ARENA LIGHTING: A COMPARISON OF FOUR METHODS

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ABSTRACT

ARENA LIGHTING: A COMPARISON OF FOUR METHODS

by Stanley Evans Abbott

This thesis compares four often used methods of lighting arena theatre stages. The purpose of the study is to discover ways to provide flexible or more workable lighting arrangements for producing groups limited as to the amount of time available to set-up or rearrange lighting instruments.

A flexible arena lighting method is defined as an arrangement of lighting instruments that, once placed in their desired mounting positions, will not have to be moved a great deal from show to show, but will still yield the desirable lighting requirements. An arena stage is that stage surrounded by an audience on all sides be it round, rectangular, or oval.

The four methods of lighting studied in this thesis are: the four instrument-per-area method; the three instrument-per-area method; the central and peripheral method; and the five instrument-per-area method. These methods were studied in a semi-laboratory situation on the Michigan State University campus in Demonstration Hall. The findings that resulted in this testing activity are studied in terms of the most useful combinations of their advantages.

The thesis renders conclusions as to which are the desirable instrument mounting positions and how the light intensity of the instruments can be controlled in relation to each other. The major conclusions being that, of the four methods studied, the five instrument-per-area method contains the greatest number of advantages.

ARENA LIGHTING: A COMPARISON OF FOUR METHODS

By

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INTRODUCTION

There are many unsolved problems dealing with arena lighting. This thesis will attempt to give some insight to the more major problems. The major problems are: instrument mounting position; intensity control, and; audience light spill. This thesis springs directly from attempts to solve these problems by the producing group connected with Michigan State University's Summer Circle Theatre.

This thesis will study those problems that arise when there must be provided a flexible lighting system for an arena theatre which produces a play every week and is limited in the amount of time available for extensive rearrangement of lighting instruments for each show. The findings are aimed at being helpful to this type of producing group or also those groups who leave the lighting instruments hanging from production to production and wish to walk right in and produce a play with a minimum of technical rearrangement.

A flexible basic arena lighting system is defined as an arrangement of lighting instruments that, once placed in their desired mounting positions, will not need to be moved appreciably from show to show, but will yield the desirable lighting requirements.

During several experiments by Summer Circle Theatre to isolate the factors contributing to a flexible lighting system, two major elements were immediately recognizable. First, there were certain ways to mount lighting instruments in arrangements that were more successful in terms of their flexibility. Secondly, and not as important, there were certain, more effective methods of controlling the light intensity of these instrument groupings. Therefore, the selection of mounting positions for the lighting instruments and the way in which focus and intensity are controlled is the major deliberation of this thesis. The author feels that if this problem is solved, the solutions for a flexible arena lighting plan are enhanced. Individual preferences from person to person can then create the only great variables.

The methods of lighting arena stages that are studied in this thesis number four. These are analyzed in nine combinations. For lack of universal names for these four methods, they may be termed the four instrument-per-area method, the three instrument-per-area method, the five instrument-per-area method, and the central plus peripheral method. Three of these methods use a given number of instruments per area. This means that each method divides the stage into lighting areas and uses these units as the smallest area of the stage that a minimum number of lighting instruments can light effectively. The last and fourth method uses the entire stage as a base.

These four methods were studied in a semi-laboratory situation on the campus of Michigan State University in Demonstration Hall. The basic illumination levels of all four methods were recorded by a footcandle meter and put on charts for comparison. The findings that resulted from the testing activity are studied in terms of their value under predetermined conditions. The most useful combination of the advantages of all four methods will be sought after in this thesis. In other words, the question was asked; which method best fulfills the requirements of good lighting practice, is easiest to maintain and mount, and is the most flexible?

Discussion of color media is not entered into in the study. As this problem is a thesis in itself, the author decided to base all information and discussion on the premise that color media would not affect the conclusions of this study.

CHAPTER I

INTRODUCTION TO ARENA STAGING AND LIGHTING

Almost all of the problems that are linked with arena stage lighting stem from the uniqueness of the arena stage itself. In all cases, when there is mention of the arena stage in this thesis, reference is to the true arena. In other words, the audience completely surrounds the stage, be it round, oval or rectangular.

This thesis is a study of major lighting problems that are peculiar to arena staging. The aim of this chapter is to briefly describe a few of the distinctive characteristics of the arena stage and to indicate how they affect arena lighting.

Although the staging concept of arena theatre has been present since the beginning of organized dramatic activity, modern usage of this theatrical form has been relatively limited until the past decade. The upsurge of community, semi-professional, and educational based producing groups have recently increased to the extent that the several attractions of the arena form are an advantage. There are several advantages to the arena form. First and foremost is the quick acceptance by the audience. Another advantage is the relative economy involved in the creation of an arena facility. Capital outlay of funds for a new facility is certainly less than constructing a good proscenium stage. More importantly, renovation of an existing building is more easily accomplished.

Some people are not attracted to arena staging by virtue of cost alone. The more intimate nature of the theatre-in-the-round is a major appeal. Of course, the term intimate refers to the closer contact between audience and actor both physically and emotionally. Rebecca Franklin feels that this greater intimacy affords more realism of action and acting emotions. She feels that the arena stage produces a staging style that needs no distortion for pure effect.[1] However, Margo Jones mentions the greater importance of such technical aspects as costumes and lighting due to the closer contact with the audience.[2]

The closeness of the audience in arena theatre negates many generally exaggerated lighting and costuming practices that are acceptable because of the greater visual distance in proscenium theatre. The above school of thought could be summed up by saying that arena theatre needs and requires a greater attention to detail, both in acting and in stage decoration.

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[1]Rebecca Franklin, "The Newest Theatre is the Oldest," New York Times Magazine, June 11, 1950, pp. 22-23.

[2]Margo Jones, "Doing What Comes Naturally," Theatre Arts, Vol. 33 (June, 1949), pp. 55-56.

The rise of arena theatre is attested to by the success of recent off-Broadway hits and its increased popularity throughout the country. This staging form is not without its critics, however. Henry Popkin feels that the advocates of arena staging are unfair in their criticizing the proscenium stage because they turn around and borrow heavily from established practices of that theatre.[1] He says they alter very little its repertoire, theory of acting, and concept of illusion.

Popkin, as well as other people alligned with this type of thinking, believe that there should be a great effort to re-evaluate central staging and attempt to discover its distinctive characteristics. This group believes that most directors recognize no great distinction as to the best plays suited to arena production. They maintain that such plays as STREET SCENE which require environmental settings are undesirable to stage in the arena form.

The reason for entering into the brief discussion above is to highlight the importance of the lighting in arena theatre. Because of the abscence of elaborate environmental settings, the stage lighting in

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[1]Henry Popkin, "The Drama vs. the One-Ring Circus," Theatre Arts, 35:38-42, February, 1951.

arena theatre must assume this role to a great degree. In other words, the lighting for each play must contain elements which can help suggest locale, mood, and time of day.

The relative newness of arena staging and its experimental possibilities sometimes work to a disadvantage. In the case of this thesis, which studies methods of lighting arena stages, limitations must be established which may enable the findings to apply to the most situations. No two arena facilities are exactly alike. Those arena stages adjusted to an existing structure vary greatly in physical appearance. Therefore, as concerns the lighting of arena stages, this thesis is not interested in how the physical plant appears or is layed out. What is important is that there be enough space available to construct a lighting plan based on basic requirements. The basic requirements are not terribly binding, but they are important. It will be shown later that there must be at least a sixteen foot high ceiling to allow for the adequate mounting height of the lighting instruments. There must also be enough space to mount instruments over the audience which may light the stage without being obstructed by building structure. These two requirements were assumed to be necessary and the methods studied in this thesis are based upon these requirements.

It is the feeling of the author that arena theatre is most efficient and effective when it is more theatrical. It seems all elements of an arena production must be strained to produce a realistic illusion. This is usually quite evident to the audience and they become aware of the theatre vehicle. However, when theatre-in-the-round is obviously theatre as theatre, greater success seems to follow.

As Parker and Smith explain in their book, the visual effect of arena lighting is not familiar to the average audience member and is thus distracting because it is unusual.[1] Margo Jones maintains that more imaginative, theatrical, and fluid lighting is possible in arena theatre.[2] It has been the experience of the author that arena lighting can contribute more to a theatrical play than the more realistic play. This is not to campaign for complete theatricalism in arena theatre. The author believes any generally acceptable play can be done in arena. The problem is to create a lighting plan that can be of greater value to a realistic style play. This is one major aim of this thesis.

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[1]Parker and Smith, Scene Design and Stage Lighting, p. 98.

[2]Jones, "Doing what Comes Naturally". . .pp. 55-56.

One thing that should always be in the back of a person's mind is the fact that one major difference between proscenium and arena staging is that in arena several planes of an actor must be illuminated simultaneously. This light must also give a similar appearance to every member of the audience. Of course, all arena lighting methods attempt to fill the demand of the 360 degree or full-circle illumination.

CHAPTER II

PRACTICAL CONSIDERATIONS IN ARENA LIGHTING

The audience is the receiver of all audio and visual stimuli that comes from the stage. In arena theatre, the productions must emit sight and sound to an audience surrounding the stage on all sides. Almost all practical lighting considerations stem from this inherent factor of this form of staging. The actors must be directed with the total audience in mind. The stage must be decorated and designed with the <u>surrounding</u> audience in mind. Consequently, the actor and his surroundings must be lighted with the omni-directional necessity in mind.

Usually the lighting designer is not required to light scenery in arena, as little or no scenery exists. What scenery there is can be adequately illuminated by the same light that strikes the nearby actor. The major scenic unit in arena is the floor of the stage. This element is usually treated differently for each show and affects the light only if it is of a very reflective nature or is painted quite light. However, many arena theatres use a rug or carpet for the floor and leave it identically treated from show to show.

The nature of arena with its surrounding audience requires that the types of lighting units used be specific focus instruments. This means the ability to control beam direction. This is opposed to a naked light bulb whose light travels in all directions. The two most common specific instruments used in arena lighting are the 500 watt 6" Fresnel-lens spotlight and the 500 watt 6" ellipsoidal-reflector spotlight. The advantage of the Fresnel in arena lighting is its ability to blend its soft edged beam with that of other beams. The advantage of the ellipsoidal-reflector is the ability to have control over beam shape and size. The ellipsoidal-reflector instrument is the more efficient of the two and, as the data in Part II shows, it emits twice the footcandle illumination under identical testing circumstances. Either instrument works well in arena as long as the designer is aware of their advantages and limitations. It is the author's experience that this knowledge comes most easily by personal contact with these particular instruments and seeing their abilities firsthand.

The four qualities of light are intensity, color, distribution, and movement.[1] Under intense study in this thesis is distribution. Distribution signifies the way in which the direction and spread of light is utilized upon the stage. Of primary importance to any flexible arena lighting method is the ability to supply

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[1]Parker and Smith, Scene Design and Stage Lighting, p. 98.

an evenly balanced illumination distribution over the stage. Again, arena lighting must do this in all four directions. This required effect, while desirable, is hard to produce. The difficulty usually arises in arranging for desired beam directions from the instruments toward the stage. Therefore, a flow of even illumination about the stage is a desired effect of arena lighting that can be achieved in part, by the proper selection of instrument mounting positions.

Part I--Chapter 4 discusses four methods of lighting arena stages which use as many variations of instrument mounting positions. They all have at least two important things in common. One, they are all pre-planned definite plans, and two, they all attempt the same thing: to surround the actor with light. The advantage of a definite plan for instrument mounting cannot be tossed aside. Stanley McCandless states that a definite plan has many practical advantages. He says that it can provide a guide for figuring new installation cost. It can also be the basis for future elaborations. He reminds us that following a definite plan saves time, energy, and expense while not hindering expression and experimentation.[1]

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[1]Stanley McCandless, A Method of Lighting the Stage, pp. 10, 11.

The way in which instruments are mounted above the stage depends upon two simple factors. One factor is the amount of money allocated for this, and the other is the room or physical space available. Alternatives usually vary from building a specially designed, elaborately flexible suspended grid and false ceiling to just hanging the instruments from existing structures. No matter what the individual situation, the greatest amount of time, money, and energy should be directed toward providing mounting positions which are the same distance from the stage and between fourteen to eighteen feet above the stage floor.[1]

Once there are physical arrangements for mounting the instruments, it is quite often the practice to construct a false ceiling to mask the instruments from the audience. This attempt is usually made in an effort to have the complete building facilities appear permanent. Sometimes a false ceiling may help improve acoustics. For whatever reasons one is constructed, practical or aesthetic, it should be attempted with the complete knowledge of what is needed. Good reference to this matter is made in Rubin and Watson's book.[2]

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[1]Rubin and Watson, Theatrical Lighting Practice, p. 59.

[2]*Ibid*., p. 60.

Taking the opposite view, some people consider the open display of lighting instruments as a convention that is already accepted. It can be said that the masking pieces or false ceiling may be, in some cases, more annoying than unmasked instruments. Also, one practical matter which should be considered is the availability of the instruments in terms of maintenance, focus and color change. Also, could not some types of false ceilings or masking pieces hinder the distinct advantage of flexibility in the ability to mount or remount a number of instruments from show to show? Therefore, the feasibility of pieces and false ceilings should be tempered with the consideration of their worth in terms of monitory value and aesthetic competence.

As long as lighting instruments are imperfect, arena theatre lighting technicians will be concerned with <u>audience light spill</u>. Audience light spill refers to stage light that is reflected or unavoidably and unintentionally directed into the audience. It is assumed, under normal circumstances, that there would not be any light focused into the audience on purpose. However, it is the nature of most all lighting instruments to emit light askew of its intended focus. This light, when compounded by the total number of instruments used, amounts to a general brightening of the audience. A certain minimum amount of light spill is accepted and conventional. However, placement of lighting instruments should always take into consideration their effect on audience illumination. Sometimes "barn door," "top hats," and other deflective devices just will not control the problem adequately.

CHAPTER III

THE AESTHETICS OF ARENA STAGE LIGHTING

The aesthetics of arena staging and lighting are only slightly established. Certainly, the opinions of people differ. For this reason, the logical course of this chapter is not to present all the many views on arena lighting aesthetics, but rather to present the objects or centers of aesthetic discussion.

Webster's Dictionary defines aesthetics as the study of theories of fine art and the people's responses to them. Essentially, this chapter will present samples of arena staging theories which affect lighting and also show how people have reacted or could be expected to react to them.

The concept of intimacy is associated with arena staging as opposed to proscenium staging. Intimacy, as used here, means the physical and psychological relationship between audience and actor. Arena theatre maintains a greater intimacy than does proscenium theatre. Many lighting problems concerned indirectly with the aesthetics of arena staging spring from this increased intimacy.

Lighting problems which are increased and intensified by arena theatre are: audience light spill; unnatural awareness of light; occasional inability to blend stage light into an even illumination.

While the intimate nature of arena staging is one of its inherent qualities, separation of audience and stage must be maintained by the use of light. A distinct cut-off of stage light is in most cases a necessity. However, this requirement creates a lighting problem as a consequence of the closer and surrounding audience.

The problem of audience light spill is one of great concern to many practitioners of arena theatre. Although great steps are made toward relieving this problem, it is interesting to note how members of the audience feel. At first thought, it would seem the audience would be quite disturbed and aware of the other audience members. This would be especially true if they were illuminated by light spilling from the stage. However, answers to a recent questionnaire revealed otherwise. The question was, "Were you aware of the audience across from you?" It was asked 810 people attending Summer Circle Theatre the week of July 11, 1962.[1] In response to this question, only 4%

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[1]Questionnaire administered by Michigan State University Graduate Seminar in Arena Theatre, Summer, 1962.

felt they were distracted by the audience across from them. At the same time, 30% said they felt they were unaware of the audience or no more distracted than in proscenium theatre. The major finding in this area was that awareness of the audience across from a person decreased in proportion to the number of arena staged productions he had witnessed. In terms of awareness, 64% said they were aware but not distracted by other members of the audience opposite them.

The above discussion illustrates the fact that the placement of lighting instruments for arena stages must take into consideration other factors than what their light will do to the stage and the actors. It is impossible in arena theatre to maintain a dark audience in conjunction with a well illuminated stage, at least not by using the techniques known today. However, one cannot forget about audience light spill because this would not be paying attention to an important facet of arena staging. This thesis will discuss in the conclusion the relative audience light spill of each method studied. This could be used as a guide as it will show which practices produce greater incidence of light spill. This is in recognition that one instrument grouping might have more potential spill than another.

The size and shape of the arena stage varies greatly from one producing group to another. Some people, such as Albert McCleery, maintain that the oval shape is the most useful.[1] In the textbooks by Rubin and Watson and Parker and Smith, reference is made to the square stage. The shape of the stage is most often dictated by the individual feeling of a producing group or is forced into a certain shape based on the facilities available. The size of the stage is usually based on the type of productions planned for it. Musical productions require more stage space than straight dramatic plays. Of course, the size of the facility can also determine the size of the stage.

What ever the shape or size of an arena stage, the lighting must adapt and present the same advantages under all conditions of size and shape. The methods of arena stage lighting presented in this thesis are all constructed in such a way as to be highly adaptable as to shape and size of stage. All that is required to adapt is to rearrange the basic element of the systems; the lighting area.

