Stage Lighting Design 101

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Stage Lighting Design

Stage Lighting Design

PART 1 - An Introduction to Stage Lighting

1.01 - THE JOY OF LIGHTING DESIGN

1.) INTRODUCTION

One of the most rewarding professions today can be that of the lighting designer working in the arts. It can also be one of the most frustrating professions on the planet.

The lighting designer will never stop learning. Every production or project will present new challenges, new obstacles, new human dynamics and new problems to solve. There can and should be many failures along the way. This is part of the artistic process. The lighting designer shouldn't hesitate to make as many mistakes as possible - just don't make the same mistake twice.

There is great satisfaction is designing the lighting for a production that fulfills the needs of the playwright and also meets the objectives of the director and other designers. There is however far greater satisfaction in knowing that you have succeeded in your goals and objectives and that you have emotionally 'moved' an entire audience through the controlled and planned use of light.

Stage lighting is no longer a matter of simple illumination as it was less than 100 years ago. Today, the lighting designer is expected to be a master of art, science, history, psychology, communications, politics and sometimes even mind reading.

The stage designer quickly learns that things are not always what they appear to be. A director who asks for 'more light' on an actor, probably doesn't mean that at all. Instead he really just wants 'to see the actor better'. The designer might chose to reduce the lighting contrast around the actor, or simply ask the actor to tip his head up a bit. Both solutions solve the problem without 'adding more light'. So the lighting designer also has to be a good listener, a careful interpreter and a skilled crafts person.

Ultimately the lighting designer must be an artist! He must understand style, composition, balance, esthetics and human emotions. He must also understand the science of light, optics, vision, the psychology of perception and lighting technology. Using these tools the lighting designer must learn to think, feel and create with his heart.

When it's good lighting design - you alone will know.
When it's bad lighting design - everyone will tell you!

1.02 - EVOLUTION OF LIGHTING DESIGN

1.) EARLY STAGE LIGHTING

Stage lighting design is probably as old as formalized theatre. The early Greeks built their theatres as open air spaces and orientated them in relation to the sun, so as to use natural light for stage lighting. They would present their plays at different times of day, to take advantage of the different types of natural lighting. This type of planning was in essence, early lighting design. The Theatre of Dionysus (Athens, about 330 BC) and the theatre at Epidaurus (finished about 340 BC) are examples of these early public theatre facilities.

Lighting for the theatre developed over the centuries, using both natural sources then artificial sources. The sun, candles, torches oil, gas, electric arc and lime lighting, all have had a place in early stage lighting. During the Renaissance period in Italy, many of the principals of modern lighting design, were firmly established.

2.) MODERN STAGE LIGHTING

Modern stage lighting design began to flourish with the development of the incandescent lamp in the late 1800's. This invention allowed for the development of small, safe, portable lighting fixtures that could be easily placed anywhere around the stage, and then controlled by a remote electrical dimmer system. Previously during the gas lighting era, complex stage lighting did indeed exist however, it was limited by this awkward smelly technology, with its many inherent problems. During the gas lighting era, a great numbers of theatres were destroyed by fire.

During the early 1900's as stage lighting continued to develop, certain parallel lighting industries began to evolve, borrowing many basic principals from the field of stage lighting design. The modern fields of display, photographic, film and television lighting design all have evolved and developed from the fundamental roots of early stage lighting design. Today stage lighting design is recognized as a field merging science with art.

3.) FUTURE STAGE LIGHTING

The future of stage lighting is tremendously exciting. After the electric filament lamp, stage lighting was revolutionized in the 1930's by the development of the ellipsoidal reflector (Leko) fixture. The development of the SCR dimmer in the 1960's provided another radical change. Now the automated lighting fixture (first introduced in the 1970's) is revolutionizing the lighting industry again. New technology has recently produced colors, never before seen in lighting design. New light sources are developing including; Xenon, Metal Halide, Fluorescent, Induction and Sulfur lamps. The use of fiber optics as a carrier of both 'light' and 'data' and the further development of liquid crystal projection technology are all part of the exciting future of entertainment lighting design.

Design software for the computer will continue to evolve and eventually allow the designer complete artistic 'interactive' control over his 'visual' technology. Lighting software now provides assistance with design, drawings and paperwork. Design software in the future will use both 'touch screen' and 'speech recognition' technology. Can the

mental control of lighting systems be far away?

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(It Bids Pretty Fair - from Steeple Bush - 1947)

1.03 - THE LIGHTING DESIGNER

1.) THE JOB, THE PROFESSION, THE LIFE

The stage lighting designer is traditionally responsible for the design and supervision of all aspects of lighting for a typical stage production. In the mid 1900's lighting designers in Britain and America developed and refined the methods of modern lighting design for theatre, dance, and opera. It was only after the development of the electric filament lamp that these early pioneers were able to establish new foundations and standards in design. Whether working in a small community theatre or in a large opera hall, the lighting designer is (or should be) an important and respected member any modern production. This designer, collaborates with the director and with other designers (set and costume) to ensure that the production is properly and suitable illuminated in all respects, from inception to completion.

Producers and theatre managers have realized years ago, that they can spend 'millions' of dollars, on scenery, costumes, and performers and have it all wasted because of 'bad' lighting. Many commercial productions now make high demands of their lighting requirements and in this respect, the lighting designer has become an important and integral member of the theatre and entertainment industry. The lighting designer is often the last designer into the theatre, and everyone fully expects him to perform magic, miracles and to make the sets, costumes and actors...'look fabulous'.

There were many individuals in the 1700's and 1800's whom contributed to the evolving art and science of stage lighting design. It wasn't until the early 1950's however until the role of the lighting designer as an artist was finally firmly established. Up until this time lighting was largely something to be taken care of by the technicians. Today, many thousands of lighting designers work around the world in many different entertainment industries.

Lighting designers today often tend to specialize in specific types of entertainment productions, each requiring slightly different working methods and techniques. Specialization may include lighting for; Theatre, Dance, Opera, Television, Theme Parks, Ice Shows, Outdoor Pageants, Trade Shows and Industrial or Corporate productions.

Some stage lighting designers may also specialize within a speciality. For example, it is not uncommon today to find a 'dance' lighting designer that may work only in the field of modern dance, or a variety lighting designer that just works in the field of 'Rock' music.

Regardless of the lighting discipline, all lighting designers must have a full understanding of their tools and both the physical and psychological aspects of light. The basic principals of light, vision and design, apply regardless of the lighting design discipline.

The only real differences from one lighting industry to another are the methodology and equipment types involved. For example, display designers may use a 3"-150 watt fresnel, theatre designers may be at home with an 8"-2000 watt

fresnel, and the television or film designer may be used to working with a 30"-10,000 watt fresnel. Further, the lighting designer must have knowledge and experience with the lighting methods, fixtures and hardware that are available to serve their particular lighting industry.

Everyone in theatre knows 2 jobs...their own...and lighting!

1.04 - OBJECTIVES OF STAGE LIGHTING

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"Stage lighting may be defined as the use of light to create a sense of VISIBILITY, NATURALISM, COMPOSITION and MOOD, (or ATMOSPHERE)". So began a chapter in the 1933 text: 'A Syllabus of Stage Lighting' by Stanley McCandless. Most comprehensive lighting texts since, also tend to discuss the artistic objectives, (functions) of lighting, in these terms. McCandless recognized that these are 'overlapping' qualities and one does not exist independently of the others.

2.) VISIBILITY

VISIBILITY is often considered to be the most basic and fundamental function of stage lighting. What we don't see, we seldom clearly understand. Visibility is dependent on far more than just the intensity of light. Other factors such as; contrast, size, color and movement all can influence visibility. Distance, age and the condition of the eye also play important roles in visibility. "Good visibility is essentially selective. Its purpose is to reveal things selectively in terms of degrees of acuity". - (S. McCandless, 1933).

3.) NATURALISM (and MOTIVATION)

NATURALISM provides a sense of TIME and PLACE. Stage settings may be highly realistic or completely abstract, absurd, or stylized. If time of day is important or the place is realistic, then MOTIVATION is often provided by sunlight, moonlight, firelight, lamplight, or other naturalistic stage sources.

Style concepts include: naturalistic, unnaturalistic, realistic, surrealistic, pointilistic, futuristic, minimalistic, impressionistic, expressionistic, expansionistic, abstract, modern, religious, romantic, Victorian, primitive, gothic, Elizabethan, Georgian and many, many more.

4.) COMPOSITION

COMPOSITION refers to the overall pictorial aspect of the stage, as influenced by the lighting. Composition also deals with the FORM of an object. A stage scene may be broadly flooded with soft, even lighting, revealing every object equally, or it may be illuminated by highly localized lighting on the actors only - or anything in between. So, composition in lighting must reveal actors, objects and scenery in proportion to their importance, by building a visual picture.

Composition concepts include: balanced, unbalanced, symmetrical, asymmetrical, simple, complex, abstract, geometric, fragmented, symbolic, dynamic, linear, random, crude, horizontal, vertical, diagonal, and many more.

5.) MOOD (and ATMOSPHERE)

MOOD considers the basic psychological reactions of the audience. If other lighting elements have been properly

applied, the result is a specific MOOD, created by the lighting design. Lighting can cause an audience to feel a wide range of different emotions. Feelings of 'happy, sad, content, horrified, excited, (and often 'bored'), all depend on a wide number of psychological and physiological factors. This is also true in respect to how the audience interprets naturalistic or atmospheric moods, such as sunny, cloudy, rainy, lightning, etc. The stage lighting designer rapidly learns that: "Things are not what they are, things are what they appear to be." (author).

1.05 - QUALITIES OF LIGHT

1.) QUALITIES OF LIGHT

Any study of lighting design must include a thorough understanding of both the PHYSICAL and the PSYCHOLOGICAL properties of light.

Knowledge of the behavior and properties of light can help explain vision and human perception. The lighting designer is especially interested in how the properties of light affect the eye/brain process and cause feelings and emotions.

An understanding of the physical properties of light can also help explain optics, lenses, color theory, lighting and projection equipment and much more. The laws and applications of reflection, refraction and absorption are encountered and used every day by the stage lighting designer and these concepts must be thoroughly understood both in theory and in practice.

These basic qualities of light are; INTENSITY, FORM, COLOR, DIRECTION and MOVEMENT. These are the lighting designer's tools.

Almost all visual images can be described, discussed and analyzed in these terms - both physically and psychologically. There is an excellent classroom exercise that usually starts with an analysis of reproduction paintings from the 'Old Masters'. Student learn to discuss the qualities of light, using such terms as intensity, brightness, direction, color, form, and distribution. These terms are used to discuss the painting in detail from one small area to another. In addition the painting as a whole is discussed in respect to overall lighting impact, style, mood, composition, emotional content and other qualities. (This exercise is sometimes known as the 'postcard' exercise as often this is the source of the reproduction paintings. The author has many in his collection.)

The experienced lighting designer also frequently relies on the qualities of light to help communicate his lighting concept to others. Example: The stage was brightly bathed in a deep blue wash. Slowly, the amber sun softly rose above the horizon gently illuminating the stage in a golden glow. Cool, textured and uncertain light slowly starts to grow and creep throughout every corner of the stage. Soon a low dominating warmth from stage right becomes evident, balanced by a diminishing and cooling of other general light. As darkness falls, the entire stage grows shadowy and covered with sharp defined leaf projections. The blue wash unnoticeably reappears as a shaft of sharp silvery moonlight slips across the stage.

1.06 - INTENSITY and BRIGHTNESS

1.) INTENSITY - (and BRIGHTNESS)

INTENSITY typical refers to the 'strength' of a light source. Intensity of a source exists independent of its distance. Intensity is measured in candela (The old term was candlepower).

ILLUMINATION refers to amount of light falling on a surface. The old term for illuminance was 'illumination'. Illuminance is measured by a light meter (corrected for the curve of the human eye) in footcandles or lux (metric). Typical stage lighting illuminance levels may range from 25 to 200 footcandles or more. The eye has an incredible power of accommodation and can comfortably adjust to illuminance levels in nature from 1 to 10,000 footcandles, or more.

BRIGHTNESS refers to the visual sensation caused by a light source when it interacts with an object and then the eye. Brightness depends on the intensity of the source, on the distance to the object and on the reflective properties of the object. The footlambert is the unit of brightness.

Example: In theatre when we change the dimmer setting of a lighting fixture, we are changing the output INTENSITY of the source. This results in a change of ILLUMINANCE (light falling on the stage) that is perceived by the eye as a change in BRIGHTNESS.

VISIBILITY depends on many factors, not just the intensity of a source or the brightness of an object. Color, contrast, distance, movement and the conditions of the eye and visual system all play an important role towards visibility.

The stage lighting designer is more concerned with the brightness of an object than the intensity of it's light source. He soon learns that objects of higher brightness generally draw attention on stage. Light attracts! Conversely, darkness conceals - but may also put the audience to sleep. One of the prime jobs of the lighting designer is to actually keep the audience awake. This is not as funny as you may think when you consider what we do to an average audience member. Usually late, after dinner and a few drinks we seat the audience in comfortable chairs - and then turn off all the lights! The lighting designer must use the power of light to keep the audience awake and direct their attention to the stage by providing proper visibility, interest and selective focus.

1.07 - FORM and DISTRIBUTION

1.) FORM - (and DISTRIBUTION)

Light provides objects with a sense of FORM. The eye is able to recognize objects in terms of shape, size and position. Our binocular vision assists with this process by providing DEPTH.

"By means of controlling the distribution of light and creating patterns and compositions of light and shade, it is possible to produce sensations on the retina that will be interpreted as forms in space." (A Syllabus of Stage Lighting, S. McCandless 1964).

Form as applied to light is rather complex. It is everything that intensity, color, movement and direction are not. Yet form is caused and influenced by these other qualities of light. Form has to do with the DISTRIBUTION of light or how light strikes a surface and reveals an object. We typically discuss form in terms of clarity and recognition of shapes.

Form and distribution can be discussed on two levels.

First, we can discuss form as applied to the stage setting in respect to how objects appear. A stage might be evenly, softly and flatly illuminated from a low front angle. Alternately, the same stage might be unevenly dappled with tight circular pools from a high overhead angle.

We can also discuss form as applied to the light produced by a stage lighting fixture. (Example: "The fixture produced a sharply defined square shaped beam with a very wide dispersion angle".)

Form becomes much more complex when you consider that an image projector can be used as a stage lighting fixtures. As a result of this technology the light produced from the 'fixture' can take on absolutely any shape, form or distribution.

As in nature, stage light sources may produce either soft diffused shadowless light or hard shadow producing light, - or anything in between. The edge of a lighting beam may also range from a soft almost invisible edge to a hard, sharply defined edge. A beam of light may also have a broken, uneven distribution, as in the case of a gobo or template pattern projection.

1.08 - COLOR

1.) COLOR

All light is colored. White light is simply a mixture of all visible wavelengths (colors). The human eye is most sensitive to light in the yellow-green portion of the visual spectrum (about 550 nanometers), than it is to red or blue at the ends of the spectrum.

Color is usually discussed in terms of HUE, VALUE and CHROMA.

HUE is the classification of a color that the eye sees as red, green amber, etc. VALUE indicates lightness or darkness of a color. CHROMA indicates the purity or saturation of the color.

The PRIMARY colors of light are RED, GREEN and BLUE. These three colors can mix together to produce any other color, including white. (The primary colors of pigments are RED, YELLOW and BLUE.)

The SECONDARY colors of light are formed when any 2 primary colors are combined. The 3 secondary colors are MAGENTA (red & blue), YELLOW (red & green) and CYAN (blue and green).

THE COMPLEMENTARY colors are any combination of a primary and a secondary color that, mixed together make white light. Examples of complementary colors are. MAGENTA & GREEN, YELLOW & BLUE, and CYAN & RED).

When white light is passed through a color filter only the wavelengths corresponding to the color are transmitted. All other wavelength are absorbed. This is referred to as SUBTRACTIVE filtering.

When 2 or more colored beams of light combine to illuminate a surface, they mix together through ADDITIVE mixing.

Stage lighting fixtures produce colored light using high temperature plastic filters. There are more than 100 different colors available from several manufacturers. These filters 'pass' or TRANSMIT their own color and 'block' or ABSORB all others.

Sometimes glass filters are also used. Conventional glass filters generally come in a limited range of colors however they are useful for high temperature applications or where prolonged life of the filter is required. A new generation of 'dichroic' glass filters are also sometimes used for entertainment lighting applications where 'vibrant' colors are needed that will not fade over time. Dichroic filters are made with thin film technology, tuned to specific wavelengths. These filters transmit a specific color and REFLECT all others. (Unlike conventional filters that absorb not reflect unwanted wavelengths.)

1.09 - DIRECTION and MOVEMENT

1.) DIRECTION

The direction of light is one of the most important attributes in stage lighting design. All light has direction. A bare candle radiates light in all directions. A spotlight radiates light in a very specific direction. In nature most light comes from the sky, from above. In theatre lighting this is also generally true as most lighting positions are above the stage or audience.

Low front lighting is often considered to be 'flat'. Very high lighting angles may cause shadows on the actor's faces. Lighting from more than one direction can add 'plasticity' and dimension to an actor. Lighting from the 'balcony rail' can fill in shadows on the actor's face however this position can also cause shadows on upstage backdrops or scenery. Very low lighting angles have always been associated with rather unnatural lighting and are usually used for effect lighting only. Footlights, once common in many theatres are seldom used today. Clearly the lighting designer must chose the direction of light very carefully.

In theatre, like in nature the 'floor' reflects some light from below, usually filling in shadows. The color and reflective qualities of a stage floor are very important and for this reason should always be selected with assistance from the lighting designer.

Interestingly enough, the property of DIRECTION was not really considered by McCandless as one of the 'qualities of light' in his 'Syllabus of Stage Lighting, 1964' He did however discuss (briefly) the importance of direction in respect to plasticity of objects and the actual 'position' of the light source.

2.) MOVEMENT

Movement in light is generally taken to mean any change in INTENSITY, COLOR, FORM or DIRECTION. Dynamic changes in all of these qualities take place in nature on a regular basis. Movement may also include the physical movement of a source, such as; a search light, police beacon, color wheel, special optical effect, moving projections, mirror ball, etc.

Movement may be rapid or very subtle, slow and imperceivable. Such may be the case of a designer that provides a slow shift in sunlight from one side of the stage to the other throughout the duration of a play. The audience may not notice the shift, however they often may 'feel' the result of the change emotionally. A sunrise or sunset might also change so slowly that the movement in light is imperceivable and the audience may only feel the result and not actually see it.

Up until recently movement was probably the least utilized quality of light, by the stage lighting designer. This all changed in the 1980's when the automated lighting fixture was born. The modern automated fixture can now move physically - directing it's beam from one part of the stage to another. In addition the automated fixture can 'move' from one color or effect wheel to another, at any speed. The changes and combinations of intensity, form, distribution, color and movement are endless.

1.10 - THE LANGUAGE OF LIGHT

1.) REPRESENTING LIGHT WITHOUT LIGHT

The lighting designer must be able to visualize images from nowhere. He must be able to see the final lighting in his mind, scene by scene, long before the production is born. Lighting design is just the process of 'reverse engineering' this mental image and putting it into practice.

The lighting designer must learn to discuss and represent visual images with words, renderings and references to art, period, history and style. This is an important part of the design and communication process. As lighting design is usually a collaborative process it is imperative that the designer learn to explain his proposed design to others to insure that his visual image is appropriate and properly realized.

It is very important to learn to use the terms of VISIBILITY, NATURALISM, COMPOSITION, MOOD, BRIGHTNESS, FORM, COLOR, DISTRIBUTION, MOVEMENT and DIRECTION. These terms and concepts form the basis of any lighting designer's verbal vocabulary and they must be fully mastered and understood.

Lighting qualities such as luminescent, opalescent, translucent, transparent, phosphorescent, fluorescent as well as surface qualities such as, spectral, reflective, refractive, matte, and diffuse should also form part of any lighting designer's understanding and vocabulary.

2.) OTHER COMMUNICATION TOOLS

A collection of reproduction 'paintings' can be an excellent design tool, teaching tool and communication tool. Many of the 'Old Masters' produced work with incredible attention to lighting detail. Some noteworthy examples include: Claude Lorraine, Claude Monet, Edouard Manet, Johannes Vermeer, Jan Steen, Leonardo de Vinci, Edgar Degas, Georges de La Tour, Rembrandt, Renoir and others. Using artwork and a process of 'show and tell' it is possible to easily identify and discuss a great number of different lighting qualities, styles, moods and emotions.

The lighting designer may also produce sketches or renderings, or use CAD (computer aided design) programs to assist in the process of discussing light. Although far from perfect, many new CAD programs do provide photo realistic imaging with very accurate and specific lighting. As a design aid these tools may prove useful, however all rely on the designer first having a complete verbal vocabulary of the objectives of lighting and the qualities of light.

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PART 1 - An Introduction to Stage Lighting

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5.) MOOD (and ATMOSPHERE)

MOOD considers the basic psychological reactions of the audience. If other lighting elements have been properly

applied, the result is a specific MOOD, created by the lighting design. Lighting can cause an audience to feel a wide range of different emotions. Feelings of 'happy, sad, content, horrified, excited, (and often 'bored'), all depend on a wide number of psychological and physiological factors. This is also true in respect to how the audience interprets naturalistic or atmospheric moods, such as sunny, cloudy, rainy, lightning, etc. The stage lighting designer rapidly learns that: "Things are not what they are, things are what they appear to be." (author).

1.05 - QUALITIES OF LIGHT

1.) QUALITIES OF LIGHT

Any study of lighting design must include a thorough understanding of both the PHYSICAL and the PSYCHOLOGICAL properties of light.

Knowledge of the behavior and properties of light can help explain vision and human perception. The lighting designer is especially interested in how the properties of light affect the eye/brain process and cause feelings and emotions.

An understanding of the physical properties of light can also help explain optics, lenses, color theory, lighting and projection equipment and much more. The laws and applications of reflection, refraction and absorption are encountered and used every day by the stage lighting designer and these concepts must be thoroughly understood both in theory and in practice.

These basic qualities of light are; INTENSITY, FORM, COLOR, DIRECTION and MOVEMENT. These are the lighting designer's tools.

Almost all visual images can be described, discussed and analyzed in these terms - both physically and psychologically. There is an excellent classroom exercise that usually starts with an analysis of reproduction paintings from the 'Old Masters'. Student learn to discuss the qualities of light, using such terms as intensity, brightness, direction, color, form, and distribution. These terms are used to discuss the painting in detail from one small area to another. In addition the painting as a whole is discussed in respect to overall lighting impact, style, mood, composition, emotional content and other qualities. (This exercise is sometimes known as the 'postcard' exercise as often this is the source of the reproduction paintings. The author has many in his collection.)

The experienced lighting designer also frequently relies on the qualities of light to help communicate his lighting concept to others. Example: The stage was brightly bathed in a deep blue wash. Slowly, the amber sun softly rose above the horizon gently illuminating the stage in a golden glow. Cool, textured and uncertain light slowly starts to grow and creep throughout every corner of the stage. Soon a low dominating warmth from stage right becomes evident, balanced by a diminishing and cooling of other general light. As darkness falls, the entire stage grows shadowy and covered with sharp defined leaf projections. The blue wash unnoticeably reappears as a shaft of sharp silvery moonlight slips across the stage.

1.06 - INTENSITY and BRIGHTNESS

1.) INTENSITY - (and BRIGHTNESS)

INTENSITY typical refers to the 'strength' of a light source. Intensity of a source exists independent of its distance. Intensity is measured in candela (The old term was candlepower).

ILLUMINATION refers to amount of light falling on a surface. The old term for illuminance was 'illumination'. Illuminance is measured by a light meter (corrected for the curve of the human eye) in footcandles or lux (metric). Typical stage lighting illuminance levels may range from 25 to 200 footcandles or more. The eye has an incredible power of accommodation and can comfortably adjust to illuminance levels in nature from 1 to 10,000 footcandles, or more.

