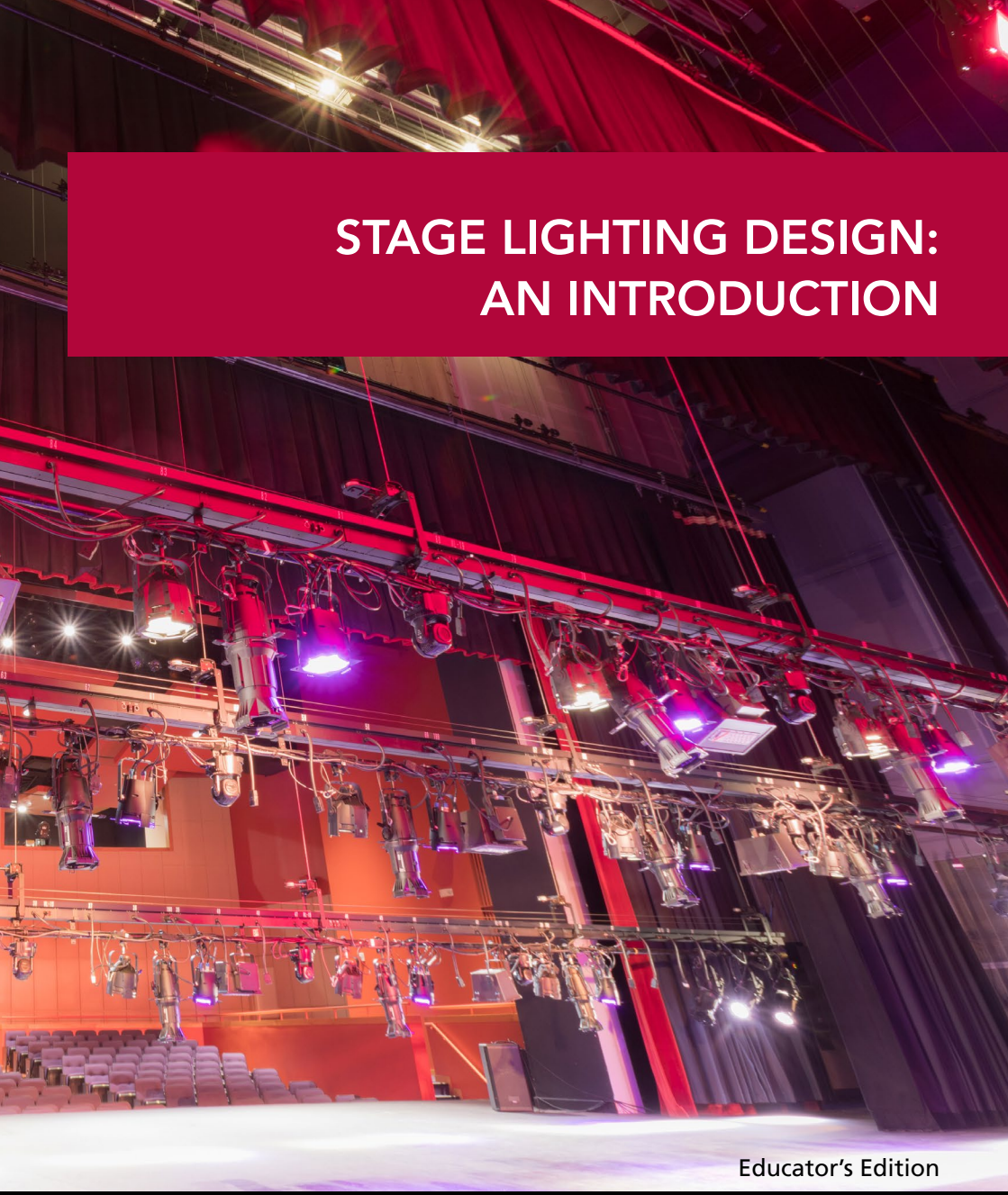
# STAGE LIGHTING DESIGN: AN INTRODUCTION



Educator's Edition

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This guide has been developed as an aid to educators who need to present stage lighting or theatre technology classes to their students and is intended to work in conjunction with the Stage Lighting Educational Poster Series.

Each section of this book is color-coded to correlate to the relevant poster in the series.

This guide contains explanatory content and some suggested projects and tasks for your students to complete.

In this guide, we use the words "play" and "production" synonymously with musicals, operas, dance, and any other type of performance. Likewise, we use "actor" synonymously with any performer.

# CHAPTER 1: INTRODUCTION TO LIGHTING

Humans are inherently storytellers. From the days when cavemen used to gather around the fire and share tales of the day's hunt, to the elaborate spectacles of modern theatre, we have always been telling stories. Theatres have developed and evolved over time to adapt to different technologies and styles of production. As our theatres were developing, lighting systems were developing too.

Ancient Greek amphitheatre

Early Greek theatre took place in large outdoor amphitheatres where the only source of illumination was the sun. As theatre moved indoors, new methods of lighting the performances was required, with flame (candle and gas) being some of the early technologies adopted. No matter the source, the ability to control the light has always been a requirement. Early mechanical dimming systems were developed to control the light from candles, complex valves and piping systems were developed for gas light, and the dimming of electric light has also undergone many iterations.

Since the mid 1900's, the tungsten light bulb was the staple of theatrical lighting instruments with discharge lamps (and occasionally fluorescent and other sources) also being used. The past few years have seen a rapid development in lighting technology, with LED lighting becoming more prevalent on our stages. This has had a dramatic effect on the way we design lighting and the level of control that we now require in order to manage our lighting systems correctly.

ETC ColorSource family of LED lighting, networking, and control

## Light and the Eye

Before we start to talk about stage lighting and the power light has in helping you to bring your show to life, it is important that we first take some time and consider how light behaves and how our eyes perceive light.

Light is the only thing that our eyes can see. When light strikes an object, whether it is sunlight, moonlight, or stage light, it is the light that object reflects that we are actually seeing. If an object does not reflect any light at all, then we see the object as being black.

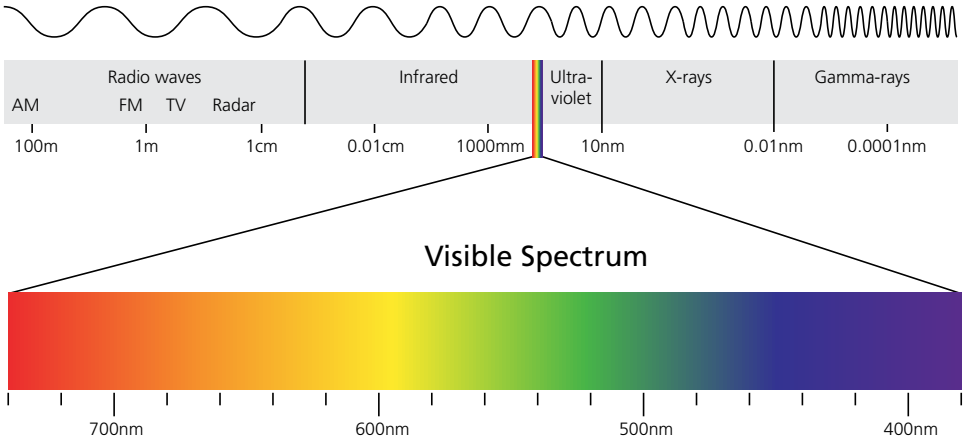
It is interesting to note that light and paint are in fact complete opposites of each other. As a painter, you would usually start with a blank canvas that is white. As a lighting designer (or theatre maker) your blank canvas tends to be black. Similarly, when working with color, the relationship between paint and light is inverted.

This is why most theatres take a "black box" approach to the overall design of the stage – by starting with a black box, you are limiting the amount of stray light that will be reflected in the theatre. Lighting design is about the precise control of light, so having the starting point of a dark theatre on a black stage means that you have a blank canvas onto which you can start to create your lighting looks.

You may have heard the expression that lighting designers 'paint with light' and, to a certain extent, this is a good description of the process.

Light behaves predictably and understanding how light works will help you take advantage of all its properties when you are creating your show.

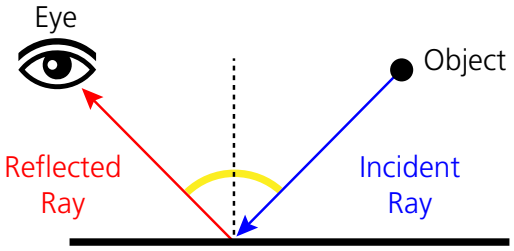
Light is part of the Electromagnetic Spectrum – the same spectrum that also includes X-rays, gamma rays, and microwaves. Visible light occupies a very narrow portion of this spectrum. Either side of the visible light spectrum is ultraviolet light and infrared light.



Light is a form of energy and as such, the rules of energy apply. Energy is never lost; it is only converted from one form to another. In terms of stage lighting, most of the energy wasted is in the form of heat. Electrical energy is converted into light and heat, with traditional tungsten fixtures being quite inefficient, as only about 30% of the electrical energy is converted into usable light, the rest being converted to heat. LED fixtures are more efficient, and a higher percentage of the energy consumed is converted into light.

Another factor to keep in mind is the rule of reflection – *angle of incidence equals the angle of reflection.*

If light strikes an object at an angle of 30°, then it will reflect at the same angle. This is important to remember, as controlling where the reflected light ends up is part of the role of the lighting designer. Lighting that is reflected towards the audience will appear brighter than light which is reflected away from them.



# CHAPTER 2: OBJECTIVES OF LIGHTING DESIGN

Zorro
Alliance Theater, Atlanta
Photo credit: Greg Mooney

*"Lighting designers create the air that the actors breathe."*
– Jean Rosenthal

In the days of the ancient Greek amphitheatres, there was not much call for stage lighting. The sun was used as the lighting source for the plays that were being performed. The ancient Greeks understood the power of light and were able to use the sunlight to create dramatic effects. They would take into account the changing position of the sun as it moved through the sky, as well as its changing color – elements that we still control in our modern lighting designs. Over the years as theatre moved indoors, the sun was no longer a suitable light source. In the era of gas and flame, the primary objective was to provide general illumination for the performance. As this technology developed, different gases were mixed together to create different colored flames, and a complex series of valves allowed for some control of intensity. The advent of the electric light bulb led to stage lighting becoming more sophisticated. Simple illumination of the stage was no longer the only objective, and the early pioneers learned that lighting could add real drama and effect to the show and enhance the audience's experience.

Over the years, technology has constantly improved, but the basic objectives of lighting design have remained the same. We can break lighting design down into five main objectives:

- Visibility
- Revelation of form
- Composition
- Mood
- Information

Let's take a look at each of these objectives in turn.

## Visibility

This is the primary objective of lighting design. We need to be able to see what is happening on stage. Our task is to ensure

that there is enough light to see what is happening clearly but also to help guide the audience's attention to the parts of the stage where the important action is taking place. Perhaps it is better to think of this in terms of "selective visibility" – you get to decide what the audience sees, when they see it, and, more importantly – how they see it. When you are planning your lighting, think about the dramatic moments in the play and how you can draw the audience's attention to those moments to make sure they do not miss them.

The Color Purple

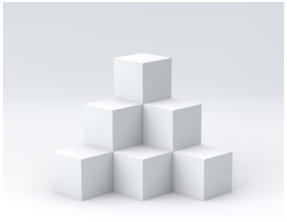
When we refer to visibility, we are talking about being able to see the actors' faces, especially, their eyes.

Any light that we use on stage will lead to a certain degree of visibility, but in the context of our main objectives, being able to see the actor's face is what is important.

Ensuring that there is sufficient front light is essential in achieving this objective. Of course, it is not essential that you see all the faces all of the time – there may well be moments when you want to close the scene down and create dramatic effects where people are intentionally placed in shadows and silhouettes are created, but these moments should be used sparingly and created thoughtfully.

## Revelation of form

It is not enough to simply "light the stage." While visibility is important, we must ensure that we make the actors (and scenery and costumes) look as good as they possibly can. With well-designed lighting, we can make them look even better than they actually are! Revelation of form basically means "introducing shadow." By introducing shadow, we create three-dimensional objects on stage.



Shadow creates three-dimensional objects.

Without shadow, things can look very flat and two-dimensional on stage. The shadows you introduce do not have to be black – by adding color to them, you create more visual interest.

Shadows can also help tell a different story. Keeping actors in deliberate shadow can create intrigue and mystery.

Shadowland, Pilobolous
Photo credit: Emmanuel Donny

## Composition

Just as the director or choreographer are creating visual pictures with the actors, the lighting designer is responsible for creating beautiful compositions without compromising on the first two objectives. Most lighting rigs tend to be symmetrical, with evenly spaced lights often mirrored about center. Symmetry tends to be aesthetically pleasing, so by placing your lights carefully it is easier to create pleasing compositions.

It is relatively easy to create striking stage pictures by lighting with bold colors and dazzling beams, or glorious rich sunsets, but we should be careful that we do not sacrifice visibility to achieve them.

City of Angels
Donmar Warehouse, London
Photo credit: Johan Persson

## Mood

Part of the subliminal magic of lighting is setting the mood of a particular moment during a play. Is the scene a happy or sad one? Is it a cheerful sunrise, or a somber afternoon? Simple adjustments to color or intensity can go a long way to help you set the right mood. Warm-toned light tends to suggest happier themes while cool tones tend to support sadder ones.

## Information (Scene Setting)

Lighting design is about telling stories and helping the audience understand the play. Theatre is all about creating "suspended disbelief" and helping the audience buy into the idea that we are not actually in a theatre, but in the world that we are representing on stage. Sometimes, a simple projection of a window (when there isn't actually a window on stage) is a great way to tell the audience where we are.

Lighting can be used to tell the audience about the location and the time of day. Lighting can help suggest:

- Interior spaces
- Exterior spaces
  - Forest
  - City

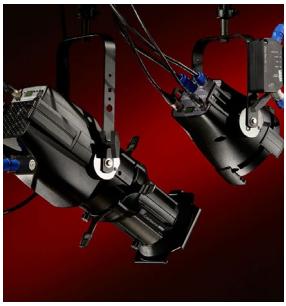
- Time of day
  - Early morning
  - Afternoon
  - Evening
  - Night
- Season

We will discuss these objectives in a little more detail in subsequent chapters. Remember that it may not be possible (or applicable) to achieve all the objectives all the time in all your cues, but they should be your starting point when you are thinking about the lighting for your show.

For more info on lighting design principles, check out ETC's Making the Light Fantastic video series.

The Color Purple

# CHAPTER 3: CONTROLLABLE PROPERTIES OF LIGHT



To achieve our five objectives, we will need to make decisions about what types of lights we will use, where we will rig them, what color they should be, and how bright they will be in each cue. As a medium, light has four properties that we can control. By manipulating these properties you will meet your five objectives and are well on your way to your first successful lighting design.

