It must be appreciated that no building surface is perfectly flat and that the best that can be expected is the appearance of flatness. Unfortunately, this appearance can easily be destroyed by the effect of glancing light, whether natural or artificial. Illumination and Decoration of Flat Surfaces shows the effect of different light sources on a variety of lining materials and paints so that best results can be achieved. Different types of building surfaces are investigated, including set plaster, fibrous plaster, hardboard and gypsum board with gloss and semi-gloss paint applied. This full-colour edition also discusses new building materials such as cement sheet, polystyrene and various composite panels, as well as new building practices, low embodied energy materials and higher energy efficiency of buildings. Illumination and Decoration of Flat Surfaces is a must-have for people involved in the building industry, both commercial and residential.
Illumination & Decoration of Flat Surfaces

BOB CAMERON
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One of the first things a young plasterer is told by his older colleagues and mentors is ‘the sun is our harshest critic’. In fact, it is not only the sunlight but sidelight from any source that will show up even the tiniest imperfection in hand-finished surfaces. This effect can be further exacerbated by the use of gloss paints.

It was early in my plastering career, while applying a polymer bound aggregate finish to the external walls of a unit development, when I first encountered this phenomenon. Although this was a relatively new technique at the time, the job had been progressing well and we had been able to achieve what we thought was a very high standard of finish. I was quite surprised when I received a frantic call from the site foreman informing me that when the scaffold had been taken down there were areas where the work was not up to standard. ‘Looks like it has been thrown on with a shovel’, I believe were his exact words. Incredulous that the walls we had so carefully finished with our stainless steel trowels should attract such comments, I told him that I would come down immediately and inspect the work myself. I was then informed this would not be suitable for it was now mid-afternoon and the walls were in the shade and apparently looked quite OK. I met with the builder and architect on site the following morning at precisely 10:15 am, when the sun would be throwing a glancing light across the offending walls, to inspect the substandard workmanship and propose a plan of action to rectify the situation. What followed was a protracted series of site meetings and discussions between architects, builders and tradesmen as well as experts of many persuasions to finally arrive at the conclusion, so simply explained in this book, that the work had been completed as well as practically
possible. In the end no further action was taken and to the best of my knowledge the walls have remained the same to this day.

It has been with great pleasure that I have undertaken the task of updating this excellent and very useful publication. It is a superb example of how the application of science can be of enduring practical value to such an ancient trade as plastering and painting – not by addressing the materials and processes themselves, but by looking at the design and how these components are arranged to achieve the desired outcome as economically as possible.

In updating the manuscript it has been important to retain the simplicity of the original text and not overburden the book with technical details. Instead we have included links to various websites where this information can be found, in its most recent and up-to-date form, or to other publications dealing with the specific topics.

Some of the changes that have occurred in the building industry within Australia since the publication of the original edition include the rise in the use of plasterboard and the almost complete disappearance of fibrous plaster. Plasterboard has also replaced a lot of hard-set plaster, although not to the same degree, and there is still plenty of hard-set plaster used in some areas.

Significant changes have occurred in the external surfaces, with rendered finishes becoming far more popular, making inroads into the dominance of face brick and in some areas almost completely replacing it. Greater awareness of energy efficiency has encouraged the use of lightweight insulation systems, which also include a rendered finish.
These trends, along with the continued push for higher quality finishes at reduced costs, have greatly increased the need for this new edition.

Part of the reason is the higher expectations from both the industry and consumers, supported by a number of developments within the industry. Modern building design and construction methods allow for increasingly larger windows with fewer beams, pelmets and columns, allowing light to enter the interior of the building almost parallel to the wall and ceiling surfaces. Often these windows receive reflected light from adjacent building surfaces or from water.

LEVELS OF FINISH
Australian/New Zealand Standard AS/NZS 2589:2007 defines three levels of finish for plasterboard linings, covering the different specifications for the framing, installation, finishing and decorating required to achieve the various levels of finish. It is imperative that the required level of finish is determined at the design stage of the project with full consideration given to the lighting and decorative finishes to be used.

