describing performance lighting

Figure 1. *The Masked Ball* by Giuseppe Verdi by English National Opera, 2003. Lighting by the author, set by Alfons Flores, costume, Merce Paloma, directed by Calixto Bieito. Photograph by ENO lighting staff.

Describing and controlling light

A designer of performance lighting should be able to talk about light in the context of the production with the other members of both the creative team and the team that will realise the lighting design. It can be hard to describe light and therefore hard to discuss it, but it is not impossible. Having the words to discuss light is clearly important for anyone wishing to be involved in lighting for performance. I would argue that this includes directors, choreographers, and designers of set and costume as well as lighting people. Often it is up to the lighting people to provide the basics of that language, just as the choreographer will provide the basic language for a discussion about dance and the musical director for a discussion about music. Clearly any discussion of a specialist aspect of performance among a team including non-specialists will use more general language than a discussion between specialists. Dancers use specialist terms when talking about dance to each other that most non-dancers do not fully understand. The same is true for musicians talking about music and for lighting people talking about performance lighting.

Specialist practitioners learn specialist terms as they train (either formally or informally) and these can be intimidating to the outsider. Lighting designers working in live performance often need to develop two ways of talking about their specialist subject — the specialist language to be used amongst fellow lighting practitioners and a more general language to be used with other members of the creative team. We have already come across some specialist terms and some ways to talk about light in more general language. This chapter introduces some more examples of both types of language, once again highlighting how important communication skills are to a lighting designer.

The fundamental physical properties of light cannot be altered, they underpin all discussion. However, as we look at light for performance in more detail, it will become clear that there are matters relating to the

constraints of most performance situations and the workings of human visual perception that must also be taken into account.

Intensity, location, colour, beam and time

The properties of performance light at any single moment fall relatively easily into four interrelated categories.

Intensity — a measure of how much light is present.

Location of the beam in 3D space — where the light comes from and what it hits and illuminates on the way to its target, how it strikes the target, and what happens afterwards, especially in terms of shadows cast and other things illuminated. In the Vari*Lite™ tradition, this is referred to as focus, but the property should not to be confused with the sharpness or softness of image.

Colour — well we know what that is, don't we? Coloured light is usually the result of filtering some colours out of white light. Different lamps produce different 'whites', and the white light of nature is actually different colours at different times of day and year, and in different places on the earth.

Beam — including edge, pattern across the beam, and light quality of the beam. The main difference between the output of different fixture types can often be described in terms of beam. For example, a conventional profile fixture has a 'flat' beam with 'sharp' edges i.e. there is relatively even intensity across the beam and at the edge the intensity drops off very quickly. In contrast, the beam of a conventional Fresnel fixture is 'peaky' with a soft edge i.e. the intensity drops more or less continuously from the central 'hot-spot' to the indefinite edge of the beam. A conventional PC fixture has a beam somewhere in between these two, flatter than that from most modern Fresnel fixtures but with a less well defined edge than the beam from a profile fixture.

These are the same categories mentioned in the section on moving light, and this is not a coincidence, but it should be understood that this is only one way to think about the properties of light. It is current in part because that is how many moving light desks, and those who use them, work, and so it will give us a common language with which to describe the light from conventional lanterns and from moving lights.

Time — the ever-present fifth element of performance lighting; on stage, as in nature, light changes over time. Very few live productions keep the same lighting state throughout the performance, and even if they did, for reasons to do with the way human eye/brain channel works, the audience perception of the light may well change over time anyway. Time affects each of the other properties — human perception seems to be largely based on an ability to recognise changes, and changes happen over time. It also has its own discrete role to play in the creation of performance lighting on stage and we will come back to time frequently in rest of the book.

Intensity

Intensity is a measure of how much of light is present. We know that for the audience to see anything there must be some light present. For performance lighting what we are usually interested in is how much light is bouncing off things and available to enter the eye of the audience member (or go down the lens tube of a camera). In the metric system, we measure intensity in Lux, the number of Lux giving the intensity of light at a particular point.[1] Lumens, the unit most usually quoted for luminaires and projectors, is the total light output at the source. Since the beam from most sources spreads out as it gets further away from its origin, the intensity falls off too, and so an intensity measurement for a single source will decrease the further away you are from the source.

Many cameras allow the user to measure relative intensity using the light meter within the camera, but an

[1]The equivalent unit in the imperial system is the Foot Candle. One Foot Candle is about 10 Lux.

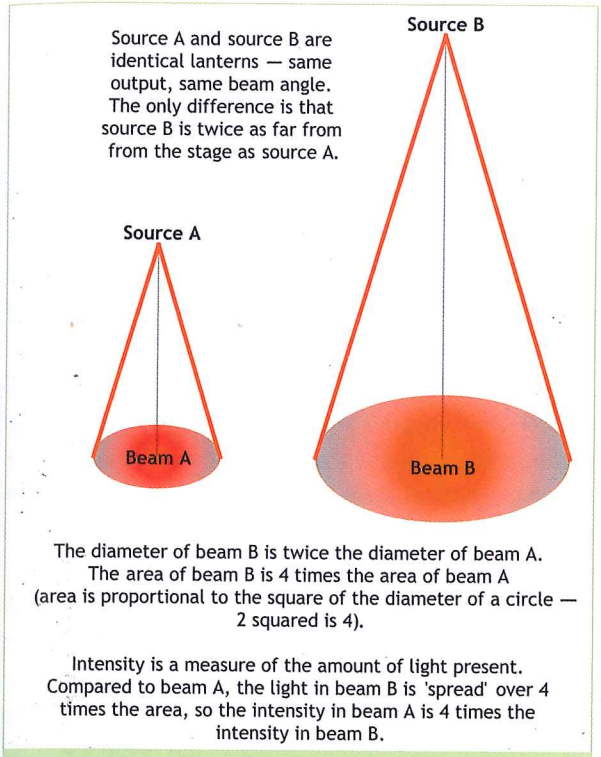

FIGURE 2. INTENSITY DECREASES AS THE SQUARE OF THE DISTANCE FROM THE SOURCE OF LIGHT. DOUBLE THE DISTANCE FROM THE SOURCE AND THE INTENSITY HALVES.

incident light meter will provide an absolute reading in Lux or Foot Candles which can be essential when working with video or film cameras. It is not common practice to measure intensity on stage for live performance, unless cameras are involved, when contrast must be more strictly controlled. Generally people can tolerate much greater differences in intensity with the visual field than cameras. A light meter can, however, be a useful tool for training your eye to spot relatively small changes in intensity, establishing an idea of what is acceptable contrast between, for example, foreground and background and in gaining an understanding of how much light is 'dim' or 'bright' in a particular situation.[2] Do not be afraid to use one if you think it will help you.

Humans can cope with an incredible range of light intensity, from 100,000 Lux of a snow field on a clear bright day to 0.00005 Lux of starlight. Unlike cameras, humans perceive relative intensity not absolute intensity. We reference intensity to what has gone before, and it takes some time for our eyes to become accustomed to radically different levels of intensity. If you went quickly from the 100,000 Lux snow field into a normally-lit room, at say 300 Lux, you would perceive the room to be very dark. If, on the other hand, you came into the room from a moonless starlit night, you would perceive it to be painfully bright. It is said that after 90 minutes under starlight the visual perception adjusts sufficiently to make it possible to read!

Although we can operate in this huge range of light intensity, we can't see detail in objects of very different intensities at the same time. Our visual perception will attempt to set its sensitivity to the average intensity level of what we are looking at. This is not the same as the average intensity level of the whole visual field; we can clearly see a bright image in an otherwise dark visual field, even if that image makes up only a small proportion of the total visual field, as is often the case when we watch a stage show from the back of a large theatre, or a rock show from the back of a sports stadium. Within the area of audience focus, we need to control the relative intensity, that is the contrast.

Intensity: glare, distraction and directing audience attention

Although we can cope with a wide range of intensity within the visual field, if there are particularly high contrast areas, especially if the very bright area appears small in the visual field, it creates discomfort. The effect is known as glare and most people will have experienced it at some time or another — looking into low sunlight or very bright car headlights on a dark road. In extreme cases glare can cause physical pain but more often it is just unpleasant and reduces visual acuity —

[2]It can also be useful for balancing the intensities of follow-spots, when grey neutral density filters can be placed in the beams of the brighter units until all intensities are the same, which is usually what we want, at least to start with.

not usually helpful to the lighting practitioner. Glare can result from any number of sources in the performance environment, from lanterns shining into the eyes of the audience, either intentionally or unintentionally, from highly reflective surfaces on the set or costume catching the light, or from extraneous light sources, such as the gap between the colour frame and the lantern on some units (particularly PAR cans) or from poorly implemented emergency lighting. The attentive lighting practitioner, whether designer or not, will endeavour to eliminate all unintentional sources of glare.

