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ROUTLEDGE

DESIGNING WITH LIGHT

AN INTRODUCTION TO STAGE LIGHTING

J. MICHAEL GILLETTE AND MICHAEL MCNAMARA

SEVENTH EDITION

Designing with Light

Now in its seventh edition, *Designing with Light* introduces readers to the art, craft, and technology of stage lighting and media projection.

The new edition is fully updated to include current information on the technology of stage lighting: lighting fixtures, lamps, cabling, dimmers, control boards, as well as electrical theory. Readers will learn how designed light is used to enhance the audience's understanding and enjoyment of a production. The book includes specific information on drafting the light plot, explores the challenges of designing for different stage configurations, and provides examples of lighting designs for dramas, musicals, and dance. It also features comments and thoughts from active designers from both mainstream theatrical productions and related industries.

Written for students of Lighting Design and Technology as well as professional technicians and designers, *Designing with Light* offers a comprehensive survey of the practical and aesthetic aspects of stage lighting design.

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For Joyce Ann because she has always known why.
—J. Michael Gillette

To Nancy, Joan, and Susan for showing the way.
—Michael McNamara

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Preface

The purpose of this book is to introduce students to stage lighting design, which is an amalgam of technology and art. Without an understanding of the technology used in the craft, it is difficult to design with light. And without an understanding of the theory and processes of design, it is almost impossible to design with light. To be successful, a designer needs to know both.

As with any art form, the basic elements for a successful creation are an understanding of the chosen artistic medium and the inspiration to create. We hope that this text will provide that basic understanding of the design potential of light and give an insight into the sources that inspire a lighting designer to create.

Organization

Because the study of theatrical lighting design covers two basic areas—technology and design—this text has been divided into two sections. Chapters 1 through 10 present practical information that is essential to developing an understanding of the technological aspects of designing with light. Chapters 11 through 17 provide information on how to design with light as well as how to draft the light plot and execute the other paperwork used by a lighting designer.

New to the Seventh Edition

In the rapidly evolving technological world of lighting design one of the challenges of updating this text is divining which of the new technologies and design innovations—that seem to be appearing at an ever-accelerating pace—are truly significant developments that will become "the new standard," and which are simply interesting ideas that, for one reason or another will quietly, or not so quietly, fade away. We've chosen to include explanations of a few of these new developments, such as sine wave dimmers and LED-source lighting fixtures because these innovations offer some clear advantages over the existing technologies at what

are relatively competitive costs. As progress is made on similarly exciting new technological developments, they will be included in future editions.

We also find it interesting that, while there have been myriad technological advancements in the past decade, almost no changes have occurred in basic design philosophy—the reason we design light for theatrical presentations in the first place. The core of that design philosophy—to provide visual reinforcement that supports the production concept—hasn't changed. And it probably won't change until such time in the future as, for whatever reason, there is a radical shift in the purpose and nature of theatrical presentation. For that reason we've chosen to make very few adjustments to the sections of this text dealing with the process of creating the lighting design.

It is probably a gross understatement to say that the world of lighting design is a much wider and deeper field than it was when the first edition of this text was published 42 years ago. What were once considered subfields of theatrical lighting—concert, club, trade show, TV specials, projections and event lighting—are now fully developed, energetic, and vital professional fields. And, since the integration of the computer and its related technologies into the lighting industry, we are being constantly bombarded with new technologies and exciting equipment. There is almost too much information to learn. And anyone working in the field needs to know, or at least be aware of, much of it. For this reason, we've included a selected bibliography that references a number of excellent sources from across the now-broad field of entertainment lighting design. We hope you will find this additional information helpful and useful.

In this edition, the basic organization of the text remains the same but there have been several significant changes in content. New technologies have been introduced, old technologies updated, and many of the equipment photos have been changed to show manufacturers' more recent designs and models.

Much of material in every chapter of this edition has been significantly rewritten to update the existing technology and equipment; introduce the new technologies being used in lighting for theatre, film, and video; bring both the terminology and practices in line with current standards; and update the photos and illustrations.

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The updating of Chapter 9, "Projections and Media," could not have been accomplished without the information, ideas, and counsel provided by John A. Boesche. His knowledge has been invaluable in making that chapters current in the areas of technology, equipment, and practice.

1 An Introduction to Designing with Light

Any dramatic production, unless it is performed outdoors during the day, needs some kind of artificial light. If illumination were the only function of stage lighting, however, you could hang a **bank** of fluorescent lights over the stage and forget all about the **dimmers**, **control boards**, **cables**, and **instruments**.

Obviously, there is more to stage lighting than simple illumination. Effective stage lighting not only lets the spectators see the action on the stage but also ties together all the visual elements of the production and helps create an appropriate mood and atmosphere that heightens the audience's understanding and enjoyment of the play.

banks
Refers to the number of individual fluorescent tubes or lamps contained in a fluorescent light fixture.

Dimmer
An electrical device that controls the intensity of a light source connected to it.

control board
A console containing controls for a number of dimmers. Also called a control console.

cable
An electrical extension cord used to connect instruments to dimmers or instruments to permanent stage circuits.

instruments
Lighting fixtures designed for use in the theatre.

Light and Perception

Why bother to "design" light in the first place? To understand these questions, we first need to understand what light is, what it does, and how light influences our perceptions and understanding.

Light is usually described in terms of its characteristics and physical nature. Explanations of what visible light *is* usually follow these boringly accurate descriptions: (1) Something that makes vision possible; (2) that portion of the electromagnetic spectrum that stimulates the visual receptors in the eye; (3) that relatively narrow band of the electromagnetic spectrum between infrared light and ultraviolet radiation; (4) light travels at approximately 186,281 miles per second.[1]

Although these definitions describe the physical nature of light, they don't really tell us what light "does." We all know that light makes objects visible. But it is *much* more important for someone interested in lighting design to understand that: *the manner in which light illuminates an object shapes the viewer's impression and understanding of what they're seeing*.

That concept is the crux of the discussion of light and perception as well as the underlying reason that we bother to design with light in the first place.

intensity
One of the four controllable qualities of light; the relative brightness of light.

color
One of the four controllable qualities of light; a perception created in the brain by the stimulation of the retina by light waves of certain lengths; a generic term applied to all light waves contained in the visible spectrum.

The angle of the light, its **intensity**, **color** and cohesion (sharpness) or diffusion (softness) all affect our impression of the object we're seeing. To illustrate, almost everyone has heard of the phrase "the ever-changing face of the mountains." But, if you stop to think about it, unless there is some cataclysmic disaster, the features of any particular mountain or mountain range change little, if at all, over hundreds or even thousands of years. However, if you were to critically look at a mountain range for even a few days or weeks, you would begin to understand the concept behind the phrase. The appearance of any mountain changes considerably in the course of the day. The patterns of highlight and shadow created by sunlight falling on the ridges and valleys shift continuously as the sun moves across the sky. A steep cliff that is bathed in brilliant morning sunshine slides into deep shadows in the late afternoon. A hillside that hides in morning gloom emerges into brilliant sunshine by midday. Clouds or fog soften or obscure part of the range. In the late afternoon we may be treated to the mountain being bathed in a soft purple or peach twilight at sunset. The manner in which the sun illuminates the mountain controls not only what we see but also, to a great extent, how we feel about what we're seeing.

Intellectually everyone understands that the physical structure of mountains doesn't often change in our lifetimes. But our individual perception, our personal understanding, of what those mountains mean to us is based on a complex process involving not only sight and intellectual recognition, but our emotional reaction to what we're seeing. To a great extent, that emotional reaction is controlled by two primary elements: instinct and learned behavior. Another example may help explain this process. Imagine it's a pleasant, sunny summer day. You're walking down the sidewalk next to a park. There is a low stone wall, about waist high, between you and the park. The park is inviting, with a thick carpet of grass beneath a canopy of large shade trees. A few benches are randomly scattered on the lawn. A young couple sit on one of the benches quietly talking. Across the street there are several stores—a bookshop, a clothing store, a bank, and a drugstore on the corner.