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No building material has an absolutely flat surface; in practice, all that may be expected is an appearance of flatness. This book reviews the effect of glancing light on the appearance of flat surfaces of hand-finished plaster, cement render and applied finishes, including internal plaster finishes such as hard-set plaster, plasterboard and fibrous plaster, as well as external surfaces such as cement render, cement sheet and applied coatings. It shows that surfaces which seem perfectly flat in diffuse light appear rough and uneven when lit by light falling nearly parallel to the surface. The conclusion is drawn that glancing light must be avoided if the appearance of flatness is desired. Some practical ways of achieving this are discussed together with the effects of gloss and semi-gloss paints on the appearance of flat surfaces.

Figure 1: The surface texture or imperfections that are not visible under diffuse light or where light of similar intensity strikes the surface at different angles (left), become obvious when light strikes the surface from one direction at an acute angle (right).
Plain, flat surfaces are an important feature of building design. Flat, unbroken surfaces free from distracting detail create an attractive, spacious effect which is very popular in both commercial and domestic buildings.

No hand-finished building material has a surface that is any better than an approximation of flatness and this is true of all the common lining and cladding materials used for large areas of unbroken surfaces. To produce a surface approaching anything a physicist would accept as flat would require the expenditure of thousands of dollars on precision grinding, and therefore a building surface that is perfectly flat is not practicable with present technology. In the building industry the aim is to produce the appearance of flatness.

If the decorative effects of flat surfaces are desired, the true nature of practical building surfaces must be considered when illumination or use of paints is planned. Incorrect lighting or decoration can completely destroy the illusion of flatness. The effects of glancing light and gloss paint are examined in this book.
It is economically impracticable to produce a building surface that is flat in the literal sense of the word. Even slight deviations from true flatness can cause light falling nearly parallel to the surface – for example, glancing light or sidelighting – to cast shadows that are irregular in shape and distribution. On a plain wall where there is no pattern of irregularities to distract the eye, such shadows are very noticeable and completely spoil the effect gained by elimination of cover strips, V-joints and other ornamentation. They are most noticeable when all the light comes from one direction and thus there is no other illumination to dilute them.

Some striking examples of shadows cast by glancing light are shown in Figures 2–6. Figure 2a shows the rendered wall of a building as it appears under most conditions of natural lighting. Figure 2b shows the same wall during the brief period when sunlight just skims the surface, and here the wall presents a very different appearance from that shown in Figure 2a. Shadows cast by differences in level that were hardly noticeable in ordinary light give a rough, broken impression and exaggerate the texture of the wall. Shadows are cast by slight differences in level caused by the floating and finishing of the surface.
Fortunately the sun remains in this critical position for only a very short period and its ability to reveal different textures in exterior surfaces is not particularly important. This is not the case, however, when the lighting of interior surfaces, especially artificial lighting, is considered. Here the effect is not transient, as in the case shown in 2a and 2b, but under unfavourable circumstances can be just as striking and the effect is permanent while the unfavourable light is directed.
Figure 2b: The same rendered wall as it appears when the sun’s rays are nearly parallel to the surface (glancing light).
Figures 3a and 3b further illustrate this point by showing another example of a rendered wall under both standard and glancing sunlight conditions, then showing the same wall illuminated by glancing light from a wall light placed close to the surface in Figure 3c, which had just been painted with a sealer and two coats of matt finish paint.
Figure 3b: The same area of rendered wall as it appears in glancing sunlight.

Figure 3c: The same area of rendered wall showing the effects of a wall mounted light.
Figures 4a and 4b show the same area of set plaster identified by a pair of drawing pins. In diffuse light the area seems quite flat and featureless but this appearance is completely destroyed by glancing light. Shadows and irregularities are now visible and it is even possible to see the track of the trowel as it was moved over the surface during polishing although the quality of workmanship was high. These marks were invisible in diffused light.