Our visual systems have evolved with a good ability to see detail in the centre of the visual field, and a refined ability to detect movement at the periphery of our vision,[3] a reason for dimming the house lights, and lighting the stage. Everything else being equal, we use the part of our vision most able to see detail to examine the brightest part of the visual field. The focus of visual attention is normally directed to where it is brightest so long as the contrast is not so great that it creates glare. This makes the ability to selectively control intensity hugely important in performance lighting design. We can use selective control of intensity to direct attention within the performance area, to point the attention of the audience towards the particular area of the stage we want them to focus on. The technique of directing the spectator's attention by using selective intensity is extensively used in the field of fine art, notably by some of the old masters of painting. Look at Renaissance paintings of interiors for the way in which the masters handle the depiction of light and shadow, and use it to draw attention to the main subject, and then to broaden the attention of the spectator into the surrounding shadows.

Big changes in intensity can leave the audience almost blind for several moments, or sometimes longer, while their eyes readjust to the new level of illumination.[4] Our attention may be directed by even relatively small increases in relative intensity, though at the same time as we have said, we are easily distracted by even relatively low points of illumination at the edge of the visual field, especially so when the point is not constant — either physical movement or flickering intensity for example.

It follows that performance lighting needs to be concerned with control of relative intensity across the performance area, and the elimination of distractions in the visual field of the audience, both within individual scenes and from scene to scene through the performance.

Intensity as a signifier

In nature, we take many signals from the intensity of the light surrounding us. For example, we are used to night being darker than day outside and the reverse inside. For anybody who has spent some time in the open air, there will be many more signals, the darkening that heralds a storm, the brightness of mid-day against the lower intensity of early morning light, the bright intensity of direct sunlight in an open space or more diffused daylight reflected from many tall buildings in a city's financial district, or through trees in a forest. Inside buildings, light intensity gives other signals. In many bars, relatively low intensity light is replaced by bright light at the end of the evening, signalling closing time. Lower intensity light can be seen as romantic in some settings or as threatening in others. High intensity can be used to help signify clean and efficient in some public spaces, or cold and uncompromising in others.

[3]This is said to have been evolutionarily useful to our distant ancestors, both when hunting and when being attacked. Whatever the evolutionary origins, it is very unhelpful when members of the audience are distracted by the peripheral sight of an usher's torch in the middle of an important speech from the stage.

[4]Compared to most camera technologies humans are able to tolerate a relatively high level of contrast within our visual field. Take a look at shadows against a bright sky on the screen of most digital cameras, and your eye will see more detail in the shadow than the camera will.

Think about the way intensity is used in fast food outlets and romantic restaurants.

What often gives the major clue to a change of time, place or location on stage is intensity. When resources are in short supply (and often even when they are not) intensity may have to carry most of the signification of time and place, and of mood. In each of these examples (and in the many more I'm sure you can think of) there are other properties of the light that change along with the intensity — the colour of light at night is different to that in the daytime, the shadows are strong in direct sunlight and weak or absent in defuse reflected light — the properties of light are interconnected, in the natural world and in performance, yet intensity remains perhaps the strongest single signifier available to the performance lighting designer.

By controlling relative intensity throughout the performance, the lighting designer can use the simple idea of the indexical sign (see the appendix on semiotics for more on indexical signs), pointing the audience towards what is important on the stage. They can use variations in intensity across the stage to signify something about how one area relates to other areas. Intensity can be varied through time, and so can be used to signify changes in the relationships between different spaces or changes in the space as a whole; changes in stage time or location. It also follows that selective use of intensity can define the size of the performance space at any particular moment.

To achieve many of these effects we need to be able to separately control the intensity of light in different areas of the performance space. One of the most important decisions to be made in the evolution of a lighting design concerns the number and shape of these separate areas, and how many areas will be illuminated at each point of the performance.

Focus — the location of light in space

If intensity is about the quantity of light, focus[5] in this context, is about which part or parts of the stage the light hits, and the direction from which the light comes. There are two distinct parts to this property. The more apparent is usually defined as the angle of incidence and has an effect on our perception of objects illuminated on or near the performance space. The angle of incidence of a beam of light on a target object or performer describes the relationship between the direction from which light comes and the direction from which the audience is observing.

The second part I will call the throw. This is to do with where the light originates and the path it takes to the stage — with the path between the source of the light and its destination.

Angle of incidence

Lit objects create shadows, and in nature it is often these shadows that give us the best visual clues as to

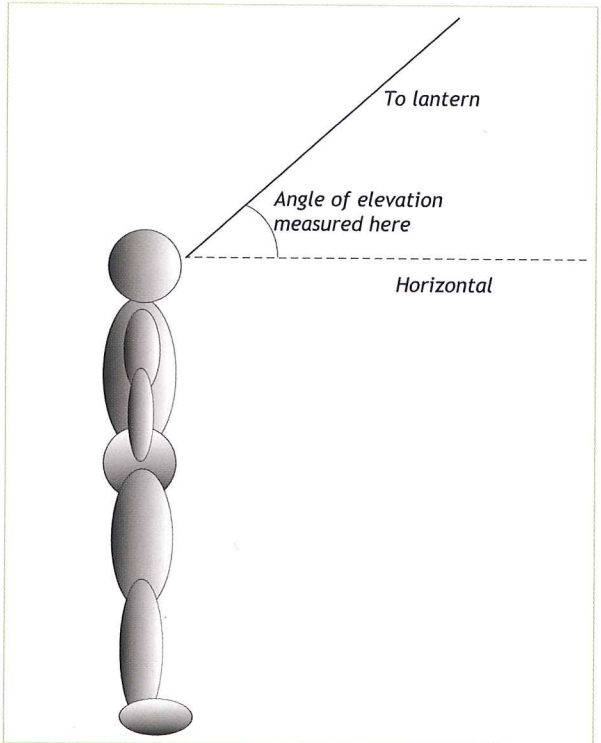

Figure 3a. One of two angles used to define the angle of incidence of a beam of light to the performer facing straight out: the angle of elevation.

[5]The word focus is used in several different ways in performance lighting. As well as the present context, it can be used to describe the size, shape and edge quality of the beam from a luminaire, and the point of stage intended to be the centre of audience attention.

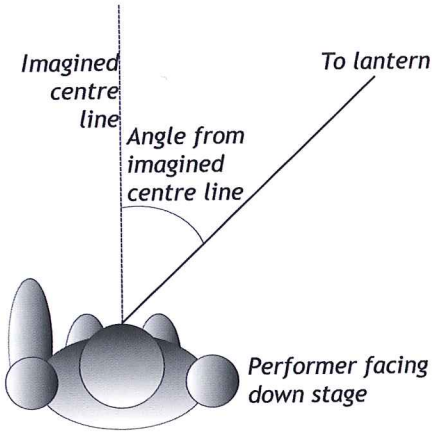

Figure 3b. The other angle used to define the angle of incidence of a beam of light to the performer facing straight out: the angle from centre line.

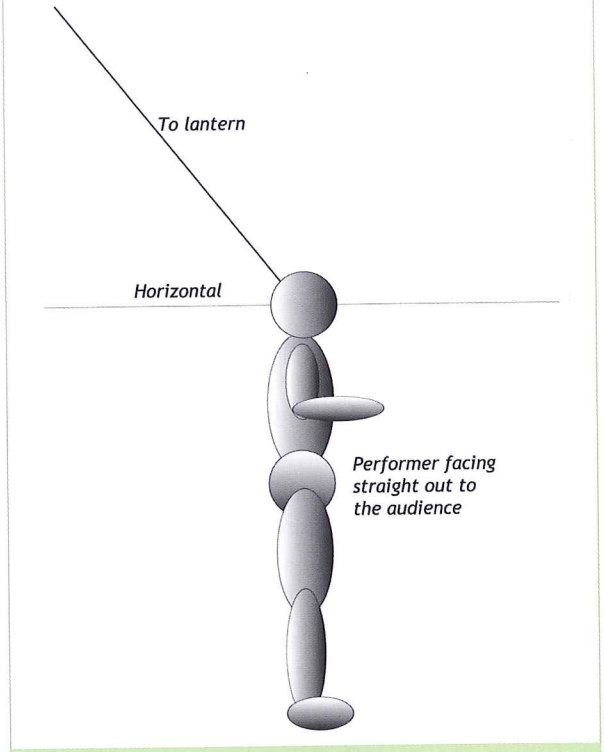

Figure 4a. Back light comes from behind the head of a performer facing down stage.

time of day, location, and to the three dimensionality of the people and objects we see. Where those shadows fall, their size and shape depend on the object, where the light is coming from, and the position of the spectator. These last two define the angle of incidence. Although frequently constrained by the architecture of the performance space, the angle of incidence of the beam to the performance area will ordinarily be the most important consideration when the lighting designer comes to decide where each lantern should hang.