Now, imagine that you're on this same street at 2:00 a.m. on a moonless night. It's really dark. The only light comes from the window of the drugstore on the far corner at the other end of the park. As you walk beside the stone wall, you peer into the blackness of the park. A little starlight filters through the leaves. You hear low **voices** coming from the park. Then you think you see something move. You're not sure. You quicken your pace as you cross the street then almost break into a run as you rush toward the drugstore.

voice
Design "voice" refers to the ability to express your own artistic style.

As mentioned earlier, our emotional reaction to what we see is controlled by two primary elements: instinct and learned response.

Instinctively, most people are afraid of the dark. This response was genetically programmed into our ancestors tens of thousands of years

ago when our progenitors roamed the plains and woodlands looking for food. Our vision was our primary defense against being eaten by something larger, stronger, and/or faster. If we saw it, we would at least have a chance of defending ourselves. If we couldn't see it, it could jump out of the dark and "get" us. Humans don't see well in the dark, so our ancestors who avoided dark places were more likely to live to pass on their gene pool than those who ventured into the dark and didn't return. With each succeeding generation this healthy act of self-preservation became more and more reinforced in our genetic code.

The second contributor to our reaction to what we see is learned response. From the time that we're infants we are busy learning. A great deal of what we learn is stored in the brain as memories. Almost all of our early learning is experiential—learning by experience. These experiences are major contributors to how we will react in any given circumstance. Occasionally I have looked outside on a cloudy summer day and absently thought, "It looks like it could snow." Logically, I know that it isn't going to snow, but there is something about the shape and color of the clouds, the direction and speed of the wind, and the color of the light that reminds me of the way it looks before a snowstorm. Our subconscious minds are constantly comparing incoming information—what we're currently seeing—with memories of what we've experienced before in our ongoing struggle to help our conscious minds make sense of our surroundings. An interesting example of this learned response occurred during the University of Arizona production of *Terra Nova*, which is primarily set in Antarctica and chronicles Scott's ill-fated trip to the South Pole. Gillette was designing the lights and the director wanted the lighting for the Antarctica scenes to be "white and painfully bright." At first I left the lights uncolored, but the **white light** seemed warm rather than cool. Before the next rehearsal I put a light blue **color media** into all the lights. At rehearsal that night almost all the people in the audience complained of being chilly or cold. The thermostat in the theatre hadn't been changed from the previous day. The only difference was the light blue color in the lights. My assumption is that our subconscious minds saw the blue light, compared it with memories of "the color of cold," and convinced our conscious minds into thinking that the theatre actually was cold. Subsequently we had several comments from the paying audience that the theatre was rather cold. We raised the thermostat a few degrees even though the production occurred in late September in Tucson when the average temperature was in the high 90s. Such is the power of the mind.

white light
Light that contains all wavelengths of the visible spectrum in relatively equal proportion.

color media
The plastic or glass materials used to color the light emitted by lighting instruments.

The reason that we design the lighting for an event or a place is to influence the audience's perception, understanding, and emotional reaction to what they're seeing. That is the reason lighting is thoughtfully designed for theatre, films, and television as well as for rock concerts, theme parks, and retail stores.

Lighting strongly influences our perceptions and understanding. Machiavellian, isn't it? Read on and learn how Machiavellian lighting design actually is.

Design Characteristics of Light

As you begin to learn about lighting design, it is important that you understand what lighting design is, as well as what it is not. Theatrical lighting design is a process and a craft used to create an artistic result. While it's easy to think that the primary purpose of stage lighting is to allow the audience to see the stage, the reality is that "the designed use of light"—lighting *design*—is much more than an exercise in illumination.

lighting designer
Person responsible for the appearance of the lighting during the production.

production concept
The creative interpretation of the script that will unify the artistic vision of the production design team.

The **lighting designer** uses light to achieve five primary goals: (1) to influence the audience's perception and understanding of what they're seeing; (2) to selectively illuminate the stage; (3) to sculpt, mold, and model actors, settings, and costumes; (4) to create an atmosphere that is supportive of the play's **production concept**; and (5) to convey the environmental circumstances of the scene—the time of day, atmospheric conditions, as well as the type of light (natural and/or artificial) that are used to help "tell the story" of that particular moment in the play. To achieve these goals the lighting designer uses the tools of lighting design—the instruments, dimmers, color media, and so forth—to create a design that works to support the production concept.

Any creative art, regardless of field, is comprised—in equal parts—of inspiration and craft. Inspiration refers to the creative element, the process used to create a conceptual image the artist "sees" in his or her mind. Craft refers to a mastery of the tools and techniques used to re-create the conceptual image in physical form. Michelangelo is reputed to have said that he released figures that were trapped in the blocks of stone that he sculpted. He first studied the stone, saw the figure entombed within it, and then used chisels and mallet to sculpt away the stone to reveal the form. Those statues are the result of the two qualities that any artist has to possess: artistic inspiration/vision and the skill needed to use the tools of the medium to re-create the inspiration.

Development of the Production Concept

The production concept is the coordinated artistic vision that the members of the production design team—the producer; the director; and the scenic, costume, lighting, and sound designers—develop (there may be others on this team, too). There is no formula for creating a production concept. It is an understanding about the artis-

tic themes—visual/auditory/textural—that is developed among the members of the production design team. This kind of development is possible only if all members of the team freely share their ideas and vision for the production. A regularly scheduled production meeting (discussed more fully in Chapter 2, "Lighting Production Team: Organization and Responsibilities") is probably the most effective method of ensuring that every member's ideas, thoughts, and opinions are heard and understood by every other member of the team.

Actors also use both process and craft. An actor uses many sources to develop the interpretation of a character. Although the character is based on elements in the script, a good actor also uses other sources to conceptualize the role to make the character portrayal seem more "real" and to create a life beyond that contained in the script. For example, an actor may recall and use characteristics of people he or she has observed; perhaps characters from literature will serve as models for certain aspects of the role; parts of the characterization will certainly be based on emotional memories from the actor's past. Although the process of analysis can lay the foundation for creating a conceptually brilliant character portrayal, if the actor doesn't have a mastery of his own body and voice so that he can move and talk as he has conceived the character would, then it will be impossible for him to fully realize his brilliantly conceived portrayal. To create a great character, an actor employs both process and craft. The intellectual process of character analysis can neither supplant nor negate the need for a basic understanding of how to move and how to talk and vice versa.

In the same way that an actor uses both process and craft to create a character, the lighting designer uses process to develop an understanding of how the lighting should look for a production and uses craft to re-create those images in, hopefully, an artful manner. (A technique used to help the lighting designer "see the light" is discussed at length in Chapter 11, "The Design Process.")

Controllable Qualities of Light

Tharon Musser, the late professional lighting designer, said,

> If you ask most people who walk in and tell you they want to be lighting designers, what kind of weather are we having—what's it like outside? — half of them won't know how to describe it, if they remember it at all. They simply don't know how to see.[2]

Learning how to see—understanding how light shapes our perception of people and objects—is absolutely essential to learning lighting design.

As Musser indicates, a lighting designer must learn how to see. Actually, it is relatively easy to train yourself to see things critically. You just need to begin studying and watching how people and objects are lit, then correlate that with your thoughts, impressions, and understanding of that person, situation, or thing. Over time you will begin to notice that relationships exist between light and understanding. Some are subtle; some are overt. But all are interesting, useful, and necessary for a lighting designer to know.

To recognize relationships between light and understanding, you first need to gain an understanding of how objects are lit in the "real world." The following list provides a good beginning point for your study of meaning in light. As you begin to examine how things—people, buildings, trees, cars, clouds—are lit, you will undoubtedly come up with additional thoughts that should help you understand how light is shaping your understanding of what you're looking at.