Arena lighting requires the actor to be illuminated from all directions. That is, any audience member will view an actor who is lighted from the front, sides, and back simultaneously. The average audience member will recognize this light as being different because he is

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[1]Albert McCleery, "The Next Step," Theatre Arts, 33:60-5, March, 1949.

unfamiliar with it, either in real life or on the traditional stage. In order for the lighting designer to provide a more estheticly pleasing light, he must strive for illumination which will appear more familiar.

The major implement the lighting designer has at his disposal to help create a more familiar light is the ability to maintain an even, balanced flow of illumination across the stage. One reason for studying the four lighting systems in this thesis is to determine which method can best accomplish this aim. Uneven illumination on an actor's face as he crosses the stage is bothersome to the audience unless specifically motivated. By removing this unevenness, the appearance is more pleasing. The unfamiliar appearance of arena lighting is always there but the audience may easily accept this or at least become accustomed to it if the lighting is well done in other respects.

CHAPTER IV

METHODS OF LIGHTING ARENA STAGES

A--Basic Factors

Arena staging requires that lighting methods for this staging style arrange light to strike the actor equally no matter which direction he is facing. This requirement sometimes presents a particular challenge in that it is often difficult to achieve an effectively balanced light around an actor. The basic differences that occur between arena lighting methods versus proscenium lighting methods are by virtue of this one requirement.

One concept that does carry over from proscenium lighting into the majority of arena lighting methods is the lighting area approach. The lighting area concept is a way of providing adequate lighting flexibility on all sections of the stage that the actor will be at any time. In arena theatre, this means literally being able to cover the entire stage with an equal amount and quality of light. Therefore, the majority of arena lighting methods use the lighting area. This involves subdividing the stage space into several smaller "stages" which can be lighted individually be a minimum number of lighting instruments. On an average stage, twenty feet in diameter or twenty feet square, nine lighting areas would usually suffice (see Diagram #1). The average size of a lighting area is between six to eight feet square. This is the size used for study in this thesis. This size may vary slightly but no more than what a given number of instruments can light effectively.

Of the four lighting methods discussed in this chapter, three use the lighting area unit. These three methods derive their names from the number of lighting instruments used in each area, thus the names: four instrument-per-area; three instrument-per area; and five instrument-per-area. The fourth method studied, the central and peripheral method, does not use the lighting area unit. This method uses a central light source which can consist of one large instrument or several smaller instruments in conjunction with lighting instruments equally spaced around the periphery of the stage.

An orderly and planned placement of instruments is a logical requisite to a flexible (which connotes efficient) lighting system.[1] One helpful starting point is a uniform height at which to mount the lighting instruments. This, of course, necessitates arranging for a lighting grid or a similar arrangement on which instruments can be placed.

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[1]McCandless, A Method of Lighting the Stage, p. 10.

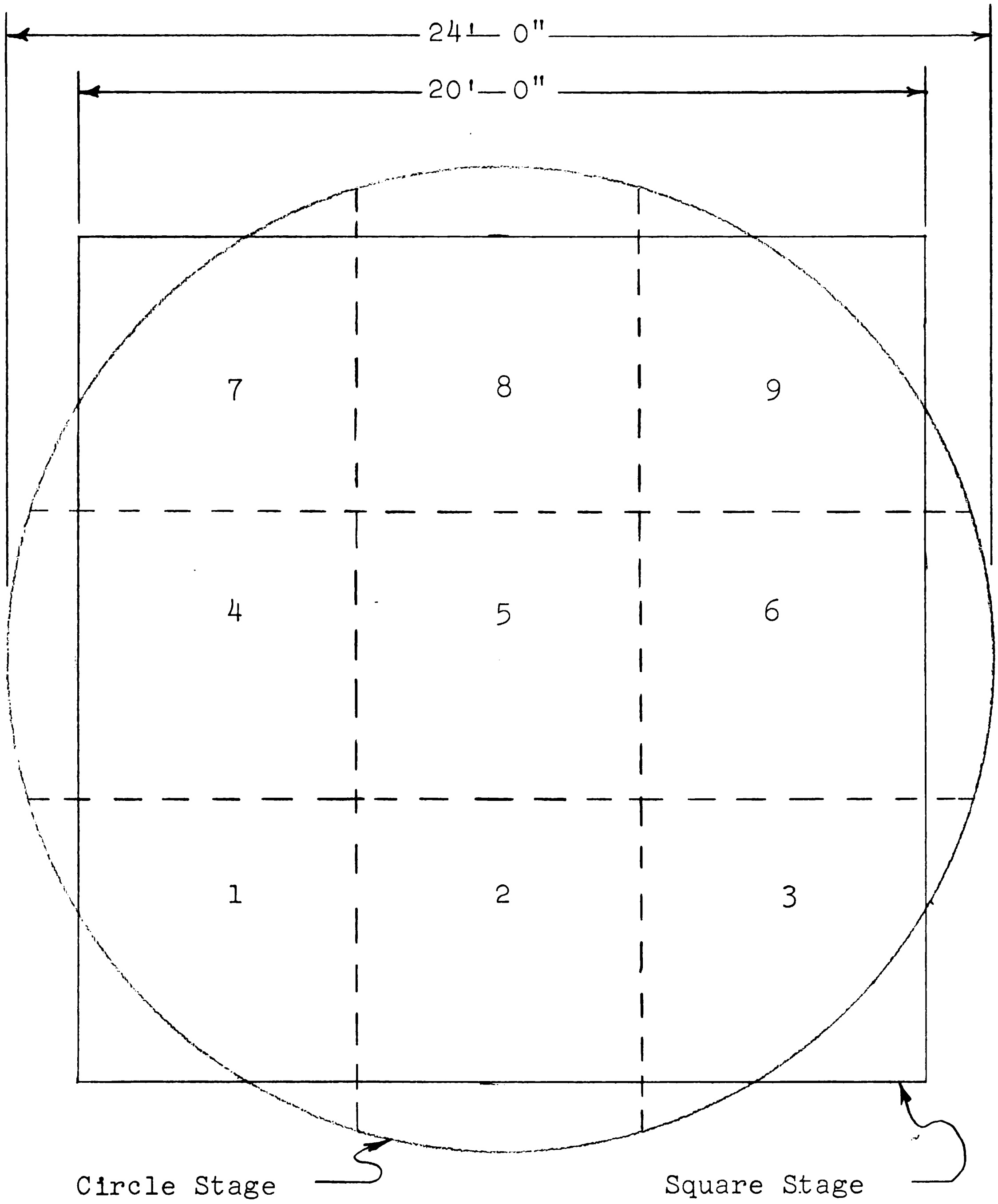

Diagram #1.--Arena stage divided into nine lighting areas.

Based on the author's experience and on recommendations by such authorities as Rubin and Watson, it seems the best instrument mounting height from the stage floor is somewhere between fifteen and seventeen feet.[1] The height for mounting instruments used for the experiments in this thesis was 15'9".

Because arena staging negates the use of such proscenium lighting practices as side lighting and footlights, none of the arena lighting methods are able to take advantage of this type of instrument placement. Of course, side lighting and footlights are not a primary source of light on the proscenium stage, but their lighting value is quite often missed in the arena situation.

The primary light direction and source in the arena lighting methods originates from instruments placed on a line 45 degrees from the horizontal and 360 degrees around a given point (see Diagram #2). This 360 degree lighting effect is achieved by several instruments placed on the circumference. The number of instruments focused into a given lighting area on this line constitutes the major difference between arena lighting methods.

The methods of arena lighting analyzed in this thesis and described in the next section of this chapter

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[1]Rubin and Watson, Theatrical Lighting Practice, p.59.

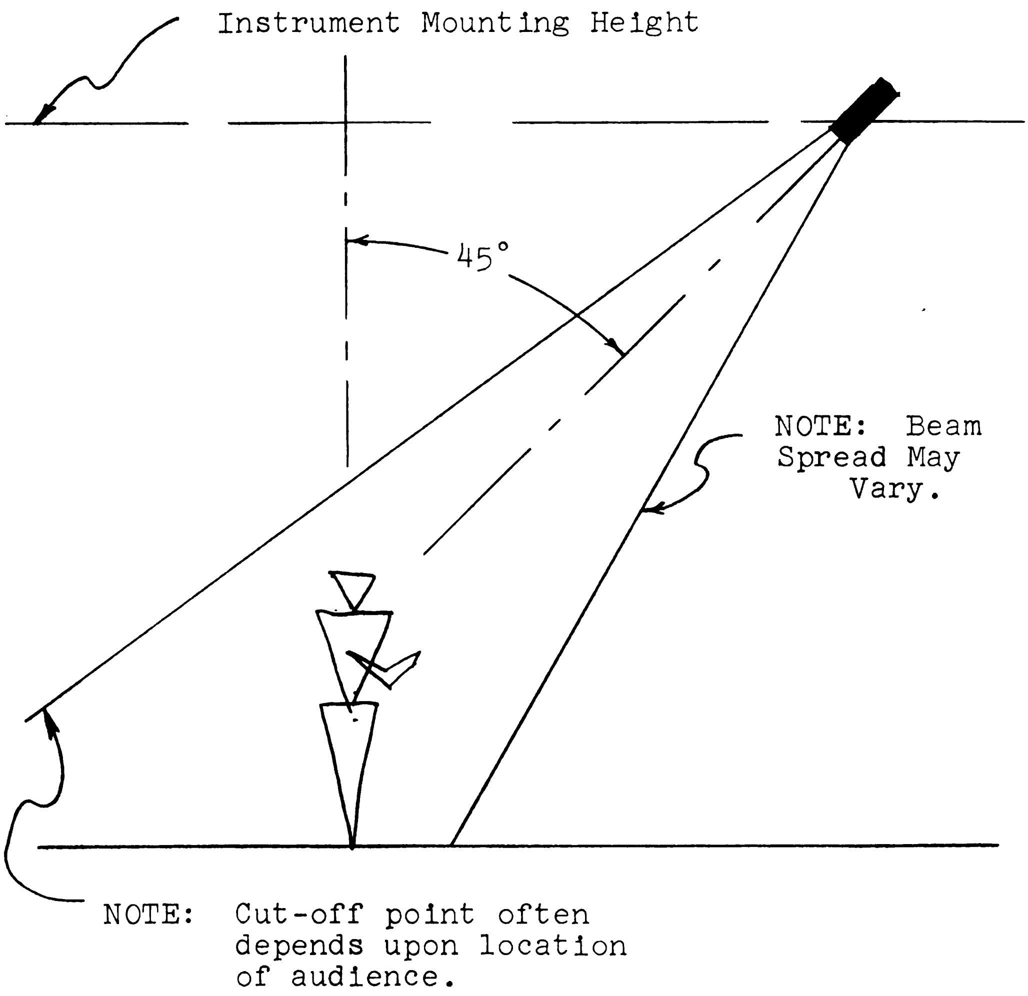

Diagram #2.--Visualization of angle of incidence as light from one instrument strikes actor.

were selected for several reasons. First of all, they were chosen because of their extended use and success. Some, such as the four instrument-per-area system, are more popular than others. However, many producing groups choose the central and peripheral method because it is relatively less expensive than others. One, the five instrument-per-area system, is possibly original with the author.

Aside from the advantages and disadvantages of each method, which will be discussed later, the following sections merely describe the physical aspects, visualize the set-up, and present some of the aims of each method.

B--The Three Instrument-Per-Area Method

This arena lighting method uses three instruments to light one lighting area, hence, its name. The three instrument-per-area method was devised in order to fill the arena stage requirement of 360 degree lighting, use the lighting area concept, and use a minimum number of lighting instruments in doing so.

For each lighting area plotted upon the stage, there are allocated three lighting instruments. In plan view, this means that the three instruments are placed 120 degrees from each other (see Diagram #3). In order for the light to appear more pleasing to the audience, these instruments are best placed so that the light from one of them does not

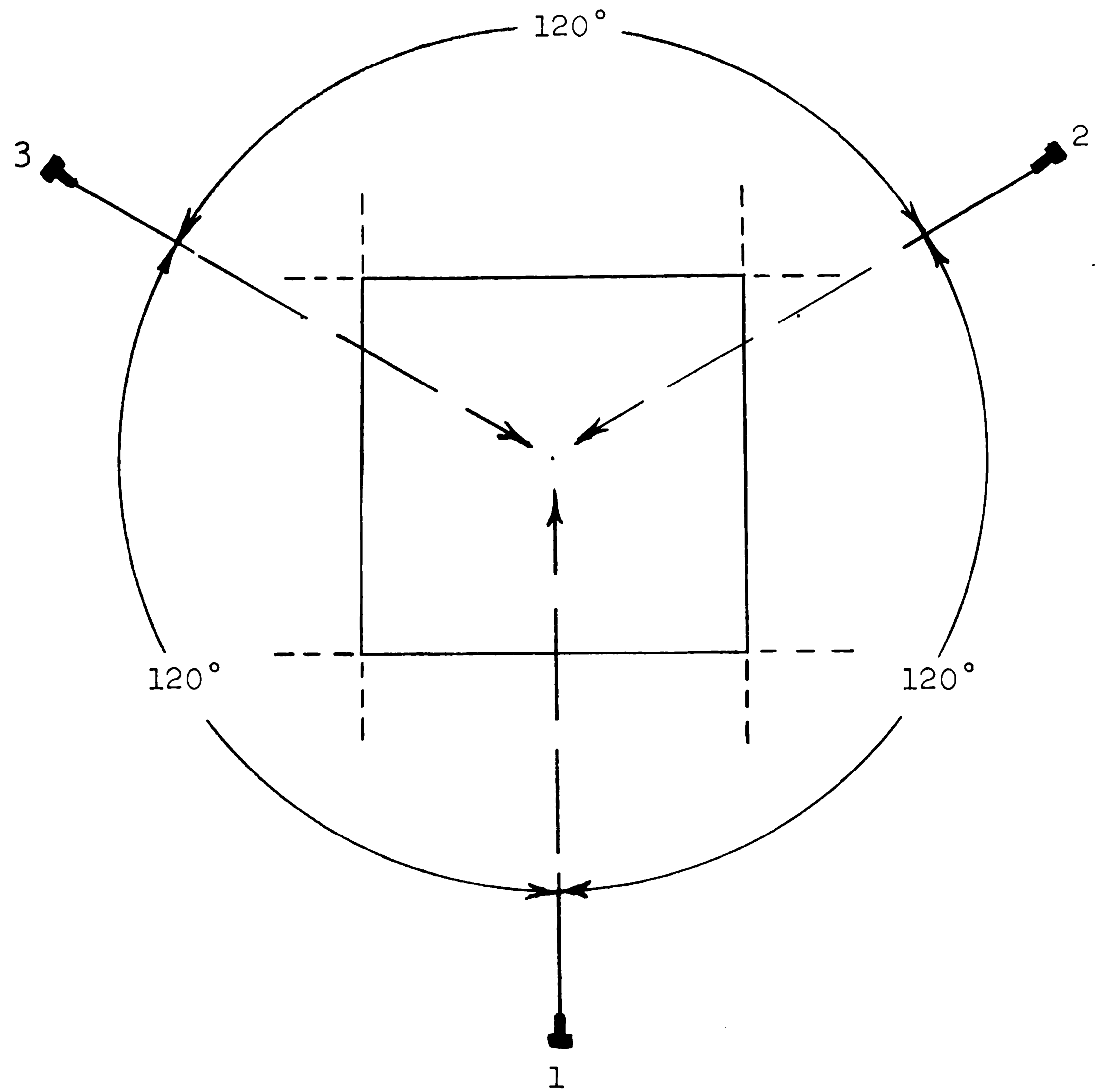

Diagram #3.--Visualization of angle of convergence--three instrument-per-area method (only one area shown).

strike an actor from straight ahead and above as he faces the audience nearest him (see Diagram #4). This means that the placement of instruments would revolve in relationship to the audience and the center of the stage. This is opposed to placement of the instruments in a static arrangement. For example, light from instrument number one in each area does not always have to come from the north (see Diagram #4).

This method necessitates that all lighting instruments used in a given area should be of like type and wattage. This presumes that mounting height and distance from the area will be the same for each instrument. Using the average mounting height of between 15' to 17', the instrument usually used is a 500 watt specific focus spotlight such as an ellipsoidal reflector spotlight or a Fresnel lens spotlight. It is usually the best practice to use either one or the other type of instrument for every basic lighting area on the stage. When combinations of different instruments must be used from lighting area to lighting area, thought should be given to the effects this will create. Most certain of the problems this practice will create is a more uneven distribution of light.