Conventionally, when performance lighting practitioners talk about angles, they refer to the angle of incidence to a performer facing straight out towards the centre of the audience. There are two angles involved: the angle of elevation, taken from the plane of the stage, which is assumed for these purposes to be flat, and the angle the performer would need to turn from looking out to centre, in order to face the lighting position.[6] High or steep angles are close to directly overhead and low or shallow angles are close to or even below the eye line of an upright performer. Up light as

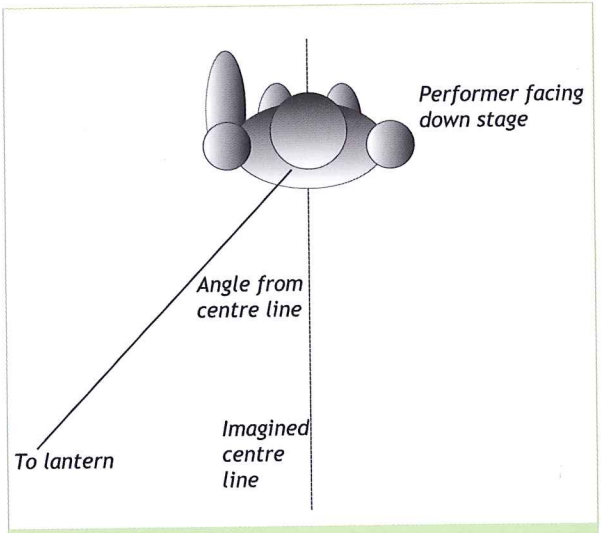

Figure 4b. Three-quarter back light from behind the performer's ear.

[6] I should say that few practitioners get out equipment for measuring angles in these discussions, and any angles mentioned are rough approximations.

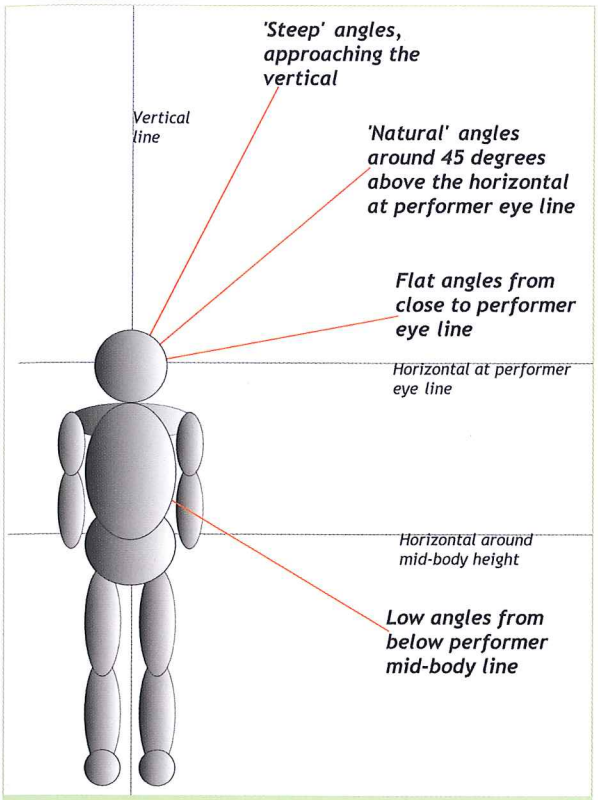

FIGURE 5. ILLUSTRATION OF MORE ANGLES OF INCIDENCE.

its name suggests is from well below the performer's eye line, for example footlights. Back light comes from behind the performer (180 degrees or ½ a turn for the performer), side or cross light from the side (90 degrees or a ¼ turn in either direction) and top light from directly above. All these terms can be modified or combined to describe different lighting positions relative to the subject or to the performance area. For example, a ¾ steep back light for a performer would be in a direction roughly behind their ear, above them, and further away vertically than horizontally (see diagram).

A low cross light could be to the performer's left or right side, it would probably be below waist level, and may be pointing slightly up. This position has a special name in dance lighting where is called a shin buster because of the potential hazard the lantern becomes to the legs of those working on the stage.

It is clear that the part of the beam that does not strike the performer continues past that illuminated performer and lights up the stage floor or the set or whatever else is in the beam of the lantern. Light from any angle of incidence other than directly above the performer, illuminates a larger area of stage floor than the

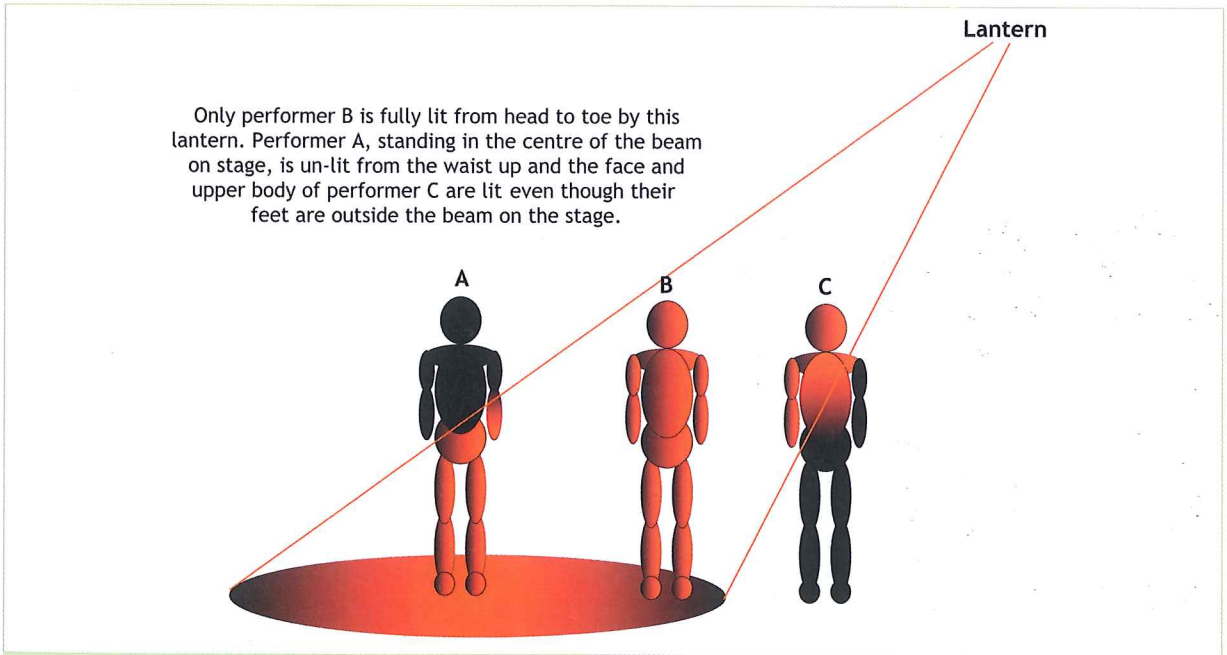

FIGURE 6. THE USABLE PART OF A BEAM OF LIGHT IS NOT NORMALLY NEAR THE CENTRE OF THE POOL ON STAGE.

area useable by a performer (see figure 8). The steeper the angle, the smaller the illuminated area or stage floor or set, the less spill outside the usefully illuminated area. Steep angles provide more tightly defined areas, which in turn gives the lighting designer a better opportunity to use selective intensity to guide the attention of the audience. However, steep angles often don't illuminate the performers' eyes — the performers' brow creates shadows that stop the light getting to the eyes. A compromise must be made between the steep angle that gives well-defined areas for selective illumination and superior modelling, and the shallower angles that get light into eyes and under noses, helping the audience to see the facial expression of the performers more clearly, but tending to flatten the stage picture, illuminate parts of the stage floor and set that we would prefer to leave unlit, or create potentially distracting shadows.

All these positions assume we are in a more or less traditional proscenium theatre space, or at least that the audience has more or less the same end on view of the performance area. If the performance space is not laid out like this, the description of lighting angles gets a little more complicated. For example, if the audience surrounds the stage, for a performance in the round, front light on the performers for some of the audience, is back light for others, and side light for the rest!

Front light

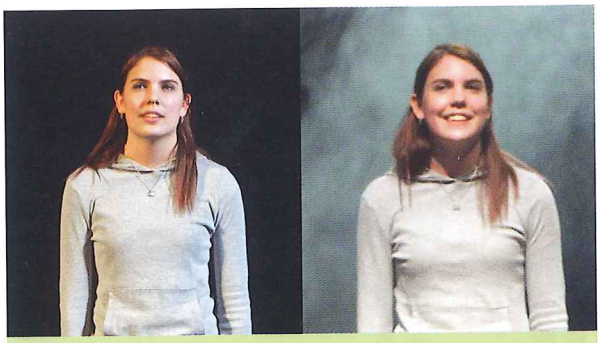

Figure 7. Two quite different effects achieved with different approaches to front light.

On the left, lighting student Jenny is lit by ¾ front light, warm from stage right, cool from stage left. The combination helps to model her face. (The effect of the coloured light on her face is somewhat exaggerated by a camera. In live performance, our eyes are more willling to accept small deviations from white.)

On the right, Jenny is lit with a steep front light and a soft back light. This combination increases the impression of depth and of the figure having three dimensions in space, but the steep front light tends to hide her eyes.

Straight on front lighting

Some of the first lighting positions installed for electric stage luminaires were on the front of the circles and galleries of the 19th century play-houses. This is a good position from which to give a more or less natural look on the faces, but it does little to model the body. As originally installed in most theatres, light from these circle front positions complemented the foot light, which had until then worked almost alone to light the performers. Light from above the heads of the performers helps audiences to see the performers' eyes and mouths clearly, so long as the angle is not too steep. If front light is from too shallow an angle, it can lead to large distracting shadows on the set. Shallow front light used in isolation tends to flatten the stage picture. Used in moderation with the fine attention to detail of, say multi-award winning UK lighting designer Mark Henderson, low angled front light 'lifts' facial features just enough to allow the audience to see eyes and mouth in an otherwise steeply focused, very area specific, rig.