1. What is the light source illuminating the object you're viewing? For example, is it the sun, a streetlight, a table lamp?
2. How bright is the light? Is there more than one source? If so, is one of the sources brighter than the other(s)?
3. From what directions is the light striking the object? For example, light normally strikes most objects from multiple directions, some direct, some indirect. What are those directions? Is the light coming from overhead or the side, coming straight from the front, or bouncing off the ground or a nearby wall?
4. Is the light hard-edged or diffused? Are the edges of the shadows cast by the object sharp or fuzzy?
5. What color is the light? Is it picking up color by being bounced off something else (grass, building, surface, sidewalk, clothes, furniture, etc.)?

As you develop an understanding of how things are lit, you also need to ask yourself if the way an object is lit has any influence on your perception of that object. An interesting way to check that perception is to imagine the object lit in some other way. For example, if you're studying the way a woman's face is lit as she reads a book while sitting in the library, imagine that same woman reading the same book while sitting by a campfire. Does that change of lighting affect your understanding of that person? If so, how? The point of this exercise? Learning to see what's really there and how the manner in which it is lit influences your perception of that object.

Any discussion of how lighting affects understanding needs to have some common terminology. Traditionally the controllable qualities of

light—those qualities the lighting designer can manipulate to affect meaning—have been divided into four categories: distribution, intensity, movement, and color.

Distribution

Distribution is a catchall term that refers to several elements: (1) the direction from which the light approaches an area, actor, or object; (2) the shape and size of the area that the light is covering; (3) the quality of the light—its cohesiveness (clarity or diffusion); and (4) the character of the light—its texture (smooth, uneven, patterned, hard- or soft-edged, and so forth). The **focus** of the lighting instruments determines both the pattern and position of highlights and shadows cast on the actors and their environment.

Intensity

Intensity is the term that refers to the actual amount of light—its level of brightness—striking the stage or actor. The most common way a lighting designer can control the intensity of lighting instruments is by adjusting the dimmers to which those instruments are connected. The intensity range can vary from total darkness to painfully brilliant white light. The normal range of intensity for stage lights typically lies somewhere between these two extremes and is modified to suit the needs of a particular scene or moment in the play. Intensity can also be controlled by other means, including varying the color, using different wattage lamps, or by using **dousers** to mechanically block the light. Each of these methods will be discussed more extensively in later chapters.

Movement

Movement can be divided into three general categories: (1) the timed duration of a **light cue**—that is, the length of time it takes for the lights of one cue to come up or go out; (2) the movement of onstage lights, such as a lantern or candle that an actor carries across the stage; and (3) the movement of an offstage light source, such as a **followspot** or **moving light fixture**. (See Chapter 10 for a discussion of moving light fixtures.)

Color

Color is an extremely powerful tool that will be discussed at length in Chapter 8, "Color." **Color media** and color-controllable LED fixtures (discussed in Chapter 10, "Advanced Technology Instruments"), both allow the designer access to the full color range of the rainbow.

distribution
One of the four controllable qualities of light; the direction, shape and size, quality (clarity or diffusion), and character (texture) of light.

focus
In stage lighting, the location onstage where the light from an instrument is directed.

douser
A mechanical dimmer with movable slats or an iris to block or allow light to pass. Typically used in fixtures with non-dimmable sources such as followspots and intelligent/moving light fixtures.

light cue
Generally, some type of action involving lighting; usually the raising or lowering of the intensity of one or more lighting instruments.

followspot
A lighting instrument with a high-intensity, narrow beam of light; mounted on a stand that allows it to tilt and swivel so that the beam can "follow" the actor.

moving light fixture
A lighting fixture that can be remotely controlled to move, change color/beam shape, and so forth. Also known as an intelligent light fixture.

visibility
One of the four functions of stage lighting: to light the stage in a manner that supports the production concept.

production design team
The producer; director; and scenic, costume, lighting, and sound designers who develop the visual and aural concept for the production.

location
In the context of lighting fixtures, those instruments designed to be used outside the studio. Typically these fixtures are small, lightweight and are equipped with a telescoping stand.

selective focus
One of the four functions of stage lighting: the ability of light to direct the audience's attention to a specific location.

unit set
A single set in which all of the play's locations are always visible and the audience's attention is usually shifted by alternately lighting various parts of the set.

acting areas
Those areas of the stage on which specific scenes, or parts of scenes, are played.

The judicious use of carefully selected colored light can enhance a scene immeasurably. Happy, pastel colors can help to create a pleasant, friendly environment for the production of an old-fashioned musical comedy like *The Boyfriend*. Stark white light etched against a black background can help reinforce the sense of conflict in Anouilh's *Antigone*.

Functions of Stage Lighting

Stage lighting design is the creative use of illumination to enhance the spectator's understanding and appreciation of the production by visually supporting the production concept. To achieve this goal, stage lighting must perform several basic functions.

Visibility

The lighting for any production must make the actors, costumes, and sets clearly visible to the audience. At the same time, because light affects meaning, it is equally important that the audience see those people and things only as the designer, director, and other members of the **production design team** want them to be seen. The dark, brooding, heavily colored shadows that we usually associate with murky tragedies would call for a completely different type of visibility than would the bright, happy look of a farce or musical comedy.

One of the real challenges of lighting design is to create a selective visibility that subtly directs the audience's attention to a specific area or **location**. The light's intensity as well as its direction and color all affect the visibility of any scene.

Selective Focus

Selective focus means directing the audience's attention to a specific area of the stage. The lighting designer can selectively focus attention in a number of ways but frequently does so by increasing the intensity of the lights on a desired area of interest. When this happens, all areas that are less brightly lit become of secondary importance to the audience. A common example of the use of selective focus occurs when the lighting designer reduces the intensity of lights on one area of a **unit set** while increasing it on another. Instinct literally forces the audience to look at the brighter area.

A subtler use of selective focus can be seen in the lighting designs for most interior settings. In these designs the lights are usually brighter in the major **acting areas** than they are in the upstage corners of the set where there is little, if any, action during the course of the play.

The most extreme use of selective focus can be seen in almost any musical, where the audience's attention is directed to the lead singer by

one or more followspots that focus on the singer while the rest of the stage lights dim or change color to emphasize the mood of the song.

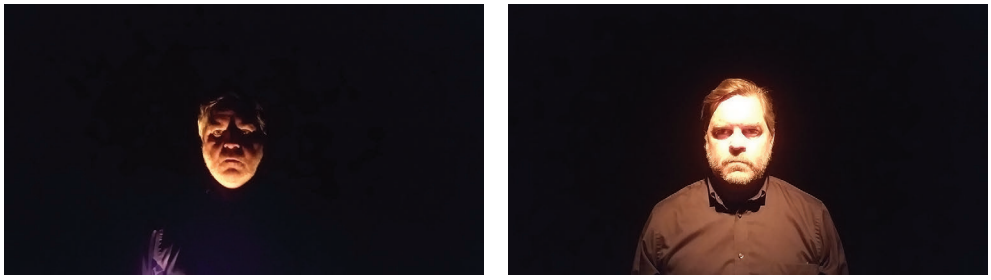
Modeling

modeling
One of the four functions of stage lighting: the ability of light to reveal three-dimensional form.

Light can be viewed as a plastic sculptural medium used to reveal form by the creation of highlight and shadow. A column is perceived as round because of the smooth gradation of light from the highlights on the sides of the column to the lowlight, or shadow, area in the center (shown in Figure 1.1A). However, if we light the shadow area, effectively creating a smooth, unvarying wash of light over the whole column (Figure 1.1B), then the column appears to be a flat, board-like rectangle with little or no apparent depth.

Almost all of us, at one time or another, have placed a flashlight under our chins and impersonated a "monster" by shining the light up into our faces. Lighting the face from beneath, as shown in Figure 1.2A, reverses the normal and expected patterns of highlight and shadow that are illustrated in Figure 1.2B. In Figure 1.2A, areas of the face that are normally

Figures 1.1A and 1.1B The modelling effect of light: (A) a column lit from the sides; (B) column lit smoothly edge to edge.