Figure 4a: An area of hard-set plaster under standard lighting conditions.
Figure 4b: The same area of hard-set plaster shown in Figure 4a as it appears by glancing light.
Figure 5a shows an area of flush-jointed fibrous plaster as it appears by ordinary light. Figure 5b shows the same area illuminated by glancing light, which has revealed minute differences in level and the positions of the flush joint and stoppings. The flush joint was of the highest workmanship and could not be detected when a joint rule was run over the surface.
Figure 5b: The same area of fibrous plaster shown in Figure 5a as it appears by glancing light.
Figures 6a and 6b show an area of gypsum board by ordinary light and by glancing light. Once again the illusion of flatness is completely destroyed by shadows cast when the light is nearly parallel to the surface.
Figure 6b: The same area under sidelight.
Figures 7a and 7b show the effects of ordinary and glancing light on an area of hardboard containing a V-joint. The effects are similar to those produced in the previous cases.
Figure 7b: The same area of cement sheet shown in Figure 7a as it appears by glancing light.
Figure 8a is an example of a cement sheet wall with the joints taped and set and a polymer render applied over the entire wall with the objective of achieving an even rendered finish (Level 4). However, this lightly textured sand finish shows up all the panel joints under the severe sidelight of the early morning sun. This is a particularly good example in that it is evident the builder has gone to considerable effort to provide a flat surface by ensuring that the sheets run the full length of the 3 m high wall, eliminating any horizontal joints.
Figure 8b shows the same wall a little later in the morning, a seamless rendered finish with no imperfections evident under normal daylight.

The illustrations show the immense changes in appearance that occur when illumination by glancing light is substituted for diffuse light. The effects make it quite clear that if the appearance of flatness is desired, it is necessary not only to have walls of good workmanship but also to ensure that illumination is designed to avoid glancing light, which can reveal the surface texture.
The worst effects are produced when a single unshaded lamp is placed close to a wall or ceiling (as in Figure 3c), in an otherwise darkened room or area. For example, the light cast by isolated, unshaded fluorescent tubes fixed directly to the ceiling has particularly severe effects on the appearance of adjoining surfaces. In this case, putting the tube about 45 cm below the ceiling will ensure a much better distribution of light and help make the irregularities in the surface much less noticeable.

The problem is less acute in rooms lit by a number of more or less evenly spaced units such as those used in large offices. Here, more diffused light helps to dilute the texture-revealing shadows cast by individual lamps, and surface irregularities will be less noticeable. Two closely spaced rows of lamps will each negate the texture-revealing shadows produced by the other in the area in between. In small rooms, light reflected by the walls, particularly light-coloured walls, produces a helpful diffused component in the lighting. Light-coloured floors and furniture also help.

An alternative to suspending lamps below the level of the ceiling is to put them above it, in recesses. Fluorescent tubes are ideal for this treatment and attractive light recesses are available from manufacturers of fibrous plaster. This treatment is quite satisfactory in purely decorative interiors where a dark ceiling is required or illumination of the ceiling doesn’t matter. However, in working interiors such as those in factories, offices and schools, the health and amenity for the worker must be considered and some loss in the appearance of the surface may have to be accepted.
Lamps mounted in recesses are liable to cause more glare than those mounted on or below the ceiling and special precautions must be taken to see that the ceiling is adequately illuminated by reflected light or by other means, such as cornice lighting. Australian Standard No. 1680: 1990 – *Code of Practice for Interior Lighting and the Visual Environment* – recommends methods of controlling glare. It is most important that these recommendations are observed in working interiors, particularly where any form of recessed lighting is used.