Three-quarter front light or gallery booms

Many 19th century theatres in the UK and elsewhere have had adaptations built into the ends of the top gallery seating area (or the gallery boxes in traditional play houses) to take theatre lanterns. Almost all proscenium theatres with electric light for the stage have been designed to accommodate these lighting positions. The ideal position is considered to be about 45 degrees up from horizontal and about 45 degrees to either side of the centre line of the stage and the audi-

Figure 8. This student is focusing ¾ front light near the proscenium. You can see the light spill and her shadow on the proscenium wall to the right of the picture.

torium.[7] For much of the 20th century, this is where front light for performers' faces came from, and for very good reasons. Light from this direction provides good illumination of the performers' faces and a degree of modelling, so it is good for achieving visual acuity. For lighting a performance staged behind the frame of a proscenium, it is as near to perfect as can normally be achieved. However, once the area of performance is pushed through the frame of the proscenium, we begin to have a problem. How do we light the performers at the down stage edge without breaking the illusion of the proscenium frame by illuminating that as well?

Another problem with ¾ front light is how to continue it further up stage. On a proscenium stage, the header, which comprises the top part of the proscenium frame, gets in the way of using ¾ front light positions from many gallery box booms further up stage. Even when the header is not in the way, the angle becomes less steep the further up stage the light is focused, and so the 'spill pool' gets bigger and the performers' shadows get longer. If there is a back wall or an up stage area that should be dark, this solution will not work. Finding positions for ¾ front light lanterns over stage can be difficult, especially so in theatres with a lot of flown scenery. The German tradition has addressed this problem well, and most large proscenium theatres there have a structure of perches and a bridge behind the proscenium to provide a comprehensive selection of rigging positions.

Breaking away from the ¾ front system to light up stage areas can make matching the feel of the lighting up stage and down stage difficult, giving the impression that we have two different worlds on stage — one world down stage with a ¾ front light look, and another up stage with a different look. It is better to try to find a solution that allows for some rigging positions for ¾ front light over the stage if the intention of the production is to attempt to show a unified space over the whole depth of the stage.

One further problem with ¾ front light on relatively small performance spaces is the increased size across

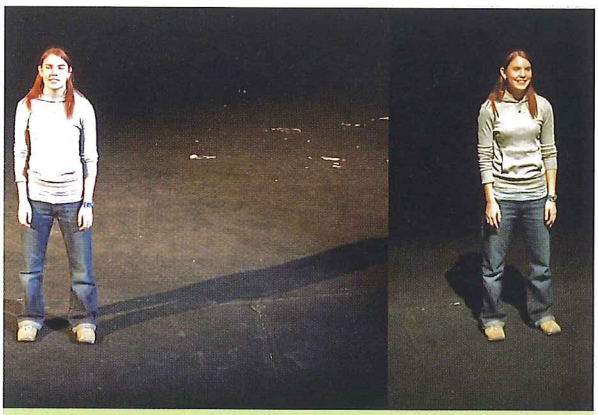

Figure 9. The shadow on the stage floor gives one of the biggest clues to the direction of the source of light — both where it lies and how long it is. Steep angles, like that on the right, result in a shadow shorter than the target, while angles below 45 degrees result in a shadow longer than the height of the target.

[7] 45 degrees is half a right angle, i.e. the same angle you get when you draw a line between the opposite corners of a square.

stage of the 'spill pool' compared to straight in front light (see fig. 9). This can make it harder to define separate areas of the stage across its width, just as straight in front light can make it hard to separate up stage and down stage areas.

So for conventional front lighting positions, there is rarely an ideal solution that successfully solves all the problems set by an evolving performance lighting design. Perhaps this explains the frequent use of follow spots for larger-scale performance. The well-placed, well-operated follow spot can be used to subtly lift key faces out of steep area lighting. This is a common technique in opera and for live music concerts, where the primary role of the lighting is often to make a statement and to light the sometimes grandiose set. In ballet, the primary role of the lighting is usually to emphasise the physicality of the dancers (the faces of chorus are less important) and here follow spots are frequently used to highlight the principal dancers.

Light from below the performer's eye-line

With the arrival of focusable electric light for the stage, most theatres threw out footlights for the 'unnatural' shadows they created and the barrier they made between performer and audience. However, many lighting designers have now re-introduced light from the down stage edge of stage, though usually in the form of small single units rather than the obtrusive floats[8] of old. Light from this position has proved very useful. It can create unnatural shadows, which may be an intentional effect. It can also get light into the performers' eyes in otherwise difficult situations, such as when wide-brimmed hats are worn on stage, or when the available positions for front light all result in steep angles.

Light from the sides

Side or cross lighting emphasises angularity and is good for modelling the body. It helps the audience's perception of depth. Cross light can be used to create strong shadows on the body, emphasising physicality, especially useful when lighting dance. To further emphasise the body, complementary colours can be used in the cross light from each side of stage. Low level cross lighting is very often arranged to cast no shadow of the performer on the stage (the shin busters mentioned above). For most classical ballet, the stage is arranged with wing flats, set to hide both the source of the cross light (rigged on vertical pipes or towers called booms) and to contain the shadows of the performers. On an open performance area the shadows from cross light can become a distraction, especially with low side light when the shadows are over life size, but the effect can also be used selectively to the advantage of the performance.

Figure 10. The lighting for much classical ballet and other dance forms relies heavily on the modelling effect of light from booms at the side of the stage to enhance the physicality of the dancer's bodies. The occasional shadow across a dancer's face is a small price to pay to enable the whole audience to see clearly her beautiful arms.

Perhaps more than any other genre of live performance, ballet, and to a lesser extent dance in general, has a set of rules concerning position and focus of lanterns. There is a requirement to produce light that shows the

[8]In the 18th and 19th centuries, floats was the name given to foot lights consisting of wicks floating in a trough of oil. Later electric versions replaced the wicks with a row of incandescent lamps, similar to the ones in common domestic use today. Both types had a reflector-cum-glare guard perhaps 200mm high mounted behind the bulb or flame, which effectively cut off any view of performers' feet for much of the audience.

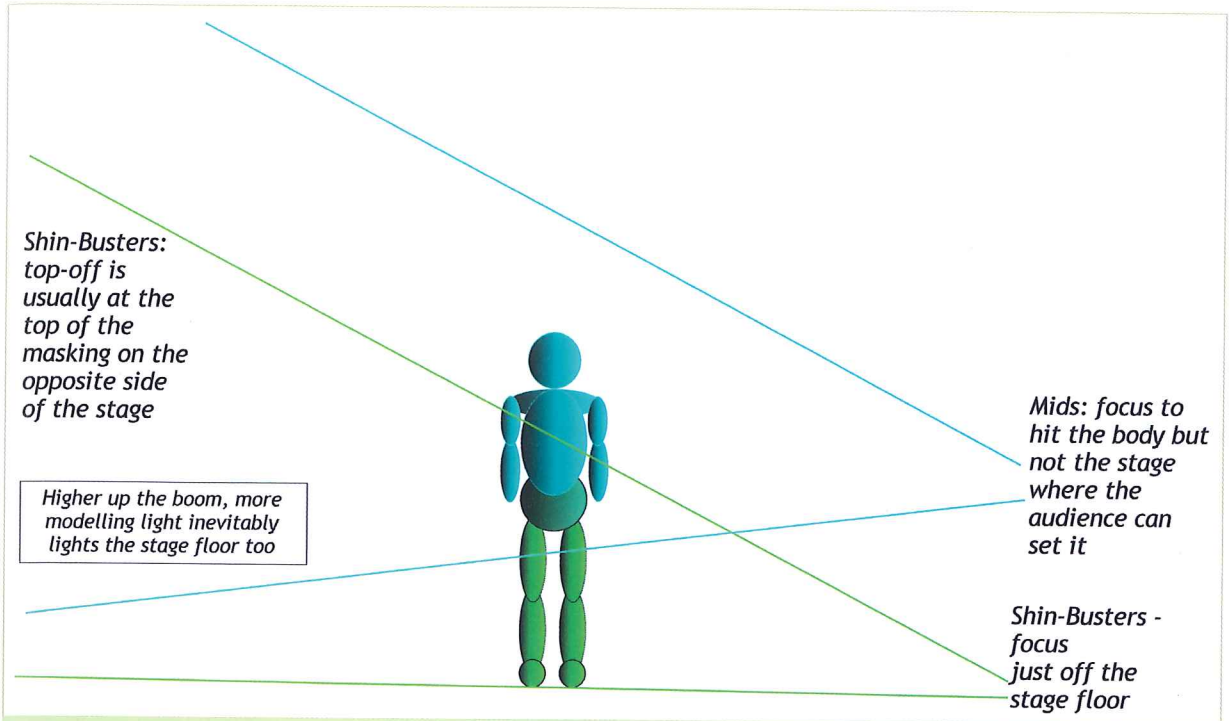

Figure 11. The focus of the lower units on a dance boom helps to model the performer's body while keeping light off the stage floor.

physicality of the dancers to best advantage over the whole stage, and to do this an arrangement of side or cross lights has developed and has become almost universal. Anyone wishing to practice lighting for this genre needs to understand how and why this system works. The diagram gives an idea of the focus, but as in other areas of performance lighting, there is no substitute for hands on practice.