BRIGHTNESS refers to the visual sensation caused by a light source when it interacts with an object and then the eye. Brightness depends on the intensity of the source, on the distance to the object and on the reflective properties of the object. The footlambert is the unit of brightness.

Example: In theatre when we change the dimmer setting of a lighting fixture, we are changing the output INTENSITY of the source. This results in a change of ILLUMINANCE (light falling on the stage) that is perceived by the eye as a change in BRIGHTNESS.

VISIBILITY depends on many factors, not just the intensity of a source or the brightness of an object. Color, contrast, distance, movement and the conditions of the eye and visual system all play an important role towards visibility.

The stage lighting designer is more concerned with the brightness of an object than the intensity of it's light source. He soon learns that objects of higher brightness generally draw attention on stage. Light attracts! Conversely, darkness conceals - but may also put the audience to sleep. One of the prime jobs of the lighting designer is to actually keep the audience awake. This is not as funny as you may think when you consider what we do to an average audience member. Usually late, after dinner and a few drinks we seat the audience in comfortable chairs - and then turn off all the lights! The lighting designer must use the power of light to keep the audience awake and direct their attention to the stage by providing proper visibility, interest and selective focus.

1.07 - FORM and DISTRIBUTION

1.) FORM - (and DISTRIBUTION)

Light provides objects with a sense of FORM. The eye is able to recognize objects in terms of shape, size and position. Our binocular vision assists with this process by providing DEPTH.

"By means of controlling the distribution of light and creating patterns and compositions of light and shade, it is possible to produce sensations on the retina that will be interpreted as forms in space." (A Syllabus of Stage Lighting, S. McCandless 1964).

Form as applied to light is rather complex. It is everything that intensity, color, movement and direction are not. Yet form is caused and influenced by these other qualities of light. Form has to do with the DISTRIBUTION of light or how light strikes a surface and reveals an object. We typically discuss form in terms of clarity and recognition of shapes.

Form and distribution can be discussed on two levels.

First, we can discuss form as applied to the stage setting in respect to how objects appear. A stage might be evenly, softly and flatly illuminated from a low front angle. Alternately, the same stage might be unevenly dappled with tight circular pools from a high overhead angle.

We can also discuss form as applied to the light produced by a stage lighting fixture. (Example: "The fixture produced a sharply defined square shaped beam with a very wide dispersion angle".)

Form becomes much more complex when you consider that an image projector can be used as a stage lighting fixtures. As a result of this technology the light produced from the 'fixture' can take on absolutely any shape, form or distribution.

As in nature, stage light sources may produce either soft diffused shadowless light or hard shadow producing light, - or anything in between. The edge of a lighting beam may also range from a soft almost invisible edge to a hard, sharply defined edge. A beam of light may also have a broken, uneven distribution, as in the case of a gobo or template pattern projection.

1.08 - COLOR

1.) COLOR

All light is colored. White light is simply a mixture of all visible wavelengths (colors). The human eye is most sensitive to light in the yellow-green portion of the visual spectrum (about 550 nanometers), than it is to red or blue at the ends of the spectrum.

Color is usually discussed in terms of HUE, VALUE and CHROMA.

HUE is the classification of a color that the eye sees as red, green amber, etc. VALUE indicates lightness or darkness of a color. CHROMA indicates the purity or saturation of the color.

The PRIMARY colors of light are RED, GREEN and BLUE. These three colors can mix together to produce any other color, including white. (The primary colors of pigments are RED, YELLOW and BLUE.)

The SECONDARY colors of light are formed when any 2 primary colors are combined. The 3 secondary colors are MAGENTA (red & blue), YELLOW (red & green) and CYAN (blue and green).

THE COMPLEMENTARY colors are any combination of a primary and a secondary color that, mixed together make white light. Examples of complementary colors are. MAGENTA & GREEN, YELLOW & BLUE, and CYAN & RED).

When white light is passed through a color filter only the wavelengths corresponding to the color are transmitted. All other wavelength are absorbed. This is referred to as SUBTRACTIVE filtering.

When 2 or more colored beams of light combine to illuminate a surface, they mix together through ADDITIVE mixing.

Stage lighting fixtures produce colored light using high temperature plastic filters. There are more than 100 different colors available from several manufacturers. These filters 'pass' or TRANSMIT their own color and 'block' or ABSORB all others.

Sometimes glass filters are also used. Conventional glass filters generally come in a limited range of colors however they are useful for high temperature applications or where prolonged life of the filter is required. A new generation of 'dichroic' glass filters are also sometimes used for entertainment lighting applications where 'vibrant' colors are needed that will not fade over time. Dichroic filters are made with thin film technology, tuned to specific wavelengths. These filters transmit a specific color and REFLECT all others. (Unlike conventional filters that absorb not reflect unwanted wavelengths.)

1.09 - DIRECTION and MOVEMENT

1.) DIRECTION

The direction of light is one of the most important attributes in stage lighting design. All light has direction. A bare candle radiates light in all directions. A spotlight radiates light in a very specific direction. In nature most light comes from the sky, from above. In theatre lighting this is also generally true as most lighting positions are above the stage or audience.

Low front lighting is often considered to be 'flat'. Very high lighting angles may cause shadows on the actor's faces. Lighting from more than one direction can add 'plasticity' and dimension to an actor. Lighting from the 'balcony rail' can fill in shadows on the actor's face however this position can also cause shadows on upstage backdrops or scenery. Very low lighting angles have always been associated with rather unnatural lighting and are usually used for effect lighting only. Footlights, once common in many theatres are seldom used today. Clearly the lighting designer must chose the direction of light very carefully.

In theatre, like in nature the 'floor' reflects some light from below, usually filling in shadows. The color and reflective qualities of a stage floor are very important and for this reason should always be selected with assistance from the lighting designer.

Interestingly enough, the property of DIRECTION was not really considered by McCandless as one of the 'qualities of light' in his 'Syllabus of Stage Lighting, 1964' He did however discuss (briefly) the importance of direction in respect to plasticity of objects and the actual 'position' of the light source.

2.) MOVEMENT

Movement in light is generally taken to mean any change in INTENSITY, COLOR, FORM or DIRECTION. Dynamic changes in all of these qualities take place in nature on a regular basis. Movement may also include the physical movement of a source, such as; a search light, police beacon, color wheel, special optical effect, moving projections, mirror ball, etc.

Movement may be rapid or very subtle, slow and imperceivable. Such may be the case of a designer that provides a slow shift in sunlight from one side of the stage to the other throughout the duration of a play. The audience may not notice the shift, however they often may 'feel' the result of the change emotionally. A sunrise or sunset might also change so slowly that the movement in light is imperceivable and the audience may only feel the result and not actually see it.

Up until recently movement was probably the least utilized quality of light, by the stage lighting designer. This all changed in the 1980's when the automated lighting fixture was born. The modern automated fixture can now move physically - directing it's beam from one part of the stage to another. In addition the automated fixture can 'move' from one color or effect wheel to another, at any speed. The changes and combinations of intensity, form, distribution, color and movement are endless.

1.10 - THE LANGUAGE OF LIGHT

1.) REPRESENTING LIGHT WITHOUT LIGHT

The lighting designer must be able to visualize images from nowhere. He must be able to see the final lighting in his mind, scene by scene, long before the production is born. Lighting design is just the process of 'reverse engineering' this mental image and putting it into practice.

The lighting designer must learn to discuss and represent visual images with words, renderings and references to art, period, history and style. This is an important part of the design and communication process. As lighting design is usually a collaborative process it is imperative that the designer learn to explain his proposed design to others to insure that his visual image is appropriate and properly realized.

It is very important to learn to use the terms of VISIBILITY, NATURALISM, COMPOSITION, MOOD, BRIGHTNESS, FORM, COLOR, DISTRIBUTION, MOVEMENT and DIRECTION. These terms and concepts form the basis of any lighting designer's verbal vocabulary and they must be fully mastered and understood.

Lighting qualities such as luminescent, opalescent, translucent, transparent, phosphorescent, fluorescent as well as surface qualities such as, spectral, reflective, refractive, matte, and diffuse should also form part of any lighting designer's understanding and vocabulary.

2.) OTHER COMMUNICATION TOOLS

A collection of reproduction 'paintings' can be an excellent design tool, teaching tool and communication tool. Many of the 'Old Masters' produced work with incredible attention to lighting detail. Some noteworthy examples include: Claude Lorraine, Claude Monet, Edouard Manet, Johannes Vermeer, Jan Steen, Leonardo de Vinci, Edgar Degas, Georges de La Tour, Rembrandt, Renoir and others. Using artwork and a process of 'show and tell' it is possible to easily identify and discuss a great number of different lighting qualities, styles, moods and emotions.

The lighting designer may also produce sketches or renderings, or use CAD (computer aided design) programs to assist in the process of discussing light. Although far from perfect, many new CAD programs do provide photo realistic imaging with very accurate and specific lighting. As a design aid these tools may prove useful, however all rely on the designer first having a complete verbal vocabulary of the objectives of lighting and the qualities of light.

Stage Lighting Design

Stage Lighting Design

PART 2 - General Design Methods

2.01 - GENERAL DESIGN METHODS

1.) INTRODUCTION TO LIGHTING METHODS

There is no one 'method' for lighting the stage - there are many. Or put another way, the first rule of stage lighting is...there aren't any. As long as the objectives of the lighting design and the lighting concept are met, the designer may use any appropriate DESIGN technique that he wishes. The professional lighting designer must however communicate his design to others, through the use of standard conventions.

Each production has very different lighting needs. Lighting for a production of 'Annie' vs a Martha Graham dance piece have totally different styles and requirements. The lighting student must not look for a 'system' or a 'method' that will work for all lighting needs. There isn't one. Instead the lighting designer must understand the needs of each particular production, carefully define them and then produce the lighting design accordingly. It is only by this approach that the lighting design will be most efficiently suited to the exact needs of the production. No two productions are ever the same and no two lighting designers ever work alike.

2.) VISIBILITY VS MOOD

The first and most important principle of stage lighting is still considered to be VISIBILITY. This was probably also true for early lighting designers, using candles, oil lamps, gas lighting and electric arcs.

Usually the designer will light the actor first for visibility and then for mood and atmosphere second. There are times however when MOOD may wish to overpower visibility (at least temporarily). Today many concert designers may light a stage first for mood and impact and then second for visibility. In this respect, much of the general lighting might consist of strong colors, projections, or moving effects. Using the followspot or the automated lighting fixture, the designer can 'cut' through the mood lighting and add controlled, precise lighting to performers, any where on the stage.

3.) EVOLUTION OF METHODS AND EQUIPMENT

Most lighting methods have evolved from light source and fixture technology. Spotlight fixtures today provide the designer with narrow beam spreads of about 10-40 degrees. This was not always the case. Less than 100 years ago, most lighting consisted only of flood lighting, as the narrow spot did not exist. With the development of the spotlight (lime light, electric arc, then incandescent), lighting methods changed. It now became possible to precisely place and localize light, anywhere on stage. As equipment continues to develop, so will lighting methods. With the new generation of automated fixtures, new lighting looks never before seen - are now possible.

2.02 - SINGLE SOURCE METHODS

1.) SINGLE SOURCE METHODS

A designer may wish to light an entire stage with a single source of light as the sun or moon lights the earth, causing strongly motivated directional lighting, with a single shadow. This is seldom practical however for a number of reasons.

First, there are very few high-power lighting fixtures that are capable of lighting an entire stage. Typically a fixture of 10,000 watts or more would be required to provide the lighting to a small stage area.

Second, a single large fixture would be quite uncontrollable and would not only illuminate the acting area, but also the surrounding stage, wings and perhaps even some of the audience.

Third, for true single (point) source lighting to 'work', the source must be a great distance away. This is seldom possible in most theatre facilities.

In nature the point source of light is a great distance away. Assume the sun to be a lighting fixture and move say 25 feet 'away'. The drop-off of light is not noticeable. You have hardly moved away from the source at all. Now imagine a single stage lighting fixture, say 100 feet from the stage. An actor might move back 25 from the source. He has now moved a much greater distance in relationship to the source and the drop-off of light will be very noticeable. This is due to the inverse square law nature of light. The further the distance from the source, the more rapidly lighting levels drop. It is generally not possible to find appropriate mounting locations in most theatres for single source lighting and as a result, multi-fixture techniques are typically used instead.

There is also an important lighting concept that relates the size of a source to the sharpness of it's shadow. In general, the smaller the source, the harder the shadow. Conversely, the larger the source, the softer the shadow. For example, at the same distance a lighting fixture with a 6 inch diameter lens will produce a harder shadow than a fixture with a 36 inch source diameter (such as a: scoop, light box or box flood). Also as the distance to the source is made to increase, the hardness of the shadow will increase.

Although lighting an entire stage production with a single source of light is usually not practical, single source lighting does have its uses. Often it is possible to use a single source of light when highly dramatic, stylized or 'effect' lighting is required for a specific scene. It is possible to light an entire scene from a single source such as the light from a table lamp or from an open refrigerator door however it is important to note that the audience can often tire easily of this.

2.03 - POINT SOURCE METHODS

1.) POINT SOURCE LIGHTING

Most stage lighting fixtures perform as 'point' sources. In this respect they produce a single shadow and they provide a light output that follows the inverse square law. For example, A lighting fixture 50 feet away might provide 100 footcandles. If the distance is doubled to 100 feet, only 25 footcandles are provided (one quarter).

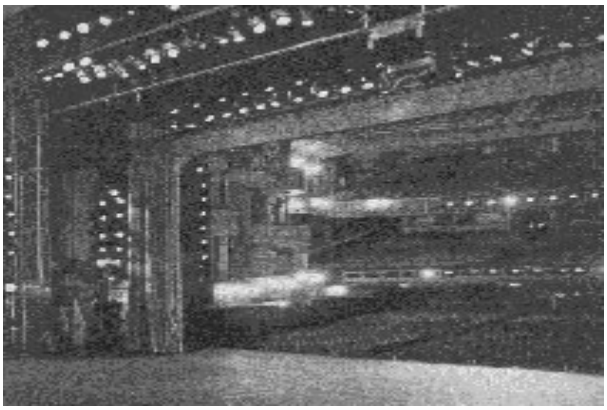
Point source lighting forms the fundamental basis of all stage lighting design. The basic ingredients of all lighting design include the FRONT, BACK, DOWN, DIAGONAL, SIDE and UP light (and everything in between). The designer will sometimes use these basic single sources alone but most often they will be combined. Nothing is more dramatic than a modern dance piece lighted only with a series of isolated down lights or a single diagonal backlight, against an illuminated cyclorama. Nothing is more tiring and boring than watching a drama illuminated only with a series of tight pools of light.

The student designer must get to know the FRONT, BACK, DOWN, DIAGONAL, SIDE and UP light very well. He should experiment in an actual theatre with different types of equipment mounted in these positions. He should try different angles and should light different backgrounds, scenery and even actors. When the basic single sources have been mastered, two or more lighting angles should be combined on a single area. This is a very important exercise and forms the basis of all lighting design.

There are also a number of lighting books that contain photographic lighting studies of the basic sources (front, back, side, etc.) lighting a mannequin or an actor. One of the better studies is by Jean Rosenthal in her book 'The Magic of Light'. This photographic essay shown a number of lighting fixtures mounted in typical theatre lighting locations. The study contains excellent photographs, renderings and drawings of many different examples. There is also a light plot included showing the type and layout of all the equipment used.

2.04 - MULTI-SOURCE METHODS

1.) MULTI-FIXTURE LIGHTING



Today most stage and entertainment lighting design uses multi-fixture lighting methods as opposed to single or point source methods. This allows the designer to have full control over the lighting, anywhere on stage, in respect to intensity, direction, distribution, color and movement.

Multi-fixture methods use a wide range of fixture types and a wide variety of lighting techniques. Today, most fixtures use the 'dimmable' tungsten-halogen lamp as a source. Increasingly however new H.I.D, (high intensity discharge) sources are finding their way into stage lighting applications. It is common today to integrate both conventional lighting fixtures with the new generation of automated fixtures, resulting in both a sophistication and simplicity of lighting design, never before possible.

It is not unusual for a modern theatre or concert hall to use 400-500 lighting fixtures for a single production. Ideally each lighting fixture will have it's own dimmer control. In older facilities with a limited number of dimmers, it is sometimes necessary to physically plug (or 'patch') several fixtures onto one dimmer.

Many lighting designers will often try to use only specific fixtures for specific scenes. Some designers may design a 'general plot' that is intended to work equally well with all scenes. Still other designers will use a combination of 'general' and 'scene specific' fixtures. The exact approach will usually be dictated by the available equipment, mounting positions, time and budget.

Usually the designer that has done his homework will only hang the number of fixtures that are required for his design, and a few spares. Other designers, not really sure of what there doing may use a 'cover your tail' approach and hang a fixture in every possible mounting position that the theatre will allow. (Just in case.) These designers can make a 400 fixture design look like a 120 fixture design, with ease.

Conventional lighting fixtures are always hung on 18 inch centers (or more). A typical 30 foot long pipe will accommodate 20 fixtures total.

2.05 - MCCANDLESS METHOD

1.) MCCANDLESS METHOD

Although there may be no 'one' method of lighting design, there is however a systematic approach that was proposed by Stanley McCandless (Yale University School of Drama 1925-1964). It is this approach that is the foundation for modern stage lighting design today.

2.) ACTING AREA LIGHTING

McCandless proposed that the stage setting be broken up into a number of ACTING AREAS, each with two (2) fixtures. The fixtures were to be positioned overhead as front lights at approximately 90 degrees to the area. Further the fixtures were to be located approximately 45 degrees horizontally. Next McCandless proposed that each lamp have a different color filter, a 'warm' from one side, a 'cool' from the other. Each area was also (ideally) given individual dimmer control.

An 'open' stage would be typically broken into 9 areas (more or less as required), each having an 8-12 foot diameter. Areas might be arranged; 3 downstage, 3 center stage and 3 upstage.

The two fixtures provided VISIBILITY to the actor. The dimmer controls allowed areas to darken or brighten as needed, providing SELECTIVE FOCUS, COMPOSITION and MOOD to the overall stage picture. The position of the two fixtures, allowed an actor to 'play' to either his right or to his left, and still be in a KEY light. The angle between the fixtures provides excellent plasticity and form to the human face. The opposing warm and cool colors assist in providing interest, contrast and naturalistic lighting.

3.) BLENDING and TONING

Light the actors first for visibility, then light the surroundings separately for mood and atmosphere, was the McCandless's approach. Sometimes no additional lighting is required, letting the 'flare' from the acting areas illuminate the walls of a set. Alternately, scenery may need WASH or FLOOD lighting to help integrate and blend it into the entire lighting picture.

4.) BACKGROUNDS and BACKDROPS

Backgrounds, backings, backdrops and cycloramas should all be illuminated separately from the actor and from the scenery.

5.) EMPHASIS and SPECIALS

McCandless recommended additional fixtures (if needed);

(a) to provide 'acting area specials' (entrances, furniture, etc).
(b) to provide motivation (sunlight, moonlight, firelight).
(c) to provide projection or effects.

2.06 - AREA LIGHTING

1.) AREA LIGHTING

Typically all stage lighting has to do with the lighting of a performer (dancer, actor, musician, etc.). Performers tend to work in AREAS. This is a good thing, because most stage lighting spotlights tend to provide localized areas or pools light.

Usually the first element of lighting design, is the ACTING AREA LIGHTING. Sometimes referred to as 'key' lighting, this lighting provides visibility to the performer - on an area by area basis. Area lighting when used with dimmer control, also provides a valuable method of isolating or accentuating a performer in any area on the stage. In addition, properly designed area lighting can also contribute to the overall, mood, atmosphere and composition of the stage picture.

It is important for the designer to be able to visualize the performance space, in the form of invisible three dimensional lighting areas. These areas should relate to the architecture and geometry of the stage or stage setting. Alternately, these areas should relate to the activities and blocking of the performers.

2.) ACTING AREA - FIXTURES

The ellipsoidal reflector and the fresnel spotlight are two luminaires particularly suited to the needs of area lighting. These fixtures provide beam spreads of from 10 - 50 degrees and are typically available in wattages of 500 to 2000 watts.

3.) ACTING AREA - METHODS

Typically the stage is broken down into a number of areas, across the front, across mid-stage and across upstage. Typically 3 x 3 or 9 areas total might be provided for a small box set. As many as 9 areas wide x 5 areas deep, might be provided for a large opera or musical. A large arena show may have over 100 areas.

Note that an uneven number of areas (3-5-7-9 etc) across the front of the stage is particularly useful. This system always provides an area on the center line - most often where half the show will take place.

Areas of 8-12 feet across seem to be most useful for theatre area lighting applications. Large arena type productions might however be better provided with areas of 12-20 feet across (or more).

Areas may be illuminated with one or more lighting fixtures. Typically, an area might be provided with a front light, a downlight, and a back light - depending on the needs of the production. Areas may also be illuminated with two (2) fixtures from the front and at 90 degrees to each other (after McCandless). The principle objective of area lighting should be to light the actor and avoid lighting the background. In this respect the lighting designer must carefully select both the angle and direction of all area lighting.

Although McCandless recommended that fixtures be mounted at 45 degrees above the horizontal, modern lighting practice tends to use angles of 45-60 degrees (or more) for front area lighting. Generally the higher the angle the more 'shadowy' and dramatic will be the lighting. Higher angles are good to prevent spill light upstage. Lower lighting angles are good for lighting the eyes and for lighting under hats.

2.07 - TONING & BLENDING

1.) TONING & BLENDING

After lighting the actor with AREA LIGHTING, it may or may not be necessary to provide additional light to the surrounding scenery. Usually lighting specifically used to light the scenery is referred to as 'toning and blending' lighting - as it helps tone the scenery and blend with the acting area lighting.

Sometimes, for example when lighting a drama, in a box set, only area lighting may be required. No additional lighting is needed to light the set. This is due to the fact that reflection from the area lighting may bounce off the floor and illuminate the walls in a most naturalistic and appropriate way.

Alternately, however, if the production is a comedy, the set may feel a bit dark and dreary. No matter how the lighting designer tries to boost the acting area lights, the set still looks dark in comparison. In this case, additional lighting of the upper walls of the box set would probably provide an appropriate visual lift.

2.) TONING & BLENDING - FIXTURES

Toning and blending lighting, tend to use different fixture types, depending on the exact lighting application. Spotlights, floodlights and striplights all have their place.

3.) TONING & BLENDING - METHODS

Often toning and blending lighting is provided by soft flood type of fixtures. Both strip lights and box floods are suitable for this application.

Alternately spotlights may provide a more dramatic form of toning and blending. I personally like to use ellipsoidal reflectors with soft focus break-up templates to provide a textured toning and blending light to each wall of a set. These fixtures are usually located at a fairly low angle (box booms), and gently 'wash' and tone the scenery as needed.

During the early 1900's and until about 1960, toning and blending lighting was often provided from a series of three (3) or four (4) color strip lights, mounted above the stage. Strips (also called X-RAYS) ran from stage left to stage right, and were often used; downstage, center stage and upstage. Some theatres might have as many as five (5) sets of strip lights, permanently installed. Strip lights typically would be colored with glass or plastic filters in; red, green, blue and amber. Musicals, operas and variety shows, found strip lighting particularly useful in providing color washes. One moment the stage could be completely bathed in a night blue, the next in daytime amber. The red, green, blue, primary

filters allowed just about any color to be mixed to provide an instant color wash to the stage, or the scenery below.

2.08 - BACKGROUND LIGHTING

1.) BACKGROUND LIGHTING

After lighting the actor with AREA LIGHTING, and after lighting the set with TONING & BLENDING LIGHTING the designer will separately light all backgrounds. Backgrounds are generally taken to mean - backdrops or background cloths. The painted backdrop has been used for hundreds of years in theatre, opera and dance. A properly painted backdrop can sometimes convey a sense of depth unrivaled by 3-dimensional scenery.

Backgrounds lighting also includes the lighting of large cycloramas to small patches of a painted drop, peaking through the window of a box set. A stylized opera or ballet might be performed on an open stage with only a 30' x 60' cyclorama as a background. Other productions might use 10 or more painted backdrops. Sometimes backgrounds may be realistic. At other times they may be abstract, surrealistic, impressionistic, or highly stylized.