Intensity control, by the use of dimmers, over the instruments in this method is complicated somewhat by the fact that there is an odd number of instruments in each area. The ideal situation with any lighting method is

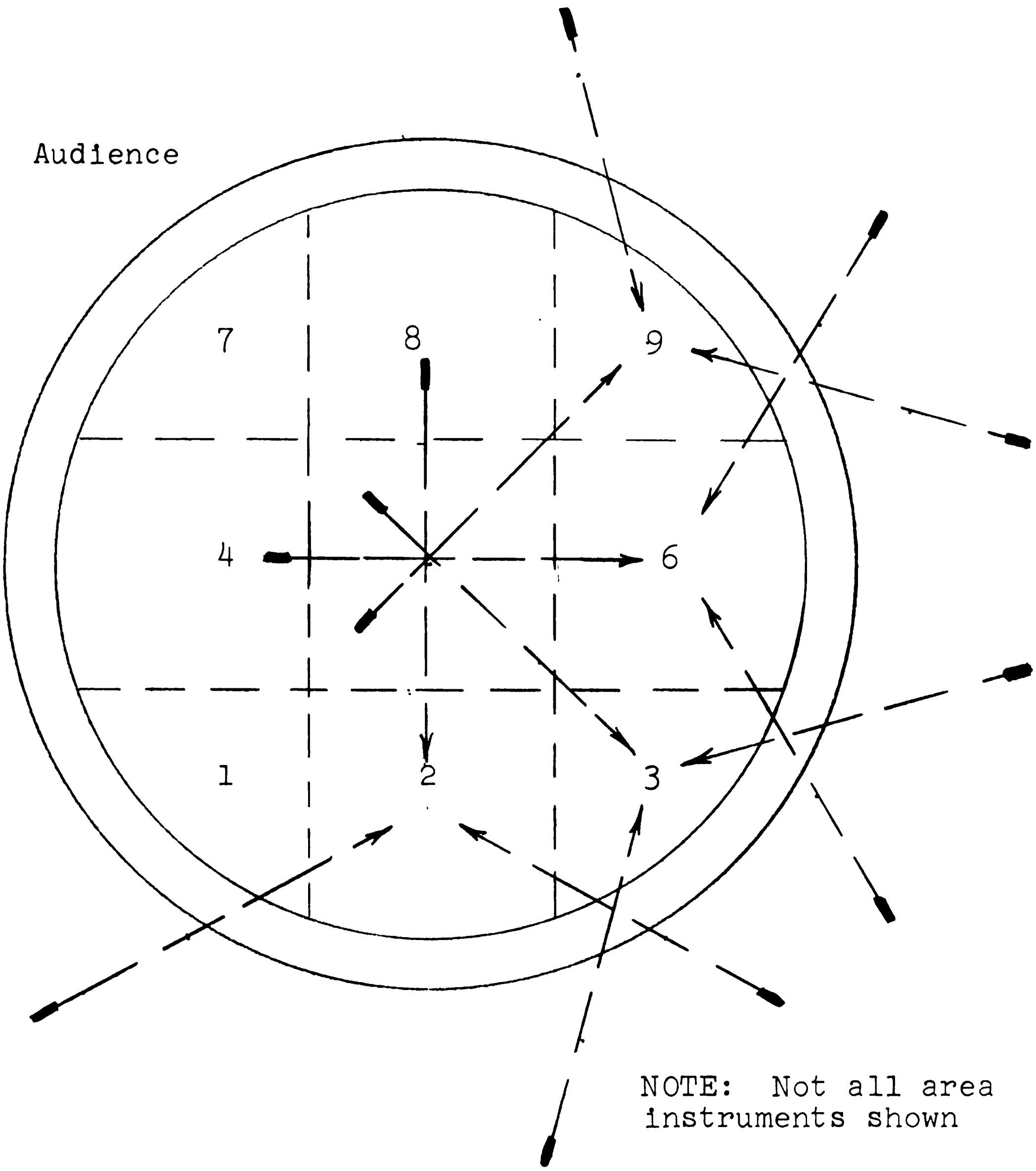

Diagram #4.--Visualization of instrument placement in relation to audience--three instrument-per-area method.

to have individual dimmer control over each instrument. However, cost restrictions usually limit the number of dimmers a producing group is able or willing to purchase. Therefore, there is a choice left between control over the color medium in the instruments or control over all instruments in one lighting area. But, in the three instrument-per-area method, color control is the same as one dimmer per instrument. This is because of the common practice of using a cool, warm, and neutral color medium in the three instruments. This leaves either area control as the primary way of assigning the dimmers or one dimmer for all three instruments in one lighting area. As this means the three instruments will always have equal light intensity, the usual method of answering a need to have one instrument less intense than the others is to block off some of the light be placing a neutral gray color medium in that instrument.

C--The Four Instrument-Per-Area Method

This arena lighting method also uses the lighting area concept. The placement of four instruments to light one area is its most distinctive trait and provides its name. This method is possibly the most popular system in use and is primarily recommended by Century Lighting Co. and in Rubin and Watson's Theatrical Lighting

Practice[1] and Parker and Smith's Scene Design and Stage Lighting.[2]

In practice, this method is an elaboration and adaptation of the proscenium lighting method explained in Stanley McCandless' book A Method of Lighting the Stage. This proscenium method uses two instruments for each lighting area.[3] Diagram #5 shows how these instruments are placed 45 degrees from the horizontal and 90 degrees from each other.

The McCandless method as it carries over into area lighting provides the basis for the four instrument-per-area method. That is, by placing the instruments 90 degrees a part, the number needed to go full circle is four. A term (often used by authorities) for this method is the "double McCandless" method. As in the three instrument-per-area method, the instruments in the four instrument-per-area method are best placed so that they are at a 45 degree, 135 degree, 225 degree, and 315 degree relationship with the audience (see Diagram #6).

There are two common practices involving the placement of color medium in the instruments of this method.

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[1]Rubin and Watson, Theatrical Lighting Practice, p. 52.

[2]Parker and Smith, Scene Design and Stage Lighting, p. 353.

[3]McCandless, A Method of Lighting the stage, p. 56.

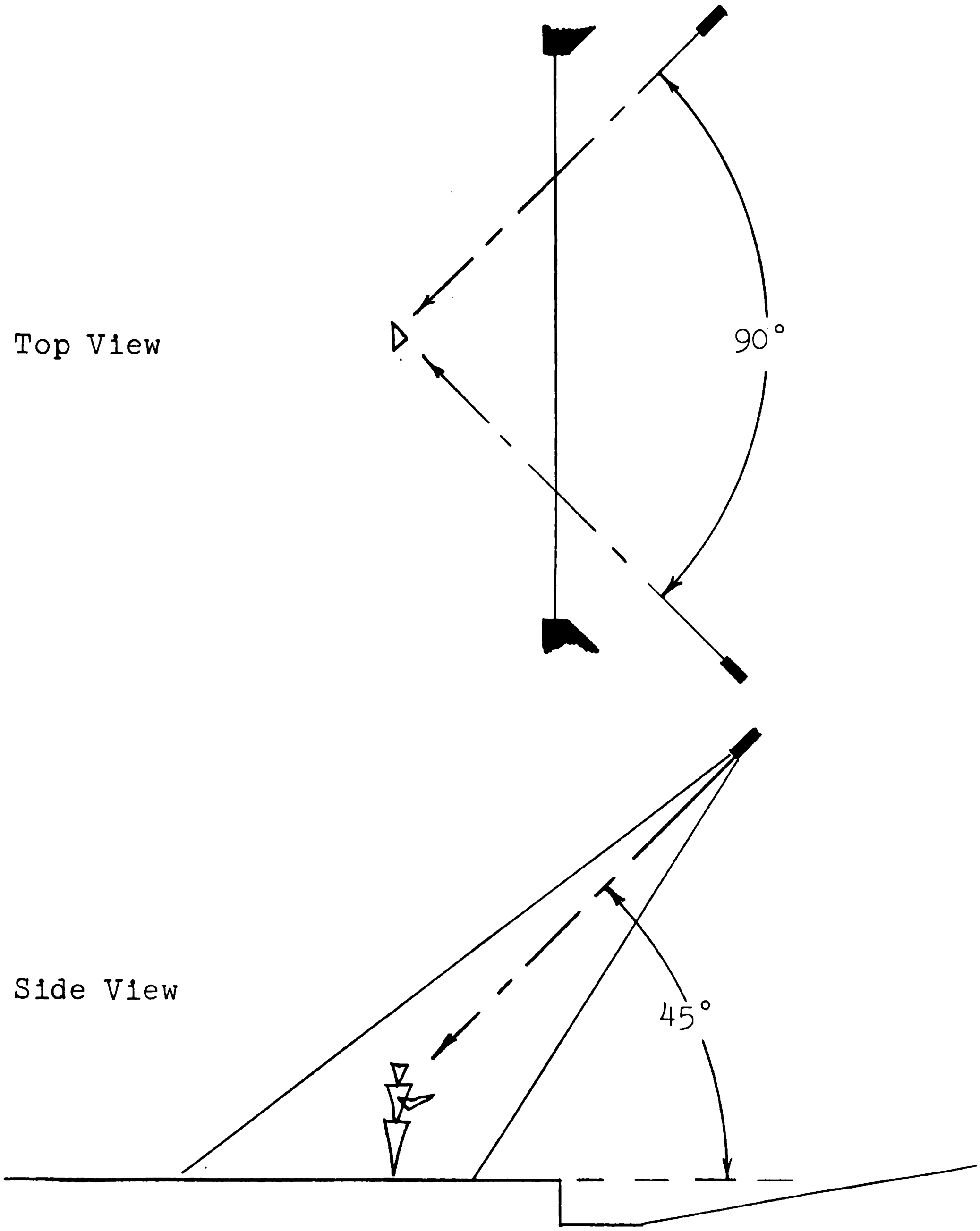
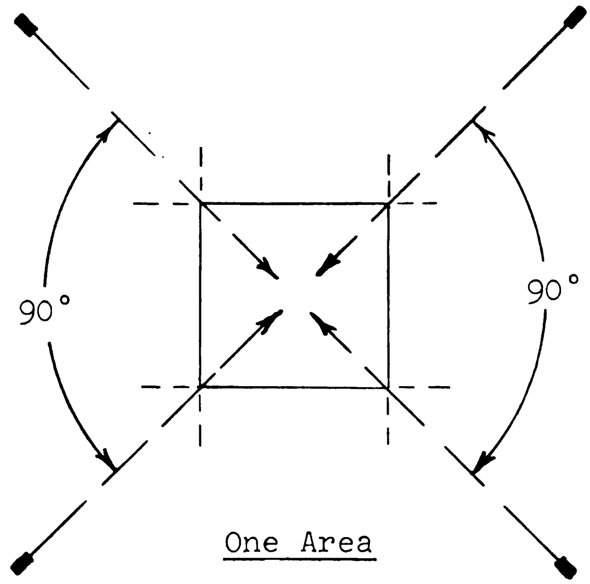
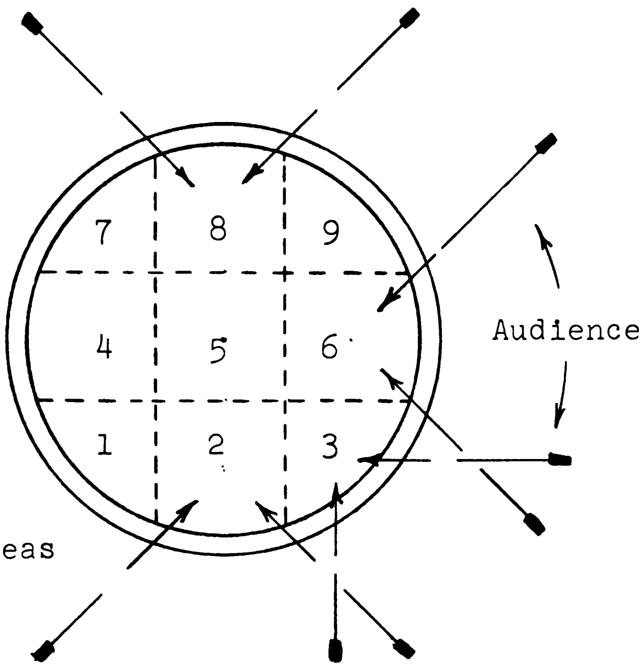


Diagram #5.--Visualization of the McCandless method of lighting proscenium stages.



One Area



NOTE: Only Instruments over audience are illustrated. Not all areas shown.

Instrument Placement in Relationship to Audience

Diagram #6.--Visualization of the four instrument-per-area Method.

One practice is to place a cool color and a warm color in opposing instruments. The remaining two opposing instruments would receive a neutral color. A more common practice is to place cool colors in opposing instruments and the warm colors in opposing instruments. This practice is more common because it allows 100% of the audience to receive all colors used; whereas in the other method, an audience member would be aware of only 50% of the color combination.

The intensity control or the way the dimmers are used in the four instrument-per-area method depends upon which color practice is used. For example, if control over color was a requisite then fewer dimmers per area could be used if the warm-cool--warm-cool system was used. This means that two dimmers would be used for each and there would be dimmer control over both the area and the colors used within the area. If the cool-warm-neutral color system is used, three dimmers in each area would be needed to provide both color and area control.

D--The Five Instrument-Per-Area Method

The five instrument-per-area method is based upon the four instrument method. In fact, the added instrument does not displace any of the instruments but is an addition to them. The fifth instrument is mounted directly in the center of each lighting area and is focused straight down (see Diagram #7). This produces, from this one instrument, what is commonly called "down lighting."

This lighting method evolved through experiments by the author during the 1962 season of Michigan State University Summer Circle Theatre. The use of the fifth instrument started out as an attempt at solving problems concerning uneveness of light. Although this was quite successful, the method was found to be useful in many other ways. Generally, the additional instrument allowed for greater flexibility of the other instruments.

Dimmer control can easily remain the same as in the four instrument method except for the additional instrument. Ideally, one dimmer for each fifth instrument would be best. However, unless this individual control is important to a single play, groups of the fifth instrument may be put on dimmers as capacity will allow.

E--The Central and Peripheral Method

Of the four arena lighting methods studied in this thesis, this method is the only one which does not use the lighting area concept. The base of reference is the total acting space. This method utilizes a single instrument or collection of instruments mounted directly over the center of the acting space. This source of light is focused down and out toward the edges of the stage in such

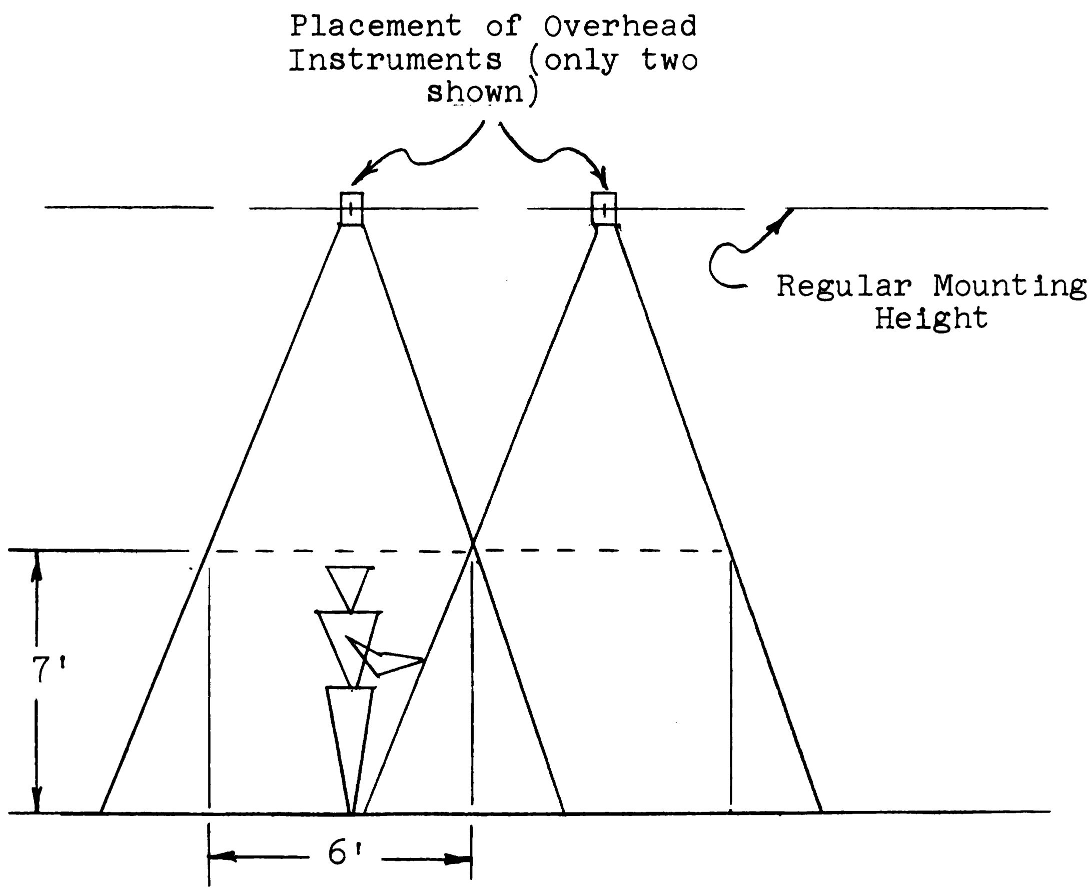


Diagram #7.--Visualization of five instrument-per-area system (only overhead instruments shown).

a way as to cover as much area as possible without spilling light into the audience. This centralized source of light is used in conjunction with a series of instruments spaced evenly about the periphery of the stage (see Diagram #8). These instruments are spaced in relation to each other in such a way as to allow an even overlap of light beams and thus complete coverage of the stage.

There is only one primary system of intensity control within this method. This is to control the central source separately from the peripheral source. Any addition to this limited flexibility must be done by using special areas separate from the basic illumination. This is useful when a certain area of the stage should be of greater illumination than the rest. Color does not greatly affect the intensity control of the instruments in this method. However, one common practice is to use warm colors on the peripheral sources and cool colors in the central sources, or vice versa.

One of the primary aims of this method is to reduce the set-up, lessen initial cost, and lessen the elaborate mounting arrangement. However, when more sophisticated lighting is desired, the cost must rise accordingly and sooner or later the total cost will match the more costly four and five instrument methods. Actually, when additions and elaborations are made upon this method, the pecuniary motives are vastly reduced.