When wing flats are not available to mask booms and extraneous shadows, and sometimes even when they are, many designers use high cross light to provide modelling, and sometimes to introduce coloured light. In music theatre, it is common to see pairs of lanterns rigged at the end of the lighting bar and pointing more or less across stage. These are referred to as pipe ends.[9] This position can be especially useful when there are a lot of bodies on stage, for example the large chorus of an opera or a musical, where light from lanterns rigged lower down on booms would be blocked by the first one or two performers on each side of stage.

Paule Constable and David Hersey, among others, make extensive use of cross light outside the dance genre. In confident hands, it becomes a tool to allow the lighting designer to develop painterly scenes, where the main intensity comes from the side producing an effect close to the chiaroscuro of Dutch and Italian Renaissance painting. The shadows are delicately filled with just enough light to provide an appropriate level of visual acuity, enabling the audience to see facial features. This kind of work cannot be accomplished without a significant level of co-operation between performer, director and lighting designer.

Top light or down light

Top light makes the figure seem more massive, creates very short shadows, and can often seem to shorten the

[9] 'Pipe' being the North American equivalent of bar or fly bar in the UK, and the name reflects the origin of this practice.

body. When the lanterns are too close to the performers, it can make the top of a performer's head the brightest part of the stage, which is not usually helpful. When there is enough height between performers and luminaires, it is a good position from which to add colour to the stage, and especially to shadows on the stage floor.

Shadows are created when a part of the beam of a dominant light source is blocked by a person or object. This often means that the light from less intense sources is more evident in shadows, and when that light is coloured, the shadows take on that colour.

Top light is frequently used to colour the stage floor itself. Very often in musical theatre, a coloured top light wash is faded up slightly ahead of the rest of the lighting for the scene, presenting a more saturated colour to the audience for a few moments before the rest of the light dilutes the effect.

Top light can also be used to add intensity to a scene without substantially changing the balance of face light, but again this effect needs to be used with care. If some of the audience cannot see the stage floor the effect could be substantially different for them. It is possible that sources of glare will be introduced for audience members who can see the floor, especially if the floor is highly polished and therefore very reflective. Such differences in audience experience for different sections of audience is not limited to the use of top light, or even to lighting effects. Conscientious members of the creative team will usually try to see the performance from as many different audience positions as possible to discover such differences.

Tight pools of top light are often used as specials. In smaller performance spaces, it is sometimes only necessary to have the performer look up slightly to provide sufficient illumination for visual acuity. Sometimes it is possible to cheat and rig the special unit slightly down stage of the performer's position, or use the performer's costume to bounce light into their eyes. Sometimes we can use the light reflected from the floor to fill the shadows just enough. More often, if it is appropriate to see the face, a low intensity, secondary source will be needed, and this could perhaps come from a foot light position. Using a top light minimises the spill required to create an area of useful illumination, and so is ideal for some kinds of 'special'.

Top light is of limited use in concert lighting in sports arenas or open air festivals. Most of the audience cannot see the floor, and the structural effect of beams is less pronounced with top light than with back light. For classical concerts, however, top light can be used to

Figure 12. Lighting student Libby is seen here in the same top light special in both the above shots. In the first shot, her features are hidden in shadow. In the second shot, on the right, light is bounced off white paper to reveal her eyes and other facial features.

illuminate the music and the instruments with the minimum of glare and extraneous shadow, good for both the players and the audience.

Back light

Light from the side of a performer or from immediately above a performer has some impact on the audience's ability to see the facial features of the performer. Light from behind the body of a performer facing the audience clearly does nothing to illuminate that performer's face, so why is it considered so important by almost all performance lighting designers? What back light does for performance lighting design is to further emphasise the three dimensional physicality of both the performers and the performance space. Back light, by illuminating the edges of performers and objects, especially curved objects with hairy edges (such as the head of a performer) helps the spectator to perceive depth in the individual objects and separation between objects and background.

Human stereoscopic vision only works over a relatively short distance. In large spaces, we need help to work out the relative distance to the various objects in our field of view. Because of this, back light is an important tool for the performance lighting designer, especially in large performance spaces, such as the sports arenas and festival sites where rock and pop acts perform. Live concert lighting rigs are often dominated by backlight sources. Standard video and film cameras, having only one 'eye', have no stereoscopic vision, and often back light provides the only visual cue separating performer from background.

Just back light on a performer can help to produce very dramatic effects, perhaps because the presence of the body is emphasised without giving the audience sight of the face — there can be no direct reading of the face so suggestion can be used to full effect. Concert lighting, especially for rock music, makes huge use of these effects, concentrating attention on shapes on stage rather than details.

Whenever there is dust or smoke in the air above stage, back light reveals itself, an effect more concerned with throw than angle of incidence, but important nevertheless.

Using angle of incidence

Angles of incidence can be used to help enhance mood and atmosphere. For example, shadows produced by light from directions not normally found in nature draw attention to themselves and can signify the supernatural or dreams. The long shadows cast by lanterns at or below performer eye-line can be very atmospheric, as can strong back lighting. A strong single source, such as the large discharge Fresnels favoured by many opera lighting designers, can create massive scenographic statements almost on their own, and getting these units in just the right place can be the key to success in this type of design work.

More often, changes in angle, causing changes in where shadows fall and in shadow length, are used to signify changes in time of day or season. The light of dawn and sunset comes from close to the horizon and produces long shadows, while the light of midday produces short shadows. The problem here is that very often urban dwellers don't notice these things, so the sign may not be widely read by the audience.

Each different direction of illumination can provide a different sign, or set of signs, to the audience, concerning the physicality of the actor/character, and may be used to signify aspects of the character's psychological make-up or relationship to other characters. It might be possible, for example, to show a particular kind of power relationship by lighting a dominant character from the side or diagonal, emphasising angularity, whilst the submissive character is lit primarily with top light, tending to shorten the figure. Such uses of particular lighting angles for different characters, however, can be hugely restricting. If both characters were on stage at the same time, they could not use each other's areas of stage without a fairly obvious lighting cue for each movement, and they would not be able to come close to each other without being lit by the light designed for the other. This kind of effect could be used at the entrance of each of the two characters, but again it is more likely to be read as artificial or a mistake if not perfectly integrated into the production.

The throw

A performance lighting rig usually needs to work with the aesthetic of both the production and the space. Visible beams can draw attention to the source of illumination and away from the performance on the stage. Whilst a massive lighting system can become a dominant element of the design, especially when it comes to concert lighting, some productions ask the audience to willingly suspend their disbelief in the 'staged' nature of the piece and the sight of lighting instruments and the beams they produce could be at odds with this aesthetic.

Usually the audience accept that they are watching a staged performance and that means they will see some lighting and other technical equipment around the performance area. They will not want the presence of this technical equipment to be distracting though, or for there to be sources of glare from unmasked lanterns. One of the key design decisions in most theatre work on a proscenium stage is whether the lanterns will be visible above stage, or will they be masked, for example by flown borders? Either decision presents the lighting designer with possibilities and problems about the placement of lanterns, that is, the choice of throw.

There are other factors to be considered in decisions relating to throw. A strong beam, apparently from an unseen source far away in the heavens, has been a strong signifier of the presence of a deity in Western art since pre-Renaissance times — clouds part, revealing the hand of God. But was that what the lighting designer wanted the audience to read into their use of a big back light? Perhaps less dramatically, we might want to

Figure 13. A 'curtain' of light has an architectural effect, creating something almost solid in the smoky air but also creating a bright pool on the stage. The lighting designer will need to balance the two effects. Photograph by Ana Vilar-Bergue.

evoke a confined interior on an open stage. If the audience can see beams from distant lanterns in dust or haze above the stage, even sources high above the performers, will they understand the scene as confined interior?

Visible beams of light can have an architectural presence on stage. Stage designer Josef Svoboda working in Prague in the last century, created curtains of light. The beams were made more visible by filling the air with tiny droplets of moisture, creating vast three dimensional shapes in space, which could appear and disappear with the push of a fader. Architectural effects such as this have been used with great effect to signify abstract notions such as the isolation of a single performer or the grandeur of the gods. Visible beams of light can be used to signify physical structures, and they are the stock in trade of concert lighting designers, used to modify the audience's perceptions of the size and nature of the performance space.

Such use of light draws attention to its self, foregrounding the language of stage lighting, potentially distracting the audience from the main action on stage. Conversely, strong architectural lighting can evoke place or atmosphere, aiding the production. As with any potentially dominant theatrical sign, the use of strong architectural lighting has to be thought out and fully integrated into the language of signs within the production.