2.) BACKGROUND LIGHTING - FIXTURES

Typically, backdrops are illuminated with striplight fixtures - sometimes called X-Rays, borderlights or battens. The striplight fixture consists of a linear lighting strip (usually 6-9 ft. long), with 9-12 individual lamp compartments. The compartments are wired in 3 or 4 circuits, with each circuit, colored as required with plastic filters. Sometimes the three (3) primary colors are used (red, green & blue), so that the designer can mix almost any color.

Striplights have developed essentially, as lamp technology has developed, using first oil and candles, then gas then the electric filament lamp, with a crude reflector. Some modern units use 'R' or 'PAR' lamps. A miniature striplight using the MR16 lamp was developed in the 1980's and is sometimes referred to as the 'Zip-strip'. Although compact and efficient, this product is not without problems. Lamps are wired in series with (typically) 10 x 12 volt lamps on each circuit. This means if one lamp 'blows', the entire circuit turns off. In addition the maximum wattage lamp available is the 75 watt, MR16 lamps. These 75 watt lamps typically burn at a temperature sufficiently hot to cause damage to most lamp sockets, after a period of time. If the designer wants reliability, he is forced to use a lower wattage lamp (ie 42 or 50 watts).

The asymmetrical box flood provides an alternate to the striplight fixture. This fixture has an asymmetrical reflector to 'push' more light towards to bottom of the drop. These fixtures are also available in compartment type fixtures of 1, 2, 3, and 4 compartments each.

3.) BACKGROUND LIGHTING - METHODS

Usually, the designer is trying to achieve a soft, even and smooth illumination across the entire backdrop. The backdrop may be illuminated only from the top, only from the bottom, or from both top and bottom at the same time. A cyclorama is often illuminated with three (3) color lighting from both the top and bottom. In this respect it is possible to provide a wide range of dynamic sky effects, using different colors from the top and bottom.

Backgrounds can also be illuminated by either front or rear screen projection. Sometimes backgrounds are illuminated with moving clouds with gobos, or with streaks, slashes or other symmetrical or asymmetrical effects.

2.09 - FEATURES AND SPECIALS

1.) FEATURE LIGHTING

Feature lighting (or specials) are lighting fixtures used for very specific applications - other than acting area and background lighting. Typically they are used to supplement the general area lighting or to provide specific lighting effects.

A 'special' might consist of a tightly focused fixture on the face of a clock or on a painting hung on stage. This can allow the designer to reduce the general lighting and 'feature' or draw attention to any object or part of the stage. (A cheap trick, but effective!)

This also works with actors. If three actors, seated at a table are each lighted with a tightly focused 'special', it will be possible to visually shift attention from one actor to another, or balance all three equally. The use of specials for actors also guarantees they will be properly illuminated when needed, for dramatic reasons.

2.) FEATURE LIGHTING - FIXTURES

The ellipsoidal reflector is usually the fixture of choice for features and specials. Typically narrow angle E.R. fixtures are used with beam spreads of 5-20 degrees. These fixtures are often used with framing shutters, irises, or with other beam shaping devices - to put the light only where needed. The beam edge may be adjusted from 'hard' to 'soft' depending on the design objectives.

Sometimes beam projectors and PAR type 'pin spots' are also suitable for use as specials. These narrow angle fixtures can only provide a soft edge beam, usually with a slightly oval shape.

When the designer uses tight specials for performers, sufficient time must be given during lighting rehearsals to allow the actor to properly 'find his light' and be confident that he can be 'on the mark' each time. An actor that is out of his isolated special generally makes everyone look bad, so spend the extra time to make specials work.

2.10 - THE SECRET METHOD

1.) THE SECRET METHOD OF LIGHTING DESIGN

There may be no one method of lighting the stage or there may be no 'rules' of lighting design - there is however 'the secret' of good lighting design. The secret is: KNOWLEDGE, UNDERSTANDING, EXPERIENCE and PROFICIENCY. Many lighting designers may take the 'experimental' approach, and just try things, with no real method or concept of what they are trying to achieve. Sometimes this method gives brilliant and exceptional results. More than often it does not. Experimentation is very important for the lighting designer and all designers should try new things whenever possible. It is only through a systematic approach however that the lighting designer will be able to provide predictable and consistent result in any number of different situations.

The designer must know what he is lighting and how he wants the production to look. The designer must be very familiar with the script and all lighting requirements of the production. He must use the qualities of light and objectives

of stage lighting to allow him to fully visualize, verbalize and define his design concept and intentions.

The designer must have a complete understanding of the many different types of luminaires, used in different lighting positions (both alone and in combination). He must know what the FRONT LIGHT, SIDE LIGHT, DOWNLIGHT, BACKLIGHT, UPLIGHT and DIAGONAL lighting positions produce - in any combination. These are the building blocks of lighting design and the designer must instinctively know what fixtures to use and from direction. This comes only from experience.

The designer must also know how to PRACTICALLY realize his design in an actual theatre or performance space. The designer must know the venue and have details of all lighting positions. He must know what equipment is needed to realize his visual image of the production and where to use it. He must know the many available design methods, (point source, single source, multi-source, etc.) and he must chose methods that will meet both his design criteria - and the budget.

Lighting design is not a solitary art. The designer must learn to collaborate with many other members of the production, design team and crew. In this respect the designer's 'human skills' can make or break the entire lighting design. The professional lighting designer must be concerned with PROCEDURE however he must also be concerned with RESULTS - and know how to get it.

Stage Lighting Design

Stage Lighting Design

PART 3 - Applied Design Methods

3.01 - STAGE LIGHTING DESIGN

1.) INTRODUCTION

Traditionally when we speak of stage lighting we usually think of lighting as applied to 'legitimate' stage productions that take place in an actual theatre. As performing arts and entertainment developed throughout the 1900's, stage lighting became far more than 'just lighting plays'. New lighting specialties were born and new lighting standards were set for; opera, ballet, modern dance, live concerts, ice shows, industrial shows, television and other 'live' presentations. STAGE LIGHTING has to do with the controlled and applied use of light to move an audience emotionally and involves far more that just lighting the stage for visibility.

Today modern performance facilities are just as varied as the styles of performance that take place inside them. Facilities include many types of theatres, auditoriums, concert halls, arenas, stadiums, shopping malls and other conventional and non conventional venues.

Most commercial events (theatre, dance, opera) usually take place in an actual theatre. This is a very good thing as usually a theatre is the only controlled environment able to withstand the very demanding requirements of staging, audience comfort, acoustics and hopefully proper lighting.

More and more today producers are taking the show out of the theatre and into the arena. The much larger arena

audience can generate far more revenue for a single show, however conditions in most arenas are usually much less than ideal. In order to provide the audience with the best lighting (and sound) possible in these problematic spaces, a tremendous amount of equipment is often required. A simple show in a theatre might require 24-100 lighting fixtures. The same show in an arena might require 300-500 fixtures. Arena shows have become very hi-tech, energetic and highly creative in recent years. New tools including the automated lighting fixture and the color changer has brought a new dimension to stage lighting design, never before seen.

Today the stage lighting designer has evolved into the ENTERTAINMENT LIGHTING DESIGNER. This new generation of designer will usually work in a wide variety of venues, performing continuous miracles for an endless number of different events. Following is a general overview of basic lighting methods for a number of performance and non-performance related industries. For information, we also include: display lighting, architectural lighting, landscape lighting, photographic lighting and museum and gallery lighting.

3.02 - THEATRE LIGHTING DESIGN

1.) THEATRE LIGHTING

Lighting for the theatre usually means design for a wide range of different types of productions, presented in theatres or spaces designed to function as a theatre. Productions may include dramatic plays, comedies, tragedies, musicals, concerts and reviews. The 'typical' theatre may range from a traditional proscenium type of theatre, to a 'thrust', a 3-sided stage, a 4 sides stage or no stage at all. Seating may range from 200 seats in a small school theatre to over 2500 seats in a large municipal auditorium.

Small productions in community halls might use 12 - 20 lighting fixtures. A typical professional production might use 48 - 200 fixtures. Today it is now not uncommon for the large 'mega-musicals' to use 500 fixtures or more. The Broadway production of 'Lion King' apparently used 700.

2.) THEATRE HANGING POSITIONS

Effective stage lighting depends very much on the equipment mounting positions that are available in a space. Most theatres usually have permanently installed lighting positions (or pipes). Several positions are usually installed above the audience for front lighting the stage (sometimes called 'Ceiling Coves'). Other auditorium lighting positions usually include 'Box Booms' (vertical pipes adjacent to the proscenium) and a 'Balcony Rail'. All lighting located in the auditorium is referred to as 'FOH' lighting (Front of House).

Other positions are installed above the stage and usually consist either of a fixed pipe grid or a system of motorized (or counterweight) pipes. Lighting distances (to the stage) typically will range 30-80 feet for equipment mounted above the audience, and 20-40 feet, for equipment mounted above the stage. Additional lighting fixtures are often used on the floor to 'uplight' backdrops, or as footlights (less often in recent years). The use of Box Booms, Tormentor Booms and portable Stage Booms as a method of mounting fixtures, is also quite common.

3.) THEATRE LIGHTING - TECHNIQUES

Most theatre lighting methods are 'loosely' based on the McCandless method; first light the actor for visibility, then light the scenery, and backgrounds for atmosphere and interest. McCandless also put forward a simple method of AREA lighting for the proscenium stage. This method divides the stage into a number of smaller areas and then provides each area with 2 front lights mounted some distance apart. Fixtures must be accurately placed to give appropriate lighting angles and direction of light to the actor. Areas must also be controlled in size, to avoid

unnecessary 'spill' light on adjacent areas or scenery. A front light at 70 degrees (horizontal) to an actor may be well suited to a dramatic production, while a lower angle of 50 degrees might be better suited for a comedy. If the actors are all wearing hats, then a front light of no more than 45 degrees may be necessary, in order to provide more light to their faces.

4.) THEATRE EQUIPMENT TYPES

The designer must carefully chose fixtures that work efficiently from a specific lighting position (distance). For most general stage lighting applications the designer will work with only about five (5) basic equipment types. Each type however is available in a number of different wattages, lens diameters and beam spreads. The basic equipment types used in theatre lighting are: The FRESNEL, ELLIPSOIDAL and PAR spotlight, the BOX FLOODLIGHT and the STRIPLIGHT. Typical wattages are 500-2000 watts. The FOLLOWSPOT is also sometimes used for very stylized plays or comedies.

3.03 - DANCE LIGHTING DESIGN

1.) DANCE LIGHTING

Lighting for dance is taken to mean all forms of performance dance, including; Ballet, Modern, and Contemporary. More traditional forms of dance are often presented under the controlled conditions of a proper theatre, with complete technical and lighting facilities. Other forms of dance (Modern & Contemporary) may be more comfortable in 'found' or nonconventional spaces. In this respect dance venues range from the elegant proscenium house, to the church basement to the shopping mall.

2.) DANCE LIGHTING - TECHNIQUES

Theatre lighting is concerned with lighting the actor's face for visibility. Dance lighting is concerned with lighting the human form for plasticity, interest and emotional impact first and visibility of the face, second. In theatre, front light usually provides the main lighting to the acting areas. In dance however, side lighting is usually a main source of illumination. Front lighting, if used at all is usually reserved for the provision of color washes or specials.

Side light was introduced to dance by Jean Rosenthal a famous American lighting designer in the early 1940's. "My system required fixed lighting booms along the side at every entrance as a basis for flexibility and for lighting the whole stage. That made the ballets look different, which rousted the European choreographers and designers for Ballet International in 1944". (Rosenthal, The Magic of Light). Ms. Rosenthal also worked with the well known American choreographer, Martha Graham, for many years.

In addition to the extensive use of side light, dance lighting often uses 'down lights' (pools), and 'back lights' (to silhouette dancer). Front light is seldom used due to its 'flattening' characteristics, and this position is usually reserved for 'color wash' lighting. The followspot is often used in Ballet to highlight the principal dancers.

Side lighting techniques, usually require a vertical lighting boom in each 'leg' or entrance. Often 4-6 booms may be required (each side). Each boom may have one (1) or more fixtures (usually 3-5). The fixtures (usually ellipsoidals) are focused straight across the stage, and usually 'shutter' off, of the opposite side, stage masking.

A typical three (3) fixture boom, might have fixtures mounted at 10', 8' and 1 ft., above the floor. The fixtures are often referred to as being in a TOP, MID or SHIN positions. The TOP and MID fixtures are usually used for general side light. Often the TOPS and MIDS will have different colored filters. The bottom lamp (shin or shin buster) has been traditionally used to light the legs of the ballet dancer, and to provide light up, under the tutu. Modern dance designers

may use the shins as the principal source for a non naturalistic angle of light, often with strong color(s). If properly shuttered off of the floor the effect can cause the dancer to appear to 'float' across the floor. The effect is very dramatic, particularly with opposing colors from opposite sides.

3.04 - OPERA LIGHTING DESIGN

1.) OPERA LIGHTING

Lighting for opera used to refer to traditional 'grand opera', however, today it may also refer to contemporary opera. As such, opera may be performed in the grandest of concert halls, or in the least elegant of hockey arenas. Opera is about music, theatre, singing, acting and dance, and as such lighting design for opera is typically a combination of theater, dance and musical theatre lighting techniques. Fortunately for the lighting designer, and due to the need for good acoustics, most professional operas take place in well designed theatres or concert halls.

2.) OPERA LIGHTING - TECHNIQUES

Opera lighting must light the singers for clarity, the dancers and chorus for interest and the scenery for atmosphere. Operas may be simplistic and straight forward, or highly complex and stylized. It is not unusual for 'visions' to appear from out of 'nowhere'. Nor is it unusual to have the 'devil' frequently appear or disappear throughout the course of the production. The opera lighting designer must be ready for this and for much more.

The 'scale' of opera lighting can often exceed that of theatre, dance or musical theatre lighting. Typically, opera will use a great deal performance space. The stage is usually large, the lighting positions are usually at a 'high trim' of 28'-35' and there is usually a large amount of scenery to light.

To further complicate matters, the opera designer must work quickly. Generally there is less time to 'light' an opera than there is for a typical stage musical, theatre or dance production. Professional performers and union crews are expensive (and plentiful) and the opera lighting designer will often have only one or two lighting rehearsals, prior to the opening of the production.

Most opera singers are like moths and they tend to gravitate towards the light. They seldom miss their specials and if they do they are very good at 'finding their light' very quickly. This designer has also learned that no matter how the director may block an opera, most opera stars will end up downstage center - in front of the conductor, most of the time.

Next to the opera director, it is the Maestro (conductor) that runs the show. The conductor is a very important member of the artistic team and is concerned with how the singers and musicians sound together. During a performance it is considered appropriate to spotlight the Maestro upon entering the orchestra pit. Further it is mandatory that the singers and musicians, all are able to clearly see the maestros' hands at all times. In this respect a downlight is usually used from above, to light the maestro's body, arms and hands.

It is generally assumed that an opera lighting designer is familiar with the music and the opera that they are lighting, unless of course it is a new original opera. Knowledge of opera is mandatory and often must be assumed when a designer is hired. If the designer does not know the opera, he has a tremendous opportunity to take the score and a recording (CD, Video, etc.) and become familiar with it before he even attends his first rehearsal. The score and the recording will provide a valuable aid to: scene breakdown, mood & atmosphere, blocking and general 'lighting looks'.

3.05 - MUSICAL THEATRE LIGHTING DESIGN

1.) MUSICAL THEATRE LIGHTING

Lighting the "Musical", typically refers to lighting the large scale musical theatre productions (al a Broadway or the West End). Classic productions include: 'Hello Dolly', 'My Fair Lady', 'The King & I' , 'Oklahoma', 'Showboat', 'Guys & Doll's, 'Sound of Music', Annie, etc. More contemporary musicals include; 'The Lion King', 'Phantom of the Opera', 'Cats', and many more.

The typical musical contains elements of drama, singing, dance and music. A small musical may only have a cast of 4 performers and 2 musicians. A large musical may have a cast of 50-100, actors and dancers and 50 musicians. The musical 'moves' quickly and usually has a great many different scenes and locations.

The usual musical theatre production takes place in a proscenium type of theatre, with the orchestra located in the orchestra pit. Usually the theatre is never quite large enough to accommodate the full amount of scenery, lighting, performers and musicians, necessary.

The musical is often structured with alternate scenes, played downstage of one of several different backdrops. This allows a full scene to be 'preset' upstage. When the drop rises, we are magically transported to a new stage setting.

2.) MUSICAL THEATRE LIGHTING - TECHNIQUES

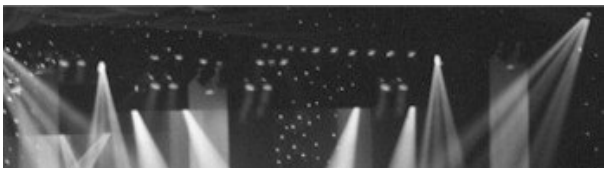
Most 'classic' musicals strive for realism. That is, many of the scenes are lavishly designed as realistic and believable interiors or exteriors. In this respect, the lighting is expected to provide a specific mood, atmosphere and indication of time of day. Often this information is also provided by the lyrics and by the script.

In addition to the element of realism expected by the audience, musicals also contain elements of fantasy and surprise. It not uncommon during a song, to completely isolate performers with follow spots, and then suddenly 'restore to reality' at the end of the song. Other numbers may be full production numbers, with full chorus and dancers requiring colorful and rapid lighting changes throughout.

Typically, musicals make extensive use of followspots. This is necessary if the performer is to be isolated during musical numbers, and featured during 'book' scenes. Two (2) to five (5) followspots are typically used, from the ceiling of the auditorium. Followspots are also sometimes used from behind the proscenium arch (bridge spot) to provide a steeper & more isolated lighting angle to the stage.

Lighting techniques for the musical are varied. Visibility is usually provided for by the followspots. 'Area lighting' is often provided for the 'book scenes', color; washes, sidelight and back light are usually provided for the production and dance numbers. The backdrops and cyclorama are illuminated for interest and mood. Musicals often have a high level of 'glitz' (or effect) lighting. Strobes, neon, beacons, tracking bulbs, mirror balls, etc. are all commonplace.

3.06 - CONCERT LIGHTING DESIGN



1.) CONCERT LIGHTING

It was in the 1960's that the relatively new field of concert (or entertainment) lighting design was born. In New York at the Filmore

East and in California at the Filmore West, popular music moved into
permanent venues and with that, a new style of presentation was born. the best known American concert lighting designers of the time was Chip Monk. At the Filmore, lighting operation literally consisted of the operator actually 'dancing' on a wall of autotransformer dimmers in time with the music.

Many early performances at the Filmore's, the Electric Circus and elsewhere throughout America, were backed by a 'light show'. A wide array of projection effects would bombard a large rear screen behind the performers, causing dynamic and ever changing patterns of light. Projections would often make political statements, be downright dirty or be totally psychedelic and far out.

Today concert lighting design has become a recognized speciality and many designers work in this field only. The basic principals of design still apply -it's just that the toys are bigger, and more expensive.

2.) CONCERT LIGHTING - TECHNIQUES

Entertainment lighting today has become tremendously exciting. This industry now uses 'automated' lighting fixtures almost exclusively. Conventional lighting fixtures are still used, however less and less often. The PAR 64 fixture is still very popular for concert lighting, as this fixture is efficient and relatively inexpensive. It is not uncommon to also incorporate; color changers, motion effects, image and background projection, video, display panels, strobes, blacklight, fog, pyro, chase lighting and other visual effects. The sky's the limit...uh...the budget's the limit.

Typically all equipment is DMX controlled from a central location. Concert lighting that uses automated fixtures depends very much on two important people - the Lighting Designer and the Programmer. The position of 'programmer' was born in the 1980's as automated fixtures became more and more capable (and complicated). A good programmer will know his equipment well and will be able to rapidly construct a number of different 'looks', based on the designer's basic criteria. A poor programmer offers little and is able to make a million dollars of equipment look like ten cents! Alternately a good programmer can produce amazing results with very little time and equipment.

Most concert performers also tour, so concert lighting must be extremely durable, well packaged, and suited to a rapid set-up and take-down. The portable 'flown' lighting truss was developed for this industry and is often used to suspend all lighting fixtures above the stage.

3.07 - ARENA LIGHTING DESIGN

1.) ARENA LIGHTING

Lighting for the "Arena" typically refers to lighting of large scale events, including rock shows, pageants, ice shows, circuses and other sizable entertainment productions. Seating for these events may range from 5,000 to 25,000 spectators, or more. Often there may be a 'main stage' at one end of the arena, or alternately, several different performance areas, located throughout the entire arena floor.

Performers often include actors, singers, dancers, musicians, skaters, aerial artists and others. Events are often visually spectacular and may utilize smoke, fog, lasers, pyro (fireworks), slide, film or video projection. Further, lighting equipment today always includes as many automated fixtures as the budget will possibly allow.

Two very important factors set arena lighting apart from other forms of traditional stage lighting. First, the 'scale' is much larger than usual theatre scale. This refers to the scale of everything, including performance and audience areas,

scenery, lighting distances and lighting fixture types. Second, everything is temporary. Typically, all special lighting equipment must be brought into the arena, hung, cabled and focused, and then removed (struck) after the event. Arena lighting should be designed to be 'quick and effective' (not necessarily 'quick and dirty').

2.) ARENA LIGHTING - TECHNIQUES

Distances to the overhead lighting in conventional theatres usually ranges from 20-50 feet. In arenas, lighting distances may range from 40-100 feet, or more. The greater distances alone, necessitate the use of narrower and more powerful lighting fixtures than used for traditional theatre lighting.

Usually, all lighting equipment is hung (usually pre-hung & cabled) on a number of lighting trusses (20-60 feet long). Trusses are assembled, laid out in position on the arena floor, and then hoisted into position with chain motors, attached to the steel roof members above. Trained lighting crews will either repel from the roof or climb a rope (wire) ladder from the floor to reach each truss. Once in place, they will carefully walk along the truss and focus each fixture one by one. The author has had a skilled crew of four (4) electricians focus over 300 units, 50 feet above the floor, in under four (4) hours).

Lighting fixtures suitable for arena applications include the 1Kw. narrow ellipsoidals (5-20 degrees), Par64-NSP fixtures, and 2Kw. ellipsoidals, fresnels, and beam projectors. HID fixtures with mechanical dimmers are also sometimes used. Effects equipment commonly includes color scrollers and automated (moving) fixtures. The followspot is typically used in great numbers for arena events. Usually, the followspots 'come with the house' and are located high in the arena ceiling around the perimeter walls. Most facilities have from four 4 - 8 units or more. Some touring productions in order to provide consistency from venue to venue, provide their own followspots, mounted in the temporary overhead lighting trusses.

3.08 - OUTDOOR LIGHTING DESIGN

1.) OUTDOOR LIGHTING

Lighting for the outdoor stage includes both open air or semi-enclosed facilities. Productions may include dramas, pageants, , operas, dance, concerts, rock shows, ceremonies, parades, and other variety or theatrical events. The outdoor facility may vary from an open field, to a semi-enclosed stadium, to a special facility constructed for theatre or music. Often the stage is enclosed or covered and the audience is not. Sometimes just the reverse is true.

Many outdoor facilities are orientated so that the sun illuminates the stage, from behind the audience. This usually promotes maximum visibility and usually keeps the direct vision of the sun from the audience. More sophisticated facilities will enclosed the stage with a 'stagehouse', some offering full 'flying' facilities. Often outdoor events are 'timed' to begin in the evening before sunset, and end in the dark of night.

The one fundamental concept that the lighting designer working on an outdoor stage must learn is: IT ISN'T EASY TO COMPETE WITH MOTHER NATURE. Stage lighting during a bright sunny day is almost impossible and has no impact. Stage lighting during a cloudy or overcast day may have some impact but usually at best provides basic illumination. During the day, the designer may need to provide 100's of kilowatts of lighting to a provide even a minor impression on a stage. The lighting may only tend to fill in the shadows at best. If suddenly a cloud passes over the sun, the stage lighting levels will seem to rise drastically. Once the sun has started to set however, a fixture of just 1 kilowatt can appear brighter to the audience than the 100's of kilowatts previously required to provide the same visual impression.

