THE VISUAL ANALYSIS AND DESIGN
OF CITY LIGHTING
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"The Visual Analysis and Design of City Lighting"

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ABSTRACT

A neglected element of the visual form of cities, and one which holds great potential as a design tool for the planner, is artificial lighting. Its dominance in the night scene is sufficient proof of its importance in the city. Rather than designing isolated elements as has been the customary strategy, this thesis recognizes that city lighting should be studied wholly, accepting the complexities as essential to understanding the full range of implications of any design decision. This thesis demonstrates that it is possible to manage the complexities of city lighting; that through systematic techniques the visual qualities of lighting may be observed, analyzed, and planned as a comprehensive statement.

The conceptual framework in which this element is studied is that of a lighting structure, a term which serves to treat city lighting as a system of interrelating parts. Basic to the lighting structure are a group of components, which are the manipulative physical elements with which the planner must work. The ways in which these components interrelate form the textures, contrasts, and rhythms which determine the perceptual organization of the lighting structure. To facilitate systematic observation, these interrelationships are then simplified into more convenient terms.

For analysis, the system must grow to include interactions with the observer, so that goals for an effective structure can be devised. Through considerations of how an observer might use city lighting, the thesis develops several general goals which form the basis for evaluation and design of any lighting structure. In addition, goals are evolved which recognize that a lighting structure is not a closed system; it must operate in a changing environment and to be effective, it should be able to adapt to internal and external modifications.

The major part of this thesis is the application of the general concepts and principles to an actual city area, in a case study intended to refine the suggested planning techniques. A nine-block area of Boston has been chosen. Preliminary investigation of the basic image leads to a set of specific lighting objectives within the framework of the general goals. Through graphic and written techniques the lighting of the area is investigated and specific revisions are proposed which fulfill the stated objectives and provide for a more effective lighting structure.
The thesis proceeds to a discussion of the problems and potentials of city lighting at various scales of space and time, emphasizing the problems of effectuation and control, and the potentials of a comprehensively planned metropolitan lighting structure. The thesis concludes with suggestions for future research into both city lighting and the techniques for its effective planning.
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INTRODUCTION

This paper will explore the use of artificial lighting, considered as an element of the visual form of cities. This is a limited study, but perhaps it may have broader implications by virtue of the methods employed in treating the subject matter. The study is not so comprehensive as would be a total analysis of the environmental image; it presumes at least a conceptual grasp of the principle of imageability by the reader, and will concentrate instead on closer examination of one characteristic of the physical form which could be manipulated to strengthen the image.

For those interested in the methods of planning and coordinating artificial lighting in the form of cities in accordance with a set of visual objectives, the paper includes a case study of a small area of Boston at night, and also the possibilities of using lighting at other scales of space and time. For those who are more interested in analytical techniques in planning problems, this paper attempts to use artificial lighting as an example of the value of systematic analysis in a problem of the visual form, as a process which perhaps may be applicable to analysis of a wider range of form problems.

The thesis presented herein is that artificial lighting in cities is a potentially useful tool in strengthening the total imageability, because the lighting can be planned consciously to fulfill such a function in the visual form. Attainment of the following objectives in this study would be significant in justifying this hypothesis:

1. In a general framework, describe the visual charac-
teristics of artificial lighting in the city, defining and classifying the perceived relationships which underlie the conceptual qualities of the images evoked.

2. Establish objectives for the planned use of lighting in the physical environment.

3. Develop a technique for representing, evaluating, and designing the lighting, the measure of effectiveness being the degree to which this particular methodology strengthens the connection between planning objectives and planning decisions.

4. Investigate methods for implementing the plan, and for incorporating the planning for artificial lighting into the total visual planning process.

5. Explore the possibilities of using the lighting at various spatial and temporal scales.
PART ONE

THE LIGHTING STRUCTURE: A FRAMEWORK FOR ANALYSIS AND DESIGN

Artificial lighting has profound functional significance in patterns of city activity, of this there can be no doubt. Nor can the observer of the city scene fail to find sensual delight in viewing the beautiful and thrilling panorama of city lights as they appear before him. But other effects of artificial lighting are also at work, the significance of which are more obscure, yet equally important to the environmental image. Gyorgy Kepes has noted the visual problems which come about through the "double life" of the city---the modification of the visual form through a superimposition of the pattern of artificial lighting. As he proceeds to look at the changes which occur when the visual form passes from day to night, and when activities change too, he sees that the double life also possesses visual possibilities for the conscious use of lighting in new ways:

The imaginative use of light is the neglected area of modern design. In other areas, architects, planners, engineers, and artists have established the basis for a physical environment impressive in scale, authentic in its solution of twentieth-century needs, and promising in its enrichment of our life. Technical advances in lighting have taken place, and designers with light have had their victories. Nevertheless, lighting can be developed in ways we have not even begun to explore, and an undreamed-of opulence of esthetic experience awaits us. 5/

The quality of lighting must be explored further, if both problems and potentials are to be made manifest. However, the complex pattern of lighting in the city is not available to systematic exploration unless it can somehow be ordered into its component parts, this ordering becoming more relevant to practical application as the system grows to
include interactions with the observer. 1/

THE CONCEPT

The general framework in which this study proposes to work is the concept of the lighting structure, a term which serves to recognize that the perceptual effect of city lighting is in reality a complex of inter-relationships which should be evaluated in the whole. There has been some work undertaken on the visual qualities of certain aspects of city lighting. Cullen, for example, has prepared a dissertation on the visual planning of public street-lighting which concludes with some visual objectives for its use, 3/ and Kohler devotes several pages of his excellent book to the role of advertising lighting in an architectural context. 6/ Such studies have tended to isolate a part of the whole, much the way one might attempt to design a building without considering its relation to the surrounding environment. Consequently, neglecting the total lighting structure perhaps closes the door on any research that could lead to the new possibilities for lighting which seem to be inherent in the Gestalt. In this more comprehensive context, previous studies seem to be of little help, for a desirable system of classifying the relationships seems to be a new problem altogether.