Glancing light also occurs where windows extend to ceiling height or are adjacent to walls, with the worst effects occurring when there are narrow windows close to the walls. In these cases, suitable curtains or pelmets will reduce the effects. The most useful light for the comfort and efficiency of the worker is that entering at the top of the window (the part nearest the ceiling), and it may be necessary for appearance to take second place over other considerations. People tend to be less aware of the appearance of overhead surfaces than those at eye level and slight irregularities that would be obvious to a plasterer or an architect will mostly go unnoticed by the average occupant.
The benefits of natural light – using diffused daylight reflected off light-coloured walls – can save energy while increasing the comfort levels and amenity of the internal environment. This will also reduce the effects of glancing light on the walls and ceilings. Paint is one of our most effective lighting tools. Light-coloured matt paint or fine textured finishes will diffuse and reflect both natural and artificial light. Diffused light reflected from a number of directions will help mask minor surface imperfections while creating a more comfortable environment for the inhabitants. Direct light from a single source, darker colours and gloss finishes will exacerbate any surface imperfections.

Figure 9: A surface mounted light fitting will cast a sidelight across the ceiling, highlighting even the smallest imperfections.
Figure 10: Improved lighting design with the light fittings either recessed into the ceiling or suspended below with reflectors direct the light into the room rather than across the ceiling.

Figure 11: Align plasterboard joints parallel with wall lighting rather than across the light.

Figure 12: Align plasterboard joints parallel with light coming from a window rather than across the light.
While plasterboard has been finished the same way for many years, modern buildings and consumer expectations require a high level of finish. Plasterboard surfaces are of particular concern in respect to the effects of glancing light. This is due to the nature of the materials, standard industry practice and consumer expectations. The plasterboard itself, being a machine-finished component, has a much flatter surface than it is possible to achieve with the hand-finished plaster joints. So even when the workmanship is of a very high standard and well within tolerances set by industry bodies, the wall surface can look very poor under glancing light with the hand-finished plastered joints ruining the desired flat, even surface. This method of finishing plasterboard, referred to as a Level 4 finish, has always been the standard specification for almost all plasterboard installations throughout Australia. However, this may no longer be the most suitable system to meet the requirements of modern buildings and consumer expectations in this country. It may well be time for Australia to follow the lead of most other western European countries and specify a higher standard of finish for our plasterboard linings.

This would require agreement within the industry on exactly what a Level 5 finish entails and the standard to be adopted by the industry. Again drawing on overseas experience, the defining feature of the Level 5 finish is the inclusion of a skim coat of plaster over the entire wall area. Although such a skim coat is a hand-finished surface, the imperfections are now overall rather than on joints and visible panels providing a much more acceptable finished effect. Having an even surface with the same surface texture and suction characteristics removes the source of many of the problems currently associated with the decoration and aesthetics of plasterboard linings.
Table 1: Levels of finish for plasterboard linings

<table>
<thead>
<tr>
<th>LEVEL OF FINISH</th>
<th>CHARACTERISTICS AND FINISH</th>
</tr>
</thead>
<tbody>
<tr>
<td>Levels 1–2</td>
<td>No longer in use.</td>
</tr>
<tr>
<td>Level 3</td>
<td>All joints, internal and external angles taped and set flush with the board surface. Suitable for areas that do not require a decorative finish such as above the ceiling level, lift shafts etc.</td>
</tr>
<tr>
<td>Level 4</td>
<td>All joints taped, set flush and sanded smooth. Fixing heads set flush and sanded. External angles beaded, set flush and sanded. Currently the default level of finish for plasterboard linings unless specified otherwise. Suitable for decoration with flat or low sheen paints.</td>
</tr>
<tr>
<td>Level 5</td>
<td>All joints and internal angles taped and set flush. Reinforcing angle beads fitted to external angles. Skim coat of plaster over entire wall. Used in areas requiring the highest possible standard of finish. Provides a smooth, flat surface with even porosity and suction.</td>
</tr>
</tbody>
</table>

Table 1 outlines only the essential characteristics of the finishing system for the respective levels of finish. For a description of the complete system see AS/NZS 2589: 2007 Gypsum Linings – Application and Finishing.
Lightweight external cladding systems installed over timber and steel frame walls have become increasingly popular. This trend was initially driven by the fashion for rendered finishes and has gained momentum in recent years with the call for more energy efficient buildings and building materials.