I regularly design the lighting at Canada's largest outdoor professional musical theatre - Rainbow Stage (stage is enclosed). The facility is located in one of Winnipeg's largest and nicest parks, not far from the city centre. The 2500 seat facility is semi-enclosed under a 200 foot diameter geodesic dome, with a view of the trees, below. Act 1 usually starts at 8:00 pm and requires almost all lighting to be at FULL due to the high ambient daylight levels in the auditorium - and the lighting is hardly even noticeable. Slowly - but steadily as the sun starts to set, the lighting becomes more and more noticeable. It is necessary to make constant adjustments to compensate for the darkening ambient daylight. By the time the sun has set, much less light is required to give the same impression as was needed, minutes earlier.

Outdoor events usually involve large venues with large audiences. In this respect the most powerful and efficient stage lighting fixtures are used. The 1000 watt Par64 fixture is one popular choice for outdoor lighting applications, due to its compact size, low weight and high efficiency. H.I.D. (high intensity discharge) fixtures are also used, with automated color changers and mechanical dimmers. High power followspots are also quite common for o outdoor events.

3.09 - DISPLAY LIGHTING DESIGN

1.) DISPLAY LIGHTING

Display lighting includes all lighting for commercial merchandising, including lighting for store windows and for in-store displays. This discipline is discussed here because there are probably more individuals practicing display lighting than stage lighting - it's just that most of them don't know it.

The display lighting designer is usually not a lighting designer at all, simply the person that 'does the lights'. In this respect training, goals and approaches vary drastically. Display lighting is often performed by the 'Display Department' of large department stores or by individual members of the merchandising team, and in this respect there are no particular standards.

The world of display lighting and stage lighting are both totally dissimilar yet quite similar. They are dissimilar in that the stage and display lighting designer seldom if ever communicate with each other. Stage display lighting and stage lighting are similar however in that most of the objectives and methods are the same. The only fundamental difference is in the smaller scale and lower wattage fixtures, frequently encountered in the display lighting field.

The goals are similar to the goals of stage lighting in that display lighting must create visibility, mood, interest, and impact and it must communicate something - even if the concept is to Sell!.

2.) DISPLAY LIGHTING - TECHNIQUES

Typical display lighting distances vary from 6-20 feet - short in comparison to distances encountered in stage lighting applications. For this reason display lighting typically makes use of comparatively wide angle fixtures.

Display lighting fixtures are generally smaller and more compact than their theatre counterparts. Typical display fixtures include the 3.5" ellipsoidal reflector, the 3" fresnel and a wide range of speciality display fixtures. Specialty display fixtures consist of both line voltage (120/240) and low voltage 'R' (reflector) and 'Par' (parabolic aluminized reflector) lamps, mounted in small housings. Pin Spots are also quite common. Typical wattages of display lighting fixtures range from about 100-300 watts.

Often 'track lighting' is used for general window display and in-store display lighting. A variety of different fixture types are available that simply 'clip' to the track, so the lighting may be rapidly changed as the display changes. Make

sure that whichever fixtures are used that they allow the use of an accessory color filter. Most do not.

3.10 - TELEVISION (TV) & VIDEO LIGHTING

1.) TELEVISION LIGHTING

Lighting for television includes commercial and closed circuit television and professional video productions - either broadcast live or recorded. TV lighting design methods were ultimately born from the practice of stage and still photography lighting. Today it is estimated that throughout the world there are actually more designers working in the field of video and TV lighting, than any other lighting discipline. The TV designer is known as the LIGHTING DIRECTOR.

Both television and stage lighting design can be considered as an art form, at least when in the right hands. While the stage designer is most concerned with how the eye of the audience reacts to light, the television lighting designer is more concerned with how the TV camera responds to light.

In the early days of television, it was not uncommon for the first black and white cameras to require in the neighborhood of 250 foot candles or more. When color cameras were introduced, even more light was typically required. During the past several decades, the amount of light required for good picture signal has steadily decreased, as television camera technology has improved. Today it is not uncommon for state-of-the art color cameras to require less than 50 f.c.

The television lighting designer is not just concerned with the quantity of light (footcandles), he is also concerned with the quality of light, just as is the stage lighting designer.

The TV designer is also concerned with color temperature and contrast (contrast between the performer and the surrounding set or background). In fact, the TV designer is much more concerned with contrast, or specifically differences in contract, everywhere throughout the picture area. This is due to the fact that the TV camera tolerates much less of a contrast range than does the human eye. Although the human eye can adjust to contrast in the field of vision in the order of 100,000:1, the TV camera can only handle a contrast range of 100:1, at the best.

Television lighting techniques also should provide a degree of interest or visual balance to the picture. Typically, TV designers will provide a strong directional KEY LIGHT to a performer from one side and a softer, less intense FILL LIGHT, at an angle of approximately 90 degrees to the KEY light. Next, a BACK light is usually used to help visually separate the performer from the background. As in theatre, once the performer is lighted for visibility (or proper signal, in TV), the background and surrounding scenery is illuminated for visual balance, (BASE LIGHT).

TV lighting fixtures resemble theatre fixtures except they are generally larger and of higher wattage. The 2, 5 and 10 Kw FRESNEL is commonly used for key, and back lighting. Other fixtures include SCOOPS and FLOODS are often used for fill and background lighting. Most TV fixtures are designed to be focused and adjusted from the studio floor using a 'long pole'.

3.11 - PHOTO and PHOTOGRAPHIC LIGHTING

1.) PHOTOGRAPHIC LIGHTING

Lighting for still photography is just as much of an art form as is stage lighting design. Generally however, there is no such thing as a 'photographic' lighting designer. Photographers usually do their own lighting and as such, they are responsible for all artistic elements of the image, including; light, contrast, balance, composition, style, impression, mood, etc.

The professional photographer must know the properties of his film in respect to proper exposure, saturation and contrast. Although the human eye can adjust to a wide range of 'brightness' all at once in the visual field, the camera and film cannot. Contrast must be limited to perhaps no more than 3:1 for some films.

Sometimes the stage lighting designer will be present during a production to work with a still photographer, taking documentary or public relations shots of a production. The designer can assist the photographer by ensuring that there is interesting light where needed. Also, background scenery and cycloramas that appear adequately illuminated to the eye, may appear dark, dingy and underexposed to the film. Add additional lighting to these elements as required to reduce subject to background contrast.

Typically theatre photographers will use a 'high speed', Black and white or color film. Positive transparencies (slides) are still preferred by most professional photographers, over a color print film, due to their higher color saturation and due to the fact that they 'reproduce' better than do prints, for most applications.

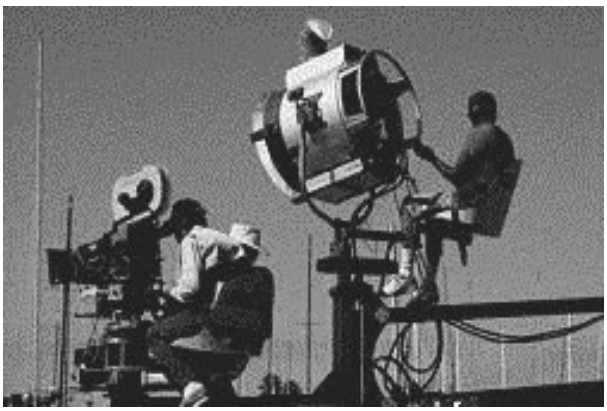
2.) PHOTOGRAPHIC LIGHTING - TECHNIQUES

Natural light and studio lighting are both commonly used for photographic lighting applications. Good studio lighting is often loosely based on the principals of McCandless. Two lights are placed at 45 degrees to each other, in front of the subject. Often one light is brighter (KEY LIGHT) and is used to provide a sense of direction and motivation. The other light (FILL LIGHT), is of slightly lower intensity and 'softer', and is used to fill in shadows caused by the main light. Often 'back' lighting to the subject to provided to help isolate the subject from the background. Additional lighting is then provided to the background as needed.

There are many photographic lighting techniques shown in many photography books. One of my favorite techniques however, is as follows: To photograph a very large room, (church, auditorium, etc.) with poor lighting do the following: Select a film speed and exposure that will allow a 3-5 minute exposure. Then, open the lens and walk throughout the room with a 1000 watt flood light, evenly painting all surfaces. All surfaces in the photo will be properly exposed, and the 'light painter' will be invisible if he moves quickly enough. Simply paint more light where darker surfaces or additional detail is required. Some experimentation with this process is required.

3.12 - FILM and MOTION PICTURE LIGHTING

1.) FILM LIGHTING



Lighting for film is an art form within itself. Witness only, many of the fine (and not so fine) films produced during the past decades. In addition, film is a wonderful and valuable medium to capture and then study lighting and lighting techniques.

Lighting for film is a marriage between the cameraman, his film and the processing lab. Film lighting techniques are heavily dependent on the knowledge of how a particular film stock will react to a particular type of light - in respect to; intensity, contrast and color temperature. A multitude of image qualities are available by manipulating; exposure, color temperature and film processing.

2.) FILM LIGHTING - TECHNIQUES

Both daylight and artificial sources are commonly used for film lighting.

Lighting fixtures for the film industry are similar to stage lighting fixtures, except, they are larger and of higher wattage. Although incandescent fixtures are still used, many new fixtures using H.I.D. (high intensity discharge) sources, are now also commonly used.

The fresnel, open face flood (broad) and the '9 light' are all popular film lighting fixtures. The '9 light' unit, consists of 9 Par lamps mounted in a 3 x 3 matrix. This provides a 'large source size', and is excellent for 'key' or motivational lighting.

Color temperature and color balance is very important in film. Often the sources will be balanced using color correction filters, either over each individual fixture, or on the camera lens itself.

Film lighting makes extensive use of reflectors (with various different types of surfaces) to bounce and reflect light and to 'fill' in the shadows.

Fixtures are usually mounted overhead, on stands or on trucks. When 'on location' large generators and 'miles' of cable are often used to power the fixtures.

3.13 - MUSEUM AND ART GALLERY LIGHTING

1.) MUSEUM / GALLERY LIGHTING

Lighting for museums and galleries always presents a challenge. Often this work is undertaken by the museum staff themselves. At other times a stage lighting designer or other lighting specialist might be engaged to provide assistance.

The lighting of objects of art must be approached with care. It is well known that the harmful effects from both infrared and ultraviolet radiation can permanently damage almost any object, depending on the degree of exposure.

Although the museum or gallery lighting designer might want to light for interest and visibility, his first concern must be for the preservation of precious objects and artifacts. In this respect the curatorial staff of the museum or gallery will often impose very strict lighting limitations for each item or room.

There are few standards even today indicating what levels of exposure to infrared and ultraviolet is safe for delicate or precious objects. Many curators seem to suggest none. Other studies allow varying levels of light (footcandles or lux) based on the object's material, construction, condition and rarity - vs the specific properties of the light source to be used. Needless to say, the lighting of precious artifacts must be considered very carefully.

We do know that the harmful effects of ultraviolet and infrared radiation are accumulative. That is, the longer the exposure (time) the greater the damage will be.

Where natural lighting is involved, no direct sunlight should fall on delicate items, including paintings, drawings, printed graphics, tapestries, etc. These items can be damaged by heat (IR) and bleached by the ultraviolet. Hi levels of indirect natural light should generally also be avoided except on more robust and durable items. Where necessary to limit the harmful effects from an artificial lighting system, the designer must first chose a source that is low in both IR

and UV radiation. Incandescent sources are typically the source of choice. The beam of many conventional display lighting fixtures however, often have a hot beam that can easily be detected with one's hand at a distance of several feet. This is particularly true of some narrow angle PAR, R and MR type lamps. Heat to an object can be limited by increasing the lighting distance with a corresponding loss of light). Alternately, special dichroic lamps can be used that remove the IR component from the light beam by passing this radiation through the reflector towards the back of the lamp.

Ultraviolet radiation from incandescent fixtures is seldom a problem as what little UV exists is 'filtered out' of the light beam by the lamps' clear lens. Some tungsten halogen sources may produce higher (and objectionable) levels of UV however these sources can be filtered with a UV blocking filter available from most theatrical supply houses.

3.14 - ARCHITECTURAL LIGHTING DESIGN

1.) ARCHITECTURAL LIGHTING

Indirectly related to stage lighting design, architectural lighting design is a relatively new field, becoming popular in the 1970's. Architectural lighting design refers to the planned lighting of both interior and exterior spaces. See also: Landscape Lighting.

Typically, for most buildings (commercial and industrial) 'illumination' is prescribed by the ELECTRICAL ENGINEER. This consultant is usually responsible for; general electrical systems, power distribution, audio systems, fire alarm systems and lighting. Occasionally, an ILLUMINATING ENGINEER may specify the lighting. Typically when these engineers specify a lighting system, they are most concerned with providing proper illumination - for specific work related tasks.

The LIGHTING DESIGNER is a fairly new addition to the architectural team. Although usually not an engineer, this consultant will often specify all lighting and illumination criteria. He will work directly with the other consultants (architectural, structural, mechanical and electrical) to ensure that the lighting systems are properly designed, detailed and drawn.

Architectural lighting is far more than illumination however. The architectural lighting designer may be concerned with properly lighting buildings and spaces. He may be concerned with lighting levels, lighting efficiency and lighting safety. The architectural lighting designer however should also be very much concerned with the performance and well being of a human being, in an architectural space. Good lighting design always works towards solving specific criteria. Architectural lighting may provide basic 'seeability' for specific tasks, or may assist in effect, esthetics, comfort, health, safety and well being.

The architectural lighting designer must have a complete understanding of both the physics of light and the psychological effects of light. He must be well versed with the architectural design and construction process and must be able to design responsibly within budgets.

2.) ARCHITECTURAL LIGHTING - TECHNIQUES

There are many hundreds of manufacturers around the world that specialize in the manufacture of architectural lighting fixtures. Fixtures come in all grades, shapes and sizes. Literally, thousands of different fixtures exist, for different application. Fixtures may use incandescent, fluorescent of high intensity discharge sources. H.I.D. sources are generally used where possible as they are highly efficient and have lamps with extremely long life.

Stage lighting fixtures are seldom used for architectural lighting. Stage fixtures use 'photo' type lamps with relatively low hours, and fixtures are generally not designed for continuous operation.

Architectural lighting (as does stage lighting) uses a combination of flood and spotlight techniques. Fixtures are typically positioned as down lights, however some applications may require uplighting or side lighting for dramatic effect.

3.15 LANDSCAPE LIGHTING DESIGN

1.) LANDSCAPE LIGHTING

The art of landscape lighting usually merges with the field of architectural lighting design. The field of landscape lighting also goes hand in hand with the relatively new architectural specialty, the landscape architect.

The landscape lighting designer is responsible for large outdoor (usually) lighting designs consisting mainly of flora and foliage. Often the lighting design includes, trees, pools, bridges, paths, fountains, sculptures, benches, rest areas and much more.

The landscape lighting designer has similar goals to other lighting designers. He is often lighting for visibility, mood, atmosphere and interest, just as does the stage lighting designer for a dramatic presentation. The landscape lighting designer also usually has an additional concern in that he often must light for safety first and atmosphere and impact second.

2.) LANDSCAPE LIGHTING - TECHNIQUES

Most landscape lighting makes use of miniature low voltage lighting fixtures. A low voltage system is mandatory to ensure greater safety and to reduce risk from electrical shock, as the fixtures and wiring are often operated under wet conditions.

Fixtures are typically located at ground level to uplight plants and shrubs or may be placed on trees to uplight (or downlight) the trunks. Other landscape lighting fixtures include the use of illuminated bollards. These post like fixtures come in a wide variety of types and are typically used to illuminate paths, foliage or other exterior areas. Decorative lampposts, available in an unlimited number of designs are also commonly used.

Usually landscape lighting is placed on a control system that turns the system 'on' or 'off' at specific times. Alternately a system might use a photocell control, turning the system on at dusk and off at dawn.

Stage Lighting Design

Stage Lighting Design

PART 4 - Professional Lighting Procedure

4.01 - DESIGN RESPONSIBILITY

1.) THE PRODUCER & DIRECTOR

Usually, it is the 'Producer' that is responsible for all aspects of a professional stage production. The Director is usually engaged by the Producer. The Producer will usually impose restrictions on the Director, who must work with available time, budgets and resources.

2.) THE DESIGNERS

The DESIGNERS (Set, Costume, Lighting and Sound) are generally selected by the Director, to provide a cohesive team able to work well together on a particular production. Sometime the designers may be selected by the Producer, however usually with the Directors' approval.

3.) THE LIGHTING DESIGNER

The LIGHTING DESIGNER is responsible for the design of all production lighting (and usually, special effects). This designer will prepare a LIGHTING DESIGN, consisting of drawings and schedules and all information necessary for the lighting crews to fully install and connect all equipment. Further the lighting designer will supervise and direct all the artistic elements of the lighting design up until the opening of the production.

4.) THE HEAD ELECTRICIAN

The HEAD ELECTRICIAN, (sometimes; Master or Chief, electrician) heads and supervises the lighting crews during the set-up and 'running' of a production. The Head Electrician will generally also run the lighting control console for each performance.

5.) THE PRODUCTION ELECTRICIAN

A PRODUCTION ELECTRICIAN is sometimes engaged by the Producer, to facilitate the lighting set-up. This individual will assist with the ordering of all lighting equipment, coordination of crews and budgets and provide general problem solving, up until 'opening night'.

6.) THE LIGHTING CREW

The LIGHTING CREW are under the supervision of the Head Electrician. Under his direction, they are responsible for the installation, hanging, cabling, plugging and coloring of all equipment. During the 'focus' they are responsible for the precise aiming and adjustment of all fixtures, as directed by the lighting designer.

7.) THE RUNNING CREW

The RUNNING CREW is responsible for the nightly operation of all production lighting. The Head Electrician will usually operate the lighting console, while the running crew electricians are usually responsible for followspot, projection or special effect operation. It is also the running crew, (& Head Elect.) that generally perform any lighting related maintenance, during the run of the production.

4.02 - DESIGN PROCEDURE

1.) DESIGN PROCEDURE - (OUTLINE CHECKLIST)

The following, outlines a procedure useful for the comprehensive and responsible lighting design, of a professional stage production. This applies to theatre, dance, opera, musical or other entertainment productions.

1.) SCRIPT ANALYSIS: Read the script (score) several times, once for enjoyment and then again to determine; the times of day, seasons, type and direction of sources, moods and other intellectual and emotional stimulus.

2.) TALK WITH THE DIRECTOR: Meet with director and other designers. Determine their interpretation of the script. What is the proposed style of design? What are their expectations regarding the lighting?

3.) SET & COSTUME DESIGN: Gather together and familiarize yourself with the set drawings, renderings, costume sketches and the model. If there is a model, take a 'Poloriod' photo of each scene, to help you during the design process.

4.) STUDY THE THEATRE: Visit the venue or study the plans. Get to know the lighting and rigging positions. Get a complete inventory of any permanent fixtures, circuits, dimming and control equipment. All other lighting equipment will need to be rented. If the production is to tour, determine and study the details of all theatres.

5.) TIME/CREW/BUDGET: Will the lighting budget allow you to meet the needs of your anticipated design? Determine exactly how many hours you have in the theatre, for all aspects of the design. Determine exactly how many crew members you will have available and when. Finally determine what budget is available for additional rented equipment.

6.) ATTEND REHEARSALS: Watch for blocking, and other mechanics. See if there is a particular style to the direction, (there should be). Are there specific conventions being used? Get exact measurements for furniture and 'specials'.

7.) PREPARE THE LIGHTING DESIGN: Form a verbal 'concept' for the lighting. Next form a visual image as to how you expect the production to look, moment by moment. Next produce the LIGHTING PLOT and all related paper work (including: the SHOP ORDER, HOOK-UP, INSTRUMENT, FOCUS and COLOR schedules).

8.) SUPERVISE THE FOCUS: Although your attendance at the HANG may not be required, your attendance at the FOCUS session is mandatory. During this session you must aim, focus & document each fixture, one by one.

9.) SUPERVISE THE LEVEL SETTING: Build each lighting picture one at a time so as to fulfill your design criteria. You must also establish exact 'counts' for the transitions from one cue, to another. Provide the Stage Manager with exact script locations (GO point) for each cue.

10.) LIGHTING REHEARSALS: Supervise and refine all lighting levels and transitions as needed. Instruct your electricians as to 'running' maintenance and provide them with all final documentation.

4.03 - DESIGN CONCEPT

1.) LIGHTING CONCEPT

At some point prior to producing the actual 'lighting design', the designer must form a LIGHTING CONCEPT. Typically, this is a statement of what the designer hopes to achieve with the lighting design, and how he hopes to achieve it. It may be written, or verbal only, but the concept must exist, at the very least in the designers' mind.

The concept should be fundamental. It should capture the intrinsic qualities in the play and relate and describe them in terms of light. If properly developed, the concept will assist the designer with every step of the lighting design process. It will be used constantly to justify the designer's choice of style, lighting methods, directions of light, use of intensity, distribution, color and movement, etc.

Often the concept may become clear after the first meeting with the director and the other designers. At other times, the concept may develop slowly over a period of weeks and may not become evident until the designer has had the opportunity of watching several rehearsals.

The lighting concept is generally based on the emotional qualities developed by the playwright and indicated by the script. The concept will also be influenced by the directors' and the other designers' interpretation of the script. Everyone must be on the same page at the same time, when it comes to the design concept.

The lighting concept may sometimes be as simple as: 'to provide a feeling of warm, muted, sunlight over the entire stage, with a strong dramatic sense of motivation from stage left'.

Often the concept will be far less simplistic and will relate more to the production on various emotional or metaphoric levels. As the designer analyzes the play, he will often find; contrasts, conflicts, juxtapositions, metaphors, symbolism, irony, and other dramatic devices. How he relates these images to the physiological of design, is an important part of the design process, and is usually defined as part of the concept.

Example: A stylized play about a couple that are diametrically opposed to each other and are always fighting - might be seen as a 'cat and mouse game'. So the designer will use 'cat and mouse colors' (maybe pink from one side and gray from the other). He may show the contrast between the two characters with contrast in the lighting. The 'cat' may be illuminated with sharp, threatening lighting, while the 'mouse' may be sympathetically illuminated with soft warm light. So every thing regarding choice of intensity, color, direction and movement of light, can all be justified by the concept.

Good lighting can and often does exist, without a concept. However, the lighting designer that takes time to develop a strong overall concept is ultimately better equipped to make rapid design decisions, as there is now complete justification and direction for all of his choices.

4.04 - DESIGN COMMUNICATIONS

1.) COMMUNICATION

The lighting designer must be able to VISUALIZE his proposed design in three-dimensions. Further he must have the necessary skills to VERBALIZE or describe the proposed design in words and visual images. Finally, he must be able to DOCUMENT the proposed design on paper and DIRECT the design in practice. Communication is fundamental in design. The art of stage lighting relies on the art of communication.

Technically speaking, it really doesn't matter how a designer communicates his design intentions to others, just as long as he does so clearly and effectively. In professional situations, certain conventions and expectations of the designer have been established over the years. Crews expect clear, concise, detailed information, so that they can work efficiently and within time restraints. It is the responsibility of the lighting designer to ensure that the lighting crews receive whatever direction and information necessary, to ensure that all details of the lighting installation, are absolutely clear.

The lighting designer must develop verbal and other skills, necessary to fully describe and illustrate the artistic components of his proposed lighting design. He must be able to visualize his design intentions and then clearly communicate them to the director and to other designers. The designer must be able to describe lighting styles, painting styles, architectural styles, detail and periods, atmospheric conditions, moods, emotions and feelings. The use of renderings may often help. Sometimes paintings from the 'Old Masters' are immensely usefully in discussing and illustrating the styles and qualities of lighting.