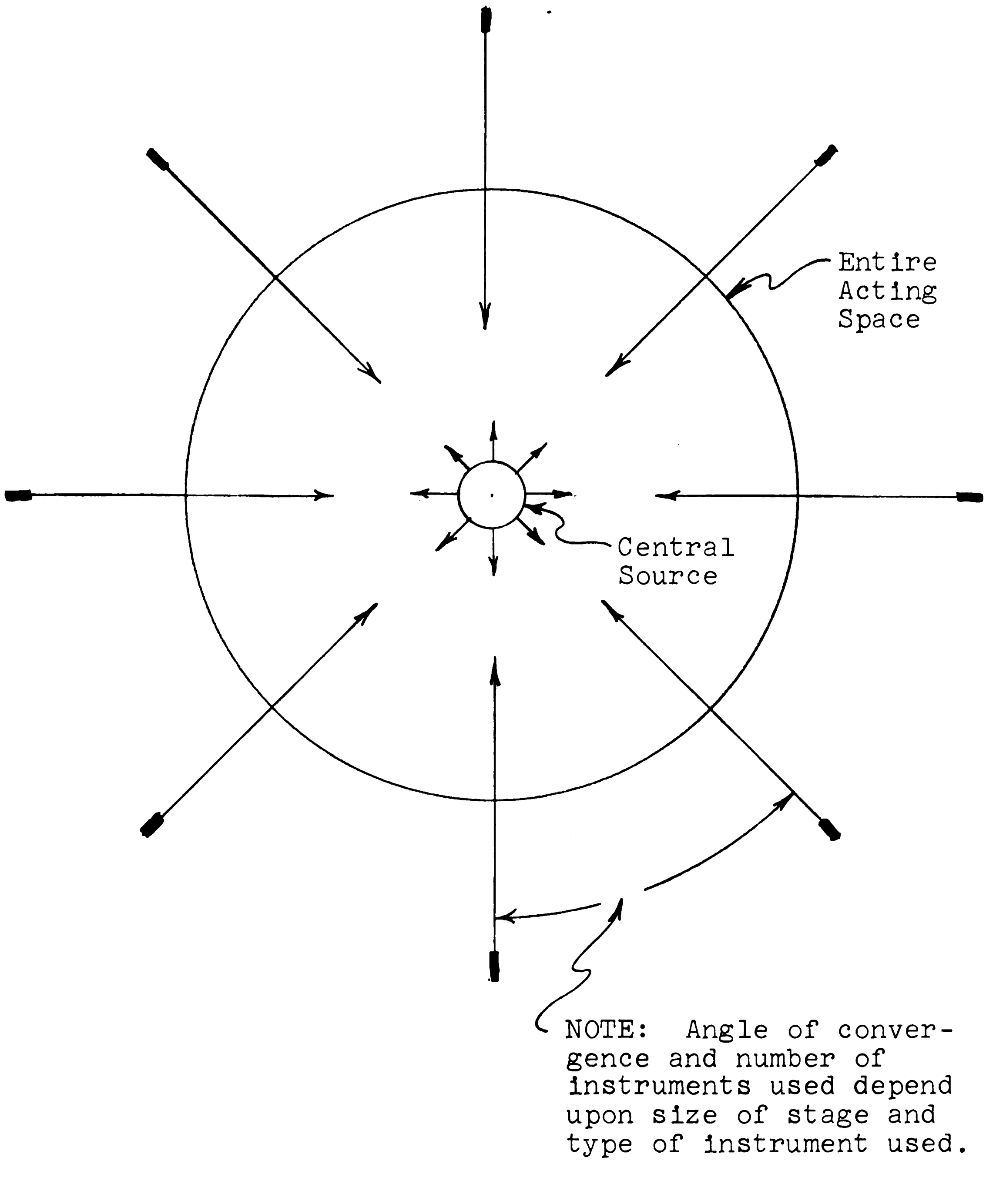


Diagram #8.--Visualization of central and peripheral method.

PART II--ANALYSIS OF THE METHODS

This part of the thesis will present findings and data gathered by the author on the arena lighting methods presented in the preceding chapter. No comparisons of one method to another will be made in this discussion. Comparisons and conclusions are reserved for the final part of the thesis. However, in addition to the presentation of data, an analysis of the material within each method will be presented in this section.

The major bulk of the data concerns the way in which illumination from each method is distributed within a lighting area. The discussion in the chapter on aesthetics concluded that arena lighting should primarily be able to provide an evenly distributed light throughout the stage. The way to achieve this is to use the best instrument mounting positions which in turn will control the direction of light and the way in which illumination behaves within a lighting area. The following data, then, represents measurement of the illumination levels within a standard lighting area as provided by the four lighting methods.

The size of the lighting area used to gather data was six feet square. In actuality, a lighting area is a six foot cube because light must be able to continue far enough above the stage to allow for the height of actors. Measurement of the illumination was accomplished by the use of a photoelectric photometer which recorded footcandle levels at 200 systematic locations within the six foot lighting area cube. The 200 readings taken within each area were distributed on two levels of 100 locations each. One level was two feet-six inches from stage level (see Diagram #9). Each level had 25 locations at which footcandle readings were taken. At each location, readings were taken in the four directions: north, south, east, west (see Diagram #10). This information was then recorded on a raw data sheet (see Diagram #11).

The human eye is an unscientific visual instrument. The eye reacts and adjusts to changes in brightness quite slowly and is, in fact, a poor judge of any total illumination level. Also, the human visual sense needs a great deal of illumination difference to be able to distinguish between the brightness of two separately lighted objects. In a recent experiment it was found that the average eye could not tell the difference between two light levels unless they were separated by as many as ten to fifteen foot candles. The photoelectric photometer, on the other hand, is highly delicate and is able to record illumination differences of as little as one-tenth of a footcandle. The instrument allows a better insight as to how much and where light is located.

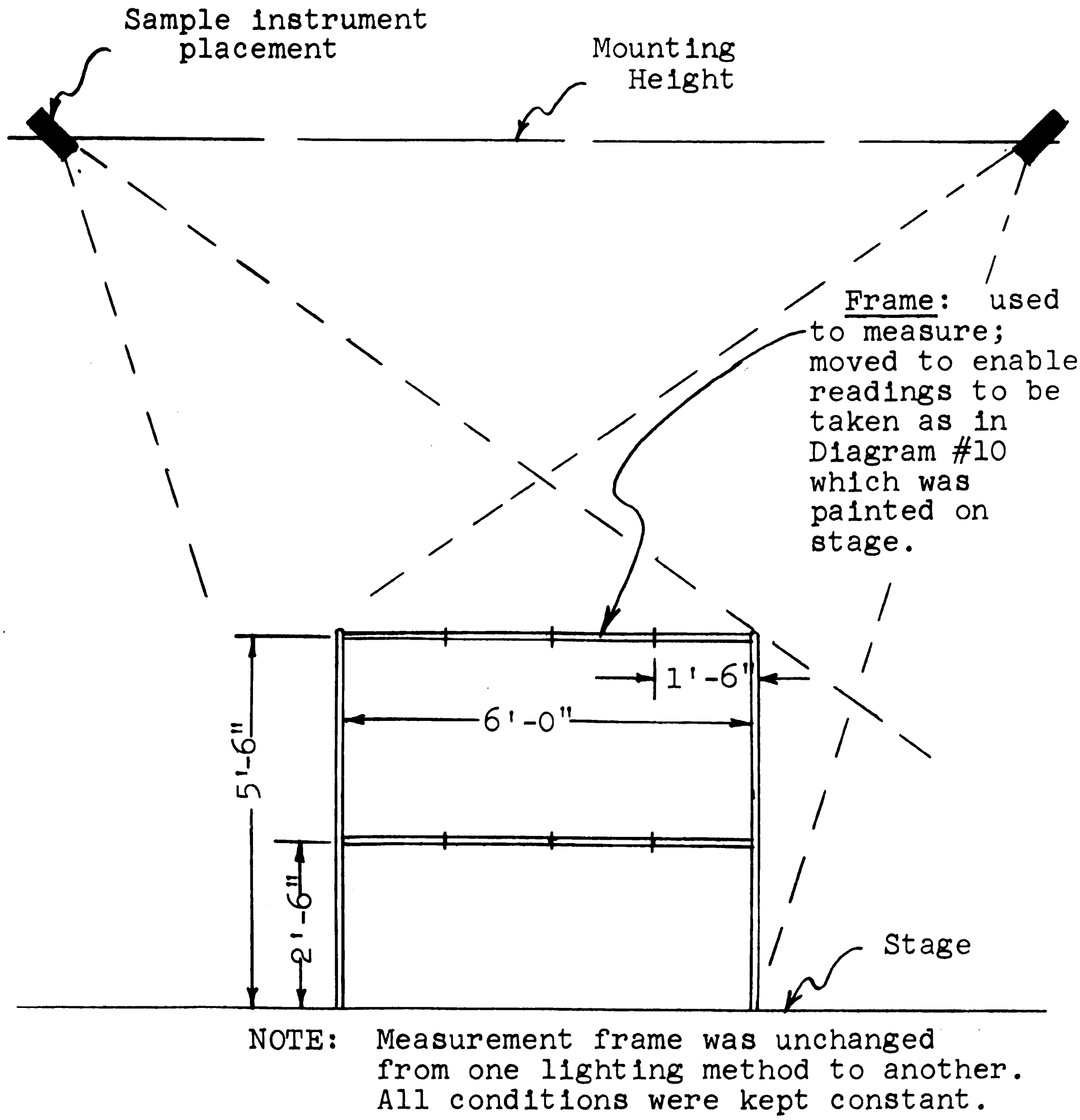


Diagram #9.--Visualization of measurement frame.

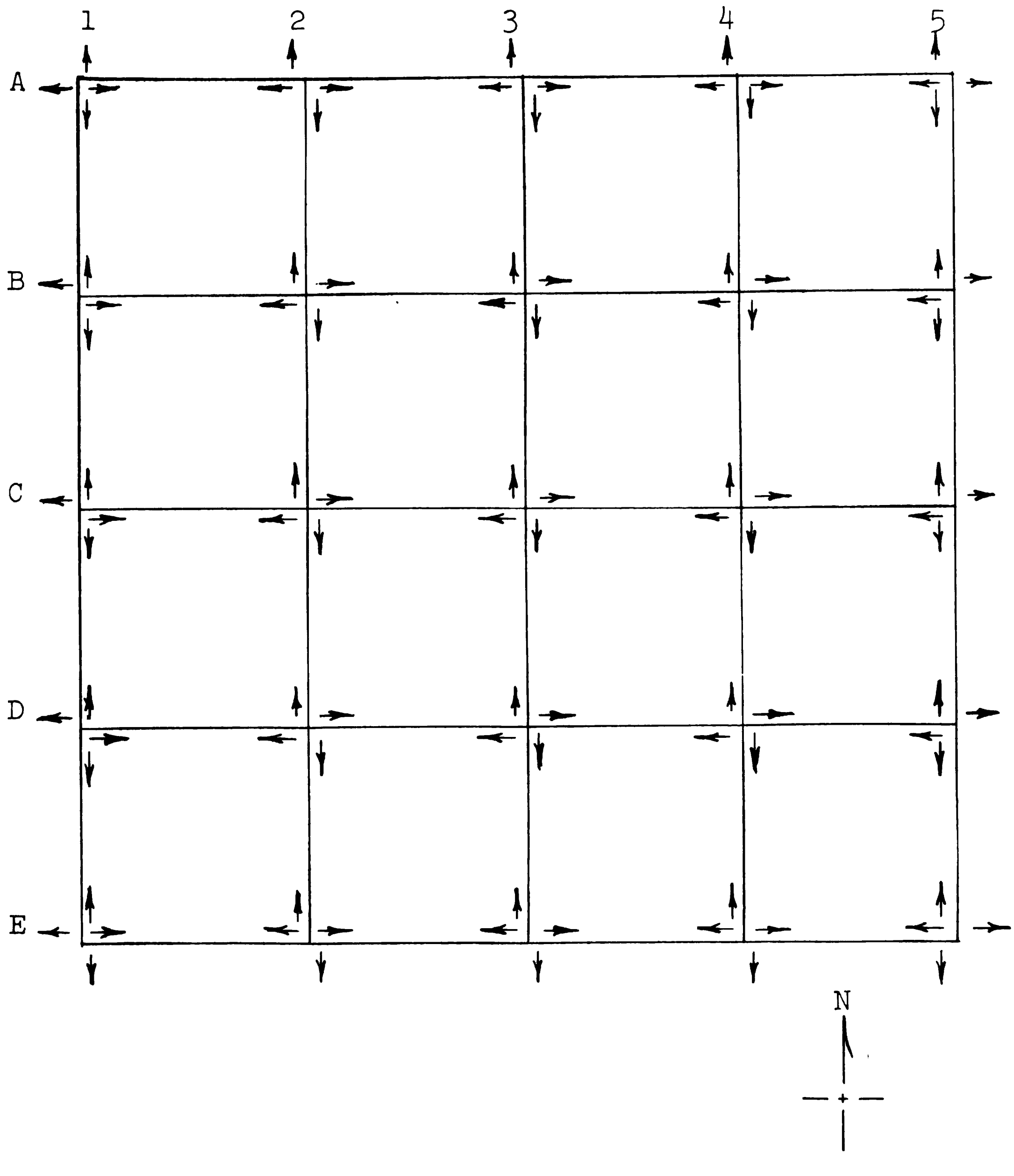


Diagram #10.--Top view of lighting showing the measuring points.

First Level (5'-6" from Stage)

	1	2	3	4	5
A					
B					
C			N S E W		
D					
E					

Second Level (2'-6" from Stage)

	1	2	3	4	5
A					
B					
C			N S E W		
D					
E					

Diagram #11.--Original raw data sheet.

The site at which the light methods were set up, tested, and studied was Demonstration Hall on the Michigan State University Campus. This building houses the Summer Circle Theatre. This location was not used solely because of this fact, but rather because of abundant power supply and proper instrument mounting positions.

The instruments for each system were mounted at a height of fifteen feet-nine inches so that the bottom of the lens housing on each instrument was an exact sixteen feet from stage level. The instruments used were either ellipsoidal reflector or Fresnel spotlights, except for one general illumination instrument used for the central light source in the central and peripheral methods. A 45 degree angle of incidence was achieved as accurately as possible and certainly no less accurate than could be achieved in any theatre situation. The same holds true for the converging beam angles.

The lighting instruments used were from the Michigan State University Theatre stock. Somewhat bothersome is the fact that in any collection of lighting instruments, there are no two instruments that perform with the same efficiency, each emiting a varied footcandle reading. Although this limitation is a bothersome one, the differences can, most of the time, be acknowledged and explained. Also, complete scientific accuracy is not an every day ingredient in the theatre.

It should be stressed that the testing situation described above is in no way meant to be a laboratory situation, that is, a situation which cannot be translated into the contaminated variables of the theatre. The data is of such a nature that its meaning will be translated only as to the visual capabilities of the human eye.

Three Instrument-Per-Area-Method

The raw data as presented in Diagram #12 at the end of this section is the basis for analysis. The breakdown of this data shows some rather surprising results. First of all, of the readings taken over this six foot square area, there was a high footcandle reading of 1.00 f.c. As would be expected, the high reading occurred toward the center of the area where the center of the beams of the three instruments were focused. The low reading occurred at the edge of the area where the less intense beam illumination was located. This in itself is not as important as it is interesting. What is important, however, is that the high reading was in an area boasting a 31 f.c. average as opposed to the low reading occurring within an average illumination of 7 f.c. The major question, then, is can the overlap illumination from an adjacent area boost the lower readings toward the outside boundaries of the area. When this was done, the illumination average toward the edges of the area was boosted to 23 f.c. and toward the

Diagram #12.--Diagram illustrating data gathered on three instrument-per-area arena lighting method.

		1					2					3					4					5				
		A	B	C	D	E	A	B	C	D	E	A	B	C	D	E	A	B	C	D	E	A	B	C	D	E
N	U	3	5	10	10	6	5	5	9	11	9	3	9	14	11	8	3	6	10	14	8	3	9	14	18	9
	L	3	6	3	9	10	2	5	5	10	11	2	7	5	9	14	3	6	4	11	15	2	6	4	10	9
S	U	10	13	12	9	9	11	19	17	20	20	11	20	27	30	37	11	26	37	40	36	6	8	9	10	4
	L	11	11	8	6	3	13	13	13	11	7	16	19	19	14	9	23	27	26	18	7	20	22	29	15	6
E	U	20	22	24	17	7	25	27	29	19	6	18	28	32	21	4	12	25	26	22	2	10	17	19	13	1
	L	12	14	19	19	12	8	11	18	19	13	6	9	13	11	11	4	7	10	9	7	4	4	6	4	3
W	U	7	18	21	17	7	18	37	37	24	8	26	52	51	23	10	17	42	46	19	7	6	23	25	12	5
	L	3	5	8	7	3	5	10	12	12	7	8	19	20	19	15	14	29	33	22	18	17	35	42	29	15

center to 37 f.c. or a 14 f.c. difference from the center to edge of the lighting area.