It does not matter which lights you are using, all of them will give you control, to varying degrees, of the following properties:

- Intensity
- Color
- Distribution (focus)
- Movement

## Intensity

We are all used to changes of intensity in light; we experience them every day. It has always been the primary desire of the lighting designer to control the amount of light on stage. When electric lighting became popular, lights were connected to dimmers as a way of controlling the intensity of the lamps. While the nature of dimming technology has changed over the years, they are still prevalent in our theatres. Lights that use LED technology are still capable of being dimmed, but this is done electronically from within the luminaire.

As lighting designers, we are less concerned about how bright a light is, and more with how bright it *appears* to be. Of course, the actual brightness is a consideration when selecting fixtures for your show, but when you are creating the lighting, you will set the intensity (also known as 'levels') of the light to create the look and feel that you want.

### Intensity and your objectives – Intensity helps you achieve your design objectives:

- **Visibility.** The more light you have on stage, the easier it is to see the action. By simply changing the intensity of the lights on different parts of the stage, it will help guide the audience's attention – our eyes are naturally drawn to the brightest parts of the stage. We should be a little cautious here though – it is possible to create a situation where there is too much light on stage. When this happens, it can be difficult to control your audience's focus. The ability to skillfully balance the intensities of all the lights in your rig is part of what makes a successful designer.

- **Revelation of form.** Some people think that the lighting designer's job is to eliminate shadows. Shadows can add depth and dimension, so it is not necessary to try and eliminate them all. When a light is at a lower intensity, the shadows can be more apparent. At higher intensities, some light may be reflected, and this will start to soften some of the shadows. If you have two lights focused on to your actor, one from each side, and one of the lights is at a lower intensity, then this will help 'shape' the actor and create a three-dimensional shape on stage.

- **Composition.** By varying the intensities of different parts of the stage you can not only guide the audience's focus, but you can create beautiful stage pictures with a brighter light center stage that fades out to the edges, for instance.

- **Mood.** As a general rule, the brighter it is on stage, the happier it will feel – you may have heard the old adage "Bright lights for comedy." Conversely, the darker it is on stage, the more moody and ominous it can start to feel – after all, murder mysteries normally take place "on a dark and stormy night…"

- **Information.** Brighter lighting will imply daylight, or a scene or location that would inherently have more light. Darker lighting will imply night-time or locations that might inherently have less light.

## Color

Theatre is rarely a monochromatic place and color is a powerful tool in the hands of the lighting designer. Color, perhaps more so than any of the other properties, helps you achieve the information, mood and composition objectives. While visibility determines whether or not we can see something, color determines how we see something. Careful color choices can enhance scenery and costumes, create fantasy worlds of swirling color, or conversely reduce the stage to a desolate, colorless place.

When you are choosing colors, try to avoid colors that are too saturated in your front light, unless it is for a special effect. Use tints in the front light and keep your more saturated colors for your back light instead.

Traditionally, before the introduction of LEDs, color was changed by using filters called "gels." Filter manufacturers each have their own range of colors, both in saturates and tints, that you use to create your world on stage. Filter selection used to be an important part of the design process. You would select your colors, cut the filters to the correct sizes and then fit them to the lights . If you wanted to change a color, you would have to cut a new piece of filter, climb a ladder and change the color on the light.

LED technology has made this much simpler: now it's possible to change the color of a light directly from your lighting desk, and you have a virtually limitless color palette to choose from. Even though we use LEDs to change color these days, the same principles of color theory still apply and we will cover this in more detail in the Color section.

American Idiot
Berkley Reperatory Theatre
Photo courtesy of mellopix.com

In addition to obvious color choices for suggesting day-time or night-time scenes, different colors can have different meanings and this is sometimes the motivation for our color choice. Sometimes, our choice of color is more subliminal – if we want to manipulate the audience's response to what is happening on stage, we can choose colors that have psychological or symbolic meaning instead.

| Color | White | Blue | Red | Green | Yellow | Amber | Purple | Pink |
|---|---|---|---|---|---|---|---|---|
| References and meanings | Purity, revelation | Sadness, loneliness, romance | Anger, passion, blood | Wickedness, unnatural | Warming, calming | Comfort | Sense of opulence | Love, romance |
| Uses | Daylight | Moonlight, night time | Strong effects | Forest & leafy scenes, evil characters | Sunlight, strong effects | Interior scenes, firelight | Effects, romance | Effect and mood |

By combining the color meanings above with the knowledge of how color can enhance scenery and actors' appearances, you are armed with a powerful tool to help convey mood and information.

It is worth remembering that different colors can have different meanings to people around the world.

**Color and your objectives – While color will mainly assist in achieving mood, composition and information, it can help with your other objectives too.**

- **Visibility.** Color can play an important role in helping with visibility. Darker, more saturated colors will make it more difficult for the audience to see what is happening on stage. Also, the darker the color (especially when using gels), the more intensity you need to achieve similar light levels.

- **Revelation of form.** Adding color into the shadows can add an extra level of dimension and depth to the stage. Similar to intensity, two lights focused to the same actor in different colors will help sculpt them and make them appear more three-dimensional.

- **Composition.** We are drawn to colors that "belong" together. We will typically choose a palette of colors that complement each other as this creates pleasing pictures on stage.

- **Mood.** The mood of the scene is largely dictated by the color choices you make. Generally speaking, warmer-toned colors (ambers, pinks, yellows, and certain lavenders) will create a happier mood on stage. Cooler-toned colors (blues, greens, and certain lavenders) will lead to a sadder or more sombre feel on stage.

- **Information.** Color can tell a story and set the location and time of day. For example, if you wanted to create the effect that the actors are sitting in front of a fireplace, you would choose warm ambers and yellows to emulate the color of the flames.

## Distribution

Floodlights

PARs

Fresnels

Profiles

This refers to both the types of lights you have chosen and the way in which they are focused – in other words, how the light will be distributed on the stage. You may want a well-defined pool of light for a monologue, or perhaps you are just looking for an even, general wash of light on stage. Within your show, there are a number of different "looks" or lighting states that you might want to create, and several different kinds of lights that you can use. Each has its own purpose and will give you different results depending on how you decide to use them.

When we talk about distribution, there are three main elements that we are referring to. The first is the type of light you are using, the second is where you choose to position it, and the third is how you choose to focus the luminaire.

Each type of light has its own unique set of characteristics and properties, and as such, has a job that it is best used for. Most lighting instruments will fall into one of these categories:

- Floodlights
- PARs
- Fresnels (Focus spots)
- Profiles

We will look at the different types of lights in greater detail in the Types of Lights section (pg 16). When planning your lighting rig, you will need to make some decisions early on about where you are going to position your lights and what types you want in each position. Different positions will give different effects. While, in theory, it is possible to put a light anywhere, there are five positions that are used most often.

- Front light
- Side light
- Back light
- Top light
- Up light

We will look at each of these in more detail in the Lighting Angles section. Use the Throw Distance Calculator (Appendix A) to help determine which lights to use.

## Movement

A change of either a single property of a single light, or all the properties for all the lights is thought of as movement. Movement in this context does not really apply to the physical movement of the light beam (something which has become very popular since moving lights became accessible) but refers to the way in which we transition from one lighting state to the other – so in this instance, movement relates to time.

We can decide whether the change from one cue to another is instantaneous – perhaps someone has entered the stage and flipped on a light switch on the set – or perhaps it is more gradual – a slow change from sunrise to a bright morning light, for instance.

Liola, National Theatre, London
Photo credit: Max Narula

**Movement and your objectives – Movement mainly contributes to the mood and information objectives, but does affect the other objectives too.**

- **Visibility.** Too many rapid changes of light can tire the audience's eyes leading to visual fatigue which may make it harder for them to focus on the action. During slow cross-fades, there may be a point at the lower portions of the intensity spectrum where there is not enough light to be able to see properly.

- **Revelation of form.** Transitions have a minimal effect on the appearance of objects on stage, although a fade from a front light to a side light would introduce more shadow, making the lighting more dramatic.

- **Composition.** While transitions rarely have an effect on the appearance of objects on stage, sometimes you may want to reveal objects to the audience more slowly and dramatically.

- **Mood.** Rapid light changes could suggest a mood that is more aggressive or passionate and would suggest a sense of pace. Slower changes, like the gradual change from sunrise to morning light, suggest a calmer scene. Similarly, a darkening sky could suggest a sense of foreboding.

- **Information.** Slower changes in the lighting states could suggest that time is passing; a change from afternoon to sunset, perhaps. A more instantaneous change would be expected if an actor turned on a switch and the room lit up.

# CHAPTER 4: TYPES OF LIGHTS

Most stage lights that you are likely to encounter will fall into one of these basic categories (in order of complexity):

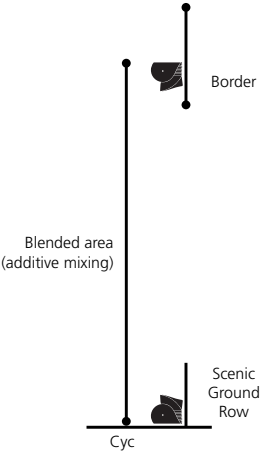
- Floodlight
- PAR
- Fresnel
- Profile
- Moving light

Tungsten Floodlight

## Floodlights

Let's start by looking at the simplest of the fixtures – This, as its name suggests is designed to 'flood an area with light.' They are traditionally used to light cyclorama and painted cloths. Floodlights typically consist of a lamp (light source) and a reflector.

There are no lenses in a tungsten floodlight and you have very little control over the size and shape of the beam. Floodlights are designed with an asymmetrical reflector that allows the light to be evenly distributed from the top of the cloth to the bottom. In conventional lighting rigs, floodlights would be rigged and then filters would be used to make them red, green, and blue. Since most floodlights were 4-cell units, the fourth color would usually be amber, open white, or another blue. (Refer to Appendix B – color mixing). Of course, floodlights do not have to be colored in red, green and blue. You could choose the filters that would suit the production needs best.




Cyc lit from above and below

Cycloramas tend to be lit from both above and below and, depending on the type of material used, they can also be lit from behind. Back-lighting a cyclorama, known as a BP or RP (back/rear projection) screen means that you do not have to worry about trying to conceal the light sources. Lighting from both above and below can create some interesting effects and

is one of the methods employed when creating the illusion of a sunrise or sunset.

LED floodlights are slightly more complex than traditional floodlights in that they do have a lens which has been specially designed to spread the light in a similar fashion, but their purpose and application is the same.

ColorSource CYC

## PARs

PARs (PARcans) have been a staple of stage lighting for years. PAR is an abbreviation for Parabolic Aluminized Reflector and and is a reference to the type of lamp used. A PAR is a lamp that has the lens, reflector, and light source in a single sealed-beam housing. PARs produce very intense beams of light that are slightly oval. Because the lamps also contain the lens and reflector, the only way to change the size of the beam is to replace the entire lamp – which can be costly. Appendix C has more information about the different kinds of PAR lamps available. PARs can be used as part of a general cover* as they provide bright washes of light when focused correctly. PARs can be focused by adjusting their position (pan & tilt) and you have a degree of control over the beam by rotating the lamp to adjust the orientation of the oval-shaped beam. PARs can be colored using gels.

Traditional PARcan

ETC has its own version of the PAR called the Source Four PAR – this is a single luminaire with a set of interchangeable lenses making it much easier and more affordable to adjust the size of the beam.

Source Four PAR (tungsten)

LED PARs have started to replace PAR because they can change color without the need for gels and are safer to use as they do not get hot. You can still change the beam shape and size by using specially designed lenses which are fitted to the front of the fixtures.

ColorSource PAR (LED)

## Fresnel

Pronounced "Fre'nel," these are the first types of light that offer us some degree of control over the size and shape of the beam. Fresnels get their name from the inventor of the lens that

*General cover – even illumination of the stage, see page 50.*

Source Four Fresnel

they use (which were originally designed for use in lighthouses), easily recognizable by the series of concentric rings on the front of the lens. A Fresnel has the capability to adjust the size of the beam from a narrow spot to a wide flood (typically 10° - 55°), making it a versatile fixture that can be used for both general cover as well as for isolating parts of the stage or highlighting certain elements during the show (known as a 'special').

A Fresnel beam has a very soft edge which makes it easy to blend when creating your general cover and stage washes. You also have the option of adding a 'barn door' – an accessory that fits to the front of the light (in front of the color) and allows you to shape the light and prevent it from spilling in areas where you do not want it.

Desire Fresnel

With a tungsten Fresnel, the lens is in a fixed position and the lamp and reflector move together to adjust the beam size. The closer the lamp is to the lens, the wider the light, and the further away from the lens the narrower the beam of light becomes.

The Fresnel has a European cousin called a "PC." A PC has a Plano-convex lens (hence its name) and operates in a similar fashion. A PC has a more defined edge than a Fresnel, a wider zoom range (6°-60°) and the beam can also be roughly shaped using barndoors.

## Profile (Ellipsoidal Spot)

Source Four LED

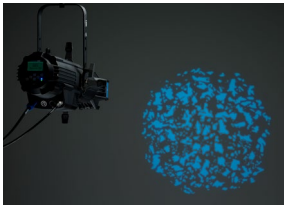
A profile is named for its ability to project a profile of an image or shape. Profiles (also referred to as 'ellipsoidals') are the most complex fixtures optically, but also offer you the most control over the light that they emit. Profiles can project a beam of light that can be either hard- or soft-edged. You can also adjust the size of the beam, either by adjusting the lenses or by using an iris, and you can shape the beam using an internal set of framing shutters. Profiles can also project patterns and add texture to the beam by using a gobo.

There are two main kinds of profiles – 'fixed beam' and 'zoom' profiles. Fixed beam profiles have a beam angle that is predetermined by the lens system. You can change the edge of the beam (hard or soft) but if you want to adjust the size of the beam you will need an accessory called an iris. There are

a number of fixed beam profiles available, the most common being 19°, 26°, 36°, and 50°. You can also get 5°, 10°, 14°, 70°, and 90° variants. (Appendix A)

Zoom profiles make use of a pair of independently controlled lenses and by adjusting these, you can change the size of the beam from a narrow spot to a wide beam. The amount of adjustment that you have depends on the beam angle of the fixture, but typically you will find there are both 'narrow zoom' and 'wide zoom' options. A 'narrow' zoom will allow for adjustment of the beam from 15° to 30° and a wide zoom will allow for a variation from 25° to 50°. You can make further adjustments to the size of the beam using an iris in a zoom profile, too.

Source Four LED 25°-50° Zoom



Profiles have a set of four framing shutters that allow for precise shaping of the beam. You can also make use of a gobo to project a pattern (like a window) or just to add a break-up texture to the beam (like a leaf pattern) which can add an additional layer and dimension to your design.

## Followspots

A followspot is a profile with a really narrow beam angle that is typically focused to produce a hard-edged beam of light used to follow an actor on the stage. You can use a 5° or 10° Source Four with an iris as a followspot too!