Figures 1.2A and 1.2B The modelling effect of light: (A) face lit from beneath; (B) face lit from in front and above.

shaded—the bottom of the nose, the eyebrows, below the chin—are highlighted, while areas that are usually highlighted—the cheekbones, bridge of the nose, and brow—are shaded. This simple example demonstrates the dramatic changes in meaning that can be made by simply reversing the expected pattern of highlight and shadow. In the same manner, our perception of the forms of actors or dancers can be changed or modified by controlling and manipulating the patterns of highlight and shadow on their faces and bodies. The use of **sidelight** highlights and accentuates the edges and vertical line of the body and makes those actors or dancers seem taller and thinner than they are in reality.

sidelight
Any light striking the side of an object relative to the view of the observer.

Direction is the primary element used in modeling, although intensity, movement, and color all affect modeling to a lesser degree. A change in any or all of these variables will inevitably result in an apparent change of form and feeling in the object being lit.

Mood

mood
One of the four functions of stage lighting: the ability of light to create a mood.

Creating a mood with light is one of the easiest and, at the same time, most difficult aspects of stage lighting. It is relatively easy to create a spectacular sunset effect or a sinister feeling of lurking terror; the difficulty comes in integrating these impressive effects with the other elements of the production. Effective stage lighting, even though it greatly affects meaning, is subtle and rarely noticed. Although it is fun to create a sunset or similar breathtaking visual display, the opportunity to do so legitimately doesn't present itself in many plays. Within the parameters of the production concept, stage lighting is usually designed to enhance the mood of the play as unobtrusively as possible. Intensity levels may be varied slightly to shift focus, change color, or create a mood, but the movement of the light generally must be so restrained that it will be felt by the audience rather than seen. Lighting handled subtly and with precision can be used to create or shift the environmental mood without distracting the audience or calling attention to itself.

An apparent exception to the concept of unobtrusive lighting involves concert and club lighting. Mirroring the vitality and energy of these venues, concert and club lighting is almost always frenetic, bold, and spectacular. But note that these sassy, **kinetic** designs are providing exactly the same function for their productions as their more unobtrusive cousins do for a production of Shakespeare, Williams, or Ayckbourn. A vital function of a successful lighting design is to create a mood that reinforces and supports the production concept.

kinetic
Having to do with movement. In the case of lighting design, having to do with moving lights.

Given Circumstances

The term "given circumstances" is borrowed from Konstantin Stanislavski's method of actor training. In that context it refers to the

environmental and situational conditions that influence a character in a play. In the context of "functions of light" that definition is expanded to include not only the 'environmental and situational conditions' of the script but of the entire production as well. Examples include: budget, venue, information gleaned from the script such as time of day, time of year, locale (both geographic and specific), weather and so forth—basically anything that might influence how the lighting should/will look for every moment of that production. If the lighting is for a club or concert the "given circumstances" would refer to the emotional/presentational requirements of both the production venue as well as the show.

Prior to roughly 1960 scenery was the primary means of indicating a scene's locale in much of the theatre produced in the United States. Lighting provided indications of the weather and time of day. But, because of the available technology at that time those efforts were frequently simple and rudimentary. Broadway shows were the glaring exception to this generalization. Those productions generally had budgets large enough to buy, rent or create whatever scenery, lighting and costumes were necessary to achieve the desired effect.

In about 1970 stage lighting technology began its meteoric development phase: effective new fixtures were being developed every year; new colors for those fixtures were created almost monthly; new lamp structures greatly enhanced the light output of the lamps used in the new fixtures; new, more reliable dimmers were replacing earlier, clunkier iterations of that technology; enhanced lighting control systems enabled designers to create the images they were visualizing—something they'd only dreamed about a few years earlier—only to be supplanted a few years later by the more technologically advanced computer boards in the 1990s and beyond.

Simultaneously—perhaps coincidentally—the realistic, pictorial style of scenic design in vogue from the 1920s through the 1960s began giving away to designs that were more sculptural and evocative than representational.

Those two developments—advances in lighting technology and the minimalization of the physical elements in stage settings—forced lighting to become a more prominent partner in setting the time, weather and locale. If their budgets permit, lighting designers could now create almost anything they could visualize to support the production: locale identified by defining areas with light, color and texture; projected images of buildings, leaves and vegetation could replace physical set pieces; weather and time of day could now be presented equally well with subtle or spectacular effects.

The possibilities in lighting design are now limited only by the lighting designer's imagination and the needs of the production.

An understanding of the functions and controllable qualities of light will enable the designer to blend and manipulate light with

the subtlety and precision necessary to create a lighting design that uniquely enhances the audience's understanding and appreciation of the production.

Psychological Effects of Light

In lighting design, just as in literature, the concepts of good and evil are often associated with light and darkness. When a scene is lit with dark shadows, most people instinctively react with a sense of foreboding. The suspicion that something could be lurking unseen in the shadows is almost universal. When a scene is brightly lit and has no shadows, we instinctively relax, because we realize that nothing can sneak up on us.

To more fully understand how we see and how we understand what we see, you might want to take courses in perception from your school's psychology department. These courses are appropriate, effective, and helpful to the training of a lighting designer. After you understand the nature of our learned and instinctive responses to light and our environment, you can apply that knowledge to create lighting designs that will effectively manipulate the audience's response to the environment of the production.

Additional information on the psychology of color can be found in Chapter 8, "Color."

Notes

1. *Webster's 11th New Collegiate Dictionary*, 2003, p. 719.
2. "Tharon Musser," *Lighting Dimensions* 1 (1977): 16.

2 Lighting Production Team: Organization and Responsibilities

In some professional theatres, such as the Broadway theatres of New York City, unions stipulate the individual jobs for which a **lighting production team** is responsible as well as the number of people necessary to perform a particular job. In regional professional theatres and professionally oriented educational training programs, the demarcation of these responsibilities becomes a little fuzzier. However, this chapter's discussion of the lighting production team's organization and responsibilities generally applies to both professional and educational theatres.

lighting production team
The personnel who work on lighting for a production.

Lighting Designer

The lighting designer is responsible for the design, installation, and, occasionally, the operation of the lighting and special electrical effects associated with lighting used in the production. Not too long ago, to present their visual ideas, lighting designers frequently drew sketches or showed visual examples—paintings, photographs, and so forth—to demonstrate the type and style of lighting that they intended to create. Many designers still do this, but that method of presentation is starting to be supplemented by the continuing development of previsualization software. These programs allow lighting designers to create pictures or animations of how the lighting is going to look. Specific information on previsualization software can be found in Chapter 10, "Advanced Technology Instruments."

To show where the lighting equipment needs to be placed, the lighting designer produces a light plot, which is a scale ground-plan drawing that details the placement of the lighting instruments relative to the physical structure of the theatre and the location of the set(s) (see Figure 2.1). The lighting designer also produces the **lighting sectional**, which is a composite side view, also drawn to scale. The side view shows the set, lighting fixtures, and masking (Figure 2.2). It enables the designer to see if there is going to be any interference—visual or physical—between the fixture hanging positions and the set/masking. In many instances the

lighting sectional
A composite side view, drawn to scale, of the set, showing the hanging position of the instruments in relation to the physical structure of the theatre, set, and stage equipment; primarily used to determine effective masking positions in a proscenium theatre.