Where the lantern hangs in relation to the stage is usually defined by what it has to illuminate, how the target will be illuminated, and the physical constraints of the space. Large numbers of very visible lanterns in the auditorium or over the stage say something to the audience about where they are and what sort of experience they may be in for. It seems clear that the decision to hide or show the lighting will have an impact on the audience's expectations of the production. In the semiotics of the French philosopher Roland Barthes, it will alter the decoding grid used by an audience.[10] It should therefore be a matter for the whole of the production team, not just the lighting designer. Having said that, often the only way to illuminate a particular element of a production is to use lanterns that show their presence to the audience, and the lighting designer must be prepared to argue that the ends justify the means — providing that they do!

Colour

In performance lighting, we can colour light with thin sheets of coloured film in a gel frame placed in the runners at the front of most theatre luminaires. These thin sheets are still referred to as gels, harking back to the original coloured gelatine, though these days plastics of various kinds are used. The major manufactures of lighting filters, Rosco, Lee Filters, GAM and others, produce swatch books of their colours for reference, some of which include graphics for each colour in the range, indicating the proportion of light filtered at each wavelength. It is relatively easy to get hold of these sample swatch books at trade fairs or from the sales counter of any decent lighting hire company.

When we use sources of light that are essentially white we create coloured light by filtering out the frequencies we don't want. The dyes, held in either plastic gels or in longer lasting but more expensive glass sheets, allow selective transmission of the various wavelengths of light. A red gel or a red glass absorbs all the wavelengths of light that are not red, letting any red light present through. The filter does not 'make' red light so if there is no red present in the original light, then no red light will emerge.

[10]Barthes introduced the idea of a decoding grid to semiotic discussions in 1970 with his book *S/Z*. His original ideas have been considerably elaborated upon since then both by himself and others. In essence, the decoding grid is the assumptions and other information we as audience use to make sense of what we see, hear, feel, etc. In this case, someone who regularly attends a range of performance types would assume a different style of presentation from an open stage with the lighting rig in clear sight and from a naturalistic interior setting with full masking.

FIGURE 14. EXAMPLES OF LIGHTING COLOUR SWATCH BOOKS.

The more light a filter absorbs the less gets to the stage. To some extent, all lighting filters reduce the intensity of the lanterns that they are used in, and using deep colour in lighting filters can dramatically reduce the amount of light reaching the stage. Strongly-coloured plastic filters tend to absorb a lot of infra-red (heat) from the light source, which makes the filter more prone to fading, and in some cases melting, over time. To some extent, this problem can be overcome by using specially dyed glass filters, which last much longer than plastic filters. However, glass is more fragile and the initial costs are much greater, as is the cost of the lighting designer changing their mind about the colour they want.[11]

Dichroic filters, used in many moving lights, work in a different way and as a consequence can produce a different quality of light. Dichroic filters are usually made with heat-proof glass coated with a very thin layer of material. They allow some light frequencies to pass through (just as in a plastic filter) but rather than absorb the rest, the other frequencies of light are reflected. A red dichroic filter may look green on the surface and does not look red unless you look through it. The band of frequencies passed by a dichroic filter can be precisely controlled in the manufacturing process. This can result in much more a-chromatic light — light of just a very few frequencies — an effect which is impossible to achieve with dyed plastic or glass filters, hence the potential for a different quality of light with dichroic filtering.

Human response to colour

Our perception of colour is subjective. What we have just seen, and what we see alongside a particular thing, has an effect on the colour we perceive that thing to be. When talking about light and colour on stage it is also worth remembering that we cannot distinguish between a neutrally-coloured object illuminated with coloured light and a coloured object illuminated with neutral light.

Much of our response to colour is also subjective and/or culturally specific. We may respond well to colours we associate with pleasant early experiences. These responses will be unique to the individual and therefore unavailable to performance practitioners wanting to communicate to a whole audience. However,

[11]The subtractive way in which colour filters work can lead to some perhaps unexpected results, for example when using two sheets of the same colour in a single gel frame. If the chosen filter removes 20% of all blue light present, the first sheet leaves 80% of all the blue light in the beam. The second sheet removes a further 20% of what is left — not of what you started with — so adding a second sheet of filter usually has a smaller effect than you might suppose on increasing the depth of the colour on stage whilst often removing more useful light thus reducing intensity. It is usually better to choose a single colour rather than double up filters.

scientific work has been done to show that some responses to colour are more general in the population. Here are some examples.

- Heart rate speeds up in response to the colour red, and slows in response to the colour blue.
- Advertisers have found that yellow is often associated with fun, red with passion, blues and greens with calm and security.
- Purple is often associated with dignity, for example, the regal purple of ancient Rome and the medieval era in Europe.
- In the West, black, brown and grey are associated with sadness and black is the colour of mourning. In some Eastern cultures white is the mourning colour.
- Most people associate the adjective 'warm' with colours near the red end of the spectrum, including orange and some yellows, and 'cool' with the blue end of the spectrum but ...

Warm and cool

These two terms are frequently used to describe light in performance, the atmosphere and mood as well as the colour. It is as well to be sure everyone understands the same things by these words before basing a discussion around them. Here is what I mean by warm and cool.

Warm — as in the comforting light of a domestic fire, the glow of a sunset in fine weather, the atmosphere between contented lovers or amongst a happy family or group of friends. In performance lighting terms I mean soft shadows, orange, red and yellow tints, perhaps relying on incandescent sources at lower intensity to increase the proportion of red light in the white. All skin tones glow and look healthy.

Cool — as in the light of a clear bright winter day, the light of clinical or scientific spaces, the atmosphere between recently separated lovers or amongst a family split by arguments. In performance lighting terms, harsh and revealing, lots of pale blue tints and no hints of reds or orange, perhaps making use of fluorescent and white discharge sources, or incandescent lamps at full. Shadows where they are present are hard edged. Pale skin tones look starved of blood. All skin tones begin to look lifeless, but this light can animate the facial features with its harder shadows.

If we are to use these notions as signifiers in a lighting design, everybody concerned has to be using the words in more or less the same ways. It is worth thinking about what your version is, and what others you are working with mean by these terms.

Red and blue and focus

Our eyes have a single lens. From Chapter 1, we saw that different wavelengths of light bend by different amounts in a lens or a prism — that is behind the formation of a rainbow, the splitting of white light into component colours by a glass prism and chromatic aberration in cheap camera lenses. For our eyes, the physics means we cannot focus both red and blue light from the same distance at the same time. In technical terms, there is a difference in the focal length of red and blue light for a simple lens system. This shows up in some moving light applications. For example, a gobo focused sharp in blue may look soft in red, requiring a lens adjustment between the two colours if sharpness is required for both.

This effect is what can make the stage of a rock concert, bathed in pure deep blue light from moving lights with dichroic filters, seem slightly fuzzy and out of focus when we are looking at the solo artist in a followspot. It is quite fun to play with the effect and with a bit of planning can be used in other places than the rock stage. To get the full effect, the saturated background light has to be close to one end or the other of the visible spectrum (blue seems to work best) and other frequencies of light (i.e. other colours of light) have to be removed — dichroic filters do this better absorptive filters. Then you need a strong central image to focus audience attention, lit to provide good visual acuity.

Colour theories and complementary colours

The colour of light can be described in a number of ways. We have seen that the different colours of the spectrum have different frequencies. However, coloured light is usually composed of a mix of frequencies. It is possible to define a colour of light by the relative

intensity of each frequency present, as some filter manufacturers do in their swatch books.

Another way of describing a colour is the CIE colour model. Developed in France by the Commission International de L'Eclairage (CIE), in the first half of the last century, this model relates more directly to the way our eyes work. It uses three terms to describe colour: hue, saturation and value. The system was designed to describe the colour of pigments rather than the colour of light, with value representing the relative lightness or darkness of a pigment. In light terms, value can be replaced by intensity. Hue is closest to what we ordinarily call colour: red, blue, green, yellow, magenta, cyan, orange, purple, turquoise, etc. In this system, six colours are called the primary and secondary colours; for light, red – green – blue are the primary colours; cyan – magenta – yellow are the secondary colours. Saturation is a measure of how much hue is present. Deep red is highly saturated, deep pink is less saturated while pale pink has a very low saturation.

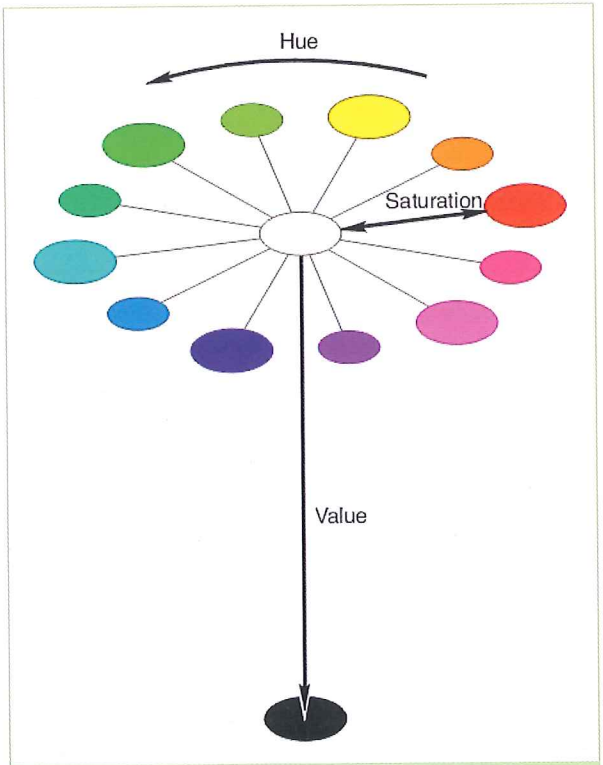

Figure 15a. CIE colour model in three dimensions to describe pigment. In lighting, we can substitute value for intensity.