## Moving lights

It is not uncommon to find moving lights in our theatres and lighting rigs. There are two categories of moving lights – "spots" and "washes." Spots behave like profiles and as such would fall into this main category. A moving spot allows you to change color, use gobos, adjust the size and edge of the beam, and some even offer a set of framing shutters for precise beam control. A moving wash light behaves more like a Fresnel (or a PAR on the simpler units). A wash light will offer you the ability to change color, adjust the size of the beam and have a Fresnel-like soft edge. Both washes and spots allow you to control their focus (position) on stage – all of these features can be controlled remotely from the lighting desk.

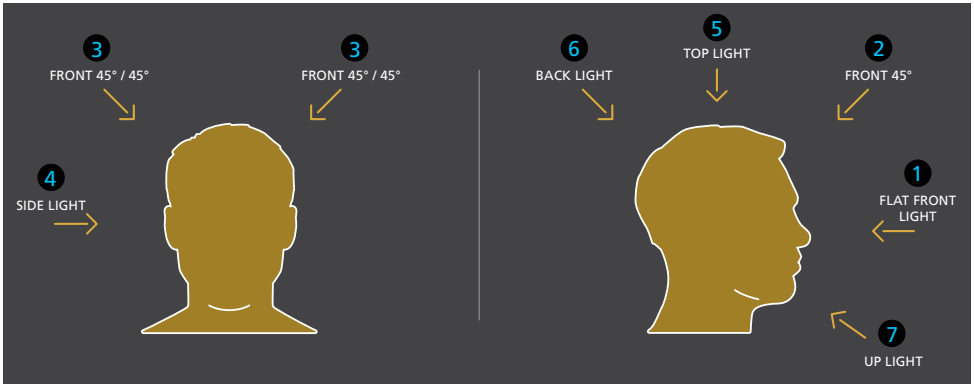
# CHAPTER 5: LIGHTING ANGLES

## Lighting Angles

Understanding the different kinds of lights that are available is only part of the process. Once you know what lights you have available, you need to decide where to position them in the lighting rig. We refer to the positions that we hang lights in as the 'lighting angles' and there are five basic lighting angles that you are most likely to use in your show. The lighting angles refer to the light's positions relative to the actor.

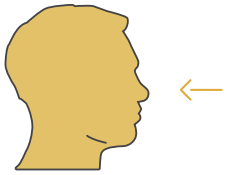
- Front light
- Back light
- Side light
- Top light
- Up light

Since visibility is our primary objective, we will start by looking at the angles that offer the best visibility and then start to look at how variations on the position of the light introduce shadow and how that achieves the other objectives. There are a few variations on 'front light' each giving slightly different results.



## 1. Flat Front Light

This is light that is placed directly in front of the performer at eye-level (or as close to as possible). This angle is rarely used for face-lighting. In most theatres, lights that are rigged on the balcony or circle rail would fall into this category.



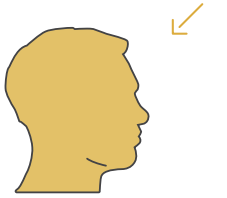
**Advantages:**
This angle offers good visibility as there are no, or minimal, shadows on the actor's face. If actors are wearing hats, it can be helpful in getting light under the brims of the hats, eliminating strong shadows on the face. It is an optimal position when using projections as there will be minimal image distortion.

**Disadvantages:**
When lighting from this position, it is almost impossible to prevent the huge shadows of the actors being cast on the set or the background which will be very hard to get rid of. When actors or objects are lit directly from the front, they can appear flat and two-dimensional. This is also a lighting position that is not always available in all theatres – it is usually only available in theatres that have balcony seating.

Because the large shadows cast by the actors will be very hard to get rid of, we want to try and avoid creating them at all, so we tend to elevate the lighting position in an effort to minimize the shadow cast by the actor. The greater the angle of elevation, the smaller the shadow cast by the actor becomes.

## 2. Front 45°

Since most theatres may not have a lighting position that would provide the 'flat front' position, and seeing as it would result in harsh shadows, the majority of front- or face-light in theatres comes from a slightly more elevated position. By lifting the lights up to an angle of approximately 45° above the eye line of the actor, we are able to achieve a light that offers good visibility while offering a reasonable containment of the shadow that the actor is casting behind them.



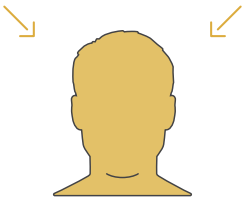
This angle also more closely resembles the light that is cast by the sun, so it looks quite natural on stage. By lifting the light up, we start to introduce some natural shadow on the actor's face; slightly under the nose and chin. We know that shadow is what

contributes to the *revelation of form* objective, so this actually works in our favor.

This is the most common lighting position in proscenium arch theatres. These are the lighting positions in the auditorium and are sometimes referred to as FOH (Front-of-house) bridges. It is an optimal lighting angle for front light, and where possible, we try to achieve this position irrespective of the stage or theatre layout.

**Advantages:**
As this is a lighting position that is readily available in most theatres, it is easy to access and will provide good front light coverage. It offers good visibility and due to the small amounts of shadow that it introduces to the face, it also helps to shape the face, so we are starting to achieve our 'revelation of form' objective. By hanging the light in an elevated position, we have also reduced the shadow behind the actor and this is now contained to the stage floor, which is easier to manage and looks more natural.

**Disadvantages:**
Even though we have introduced some shadow, it is possible that the actors might still appear a little 'flat' on stage.



### 3. Front 45° / 45°

Whenever it is possible (depending on available equipment and rigging positions) we tend to elevate the light to a 45° angle and we also offset it by 45° to the side. This position is then mirrored so that we have a matching light from the other side – in other words, we are lighting our actor from two sides at the same time – something known as the FRONT 45-45 which is based on a lighting principle developed by Stanley McCandless (first published in 1932). Typically, one light is colored as a "warm" (pale amber) and the other as a "cold" (pale blue).

The same FOH lighting positions are used here that you would use for the single Front 45 approach.

The 45° elevation offers good visibility. By moving the light 45° off its axis, you are introducing more shadow on the face, so the *revelation of form* objective is also achieved by this position.

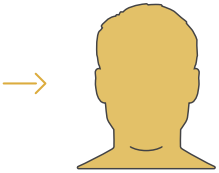
**Advantages:**
This system is favored when lighting plays, where visibility and the ability to see the actors' faces clearly is essential. The 45° angles offer great visibility and the two different color tones shape and mold the face, providing good revelation of form too.

**Disadvantages:**
It is possible that there may still be some unwanted shadows cast on the scenery, particularly upstage. It also may not always be possible to achieve the 45° offset for all units from the FOH bridges as this would require the bridges to be wider than the auditorium.

Lighting design is not just about visibility. It is also the responsibility of the lighting designer to make sure that the actors (and scenery and costumes) look as good as they can (or even better than they actually are!) and, that they appear to exist as three-dimensional objects in a space.

Front light offers us good visibility, so let's look at some lighting angles that focus more on the 'revelation of form' objective.

## 4. Side Light



Because it only lights one side of the performer, casting the other into full shadow, side lighting has wonderful sculpting and molding properties and as such, is the favored angle when lighting dance.

Side lighting is usually rigged on booms, or "trees," in the wings on the side of the stage, and it is not uncommon to have multiple fixtures in each location. It is also possible for side lighting to be rigged on a floor stand and these are affectionately known as "shin-busters" (or just "shins") – just ask any dancer who has ever run off into the wings!

Usually, profiles (ellipsoidals) will be the light of choice for side lighting, as you have the most control of the light. By using the internal shutters you can cut the light off the floor completely to create a "floating effect." You are not limited to the use of profiles in this position, you can also use Fresnels or PARs, but you sacrifice some degree of control over the beam quality. LED

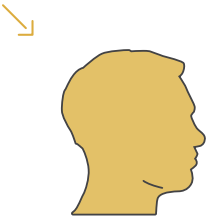
By rigging a light at the very ends of the lighting bar (called a 'pipe-end') and focusing them across the stage, you can achieve the side light effect, but your actors will not cast shadows on each other.

battens like the ColorSource Linear, when rigged vertically, are also very effective as side lights.

**Advantages:**
While this angle offers a degree of visibility, its primary advantage is its sculpting properties. Side light creates strong shadows and this high contrast gives perfomers or scenic objects a real three-dimensionality, enhancing their form. Shadows from side light, when rigged on booms, falls into the wings on the opposite side of the stage, so you do not have to be as concerned about shadows falling on the scenery.

**Disadvantages:**
If your only source of light is side light, you may run the risk of the performers casting shadows on each other, when they are standing in front of the light. It is rare that a single side light will be your only source of light on stage, so the overlap from the other beams of light will help to alleviate this problem to an extent.

## 5. Back Light



Lighting actors from behind is one of the most effective ways to ensure that they appear as three-dimensional objects on stage and do not blend in to the background. Back light creates a halo effect around their head and shoulders which gives them form, shape, and separates them from the scenery. Back light helps create depth on stage.

Another of our objectives is *mood* – back light is a wonderful tool for creating mood onstage. You are able to introduce more saturated color into the back light as this will not have an impact on skin tones. Also, the principle of 'angle of incidence equals angle of reflection', means that it is the back light color that the audience will perceive, as this light is reflecting directly from the stage to the audience, so changes in the back light color are noticeable and a great way to change the mood of the scene.

Back light is usually rigged on the overhead lighting bars, and where possible, is positioned so that it is approximately 45° behind the actors so that it is a mirror of the front light position. Of course, in practice, this is not always possible as there may be limitations due to the location of the lighting bars or scenery.

**Advantages:**
Back light provides excellent sculpting on stage and should be considered an essential part of any design. Back light can create a sense of depth on stage and is a good way to introduce more saturated color into the lighting design without there being an impact on skin tones. Back light is more readily perceived by the audience as it reflects off the stage floor, so it is a useful way to change the mood on stage. We will look at how color can be used to change mood in the Color section (pg 29) .

**Disadvantages:**
Back light offers little visibility in terms of face light and it is rare that it is used in isolation, although sometimes a striking silhouette is called for. Back light can result in some dramatic shadows on the floor in front of the actors, and care should be taken when focusing to ensure that it does not shine into the eyes of the audience in the first few rows of the theatre.

## 6. Top Light

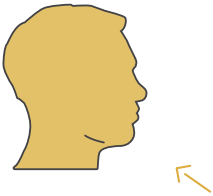
Top light has the advantage of being the most contained when it comes to shadows. With the light directly above the actor, the shadow is cast directly below them, so you don't have to worry about shadows on the set or backcloth. Top light offers similar properties to the back light in that it offers some good sculpting qualities, but it will cast big shadows in the eye sockets and under the nose – making the eyes and mouth difficult to see.

Top light is usually reserved for 'specials' as it is an effective way to isolate someone on stage. When used at high intensities, it can result in shadows on the actor's face that are slightly unnatural and are difficult to get rid of. Saturated color can be used in top light if used carefully and sparingly. When plotted at high intensities, some light will be reflected off the floor and will light up under the actor's chin.

**Advantages:**
Top light provides a contained light with minimal shadows on the stage floor. Depending on the finish of the floor, it sometimes reflects to cast a soft up light on the actor's face. It offers some sculpting properties similar to a back light, but should be used sparingly. If you are lighting a traverse, thrust, or theatre-in-the-round stage, top light tends to replace your back light as a way of introducing more saturated color.

**Disadvantages:**
When used at high intensities, it can cast strong shadows on the face which can be difficult to eliminate.

## 7. Up Light



Up light is typically reserved for effects, whereas in the days of gas lighting, it was the primary angle used as the gas lamps would be found along the front edge of the stage and would up-light the actors. This angle is not common these days, and when used in this position, is referred to as 'foot lights' or simply 'foots.'

The light cast by an up light does not look natural at all – this is because we are used to our light sources typically coming from above – think of the sun or the lights in the ceilings of our homes or offices. Light from above is something we have become accustomed to, so when it comes from below, it looks unnatural and almost scary – I am sure we have all scared our little brothers and sisters by holding a torch under our chins and leaping out of the dark!

Up lights are typically found along the front edge of the stage. Some stages may have special slots in the stage floor to accommodate foot lights, and sometimes it is up to the set designer to incorporate a space for them in the set design. It is not uncommon for the lights to be secured to the front edge of the stage where they are visible to the audience. Footlights tend to be smaller fixtures as they need to be able to fit into small spaces and not block the audience's view of the stage. Battens like the ColorSource Linear can also be used as footlights. Not all up lights have to be placed on the front of the stage. Any position that will result in the actor being lit from below is considered to be an up light.

You may be wondering "if this looks so unnatural, why would I use it?" There are a couple of instances where up light can be really effective. If your actors are wearing wide brimmed hats, then using some up lights at a low intensity is another way of eliminating shadows on their faces cast by the hats. Thinking about our objectives, *information*, and creating suspended disbelief, is one that we are also working towards. Let's imagine that you are lighting a scene that is taking place around a camp

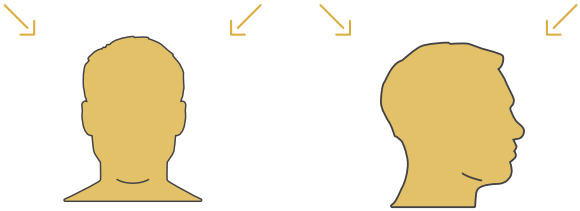
fire – by using footlights you are recreating the effect of the flames from the fire by lighting faces from below – add an amber filter and a flicker effect and you have achieved a realistic effect of someone sitting beside the fire!

**Advantages:**
Up light is often used to create dramatic effects and can be helpful when you deliberately want to cast shadows on the background. It is a useful angle when creating firelight effects on stage. When used at low intensity, it can be helpful in removing shadows on actors faces caused by wearing hats.

**Disadvantages:**
Up light can look very unnatural when used in isolation or at high intensities and will result in large shadows being cast on the background which, if not intentional, can be very difficult to eliminate.

The lighting angles listed above are not exhaustive, but form the basis of any lighting rig. There can be variations on the angles depending on the requirements of the show, the design of the set, and the limitations of available rigging positions in the theatre. It is also possible to combine some of the angles to create alternatives – for instance, it is possible to move the back light to a 45° off center (as we do for our front lights) – resulting in a diagonal back light – an angle which is popular when lighting dance. We have already talked about side lights which are rigged on the ends of the lighting bars – this is effectively making them a 45° side light and is called a pipe-end.

Below is an example of combinations of lighting angles as you might expect to find them on stage.



**Distribution and the objectives – Carefully choosing your light, its place and its focus, you can make sure that you have covered the visibility, revelation of form, and information objectives. By adding color you can start to cover the mood and composition objectives as well.**

- **Visibility.** Ensuring that you have a good front-light coverage of the stage is the key to being able to see the actors. Front-light (flat front, front 45 or front 45-45) and side light are good choices here. Using lights that offer precise beam control is also helpful. Profiles (ellipsoidals) are typically used for this purpose, although it is not uncommon to use Fresnels too.