Once the designer has a full understanding of all the ingredients, a rough 'lighting concept' drawing, is usually prepared for each scene. These sketches summarize the actor's blocking and provide other important lighting details including; mood, atmosphere, time of day, and indication of any natural or artificial light sources.

2.) DRAWINGS

Ultimately, the lighting designer must produce a PLAN drawing, showing all the required lighting fixtures, precisely located in scale and in relationship to the stage. This is the LIGHTING PLOT, (or LIGHTING PLAN) and it is this drawing that the stage electricians will use to install, cable, plug and color all fixtures. The designer should take great care and pride in the quality of drawings and paperwork produced for the lighting crews. Often if the crew sees that the designer cares about the production, they will also.

3.) SCHEDULES

Any information that cannot be shown CLEARLY on the light plot must be shown in the form of separate schedules. Further, the electrical crew will expect summary schedules showing, fixture; hook-up, color, focus and accessories. These schedules will facilitate both the set-up and daily maintenance of the production lighting. Take pride in your work.

4.05 - DESIGN PLANNING

Lighting design is a two part process. First the designer must create the lighting in his mind. Next he must create it in the real world.

Any lighting design process begins with having a complete understanding of just what it is you are lighting - from the physical point of view. This only comes from a through understanding of the stage scenic design and how it integrates with the theatre and relates to the audience. All of this is very important! The lighting designer must be able to accurately visualize the proposed production - in the actual performance space or venue. He must intimately understand

the scale of the theatre and the distances and angles to the permanent lighting positions. Without this understanding, at best the lighting designer will only be able to 'fumble' through his design. Maybe things will work, but if they do it won't be because of planning.

In order to allow the lighting designer to fully visualize the practical real world factors that he has to work with, he must rely on a number of different tools.

Usually, the set designer will provide a rendering and plan of each scene. These are tremendously useful to the lighting designer and will show each scene both drawn from the front (elevation) and from the above, (plan view). The lighting designer must be able to 'place' these scene plans accurately on the stage and be able to visualize the location of all of the lighting positions. This is no easy task as the designer has to think in 3 dimensions! Typically the stage plans are superimposed on the theatre plans to provide a 'composite' drawing of the stage and all adjacent lighting positions. Needless to say it is important that both the scene plans and the theatre plans must be drawn at the same scale. In Canada and the USA, common scales used for lighting drawings are: 1/8", 1/4" and 1/2" = 1.0 foot.

For professional productions a 3-D, scale model of the set is often provided (accurately painted). The model is worth it's weight in gold and should be monopolized by the lighting designer at all times. This is the best design aid the lighting designer will ever have. He can position the model on a drawing of the theatre and easily determine the distances and angles to any lighting position. It doesn't get much better than this.

Today many different computer aided design (CAD) programs exist to help the lighting designer visualize the performance space in 3-D. Modern programs allow accurately rendered models to be 'rotated in space' and viewed from any angle. Some programs have excellent light rendering capabilities and are great visual aids.

Regardless of how he does it, the lighting designer must quickly be able to visualize a particular production in a specific venue. He must also be able to accurately determine the distance and angle to any lighting position. The designer not equipped with this basic information is poorly equipped to proceed with any lighting design.

4.06 - THE LIGHTING SECTION

1.) CROSS-SECTION

Although the various scenic plans are of great use to the lighting designer, it is only with the CROSS-SECTION drawing that this designer can fully visualize the stage setting, in 3-Dimensions.

The 'section' typically is drawn as a 'slice' along the center line, from the back wall of the stage to the back wall of the auditorium. It shows in section; the stage floor, the ceiling, (or grid) audience seating, the stage set and all lighting positions (both above the stage and in the auditorium). Often the section will show the stage scenery at the center line as well as portions of the set, right and left of the center line. This is a 'composite' section, and is typically required when scenery isn't placed parallel in relationship to the lighting positions.

Alternately, additional section drawings are often produced showing cross sections at the far stage left or stage right walls of the stage and auditorium. All of these drawing are invaluable in allowing the designer to fully understand and visualize the three-dimensional relationships between the audience, the stage, the setting and the lighting positions.

It is only with this drawing, (the lighting section) that the designer will be able to accurately 'measure' the throw distances from any particular lighting fixture, to the stage. The plan view drawings, alone, are of no use in this regard. The lighting cross-section is always prepared prior to the 'lighting design', and is a most important tool to check lighting angles, sight lines and masking. A scale model is also invaluable.

The lighting section is generally prepared by the set designer, the technical director or the lighting designer, depending

on the exact nature of the production, venue, or producing company. Regardless of who produces it, someone must, before the lighting designer is able to produce a responsible lighting design. Further the lighting section will show the 'trim' heights of all electric pipes and all masking borders. This information is necessary to that the stage crew will install the masking exactly as indicated, so as to ensure no interference with the lighting equipment.

The section is always drawn to scale, and this is typically the same scale as the theatre ground plans and the set designer's drawings. Typical scales are 1/4"=1'-0", 1/2" = 1'-0', 1:25 and 1:50. Any section can be rotated 90 degrees to align with it's floor plan view.

Although the lighting section is an essential drawing for the proper planning of a lighting plot, it seldom progresses past the 'working drawing' stage. Once the heights of all lighting pipes, masking borders and other scenic elements have been drawn and checked, this information is usually transferred to a HANGING SCHEDULE, for use by the set-up crew. This eliminates the need for the crew to continue to scale or measure the drawings during the actual set-up.

4.07 - THE LIGHTING PLOT

1.) LIGHTING PLOT (LIGHT PLOT)

The 'physical' lighting design is typically drawn as a single drawing, commonly referred to as THE LIGHTING PLOT, (or the Light Plot). This is a scale drawing of the theatre and auditorium, with all lighting fixtures drawn exactly in their required location. The light plot must show all information necessary to allow the electricians to install all lighting, including fixtures, special effects, projectors and practical sources, in their exact location. In the world of professional theatre: "If it ain't on the page, It ain't on the stage"

The LIGHTING PLOT must be drawn clearly in order to provide specific information. Superfluous information is not required and serves only to provide less clarity. Remember, this drawing is to clearly communicate information to others, not to show off your drawing skills. The following are conventions used internationally:

The PLOT is usually a horizontal ('landscape') drawing, with the stage running right-left. Common scales include 1/4" = 1' and 1/2" = 1'. Pick a useful scale. Try and use the same scale that the theatre architectural drawings and the stage designs use. An inappropriate scale can result in a drawing that is far too large to readily handle or far too small to show the required information and detail, clearly.

2.) LIGHT PLOT DETAILS

```
A.)  Outline of THEATRE & AUDITORIUM WALLS   - (heavy solid line)
B.)  Outline of STAGE SCENERY                - (light dot line)
C.)  Center line of stage                    - (dot-dash line)
D.)  All lighting POSITIONS (pipes)          - (light solid line)

E.)  FIXTURES, draw in exact POSITION        - (include a.- h.)
     --------------------------------
     a.) TYPE & WATTAGE (shown by standard template fixture symbols)
     b.) UNIT #         (shown by 'number' in body of fixture symbol)
     c.) COLOR #        (manuf'rs filter number (#xx) in front of lens
     d.) ACCESSORIES    (barn doors, gobos, iris, color wheels, etc.)
     e.) CIRCUIT #      (a 'circle' to be filled in by electrician)
     f.) DIMMER  #      (optional)
     g.) CHANNEL #       (optional)
     h.) FOCUS           (optional)

F.)  KEY TO SYMBOLS  (Show each symbol, with fixture type & wattage)

G.)  TITLE BLOCK, with:
```

```
     -----------------
     a.) DRAWING NAME: LIGHT PLOT       d.) NAME of DESIGNERS & DIR)
     b.) NAME OF PRODUCTION             e.) SCALE of drawing
     c.) NAME OF THEATRE/VENUE          f.) DATE of drawing

H.)  SPECIAL NOTES or SCHEDULES
-------------------------------

Provide an area for 'numbered' notes, and details when required.
```

4.08 - THE HOOK-UP

1.) HOOK-UP

Somehow all of the lighting symbols shown on the lighting plot must be connected via their electrical circuits to dimmers and then to control channels at the control console. It is only the channel numbers that the lighting designer is ultimately interested in. He will usually assign or 'patch' specific dimmers to specific channels, in a logical and organized sequence. Some older systems require circuits to be plugged first to a dimmer through a manual 'patch panel'. In this case it may be possible to assign more than one circuit to a dimmer. In some older control systems, the dimmer number is also the channel number. In newer systems, each dimmer may be assigned to any channel by a 'soft-patch'. So the Hook-up must clearly and logically show the relationship between circuit numbers, dimmer numbers and channel numbers. Again, the sequence of plugging or patching should be logical and organized.

THE HOOK-UP, (or CHANNEL SCHEDULE) is a numerical list of all channels used in a particular production. Not only does this schedule contain; circuit, dimmer and channel assignments, it also shows a summary of all fixture details, shown on the lighting plot. A typical HOOK-UP will show the CHANNEL#, DIMMER#, CIRCUIT#, FIXTURE#, and (Type, Watts, Purpose, Accessories & Color filters, for all units). This schedule is invaluable to both the lighting designer and to the electrical crew.

Typically a small scale production might require 12-24 dimmers with up to 24 channels of control. A large scale production might require more than 500 dimmers assigned to 300 control channels. Although schedules can be prepared by hand, several computer programs exist to assist the designer. 'Lightwright', a well known paperwork program (by John McKernon) produces a 'hook-up' similar to the following:

```
=====================================================================
CHANNEL HOOK-UP                                       DATE: 1999-12-31
=====================================================================
PRODUCTION: WAR & PEACE                                     Page 1/x
=====================================================================
CH. DIM. CIR. POSITION  UNIT#    TYPE      WATTS PURPOSE  ACCES. COLOR
--|-------------------------------------------------------------------
1 |  45   45  #1 Bridge - 1   30 deg. E.R.  1000   AREA 1  Gobo5   R08
  |  65   65  #1 Bridge - 17  30 deg. E.R.  1000   AREA 1  Gobo5   R08
--|-------------------------------------------------------------------
2 |  46   46  #1 Bridge - 2   30 deg. E.R.  1000   AREA 2  Gobo5   R66
  |  66   66  #1 Bridge -18   30 deg. E.R.  1000   AREA 2  Gobo5   R66
--|-------------------------------------------------------------------
3 | 120  120  #1 Pipe   - 1   6" Fresnel    1000   AREA 3  Doors   R08
  | 132  132  #1 Pipe   -15   6" Fresnel    1000   AREA 3  Doors   R08
--|-------------------------------------------------------------------
4 | 121  121  #1 Pipe   - 2   6" Fresnel    1000   AREA 4  Doors   R66
  | 138  138  #1 Pipe   -16   6" Fresnel    1000   AREA 4  Doors   R66
--|-------------------------------------------------------------------
5 | 118  118  #1 Pipe   - 7   20 deg. E.R.   750   WINDOW-R   -    R88
--|-------------------------------------------------------------------
```

```
6 | 119  119  #1 Pipe   - 8   20 deg. E.R.   750   WINDOW-C   -    R88
--|-------------------------------------------------------------------
7 | 121  121  #1 Pipe   - 9   20 deg. E.R.   750   WINDOW-L   -    R88
--|-------------------------------------------------------------------
```

4.09 - THE INSTRUMENT SCHEDULE

1.) INSTRUMENT SCHEDULE

The INSTRUMENT SCHEDULE is a detailed list of all fixtures on the light plot, shown by HANGING POSITIONS It allows the Head Electrician to rapidly identify all the details, for any fixture.

Each fixture (unit) is given a number. As a result, any fixture can be easily identified by the POSITION and UNIT #. Examples: #1 Bridge-5, #1 Pipe-12, #1Boom-8, etc.

Positions are typically listed in the following order:
a.) from curtain line to rear of auditorium (overhead)(1cove, 2cove)
b.) from curtain line to rear of stage (overhead)(1pipe, 2pipe, etc)
c.) booms (on stands or hanging)
d.) floor positions
e.) special effect equipment and practical fixtures

Fixtures are typically numbered in the following order;
a.) from stage left to stage right (overhead pipes)
b.) from top to bottom (booms)
c.) from down stage to up stage

This Instrument Schedule contains all the information, shown on the HOOK-UP, except the columns are simply in a different order. This schedule typically shows the following information:

```
=====================================================================
INSTRUMENT SCHEDULE                                  DATE: 1999-12-31
=====================================================================
PRODUCTION: WAR & PEACE                                     Page 1/x
=====================================================================
POSITION  UNIT#     TYPE      WATTS CH. DIM. CIR. PURPOSE ACCES. COLOR
---------------------------------------------------------------------
#1 Pipe   - 1    6" Fresnel    1000 71  135  128  AREA 1   Doors   R08
---------------------------------------------------------------------
#1 Pipe   - 2    6" Fresnel    1000 37  136  127  AREA 2   Doors   R08
---------------------------------------------------------------------
#1 Pipe   - 3    6" Fresnel    1000 43  137  126  AREA 3   Doors   R08
---------------------------------------------------------------------
#1 Pipe   - 4    6" E.R. 20deg. 750 95  151  125  WINDOW R Gobo5    NC
---------------------------------------------------------------------
#1 Pipe   - 5    6" E.R. 20deg. 750 16  152  124  WINDOW C Gobo5    NC
---------------------------------------------------------------------
#1 Pipe   - 6    6" E.R. 20deg. 750 17  153  123  WINDOW L Gobo5    NC
---------------------------------------------------------------------
#1 Pipe   - 7    6" Fresnel    1000 33  135  122  AREA 1   Doors   R66
---------------------------------------------------------------------
#1 Pipe   - 8    6" Fresnel    1000 12  136  121  AREA 2   Doors   R66
---------------------------------------------------------------------
#1 Pipe   - 9    6" Fresnel    1000 72  137  120  AREA 3   Doors   R66
---------------------------------------------------------------------
```

4.10 - THE MAGIC SHEET

1.) MAGIC SHEET

Although the INSTRUMENT SCHEDULE and the HOOK-UP are of immense use, they are created primarily to show the electrics crew the correct connection of all equipment. Stage lighting is a visual art and as such, the lighting designer must find a way to think visually.

Perhaps only twenty-five years ago, the process of the designer keeping track of all the numbers of his 'visual' components, was with the HOOK-UP. This schedule is usually nothing more than a long list of numbers with fixture, focus and color details. It in no way shows 'visually' what is connected to each channel. Often the designer could rapidly visualize; 'a blue wash from stage left', but it would take him 5 minutes to find the channel number, especially if he had several hundreds of channels to work with. Needless to say this process could be very slow during both the focus and the level setting sessions.

Somewhere in recent years, the process changed and the MAGIC SHEET was born. The concept is so simple that it is surprising that it wasn't developed long before. As a former student of Tom Skeleton, I learned the concept from him in New York in about 1970, and have been using it ever since. I credit Tom with the development of the concept, although others may also take credit for a similar means of visually representing their lighting plot.

The magic sheet typically consists of a single piece of paper (about 8.5" x 14") and usually divided into 15 squares (3 x 5). More squares (or paper) might be required for a very large show. Each square represents a visual group of fixtures. This allows, the designer to locate just the acting areas, front light, side light, back light, etc., very rapidly. Each channel number is shown in a circle. The number of arrows indicate the number of fixtures and the direction of the light. Often a small picture of the scenery is drawn, to show the exact focus of each channel. Partial MAGIC SHEET follows:

```
=====================================================================
|     ACTING AREAS     |     ACTING AREAS      |     SIDE LIGHTS     |
|   (LIGHT AMBER #08)  |   (LIGHT BLUE #66)    |  (LIGHT PINK #44)   |
|                      |                       |                     |
|   ^      ^     ^     |    ^      ^      ^    |                     |
|  (4)    (5)   (6) US |  (10)   (11)   (12) DS| (15)->> US  <<-(16) |
|   R      C     L     |    R      C      L    |                     |
|   ^      ^     ^     |    ^      ^      ^    |                     |
|  (1)    (2)   (3) DS |  (7)    (8)    (9)  DS| (13)->  DS   <-(14) |
|----------------------|-----------------------|---------------------|
|     BACK LIGHTING    |       CYCLORAMA       |       SPECIALS      |
|    (DARK BLUE #80)   |                       |  UR     UC     UL   |
|                      | (21) RED      Top     |   ^      ^      ^   |
|         v(17)v       | (22) GREEN     "      | (27)   (28)   (29)  |
|         v(18)v       | (23) BLUE      "      |                     |
|         v(19)v       | (24) RED     Bottom   |  DR     DC     DL   |
|         v(20)v       | (25) BLUE      "      |   ^      ^      ^   |
|                      | (26) GREEN     "      | (30)   (31)   (32)  |
=====================================================================
```

4.11 - THE FOCUS SESSION

1.) FOCUS SESSION

The lighting designer may; analyze, discuss, plan, draw and draft for days or weeks to produce the lighting plot, and the related schedules. It is during the focus session however, that the lighting designer will see for the first time if he has selected appropriate equipment and appropriate mounting positions to accomplish his objectives.

During the focus session, the lighting designer and the lighting crew work in a darkened theatre. Usually an electrician will operate the lighting control console, either from the stage or from the control booth. The designer will usually stand on the stage and request which channel number he wishes to have active. Next, a crew member at the particular fixture will be directed by the designer in the proper aiming (focus) of the fixture. The fixture must have its pan and tilt set, then be firmly 'locked' with a wrench. Next beam adjustments (size, edge, distribution, shutters and templates) are made. Finally, the appropriate color filter (and or diffusion material is added. This process must be repeated for each fixture on the lighting plot and may take from 1-5 minutes per fixture.

Lighting above the auditorium may be accessible from fixed catwalks. Other auditorium fixtures may require ladders to access. Fixtures mounted above the stage are typically focused from an 'A-Frame' ladder or a man lift. It is usually important to work quickly during a focus session, but it is also important to work safely.

It is during the focus session that the designer will generally get a sense of whether his lighting design will 'work' or not. More particularly if the designer has not done the appropriate planning, he may find during the focus session that his design may not work. For this reason, the focus session may often be rather tense. The designer will usually insist on total concentration from the lighting crew so that he may work as efficiently as possible. In professional situations, the producer may require the lighting to be focused in 4-12 hours (usually in 4 hour calls), depending on the number of fixtures, their accessibility and the number and caliber of lighting crew. A single crew member will typically average 12-60 fixtures per hour. Often the designer may keep several electricians focusing at the same time and it is not unusual to see a 400 fixture 'rock and roll' plot, focused in 4 hours, by an experienced lighting crew.

It is mainly the responsibility of the lighting designer to insure that all the fixtures shown on the lighting plot can be focused in the allotted time. It is the irresponsible designer that order fixtures hung in a location that can not be quickly and safely accessed during the focus session. The designer must be able to realistically estimate his required focus time and the complexity of the light plot must reflect this in respect to quantity and accessibility of fixtures.

During the focus, the lighting designer (or assistant L.D.) will usually document the aiming of each fixture, necessary to insure integrity of design or for future remounting of the production.

4.12 - THE LEVEL SESSION

1.) LEVEL SESSION

Once all of the lighting fixtures have been assigned to the dimmers, and individually focused, it is time for the designer to build the lighting 'pictures'. This is the LEVEL or CUE setting session.

Typically the lighting designer may have only 4-8 hours to set all the lighting 'cues' for a production, into the memory system. The may be as few as 12 cues or as many as 200 cues for a large production.

The lighting designer, will typically be in charge of this session. The director, stage manager and other designers will generally also be present. Typically this team will gather around the production table in the darkened auditorium, like moths gather around a light.

The lighting designer will work through the show in sequence, from the first house lights going down, to the final house lights going up. He will build each lighting look, channel by channel and then when complete, will seek approval from the director and other designers. Once the look is approved, it is either recorded on a 'cue sheet' or recorded in 'memory', by the head electrician. Generally every lighting change will be given a CUE NUMBER, (usually in

sequence) and a TIME so that it may be positioned in the script by the Stage Manager.

The lighting designer is usually under great pressure to demonstrate to the others (and himself) that he is able to provide the appropriate and expected lighting. Typically the stage setting will not be finished. Props, furniture, curtains or carpets may be missing, the set or floor may not be fully painted and the actors will be missing. Any missing elements can make the lighting designers' job very difficult, if he, the director or the other designers can't fully visualize the final results when the set is finished and the actors are in place. For this reason, it is best to insist whenever possible that the Level Session not take place, until the set is fully complete, painted and dressed.

This designer learned many years ago that it is senseless to waste time trying to refine a lighting look, without the set being finished and the actors on the stage. The lighting MUST be seen in context with the rest of the production to be fully understood and appreciated. I have spent many productions, plotting the intensity of a white wall to a low level, only to plot it back up to full several days latter when the wall paper finally arrived.

Although the actors are seldom present during this session, it is very valuable to have a 'walker' present, usually dressed in typical costume tones. The walker, will move as directed, through the actors' blocking, allowing the director and designer to check lighting levels on 'faces', any where on the stage. Generally the lighting designer must work quickly and with confidence. Although he should not rush the director in his approval of a particular lighting look, he should do his best to be positive, remind him if they are seeing things out of context, and describe any possible solutions to any concerns.

4.13 - THE CUE SHEET

1.) LIGHTING CUE SHEET

During the Level session, each lighting 'look' is carefully built, dimmer by dimmer. It may take from one minutes to over an hour to fully balance each 'cue' or look. It is imperative that this information be properly documented for a number of reasons. The CUE SHEET is the written documentation of each lighting cue. Usually it consists of columns for each dimmer (or channel) number, across the top of the page. Each cue is given a NUMBER and TIME, and then the level information is clearly written, below the corresponding channel numbers. An additional area should be provided for OPERATION.

The CUE sheet is needed for two reasons. First, if the lighting control board is a manual system (with no electronic memory), it is the only record of the lighting. Second, even if the lighting control board has an electronic memory, a written record of each lighting cue should be kept for backup and safety reasons. Remember, the designer spends considerable time balancing the lighting to the directors' and his own approval. It would be totally irresponsible not to have a written record of this session, should for any reason the lighting control system, 'lose memory'. It is a laborious process to write Cue Sheets by hand, especially for a production with more than 100 channels. Often the task of writing the Cue Sheets can be assigned to the Assistant Lighting Designer, (as a form of penance).

Recently computer assisted control boards have become widely available and are now considered to be the norm. Most systems also come with a printer. This means that each cue can now be recorded and printed at the same time, thus always maintaining a 'hardcopy' of each cue.

During the lighting rehearsals that follow, the designer may request printouts of all cues, after a particular rehearsal, again for purposes of back-up and safety, for if the lighting control 'crashes', it may be necessary to manually type in the all the cue and level information, into a new system. This may be a tedious process, but at least it is possible with a hardcopy record. Without it, all the time spent at the lighting cue session, and subsequent rehearsals, has been wasted.

A final printout should be made just prior to the opening production (or when the designer is sure that no more changes will be made). The final printout should be retained by both the producer (theatre) and the designer, for the duration of

the production. If the production is ever remounted in the form of a transfer or tour, the Cue Sheet printout will be used as a basis to reconstruct the lighting.

2.) TYPICAL CUE SHEET

```
Channel:   1   2   3   4   5   6   7   8   9   10  11  12  13  14  15
-------|-------------------------------------------------------------
Q17 T5 |  80  75  75  80  45   00  45  45  00  60  60  80  30  20  65
-------|-------------------------------------------------------------
Q18 T8 |  0v  75  75  80  50^  50^ 45  45  45^ 60  30v 60v 30  20  65
```

Stage Lighting Design

Stage Lighting Design

PART 5 - Stage Lighting Fixtures

5.01 - GENERAL LUMINAIRE TYPES

1.) THE LUMINAIRE

A STAGE LIGHT is referred to as a 'fixture' an 'instrument' or a 'unit' in North America, as a 'light fitting' or a 'lantern' in Britain and as a 'luminaire' (the 'e' is silent), in other parts of the world and by the engineering and architectural communities All terms have one thing in common. They all refer to a complete lighting 'package' - consisting of a housing, lamp (bulb), socket, reflector, electrical cord, connector and sometimes a lens, mounting clamp and color frame.