The average footcandle reading of the entire area was 14.23 f.c. The average was 16.57 f.c. on the upper level of five feet-six inches from stage level. The averages on this upper level as an actor would face each direction were: north, 8.4 f.c.; south, 17.7 f.c.; east, 17.8 f.c.; west, 23.8 f.c. It cannot be readily determined if the 15 f.c. maximum differences between the north and west directions would occur under any three instrument set ups. A certain amount of this difference can be explained as attributible to differences in instrument efficiency. A small per cent of the difference, however, seems attributible to the nature of the three instrument method with its oblique 120 degree angle of beam convergence.

The profile and distribution of footcandle readings within the measurement area is shown in graphic form in Diagram #13. It may be seen here that the majority of readings fall below the average of 14.23 f.c. There were 38 readings in the 9 to 11 f.c. group alone. The mean footcandle reading was 11 f.c. This shows that the higher readings above the 29 f.c. tend to pull the average higher than what could be termed the "background illumination." However, there were only 13 readings above the 29 f.c. and these can be due to what are termed "hotspots." A hotspot is the part of the spotlight beam that is of a much higher

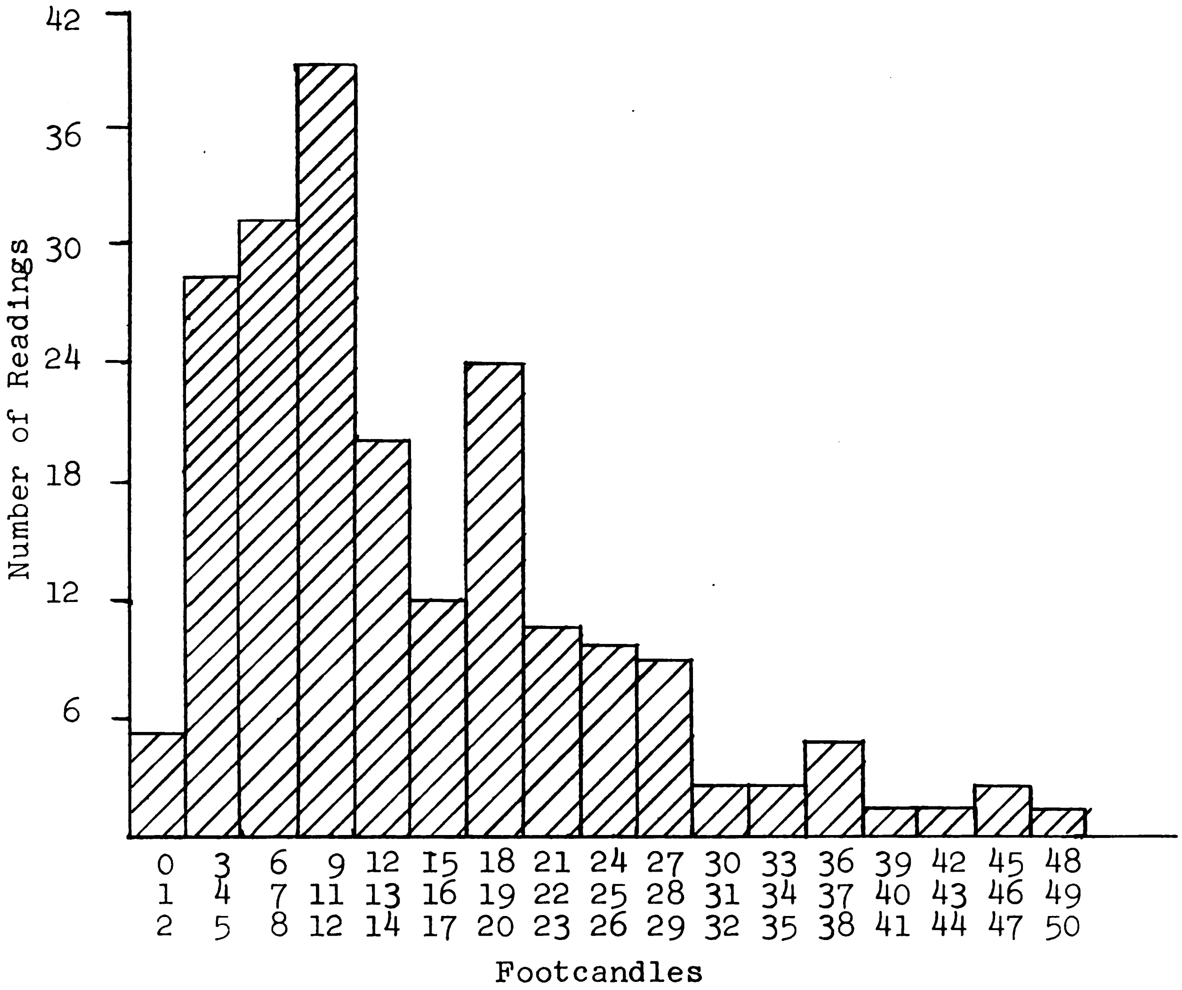


Diagram # 13.--Distribution of footcandle readings three instrument-per-area method.

intensity than the rest and can be called the focus or center of the beam. This hotspot is of a local nature and usually represents a difference of as much as 15 f.c. above the average intensity of the beam illumination.

The illumination average on the lower level of two feet six inches from the stage is lower by almost 5 f.c. than the upper level of readings. This is due to the fact that when this one area was tested, light from other areas was not entering. When an adjacent area illumination was brought into the readings, the lower level average increased to as much or more than the upper level. The reason for this is that the central beam illumination is focused primarily toward the center of the upper level thus allowing most of the higher illumination to escape the area before it can be measured at the edge and therefore overlapping into the next area adjacent.

The Four Instrument-Per-Area Method

The data that will be analyzed in this section is presented in Diagrams #14, 15, and 16. The diagrams represent data taken for the four instrument method in three instances. First, Diagram #14 represents the four instrument method using the fresnel lens spotlight. Secondly, Diagram #15 shows the same only with the ellipsoidal reflector spotlight. Lastly, Diagram #16 shows the effects of adjacent area light on the data presented in diagram.

Diagram #14.--Diagram illustrating data gathered on four instrument-per-area arena lighting method.

		1					2					3					4					5				
		A	B	C	D	E	A	B	C	D	E	A	B	C	D	E	A	B	C	D	E	A	B	C	D	E
N	U	1	2	5	6	3	1	2	5	6	4	1	2	5	6	4	1	2	5	6	3	1	3	6	6	2
	L	1	2	4	5	4	1	3	5	7	6	1	3	6	7	6	1	3	5	7	6	1	2	6	4	3
S	U	4	6	4	2	1	5	7	6	3	1	5	7	7	3	1	5	7	6	4	2	4	5	5	3	1
	L	5	4	3	1	1	6	4	3	2	1	6	5	4	3	1	6	5	4	2	1	5	5	3	2	1
E	U	2	4	5	5	3	5	9	9	9	5	10	14	14	13	9	14	17	16	13	10	11	13	13	9	7
	L	6	10	11	10	6	9	13	13	12	8	9	13	12	13	8	8	11	11	10	6	4	8	6	6	3
W	U	8	12	12	10	7	12	12	12	14	10	15	20	20	17	11	9	14	16	13	8	3	5	7	6	4
	L	6	6	7	6	5	8	7	9	6	7	9	10	12	10	10	12	12	13	13	10	10	12	13	10	8

Diagram #15.--Diagram illustrating data gathered on four instrument-per-area arena lighting method.

		1					2					3					4					5				
		A	B	C	D	E	A	B	C	D	E	A	B	C	D	E	A	B	C	D	E	A	B	C	D	E
N	U	9	18	20	13	5	12	18	20	15	6	9	16	25	12	7	6	16	20	12	7	6	12	18	12	8
	L	3	8	13	13	12	8	15	29	22	18	7	15	19	20	18	8	15	20	21	20	4	10	18	18	15
S	U	7	15	19	10	5	15	30	32	29	13	16	30	35	35	18	11	21	35	35	18	3	8	26	32	20
	L	12	12	10	8	4	17	19	16	14	5	25	29	30	27	11	25	29	35	30	12	19	26	28	18	9
E	U	4	4	4	4	4	6	11	12	12	12	17	21	25	25	25	18	18	27	33	27	13	13	22	33	30
	L	10	17	18	19	11	16	25	25	25	16	17	27	31	27	18	13	24	29	34	20	7	13	16	14	9
W	U	10	15	18	16	9	33	33	35	35	35	43	42	41	43	32	30	30	28	34	30	13	13	15	17	12
	L	5	10	9	7	5	16	16	13	12	9	26	30	28	23	19	34	37	43	33	25	32	30	35	35	24

Diagram #16.--Diagram illustrating data gathered on four instrument-per-area arena lighting area.

		1					2					3					4					5				
		A	B	C	D	E	A	B	C	D	E	A	B	C	D	E	A	B	C	D	E	A	B	C	D	E
N	U	9	18	21	14	4	17	19	22	18	8	14	17	20	15	10	13	25	33	22	10	10	30	40	32	16
	L	3	6	12	14	12	5	19	17	20	16	8	14	19	22	21	5	14	22	23	24	6	17	28	35	32
S	U	7	17	20	11	4	14	27	24	21	10	16	27	26	23	12	11	19	36	34	15	7	32	44	45	18
	L	13	12	10	5	1	20	21	17	10	4	25	26	27	17	5	30	33	34	22	7	35	40	36	21	6
E	U	3	5	5	5	4	4	11	11	11	12	17	19	20	22	26	20	19	27	35	32	20	22	28	39	31
	L	12	14	20	20	11	18	25	28	28	17	17	27	33	31	18	20	35	44	36	22	22	36	40	37	24
W	U	7	9	11	7	5	26	23	26	22	21	40	36	33	41	35	33	31	32	36	34	11	32	38	30	18
	L	2	4	4	4	2	9	11	9	9	6	20	26	22	20	14	30	34	35	31	23	36	40	41	36	27

The difference between total illumination by the fresnel spotlight as opposed to the ellipsoidal reflector spotlight can be seen by the fact that the ellipsoidal reflector spotlight readings averaged three times that of the fresnel; 18.89 f.c. to 6.54 f.c. Some interesting characteristics concerning the fresnel are demonstrated by the data. Diagram #17 shows that the readings fall into a relatively well balanced bell curve. This is usually very desirable as it means the majority of light is toward the average. This is explainable in that the fresnel lens has a less pronounced "hotspot" that could tend the skew the readings upward. However, it is disappointing to note that there are greater differences of instrument efficiency among the fresnel spotlights. This is demonstrated by the varied readings from the four directions. They read: north, 3.26 f.c.; south, 3.44 f.c.; east, 9.44 f.c.; west, 11.04 f.c. A random check of fresnels in the university stock showed an efficiency difference of as much as seven to eight footcandles (see Diagram #18).

Concerning the data in the lighting area using ellipsoidal reflector spotlights, the high reading was 43.00 f.c. as contrasted with a low of 3.00 f.c. Again, as in the three instrument method, the higher readings occur toward the middle. But, the instruments focused primarily from the west seemed to be more efficient because their readings were 7 f.c. above the average. The readings

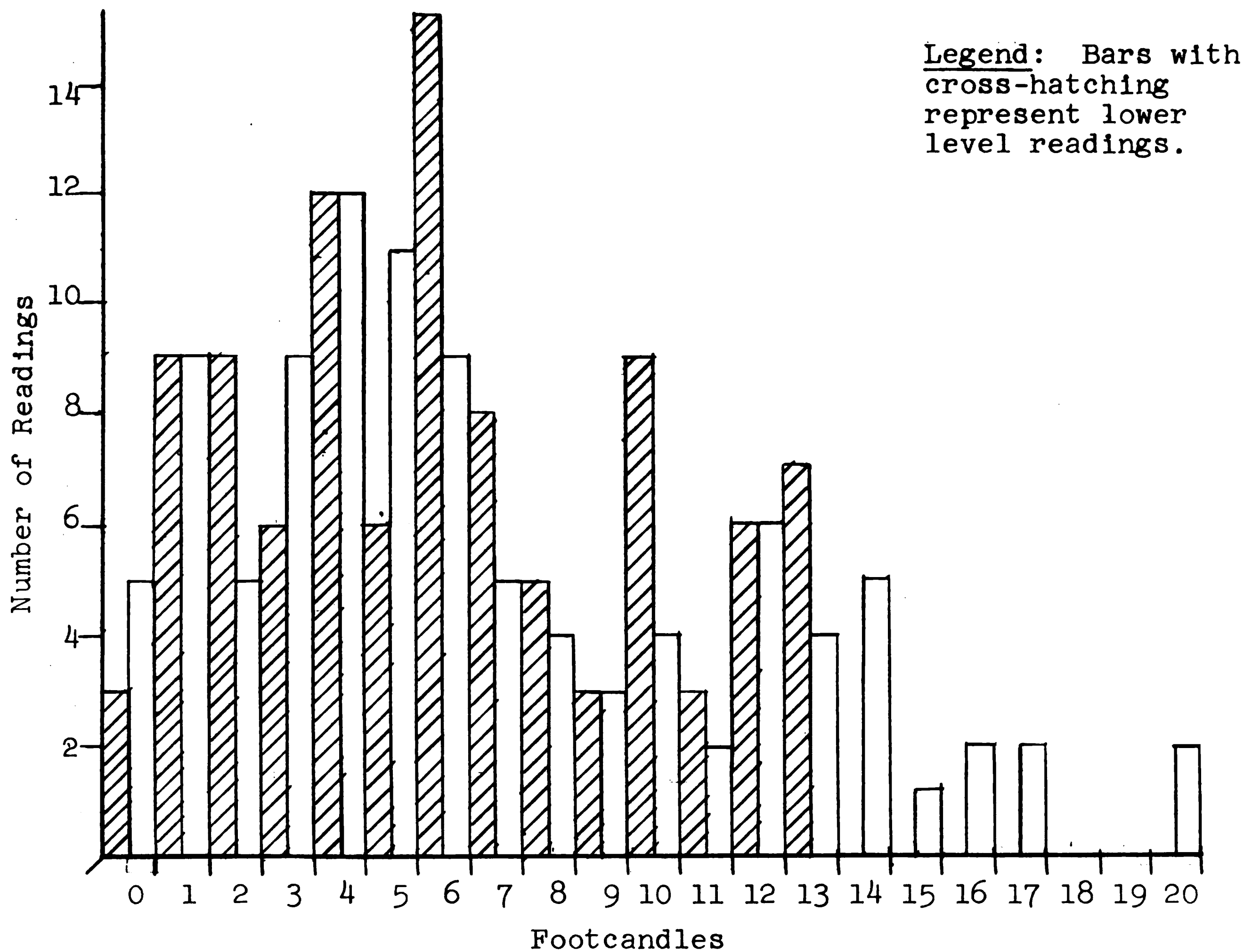
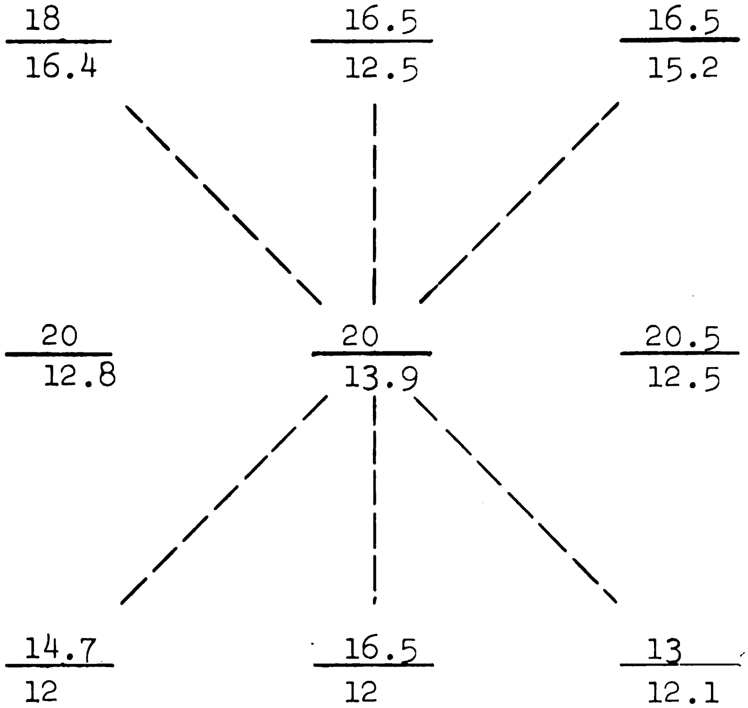


Diagram #17.--Distribution of footcandle readings--four instruments per-area (using fresnels).



Readings taken two and one-half feet apart

NOTE: Upper reading is one instrument. Lower reading is another.

Diagram #18.--Comparative footcandle readings in beams two fresnels chosen at random.

in each direction on the upper level averaged as follows: north, 12.88 f.c.; south, 20.72 f.c.; east, 16.80 f.c.; west, 26.12 f.c. The average for the total area was 18.89 f.c.

The readings toward the center of the area averaged 31 f.c. as opposed to a 23 f.c. on the edges of the area. When adjacent area lights were brought up, the average on the edges was boosted to as high or higher than the 31 f.c. average in the center (see Diagram #16). When adjacent light was present, the averages in this case were: north, 18.28 f.c.; south, 20.84 f.c.; east, 17.92 f.c.; west, 25.48 f.c.

Consult Diagram #19. This graph shows that the adjacent light not only tends to even out the illumination in the four directions but also distributes the illumination into a clearly shaped bell curve. Compare this to Diagram #20 which shows the illumination distribution without adjacent light entering the area. There are some distinct gaps visible. Especially noticeable is the large gap so near the average illumination.