- **Revelation of form.** Careful placement of the FOH lighting can help achieve this, but it is usually also accomplished with back light, side light, and top light. Depending on the area you need to cover, you can use profiles, Fresnels, or PARs.

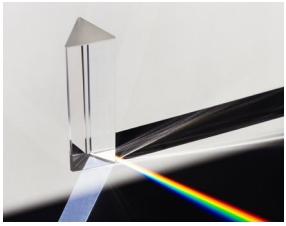
- **Mood.** Although mood is largely achieved through use of color and intensity, the types of lights and how they are focused will also have an effect. Steeper angles with more dramatic shadows will portray a different mood to those with softer, more evenly illuminated areas. Similarly, tighter areas of light will have a different feel to broader more open areas.

- **Information.** The choice of instrument and its focus can contribute to the setting of the scene. If you want to introduce any form of projected image, a profile will be the only choice. The angle that the light strikes the stage (or actor) can also convey information. Steeper angles might suggest mid-day sunlight while lower angles might invoke the feel of a sunset. Broader areas of coverage would be more suited to suggesting sunlight, while a more contained light might be used to suggest the pool of light beneath a street lamp, for instance.

- **Composition.** All of the above elements work together to create the overall composition of the lighting state on stage.

# CHAPTER 6: COLOR

Before we start to look at how we use color on stage, we need to take some time and look at how color works.

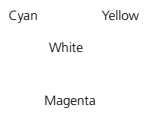


When we talk about color and color theory, we use white light as our base point, and when we think of 'white light' we use noon-day sunlight as our reference point. We have all seen the image of Newton's famous experiment where white light was passed through a prism and it diffracted into the colors of the rainbow.

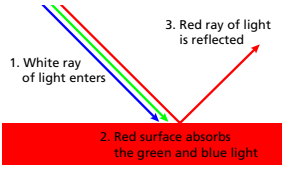
From this experiment, Newton determined that white light is made up of seven basic colors: red, orange, yellow, green, blue, indigo, and violet. These seven colors have been further distilled into three primary colors, namely red, green, and blue.

The primary colors of light are red, green, and blue. You may have already come across this before – your TV screen, computer monitor, and all the screens on your devices use this principle. Some of the more basic LED luminaires also use this color model. The reason we refer to these colors (often written simply as RGB) as the primary colors of light is because, if we mix these three colors together, they form white light.

If we mix any two of the primary colors together, we will get a new color – and this is called a secondary color. If we mix red and green light, the result is yellow. Mix red and blue, the result is magenta. Mix green and blue light and the resulting color is cyan. Cyan, yellow, and magenta are the secondary colors of light and are often expressed as CMY.




A unique relationship exists between the primary and secondary colors. The primary colors of light are the secondary colors of pigment, and vice versa. If you think about the ink cartridges in your ink-jet printer, they use cyan, yellow and magenta as the basis for their mixing system. Similarly, mixing two of these primary colors together creates a secondary color. For instance, mix yellow and magenta and the result is red.




Knowing that white light is in fact made up of several different colors, let's examine how our eyes see color. We have already learned that our eyes only see the light that an object is reflecting back towards us. So, let's take a red dress and shine white light at it. What is happening? The dress is absorbing the blue and green portions of the light and is only reflecting the red light back to us, so the dress appears to be red. If we shine white light at a green dress, it will absorb the red and blue portions of the spectrum and only reflect the green light back to us. If, on the other hand, we shine green light at the red dress, the dress will absorb all the green portion of the light, and because there is no red light to reflect, it reflects no light, so appears to be black.

To illustrate the above concept, take a piece of red lighting filter (called "gel") and look at the dresses on the left. Notice how they change? Now do the same with a piece of green gel.

## Color mixing

When we talk about 'color mixing,' there are two types of mixing that we refer to – Additive and Subtractive color mixing.

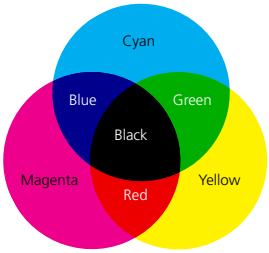

Primary and secondary colors in a color wheel.

**Additive color mixing** – this occurs when you have more than one light, each in a different color, focused onto the same area. This is most prevalent on cyclorama lighting where you traditionally have floodlights in red, green and blue (or a different combination of colors) and you use these to mix the different colors on the back cloth. LED fixtures also use additive color mixing – typically based on the RGB color model. Even though all three colors are housed within one luminaire, it is still additive color mixing at play as you are able to control the three colors separately. We call it additive mixing because as you mix new colors each new color is less saturated than the original colors – in other words, you are working towards achieving white light.


Additive color mixing

In reality these days, most LED luminaires have more than just RGB sources as the base of their mixing system, some manufacturers add a white LED, others use different colors and some of the luminaires made by ETC use eight different colors in the mixing system – but irrespective of the number of colored emitters, it is still additive color mixing.

**Subtractive color mixing** – this occurs when you have one light source and you add more than one color filter in front of it. It is called subtractive mixing because each new color will be more saturated than the original – in other words, you are working towards black. You are most likely to encounter this type of color mixing system in moving lights (that use a white light engine) or if you want to mix your own new color by adding two pieces of filter together.



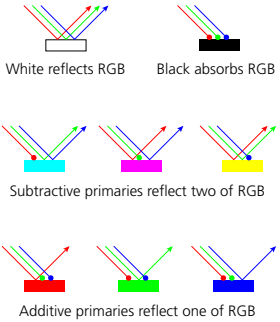
Subtractive color mixing

The Sola Family fixtures from High End Systems use a subtractive mixing model.

Additive color mixing uses the RGB system as a base and subtractive color mixing uses the CMY system.

When we think of additive color mixing, we think of using the primary RGB system, but in reality there are usually more than just those three colors used in an LED fixture. The ColorSource range of fixtures from ETC uses RGBL (Red, Green, Blue, and Lime) as the base. Other fixtures might substitute the Lime for White (RGBW) or even Amber (RGBA), but there will always need to be at least red, green and blue present in the color mix system if you are going to be able to mix your favorite colors!

**Reflection and absorbtion**



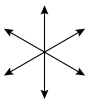

Now that you understand the basic principle of color mixing, let's take another look at our red dress example. If we shine Yellow light at the red dress, what color do you think it will appear? The answer is RED. Yellow light is made up of red and green, so the dress absorbs all the green and only reflects the red light back, appearing red.

If we have a green dress and we shine cyan light at it – what color do you think it will appear to be? Green, of course! Cyan is made up of green and blue light, so the dress absorbs all the blue light an only reflects the green light back to us.

To illustrate the above concept, take a piece of yellow gel and look at both dresses. Notice how they change? Now do the same with a piece of cyan gel.

## Complementary colors

When we speak of color, we tend to talk about primary, secondary and complementary colors. Complementary colors are colors which are opposite each other on the color wheel that, when mixed together additively, form white light.


Complementary colors on the color wheel

Cyan
(Blue + Green)

Green

Yellow
(Red + Green)

Complementary colors mix to create white light.

Red and Cyan are complementary colors – if we mix red and cyan together additively, we will get white light. Why? Well, cyan is already a mixture of green and blue light – so by mixing red and cyan, we are in fact mixing red, green and blue together – so we end up with white light. Other complementary colors are:

Blue and Yellow: blue + yellow (red & green) = white

Green and Magenta: green + magenta (red & blue) = white

We can change the color of light in two ways, by either adding a filter (or 'gel') to the light, or by using the LEDs built into the light to mix colors additively.

Gels change the color of the light by absorbing the portions of the spectrum that are not wanted and only allowing the color we want to transmit through the filter. If we use a red filter, the filer will absorb the green and blue portions of the light and only allow the red light to pass through.

LEDs change color by varying the intensity of the red, green and blue emitters within the light.

**Color and your objectives – Like intensity, careful use of color can also help you achieve your five objectives.**

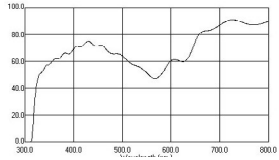
- **Visibility.** Paler colors will aid in visibility and make skin tones appear more natural. Darker colors emit less light, so the darker the colors you use, the less light there will be on stage. Remember the principles of reflection and absorption – darker colors will also reflect less light
- **Revelation of form.** Using color to fill in your shadows is a great way to create depth and make things look wonderful.
- **Composition.** Using colors that complement each other will create pleasing looks on stage.
- **Mood.** Color is a wonderful way to help convey mood and emotion to the audience.
- **Information.** We use color to help tell us time of day and location –perhaps a dark blue to suggest night time, or a pale gold to suggest the rising sun.

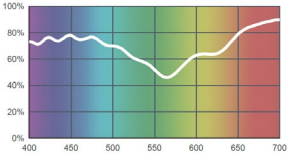
## Selecting colors

One could argue that the introduction of LED technology has actually made the process of selecting colors for your show more difficult. While it is physically easier to select and change colors from the lighting desk, it is much harder to test colors in advance.

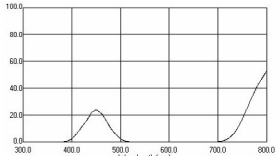
When using gels to add color to your rig, you could use the swatch book from your favorite filter manufacturer and hold it up and look at the set model or costume swatches to see the result. This method does not really work when using LED. Let's start by looking at color filters and then we will look at how our method changes when working with LEDs.

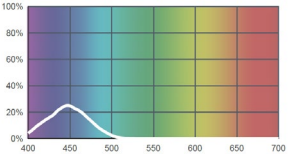
When looking at your filter swatch book, you will see that for every color swatch, there is a transmission curve graph. These can be really helpful when selecting colors for your show. The graph shows you the amount of color that each gel will transmit. The numbers on the X-axis represent the color in wavelength (based on the electromagnetic spectrum) and the Y-axis is the percentage of that color transmitted by the filter.




**Pale lavender**
A pale lavender has good transmission in the blue and red portions of the spectrum and less so in the green and yellow portions. Therefore, blues and reds would render well, while the greens and yellows, less so.



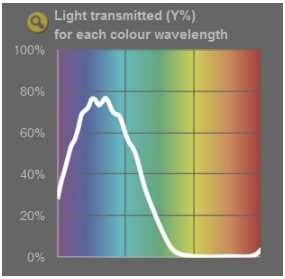




**Deep blue**
A deep blue, which allows zero transmission of the yellow and red portions of the spectrum will cause these colors to render poorly and almost appear black on stage.

By reading these graphs, we can quickly determine whether a particular filter will work for the show. If the set and costumes have a blue bias, then using colors that have low amounts of blue in them will render them looking dull and lifeless. Conversely, colors that have a high blue content will make them come alive on stage.

Another method would be to use a torch and shine the light through the filter at the set model or costume fabric. The pitfall here is that you need to make sure that the torch you are using

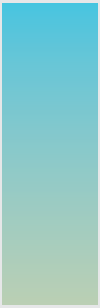
is the same color as the lights you will be using in the theatre. Most LED torches use a cool white LED, so the colors will not render accurately if you are using tungsten sources in the theatre. Tungsten light is much warmer, and this will affect the color the filter produces.




If you are using tungsten lights in your design, you need to keep in mind when a tungsten light dims, it gets warmer, or more orange. This change in the color of the light (referred to as "color temperature") will have an impact on the colors you choose. For example, if you select a blue filter that has a high green content, when the light dims, the light will shift from blue to green. This is known as "amber drift" or "red shift." This change in color temperature can result in some unexpected changes, so giving some thought to what might happen to the color as it dims is important.

When working with LED sources, the problem caused by amber drift can be avoided. When LED dims, it does not, by default, change color or get warmer. This means that you can maintain your selected color throughout the dimming cycle which means there will be no big color surprises as your lights fade out at the end of the scene. Some LED luminaires (like the ETC Source Four Series 2 Lustr) have a function called "red shift" which deliberately introduces this color shift into the light as it dims. If you want to emulate the effect of a tungsten light when it fades using LED, then you can turn this feature on in the fixture menu.

### Tungsten dimming

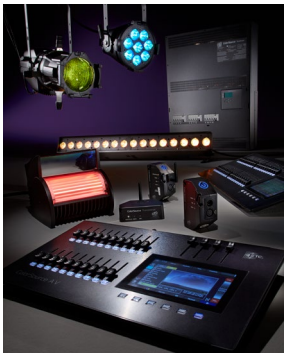



As the light dims, the color temperature lowers, making the light warmer, or more amber. This amber light interacts with the filter to change the color from a bright blue to a murky green.

While it is not as easy to test colors in the model box when using LED, it is much easier to change colors while you are programming. Most consoles have color libraries built in and changing the color is as easy as scrolling through the library and choosing the color you want.

While you are finding your way in lighting design, don't be afraid to experiment with color – it's the best way to learn and find out what works and what doesn't. Using your knowledge of how color works will get you started. Using your keen eye and sense of good taste will do the rest.

# CHAPTER 7: LIGHTING SYSTEMS



Now that we understand the objectives of lighting design and have a good grasp on the properties that we can control to help achieve this, let's look at the various components that make up a lighting system.

A lighting system will generally consist of a number of fixtures (rigged in different places in the theatre space), dimmers and power distribution, a cable infrastructure, and a lighting control desk.

Your theatre might have a combination of tungsten stage lights and LED fixtures. In order to control the intensity of the tungsten lamps, they will need to be plugged in to a dimmer, which is in turn connected to the lighting desk. Let's take a look at each individual component in the system.

## The lighting console


Sometimes simply referred to as the lighting desk, or lighting board, this is a key component of the lighting system. Most modern consoles have a digital interface that you use to program the lighting, but some will still have some faders for manual control of the lights.

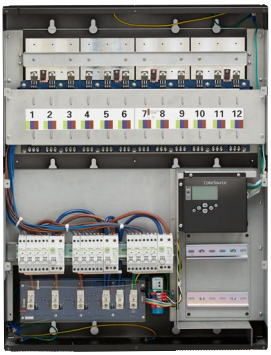
Each console will behave slightly differently, but all should have the same basic functionality. You will be able to select the lights you want to use, set their intensity, change their color (if they have the ability) and record the state you have created. Each new lighting state is called a "cue." When you are recording each cue, you will also need to set the cross-fade time – the time it will take for the change to happen from one cue to the next.

On most consoles, each light is called a "channel" and each channel will have its own unique number that you use to select

and control it with. Irrespective of whether you are using faders or a keypad to select the lights, the channel number needs to be assigned first. To assign channel numbers, you need to patch the lights into the console. Patching is the process where you tell the lighting desk which kind of lights are hanging in your rig and which channel numbers you want to use to control them. Each console will have its own unique way of patching, so take some time to read the manual before you get started. We assign channel numbers to the lights as it gives us an easy way to talk to (and about) the rig.