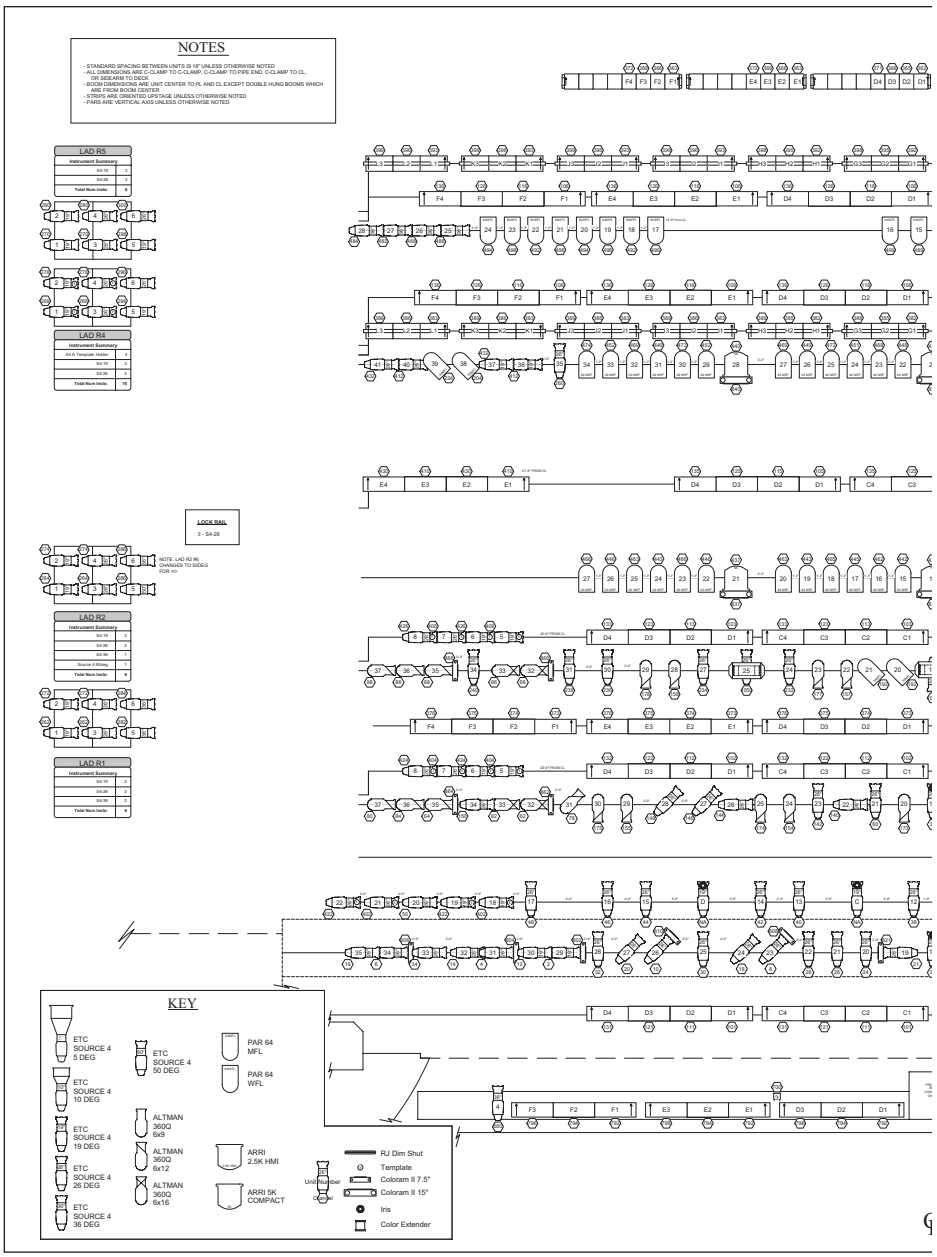
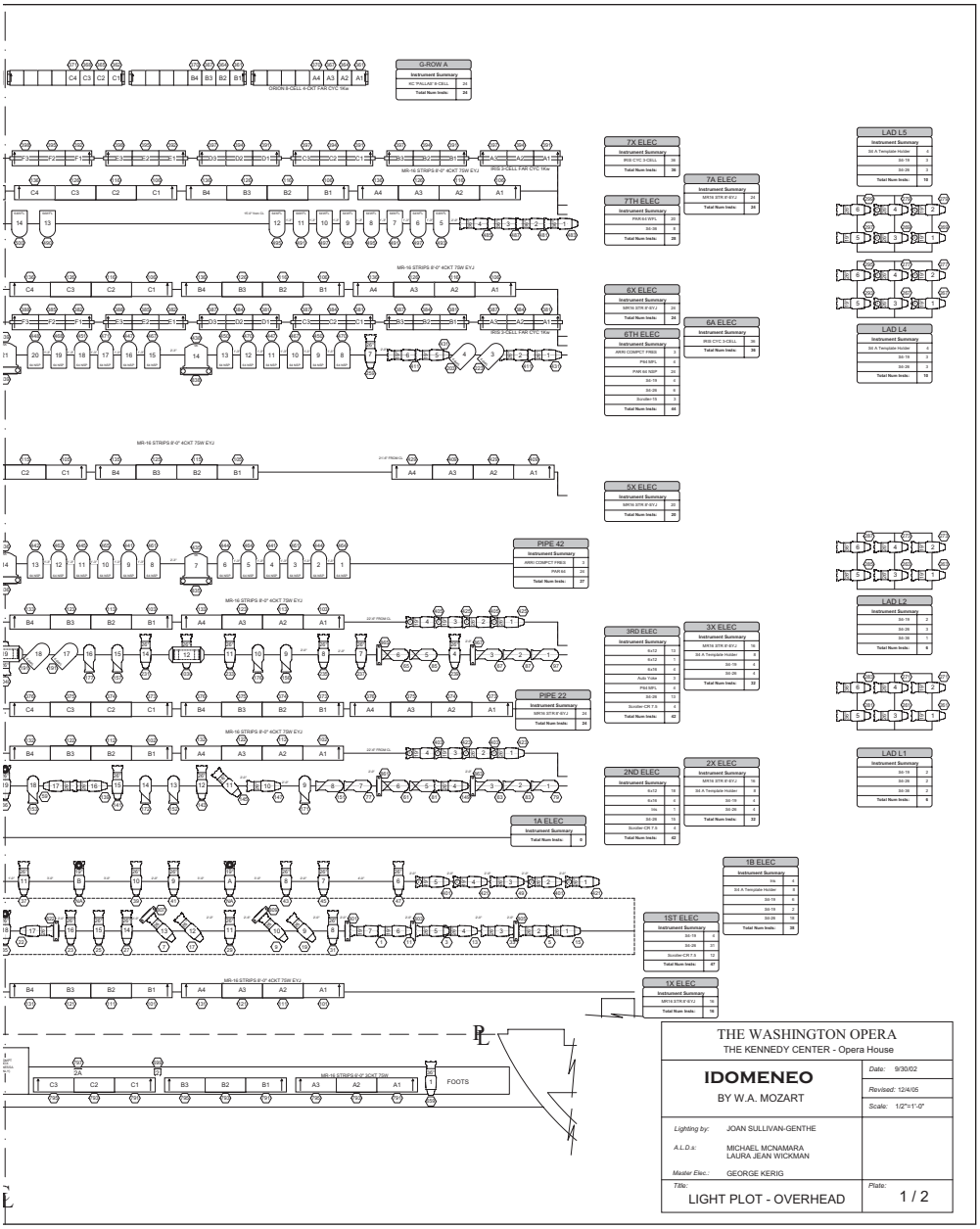


Figure 2.1 The light plot for the 2002 Washington National Opera production of *Idomeneo*.
Credit: Lighting design by Joan Sullivan-Genthe. Drafting by Michael McNamara and Laura Jean Wickman.