2.) BASIC TYPES

Luminaires designed for stage, television and film lighting applications fall into two (2) main categories; SPOTLIGHTS and FLOODLIGHTS. A third specialized category includes PROJECTORS and special lighting effects. Fixtures are typically designed to be mounted from overhead pipes, from vertical pipes or from floor stands. In this respect all fixtures incorporate a mounting yoke and usually a pipe ('C') clamp. The yoke and clamp allow the fixture to pan, tilt or rotate into any position and then securely lock in place. All types are fitted with color frame clips to accept a square metal (or cardboard) 'color frame'. The color frame clips often accept other accessories including, barn doors, top hats, donuts and color wheels.

Stage lighting fixtures range in wattage from about 300 watts to over 10,000 watts in size and capacity. Common fixtures used for stage, film and television have wattages of 300, 500, 575, 600, 750, 1000, 1200, 1500, 2000, 5000, and 10,000 watts. The wattage required depends on the amount of light needed at a specific distance and the particular characteristics of the fixture itself. Needless to say, the larger the wattage, usually the larger the fixture. In the display lighting field for example, miniature fixtures may range from 50 to 300 watts. Fixtures used for theatre lighting usually

range from 500 to 2000 watts, and television and film lighting frequently employs fixtures of 1000 to 10,000 watts (or more).

3.) LAMPS

Most modern stage lighting fixtures still use incandescent (or electric filament) lamps, in order to provide a completely 'dimmable' source. Specifically it is the tungsten halogen lamp that is used almost exclusively for stage lighting applications. This type of lamp actually has a 'self cleaning' cycle whereby the tungsten that normally blackens the outer glass bulb is redeposited back onto the filament, resulting in a more consistent light output over the life of the lamp.

Stage lighting luminaires (and lamps) are available for either 120 volt, or 240 volt lamps operation from about 12 major manufacturers, world wide. The incandescent lamp however is largely inefficient, using most of its energy to produce heat, not light. New more efficient lamp sources are slowly being introduced to stage lighting, using discharge and other lamp technology, however inherent dimming and re-strike problems still exist with these sources.

HID and fluorescent lamps, although seldom used for theatre lighting applications, are now commonly being used for film and television lighting. These sources are much more efficient than the electric filament lamp and produce much higher 'lumen per watt' outputs. The use of HID and other ARC LAMPS for stage lighting however is slowly starting to develop. New automated luminaires of the future will use sophisticated new sources and will be capable of producing any color or pattern, upon demand (software based). Many of today's automated lighting fixtures do use arc lamp capable of excellent dimming through mechanical means. (Most fixtures are still quite noisy due to lamp cooling requirements).

4.) SPOTLIGHT FIXTURES

Spotlight fixtures include the PLANO CONVEX, ELLIPSOIDAL REFLECTOR, FRESNEL, PAR LAMP, BEAM PROJECTOR and FOLLOWSPOT. These fixtures are used to provide a narrow and controlled beam of localized light, to the stage. All spotlight fixtures have one or more lenses and are generally available in beam spreads of approximately 5 to 70 degrees.

Designers use spotlight fixtures for AREA and WASH lighting applications, at distances of 15-150 ft. Designers will often provide a series of 'tight', circular pools of light, to each acting area, approximately, 8' to 20' wide (depending on the application). A single acting area will usually consists of 1 to 6 fixtures positioned as; front, back, side or down lights.

5.) FLOODLIGHT FIXTURES

Floodlight fixtures include; SCOOPS, BOX FLOODS and STRIPLIGHTS. These fixtures provide a WIDE distribution of light over a broad area and are primarily used to light backdrops and scenery at close distances of from 3 to 25 feet. Almost all floodlight fixtures are lensless. The exceptions are flood PAR/R lamps that have either spread lenses or diffusion applied to the bulb. Floodlight fixtures generally have fixed beam spreads of 70-150 degrees.

5.02 - PLANO CONVEX SPOTLIGHT

1.) DESCRIPTION

The PLANO-CONVEX (or PC) spotlight is the earliest form of theatre spotlight, to use a lens. It consists of a simple 'box' housing containing a lamp and reflector behind a

plano-convex lens. Modern units range from 300 to 2000 watts. Lens diameters include 5", 6" and 8" wide. Beam spreads typically are variable from approximately 10 to 65 degrees in a single fixture.

Originally developed for a 'limelight' source in the 1870's, this fixture was adapted for the incandescent lamp in the early 1890's. The plano-convex fixture was slowly replaced starting in the 1930's with the development of the ellipsoidal reflector fixture. The 'ER' not only provided a 'hard' defined beam edge, as did the PC fixture, but it also allowed the projection of integral framing shutters, an iris, or an etched metal pattern (gobo). The plano-convex fixture is still available today however from a number of manufacturers. They are very simple in construction and operation.

This fixture provides a circular beam pattern with a sharply defined 'hard' outer edge. Unfortunately, the field of light, (distribution of light across the beam) is often quite uneven. Further, optical aberrations in the form of rainbow effects, are often seen at the edges of the beam.

The lamp and reflector are mounted together, and move forward or backwards, in relationship to the lens. As they move closer to the lens, the beam expands in size. As they move away from the lens, the beam becomes narrower.

2.) APPLICATIONS

Plano-convex spotlights are useful in providing ACTING AREA lighting and localized lighting to specific areas of the stage. They have no beam controls (shutters, iris, barndoors) available.

3.) TYPES

The plano-convex spotlight is generally available everywhere in the world - except in North America. Although this flexible spotlight is in use almost everywhere else in the world it has never caught on in Canada or the USA. Priced between the ellipsoidal reflector (ER) and the fresnel the plano-convex spotlight is still a very important, useful and efficient luminaire for many lighting applications. Strand Lighting, Selecon, ADB and others still produce a number of different models for the non North American market.

TYPE	BEAM SPREADS	WATTAGE	DESCRIPTION
Plano-Convex	10-65 variable	300-2000	ROUND beam, HARD edge

INCLUDED: - (a) power cord.

OPTIONS: - (a) lamp, (b) pipe clamp, (c) color frame, (d) electrical connector, (e) safety cable.

5.03 - ELLIPSOIDAL REFLECTOR SPOTLIGHT

1.) DESCRIPTION

The ELLIPSOIDAL REFLECTOR spotlight, (sometimes known as the LEKO or LEKOLITE) is a common fixture for many stage lighting applications. The 'ER' as it is sometimes called is available from many different manufacturers and is available in a number of different sizes and beam spreads.

The ellipsoidal fixture was first introduced back in 1933 by Joseph Levy and Edward Kook, founders of Century Lighting, each giving half of their names to the new invention, 'Lekolite' or 'Leko'. About the same time, Kliegl Brothers introduced their EF fixture known as the 'Klieglight'. Although ER's are now commonly called 'Lekos',

the name is now owned by Strand Lighting and correctly only refers to their ellipsoidal reflector products.

2.) APPLICATIONS

The ER spotlight provides a narrow, directional beam with a hard edge. It is able to provide a sharp focus of integral metal shutters, an iris or a metal projection template. The ability to project a metal etched pattern (template or gobo), makes this fixture particularly useful to the stage lighting designer.

All ER's also allow focus adjustments by moving the lens tube forward or backwards. This produces an adjustable beam edge ranging from very sharp and hard to very soft. Some ER's do not allow the edges of the beams to soften sufficiently for the proper blending and sometimes the edge may need to be further softened using diffusion material.

Ellipsoidal reflector fixtures have one (1) or more lenses, usually, 4.5, 6, 8, 10 or 12" in diameter. Most ER's particularly the wider units, have two lenses. Generally, the narrower the beam spread (in degrees), the heavier the fixture will be, due to the longer lens barrel and the larger diameter lens, required.

Some (American) manufacturers specify a fixture by indicating the lens diameter then the focal length. For example a '6x9' (pronounced "6 by 9"), indicates a fixture with a 6" diameter lens and a 9" focal length. This tells the designer nothing about the beam spread of the fixture. Most modern lighting manufacturers now specify fixture beam spread simply in degrees. Approximate spread angles for typical ellipsoidal reflector fixtures are as follows: (in degrees) 4.5x9 =50, 6x9 =40, 6x12 =30, 6x16 =25, 6x22 =15, 8x13 =12, 10x23 =9.

3.) TYPES

Modern ER spotlights have beam spreads of 5 to 50 degrees and are available in wattages of 500 - 2000 watts.

They are available in both fixed focal length and variable focal length (zoom) models. Standard focal lengths include 5, 10, 20, 30, 40, 50 degrees, and many others in between. Generally, the adjustable focal length units are less efficient, heavier and more expensive than their fixed focal length counterparts. Some modern 'zoom' ER's however do perform very well and may indeed be the choice over comparable fixed focal length units.

ZOOM ER'S with adjustable focal lengths have been available since the 1970's. A typical fixture might provide spread angles of 12-35 degrees or 25-50 degrees. No single zoom fixture is available to provide a wide zoom range of say, 10-50 deg.

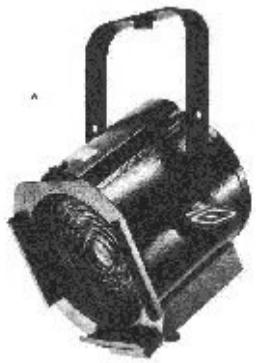
TYPE	BEAM SPREADS	WATTAGE	DESCRIPTION
Ellipsoidal Fixed f.l.	5-50 (fixed)	500-2000	ROUND beam, HARD edge, with shutters & gobo slot Beam or image can soften
Ellipsoidal Zoom (typ.)	15-35 (zoom) 25-50 (zoom)	500-2000	ROUND beam, HARD edge, with shutters & gobo slot Beam or image can soften.

INCLUDED: - (a) power cord, (b) four framing shutters, (c) template slot, (d) removable lens tube.

OPTIONS: - (a) lamp, (b) pipe clamp, (c) color frame, (d) electrical connector, (e) safety cable, (f) template holder, (g) iris, (h) lens safety mesh, (i) special accessories including gobo rotators and color wheels.

5.04 - FRESNEL SPOTLIGHT

1.) DESCRIPTION



The FRESNEL SPOTLIGHT, (pronounced: 'fren-el') provides adjustable beam spreads, from SPOT to FLOOD, (about 15-70 deg.) all in one fixture. This fixture produces a directional beam with a very soft edge (only). Fresnels are used as an efficient means of providing ACTING AREA or COLOR WASH lighting.

All Fresnel spotlights use a single fresnel lens, deriving the name from the French physicist Augustin Fresnel, (1788-1827). A fresnel lens is simply a form of a plano-convex lens, with certain portions of glass removed, in parallel 'steps'. This results is a lens that is thinner, lighter and more efficient that an equivalent PC (plano-convex) lens.

Fresnels are considerably less expensive than comparable ellipsoidal reflector fixtures, however, they do not have the ability to project a pattern or produce a sharp beam cut-off edge, as does an ellipsoidal fixture. Fresnels are very similar in size and construction to their counterparts, the plano-convex spotlights, the only significant difference is one uses a fresnel lens, the other a PC lens.

A fresnel lens is easy to recognize from a series of concentric rings on it's surface. In addition, most fresnel lenses have a 'stipple' etched on the back side, to further soften the beam. The higher the wattage of the fixture, the heavier the fixture weight will be, due to the larger housing and lens diameter required to withstand the extra heat generated by the lamp.

2.) APPLICATIONS

Fresnels are particularly useful in providing COLOR WASHES to acting areas or scenery. Typically, 27 fresnels might be arranged above the stage to illuminate 9 areas (with 3 fixtures each). Each area is said to have a 3 COLOR WASH. With dimmer control, and colored filters, it is possible to mix many different color combinations to each area.

Fresnel fixtures tend to 'flare' more than do ellipsoidal fixtures and as a result they are usually used with a barn door accessory, to help control unnecessary 'spill' light.

3.) TYPES

Fresnels are generally available in wattages of 150 to 5000 watts, and come in lens diameters of 3, 6, 8, 10 and 12". The units most often used for the stage, include the 6" 1000 watt and the 8" 2000 watt fresnel.

TYPE	BEAM SPREADS	WATTAGE	DESCRIPTION
Fresnel	15-70 variable	500-5000	ROUND beam, SOFT edge, Accessories: barn doors Beam edge is soft ONLY

INCLUDED: - (a) power cord.

OPTIONS: - (a) lamp, (b) pipe clamp, (c) color frame, (d) electrical connector, (e) safety cable, (f) lens safety mesh, (g) barn doors.

5.05 - PAR64 SPOTLIGHT

1.) DESCRIPTION

The PAR64 SPOTLIGHT (Parabolic Aluminized Reflector) fixtures, consist of a sealed beam lamp (like an automotive headlight), in a simple metal housing. PAR fixtures are highly efficient as the; reflector, filament and lens are all optically aligned and sealed into the lamp at the factory. The beam spread of PAR fixtures is determined by the design of the lamp, not by the design of the fixture.

PAR LAMPS are available in a number of different diameters and wattages. Typically PAR64 (1000 watt) lamps are used for stage and studio lighting applications. Smaller PAR lamps are used for display and architectural applications, and include the PAR56 and the PAR38.

(To determine the diameter of any PAR lamp, divide the PAR # by 8 - ie: a PAR56 is: 7" in diameter, a PAR 38 is: 5.5" in diameter).

2.) APPLICATIONS

Where flare and a very soft beam edge is not a problem, these fixtures are particularly useful for ACTING AREA and WASH LIGHTING. They are also usually the fixture of choice for COLOR WASH and BACK LIGHTING for entertainment productions, again, where flare and spill are not a problem.

3.) TYPES

The most common PAR fixture used in the theatre industry is the PAR64-1K (1000 watts). The fixture is generally available in both steel and aluminum. Both black and chrome versions are available. The color frame for a PAR64 fixture is usually 10" x 10".

This fixture uses the PAR64 lamp. This lamp has an 8" diameter lens and comes in four different standard beam spreads, and several different voltages. This 1000 watt lamp is extremely efficient at producing light - more so than an equivalent 1000 watt ellipsoidal or fresnel fixture. The PAR64 has is the only spotlight that has an oval (not round) beam pattern. The PAR64 has a very soft beam edge and a high degree of beam 'flare' making it totally unsuitable for many lighting applications and very well suited to others.

TYPE	BEAM SPREADS	WATTAGE	DESCRIPTION
PAR64	10-70 fixed	500-1000	OVAL Beam, SOFT edge

INCLUDED: - (a) power cord.

OPTIONS: - (a) lamp, (b) pipe clamp, (c) color frame, (d) electrical connector, (e) safety cable, (f) lens safety mesh, (g) snoot.

5.06 - PAR PIN SPOTLIGHT

1.) DESCRIPTION

The 'pin spot', although one of the least used fixtures, can be one of the most useful for many stage and entertainment lighting applications. Pin spots are available from a wide range of manufacturers in several different wattages.

Pin Spots are simply very narrow angle, low voltage PAR lamps, in a basic 'can' type housing. These PAR lamps are manufactured for use in portable hand lanterns, for architectural lighting, marine lighting and for use as aircraft landing lights. Beam spreads are very narrow and range from approximately 5 to 10 degrees. Pin Spots are sometime referred to as 'rain lights'.

All PAR lamps for pin spots are low voltage and operate on various voltages on either 5.5, 6, 12, 24 or 28 volts. All pin spots require transformers to transform the mains voltage (120 or 240 vac) to the proper lamp operating voltage. Usually, the transformer is incorporated into the rear of the fixture.

2.) APPLICATIONS

Pin spots can be very useful for providing accents, highlights and specials. This very low cost fixture provides an almost parallel beam of light (similar to a beam projector) can be used to provide special very 'tight' lighting to actors and objects. Pin spots can be particularly effective when all general lighting is dimmed down low allowing the pin spot (s) to highlight or draw attention to something (for example the clock on the wall, the door knob or any other very small localized area. Most pin spots can be dimmed from conventional (SCR) type dimming systems and most have color frame clips.

3.) TYPES

TYPE	BEAM SPREADS	WATTAGE	DESCRIPTION
PAR36-64 PIN	5 -10 fixed	25 - 480	OVAL Beam, SOFT edge

INCLUDED: - (a) power cord, (b) internal transformer.

OPTIONS: - (a) lamp, (b) pipe clamp, (c) color frame, (d) electrical connector, (e) safety cable.

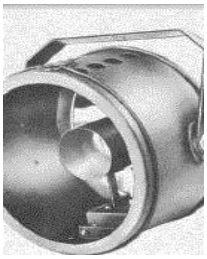
4.) SELECTED LOW VOLTAGE PAR LAMPS:

TYPE	ANSI	VOLT	WATT	BASE	TYPE	C.TEMP	HOURS	BEAM	FIELD	C.P.	MFR
25PAR36	PAR36	5.5	25	ST	VNSP	3000K	1000	5.5X5	-	30,000	G
4515	PAR36	6.0	27	-	VNSP	-	250	5X5	-	44,000	G
4405	PAR36	12	27	-	VNSP	-	250	6X5	-	40,000	G
50PAR36VNSP	PAR36	12	50	-	VNSP	-	2000	5X8	-	20,000	G
H7616	PAR36	12	34	-	VNSP	-	750	7X4	-	56,000	G
H7604	PAR36	12	45	-	VNSP	-	250	7X5	-	90,000	G
4509X	PAR36	12	88	-	NSP	-	70	12X6	-	84,000	G
4595	PAR36	12	88	-	NSP	-	840	14X6	-	46,000	G
4591	PAR36	24	80	-	NSP	-	100	12X6	-	54,000	G
4505	PAR36	24	40	-	NSP	-	1600	11X5	-	27,000	G
4594	PAR36	24	80	-	NSP	-	1200	13X7	-	42,000	G
4596	PAR36	24	200	-	NSP	-	100	11X12	-	90,000	G
25PAR46	PAR46	5.5	25	-	VNSP	-	1000	4.5X4.5	-	55,000	G
4535	PAR46	6.0	27	-	VNSP	-	250	5.5X4.0	-	76,000	G
4436	PAR46	12	32	-	NSP	-	750	10X4	-	48,000	G
4435	PAR46	12	27	-	VNSP	-	250	5X5	-	60,000	G
H7635	PAR46	12	45		VNSP	-	250	6.5X4	-	128,000	G
4553	PAR46	28	250W	ST	ACL	-	25	-	11x12	300,000	G

4545	PAR56	12	100	-	VNSP	-	100	9X5	-	225,000	G
4543	PAR56	12	94	-	VNSP	-	85	9X5	-	220,000	G
120PAR56VNSP	PAR56	12	120	-	VNSP	-	2000	7.5X7	-	62,000	G
240PAR56VNSP	PAR56	12	240	-	VNSP	-	2000	9.5X6.5	-	110,000	G
4541	PAR56	24	360	-	SP	-	100	15X11	-	280,000	G
120PAR	PAR64	6.0	120W ST		VNSP	-	3000	5x9		180,000	G
120PAR/1	PAR64	6.0	120W ST		VNSP	-	1000	5x9		220,000	x
120PAR64VNSP	PAR64	6.0	120W ST		VNSP	-	2000	4.5X7		210,000	x
4552	PAR64	28	250W ST		ACL	-	25	7x8	-	300,000	G
Q4559	PAR64	24	480W		NSP	-	400	12X8		360,000	G
Q4559X	PAR64	24	480W		NSP	-	400	11X7.5		460,000	G

5.07 - BEAM PROJECTOR SPOTLIGHT

1.) DESCRIPTION



The BEAM PROJECTOR (or BEAM LIGHT), is similar to a fresnel fixture, without a lens. A typical Beam Light produces a very narrow intense beam of light with a very soft edge.

Beam lights range in wattage from 500 to 2000 watts and they typically have an open circular front (10-24" in dia.). They uses a parabolic reflector to provide a near parallel beam of light. In this respect, the beam light is not really a spotlight, instead, it is more of a searchlight.

This fixture is considered more of a 'speciality fixture' in North America and Britain, however, they are widely used in Germany and other European countries.

2.) APPLICATIONS

Where a near parallel, intense beam of light is need, the beam projector is the fixture of choice. Designers find this fixture useful to simulate sunlight, moonlight and to provide strong motivated beams of light. The edge of the beam light is generally round, but has a very soft edge.

Beam lights are also sometimes used as follow spots, due to their tight, near parallel beams. They can be excellent for this application and sometimes are mounted directly behind the prosecenium arch in a 'perch' or 'tormentor'position.

3.) TYPES

The most common beam light for the North American Market is 10-12 inches in diameter, and rated to a maximum of 1000 watts.

TYPE	BEAM SPREADS	WATTAGE	DESCRIPTION
Beam Projector	5-15 variable	500-2000	ROUND Beam, SOFT edge

INCLUDED: - (a) power cord.

OPTIONS: - available: (a) lamp, (b) pipe clamp, (c) color frame, (d) electrical connector, (e) lens safety mesh.

5.08 - FOLLOWSPOT SPOTLIGHT

1.) DESCRIPTION

The FOLLOW SPOT is simply a narrow spotlight, used to 'follow' or to spotlight a performer on a stage. The follow spot usually consists of a 'movable', high power fixture mounted on a stand, with an attendant operator. Typical mounting distances range from 25 to 250 feet.

In 1826, a new, very intense light source was developed, (in Scotland). This was the 'limelight'. Fed by two separate lines, the limelight burned oxygen and hydrogen against a block of lime, heated to incandescence. Around 1860, limelights were fitted with lenses thereby becoming the first modern theatre lighting spotlights.

The electric arc (or carbon arc) was developed in 1808 by Sir Humphrey Davy. The carbon arc, was soon to replace the limelight. This type of fixture (example Strong, Super Trouper) served the industry for many years, and still does in some parts of the world. In the modern theatre industry however, the carbon arc spotlight has been replaced by newer incandescent and sealed electric arc lamps.

Modern followspot fixtures, usually consist of a cylindrical housing, 4-6 feet in length, mounted on a telescopic stand with castered legs. They are usually fitted with a manual iris and a color filter changer. Usually a followspot is designed to provide a 'hard' beam edge. Controls often exist, to 'soften' the beam edge, when required.

2.) APPLICATIONS

Designers typically use the followspot fixture to provide HIGHLIGHTS to a performer or a group of performers. Modern musicals, operas, and other large productions, may frequently use from 2 to 12 followspots or more.

Followspots are traditionally mounted 'as high as possible' at the rear of an auditorium, so as to 'front light' the actors. Followspots are also gaining increased use in a 'bridge' position, above the stage, providing a steep' front, back or side light to the performer.

3.) TYPES

Today, follow spotlights are available that use either incandescent or HID (discharge) type of lamps. They are manufactured for; short, medium and long throw applications and usually are mounted on stands. Various arc lamps used include: CIS, HID and Xenon. They come with color changers and usually have an iris and sometimes a dowser. Beam spreads are very narrow and typically range from approximately 1 to 10 degrees. Followspots range in size from the small 600 watt model suitable for community theatre to the giant 2500 watt "Strong Super Trouper" used in large arena events.

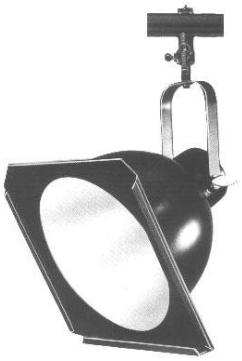
TYPE	BEAM SPREADS	WATTAGE	DESCRIPTION
Followspot	1-10 variable	500-2500	ROUND Beam, VARIABLE edge

INCLUDED: - (a) power cord, (b) stand, (c) color changer, (d) ballast if required).

OPTIONS: - (a) lamp, (b) electrical connector.