Instead of saying "please can you turn on the third light from the left on the second lighting bar", we can simply say "please turn on Channel 5." the advantage of this system is that you get to choose the numbers you want to use – so think about a numbering system that will make sense to you.

Once all your cues have been created, you will be able to play them back in sequence for your show.


## Dimmers

If you are using tungsten luminaires, you will need to connect the light to a dimmer in order to control the intensity. A dimmer is an electronic device that is used to vary the intensity of a lamp. Dimmers are typically located in a separate room in the theatre and each line of dimming is then wired back to the various lighting positions in the theatre. When you are patching your lights into the console, you are actually patching the dimmers – the light being connected to the dimmers. When you bring up a channel on the lighting desk, you are controlling the dimmer and the dimmer is controlling the intensity of the light. Dimmers work by varying the voltage that is supplied to the lamp. The lower the voltage, the dimmer the light.

## Switched Power

If you are using LEDs (or moving lights if you have them), they will not be connected to a dimmer. LEDs and moving lights should NEVER be connected to a dimmer as this will likely cause damage to the fixture. LEDs  will need to be plugged in to a mains voltage or 'live power' supply. Depending on the types

of lights you are using, and the electrical installation at your theatre, you might encounter different power connectors. If you have LEDs and tungsten lights in your theatre, you will most likely have two different types of lighting sockets that you can plug lights into. We tend to use different power connectors for lights that need to be dimmed and ones that need mains power to prevent from any accidental damage.

Some power control systems can be either a dimmer or a mains power circuit on a per-channel basis. It is worth making sure you know and understand the type of system that is installed in your theatre.

## Data

Once we have rigged the lights and plugged them in to their outlets, we need to also make sure that there is a link between the lighting desk, dimmers, LEDs, and moving lights. We use a dedicated digital data called DMX (or DMX-512A as it is known officially) as the interface between lighting console and lights. A DMX (or "data") cable is used to link the lighting desk to the dimmers (to control intensity) and the LEDs.

In most instances, the DMX connector is a 5-pin XLR connector although some manufacturers will use a 3-pin connector instead.

As the console is the source of the DMX data, the data connection needs to start here. From the console, we usually link to the dimmers first, before linking to the LEDs and moving lights. Most theatre installations will have these links already in place, but it is good to know that they exist in case something goes wrong and you need to do some troubleshooting. If you are adding new lights into the theatre, then you may need to link them into the data network as well as giving them power. In more complex systems, you may have more than one line of DMX. If your console has more than one DMX output, it means that you are capable of controlling bigger lighting systems. Each DMX output is called a "universe" and each universe can control 512 addresses.

In lighting systems where you are using dimmers to control the intensity of the lights, usually the number of the socket you plugged the light into will correspond to the channel number

you will use to control it. You can also use the 'patch' function to change these number allocations. When you are using LEDs (or moving lights) you also need to give each fixture a unique address. This digital address is the lighting desk's way of knowing how to control the particular LED fixture you have connected. With a dimmer, there is only one control parameter – intensity. With an LED fixture, there is more than one control parameter. You can control intensity, but you can also control color and may have a strobe parameter.

When you assign the addresses to the lights, you should be sure to leave a big enough gap between addresses so that none of the control parameters overlap each other as this can cause some problems further down the line.

Most modern consoles are capable of assigning addresses to the fixtures for you, using a feature called RDM (Remote Device Management) – so it is one less thing for you to think about!

Once your fixtures have been rigged and patched, you can 'flash' all the channels to make sure that everything is working. You are now ready to start focusing the lights.

When patching, consider using multiples of ten, rounded up above the number of required addresses. For example, if you need 13 addresses,offset your patch by 20 for each new fixture: 1, 21, 41, 61, etc.

Don't forget to read the manual for your lighting console so that you can be sure to get the most out of it!

## What is "patching"?

Patching is how we connect the lights in our rig to the lighting console. We have already plugged them in to the dimmer or power outlets, and where needed, connected the DMX. Patching is the virtual connection between the instruments and the console. As the size and complexity of the lighting rig increases, there is more and more information that the lighting desk needs to distribute to the units on the rig. Patching is a way of ensuring that you can control the right lights in the right way and ensure that only information intended for a specific instrument is actually delivered to that instrument. It is a way of organizing the lights and channel numbers into a logical system that will be easy to work with and recall. There are two types of patching systems, or methods, that you are likely to come across: Hard- and Soft-patching.

Hard patching is the system in which the luminaires are connected directly to the dimmer outlet (or switched outlet) on the lighting bar.

Soft patching occurs at console level and is a way of telling the console which lights you have rigged and which channel numbers you want to use to control them with.

Patching gives us a way to talk to (via the lighting desk) and talk about (to our colleagues) the lighting rig. If, every time we wanted to use a light we had to say (or type in) "third light from the left on the fourth electrix" it would take ages to get any work done.  So, we allocate a dedicated number to each light on the rig which we call a "channel number" or simply a "channel."

The advantage of doing this is that we get to decide on a numbering system that makes sense to us. You might decide that you want your FOH lighting to be Channels 1 thru 8 and the wash lights to be Channels 101 thru 108 – for no reason other than it makes sense to you!

Patching allows you to do this. A channel number can be either single fixture like a Source Four, or it can be a fixture like an LED or a moving light, or it can even be a number of individual lights that you may want to control together, like your houselights, for instance.

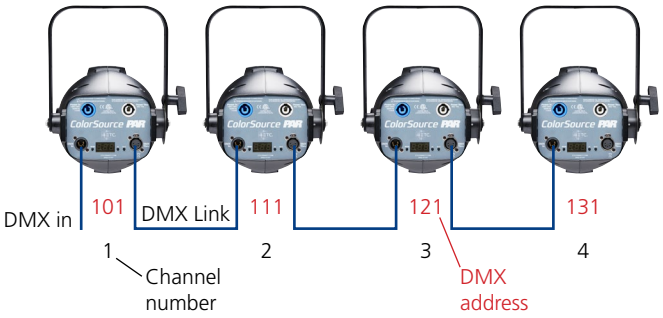
When you are patching conventional (tungsten-based) instruments, one dimmer is typically patched to one channel number. There are some exceptions to this, but that is the general rule, as you probably want to be able to control each light individually. When patching conventionals, the type of light is not important – all you are patching is the dimmer. When patching, we talk of the dimmers as "addresses". Each dimmer is an "address". Dimmer 1 = Address 1, and so on.

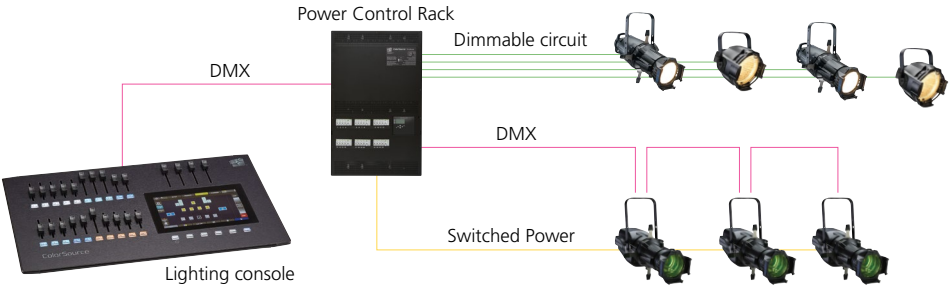
When it comes to controlling LEDs (or moving lights), there is more than one control parameter. With a tungsten source, you are only controlling intensity. With a moving light, you can also control color, position, gobo, and any number of other parameters. Each parameter requires its own address so that the console knows which parameters to send instructions to. All you need to do is determine the STARTING ADDRESS and the fixture and console will work out the rest.

| Parameter | Default Address | Patched Address |
|---|---|---|
| Intensity | 1 | 101 |
| Red | 2 | 102 |
| Green | 3 | 103 |
| Blue | 4 | 104 |
| Lime | 5 | 105 |
| Strobe | 6 | 106 |

Unique DMX address setting

When you are setting the addresses of the fixtures, each light must have its own unique address and they should not overlap. There will be a way to set the address of the fixture on the light itself – the user manual for your lights will guide you through this process.

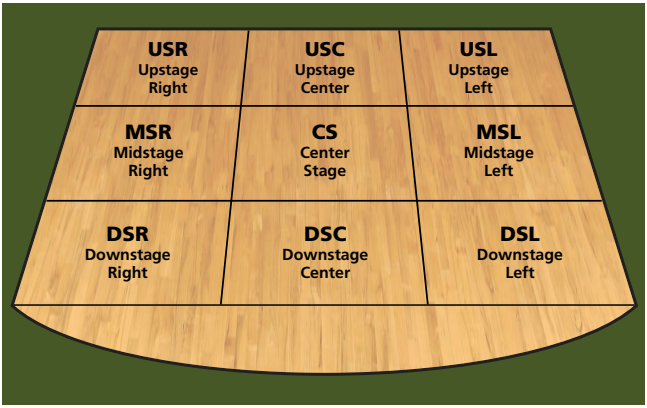


# CHAPTER 8: PLANNING YOUR DESIGN

Theatre is a collaborative process – the relationship between the director, designers, crew and cast is important. Everyone needs to be speaking the same "language" when it comes to the production. It is important to establish a means of referring to the stage so that we all understand where the actors, props and furniture will be placed. One of the ways we do this is to divide the stage into virtual zones called "acting areas." This grid divides the stage into a number of areas that we can refer to consistently so that everyone shares an understanding of direction and placement.

The number of acting areas on the stage will vary depending on the size of the stage, but as a typical rule, they are approximately 3m (10ft) wide zones. The stage is divided both horizontally and vertically and all the zones are names from the actor's point of view, as they are looking at the audience. In European theatres, this convention is reversed, and the parts of the stage are named from the audience's (or director's) point of view. For the purposes of this book, we will be naming the areas as shown in the image below. This is not the only way of referencing the stage positioning, but it is the most common.



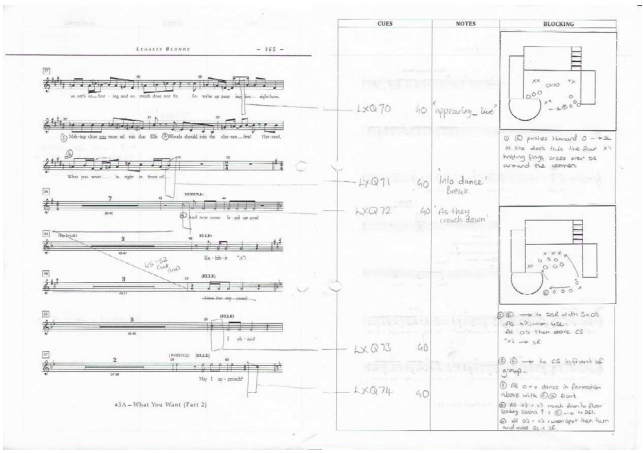
As a general rule, most lighting designs start with the designer reading the script, or in the case of a musical, reading the 'book' and listening to the score. The script is the starting point for you as the designer and will, as the design develops, become the main resource for all your lighting information.

Script reading is a bit like painting a picture – you start with the broad strokes, then you go over it again and add in any specific elements and then you go over it again and add in all the details. It is a good idea to read the script at least three times – the first time is simply to understand the story and learn about the characters, the period and any other 'broad strokes' information that you can glean.

**Top tip!**

Using small Post-It® notes to mark up the script is a quick way to highlight your cues. It also means that you can use different colors for different ideas, and if a cue moves, then you can just move the note.

When you read it for the second time, you can start looking for some of the specific details that might be referred to in the text which will usually be in the stage directions. For instance, the opening stage direction might read: "The lights fade up slowly and we discover Susan sitting at the kitchen table bathed in the early morning sunlight". Based on our objectives, it is a given that we will make sure we can see the actors and that we will do what we can to make them look well-sculpted and three-dimensional. When reading the script, we are looking for clues as to two of our other objectives – mood and information. We are looking for the 'when and the where' as well as the 'how are they feeling.' Remember, sometimes the clues will be in the spoken words by the actors and not in the stage directions – so skimming over the text just looking for the stage directions might mean that you miss some important bits of information!



When you read the script for the third time, you are looking more closely for other references that might offer up some clues about the lighting and that might inform some of the choices you make. Look at metaphor – does the playwright use weather or color to convey meaning? How can you pick up on these themes in your design? You might also start looking at possible blocking notes and mentions of entrances and exits – will these require you to do anything specific?

You do not have to sit down and read the script three times in close succession – in fact, it is probably better if you don't! You may want to meet with the director and other designers after you have read it for the first time to talk about style and period and to get a sense of what the director's vision for the play is – this is all information that will inform and affect how you read the script and what you might be looking for when you read it again. Start to make notes in your script about where you think cues might be placed and make notes about what each cue might do and what the mood of each moment might be. It is a good idea to find some visual references to help remind you of your ideas and make them easier to convey to the director and other designers.

Part of your preparation process should be attending rehearsals. This is where you will get a chance to see the blocking of the play and get a good sense of timings for your cues. You will also be able to clarify any concerns that you may have with the director or stage manager. You should also meet with the other designers (set, costume, and sound) and start to familiarize yourself with their designs too. Pay attention to the set design, study the plans and drawings and be sure to let everyone know if you spot any potential difficulties as soon as possible. There will usually be a model box of the set too and this is a great way to get a really good sense of what the finished set will look like. Make sure that you have seen the costume designs as you want to be certain that any colors you decide to use will be flattering on the fabrics that the costume designer has chosen. It is worth talking to the sound designer too – perhaps they have some elements as a part of the soundscape they are creating that you will need to add to – is there a crack of thunder that might need a flash of lightning to go with it?

Lighting design is the most reactionary of the creative aspects of the show – you tend to make choices based on the decisions that have already been made by the other designers and director. Preparation is essential so that you are not caught by surprise.

Once you have a good understanding of the script and you have attended rehearsals, you will be in a good place to start planning your design in detail. Part of this process is the drawing of the actual lighting plan itself and the creation of all the associated paperwork. The lighting plan is a drawing (usually to scale) that shows the crew exactly which lights are going to be hung in which position. The plan will also carry other information like color choice, channel numbers and any other bits of information that the crew will need in order to be able to install the lighting correctly.

You have read the script. You have met with the director and other designers. Now what? Where do you begin? If you follow the objectives as the basis for your design, this will guide you in the placing of fixtures and selection of colors.

There are generally four elements to a lighting design:

- General cover
- Specials
- Set lighting
- Effects

The priority of these may vary slightly depending on the type of show you are doing, but if you follow this approach you can be sure of covering all your bases.