Again "hotspots" show up on the distribution charts although they are not as noticeable as with the three instrument-per-area method. The reason for this is the presence of greater illumination due to the additional instrument thus averaging and obscuring the "hotspot" illumination.

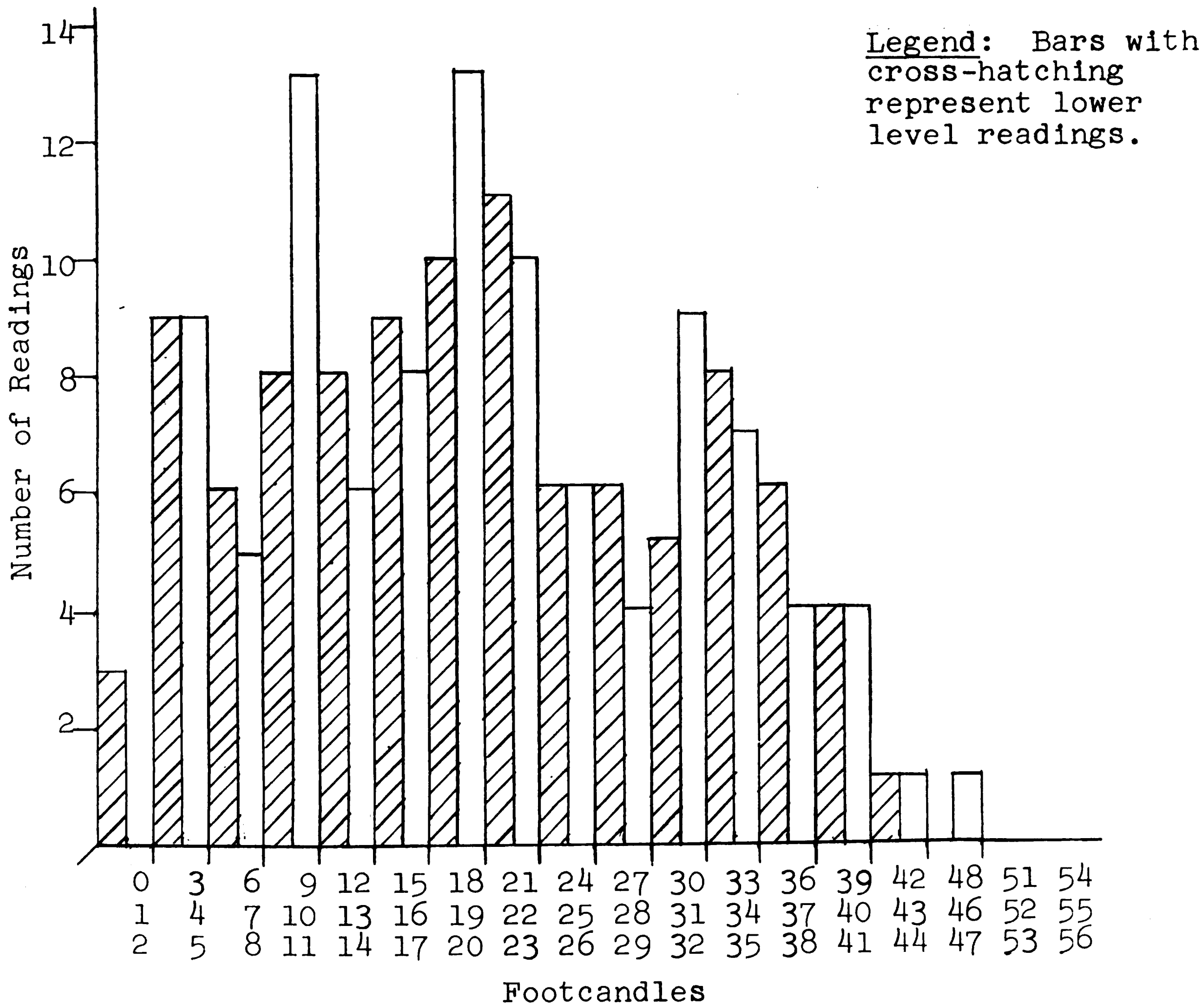


Diagram #19.--Distribution of footcandle readings four instrument-per-area.

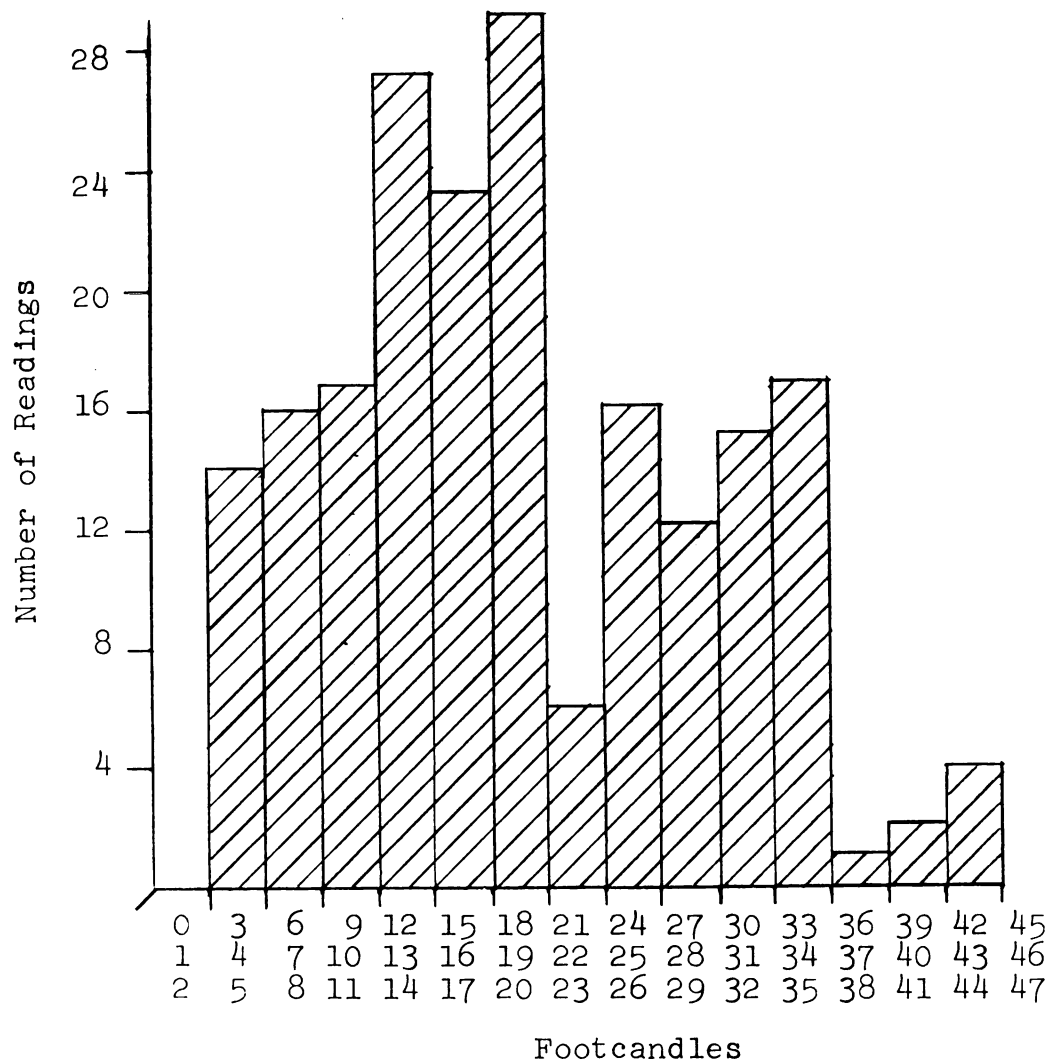


Diagram #20.--Distribution of footcandle readings four instrument-per-area method.

The Five Instrument-Per-Area Method

There were four groups of readings taken for this method. The reasons for obtaining more information were not arbitrary. Because the method evolved in trying to solve the same problems this thesis is concerned with, it was felt that there should be greater attention toward either finding fault with the method or substantiating its hypothesis. The hypothesis being that the added instrument would lend a helping hand in attempts at a more even distribution of illumination.

Diagram #21 shows the effect of the fifth instrument placed directly over the center of the lighting area of a four instrument-per-area set up. The fifth instrument is a fresnel spotlight. The other four are ellipsoidal reflector spotlights. The average footcandle illumination with this area was 19.86 f.c.--an increase of about 1 f.c. per reading over the four instrument method. The directional readings were as follows: north, 13.88 f.c.; south, 24.96 f.c.; east, 20.04 f.c.; west, 24.60 f.c. This is an average variance of 4.1 f.c. from the average of 21.02 f.c. for this level. Compare this to the average variance of 4.3 f.c. obtained with the four instrument method. The difference is negligible.

The distribution of light within the area of the five light method is illustrated in Diagram #28. The footcandle distribution represents a fairly well defined bell curve.

Diagram #21.--Diagram illustrating data gathered on five instrument-per-area arena lighting method.

		1					2					3					4					5				
		A	B	C	D	E	A	B	C	D	E	A	B	C	D	E	A	B	C	D	E	A	B	C	D	E
N	U	7	13	21	15	5	9	17	20	16	9	11	19	21	13	19	6	22	19	12	9	6	18	29	18	11
	L	2	10	11	15	14	7	15	16	23	29	7	12	29	27	21	7	13	21	26	24	6	6	17	19	18
S	U	7	17	21	14	6	17	34	33	27	17	24	37	35	35	25	23	28	37	43	24	7	12	39	42	28
	L	14	13	10	5	2	22	20	15	9	3	31	31	31	19	7	29	33	36	23	8	19	26	28	16	6
E	U	2	6	7	6	4	3	14	15	13	13	18	22	22	29	28	21	24	31	42	31	16	29	32	48	34
	L	13	19	24	23	11	17	24	39	24	17	17	22	27	39	16	12	29	36	30	16	7	14	17	15	9
W	U	8	12	11	7	6	27	23	28	24	27	40	39	39	44	49	34	29	32	36	33	15	19	21	21	14
	L	3	6	7	4	3	10	14	11	10	9	21	28	24	26	18	31	41	45	33	23	33	41	39	40	26

Diagram #22.--Diagram illustrating data gathered on five instrument-per-area arena lighting method.

		1					2					3					4					5				
		A	B	C	D	E	A	B	C	D	E	A	B	C	D	E	A	B	C	D	E	A	B	C	D	E
N	U	4	6	9	6	3	8	8	11	10	7	8	9	11	9	8	8	9	9	7	6	5	8	10	9	5
	L	3	5	5	7	6	3	8	8	9	9	3	9	9	11	11	3	8	9	14	11	3	6	9	13	9
S	U	6	11	11	6	3	12	16	17	9	7	15	16	18	14	8	10	12	15	13	8	6	8	15	13	8
	L	8	9	6	4	3	14	12	10	7	3	18	16	15	11	4	17	18	18	17	5	12	13	14	7	5
E	U	2	7	7	5	3	3	8	7	7	6	10	11	10	10	12	11	11	11	16	12	8	8	10	12	12
	L	7	10	12	12	7	9	13	14	13	9	9	11	16	11	8	7	10	13	14	10	4	6	7	6	5
W	U	4	6	7	7	3	16	13	14	14	11	18	15	15	19	18	14	12	13	17	16	8	10	10	11	8
	L	2	3	2	2	2	7	7	7	5	5	10	13	12	12	9	18	20	19	20	13	19	18	21	20	13

The average reading of 19.86 f.c. is 0.14 f.c. away from the mean reading of 20.00 f.c. This shows there are as many readings above the average as there were below. In other words, the graph is not skewed in one direction.

A group of readings were taken to see the effect of dimming the four regular instruments to one-half and keeping the fifth overhead instrument at full illumination. The results are shown in Diagram #22. This produced an average variance of 1.1 f.c. between the four directions. In other words, by bringing down the basic level of illumination to that which would be produced in the same situation, the distribution of light was very even. Another way of stating this effect would be to say that by cutting the illumination in half, by the method stated above, the average variance from the average was quartered. By consulting Diagram #23 it can be seen that this also distributed the illumination into a symetrical bell curve that brings the majority of illumination toward the average.

The data presented in Diagram #24 shows the effect of adjacent illumination. This additional illumination boosts the average to 20.30 f.c. The directional readings of north, 23.3 f.c.; south 26.8 f.c.; east, 23.3 f.c.; and west, 26.8 f.c. produced an average variance of 1.52 f.c. from the 25.15 f.c. average on that level. The addition of adjacent illumination also tends to produce remarkable eveness. Diagram #25 shows this in a distribution of

Diagram #23.--Distribution of footcandle readings five instrument-per-area method.

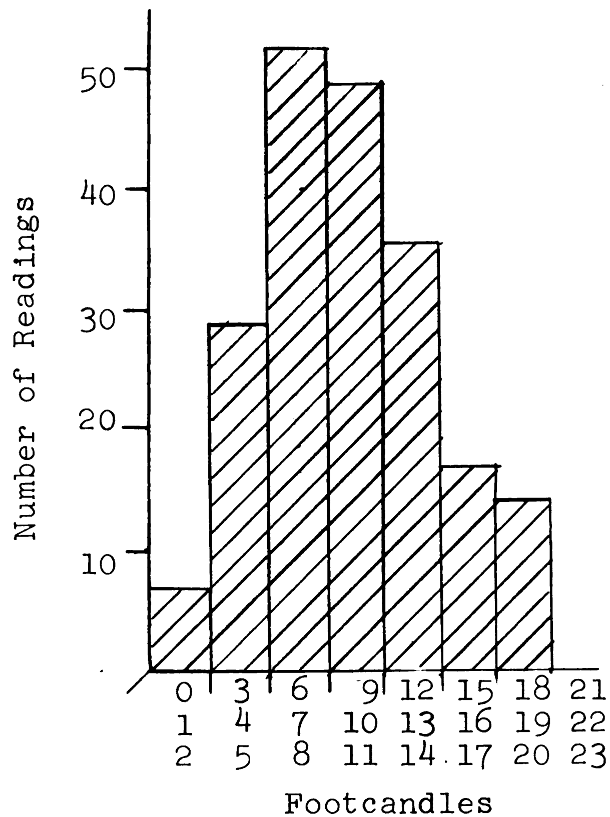


Diagram #24.--Diagram illustrating data gathered on five instrument-per-area arena lighting method

		1					2					3					4					5				
		A	B	C	D	E	A	B	C	D	E	A	B	C	D	E	A	B	C	D	E	A	B	C	D	E
N	U	18	25	28	25	17	18	22	28	26	20	21	38	37	25	15	23	31	40	31	19	8	18	23	17	11
	L	6	12	15	18	22	6	11	15	20	21	4	10	22	29	26	7	15	22	28	29	4	11	19	22	26
S	U	26	32	31	21	11	37	55	53	31	15	33	38	34	20	10	38	32	23	18	13	29	25	20	16	12
	L	28	22	13	8	6	32	21	13	7	6	25	18	10	6	4	18	12	10	7	5	16	12	10	8	6
E	U	14	17	18	19	13	19	28	25	26	21	28	42	36	39	23	27	40	37	23	18	15	22	16	15	11
	L	25	27	21	19	18	26	29	25	19	17	19	20	19	14	14	10	10	10	10	9	5	5	5	5	5
W	U	8	20	21	17	11	14	43	40	24	16	23	50	54	32	18	24	53	38	27	21	16	30	26	20	13
	L	3	4	5	5	4	8	11	11	10	7	9	22	19	15	11	22	34	31	19	16	31	41	35	24	18

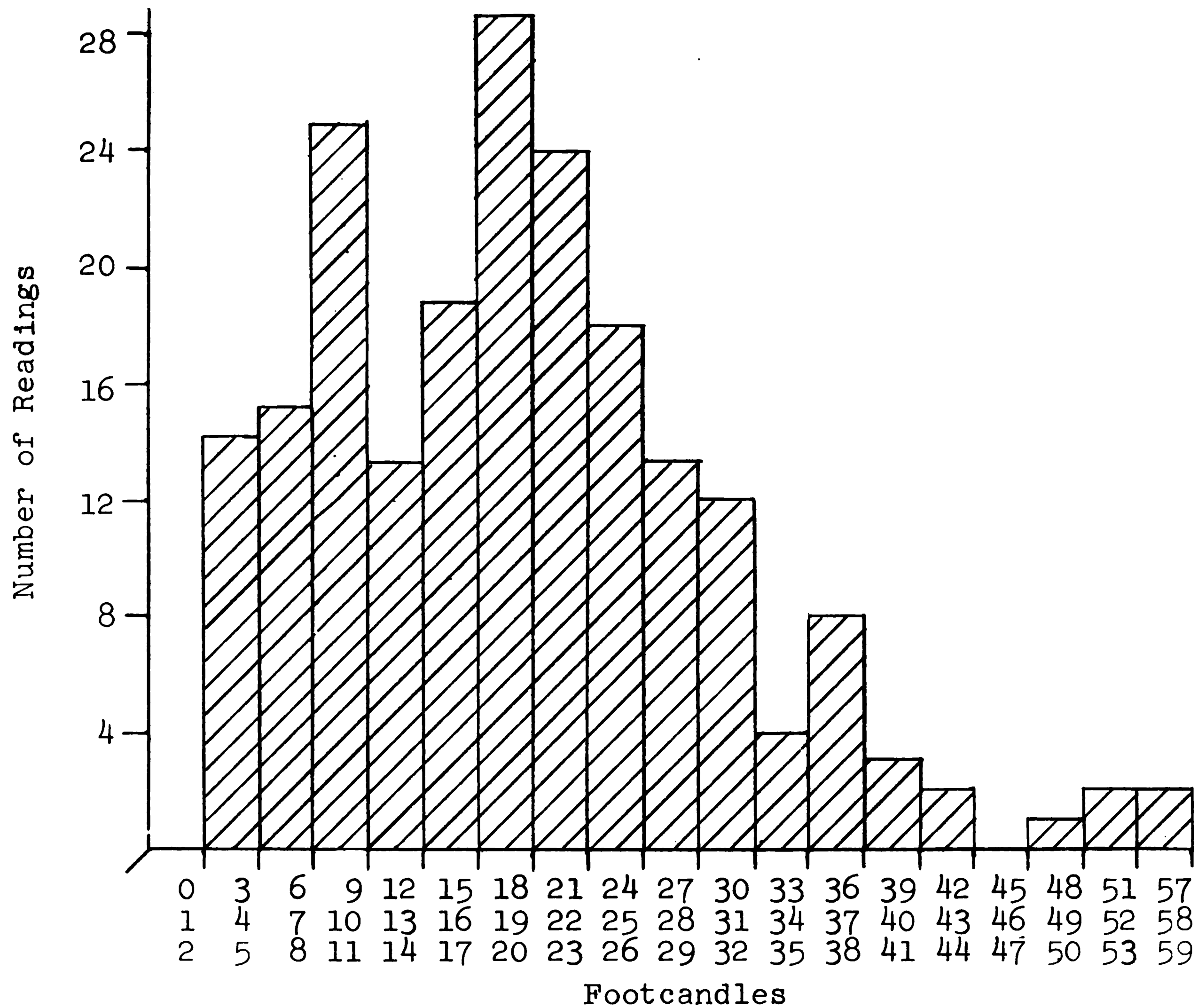


Diagram #25.--Distribution of footcandle readings five instrument-per-area method.

readings. The readings form a bell shaped curve. However, again the "hotspots" of the instruments show quite clearly.

