the task more difficult.

**LIGHTING RETROFIT**

Rooms not specifically designed for VDU operation can be modified conveniently as follows:

1. Disconnect fixtures placed in the offending glare zone (use mirror test).
2. Retrofit remaining fixtures with parabolic louvre lenses after determining that their number and placement is correct.
3. Rewire fixtures to facilitate zone control by switching or dimming.
4. Eliminate sources of natural glare (skylights, windows, etc.) by installing drapes or blinds.
5. Use individual desk lights for illuminating textbooks, worksheets, etc.
6. Fit VDU screen with shroud and/or optical filter.

*Figure 4. Two problems here—room ambient and task lighting mask the screen text, and the screen should not be placed against a bright background*

**OPTICAL FILTERS**

VDU operator fatigue and eyestrain can be reduced by the installation of an anti-glare, anti-reflection screen filter. The filter polarizes light rays and permits those from a particular angle or direction to be transmitted. When placed on a VDU, room light can pass through the filter to reach the screen but the returning reflected rays are absorbed by the polarizer. In addition, the filter...
traps stray light rays from the phosphor screen that cause glare. Image enhancement also occurs through an increase in text contrast and sharpened resolution.

LIGHTING RECOMMENDATIONS

Discerning VDU text is enhanced by reduced ambient or environmental illumination. Light characters on a dark screen requires less light for reading than do dark characters on a light background.

When the student's task involves both VDU and document reading, compromise illumination and reflectance levels are required, bright enough for paperwork but sufficiently low enough to not reduce screen contrast and produce glare.

1. Approximately 300–500 lux* for direct overhead lighting is adequate, with 200–300 lux available for indirect (individual) lighting. Both horizontal and vertical luminances are important at the VDU work place, a document placed on a desk top is illuminated by horizontal illuminance whereas the display screen receives vertical illuminance.

2. Connect alternate fixtures on different switchable circuits, thus if a room is to be converted from a general classroom to one containing VDU’s, alternate fixtures can be switched off conveniently.

3. VDU lighting is a relatively new and as yet unchartered territory. The scope for innovative design, perhaps featuring indirect HID sources is large and only limited by the ability of the lighting specialist.

4. Consideration should be given to ‘plug-in’ type ceiling fixtures, thus if the VDU layout should be altered, the illumination level can be changed in an effective and economical manner.

5. Multi-level switching and individual or small zone switching should be considered, along with automatic lighting controls which use a photocell to monitor and maintain a constant ambient illumination level with varying room daylight.

Given the remarkable changes currently underway in education, with increasing numbers of computers entering schools, instructors should be familiar with good lighting practices as they promote, benefit and enhance the pedagogical process.

VDU LIGHTING CHECKLIST

Use this checklist to evaluate your present VDU lighting environment. You may be able to identify areas where improvements can be accomplished with minimum disruption and inconvenience.

<table>
<thead>
<tr>
<th>Question</th>
<th>Yes</th>
<th>No</th>
</tr>
</thead>
<tbody>
<tr>
<td>1. Is the illuminance between 300 and 500 lux?</td>
<td></td>
<td></td>
</tr>
<tr>
<td>2. Is the operator’s field of vision free of direct reflections from the display screen, keyboard, desk, papers etc.?</td>
<td></td>
<td></td>
</tr>
<tr>
<td>3. Are there glare sources in the operator’s field of vision, lights, windows etc.?</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

*The metric unit of illumination (10 lux = 1 decalux = 0.929 footcandles).
4. Are the luminaries equipped with prismatic or grid-type glare shields?
5. Is the lighting system controllable and equipped with dimmers or switching?
6. Are the VDU work places positioned such that the operators line of vision is:
   (a) Parallel to luminaires?
   (b) Parallel to windows?
7. Are the windows fitted with internal or external blinds?
8. Are task (individual) light sources available to supplement the general lighting?
9. Are the windows fitted with drapes, with a reflectance in the range of 50–70 per cent?
10. Is the average reflectance of the ceiling greater than 60 per cent?
11. Is the reflectance of the walls between 30 and 80 per cent?
12. Is the reflectance of the floor about 30 per cent?
13. Has the regular cleaning and maintenance of the luminaires been properly considered?