THE WASHINGTON OPERA
THE KENNEDY CENTER - Opera House

IDOMENEO
BY W.A. MOZART

Date: 9/30/02
Revised: 12/4/05
Scale: 1/2"=1'-0"

Lighting by: JOAN SULLIVAN-GENTHE
A.L.D.s: MICHAEL MCNAMARA
LAURA JEAN WICKMAN
Master Elec.: GEORGE KERIG

Title:
LIGHT PLOT - OVERHEAD

Plate:
1 / 2

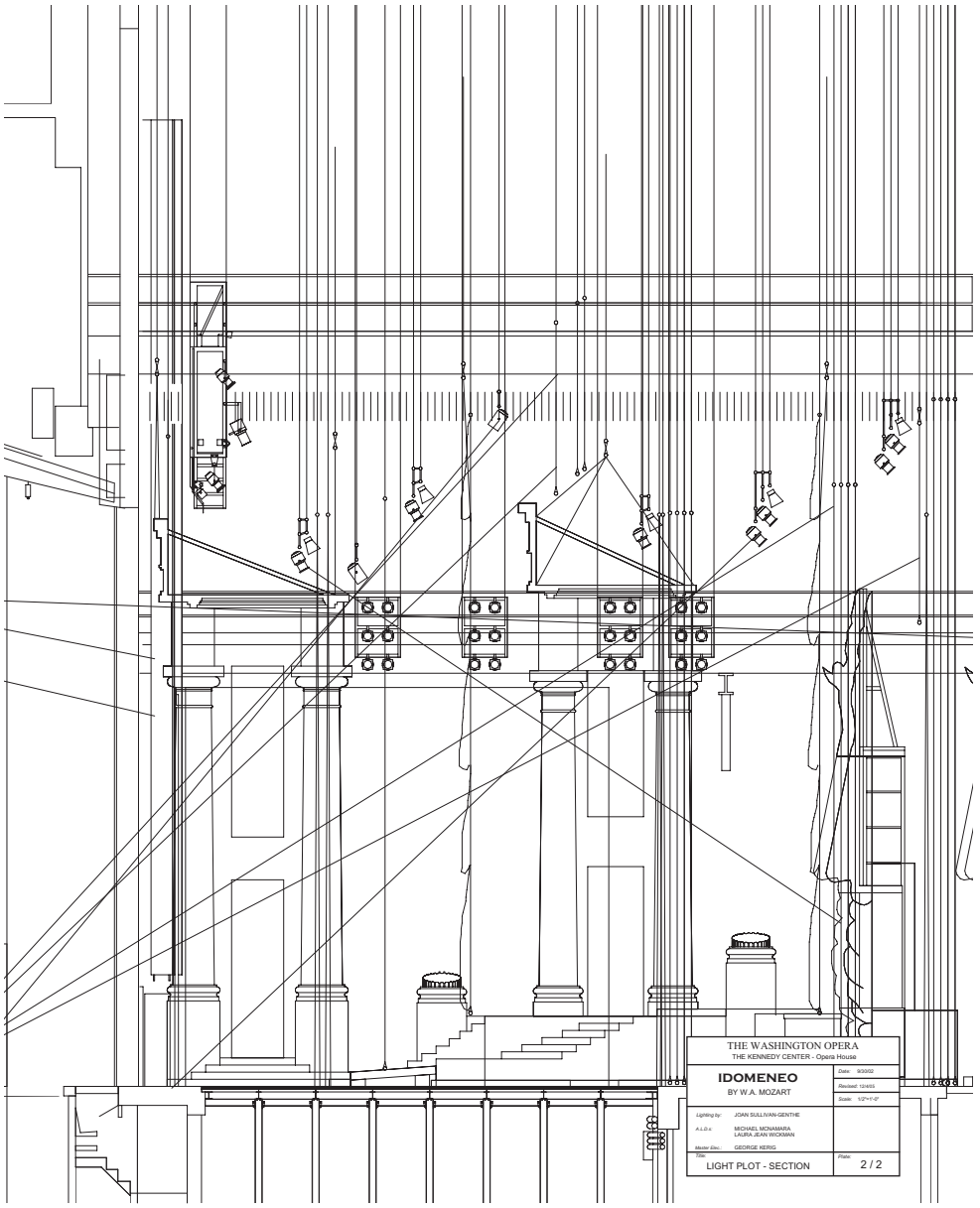


Figure 2.2 The lighting section for the 2002 Washington National Opera production of *Idomeneo*.
Credit: Lighting design by Joan Sullivan-Genthe. Drafting by Michael McNamara and Laura Jean Wickman.

lighting sectional isn't a "production" or "contract" requirement but is simply created for the designer's own use.

The lighting designer also has the responsibility to compile the instrument schedule and channel hookup sheet, which are forms used to record all of the technical data about each instrument used in the production (see Figure 2.3). Some of these drawings may actually be produced by assistant designers under the direction of the lighting designer.

In a **repertory theatre** situation, the lighting designer frequently designs a permanent light plot to create a basic lighting design that will work for each of the plays in the repertory. The lighting design for each play uses this basic plot, but additional instruments will be added and adjustments may be made to the focus and color of some instruments in the basic plot. While these design features will be placed on the plot and paperwork for each play, the physical changes of focus and color media must be accomplished each time that there is a **changeover** between plays. The lighting designer can supervise the crew doing this work, or an assistant lighting designer (discussed in the next section) may be assigned to each or all of the plays in the repertory to do the changeover.

repertory theatre
A company that presents several different plays alternately in one theatre in the course of a season. In the context of lighting design, adjustments are normally made to the focus and color of lighting instruments for each play each time it is performed.

changeover
Changing from one play to another in a repertory theatre situation. Involves exchanging sets, costumes, and properties and making adjustments to lighting and sound.

Assistant Lighting Designer

Over the past several decades the assistant lighting designer's duties have been divided into several subcategories. The general rules for determining which type of, and how many, assistants are needed on a show are determined by the preferred working style of the designer, the complexity of the design, and, if the assistants are to be hired, the budget. The basic subcategories are these:

Assistant to the Lighting Designer—The assistant to the lighting designer primarily functions as a general assistant and may or may not be present at the venue of the production.

Assistant Lighting Designer—The assistant lighting designer may create any or all of the associated paperwork—light plot, lighting sectional, instrument schedule, and so forth—as requested by the lighting designer. Depending on the nature and personality/disposition of the lighting designer, as well as the complexity of the show, the assistant lighting designer may focus or participate in focusing the instruments, write cues, update paperwork, or perform any of the other myriad tasks necessary to make the lighting design come alive onstage. He or she may also make some minor design decisions, design some of the cues, and substitute for the lighting designer in his or her absence.

Associate Lighting Designer—The associate lighting designer effectively performs all the duties of a lighting designer while under the artistic direction of a more senior designer.