The last raw data graph (Diagram #26) for this method illustrates the readings produced by placing the fresnel fifth light not above the center of the area but rather directly over where two area would adjoin. The results of this placement were not as satisfactory as would be expected; nor were the results as good when using the central placement of the fifth instrument. The variance from the average in this case was 2.5 f.c. What is more important, the distribution of light was not arranged in a bell curve but tended to flucuate and scatter from the average reading (see Diagram #27).

There were two major discoveries the data on the five instrument method. The first was that by decreasing the illumination by one-half, the light throughout the area was much more evenly distributed. The second was the smaller illumination variance from the average.

The Central and Peripheral Method

The data for the central and peripheral method is of a different nature than the other three methods. For this method, the readings presented in Diagram #29 cover the total acting area. In this case, the area was a circle, twenty feet in diameter.

Diagram #26.--Diagram illustrating data gathered on five instrument-per-area arena lighting method.

		1					2					3					4					5				
		A	B	C	D	E	A	B	C	D	E	A	B	C	D	E	A	B	C	D	E	A	B	C	D	E
N	U	5	14	26	30	20	12	30	30	36	30	11	28	41	34	30	7	24	31	30	27	3	11	20	25	18
	L	3	7	13	18	22	3	8	15	22	24	3	11	20	24	24	2	9	15	21	23	2	8	12	20	20
S	U	16	29	31	16	5	33	63	67	30	11	40	57	52	27	11	31	33	26	19	7	21	26	20	12	4
	L	19	22	14	7	2	24	26	15	7	3	29	26	13	7	4	31	24	11	6	3	26	18	13	6	3
E	U	25	33	36	30	14	37	46	49	40	26	38	52	38	33	21	22	26	18	16	11	7	9	8	6	4
	L	27	36	30	26	17	23	26	28	20	16	13	13	14	12	11	6	6	6	6	6	3	4	4	4	3
W	U	5	13	19	15	7	23	50	38	29	19	38	68	60	36	25	33	61	54	34	23	15	32	34	25	13
	L	3	4	6	4	3	8	10	11	10	8	24	24	23	17	14	31	34	30	23	17	28	32	33	28	22

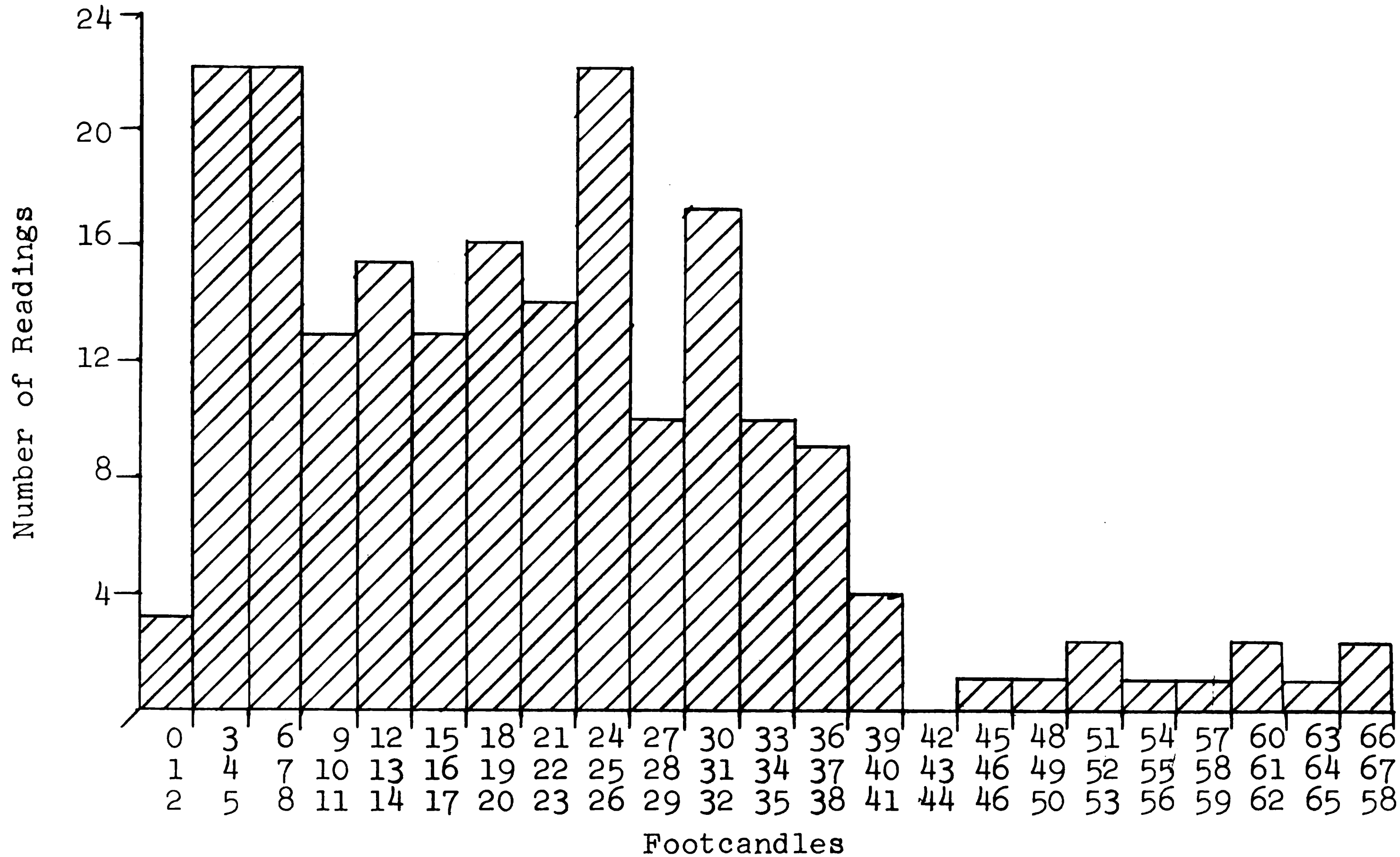


Diagram #27.--Distribution of footcandle readings five instrument-per-area method.

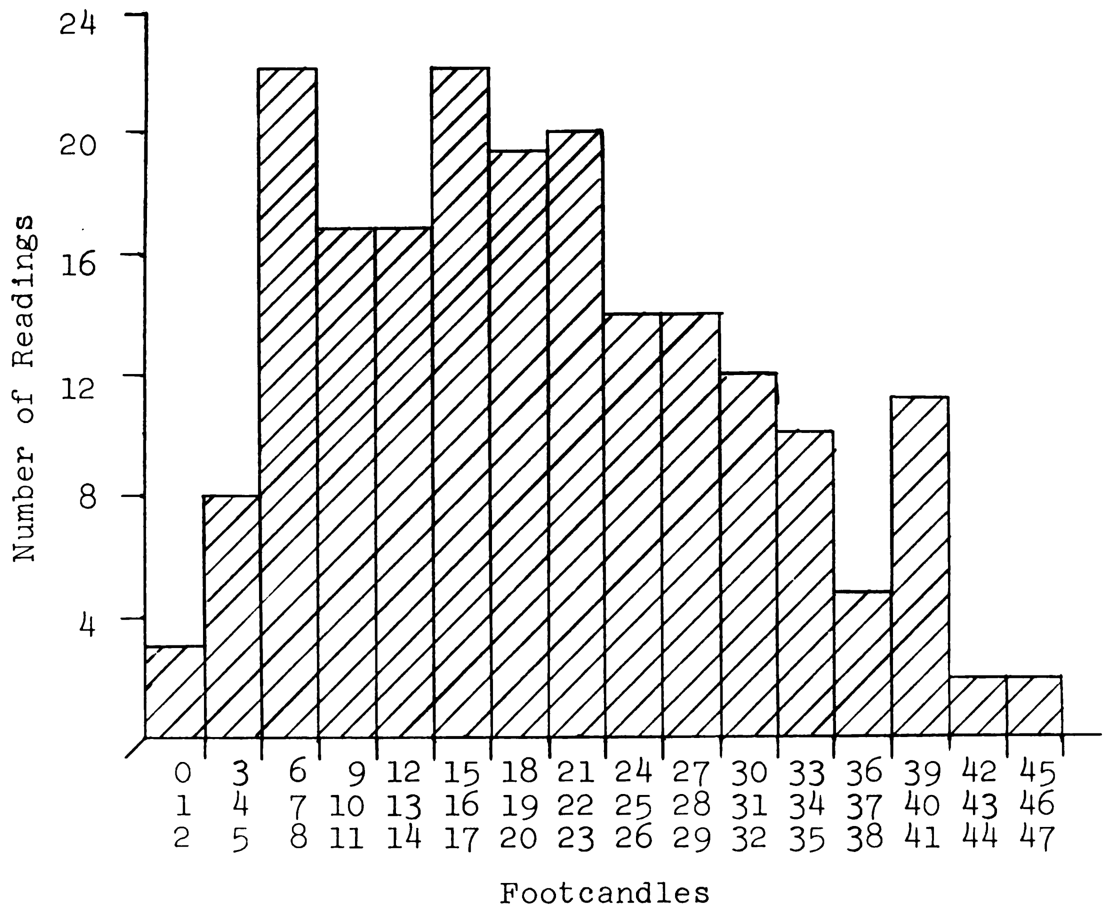


Diagram #28.--Distribution of footcandle readings five instrument-per-area method.

Diagram #29.--Diagram illustrating raw data gathered for central and peripheral method.

		1					2					3					4					5				
		A	B	C	D	E	A	B	C	D	E	A	B	C	D	E	A	B	C	D	E	A	B	C	D	E
N	U	13	X	1	X	3	X	42	9	5	X	14	18	13	15	5	X	29	16	11	X	9	X	1	X	4
	L	2	X	x	X	4	X	28	23	15	X	5	13	28	21	10	X	16	21	23	X	2	X	1	X	7
S	U	3	X	1	X	9	X	12	17	33	X	5	13	17	19	16	X	9	14	65	X	4	X	1	X	10
	L	5	X	1	X	1	X	25	30	18	X	9	21	35	14	4	X	21	25	28	X	5	X	1	X	2
E	U	3	X	5	X	3	X	7	9	8	X	1	8	12	7	1	X	17	33	45	X	3	X	11	X	6
	L	4	X	%	X	3	X	13	14	13	X	1	14	33	12	1	X	13	17	26	X	1	X	2	X	1
W	U	15	X	5	X	8	X	48	47	26	X	1	7	14	5	1	X	10	12	8	X	3	X	5	X	4
	L	3	X	1	X	1	X	26	16	12	X	2	18	40	13	L	X	16	18	13	X	5	X	7	X	5

X = No Reading Taken

The average illumination about the stage was 12.43 f.c. The high reading was 47.5 f.c. The low was 0.9 f.c. Not only was the range quite vast, considering the average, but the distribution was quite amazing. A quick glance at Diagram #30 will illustrate this. It is shown on the distribution graph that the higher the footcandle reading goes, readings occur less often. In other words, the majority of readings occur below the average. It is important to note, however, that although there is a wide range of readings, the flow of illumination from the center of the stage to edge is very smooth.

The illumination produced by just the central source is demonstrated in Diagram #31. The results are not surprising but demonstrate the fact that this method provides little light for the actor who is blocked close to the audience on one side but faces toward the audience on the other side. It appears that the best illumination in this method occurs on a radius halfway between the center of the stage and the edge.

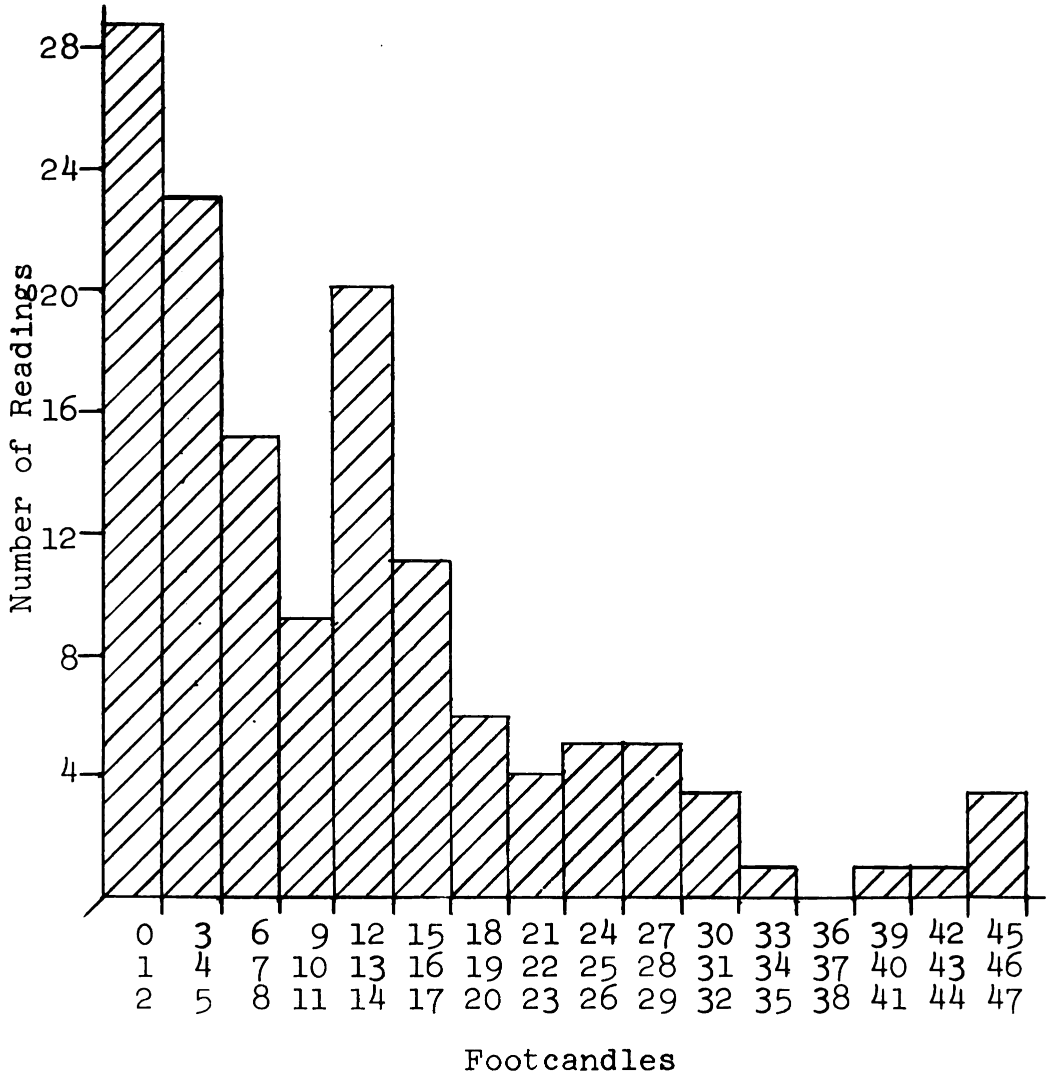


Diagram #30.--Distribution of footcandle readings central and peripheral method.