**Top tip!**

When you are dividing your stage into acting areas, always try and get an odd number of areas from left to right. This way, you will always have a center area and we all know that the majority of important moments on stage happen center stage! This means that if you need to isolate the central area to help focus the audience's attention, then you can do so using your general cover and you may not need to add a special to do this job. If you need help in deciding which lights to use for the best coverage, refer to Appendix A.

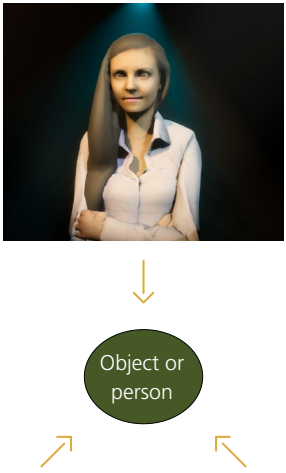
## General cover

You know you need lights for visibility (face light) as well as some that will tick the 'revelation of form' box. A good starting point is to divide the stage into 'acting areas' and make sure that you provide good general cover for these areas. An 'acting area' is typically 3m x 3m (10' x 10'). On your average stage, this will mean that you are able to divide the stage into nine acting areas.

Each acting area should have at least one face light and one back light, but if it is possible, try to get two face lights (front 45/45) and a back light per area. This is known as a '3-point general' and will give you excellent visibility and revelation of form – two of your objectives covered just by getting the general cover right! Remember when you are focusing, that you should allow for a little bit of an overlap between the areas so that you do not have any actors walking through a dark patch or 'dip' in the lighting.

Lights from the FOH bridges will most likely be profiles (like the ColorSource Spot) and the back lights will most likely be PARs or Fresnels like the ColorSource PAR or Desire Fresnel. Using lights from the ColorSource family will ensure that you have full control over the color choices you make so it will be easy to adjust color to suit the mood of the play and you will not have to worry about ordering or cutting any gels.

Once you have placed your general cover, then you can start to add in the specials and any other lights that are over and above what you need for your general. The above process applies mostly to lighting plays. If you are lighting dance, then you would probably favor side light and back light and have less light in the FOH positions.




3-point general:
2 front 45/45 and 1 backlight

## Specials

Now that you have your general cover taken care of, you can start to consider what, if any, specials you may need for your show. Specials are anything that fall outside of the general cover. For example, you may need to have a light focused to a specific place for the final monologue, or perhaps you want a window gobo to suggest time of day. Specials are there to help you tell the story and to take the design to the next level – lighting is about so much more than just a good general wash of light. If there are practicals on the set, then these are also considered to be specials and you should make provision for controlling them in your design. Practicals are lighting elements that the actors interact with – table lamps, chandeliers, wall sconces or other appliances – if it lights up or turns on, then you need to be able to control it!

A special is the theatrical equivalent of a close-up. In film or television, the camera is able to zoom in on what the director wants us to focus on. On stage, we use a special to highlight the actor (or object) that we want the audience to focus on.

## Set lighting

There are times when you will need to allocate some fixtures to specifically light the scenery – perhaps there is an odd shadow that you need to get rid of, or perhaps there is a doorway and you want some light to come streaming through. Once you have your general cover and specials allocated, then you can add in the fixtures that you will need here. It is worth noting that allocating lights for your cyclorama should be thought of as part of your general cover. As you tend to use floodlights or ColorSource Cyc units for this purpose, you can build this into your general cover as these units do not generally have a use outside of this application.

## Effects

These are really the icing on the cake and unless they are specifically called for in the text, tend to be the last things that we add into our design. Smoke, haze, rain, fire, snow, strobes, etc. are all effects and should be used with caution. When you are adding in effects, always be careful that your lighting or effect will not distract the audience from the action that is happening on stage – lighting should always support the action on stage.

# CHAPTER 9: GETTING TECHNICAL

Now that the lighting plan is finished, it is time to start hanging lights and get ready for the show.

Working in theatre can be dangerous if safety isn't everyone's priority. Before you start to rig any lighting, there are several checks that should be completed first for each light that you are going to hang.

- Electrical
- Mechanical
- Optical

## Electrical checks

Before you hang any of the lights, you should inspect each one for electrical safety. It is worth looking into your local legislations as most countries have laws that require that each electrical apparatus is tested for electrical safety and compliance every year (this should be done by a qualified professional) but it is a good habit to do a quick visual check on each unit each time before you use it.

- Check the plug
  - Are there any exposed wires?
  - If it rattles when you shake it, there might be something loose inside – so get it checked
- Check the cable
  - Is the outer sleeve damaged?
  - Are there any exposed wires?
  - Is there any exposed copper?
  - Is the cable properly secured to the fixture?
- Check the lamp holder (in the case of tungsten lights)
  - Are the wires burnt?
  - Are there exposed bits of copper wire?
  - Is the earth cable properly attached?
  - Is the lamp sitting securely in the holder?

## Mechanical checks

It is important to make sure that the light is working properly and that you will be able to focus it the way you want. A quick visual inspection of the following elements will save you lots of time later on:

- Is there a safety cable attached to the light?
- Is the hook clamp fastened securely with the correct bolts, nuts and washers?
- Does the yoke move freely but lock off securely?
- Do the focus mechanisms (lens tube, or lamp adjustment knobs) move freely but lock off securely?
- Are the accessories (barndoors, color frames, shutters, gobo holders, etc.) properly secured and working correctly?

## Optical checks

For lights to perform at their optimum, it is important that the optical systems (lamps, reflectors, lenses) are all clean and working properly. It is worth checking the following points before you hang the light:

- Lenses
  - Are they clean and free of dust and grime?
  - Are they free of cracks or other damage?
- Reflectors (for tungsten lights)
  - Are they clean and free of dust and grime?
  - Are they free of cracks and other damage?
  - Are they secured and aligned properly?
- Lamps (for tungsten lights)
  - Are they clean and free of dust and grime?
  - Are they free of cracks and other damage?
- REMEMBER – if you have to change the lamp, NEVER touch the glass with your fingers. Always use a cloth to handle and replace the lamps. If you do touch the glass accidentally, be sure to wipe it clean with an alcoholic swab to remove any fingerprints and residue.

If something looks wrong, or feels unsafe, do not use it until you have had it inspected by a qualified professional. Once all the safety inspections have taken place, you can start to hang the lights on the bars. When all the lights have been rigged and

plugged in, take some time to "flash out" every circuit to make sure the light is working. Checking as you work will save you time in the long run. You may need to patch the lights into the lighting desk first before you can control them. If your theatre has lighting bars that fly in and out, once you have made sure that everything is rigged correctly and working properly, you can set the "trim" on the bar. This is the height that you want the bar to be at for the show. If there is a set, then it will probably need to be installed before you can start to focus.

The focus session is the time when you get to set all the lights where you want them. There is usually a large team required for the focus session. Typically, there will be one person sitting at the lighting desk to bring up the lights so that they can be focused. There will be a person at the top of the ladder who is doing the focusing, there will be a couple of people at the bottom of the ladder supporting it (always ensure that you are working within the 'safe practice for working at height' guidelines) and the lighting designer who will be giving the instructions to the person who is focusing. When you have set each light where you want it, before moving on to the next light, be sure to give the instruction to "lock it off." This means that all the locking mechanisms should be tightened so that it will not move once you have finished.

Once all the lights have been focused, it is time to start plotting.

The plotting session is the time where you get to build up and program the cues into the lighting desk. This is the time where you set the intensities, select the colors and adjust any of the other parameters that you might have control over to create your cue list based on the notes you have made from reading the script, talking to the director and watching rehearsals. You do not need to have all your cues finished at this stage – but it is a good idea to at least have a rough look for each scene – that way, it will give you a base to build on during the technical rehearsals and will give you a starting point to show the director. While you are building your cues, keep your objectives in mind as this will form the building blocks of your design:

- Start with the lights that will give you the visibility you need (front lights).
- Add the lights that sculpt and give the scene dimension (side or back lights).

- Choose the colors to help support the mood of the scene
- Add in any lights that help impart information about the scene – time of day, location, etc.
- Finally, look at the cue critically and make sure that you have created a beautiful composition.
- You can adjust the timings of the cues in the technical rehearsals, so you do not need to worry too much about this for now.

Even though you are working towards achieving all your objectives, it is not always essential, or even possible, to hit all five objectives in every cue.

Once you have a rough cue list programmed, it is probably time to get the actors on stage and start the technical rehearsals.

Technical rehearsals are when all the technical elements and the actors come together for the first time. You will get to see the costumes under the lighting you have created, you will get to see the set come to life with your lighting layered on top and the actors will get a chance to rehearse with the technical elements of the show. It can usually be a slow process and you may need to make changes to your lighting as you work through the play with the actors and the director.

Once you have worked through the show you will then put it all together and run it through in a dress rehearsal. There will hopefully be some time for notes after the dress rehearsals which is when you make any final adjustments to the lighting design.

All that is left is to invite the audience and have the opening performance!

# Lighting checklist

*Print or copy this page to use as a guide when rigging.*

## Electrical checks

- Check the plug
  - ☐ Are there any exposed wires?
  - ☐ If it rattles when you shake it, there might be something loose inside – so get it checked
- Check the cable
  - ☐ Is the outer sleeve damaged?
  - ☐ Are there any exposed wires?
  - ☐ Is there any exposed copper?
  - ☐ Is the cable properly secured to the fixture?
- Check the lamp holder (in the case of tungsten lights)
  - ☐ Are the wires burnt?
  - ☐ Are there exposed bits of copper wire?
  - ☐ Is the earth cable properly attached?
  - ☐ Is the lamp sitting securely in the holder?

## Mechanical checks

☐ Is there a safety cable attached to the light?
☐ Is the hook clamp fastened securely with the correct bolts, nuts and washers?
☐ Does the yoke move freely but lock off securely?
☐ Do the focus mechanisms (lens tube, or lamp adjustment knobs) move freely but lock off securely?
☐ Are the accessories (barndoors, color frames, shutters, gobo holders, etc.) properly secured and working correctly?

## Optical checks

- Lenses
  - ☐ Are they clean and free of dust and grime?
  - ☐ Are they free of cracks or other damage?
- Reflectors (for tungsten lights)
  - ☐ Are they clean and free of dust and grime?
  - ☐ Are they free of cracks and other damage?
  - ☐ Are they secured and aligned properly?
- Lamps (for tungsten lights)
  - ☐ Are they clean and free of dust and grime?
  - ☐ Are they free of cracks and other damage?
- REMEMBER – if you have to change the lamp, NEVER touch the glass with your fingers. Always use a cloth to handle and replace the lamps. If you do touch the glass accidentally, be sure to wipe it clean with an alcoholic swab to remove any fingerprints and residue.

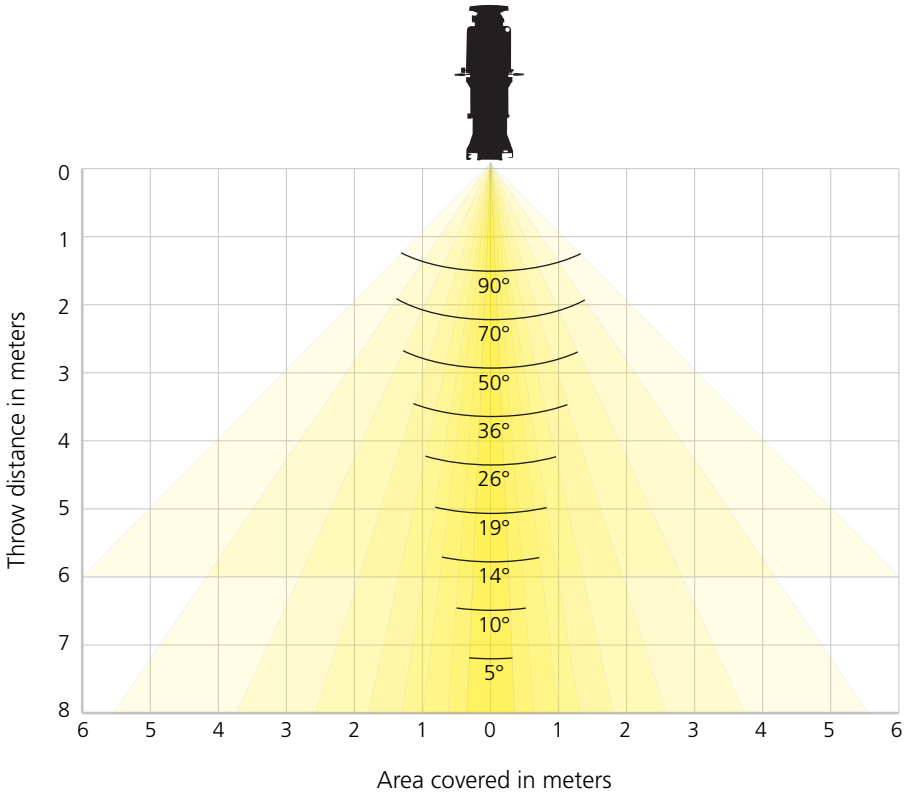
# APPENDIX A

## Beam Spread Calculator

Use this graphic to calculate your beam spread. This will help you to select the right light for the right job and ensure that you get the coverage on stage that you require.

**Top tip!**

If you are using a gobo, this will effectively reduce your spread by one "lens factor" - so if you are using a 36° spot with a gobo, use the 26° reference for calculating your beam angle.



## RGB Color Mixing

| Red | Green | Blue | Color | |
|---|---|---|---|---|
| Full | 35% | Out | Orange | |
| Full | 65% | Out | Amber | |
| Full | Full | Out | Yellow | |
| 65% | Full | Out | Pea green | |
| 35% | Full | Out | Light green | |
| Out | Full | Out | Green | |
| Out | Full | 35% | Deep green | |
| Out | Full | 65% | Peacock | |
| Out | Full | Full | Blue-green | |
| Out | 65% | Full | Light blue | |
| Out | 35% | Full | Mid-blue | |
| Out | Out | Full | Blue | |
| 35% | Out | Full | Violet | |
| 65% | Out | Full | Mauve | |
| Full | Out | Full | Magenta | |
| Full | Out | 65% | Claret | |
| Full | Out | 35% | Scarlet | |
| Full | Out | Out | Red | |
| Full | 50% | 50% | Deep salmon | |
| Full | 75% | 50% | Light salmon | |
| Full | Full | 50% | Warm grey | |
| 75% | Full | 50% | Green tint | |
| 50% | Full | 50% | Pale green | |
| 50% | Full | 75% | Steel grey | |
| 50% | Full | Full | Steel blue | |
| 50% | 75% | Full | Cold white | |
| 50% | 50% | Full | Lavender | |
| 75% | 50% | Full | Pale rose | |
| Full | 50% | Full | Deep rose | |
| Full | 50% | 75% | Pink | |

These values are an estimate – actual values may differ from fixture to fixture.