5.09 - FLOODLIGHTS

1.) DESCRIPTION



FLOODLIGHT fixtures, (Scoops and Box Floods) are the simplest of all stage lighting fixtures, consisting simply of an enclosed light source in a box with one open side. Floods are designed to provide a wide, even distribution of light, over a large area. Typical beam spreads range from 70-150 degrees. Most units come with a fixed 'beam spread' however a few units are adjustable between 'flood' and 'wide flood'. Typical wattages range from 500 to 1500 watts. Floodlights do not use lenses, however some may have a clear protective safety glass. The 'scoop' is really just a streamlined box flood, usually with similar lighting characteristics.

2.) THE BOX FLOOD

The single unit box flood has been a standard stage lighting fixture for many 100's of years and was probably the first actual stage lighting fixture. First using oil or candles, then gas and now the electric filament lamp, this simple flood light is still the most basic of all lighting instruments. The design of the box floodlight has changed little over the years however, the modern box flood now uses an internal reflector, for greater efficiency.

3.) APPLICATIONS

Floodlight fixtures are particularly well suited for lighting backdrops and sky cloths. Typically, a continuous row of floodlights is arranged above and parallel to the backdrop, at a distance of 3-10 feet away. For additional interest and impact, a row of fixtures may be also used to 'bottom light' the drop, from the floor.

Floodlights are also sometimes used for the lighting of scenery or to provide large area WASHES. Less often they are used for toning and blending. Floodlights are typically used in every theatre as 'work lights'.

4.) TYPES

Individual fixtures are commonly available in both SCOOP (round, open front) and BOX FLOOD (square or rectangular, open front) designs. Few manufacturers now make the scoop, preferring to offer the more sophisticated box flood instead.

The BOX FLOOD is available, either as a single unit, or as a 'ganged', or multiple unit of 2, 3 or 4 compartments, usually connected, end to end. This type of fixture is used to provide a 1-4 color wash to backdrops and large areas of scenery.

Box Flood fixtures are available with either a SYMMETRICAL or ASYMMETRICAL reflector design. The SYMMETRICAL type, (standard) provides regular square law illumination. That is, if the fixture is placed on the floor at a distance of 4', from a backdrop, the bottom of the drop will be much 'brighter than the top, (say 25 feet away). A fixture with an ASYMMETRICAL reflector, will 'push' more light to the top of the drop, and provide less to the bottom. The visual result being, more even overall illumination. The fixture type and mounting distance must be carefully selected, to provided the required distribution of light and visual effect.

TYPE	BEAM SPREADS	WATTAGE	DESCRIPTION
Box Flood	70-130 fixed	500-2000	VERY SOFT edge *
Scoop	70-130 fixed	500-2000	VERY SOFT edge

```
---------------------------------------------------------------------
* some box floods have a sharp hard cutoff on one side.
```

INCLUDED: - (a) power cord.

OPTIONS: - (a) lamp, (b) pipe clamp, (c) color frame, (d) safety cable, (e) electrical connector, (f) safety mesh, (g) floor mounting hardware.

5.10 - STRIPLIGHTS

1.) DESCRIPTION

Often the simple compartment floodlight is combined into multiple units connected together, forming a STRIPLIGHT. The striplight is one of the oldest stage lighting fixtures first having been developed for oil and candles and later for gas lighting. The striplight is also sometimes referred to a BATTEN or BORDER light as it often hung between the overhead masking borders.

With the introduction of the electric filament lamp it was possible to wire (or gang) a number of compartment floods together, forming a long linear fixture. The striplight has changed very little in the past 100 years. The typical unit of today is 4-9 feet long and is wired in 3 or 4 electrical circuits. By using alternating color filters (usually red, blue, green and sometimes amber) the striplight makes a very flexible color wash lighting fixture.

2.) APPLICATIONS

Permanent striplights are often found installed in older theatres, auditoriums and schools. Typically several units are used, running continuously from stage-left to stage-right. The 'strips' are usually installed downstage, centre stage and upstage. Through dimmer control, and using the 3 primary colors of light, the designer can mix almost any color. One moment the entire stage can be bathed in deep cold blue and the next it can be transformed into a warm golden amber. Overhead striplights as a general source of 3 color illumination are seldom used today, most designer preferring the more controlled use of the fresnel spotlight or even the PAR64, for wash, toning and blending applications. (p> Today, 3 or 4 circuit striplights are commonly used to light the top and bottom of backdrops and cycloramas (sky cloths).

FOOTLIGHTS are simply striplights placed on the floor, along the downstage edge of the stage. Once a principal source of stage lighting, footlights were also often wired to provide 3 or 4 color washes. Although seldom used today, footlights still can prove invaluable for certain lighting applications. Used sparingly, they can provide excellent low 'fill' light to a performer's face and can help eliminate shadows from overhead lighting, from hats, roofs, etc.

3.) TYPES

The modern STRIPLIGHT typically consist of a row of MR16, PAR, R (reflector) or double ended halogen lamps, mounted into a single compartmented fixture approximately 6-9 ft. long. The modern striplight is also wired in 3 (or 4) color circuits. Striplights are manufactured in various sizes, to use lamps with wattages of 75, 150, 300, 500 or 1000 watts each. Striplight fixtures commonly use glass or plastic colored filters in removable color frames. The modern striplight is used both in overhead and floor mounted applications (downlight and uplight)

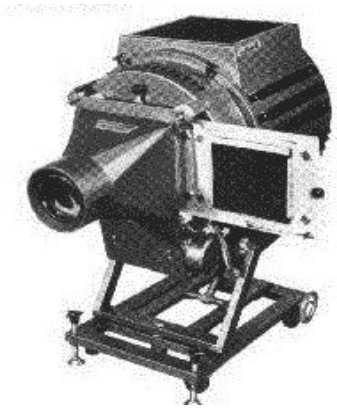
```
TYPE           BEAM SPREADS     WATTAGE    DESCRIPTION
=====================================================================
Striplights    70-100 fixed     75-1000   VERY SOFT edge
---------------------------------------------------------------------
```

INCLUDED: - (a) power cord (usually 3 or 4).

OPTIONS: - (a) lamps, (b) pipe clamps, (c) color frames, (d) safety cables, (e) electrical connectors, 3 or 4, (f) hanging hardware, (g) floor mounting hardware.

5.11 - PROJECTORS

1.) DESCRIPTION



Scenic projection has existed in the theatre for hundreds of years. From the early days of the shadow puppet to the Laterna Magica (magic lantern) to the optical projector of today, projection technology has grown and developed to become an important part of modern stage lighting. Today many modern stage shows make use of sophisticated projection from conventional projectors and from a new range of dynamic automated fixtures.

2.) LINNEBACH PROJECTOR

One of the simplest and first projectors used for scenic projection was the Linnebach projector developed in Germany by Adof Linnebach. Developed in the early 1900's, this very simple projector consisted only of an enclosed box with a large transparent slide placed on one side. A point light source inside the box caused an the image of the slide to be projected and enlarged onto an adjacent background. The image had a slightly soft definition (due to no lens) and was particularly well suited to a stylized theatrical productions. Many early designers produced elaborate hand painted slides for a wide variety of productions. The Linnebach projector is seldom used today as it requires a rather large transparency and is almost impossible to find manufacturers that produce the unit. They are however very easy to make.

3.) THE OPTICAL PROJECTOR

The modern optical projector of today is simply a refinement of the ancient Laterna Magica. One of the first magic lanterns was demonstrated by Kircher about 1560. Others including Huygens and Walgenstein also take credit for the invention of the device. Scenic projection developed over the years and many major lighting companies produced large scale projectors, including Century, Kliegl and Strand.

Today for large scale professional stage productions, where projection is used, it is almost always from the 'Pani' projector. This Austrian company (Ludwig Pani) makes a wide range of optical projectors and accessories. Their projectors are the best in the world for large scale projection and are available in wattages of 2000 to 10,000 watts.

4.) APPLICATIONS

Projection and projection effects have a wide range of applications for theatre, dance, opera and other entertainment productions. Background projection is common and is usually provided by a 'rear screen' projection system. Alternately, background projection can also be 'front screen' projection. There are many moving effects available for the Pani projection system, including clouds, rain, water, fire, etc.

In addition to backgrounds, projections can provide information and help create a special mood and atmosphere. Projectors can also provide area lighting to highly stylized productions. This takes a great deal of time and planning.

5.) INCLUDED: - (a) power cord.

6.) OPTIONS: - (a) lamp, (b) objective lens (c) condenser lens) (d) safety cables, (e) electrical connector, (f) hanging hardware, (g) floor mounting hardware, usually included.

5.12 - AUTOMATED FIXTURES

1.) DESCRIPTION

In the history of the stage lighting, no fixture has revolutionized the art more than has the automated fixture. Throughout all of recorded history and up until the 1970's, all stage lighting fixtures had one thing in common. They were static. They provided a single color, a single focus and were useful only for a single lighting application.

It was only a matter of time before someone decided to try and automate a lighting fixture. Early designs in the 1970's included motors to pan and tilt the fixtures in real time, much as a human operator manipulates a followspot. Although rather primitive at first, the automated lighting fixture was indeed born.

During the 1980 and 1990's the technology continued to develop. Companies such as Vari*Lite, Clay Paky, Hi-End Systems and Martin all started to produce automated fixtures. Some fixtures actually moved (moving fixtures). Other fixtures remained static and a moving mirror directed the light beam (moving mirror). As fixtures developed they became known as 'intelligent' fixtures.

Today the modern automated lighting fixture is a technological wonder. Using modern light sources, they move, change color, dim, project patterns and images, strobe effects and much more.

2.) APPLICATIONS

Automated fixtures are available in two basis types; moving fixture or moving mirror. Each has their advantages and disadvantages and each are suited for specific lighting applications. Generally fixtures are designed for COLOR WASH lighting (wide angle) or AREA LIGHTING AND IMAGING EFFECTS (narrow angle).

Automated fixtures can be, and are used for all lighting applications, depending on the design of the particular fixture. The lighting designer is advised to work closely with the manufacturer in order to select a unit best suited to his needs, as this technology changes almost daily.

Many current automated fixtures are quite noisy in operation, mainly from the fan required to cool the lamp. This fact and their general overall expense and poor record of reliability have kept the automated luminaire from replacing conventional fixtures for most stage lighting applications. As these fixtures become quieter and more reliable they certainly will find more and more use for theatre, dance and opera related productions.

5.13 - SUMMARY OF TYPES

TYPE	BEAM SPREADS	WATTAGE	DESCRIPTION
Plano-Convex	10-65 VARI.	300-2000	ROUND beam, HARD edge
Ellipsoidal Fixed f.l.	5-50 FIXED	500-2000	ROUND beam, HARD edge, VARABLE EDGE (hard - soft) with shutters & gobo slot
Ellipsoidal Zoom (typ.)	15-35 VARI. 25-50 VARI.	500-2000	ROUND beam, HARD edge, VARABLE EDGE (hard - soft) with shutters & gobo slot
Fresnel	15-70 VARI.	500-5000	ROUND beam, SOFT edge,

				Accessories: barn doors Beam edge is soft ONLY
PAR64-1K	10-70	FIXED	500-1000	OVAL Beam, SOFT edge
PAR36-64 PIN	5 -10	FIXED	25 - 480	OVAL Beam, SOFT edge
Beam Projector	5-15	VARI.	500-2000	ROUND Beam, SOFT edge
Followspot	1-10	VARI.	500-2500	ROUND Beam, VARIABLE edge
Box Flood	70-130	FIXED	500-2000	VERY SOFT edge *
Scoop	70-130	FIXED	500-2000	VERY SOFT edge
Striplights	70-100	FIXED	75-1000	VERY SOFT edge *

* some units have a sharp hard cutoff on one or more sides.

Stage Lighting Design

Stage Lighting Design

PART 6 - Lighting Mechanics

6.01 - INTRODUCTION TO MECHANICS

1.) MODERN LIGHTING DESIGN

Modern lighting methods are based, first on the lighting designer having a full and complete understanding of what it is he is tying to accomplish and exactly what he is tying to light. Next, the designer must intimately understand the characteristics of lighting fixtures and be able to chose the appropriate fixture for the appropriate job. The designer must know what he wants to do and how to accomplish it.

The designer must also have a full understanding of the physics of light and the psychology of human perception and vision. For example a single lighting fixture 'appears' very different when used to illuminate an actor against a 'black' or dark setting, compared to against a 'white' or light setting. The fixture has not changed at all, however the change in visual effect, appearance and impression on a human observer, is absolutely enormous, drastic and extreme. Things in theatre are "not what they are...they are what they appear to be".

Stage fixtures are available in relatively few types; (ELLIPSOIDAL REFLECTORS, FRESNELS, PARS, BEAM PROJECTORS and FLOODS. These five (5) basic fixture types are capable of producing an unlimited number of affects or visual impressions, depending on variable factors such as; fixture beam spread and mounting direction and distance, color & reflectance of object being illuminated, color & reflectance of surrounding objects, etc. All of these factors can and do greatly influence the perception of what a lighting fixture is able to do.

Not only must the designer understand how single fixtures perform under a countless variety of conditions, he must also understand how many fixtures work together to light a scene.

2.) ART AND SCIENCE OF DESIGN

Although lighting design is very much an art form, the artist must understand his tools. Fundamentally, the lighting designer must know how any particular lighting fixture will perform at any specified distance. The designer must know for example that a 25 degree, 1000 watt ellipsoidal, will typically produce a 12 foot diameter pool at 50 feet. Further, this fixture will provide approximately 100 foot candles (1000 lux) of light at this distance.

Lighting design is ultimately not about numbers and calculations. It is about feelings and spontaneous reactions. Although the designer can calculate how 'big and bright' a fixture will be at any distance, from the manufacturer's data sheet, eventually he must just instinctively 'know', how a specific fixture will perform at any distance. This comes from both practice and experience. Lacking experience and intuition the designer is best able to start to learn about his tools (lighting fixtures) from the manufacturer's data sheets.

The designer must find the balance between mechanics and art. Good lighting design should be spontaneous, instinctive and from the heart. Competent lighting design is from tables and formulas.

6.02 - THE LUMINAIRE

1.) THE LUMINAIRE

All lighting fixtures have several features in common. First, the correct term for a lighting fixture is really 'luminaire', (French). A LUMINAIRE refers to a complete lighting package; including: housing, lamp, socket, reflector, lens, color frame and electrical cord. Luminiares however are commonly referred to as; LIGHTS, INSTRUMENTS, UNITS, FIXTURES or LANTERNS. All lighting fixtures have the following in common:

2.) MECHANICAL

All stage lighting fixtures are constructed from steel (or aluminum), and are designed for high temperature although intermittent operation. Most fixtures are designed to be hung or mounted from a standard PIPE CLAMP ("C"-clamp), attached to the integral YOKE of the fixture. Using adjustments on the clamp and on the fixture, it is possible to 'pan', 'tilt' then 'lock' a fixture into any possible aiming position. All adjustments are made using a standard adjustable crescent wrench (spanner).

All stage lighting fixtures have an attached COLOR FRAME HOLDER at the front of the unit - for a plastic (or sometimes glass) color filter in a metal frame. Beam adjustment controls may also exist at the front, back, sides, top or bottom of the unit.

3.) ELECTRICAL

All stage lighting fixtures are manufactured for either 120 volt (North America) or 240 volt operation, (most other countries) Low voltage fixtures are also available, (in 6, 12, 24 and 48 v.), however these fixtures are usually powered by a transformer connected to either a 120 or 240 volt power supply. All fixtures are usually factory supplied, with an attached electrical cord (without plug).

4.) OPTICAL

Most stage lighting fixtures use lenses (Ellipsoidal Reflectors, Fresnels and Pars), but some do not (Floods and Beam Projectors). The manufacturer's data sheet will often provide valuable information relating to the beam spread of the fixture and the intensity of the beam.

5.) MANUFACTURER'S DATA SHEETS

Most lighting manufacturers publish a data sheet for each fixture that they manufacture. These data sheets may be used

by the designer and lighting technician to help understand the various properties of the lighting fixture. A data sheet for a typical fixture, will usually show the following information.

```
a.) dimensions    (usually a drawing with dimensions)
b.) weight        (in lbs/kg)
c.) voltage       (120/240)
d.) wattage       (in watts)
e.) beam spread   (in degrees)
f.) features      (any beam adjustments or controls)
```

6.03 - SELECTING A SPOTLIGHT

1.) BASIC SPOTLIGHT TYPES

A designer usually selects a fixture based on the required BEAM SPREAD and then next, on other physical and optical properties. The exact choice of a fixture for a particular lighting application is also sometimes influenced by; cost, size, weight and availability. The following basic spotlight types are generally available on a worldwide basis for stage and theatre use. Each type is available in different sizes, wattages and voltages. They are; the Ellipsoidal Reflector, the Fresnel, the Plano-Convex and PAR spotlights.

2.) ELLIPSOIDAL REFLECTOR Spotlight

The ELLIPSOIDAL REFLECTOR (ER) spotlight is one of the most common and useful stage lighting fixtures, in use today - and is commonly referred to as a LEKO (North America) or a PROFILE SPOT (Britain). All ER fixtures use lenses to produce highly controlled beams of light for isolated lighting applications. Their beams are 'round' and symmetrical. They have a 'very hard' and sharply defined beam cut-off edge and they are able to sharply project; either an iris, 4 integral adjustable shutters, or a metal pattern (gobo). The focus is adjustable from 'hard to soft'. This fixture is available in fixed BEAM SPREADS of 5-10-15-20-25-30-35-40-45 and 50 degrees. Several variable focal length (zoom) models are also available.

3.) FRESNEL Spotlight

The FRESNEL (fre'nel) spotlight uses a fresnel lens and also provides 'round' symmetrical beams as does the ER, however, this fixture has a 'soft' beam edge and is not capable of projecting patterns. All fresnels are adjustable from spot to flood, with a focusing knob. Cost is considerably less than that of the ER spotlight.

4.) PLANO CONVEX (PC) spotlight

The PC spotlight uses a PLANO CONVEX lens and provides 'round' beams, symmetrical beams, similar to a fresnel fixture. The beam edge is usually 'hard', and most fixtures are adjustable from spot to flood. The PC, although still manufactured today, has generally been replaced by the fresnel fixture or ellipsoidal reflector spotlights. Cost is typically between the cost of an ER and a fresnel spotlight.

5.) PARABOLIC ALUMINIZED REFLECTOR (PAR) spotlight.

The PAR fixture uses a sealed beam PAR lamp, available in various different 'oval' or rectangular beam spreads. This lamp has a very 'soft' beam edge with an oval (not round) shape. The 1000 watt PAR64 lamp is commonly used for stage lighting applications. Very low cost.

6.) SUMMARY OF FIXTURE TYPES

```
TYPE            BEAM   DEG.  BEAM    BEAM CONTROLS                COST
```

ELLIPSOIDAL	hard	5-50	round	shutters/gobo/iris	highest
FRESNEL	soft	10-70	round	adjusts spot to flood	|
PC FIXTURE	hard	10-60	round	no shutters or gobo slot	|
PAR64	soft	10-70	oval	no beam controls	lowest

6.04 - BEAM SPREAD CONCEPT

A.) BEAM SPREAD ANGLE

The manufacturer's data sheet for any typical fixture, will show a SPREAD ANGLE (in degrees), around the central beam axis. This angle describes how narrow or wide the beam will be, and does not vary with distance. Stage lighting fixtures, have a spread angle of between 5 and 150 degrees, depending on the exact type and design of the fixture. Typical SPOTLIGHT fixtures range between 5-70 degrees and typical FLOODLIGHT fixtures range between about 70-150 degrees.

B.) BEAM, FIELD & CUT-OFF ANGLE

Although we refer to the 'Beam Spread' of a fixture - this is NOT the 'BEAM ANGLE' of the fixture. It is actually the 'FIELD ANGLE' (or sometimes the 'CUT-OFF ANGLE'). The field angle is the beam spread angle at which beam intensity drops to 10% of the central beam intensity. The field angle is also referred to as 1/10 peak angle.

Sometimes the manufacturer's data sheet will also show a 'CUT-OFF ANGLE', for a particular fixture. This is the angle at which the beam intensity drops to '0 %' of the central beam intensity. Although this is of interest to the designer, it is the FIELD ANGLE that better represents the 'useful' spread angle of the fixture, and it is this angle that the designer uses in most beam spread calculations.

The actual 'BEAM ANGLE" of a fixture is defined as the angle at which central intensity (in candelas/candlepower) drops to 50 percent.

TYPICAL SPOTLIGHT - FIELD ANGLES

FIXTURE TYPE	FIELD ANGLE	NOTES
ELLIPSOIDAL	5 - 50 deg.	fixed spread or zoom units available.
FRESNEL	10 - 65 deg.	all units, adjustable: spot to flood.
PLANO CONVEX	10 - 60 deg.	all units, adjustable: spot to flood.
PAR64	10 - 70 deg.	fixed spread - different lamps avail.

C.) DETERMINING - BEAM SPREAD ANGLE

Usually a designer will chose a lighting fixture for a particular application, by first choosing the beam SPREAD ANGLE (Field Angle) required. For example if a designer wants to produce a 12' diameter pool of light at 30' he must use a 20 DEGREE fixture.

You can also 'reverse engineer' the process and determine what BEAM DIAMETER a particular fixture will produce at any particular distance, by using, the 'goofy' little charts on the manufacturer's data sheets. Alternately, the sheets will provide a MULTIPLYING FACTOR for a particular fixture. Simply multiply this factor by the distance (in meters or feet) to determine the beam width, at that distance. SEE: BEAM SPREAD CALCULATIONS.

6.05 - BEAM DIAMETER AND DISTANCE

D.) BEAM SPREAD ANGLE - SELECTION

The following process will assist the designer in the selection of the proper BEAM SPREAD, for any specific lighting application.

a.) FIXTURE DISTANCE (measure)

First determine the required DISTANCE at which the fixture will be used, (normally 15'-100' / 5m.-30m.) The distance is often referred to as THROW DISTANCE and is measured from the lighting fixture (or hanging position) to the center of the object, illuminated. The distance can be determined from a scale drawings of the venue, from a scale model of the venue or from actual site measurements.

Often the designer will draw a scale 'cross section' showing the lighting fixture and the actor (or surface to be illuminated). The distance can then be accurately measured using a scale rule. When lighting acting areas, the designer will usually measure the distance, to the actor's 'head height', (approximately 6'/1.8m. above the floor). When lighting an actor seated in a chair, then the distance is measured to the nose of the seated actor. The DISTANCE may be specified in either meters or feet.

b.) BEAM DIAMETER (specify)

Next, the designer must specify the BEAM DIAMETER (or the size of the lighting pool), that is required to light the actor or scenery at the given distance. (The BEAM DIAMETER may be specified in m. or ft.).

BEAM WIDTH is often used interchangeably with beam diameter. For the purposes of calculations, BEAM WIDTH provides a 2-dimensional 'slice' through the center of the beam. However, the beams from all theatre lighting fixtures are 3-dimensional and either 'symmetrical' or asymmetrical around a central axis and in this respect they produce a round (or oval) beam.

The beam diameter of an ACTING AREA pool, will usually need to be 8'-12' (2.4-3.6 m) in diameter, or as needed, to light the actor and not light the adjacent scenery.

When lighting an ACTING AREA, the beam diameters required are usually specified at the actors head height. For example, a down light mounted at 20' above the floor might provide a 9' diameter pool on the floor, however, at 6' above the floor, it provides the actor with less than a 7' diameter pool, or 'workable' acting area.

When not lighting the actor, DISTANCE and BEAM DIAMETER are usually measured, to the center of the actual scenic element being illuminated. Fixtures used for WASH lighting, may require beam diameters of 12'-20', 3.6-6.0 m) or more. An accent fixture (or special) used to light a small picture on the wall might only require a beam diameter of only 18" (.5 m).

6.06 - BEAM SPREAD - CALCULATIONS

c.) CALCULATING SPREAD ANGLE REQUIRED

Once you know; fixture DISTANCE and the required BEAM WIDTH, it is an easy matter to calculate what SPREAD ANGLE of fixture, is required.