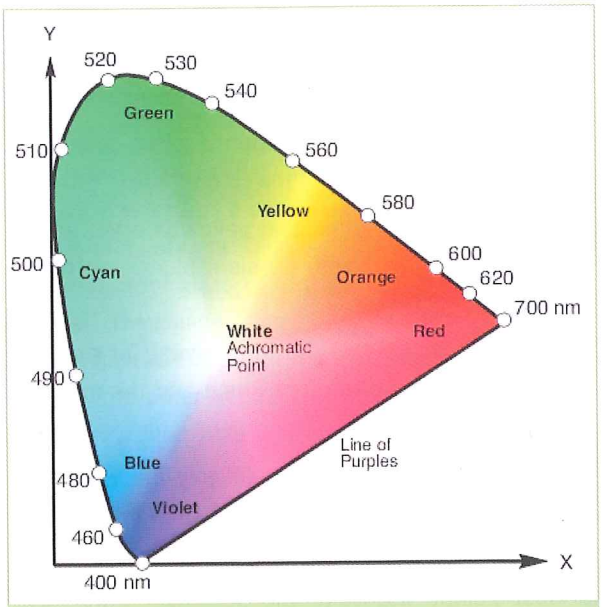

Figure 15b. The CIE colour model mapped to two dimensions. Saturation is highest at the edge of the colour space and lowest (actually zero) at the a-chromatic point. Hue rotates around the edge of the colour space. The link between red and violet has no basis in physics and is purely for the convenience of representation. This can lead to some descriptive problems.

So how does this relate to the practice of performance lighting? Many moving lights are able to mix colour, using a variety of systems. In theory these units can produce any colour of light from the two-dimensional CIE diagram. In practice there are a number of limiting factors, including the colour temperature and colour rendition index (CRI) of the light source, and the precision with which the filters are manufactured. Many moving light consoles are now offering practitioners the opportunity to pick and adjust the colours they use with controls for hue and saturation. The hue control selects the base colour and saturation control the depth of that colour.

Warm from one side, cool from the other

It is common practice in theatre lighting to fill the shadows created by the main light sources with less dominant sources in a complementary colour, but what are complementary colours in light? For most performance lighting practitioners, complementary colours of light are those that, when added together, make something close to white light. The complementary for any

colour of light should be on a straight line through the achromatic point of the CIE colour diagram. However, our visual perception does not function quite like that, and the best results are obtained by experiment.

For the practice of lighting performers from either side in different colours, we are usually looking for complementary tints which don't look too unnatural on their own. These pairs will be found near the achromatic point. This technique enables fuller illumination of the subjects, without losing too much of the definition created shadows (see figure 7).

Back light is often more strongly coloured than front light and this can lift the performers away from the settings, providing a degree of colour contrast. Because back light does not generally fall on the faces of performers, there is less chance of disturbing the audience with 'unnatural' colours. As we have said, back light illuminates the fringes of people and objects, so if it has a strong colour, objects can appear fringed in that colour. We are used to seeing the blue of the sky as a background to our world, and perhaps this is why audiences appear to accept blue back light so easily. Whatever the reason, blue back light is almost ubiquitous in Western performance lighting.

Using complementary tints from each side of stage and more strongly coloured back light is primarily a functional sign. It is a technique that helps the audience to see better without really being conscious of how much visual acuity would be lost without its use. This is not to say that the use of tints from the sides, or stronger colour from the back light, cannot be used to indicate other things; the cooler light of winter against the warmer light of summer, the yellow tint of candle light against the white of sun light, the 'naturalness' of blue back light against the 'magicalness' of say purple back light. All of these can be employed as signifiers of time and place and mood, along with aiding visual acuity.

Each of the colour signifiers above is presented as part of a pair, and this comes back to the way we perceive each colour in comparison to the other colours around at the moment of perception and in the immediate past. We have to have some other colour to compare each newly perceived colour with. There appears to be no colour equivalent to perfect pitch, where some individuals can hear a musical note and immediately place it accurately on a scale. This fact has some fundamental implications for the performance lighting practitioner. Here are just three things to consider.

- Looking at lighting states out of sequence can give a false impression of what the audience will perceive. (This is true for intensity too.)
- Some tints, such as pale lavenders, can be made to seem warm or cool depending on what other colours are dominant at the time.
- Large areas of strong colour, for example from the set, or even more so from a brightly lit cyclorama, will have a significant influence on the audience's perception of other colours.

Colour clearly plays an important role, but for now here is a brief description of two potentially disruptive colour effects.

Colour fatigue

This effect leads to the apparent 'dilution' of strong colour over time — as little as a minute — even when no actual change in the colour occurs. Several conceptual artists have used this effect. For example Dan Flavin[12] and Olafur Eliasson[13] have both used arrays of discharge lamps whose colour cannot change, and yet an

[12]Flavin has used fluorescent and other cold cathode lamps (for example neon lights) to create art works that although unchanging appear to the observer to change over time.

[13] The weather project installed at the Tate Modern in London in 2003/4 had a large sun, powered by low pressure sodium lamps of the kind used in street lighting. They emit a very narrow band of yellow light, unvarying in its colour. Despite this most observers perceived the colour of Eliasson's sun to change over time, due in part to the effect of colour fatigue.

observer perceives that the colour (and intensity) does change.

Colour adaptation

This is the effect where our perception 're-sets the white balance' of the eye to help to make sense of the world. This happens when we wear coloured sunglasses. Very quickly, we perceive faces and other objects we know well to look a natural colour. If you take a photograph through (non-prescription) coloured sunglasses, you will see how distorted the colours really are, but your brain refuse to be 'fooled' by tinted glasses.

Colour as a signifier

For many traditions of performance lighting, colour provides only subliminal cues, aiding audience perception of space when used in conjunction with other variables. Important for the variation and depth that it helps to add to the stage picture, the use of strong colour can be problematic due to the subjectivity of audience response, and the perceived anti-naturalism it evokes. Generally we do not see strongly coloured light in nature, so when we do see it, we become aware of both the light (which most people hardly ever notice except when it is not 'natural') and its colour. As with other ways in which light in performance makes its presence directly felt, strongly-coloured light needs to be handled with care.

Beam and movement

Glory be to God for dappled things
***Pied Beauty*. Gerard Manley Hopkins**

Long before the birth of modern moving lights, Adolph Appia[14] was trying to persuade the great opera composer Richard Wagner that dappled light could be a more powerful sign of a forest than any number of painted cloths. Since then this notion has been enthusiastically taken up by lighting designers working in many genre of performance. Gobos[15] are usually cut from metal or etched on to glass, and placed in the gate of the lantern. The image etched or painted on the gobo is then projected in the beam of the lantern.

Figure 16. Three break-up gobos, usually used to add texture to set or stage floor. The lower two gobos have been used in lanterns. They show the marks of the heat generated in the gate, the slot in which the gobos are positioned. Gobos frequently glow red hot when in use!

To use the formal language signs, semiotics, which is further explained in the appendix, the gobo has become a prominent signifier in much of British and American performance lighting. Hard focused and thus clear and distinct, or soft and impressionistic, these patterns projected in light have been used in many different ways, to 'paint' New York fire escapes onto a plain brick wall, to depict flashing neon signs, to signify the sun shining through a tall window (all iconic signs) or to provide the gently moving dappled light signifying a forest (perhaps a more complex sign, iconic of light in a forest, index of 'hidden' trees and often symbol of something else — fruitless searching or pastoral tranquillity perhaps).

[14]Adolph Appia (1862–1928) worked with Wagner at the composer's theatre in Bayreuth. He argued that the scenographer should create a three dimensional world for the performers to inhabit rather than a set of two dimentional painted cloths for the performer to stand in front of. Along with Gordon Craig (1872–1966), Appia is frequently cited as the one of the fathers of modern scenography.

[15]Gobos are referred to as templates in North America.

The lighting industry provides several ways to animate the image projected from the gobo, so we can create the gently rippling light through trees dreamed of by Appia, or imitate light reflected from a canal, without any water on stage.

Figure 17. This profile is fitted with an animation disc, which, as the name suggests, is used to add an impression of movement in the beam. Usually used in conjunction with a gobo, animation discs can help to imitate the light reflected from water, or light from a fire, or Appia's light filtered through a forest canopy.