IDOMENEO CHANNEL HOOKUP

04 Dec 2005

LD: Joan Sullivan-Genthe
The Washington Opera
Kennedy Center Opera House

ALD: Michael McNamara
ALD: Laura Jean Wickman
Master Electrician: George Kerig

Channel	Dim	Position	Unit	Type & Accessories & Watts	Purpose	Color & Temp
(1)	149	1ST ELEC	7	S4-19+SCR 575w	X FAR W	SCROLL 1
(2)	224	1ST ELEC	29	S4-19+SCR 575w	X FAR W	SCROLL 1
(3)	146	1ST ELEC	5	S4-26+SCR 575w	X CEN W	SCROLL 1
(4)	178	1ST ELEC	31	S4-26+SCR 575w	X CEN W	SCROLL 1
(5)	143	1ST ELEC	2	S4-26+SCR 575w	X NR W	SCROLL 1
(6)	181	1ST ELEC	34	S4-26+SCR 575w	X NR W	SCROLL 1
(7)	202	1ST ELEC	13	S4-26+SCR 575w	P2 FAR W	SCROLL 1
(8)	169	1ST ELEC	23	S4-26+SCR 575w	P2 FAR W	SCROLL 1
(9)	153	1ST ELEC	10	S4-26+SCR 575w	P2 CEN W	SCROLL 1
(10)	219	1ST ELEC	26	S4-26+SCR 575w	P2 CEN W	SCROLL 1
(11)	147	1ST ELEC	6	S4-19 575w	X FAR C	L161
(12)	179	1ST ELEC	30	S4-19 575w	X FAR C	L161
(13)	145	1ST ELEC	4	S4-26 575w	X CEN C	L161
(14)	227	1ST ELEC	32	S4-26 575w	X CEN C	L161
(15)	186	1ST ELEC	1	S4-26+T 575w	X NR C	L161
(16)	182	1ST ELEC	35	S4-26+T 575w	X NR C	L161
(17)	156	1ST ELEC	12	S4-26 575w	P2 FAR C	L161
(18)	217	1ST ELEC	24	S4-26 575w	P2 FAR C	L161
(19)	194	1ST ELEC	9	S4-26 575w	P2 CEN C	L161
(20)	221	1ST ELEC	27	S4-26 575w	P2 CEN C	L161
(21)	210	1ST ELEC	19	S4-26+SCR 575w	XO RIGHT	SCROLL 1
(22)	206	1ST ELEC	17	S4-26+SCR 575w	XO LEFT	SCROLL 1
(23)	205	1ST ELEC	16	S4-26 575w	SPARE	L202
(24)	211	1ST ELEC	20	S4-26 575w	SPARE	N/C
(25)	203	1ST ELEC	15	S4-26 575w	SPARE	N/C
(26)	212	1ST ELEC	21	S4-26 575w	CHAIR	L202
(27)	160	1ST ELEC	14	S4-26 575w	SPARE	N/C
(28)	214	1ST ELEC	22	S4-26 575w	FACE SL	L161
(29)	155	1ST ELEC	11	S4-26 575w	SPARE	N/C
(30)	172	1ST ELEC	25	S4-26 575w	SPARE	N/C
(31)	152	1ST ELEC	8	S4-26 575w	SPARE	N/C
(32)	223	1ST ELEC	28	S4-26 575w	SPARE	N/C
(35)	207	1ST ELEC	18	S4-26+IRIS 575w	SPARE	L281
(36)	270	2ND ELEC	19	S4-26+IRIS 575w	SPARE	N/C
(37)	239	1B ELEC	11	S4-26 575w	SR MIR	L201
(38)	240	1B ELEC	12	S4-26 575w	SL MIR	L201
(39)	200	1B ELEC	10	S4-26 575w	CR MIR	L201
(40)	215	1B ELEC	13	S4-26 575w	CL MIR	L201
(41)	199	1B ELEC	9	S4-26 575w	FACE SR	L281
(42)	216	1B ELEC	14	S4-26 575w	WCHAIR SP	L161
(43)	197	1B ELEC	8	S4-26 575w	SPARE	L202, T:R7797
(44)	173	1B ELEC	15	S4-26 575w	SPARE	L202, T:R7797
(45)	193	1B ELEC	7	S4-26 575w	MIR ON FLR DR	L202
(46)	222	1B ELEC	16	S4-26 575w	SPARE	N/C
(47)	189	1B ELEC	6	S4-26 575w	SPARE	L202, T:R7797
(48)	225	1B ELEC	17	S4-26 575w	SPARE	L202, T:R7797
(49)	231	1B ELEC	3	S4-26 575w	SPARE	N/C
(50)	230	1B ELEC	20	S4-26 575w	SPARE	N/C

Figure 2.3 A sample page from the hookup sheet for the 2002 Washington National Opera production of *Idomeneo*.

Credit: Lighting design by Joan Sullivan-Genthe. Paperwork by Michael McNamara and Laura Jean Wickman.

Examples may help explain the associate lighting designer's job. In the professional theatre it has become relatively standard for an associate lighting designer to perform the lighting designer's duties when a show is mounted in a new or different location than the original theatre. The associate designer follows the artistic vision, light plot, and cuing of the original production as closely as possible. But each new venue almost always requires that adjustments be made. Fixtures normally cannot be hung in exactly the same position as the original production. The associate lighting designer decides the new hanging positions. Changing the location of the fixtures necessitates adjusting the intensity levels of the channels to match the **look** of the original production. This work is also the responsibility of the associate lighting designer. He or she also updates the paperwork—plot, cues, and so forth—to reflect any changes that have been made. Typically, all paperwork for a traveling or "new venue" production will be stored in a data file so making changes to any of the production's lighting-related paperwork can be accomplished quickly and efficiently.

look
The appearance—the way the light looks onstage—of a particular cue.

An associate lighting designer may also be employed to create the lighting design while working under the artistic supervision of a **scenographic designer** who is focusing his or her design efforts on the scenery and costumes.

scenographic designer
A designer responsible for the entire artistic look—scenery, costumes, lighting, properties—of a production.

Programmer

Programmers are individuals who program the specialized consoles used to control conventional and/or automated/moving light fixtures. The programmer may also control/program projectors being used if a projection specialist is not assigned to the production.

Programmers generally work under the aesthetic direction of the lighting designer. Programmers may be freelance technicians and they may also be associated with companies that manufacture or distribute automated fixtures or projectors. Programmers are usually hired for individual projects to program and/or operate these highly specialized fixtures and projectors rather than being employed by a producing organization for the full run of a show or for an entire season.

Skilled, experienced programmers are normally in great demand. And, on a purely practical note, top-level programmers are usually well paid—a most unusual situation in theatre—because of the high level of expertise required, the short time frames between load-in and performance, and the need for a quick, and accurate, implementation of the designer's visions.

Programmers normally run the console for one-off performances such as television specials and concert events, where making adjustments "on the fly" (known widely as "**busking**") is frequently the norm rather than the exception. For events with more consistent performance

busking
An improvisational style of light board operation widely used in concert settings where the exact musical content is also improvised.

hanging
The process of placing lighting instruments in their specified locations.

circuiting
The process of connecting a lighting instrument to its specific stage circuit.

running
Controlling or operating some aspect of a production.

electricians
Those who work on the stage lighting for a production.

pipe
A counterweighted batten or fixed metal pipe that holds lighting instruments or equipment.

boom
A vertical pipe with a heavy base, frequently equipped with horizontal crossbars or sidearms. Used as a hanging position for lighting instruments.

lamp
The stage term for "light bulbs" used in stage lighting instruments.

patch
To connect a stage circuit to a dimmer circuit (hard patch) or, in computer lighting consoles, to virtually connect a channel to a dimmer (soft patch).

expectations, such as theatre performances with multi-week (or longer) runs, programmers normally train other (less expensive) electricians to serve as board operators for the specialized consoles.

Master Electrician

The master electrician, under the supervision of the lighting designer and his/her staff, implements the lighting design. He or she is directly responsible for the acquisition, installation, and maintenance of all lighting equipment and the supervision of the crews who hang, focus, and run the lighting equipment during the production.

As head of the lighting crew, the master electrician is responsible for **hanging** and **circuiting** the equipment used in the lighting design. Each instrument is hung in the exact position shown on the light plot and is checked by the master electrician and crew to determine that it is functioning and circuited according to the instructions of the lighting designer.

The importance of the master electrician cannot be overstated. He or she is not only responsible for making sure that the design is implemented according to the vision of the lighting designer, but for maintaining that look throughout the run of the production. After a number of performances, color media, particularly the darker shades, may bleach out and need to be replaced. Instruments may **drift** or be knocked out of focus. Lamps may burn out and need to be replaced. It is the responsibility of the master electrician, under the direction of the lighting designer (or his or her designate), to notice these discrepancies and correct them. Only if these tasks are accomplished will the design continue to look as it was intended.

Electricians

The work of the electricians can be divided into three areas: hanging, focusing, and **running**.

The hanging, or hang, crew places the lighting instruments and associated equipment in the positions designated by the light plot. This job is very important because the accurate placement of the instruments on the **pipes**, **booms**, and other locations affects the distribution of the light on the stage. The proper wattage and type of **lamp** are also indicated on the plot or hookup sheet, and it is the electrician's responsibility to ensure that the instruments are "lamped" as required. Additionally, the electricians also circuit and **patch** the instruments. The appropriate circuit and dimmer for each instrument are normally indicated on the light plot or instrument schedule, or the master electrician designates the appropriate circuit and dimmer during the hanging sessions. Finally, the electricians who are hanging the show may also **gel** the instruments

and, under the supervision of the lighting designer or assistant/associate designer, focus the instruments.