# APPENDIX C

## PAR Lamps comparison table

The table below is a comparison of beam angles for PAR64 lamps – the lamps most commonly found in PARcans.

| Lamp Type | Lamp Name | Beam Angle |
|---|---|---|
| VNSP (USA) | Very Narrow Spot | 12° x 6° |
| NSP (USA) | Narrow Spot | 14° x 7° |
| MFL (USA) | Medium Flood | 28° x 12° |
| WFL (USA) | Wide Flood | 48° x 24° |
| CP60 (UK) | Very Narrow Spot | 12° x 6° |
| CP61 (UK) | Narrow Spot | 13° x 10° |
| CP62 (UK) | Medium Flood | 25° x 14° |
| EXG (UK) | Wide Flood | 26° x 40° |
| CP95 (UK) | Very Wide Flood | 45° x 70° |

## ETC Source Four PAR lens comparison table

The Source Four PAR is cheaper to use as you do not need to keep a large stock of different lamps. You can change the size of the beam by swapping the lens.

| Lens Type | Lens Name | Beam Angle |
|---|---|---|
| Clear, flat | Clear | 8° |
| Frosted | Very Narrow Spot | 8° |
| Eight rows | Narrow Spot | 10° |
| Ten rows | Medium Flood | 12° x 19° |
| Twelve rows | Wide Flood | 30° x 51° |

Look at these images through a red filter and then a green filter and see how they change color!

# GLOSSARY

**Ampere:** Amps define the rate of electrical current on a circuit. Electrical circuits are defined by their amperage, which in combination with the supply voltage determines how much wattage can be safely connected to that circuit.

**Apron:** A part of the stage that extends in front of the proscenium arch.

**Array:** The term used to describe a collection of LED emitters in a luminaire. The recipe of LED colors in an array defines the type of light that luminaire can produce (the color gamut).

**Back light:** Light shone on a subject from behind, used to push the subject out of the background and define form.

**Backing:** A light that illuminates the area behind a door or window.

**Backstage:** Stage area behind the proscenium and scenery.

**Bar:** A plain bar or internally wired lighting bar (IWB) suspended above the stage or auditorium onto which spotlights are attached.

**Barn doors:** Hinged metal flaps that can be attached to the front of Fresnels to adjust the beam shape. These can also be used with other types of lights to reduce glare.

**Beam spread:** Light from theatrical luminaires typically forms a conical beam – narrow at the fixture and wider as the light gets farther from the fixture. The angle of the cone is called beam spread. This value is important in calculating how much light will hit the stage from a luminaire rigged at a certain distance from the stage.

**Blind:** Changes made to the programmed lighting states that do not affect the current lighting state on stage.

**Board:** Another term for a lighting control desk or console.

**Boom:** A vertical lighting bar.

**Boom arm:** A metal support that attaches a spotlight to a boom.

**Build:** Slow increase in light intensity.

**Check (back):** Reduce light intensity.

**Circuit breaker:** A device that automatically interrupts an electrical circuit when an overloading fault is detected. This is usually caused by a short circuit or too much connected load.

**Color call:** List of colored filters required for tungsten lighting when rigging a show.

**Color filter booklet (or swatch):** A small booklet of sample pieces of color filter materials including their name, number and spectral distribution characteristics. These booklets serve as a reference for the lighting designer when choosing the colors for a production. Color filters are generally designed to work on conventional tungsten luminaires, but there are some manufacturers making color filters for white-light LED luminaires as well. Color filter booklets are available from a theatrical equipment dealer.

**Control channel:** The control channel is the numerical name the designer uses for a luminaire or set of luminaires that are controlled together. Control channels are used to group sets of luminaires or devices together in a logical way relating to how the designer thinks about the design, rather than to their physical location in the venue.

**Cross-fade:** Gradual change from one lighting state to another where the incoming state replaces the previous state.

**Cue:** The starting point for a lighting change. A word or action or signal from performer or stage manager that initiates a lighting change or some other change onstage.

**Cyclorama (cyc):** A white backcloth or painted surface at the rear of the stage.

**Dimmer:** A device that increases or reduces the power reaching the luminaires in a tungsten lighting system, usually in response to signals from a control desk.

**Dimmer rack:** A wall mounted or floor standing cabinet which contains a number of dimmers, controlled by a lighting desk. Dimmers in a rack can sometimes be replaced by relays, which turn the power for a circuit on or off, like a switch. The ETC ColorSource ThruPower rack combines dimmers and relays on each lighting circuit – the user can change the setting of each circuit at the rack. The circuit can then be used either with traditional tungsten load (with a dimmer) or with LEDs, moving lights or other devices that require constant power (with a relay).

**DMX512-A:** A Digital Multiplex protocol used for controlling dimmers and devices from a lighting control desk.

**DMX terminator:** A device used to dampen the end of a run of DMX512-A signal. This consists of an XLR-M connector with a 100 ohm resistor soldered between pins 1 and 2. These can be hand-made or purchased from an equipment dealer.

**Deputy Stage Manager (DSM):** The DSM is the person in charge of running the show on a daily basis. It is their job to call all the lighting cues, scene changes etc, ensuring the performance runs as rehearsed and agreed. All the information, cues, scripts and important notes are kept in a book which never leaves the stage or theatre. The DSM usually sits at the SM desk, sometimes called the prompt desk, on stage left (Prompt side).

**Dips:** Low level electrical sockets or sockets below the surface of the stage.

**Fixed lens:** A lens fitted to a profile luminaire that will produce a beam of light at a known or "fixed" angle.

**Floodlight:** Stage luminaires that produce a wide beam of light. Floods are not normally fitted with lenses.

**Focus:** To adjust a beam of light to deliver the required beam shape or sharpness.

**Follow-spot:** A long-throw profile spotlight mounted on a swivel base, used to follow a person as they move around the stage.

**Fresnel:** A stage luminaire fitted with a Fresnel lens that produces a soft edged, controllable beam of light.

**Front of House (FoH):** The area in front of the stage or proscenium containing the audience.

**Front light:** Light that hits a subject from the same direction as the audience is looking. Front light is used for visibility of actors' faces.

**Fuse:** A safety device fitted to older dimmer circuits and some plug tops (13A) to detect overload. Modern dimmers use circuit breakers.

**Gamut:** The color gamut is the complete range of colors that an LED luminaire can produce. The fewer the colors in the LED array, the smaller the color gamut.

**Gate:** Part of a profile spotlight, located at the internal focal point where gobos and other beam shaping devices can be placed.

**Gels:** Sheets of colored, transparent material which are fitted at the front of stage luminaires in order to color the beam of light (from Gelatin, the original color filter material).

**Gobo:** A patterned metal or glass disc which, when fitted into the gate of a profile spotlight, will project the pattern onto the stage, cyc or scenery.

**Ground-row:** A row of floodlights, used to illuminate a cyc or backcloth from below.

**Hook clamp:** A hook-shaped clamp used to attach luminaires on to a bar.

**Inrush current:** A surge of current on an electrical circuit, produced when a device is first turned on. The inrush current of a set of devices may exceed the current rating of a circuit and cause a circuit breaker to trip, even if the normal operating current is under the limit of that circuit.

**Iris diaphragm:** A device with an adjustable hole, which can be inserted into the gate of a profile to change the diameter of the projected beam.

**Kilowatt (kW):** 1000 watts.

**Lamp:** A glass envelope containing a tungsten filament or other lighting source. Not required in LED luminaires.

**Lantern:** The original term for a stage luminaire.

**LED – Light Emitting Diode:** An LED is a small electronic device that emits light of a specific color. LEDs may produce very narrow frequencies of light or may produce a wider range of frequencies when manufactured with phosphors. LEDs are combined into arrays to produce the light in entertainment luminaires – the more colors available in an array, the greater the range of colored light a luminaire can produce.

**Lighting control desk:** The computer used to control connected dimmers and devices and to store programmed cue information for a production. Also known as a light board or console.

**Lighting Plan or Light Plot:** a schematic drawing of the lighting rig, used to communicate to technicians where to hang luminaires and how luminaires will be patched in the lighting control desk.

**Limes:** The old name for follow-spots derived from the use of lime – the original light source.

**Master:** A fader that can override all other fades and function on a lighting desk.

**Ohm:** A unit of electrical resistance. Conductors (wires) are rated in ohms.

**O.P. (Opposite Prompt):** A stage direction meaning stage right.

**Offstage:** Any area of a stage which cannot be seen by the audience.

**Onstage:** Any area of a stage which can be seen by the audience.

**Open white:** The term used to describe a light that has no gel fitted. When thinking of LED, this would refer to all emitters being at full, creating white light.

**P.S. (Prompt Side):** A stage direction meaning stage left.

**Pan:** To move a spotlight or moving light in a generally left-right or horizontal motion.

**PARcan:** A luminaire based on a sealed beam lamp contained in a simple can-shaped housing.

**PAR lamp:** Sealed beam lamp to fit into a PARcan.

**Patch panel:** A physical connection point between numbered circuits in the theatre and the dimmers in the dimmer rack. Patch panels have been replaced by dimmer-per-circuit systems where each circuit is directly wiredto a dimmer position in a dimmer rack.

**Patching:** The linking of dimmer circuits or DMX addresses to control channels in the lighting control desk.

**Perch:** A stage lighting position located on either side of the proscenium.

**Plan:** The drawing indicating where all luminaires should be placed and how they should be connected to the lighting system. This drawing is usually drawn to scale.

**Plot:** The list of cues and other instructions necessary to produce the necessary lighting changes for the entire performance.

**Practical:** A prop or other electrical device (table lamp, TV, etc) which is operated, or apparently operated, by a member of the cast. Depending upon function, the practical may not be connected to the dimming system.

**Preset (1):** A term originally applied to a simple manual lighting desk where two groups of faders (A and B) were raised to the levels needed in two different scenes. A cross-fader provided a means to fade between "Preset A" and "Preset B." Not widely used now.

**Preset (2):** A term used in some modern control desks to denote a single fader to which a number of channels at different intensities has assigned and recorded. These may also be known as submasters.

**Preset (3):** A lighting state on stage before the performance begins.

**Profile spot:** A stage luminaire fitted with either one (fixed angle) or two lenses (zoom). The profile can project images or patterns (gobos) and can be accurately focused and shaped using internal shutters.

**Prompt:** Lines fed to an actor who has forgotten his/her place. The "prompter" is the person who would normally give these lines, but this is no longer used in the professional theatre. If lines are missed, the Deputy Stage Manager (DSM) on the "book" will call the missing dialogue. Also see P.S.

**Proscenium (arch):** An arch or opening in the front wall of the stage, which frames the audience's view of the show. Some performance spaces have no proscenium; others install a temporary "false proscenium" made from drapes or curtain or scenery flattage.

**RCD (Residual Current Device):** A safety device connected to an electrical supply to detect whether the current between the energized and return conductors of a circuit is balanced. A difference in current on these two lines can indicate a short circuit or leakage to the earth conductor (a live shock in progress). Imbalance causes the RCD to trip, breaking the circuit.

**Record:** The process of saving information to a computerized, or memory desk. All the information relating to the show is recorded and will include cues, times, soft patching and other set up procedures. The combined show data is stored in a show file, which can be stored on the console hard disk itself, and to an external memory stick for backup.

**Rig:** The lighting installation and placement of luminaires for a particular show. The rig may be changed from show to show.

**Safety bond:** A safety device made of rated clips and wire rope, intended to prevent a stage luminaire falling if the main suspension point fails. Safety bonds have replaced safety chains. Unlike chains, safety bonds can be tested and made to a common safe weight standard. Safety bonds should be weight stamped so the correct bond can be used with the selected luminaire.

**Safety chain:** A strong welded link chain used to prevent a stage luminaire falling if the main suspension point fails. Replaced by safety bonds.

**Shutter:** Metal plates that are fitted into the gate position of a profile spotlight, used to control the shape and size of the projected beam.

**Sidelight:** Light that hits its subject from the left or right (from the point of view of the audience). Sidelight is used to reveal the form of three-dimensional objects or performers.

**Special:** A light that is intended to perform very specific task, like spotlighting an actor during a big downstage monologue or lighting a presenter at a podium. Specials may be added to help an existing rig better suit the needs of a show.

**Spigot:** A short metal rod which connects a luminaire to a lighting stand.

**Spill:** Unwanted light from a luminaire.

**Spotlight:** The generic name for any luminaire which has a controllable beam.

**Stage Manager's desk (SM desk):** Located on stage left (PS or prompt side) this is where the DSM on the "book" will call all the cues for the show. In some theatres, the SM desk is located on stage right (O.P. or opposite prompt) this is known as a bastard prompt.

**Stirrup:** The U-shaped metal supporting hoop attached to a luminaire (also known as a trunnion arm).

**Tabs:** A set of curtains that can be closed across the front of the stage (behind the proscenium, if there is one).

**Throw:** The distance from a luminaire to the stage or area on the stage. Throw affects the size of the beam of light and will help to determine which size lens to use.

**Thrust stage:** a stage that extends into the auditorium and is surrounded on three sides by audience seating.

**Tungsten-halogen:** The correct description of a tungsten lamp. A thin tungsten filament is supported in quartz-glass envelope filled with a halogen gas.

**UV:** Ultraviolet light, used for special effects.

**Upstage:** The area of a stage closest to the back wall or cyclorama.

**Volt:** A unit of power that quantifies the difference of potential that carries one ampere of current against one ohm of resistance. Electrical supplies are rated in voltage.

**Watt:** A unit of power that quantifies the rate of energy transfer. Used to describe the power consumption of lamps and devices. Wattage equals a circuit's voltage multiplied by its amperage (W=VA).

**Wings:** The side areas of a stage not seen by the audience.

**Working lights (1):** An independent lighting system, not connected to the stage dimming systems, which can be switched on and off as required by the stage crew.

**Working light (2):** Lighting is sometimes required on stage for the crew to set a new scene. In some circumstances normal working lights would be too bright, so a cue is incorporated into the lighting plot allowing the crew to work quickly and safely.

**Zoom:** A system comprising two lenses that can be adjusted to vary the size and focus of a beam of light from a profile luminaire.

## Lighting Angles

This exercise is called "Circle of Light" and is a good way to demonstrate the different lighting angles and the effect that these have on the performer. For this exercise, you will need to be in a large open space, preferably one that you black out, as you will need darkness for this to be really effective.

Ask the students to stand in a circle with a volunteer in the center of the circle. Students can use the torches on their mobile phones for this exercise. If mobile phones are not allowed at school, then some cheap LED torches will work just as well.

The students stand in a large circle with their phones held close to themselves (this is so that we can control the light).

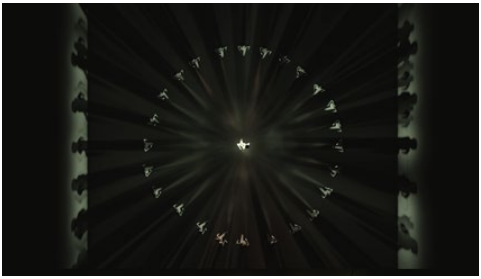
Divide the group up into four quarters and have everyone in Q1 light the person in the middle.