The present generation of moving lights have multiple gobos, often able to rotate, and often on two or more wheels, so that patterns can appear to dissolve, or morph, from one image to another. Some moving lights incorporate an animation wheel, which can be selected remotely. The promised next generation of moving lights will have a video gate. This technology offers the possibility of lanterns projecting virtually any image, still or moving, onto the stage, or wherever the beam can reach. This concept, sometimes called digital lighting, is covered later in the book.

Shutters

Shutters, the beam shaping blades of profile luminaires, have recently been added to several hard edged moving lights. The ability to remotely and dynamically shape a box of light on stage is an exciting prospect for many performance lighting practitioners. Accurate remotely-controlled shuttering allows the possibility of creating and manipulating spaces on a stage with much more fluidity than is possible with conventional flown or trucked scenery. It offers a new dynamic on the performance stage, potentially more powerful than anything moving lights have brought us so far. The round edge of a beam on stage remains just that — the edge of a beam. A sharply-defined square or rectangular beam, however, can signify the edges of a real or imagined space — and when those edges can move, more possibilities present themselves. This is a rapidly-evolving area of performance lighting practice. There is sure to be some resistance to this very noticeable use of light, and it is a technique that could easily be overused. The potential in many genre of performance is exciting however, whether remotely-controlled shutters are used to compensate for last-minute changes to blocking or to dynamically manipulate the audience's perception of space.

Quality

Beam quality is used with at least two different meanings in performance lighting. The first we have already touched on and refers more to the colour composition of the beam, how much of each frequency of light is present. We talk about the quality of light from an incandescent lamp being different to that from a discharge lamp, and by that we usually mean that the balance of light frequencies in each beam is different. Architectural lighting practitioners use the colour rendition index (CRI) of a source to give a measure of how 'complete' the spectrum of the source is and how similar its light is to idealised sunlight. CRI is often quoted in lamp data sheets and on the packaging of some lamps. In light from a source with a CRI at or very near 100, colours look as they would do in sunlight. In anything else there will be some differences for some colours; the lower the number, the more noticeable the differences.

The second meaning refers to the pattern of intensity across the beam of a luminaire, how the intensity falls off towards the edge of the beam, and the crispness of the shadows produced by that luminaire. This gives us words to describe the difference between the light from, for example, a Fresnel luminaire and a profile luminaire,

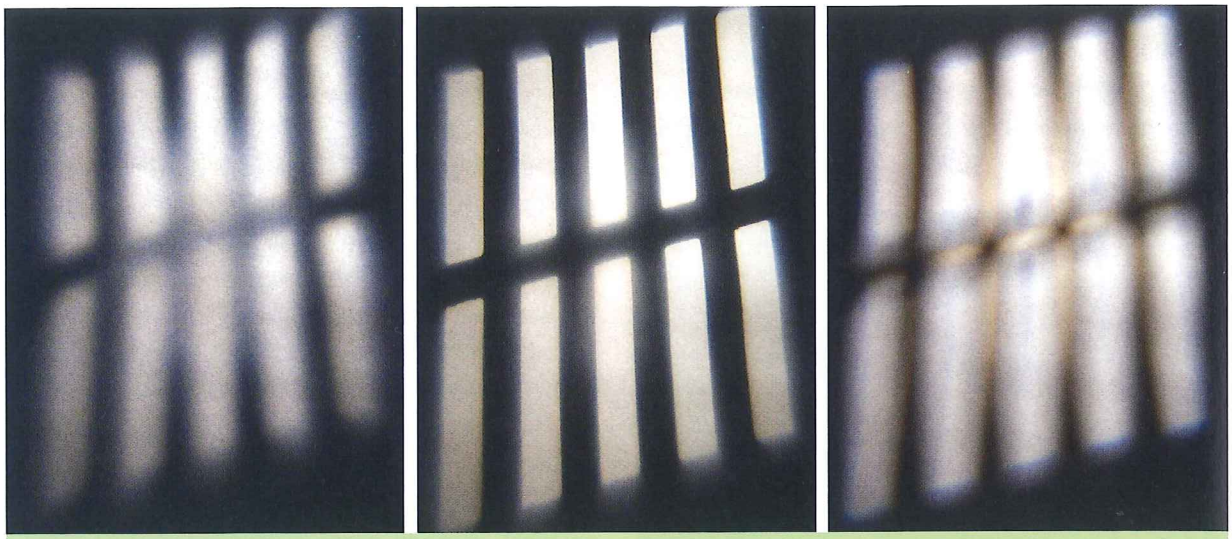

Figure 18. Three views of the beam of a profile lantern with a gobo, showing two different versions of a soft beam either side of a sharp beam.

between a unit with a lens and a soft light, and between a profile luminaires focused in several different ways. In this context, we use the words 'focus it' to mean how the lens or lenses of the profile lantern are adjusted, as opposed to how the light hits the stage and objects on it (angle of incidence) or the path the light takes to the stage (throw).[16]

Soft and hard edges are important in performance lighting. Soft-edged beams are easier to blend into one another, hard-edged beams stand out, drawing attention to themselves. Hard-edged beams seem brighter than soft-edged ones because we are more sensitive to the sharp changes in intensity that occur at the edge of a hard-edged beam. Most performance lighting will make use of both, for example, the soft edges for lanterns used in a wash and the hard edges for those used as specials. In a proscenium theatre, soft-edged beams front of house can lead to too much spill or flare, unintended light illuminating the auditorium and causing distractions.

Describing performance light – a summary

Once again we have covered a lot of ground in this chapter, about the mechanics of lanterns and lantern placement, a little of the history of performance lighting, some useful stuff on human visual perception — what we might call the psycho-physics of human perception — and the beginnings of how choices of lantern and position impact the images we produce on stage. Here are some points to carry with you into the following chapters.

- It is useful to consider performance light in terms of four interrelated properties, intensity, focus, colour and beam, but remember that time as a variable impacts on everything we do.
- The mechanics of human visual perception are just as important as the physics of light and light production.
- Humans are able to concentrate on detail in a relatively small area of our visual field — we can watch the show from the back of a large theatre or stadium,

[16]Unfortunately this multiple use of the word focus is widespread in performance lighting practice, amongst native English speakers and beyond. Context will usually define which meaning is intended, but there will be occasions when it becomes necessary to distinguish between 'focus the unit' meaning change its pan and tilt, and adjust the relative position of lenses and other optical elements.

even though the action only occupies a small proportion of what we can see.

- It helps if the rest of the visual field is dark so dim those houselights, especially in large auditoriums.
- We are distracted by small areas of light, and especially movement, at the edge of the visual field — keep an eye out for flickers from faulty emergency lighting and extraneous light spilling from the lighting fixtures.
- Human eyes can make more use of both lower and higher intensities than many cameras, but there are limits. We are not great at dealing with both very low and very high intensity at the same time (but we are better than most cameras are at this).
- Humans don't perceive absolute intensity. A candle flame that is bright in a windowless cellar is barely visible outside in daylight. Perceived intensity depends on what went before. A black-out is usually only relative. If the audience has become accustomed to a bright state on stage, they will perceive a stage with enough light for a scene change as blacked out.
- We don't have an absolute reference for colour either; for example, lavender light can appear warm in comparison to blue tints and cool in comparison to amber tints.
- Adding colours together in light tends towards white. Overlapping the beams of three lanterns each with a different primary colour filter will result in white light (providing the intensity of each beam is matched).
- One way of describing complementary colours in light is to say they add up to something close to white. This is useful when it comes to combining light from two sides of a performance space to achieve a natural colour where the two sources combine and the shadows that help with modelling where they don't.
- Dimming the intensity of an incandescent lamp changes the colour of the light it emits. Lower intensities have proportionally more red light — they look warmer. At or near full power, not only is there more intensity, there is proportionally more blue in the light — and the light looks cooler.
- The closer a luminaire is to the stage, the brighter its beam on stage. Generally if you halve the distance between stage and luminaire you get four times the intensity.
- Different angles of incidence allow different proportions of light to be reflected towards the audience, thus affecting perceived intensity. Front light usually presents the audience with most usable intensity, and back light with least.
- Light from some angles can counteract the effect of light from other angles. For example, light from directly above a performer can make them seem squat, and can hide their eyes. When sufficient light from below is added, eyes are revealed, and the performer can be made to seem gaunt.
- Our eyes have a different sensitivity to different colours, so a particular intensity of yellow light will seem brighter than the same intensity of blue light.
- Almost any change we make to the beam of a luminaire will affect its intensity, that is the amount of usable light that hits the stage and the people and objects on it including introducing a gobo or changing the edge quality (focusing the lenses).
- Filtering white light with glass or plastic lighting filters or dichroic filters reduces the intensity of light reaching the stage.

As we saw in the last chapter, what we are used to seeing we perceive as natural and generally don't consciously notice. Things we perceive as unnatural can draw attention to themselves. Performance lighting can make use of this, and can be tripped up by it too. When the lighting for a performance creates shadows that are too different from those the audience perceive as natural, when the colours used are too far from those seen in nature, the audience will begin to read the lighting. If that is the intention, then all is well. If it is not, then the lighting practitioners on the production may be in trouble. As always, anyone concerned with performance lighting must take care to ensure that what is read by the audience is in harmony with what is intended by the whole creative team working on the production.