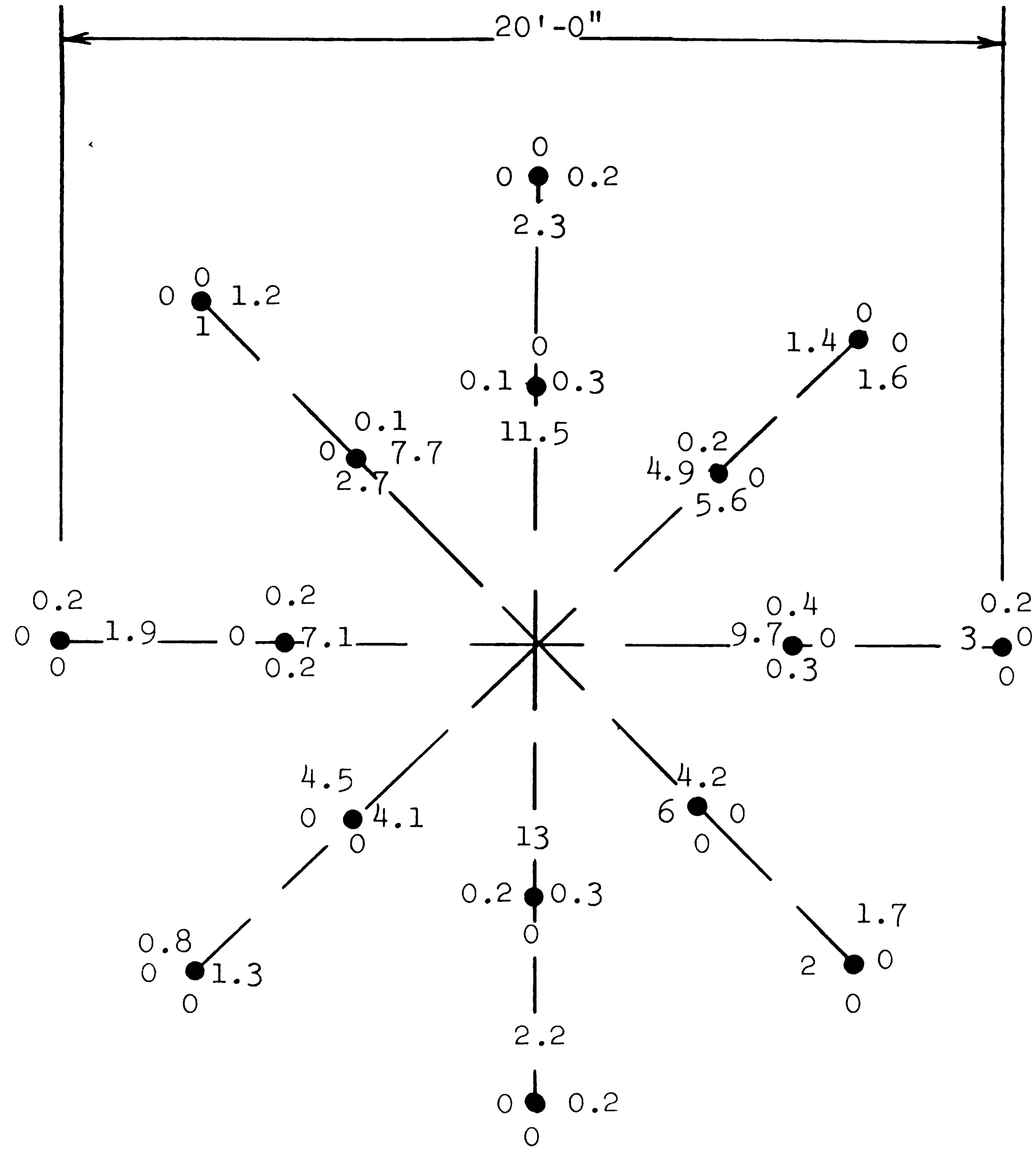


Diagram #31.--Diagram illustrating footcandle readings central light source only.

PART III--COMPARISONS AND CONCLUSIONS

The remainder of this thesis will select and compare elements drawn from the data and analysis presented in the last section. It should be pointed out that the conclusions presented here are based on the findings of this data weighed against the aesthetic and practical considerations presented in the first part of this thesis.

The four arena lighting methods presented in preceeding sections represent the four major ways to illuminate an arena stage. They are the most commonly used. As stated earlier, the five instrument-per-area method is probably original with the author in its execution as presented in this thesis. Certainly, the concept of downlighting or focusing light straight down is not original. However, the use of one specific instrument placed over each lighting area solely for this use is possibly unique in its execution. The advantages and disadvantages of this practice will be discussed later.

The three instrument-per-area method solves the arena lighting problem by giving the designer the ability to light individual lighting arena with a minimum number of lighting instruments. This method calls for exact placement of instruments, otherwise the beam coverage of each instrument will not allow an even illumination on all sides of an object or person. If one instrument is not performing as efficiently as the others, results will occur such as that shown by the data. That is, in the data, a fifteen footcandle difference was present between the North and West directions. Most of this difference was attributable to an inefficient instrument plus inadequate to coverage of this lost illumination by other instruments. The possibility of this being a common reoccurrence is probably quite high given the average range of instrument efficiency. What effect does this have on the appearance of the lighting to the audience? The appearance will be that of uneven or spotty illumination.

We can compare the above problem concerning the three instrument-per-area method with the four instrument-per-area method and find that the addition of another instrument helps to combat instrument inefficiency. The reduced angle of beam convergency in the four instrument method can, and will, universally produce a more even light based on the limitation of instrument efficiency differences. The data showed this to be true to the extent the differences were less, albeit not resolved. Until engineering practices guarantee the same footcandle efficiency from instrument to instrument, this problem will be present. For the time being, at least, the way to combat this problem is to not depend heavily on a sparce spacing of instruments being able to give consistant illumination. Of course, a heavy saturation of instruments is expensive and impractical. Therefore, a median must be attempted.

One way instrument differences in any lighting method can be controlled is by an elaborate dimming arrangement. In order to do this there must first of all be a dimmer for one instrument. Each instrument must then be metered to determine which dimmer setting for each instrument will produce like illumination. For example, Instrument One must be on dimmer reading eight to produce 12 f.c. and Instrument Two must be on dimmer reading ten to produce 12 f.c. A chart must then be kept for each instrument and its dimmer with this information. Needless to say, this involves many variables and would have to be performed frequently because changes would take place depending on the changing efficiency of the lamp in the instrument and focal point readjustments due to handling. The above thought is offered only as a possible way of controlling efficiency differences and is not advocated in any way.

So far, the author has concluded that the three instrument-per-area method has one distinct disadvantage. That is the lack of thorough coverage of individual lighting areas which can manifest itself in uneven distribution of illumination upon the entire stage. However, the three instrument system may be used satisfactorily for "special" or extra areas within other methods. Usually the "special" area is not as large as a regular lighting area and may be covered quite effectively by three instruments. Also, if there are several occasions in which this method can be used for "specials," not as many instruments will be consumed.

It is possible to use even as little as two lighting instruments to light a special area. The author has had occasion to do this frequently with some success. In this instance, the two instruments are placed as nearly opposite each other as possible and focused on a common object. Unless these instruments are used at full intensity they will usually suffice for lighting a special area. When used alone at full intensity these two instruments are less than satisfactory, however. The illumination they provide is apt to distort an actor's face when a movement of turn is executed in this light. Of course, this can be done on purpose for "effect."

The next comparisons concerns two variations of the four instrument-per-area method. They are both the same in execution except for type of instrument used. This concerns the use of the fresnel lens spotlight as compared to the ellipsoidal reflector spotlight.

The data in the preceding analysis section on the four instrument system demonstrated that the use of the fresnel produced one-third the total average illumination as that of the ellipsoidal spotlight. The footcandle readings were 6.54 f.c. for the fresnel and 18.89 for the ellipsoidal. The difference between these two instruments does not end with variances in total intensity. There are other distinct advantages and disadvantages connected with the use of each. The data in the preceding sections showed that there tended to be a more evenly distributed illumination when the fresnel was used. This fact was attributed to the absence of a distinct and measurable "hot-spot" in the fresnel. The ellipsoidal reflector spotlight has a characteristic hot-spot which can easily be quite apparent to the eye. A "hot-spot" is that part of the beam illumination which is much brighter than the rest of the beam due to focal characteristics of the spot-light lens and reflector.

The advantage of the ellipsoidal reflector spotlight is due to this instrument's ability to be focused in more ways than the fresnel. The fresnel has only one primary focus: beam size. The ellipsoidal may be focused as to beam size and shape, plus, the edges of the beam may be either sharp or fuzzy. All of the data gathered in Part Two was from the ellipsoidal reflector spotlight except for the one instance in the four instrument system. The fresnel was used in this case to obtain a comparison. The result and conclusion of this comparison was that either instrument may be used for any method studied in this thesis. Different illumination will result, however. In either case, regardless of which instrument is used, once the decision is made to use one instrument type there can be no mixing or interspersing of the other type of instrument into the basic lighting plan if the aim is even and uniform distribution of light.

The findings gathered on the four instrument-per-area method demonstrated an improved distribution of even illumination as compared to the three instrument system. However, there were and are other advantages available within the concept of the four instrument system. Obviously, there is a greater intensity of illumination. This is not singularly important. What becomes important is the greater flexibility the added instrument affords.

In the three instrument system there is always a problem of which color should be designated each instrument. Should they all contain the same color? Should they contain three different colors? The solutions to these questions often manifests in a color scheme which appears differently to certain separate sections of the audience. This is in addition to the increased inability to coordinate one group of instruments in relation to another in order to obtain a harmonious whole. On the other hand, the four instrument system can be less of a problem concerning color designation. The opposing instruments are most commonly designed to contain a duplicate color of the one opposite. This allows a greater freedom in color selection and under adequate dimming facilities allows for the balance of these colors in relation to each other. This is termed "color control" in that each color within a lighting area is contained on a separate dimmer. This cannot be done with the three instrument system unless there is a dimmer for each instrument or they all contain the same color.

The four instrument method allows a greater ease of blending or melding together of one lighting area with another producing an even distribution of light. This is due to the 90 degree angle between instruments. Diagram #6 in Part I shows the usual placement of instruments in the four instrument system. This diagram differs from some recommendations. Century Lighting Company in their lighting catalog visualize placement of instruments all on a N, S, E, W, basis. In other words, all instruments in one lighting area would be aimed in the same direction as their counterpart in another lighting area. The author, however, through experience has found that more successful blending of light occurs when the corner areas are skewed 45 degrees so that the instruments remain in the same relationship to the audience and not the stage.

It was quite often the practice of the author while connected with Summer Circle at Michigan State to use a single instrument as a "special" focused straight down to complement or highlight a scene or to singularly illuminate an object. It should be pointed out that the lighting method used for the theatre was the four instrument system. This method was used for "basic" illumination. There was always enough "extra" dimmer capacity in terms of numbers to allow freedom for using "specials" and other instrument and power uses.

The several occasions in which the "special" instrument aimed straight down was used were so successful that the author was urged to experiment with this concept on a stagewide basis to complement the four instrument-per-area method. The reason being that there had been too much time and manpower needed to obtain an even distribution of light with the existing four instrument system. The results of the experimentation were so fruitful that the author decided to continue with a more detailed comparison. This resulted in this thesis.

Used alone, the instruments focused straight down produces a rather grotesque light on an actor's face, especially if he has a long nose and deep set eyes. This light also tends to magnify wrinkles in the costumes. However, if used on a reduced dimmer setting of approximately one quarter the original light, they tend to produce a useful "glow" or general illumination not unlike a darkened room or late dusk. But, this is not their sole intended purpose although this quality certainly adds to the flexibility of a lighting system.

The data in Part II of this thesis demonstrates the effect of the fifth instrument. Generally, this extra instrument does not add a tremendous amount of light. The use of the overhead instrument adds only an average of one footcandle per reading. The important thing is where it helped. The nature of the beam angle of the fifth instrument increases the footcandle reading where it is needed most; toward the edges of a lighting area. The result is an improved distribution of illumination, both to the eye and the photometer. However, the fifth instrument still tends to bring out wrinkles in costumes even with the other four instruments up full. To counterbalance this disadvantage, the addition of the overhead instruments creates a "halo" or bright outline of illumination on the head and shoulders of an actor which serves to separate the actor more distinctly from the audience background always present in arena.

The five instrument-per-area method requires a generous supply of dimming equipment. For each 6' by 6' lighting area, there must be alloted three dimmers in order to have color and area control. This assumes that the usual color schedule will involve use of three colors; one color in two opposing instruments, another color in the other two opposing instruments, and a third color in the overhead instrument. This arrangement allows a great deal of flexibility. First of all, the standard four instruments may be used alone. Secondly, the overhead instruments may be used alone. Thirdly, they may all be used at once, and lastly, the overhead instrument may be used in connection with any set of two of the other four.

The central and peripheral method is unlike the other three methods in that this system does not use the lighting area unit. The central and peripheral involves equal spacing of instruments about the outer edges of the stage and focused toward the stage plus a central light source located in the exact center of the stage and focused toward the edge of the stage. The central light source may be one instrument or many, depending upon the type used.

The advantage of the central and peripheral is that it is relatively inexpensive to construct. This system requires no elaborate grid structure to mount the instruments. The instruments are arranged in a circle around the stage and could be permanently anchored to the ceiling or made part of the ceiling structure. This practice is the one followed at Michigan State University where each new dormitory will include a small open stage theatre. There are now three such locations. In each, the architects designed into the ceiling arrangement, the lighting instruments which would follow the central and peripheral method of lighting the stage. The plays then tour from building to building without transporting lighting instruments.

The big drawback of the central and peripheral method is its lack of flexibility. The system is unable to light small individual sections of the stage adequately because there is no small term of reference for each instrument. All instruments in this system must cover as much of the stage as possible. In order to obtain great flexibility and movement of the light on the stage, this method requires an abundance of "specials." Once "specials" are used in abundance, the cost advantage of this system is defeated and another more flexible system should be attempted.

The use of color in the central and peripheral method is usually restricted to very light tints with one color going into the central light source and another color used in the peripheral instruments. Dimmer control should be arranged so that these colors can be controlled separately.

All of the lighting methods for arena stage have one problem in common. This is illustrated in the pictures on the next page (Diagram #32). These three pictures show an actor's face in three levels of tilt. Picture #1 shows a darkened center section of the face due to the low angle of the head. Picture #2 shows eye shadows and the mustache obscures the mouth. Picture #3 shows the actor's face in about the normal playing position. Notice even now there are shadows under the chin. The only cheap remedy in arena theatre is to have the actors spend the majority of their

Diagram #32.--An Actor's Face at Three Levels of Tilt.

Picture #1

Picture #2

Picture #3

time sitting at a table with a white tablecloth. A white costume also helps. Elizabethan Ruffs are popular with those who have observed this problem. All methods are alike in this area as arena theatre does not allow the use of footlights and other measures which proscenium theatre lighting can use.

The author's conclusion as to the most flexible lighting method is based on the analysis of each method and the comparisons between them judged in relation to the requirements set forth in Part I. Based on this information the most flexible and useful of the four methods presented in this thesis is the five instrument-per-area method. A composite chart comparing the four methods is presented in Diagram #33.

The central and peripheral method can only be recommended to those concerned with reduction in cost. The three instrument-per-area method has proved lacking in providing good basic even illumination. The four instrument-per-area method is quite adequate but can be greatly improved by the addition of the overhead illumination concept. This improvement is realized not only in an improved basic illumination but in a greater flexibility of lighting in general. In other words, more can be accomplished with the five instrument system without adjusting a great many instruments.

Diagram #33.--Chart comparing elements of each lighting method.

Method	Number of Instruments Per Lighting area	Lighting area size	Number of Instrument Needed for 20' x 20' Stage	Number of Dimmers for area Control	Number of Dimmers for area and Color Control	Relative Cost to Install	Average Available Illumination Per Area
3 Inst.	3- Either all Fresnel or All Leko.	No Larger than 6' x 6'	27 (9 Areas)	9 (1,500 W.)	27 If Each Instrument is Different Color	Moderate	14.23 f.c.
4 Inst.	4- Either all Fresnel or All Leko.	6' x 6'	36 (9 Areas)	9 (2,000W.)	18 If Opposing Instruments Are Like Color	Cost Difference between 3-4-5 Instrument Methods Based on Total Number of Instruments used.	18.89 f.c. (6.64 f.c. with Fresnels).
5 Inst.	5- 4 Fresnel or 4 Leko. and Over-	6' x 6' could be slightly Larger	45 (9 Areas)	9 (2,500W.) or 18 (9-2,000W. & 9-500W.)	18 (As Above) plus 9 for overhead Instrument.	Most Expensive (More Instruments)	19.86 f.c.
C. & P.	No Lighting Area Used	Entire Stage	8 to 12 Periphery --- Central as desired	Depend on Number of Instruments and Capacity of Dimmer	Depends on Number of Instruments and Capacity of Dimmer	Least Expensive (Less Instruments and less Elaborate Mounting)	12.43 f.c.

The five instrument-per-area method provides good basic illumination which is flexible in terms of various illumination requirements. However, special areas may still be illuminated effectively by other previously mentioned methods. For example, the three instrument system may fulfill its role as it can adequately illuminate smaller "special" areas where great numbers of instruments cannot be used prudently. Likewise, even one or two instruments can suffice for minor "special" areas if not allowed to be primary illumination for long periods. In short, given a basic method for illuminating the stage, the complete system will be as flexible and elaborate as funds and ingenuity of the operators permit.

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