Example: What fixture SPREAD ANGLE (in degrees) is required to produce a 12 ft. diameter pool (BEAM WIDTH)

at a DISTANCE of 25 ft.?

```
            BEAM WIDTH                    12 ft. BEAM WIDTH
ANGLE  =  ---------------   EXAMPLE:   ---------------------- = 26.6
          DISTANCE x .018               25 ft. DISTANCE X .018
```

Next select a fixture with a beam spread as close as possible to 26.6 degrees. For example, a 25 or 30 degree fixtures would produce an area, either slightly smaller or slightly larger than the required 12 ft. pool).

d.) CALCULATING BEAM WIDTH

Alternately, if you know the SPREAD ANGLE and DISTANCE of a fixture, you can easily calculate the resulting BEAM WIDTH. Example: What BEAM WIDTH is produced at a DISTANCE of 25 feet, from a fixture with a SPREAD ANGLE of 30 degrees?

```
BEAM WIDTH = ANGLE x .018 x DIST.  (EXAMPLE: 30 x.018 x 25' = 13.5')
```

e.) CALCULATING BEAM WIDTH WITH MULTIPLYING FACTORS

If you know the MULTIPLYING FACTOR for a particular fixture, you only need to multiply this factor X DISTANCE to find BEAM WIDTH at any distance. Example: If a lamp has a multiplying factor of .63, what is the BEAM WIDTH at 30 feet?

```
MF X DISTANCE = BEAM WIDTH         (EXAMPLE .63 X 30' = 18.9')
```

f.) CALCULATING MULTIPLYING FACTOR

If you don't know the multiplying factor for a fixture, you can calculate it as follows. Example, what is the MULTIPLYING FACTOR of a 35 DEGREE fixture?

```
ANGLE X .018 = MF                  (EXAMPLE: 35 x .018 = .63
```

g.) ASYMMETRICAL BEAMS

PAR64 LAMPS are asymmetrical. That is their horizontal and vertical spread angles are different. These lamps produce oval or 'rectangular' beams and you must perform both calculations separately.

6.07 - BEAM SPREAD - REFERENCE

```
                                                          .       Â
1.  Calculate: BEAM WIDTH of any angle          Angle ---. .      ³
               (beam, field or cut-off)                   .   .    ³
                                                        .     .   Dist.
                                                       .       .  ³
    BEAM WIDTH = ANGLE x .018 x DISTANCE, or          .         . ³
                                                     . . . . . . . Á
    BEAM WIDTH = MULTIPLYING FACTOR x DISTANCE      ÃÄÄ Width ÄÄ´
-------------------------------------------------------------------------
```

2. Calculate: MULTIPLYING FACTOR of any angle, as follows:

$$MF = \frac{\text{BEAM WIDTH}}{\text{DISTANCE}} \quad \text{-or-} \quad MF = \text{ANGLE} \times .018$$

---

3. Calculate: ANGLE, as follows:

$$\text{ANGLE} = \frac{MF}{.018} \quad \text{-or-} \quad \text{ANGLE} = \frac{\text{BEAM WIDTH}}{\text{DIST.} \times .018}$$

---

4. WIDTH OF LIGHTING BEAM - AT ANY SPREAD ANGLE & DISTANCE

D.in ft.	ANGLE (in degrees) 10	15	20	25	30	35	40	45	50	55	60
5	.9	1.4	1.8	2.3	2.7	3.2	3.6	4.1	4.5	5.0	5.4
10	1.8	2.7	3.6	4.5	5.4	6.3	7.2	8.1	9.0	9.9	10.8
15	2.7	4.0	5.4	6.8	8.1	9.5	10.8	12.2	13.5	14.9	16.2
20	3.6	5.4	7.2	9.0	10.8	12.6	14.4	16.2	18.0	19.8	21.6
25	4.5	6.8	9.0	11.3	13.5	15.8	18.0	20.3	22.5	24.6	27.0
30	5.4	8.1	10.8	13.5	16.2	18.9	21.6	24.3	27.0	29.7	32.4
35	6.3	9.5	12.6	15.8	18.9	22.0	25.2	28.4	31.5	34.7	37.8
40	7.2	10.8	14.4	18.0	21.6	25.2	28.8	32.4	36.0	39.6	43.2
45	8.1	12.2	16.2	20.3	24.3	28.4	32.4	36.5	40.5	44.6	48.6
50	9.0	13.5	18.0	22.5	27.0	31.5	36.0	40.5	45.0	49.5	54.0
55	9.9	14.6	19.8	24.8	29.7	34.7	39.6	44.6	49.5	54.5	59.4
60	10.8	16.2	21.6	27.0	32.4	37.8	43.2	48.6	54.0	59.4	64.8
65	11.7	17.6	23.4	29.3	35.1	41.0	46.8	52.7	58.5	64.4	70.2
70	12.6	18.9	25.2	31.5	37.8	44.1	50.4	56.7	63.0	69.3	75.6
75	13.5	20.3	27.0	33.8	40.5	47.3	54.0	60.8	67.6	74.3	81.0
80	14.4	21.6	28.8	36.0	43.2	50.4	57.6	64.8	72.0	79.2	86.4
85	15.3	23.0	30.6	38.3	46.0	53.6	61.2	68.9	76.5	84.2	91.8
90	16.2	24.3	32.4	40.5	48.6	56.7	64.8	72.9	81.0	89.1	97.2
95	17.1	25.7	34.2	42.8	51.3	59.9	68.4	77.0	85.5	94.1	102.6
100	18.0	27.0	36.0	45.0	54.0	63.0	72.0	81.0	90.0	99.0	108.0

6.08 - WATTAGE AND INTENSITY

1.) FIXTURE WATTAGE

Once a fixture TYPE and BEAM SPREAD has been selected, the designer may need to check if the fixture will produce the appropriate level of illumination on the actor or scenery, (at the given distance).

Fixtures are available in various wattages. Generally, as the wattage of the fixture increases, so does the light output, as well as the size, lens diameter, weight and cost of the fixture.

In theatre lighting applications fixture wattages usually range from 500 to 1000 watts. In arena , television and film applications, fixture wattages usually range from 1000 to 5000 watts (incandescent).

Stage and Studio lamps come in the following standard wattages; 300-500-750-1000-1500-2000 watts. New highly efficient fixtures (developed in the 1990's) now use lamps of 575 or 600 watts that actually outperform a similar 1000 watt fixture of older design.

2.) CENTRAL INTENSITY

The lighting designer is not really interested in 'wattages' for photometric calculations. Instead, he wants to know the INTENSITY of light produced by a particular fixture.

The data sheet from a typical fixture will show CENTRAL INTENSITY (expressed in 'candela' or 'candlepower'). This is the intensity along the central axis of the fixture AND IT DOES NOT VARY WITH DISTANCE. Different central intensities may be shown for different wattages of lamps, in a particular fixture. The central intensity is commonly used to compare one fixture to another and to calculate the 'center beam' foot candles (or LUX), that the fixture will provide, at any distance.

For example, many ellipsoidal type fixtures use the 1000 watt, FEL lamp. They will all have different central intensities, based on the fixture optics; beam spread, reflector design, etc. For example:

3.) CENTRAL INTENSITY of common 'Strand' fixtures using a 1000 watt, FEL lamp:

FIXTURE	A.K.A.	FIELD ANGLE	CENTRAL INTENSITY
Strand 2250	50 degree	53	46,000
Strand 2209	6X9	43	58,500
Strand 2240	40 degree	38	90,000
Strand 2212	6X12	31	91,000
Strand 2230	30 degree	30	121,000
Strand 2216	6X16	23	149,600
Strand 2220	20 degree	20	184,000
Strand 2215	15 degree	15	250,000
Strand 2113	8X13	13	420,000
Strand 2223	10X23	9	800,000

all fixtures set to 'cosine' illumination.

6.09 - ILLUMINANCE, FOOTCANDLES AND LUX

1.) ILLUMINANCE

In fact he really isn't directly interested in intensity, unless he wishes to compare one lighting fixture against the other. What the designer ultimately wants to know is the ILLUMINANCE at the actor (measured in foot candles or lux). NOTE: 'illuminance', replaces the old term 'illumination' and refers to the AMOUNT OF LIGHT FALLING ON A SURFACE (i.e. an actor or scenery).

2.) FOOTCANDLES and LUX

The FOOTCANDLE is used as the unit of illuminance when the foot is taken as the unit of length. It is the illumination produced on a surface all points of which are at a distance of one foot from a directionally uniform point source of one CANDELA.

LUX (lx) is the SI unit of illuminance. 100 fc = 1076 lux.

3.) STAGE LIGHTING LEVELS

Average illuminance levels during a typical stage production may vary from 10-200 FC - depending on the needs of atmosphere verses visibility. Acting areas with 50-100 FC are usually suitable for most dramatic plays, comedies, and musicals, providing that surrounding and background lighting levels are lower (for contrast). The author has found that acting areas of about 100 FC (yes I do measure them from time to time) will allow the 'aging eye' to see good facial details from a distance of 75 feet (approximately row 20). Lighting levels that are too low for too long a time can cause visual fatigue.

Sometimes however 10 FC may appear BRIGHTER than 200 FC. It is not only the amount of light that is important. Good visibility and seeing detail, also depend on an objects visual contrast with its surroundings, on viewing distance and on the condition of the human visual system.

4.) ILLUMINANCE MEASUREMENTS

Footcandles (& lux) are measured with LIGHT METERS. Typically, the stage lighting designer never caries a light meter, while a television lighting designer, always does. The eye has a huge dynamic range and can accommodate a wide range of illuminance. (from very dim to very bright). The television camera is much less accommodating and light must be specific within limits of illuminance levels and contrast.

The stage lighting designer, in practice, is seldom concerned with footcandles, lux levels and calculations. Instead, he just 'instinctively knows' which fixture, with which wattage of lamp, with which density of color filter, - will provide the required impression of brightness - to the audience. The stage lighting designer must not light for the lightmeter, he must design only for the human eye.

6.10 - ILLUMINANCE - CALCULATIONS

1.) CALCULATION OF ILLUMINANCE

To calculate ILLUMINANCE, the designer must first know the intensity of light produced by a fixture. Using the manufacturer's data sheet, find the 'central intensity' (in candela), and then calculate the center beam illumination at any distance, as follows:

```
FORMULA:  ILLUMINANCE (fc or lux) = CENTRAL INTENSITY ö DISTANCEý.

FORMULA:  ILLUMINANCE (E) = (I) (candela)
                            -------------
                              DISTANCEý
```

EXAMPLES

If a 1000 watt fixture, has a central INTENSITY of 90,000 CANDELA, what is the center beam ILLUMINANCE (fc or lx) at a DISTANCE of 30 feet?

ANSWER: 90,000 ö 30 FT.ý = 100 Footcandles.

2.) CALCULATION OF INTENSITY

You may also calculate the central INTENSITY (in candela) required from a lighting fixture - to produce a specific ILLUMINANCE (fc or lx) at any DISTANCE - using the following formula.

FORMULA: CANDELA = (FC or LUX) x (DISTANCE SQ.)

EXAMPLES

For example, what central INTENSITY (fixture) is required to produce a center beam ILLUMINANCE (fc or lx) at a DISTANCE of 30 feet?

ANSWER: 100 Footcandles x 90 = 90,000 CANDELA

3.) UNITS OF CALCULATION

When the 'foot' is taken as the unit for distance, the answer will be in footcandles (fc). When the meter is taken as the unit for distance, the answer will be in lux (lx).

6.11 - ILLUMINANCE - REFERENCE

Inverse-Square Law Method - (Illumination normal to surface)

```
1.  To calculate ILLUMINANCE at any DISTANCE,
    (given: Central INTENSITY in Candela).
                                                   Source Intensity
    E(fc)= I (candela)    E(lux)=  I (candela)
           -----------             -----------            *       -
          DIST. SQ (ft.)          DIST. SQ (m.)          . .      |
                                                        .   .     |
    Assumes central intensity of source is             .     .   D.sq.
    perpendicular to surface. The distance            .       .   |
    to the source must be at least 5 times           .         .  |
    the minimum dimension of the source.            . . . E . . . -
                                                       Surface
-----------------------------------------------------------------------

2.  To calculate INTENSITY, (given: ILLUMINANCE and DISTANCE):

    CANDELA = (FC or LUX) x (DISTANCE SQ.)

                                -or-

2a. CANDELA required for various levels of ILLUMINANCE:
```

DISTANCE in (Feet)	ILLUMINANCE REQUIRED (Footcandles) 25	50	75	100	125	150
10	2,500	5,000	7,500	10,000	12,500	15,000
20	10.000	20,000	30,000	40,000	50,000	60,000
30	22,500	45,000	67,500	90,000	112,500	135,000
40	40,000	80,000	120,000	160,000	200,000	240,000
50	62,500	125,000	187,500	250,000	312,500	375,000
60	90,000	180,000	270,000	360,000	450,000	540,000
70	122,500	245,000	367,500	490,000	612,500	735,000
80	160,000	320,000	480,000	640,000	800,000	960,000
90	202,500	405,000	607,500	810,000	1,012,500	1,215,000
100	250,000	500,000	750,000	1,000,000	1,250,000	1,500,000

```
---------------------------------------------------------------------

3.   To convert from FC to LUX (or LUX to FC):

      LUX x .0929 = FC                FC x .10.76 = LUX

      (500 LUX = 46 FC)               (50 FC = 538 LUX)

---------------------------------------------------------------------
```

6.12 - BEAM DISTRIBUTION

1.) BEAM, FIELD, CUT-OFF ANGLE

Manufacturer's data sheets will refer to the BEAM, FIELD and CUT-OFF angles, for a particular fixture. It is the FIELD angle that defines the 'useful' spread of a particular fixture, and it is this figure that designers use, in beam width calculations, (spread angle).

2.) BEAM DISTRIBUTION

Generally, the central axis of a fixture's beam has the maximum intensity. This is the CENTRAL INTENSITY of the fixture. The BEAM angle is the angle where central intensity drops to 50%. So, a fixture with a 40 degree FIELD angle could have; a 5 degree BEAM angle (peak, or hot center), a 20 degree BEAM angle (cosine) or a 40 degree BEAM angle (flat field, even) - or anything in between.

You will note from the above that it is the relationship between the central intensity and the beam and field angles that define the distribution or 'evenness' of light, across the beam. Sometimes a beam with a 'hot center' is desired. Sometimes a beam with a 'flat field' is needed. Sometimes, only cosine illumination is required. It is important to understand what type of distribution each fixture is capable of producing.

3.) REPORTING

In order to report the highest possible light output, manufacturer's will generally report output with the fixture set for PEAK distribution (hot center). A fixture is typically seldom used in the PEAK setting as this usually results in a hot beam center, with much less light, elsewhere in the beam. Note: PEAK, COSINE and FLAT FIELD distributions all have their uses, for stage lighting applications. These reports should also be included with the data sheets, if the fixture can be adjusted for these distributions.

```
4.)  DEFINITIONS
---------------------------------------------------------------------
ANGLES:
---------------------------------------------------------------------
Peak Intensity     - Brightest point in beam, usually on central axis
1/2 Peak Angle     - where intensity drops to 1/2 Peak intensity.
1/10 Peak Angle    - where intensity falls to 1/10 Peak intensity.
Cut-Off Angle      - total beam diameter
Beam Angle         - same as 1/2 Peak Angle
Field Angle        - same as 1/10 Peak Angle
---------------------------------------------------------------------
DISTRIBUTIONS:
---------------------------------------------------------------------
Peak Distribution  - set to: maximum center intensity
Cosine Distribution- set to: 1/2 of C.I. at 2/3 total spread.
Flat field Dist.   - set to: even beam, no hot center.
```

6.13 - MANUFACTURER'S TERMS

```
1.) PERFORMANCE DATA - TERMS USED BY VARIOUS MANUFACTURERS
-------------------------------------------------------------------------
Pk = Peaky                    Strand
PD = Peak Distribution        Strand
Pk = Peak                     Colortran
PC = Peak Center              Altman
PF = Peak Focus               Colortran
PB = Peak Beam                Electronic Theatre Controls
-------------------------------------------------------------------------
CD = Cosine Distribution      Strand
Co = Cosine                   Altman (360 series), Colortran, Strand
-------------------------------------------------------------------------
FF = Flat Field               Altman, Emil Niethammer, ETC
-------------------------------------------------------------------------
```

Stage Lighting Design

PART 7 - Lighting Education

7.01 - TRAINING AND EDUCATION

1.) LIGHTING DESIGN - TRAINING

"It is necessary to improve educational programs for lighting design. Design and energy consultants require special instruction with a broader foundation than present curricula provides. Lighting design education should cross departmental lines.

Lighting design encompasses esthetics, perception, illumination and specific technical expertise. These are used to reinforce project goals. Improvement in lighting design education must fulfill the needs of the designer and those served.

Design for the arts, architecture, industry and other applications requires a thorough understanding of the psychological, psycho-physical and physical aspects of lighting. The characteristics of human, photographic and photo-electric receptors must be addressed.

Properly trained people are readily employable but job entry requirements are significantly more stringent than in the past. Educators must respond.

Lighting design is the process of creativity using the qualities and functions of light to affect people, objects and space. The qualities of lighting are intensity, form, color and movement. The functions of lighting are visibility, mood (atmosphere), composition and motivation. Study should include at least a fundamental understanding of the following:"

```
A)  Design Technique and Application
------------------------------------
    Color, light  sources,  photometrics,   brightness  relationships,
    introduction  to and evaluation of typical lighting  applications.
    Drafting and visualization.

B)  Human Responses to Light
----------------------------
    Sight, esthetics, behavior, photobiology

C)  Electrical Control and Distribution
```

```
---------------------------------------
D)  Optical Control and Distribution
-----------------------------------
E)  Lighting Equipment Types and Application
--------------------------------------------
F)  Specialized Topics
----------------------
    Conservation  of energy, materials, safety codes and  regulations,
    history,     photographic    and    photoelectric     reproduction
    technology.
```

NOTE: This above statement was formulated by T.O.L.D. (Training of Lighting Designers) in 1981. It was supported by many professional lighting organizations. This statement still very much applies today and should be used as the basis of any complete educational program.

7.02 - HANDS ON EXPERIENCE

1.) LIGHTING DESIGN - EXPERIENCE

Any successful lighting design ultimately depends on the designer understanding his equipment, not just in theory but in practice. Experience is the key to any good design.

2.) A BEST EXERCISE

One of the best exercises for any potential lighting designer is to simply work in a small theatre with typical fixture types. The fixtures should be in typical positions, (front, back, side, down, etc.) at a usual distance (12-30'). Start with the four (4) basic fixture types.

```
a.) 6"  ellipsoidal reflector
b.) 6"  fresnel
c.) 10" Par64MFL
d.) 24" Flood
```

Each fixture should be used (one at a time) to light a small scene, against a black backdrop and floor and then against a white backdrop and floor. The designer will usually be quite surprised at how just changing the scenery from black to white (light to dark), can drastically 'change the lighting'. This provides a great lesson regarding reflection, absorption, intensity, color, moods, etc.

The designer will also note the different lighting qualities of each of the different fixture types. He must learn to visualize the beam of light as a three dimensional cone of light traveling through space and intersecting with the scenery (or actor). He must know how bright any fixture will be at any distance and what the beam size will be.

Next the designer should repeat the exercise with the same four basic fixtures, but this time at a nearer then farther distance. It will be noted how drastically both beam size and intensity change.

Now repeat the exercise combining 2 or more fixtures positioned as front, side, back or down lights. Next, repeat all of this with an actor. Got the idea?

Once the designer instinctively 'knows' exactly what his equipment is capable of, the job of design becomes the joy of design. Lighting design, regardless of style or method, simply consists of placing light accurately, where needed.

There are a number of stage lighting texts that try to photographically illustrate the basic lighting fixture types in

various positions, in relation to an actors. One of the best studies can be found in 'The Magic of Light' (Jean Rosenthal). This black and white study shows both single and multiple lamp arrangements, using both ellipsoidal reflector and fresnel fixtures.

7.03 - PROCEDURE VS RESULTS

1.) THE DILEMMA OF THE DESIGNER Much of what the stage lighting designer does, has to do with solving problems. It is usually important for the director and other designers to impose their visions, on the production. When they do however, they must have the necessary skills to know how to realize these visions.

When a director and designers, conceive a production, they must first define their fixed parameters, including; budgets, space limitations, number of cast members, time and labor available, etc. Next, they must conceive the production in a responsible way, so as to work within the given parameters. The key word here is 'responsible'.

Any design problems that the director and designers create, they must be able to solve. Not in theory, with unlimited budgets, space, crew and time, but 'now' and within the budget of their show, and not some imaginary fantasy production. "If we only had more time",...usually means..."If only we had planned properly".

"Don't worry we'll fix it with light". Lighting designers have always been considered both magicians and miracle workers, or so it seems from the attitudes of others. Because we can't see, touch, taste, hear or smell light, it often seems mysterious and difficult to understand.

Well yes, the lighting designer can 'fix' a number of problems, with light, but there are also limitations. It is important that the lighting designer understands these limitations and fully collaborates with the director and other designers during all stages of design, ... so that it isn't necessary to "fix the production with light."

The lighting designer is not a god. He is however an important member of the design or production team. It is usually the PERFORMER that audiences pay money to see, not the lighting. In this respect the lighting designer may have to remind himself from time to time that he is of secondary importance only. Sometimes however the performer may indeed be secondary to the lighting, as in the case of some modern 'rock' shows or in the case of bad lighting design.

In an educational (or learning) situation it is usually PROCEDURE that is far more important than results. In a professional situation, it is RESULTS that are usually far more important than the procedure. The designer must work well with his electricians, and other members of the production team, to meet the expectations of the director and the needs of the production. If the lighting designer has been realistic about his design and resources, he usually has nothing to worry about.

It is often the designer that hasn't done their homework, that starts to panic during the lighting set-up. Tempers may flare and the crew may suddenly grow donkey ears and become incompetent. This usually scores no points with anyone. Remember, you are there to solve problems, not create them. Lighting design often has more to do with the psychology of working with people than it does with light and lighting, so PROCEDURE is also important. Lighting design is not a solitary process.

7.04 - EDUCATION - BEAM SPREAD CONCEPT

1.) INTRODUCTION

The lighting designer (and technician) must be able to rapidly determine the width of a beam, of a lighting fixture, at any distance. Usually the process requires the use of tables or multiplying factors, provided by the manufacturer. Throw

away all your tables and never use them again. This method allows you to calculate the beam width of any fixture, at any distance, mentally!

2.) FIXTURE LIGHTING ANGLES

Stage, television, architectural and display spotlights all come with specific 'beam spreads', usually referred to as the; beam, field & cutoff angles. Typically focal lengths range from 5 to 150 degrees.

When a manufacturer claims that a fixture is '20 degrees', he usually means that the 'field' or 'cutoff' angle, is 20 degrees. Lighting fixtures come in two basic types: fixed and adjustable focal lengths.

3.) THE METHOD

What is the beam width of a 55 deg. fixture at 55 ft.? ANS: 55 ft.

Yes that's right a 55 degree angle produces a beam spread of 1:1. So at 10 feet, the fixture would produce a 10 foot wide beam.

Draw a 55 degree angle (to scale) and check this for yourself. Learn to visualize in your mind what a 55 deg. angle, looks like. Also learn to visualize it as a three dimensional cone of light. A 'wide' angle ellipsoidal fixture and an adjustable fresnel type fixture are both examples of fixtures able to produce this spread angle.

Now through simple interpolation if a fixture of 55 degrees provided a 55 foot wide beam, (at a given distance), what would a 25 degree fixture produce? That's right, the beam would be just under 1/2, or about 25 ft. wide.

4.) EXAMPLE

What is the beam width of a 40 degree fixture (6x9) at 18 feet?

Well, you already know that if it was 55 degrees spread, then the beam width would be 18 feet. And, you also know that a 25 degree fixture would produce a beam width of about 8 feet. So, your 40 degree fixture is right in the middle of the range.

```
So if 55 degrees = 18 ft.beam width
And   25 degrees =  8 ft.beam width
Then  40 degrees = 13 ft.beam width (halfway between 8 & 18).
```

Once the designer has mastered the above technique, tables and formulae may be used for even faster calculations.

Stage Lighting Design