These systems are based on either cement sheet, expanded polystyrene, extruded polystyrene or various composite panels. There are essentially two distinct methods of finishing these systems, each capable of providing a different standard of finish (see Table 2).

Standard industry practice for finishing cement sheet walls with an applied finish is to tape and set the joints, prime the wall and apply an acrylic-based texture coating or polymer-based render. A competent applicator using this procedure can only count on achieving a Level 4 finish. Under glancing light the panel joints may still be visible. In fact, these cladding systems fare particularly badly under glancing light, leading to many complaints from the industry and end users alike.

To achieve a higher level of finish over lightweight cladding installations a screeded cement render is the preferred option. This consists of a polymer modified cement render incorporating a glass fibre reinforcing mesh. The render is applied to a thickness of approximately 4–8 mm and the wall is screeded, helping to cover
any irregularities in the substrate. This process can provide the look and feel of a rendered solid masonry wall over lightweight insulation systems.

A Level 5 finish will still show the normal imperfections under glancing light that could be expected from any other screeded render finish; however, the panel joints should not be visible under any lighting conditions.
We have seen that badly designed lighting can spoil the appearance of a flat surface and that similar effects may also occur when gloss paints are used. Gloss paint reflects light so that a blurred mirror image of the light source is formed which is distorted by irregularities in the surface. The irregularities become particularly noticeable when the observer moves in relation to the surface just like an image in an uneven mirror changes in shape or size when observed from different positions.

For this reason gloss paint should not be applied to flat walls which may be observed from a wide angle, or to upper surfaces or the ceiling on which tell-tale reflections of the lighting units may be seen. Its use on ceilings and long walls may therefore be undesirable but it can probably be applied to short walls with reasonably good results. The same effects seen with gloss paints occur to a lesser degree with satin- or silk-finish paints. High-gloss paints can safely be used on doors, woodwork and architraves which have plenty of detail to distract the eye from the distorted reflections.

It must be emphasised that these considerations apply only where the effect of a flat, featureless surface is the main requirement. There are circumstances in which gloss paints may be desirable for functional reasons, for example in kitchens, bathrooms or laundries, in which case some loss in appearance of the surfaces may have to be accepted.
If the decorative effects of expanses of flat, unbroken surfaces are to be appreciated it must be recognised when the lighting is planned that no building surface is perfectly flat. The aim in building is to produce the appearance of flatness and with practical surfaces the appearance of flatness can always be destroyed by glancing light. This is not a serious difficulty in offices and factories lit in accordance with the principles outlined in Australian Standard No. 1680: 1990; however, in domestic situations where the code does not apply, isolated lamps are often used and the following points should be especially considered.

Glancing light from isolated sources must be avoided. Where isolated lamps are used, they are best placed well below the level of the ceiling, or above it in suitably recessed light fittings. Care must be taken when placing lights close to walls. In decorative interiors, valances or ‘cafe curtains’ may be used on windows that reach ceiling height and narrow windows close to walls should be curtained.

High-gloss paint should be avoided whenever the surface can be seen from a wide angle. This precludes its use on ceilings and long walls if an even appearance is required.

If the effect of a flat, unbroken surface is desired the painting and illumination must be planned accordingly. If this is not done and unsightly effects are obtained one cannot justly blame the lights, the lining material or the paint. It is the way in which these elements have been combined that is at fault.
It is beyond the scope of this book to fully explore the technical details relating to the design, construction, lining, plastering, decorating and lighting of buildings. Moreover, these technical details can change over time. So we have included various links to industry bodies and company websites where the latest information and standards can be obtained. Also listed are reference books that contain useful and relevant information on these topics.

LINKS
REFERENCE BOOKS