Those shining the light will be seeing front light. Those not shining the light will be seeing back light if they are opposite the light holders or side light if they are adjacent.

Now call the next quarter and so on and investigate how the light on the person in the middle changes. Keep going until you have gone all the way around. Now try doing opposite groups together and then adjacent groups together.

If the session is going well, the teacher can try varying the number of students shining lights from a particular angle, this gives a basic idea of light balance. Try lifting the lights high above your heads or low down to the ground and see what changes in the shadow play on the person in the middle.

When investigating side light, arrange the class in parallel lines across the space, ready to point their phones in straight lines at the opposing person.



# TEACHING EXERCISE 2

## Revelation of Form

A flat front light does not reveal much texture as there are minimal shadows.

As the angle gets steeper, more shadows are introduced, the texture becomes more defined.

Almost directly overhead, the shadows are dramatic and the texture is prominent.

A side light helps to sculpt the object and reveal texture.

Ask the students to find some objects that have texture. This can be anything from a section of corrugated cardboard, to a rock, to a piece of bark, or even a crunched up piece of paper.

Again, using the torches on their mobile phones (if allowed) ask them to light the object using the six basic lighting angles – Flat Front Light, Front 45, Side Light, Back Light, Top Light and Up Light and to take note of how the object transforms from appearing as a flat two-dimensional object into something more visually interesting as the shadows start to have an effect on the object.

Ask another student to add their torch onto the same object, but in a different color. You can use a piece of gel to add color to their torch. Notice how the introduction of color (and it does not have to be saturated) adds another dimension to the object they are lighting.

Ask the students to arrange a series of objects on a table (or other flat space). These can be the objects used in the above exercise. Arrange them as if they were scenic elements on the stage and then ask the students to light them using a single torch and then multiple torches and see the different effects that can be created. You can also experiment with different colors.

## Color

For this experiment, you will need a light to be rigged above a table. If you have an LED (RGB or better), this is ideal. If you only have a tungsten source, then you will need three pieces of filter – primary red, primary green and primary blue. The light should be easily within reach so that you can change colors during the experiment. If you are using an LED fixture, then have it connected to the lighting desk so that you can change colors quickly and easily.

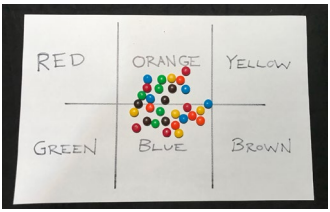
Pour out some M&M's or Skittles into a bowl and set them on a table under the light. Start by turning the light on in open white.

Ask the students to sort the M&M's into separate piles according to color. Once they start to sort the sweets, change the color of the light to red. This will make this seemingly simple task much more difficult. Let them keep sorting the sweets for a while longer. Remove the color from the light and let them see how well they sorted the sweets.

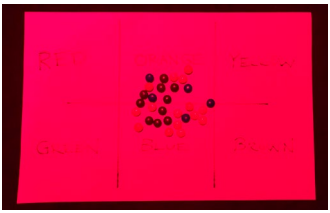
Ask them to continue sorting the sweets into separate color piles.

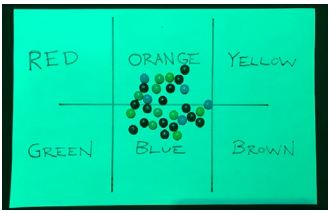
After a while, change the color of the light to green, and then to blue.

Changing the color of the light will change the colors of the sweets making them harder to sort, showing how important color choice can be on stage.

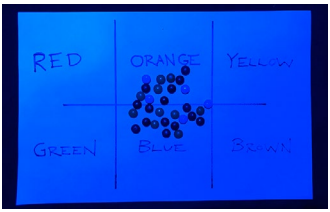


White light


Red light



Green light



Blue light

# TEACHING EXERCISE 4

## Information Exercise

The aim of this exercise is to get the students thinking about the different ways that lighting can convey information to the audience and help to establish the location of the play, the time of day etc.

## The Window Test

Imagine that you are working in a black box theatre – the only piece of scenery that you have is a window frame hanging upstage, and a small table and chair.

Try to come up with as many different lighting solutions as possible using the window as your main "source" of light to change the location, time of day, and feel of the room.

You can start with the simpler, more obvious choices and work towards more complex solutions and moods.

Easy: Time of day – Talk about how the light could be changed to show morning, afternoon, evening and night time. Think about choices of color as well as angle.

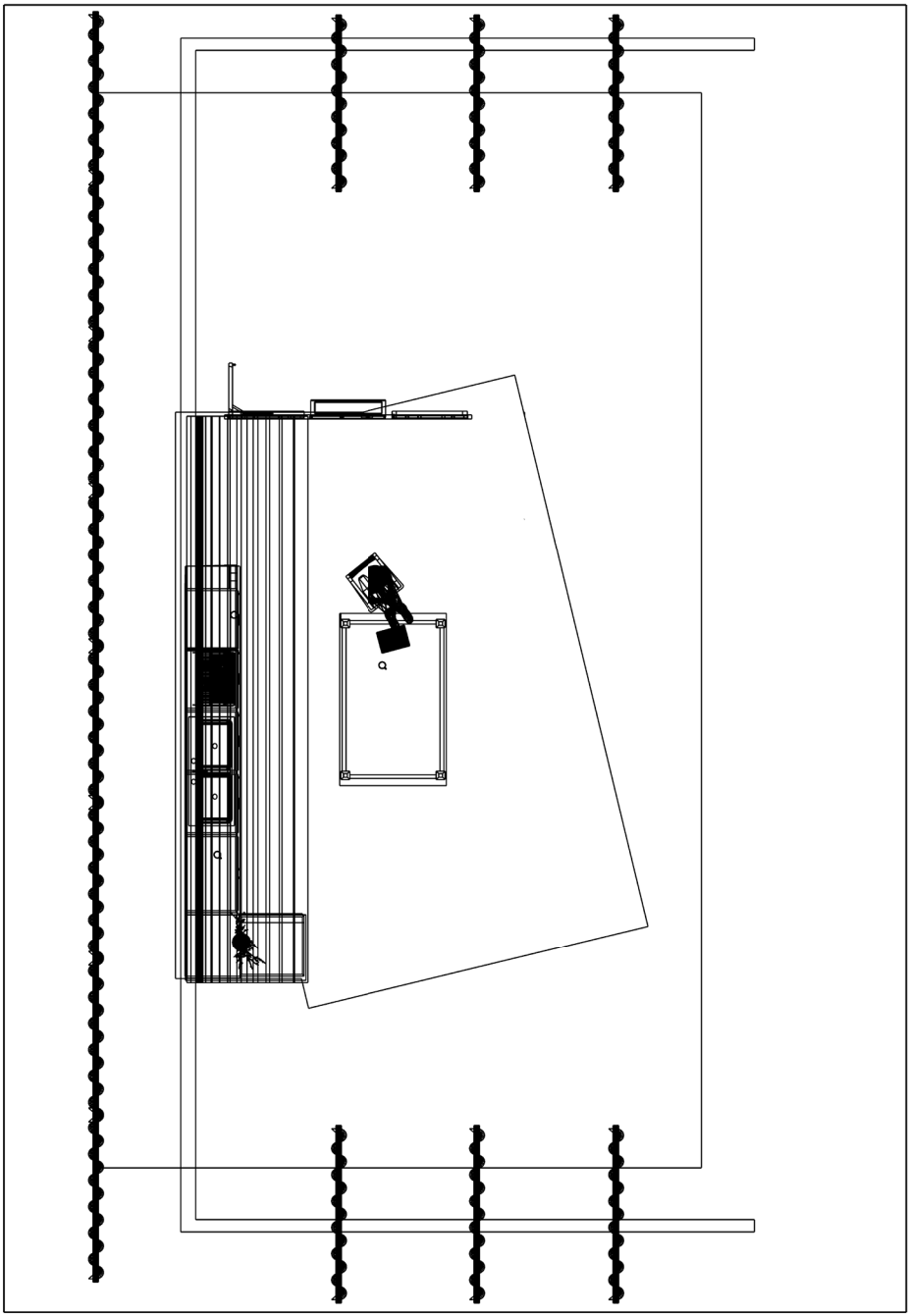
Difficult: Season – Talk about how the light might change through the seasons – how could you convey this to your audience? Winter light might be softer, cooler and not as harsh as summer sunlight, for instance.

Challenging: Do you think it would be possible to convey that the window is perhaps on the 2nd floor of a building, an apartment, for example. How would you go about this? How could you suggest inclement weather outside? A flash of lightning through the window, perhaps?

What other effects can you think of to tell a different story about this location? Some might include using a flashing red (or pink) light to suggest a neon sign outside the window – perhaps this is a room in a seedy motel. Maybe you want to create the effect of car headlights passing by as someone stands near the window looking out, waiting for someone to arrive. Another alternative could be seeing the flashing lights of an emergency vehicle going past.

See how many other narratives your students can come up with and talk about how they might achieve them.

## Window Groundplan



## Window Lighting Examples

Cool, direct light through window. Could be very early morning, or nighttime.

Same angles, but a simple color change has altered the time of day to a late afternoon feel.

Same warm colors, but the steeper angle of window light suggests a different time of day.

Again, steeper angle suggests the sun is higher in the sky, so earlier in the day.

Absence of any light through the window makes the room feel lonely and isolated.

Long rays of sunlight stretching into the room suggest a low sun, almost sunset.

Adding a "Shutters" gobo and changing the color tones creates the sense that it is nighttime and gives a more mysterious feel.

A lower angle through the window suggests light is coming from a streetlight, suggesting that this is an apartment on the second floor.

Adding a "Leaf" gobo to the low angle suggests that the light is shining through a tree – perhaps this is the effect created as a car drives past the window.

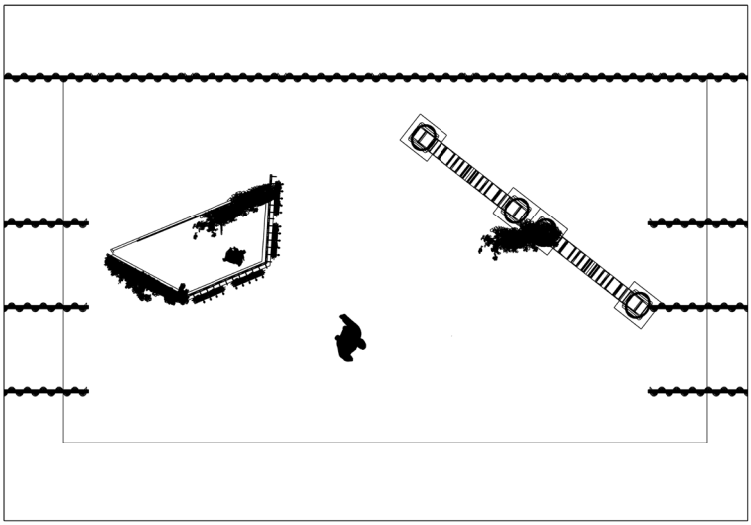
Changing the color of the "Shutters" gobo (and adding a simple flashing effect) might suggest there is a neon sign outside the window, placing this room in a seedy part of town.

Flashing red and blue lights through the window could suggest a passing emergency vehicle.

## Plan Drawing

This exercise can be done individually, or in groups.

Using the images of the set design below, start to plan your lighting design for Act II, Scene ii of William Shakespeare's Rome and Juliet – the balcony scene.



Romeo and Juliet ground plan

Romeo and Juliet set under work light condition

Give some thought to what type of mood you would like to create and how you might achieve that, but also give consideration to all five lighting design objectives.

Start by reading the extract from the script and analyzing the context of the spoken words and think about how this scene might be staged.

Then, jot down the five objectives (Visibility, Revelation of Form, Composition, Mood, Information) and then start to allocate lights to the scene that will help you meet these objectives.

The next step would be to make a list of the controllable properties of light (Intensity, Color, Distribution, Movement) and then make notations about how these will impact on your choices.

Remember to consider that you are lighting the whole stage, not just the pair of young lovers, so be sure to include lighting that will help to set the scene for the rest of the stage too.

Once you have planned your lighting, draw a plan that will convey these ideas to the crew so that they can hang the lights and get them working for you. Your plan does not have to make use of accurate lighting symbols, as long as there is a key that explains what you have done. Your plan may end up looking something like this: (insert pic of a rough lighting plan).

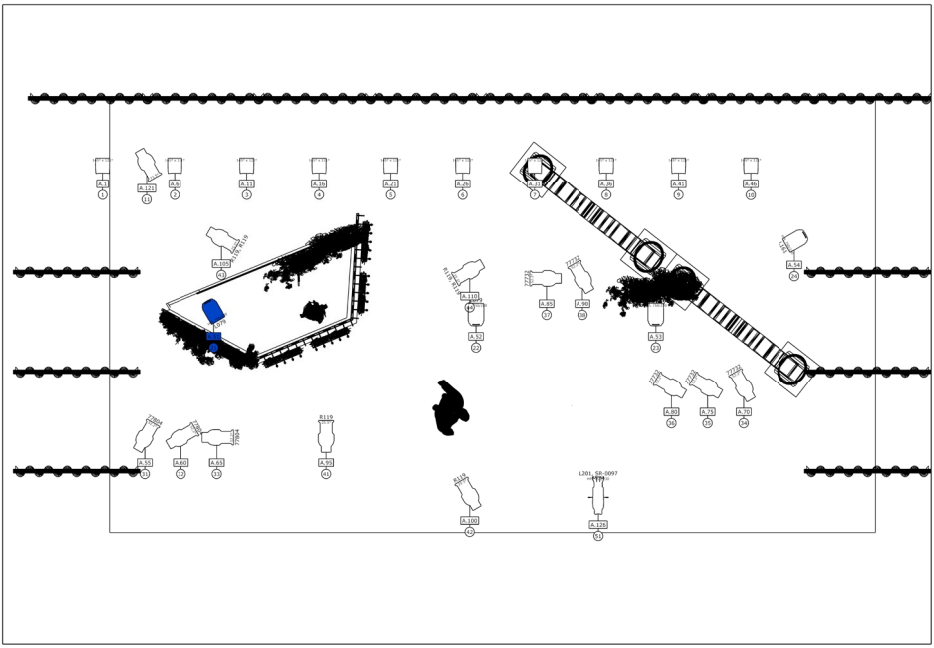
At the end of the task, students can present their ideas to their classmates. It will be interesting to see where ideas and concepts are similar and where they are different.

A further extension to this project will be to draw up a cue list for this scene, describing the cue, its placement and timing.

A possible way to light the scene – keeping the colors muted initially.

The same scene, but with more saturation – perhaps you crossfade to this state as they fall in love.

A more dramatic approach to the scene – keeping a sense of danger.



Your lighting plan might look something like this.

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