The **running crew** is responsible for the operation of the lighting equipment during rehearsals and performances. Depending on the complexity of the production, as few as one or as many as five or more electricians are needed to run the lights for a production.

Although the electricians who operate the **light board** and specialty equipment during a performance have written or programmed instructions regarding the timed duration of each **cue**, they should be able to sense the rhythm of the play and integrate the various **fades** and other movements of the lights into the flow of the performance.

As previously mentioned, musicals and many other kinds of productions frequently require the use of one or more followspots. It is essential that the electrician who operates this instrument have a good sense of movement and timing as well as steady hands. Nothing is more distracting to an audience than a followspot that moves one way while the actor goes another. A followspot operator must master the mechanical intricacies of the instrument and follow the onstage action in a smooth, fluid, and unobtrusive manner.

In theatres with **patch panels**, it may be necessary for the running crew electricians to **repatch** during the performance. Occasionally, a circuit must be patched into or removed from a dimmer during a performance. In patch panel systems that don't have a large number of dimmers, repatching may occur frequently and indeed may be the norm more than the exception. Fortunately, these types of systems are becoming more and more rare.

Running crew electricians are also normally responsible for replacing burned-out lamps and color media that deteriorate during the run of the production, as well as refocusing instruments that have drifted or been knocked out of focus. They also recircuit instruments, move booms, and take care of any other activities involving lighting equipment during rehearsals or performances.

Production Design Team

The lighting designer is a working member of the production design team. The composition of the team may vary slightly from organization to organization and even from production to production, but the positions of responsibility and the lines of communication among the various members of the team are the same. Close coordination among the producer; director; and scenic, costume, lighting, and sound designers cannot be overemphasized. If there is unity of thought, style, and direction among the various members of this team, then the chances are good that the production concept will also be realized as conceived.

gel
To insert color media in a color frame and place on a lighting instrument. Color media made from gelatin or plastic.

running crew
The individuals for running the various technical areas—sets, lights, costumes, sound, props—during rehearsals and performances; also known as "run crew."

light board
A generic term used to describe all types of lighting control consoles.

cue
A directive for action: for example, a change in the lighting.

fade
To increase (fade-in) or decrease (fade-out) the intensity of the lights.

patch panel
An interconnecting device that allows you to connect any stage circuit into any dimmer.

repatch
(1) To remove one circuit from a dimmer and replace it with another during a performance. (2) To shift a dimmer from one channel and to another (on computer lighting consoles).

The director is the artistic manager and inspirational leader of the production design team. As such, he or she usually makes the final decisions on all artistic aspects of the production. The lighting designer frequently meets with the director during the production meetings (see the box "Production Meeting").

Under ideal conditions, the production concept evolves during these meetings. If the members of the production design team cannot be assembled either physically or electronically to jointly develop the production concept, then the director frequently takes a more authoritarian stance and develops the production concept alone. Either way, the lighting designer must meet with the director—either face-to-face or electronically—to learn of his or her thoughts regarding the production. If the director decides to change or adapt the script, the lighting designer has to know about it so that the lighting can be adjusted accordingly.

The lighting designer must work closely with the scenic designer because the work of one directly affects the work of the other. In some productions, the same person functions as both scenic and lighting designer. The form of the scenic design dictates, to a certain extent, the positions in which the lighting designer can place the lighting instruments. Obviously, if the set has a ceiling, the use of overhead or **top lighting** will be restricted, though not necessarily precluded. The scenic and lighting designers could decide, for example, to place beams on the ceiling. These beams could, in turn, **mask** slots cut on the upstage side of the beams, and instruments could be focused through those slots. Both the scenic and lighting designers will often have to compromise on their designs to achieve a compatible blend of the two.

top light
A directional term meaning light that approaches the stage from above, or on top of, the stage floor.

mask
To block the audience's view—generally of backstage equipment and space.

Because even moderately saturated color can drastically alter the appearance of delicately colored costumes, the lighting designer must hold discussions with the costume designer to learn the color palette being used on the costumes. It is the lighting designer's responsibility to see that the costume designer's palette remains unchanged when the costumes appear onstage under the lights.

production meeting
A conference of appropriate production personnel to share information.

Production Meeting

For any theatrical production to be successful it must be well organized, and communication within the group must be excellent. The production meeting is probably the single most important device for ensuring smooth communication between the members of the production design team—the producer; the director; the scenic, costume, lighting, and sound designers, and a projection specialist/designer if projections are being used on the production.

The initial production meetings will probably be attended only by the production design team. The purpose of these early meetings—ideally held on a daily or relatively frequent basis—is to develop the production concept.

After the designers begin to produce their drawings, sketches, and plans, the production meetings decrease in frequency to about once a week, and their main purpose is then to keep other members of the team informed about progress and changes in all production areas. At this time the stage manager normally joins the discussions, although the stage manager may have been a part of the production design team from the beginning. The last production meeting is usually held just before the opening of the production.

It isn't unusual for the designers working on a single production to be located in different parts of the country or the world. For that reason many production meetings occur via phone, Skype, or some other conference-call technology with the visual and written files being shared prior to and during the meetings. This method works well. The only caveat to any type of production meeting is that there should be an open atmosphere of informational sharing between all members of the team.

The ultimate goal of the production design team is the creation of an atmosphere and environment that support the production concept. This goal can be achieved only when each member of the production design team openly shares his or her concepts and plans with other members of the team.

Communication among the members of the production design team, as well as effective and conscientious work by every member of the lighting production team, is critical to the successful realization of the entire production. Each member of every team is an important link in the chain, and a chain is only as strong as its weakest link.

3 Electrical Theory and Practice

electricity
A directed flow of electrons used to create kinetic energy.

atom
The smallest particle of a chemical element that retains the structural properties of that element.

proton
A fundamental particle in the structure of the nucleus of an atom; possesses a positive charge.

neutron
A fundamental particle in the structure of the nucleus of an atom; possesses a neutral charge.

atomic theory
A generally accepted theory concerning the structure and composition of substances.

electron
A negatively charged fundamental particle that orbits around the nucleus of an atom.

It is a pragmatic reality that students of lighting design and technology must comprehend the function of electricity and electronics. The discussion that follows differentiates between the terms: electricity generally pertains to the use of the electromotive force to perform work—make lamps glow, motors run, and so on; electronics generally refers to the low-voltage circuits and devices used to control the flow of electricity.

Electricity—What Is It?

The study of electricity has to begin with a brief excursion into the not-so-mysterious realm of basic **atomic theory**. This is because some fundamental laws of electricity are based on the laws of atomic structure. For this reason we need to know a little bit about the atom.

The **atom** is often thought of as the smallest complete building block in nature. But an atom is composed of even smaller particles: protons, neutrons, and electrons. The subatomic particles possess specific electrical properties. The **proton** has a positive charge, the **neutron** a neutral charge, and the **electron** a negative charge.

In a stable atom the number of electrons in orbit around the **nucleus** is equaled by the number of protons in the nucleus. Hydrogen, the lightest and least complex atom, is a perfect example of this principle. Figure 3.1 shows the single electron of the hydrogen atom in orbit around the nucleus, which is composed of a single proton. The electron in the hydrogen atom orbits the nucleus in a spherical pattern called a shell. The outermost shell of any atom is called the **valence shell**. Because the orbiting electron has a negative charge and the proton in the nucleus has a positive charge, an electrical attraction exists between them. The electron is prevented from being pulled into the nucleus by the **centrifugal force** of its orbital movement. At the same time, the electron is restrained from breaking out of orbit and flying away by the attraction. This attraction is an important underlying principle of electricity and is the basis for the first important law of electricity, the law of charges: *like charges repel, and unlike charges attract.*