THE COMPONENTS OF CITY LIGHTING

The potentials of conceiving of all of city lighting as one structure are many, but are only useful under conditions of better knowledge of what will be termed the structural components, those parts of a lighting structure whose manipulation will produce new visual effects. As a basis for analysis, these components will be grouped into three general categories: sources, forms, and fixtures. There may be other ways of
classifying the components, more carefully constructed systems which permit finer distinctions, but, as this paper will eventually show, these are primarily refinements to better facilitate analysis in particular cases, and are not easily generalized. The purposes of this immediate study are such to demand only the broadest of categorizations anyway. It proves sufficient in that it gives a convenient number of reference points around which the necessary information concerning the manipulative aspects of the lighting structure may be grouped. These categories may be outlined briefly:

Sources. Sources are components whose primary task is to send light; they are the originators of whatever else will happen in the lighting structure. Each source exhibits certain physical characteristics, the proportions of which vary from source to source. Brightness, color, motion, shape, size, and location are thought of immediately and hardly require explanation. But there are other characteristics which seem peculiar to city lighting.

In discussing the use of lighting in architecture, one author has commented on the need to put new emphasis on the psychological effects of the light which is seen, since it often takes precedence over the light to see by. 7/ This reference applies equally as well to the lighting for the city, and quite literally to the source components in the lighting structure. Sources are more apt to be exposed in the cityscape than in architectural interiors partly because the task of sending light often includes the need to be seen, as in advertising lighting, or an ordinary traffic signal. It is possible, then, that the ability and the need to see exposed sources would make the messages they transmit
significant factors in the phemonology of a lighting structure. Moreover, exposed sources enjoy a high degree of use in the cityscape, due in part to the high visibility they might offer with relative ease and economy. This makes their message characteristics more significant in human reactions to the lighting structure. The message of a source may be explicit, as in a sign, or may have meaningful symbolic qualities by virtue of what it represents, such as the meaning imparted by the color of a traffic light. This message leads to an association which can be anything from the physical location of the source to an abstract quality with no physical manifestation. The influence of the message characteristics of the sources upon the observer may require particular attention in evaluating a lighting structure.

Forms. Form components include surfaces and objects which, in the lighting structure, function primarily as direct receivers of light (and may in turn become senders, depending on their reflectance qualities and their relation to surroundings). Generally speaking, they may be thought of as the physical qualities of the elements of the city image and, especially in architectural interiors, are the components most immediately associated with Lam's considerations. Forms are not only man-made; topography, water, and in a broad sense, even the sky may be included in this category.

Taken alone, a form will exhibit the same physical characteristics as a source, but since the light which is seen so often results from the fundamental relationship of the actual composition of the receivers with the type of light produced by the senders, forms have certain
additional, highly descriptive characteristics, including form clarity (articulation of shape and detail) and textural reception (type and intensity of pattern produced).

**Fixtures.** Fixtures are special types of forms. They are treated here as a distinct system of components because their role in the visual form may be more important during the day, when the remainder of the lighting structure is not used. A form becomes a fixture when its primary purpose is as a receptacle for a source, dependent for its existence on the existence of a source. Being an object in space a fixture may exhibit the same characteristics as other forms at night.

THE STRUCTURE AS A SYSTEM OF INTERRELATING COMPONENTS

These components are the tools with which the planner ultimately must work when designing the city lighting. Their definition in the physical form of the lighting structure has been sketched, but this seems less useful for structural analysis than would be a further sketch, one which treats the synthesis of these components as the significant factor. This would be essential to understanding more completely the visual implications of any design changes. As an initial step, it seems important to consider how an observer might undertake to conceptualize his environment through his perceptions of space; for the perceived spatial characteristics created by light, if simply described in terms relative to the framework of a lighting structure, can provide part of the additional information needed to manipulate the components.

The observer does in fact attempt such simplifications, albeit in
terms less useful to the visual planner. The observer looks for short-cut methods for explaining and interpreting the environment, because the complexities must be mentally managed if the city-dweller is to achieve a proper relation between himself and the world he lives in. The spatial features of a city require such representation, a prerequisite "in the form of devices for simplifying and for evoking images and sentiment". 11/

For example, one way in which the interpretation is handled is through the assignment of distinctive qualities, sometimes in an adjectival sense, to the space. The reason is two-fold: to reduce the phenomena to an understandable description, and, concurrently, to have means of distinguishing that set of phenomena from another, one city place from another. 11/

This psychological thesis carries considerable weight when applied to city lighting. Certainly the lighting structure is complex, and because it is the dominant element at night, it is reasonable to assume that it is the primary influence on the perceptual organization of space. Intensity of activity is important, but tends to serve as a means of strengthening the distinctive spatial qualities created by city lighting; that an area is "busy" or "dull", "big" or "small", "bright" or "dark" is to a large measure a function of the interrelation of the components of the lighting structure.

Within the conceptual framework of a lighting structure it seems possible to describe the causes of these spatial perceptions in terms of the qualities of light. Textures, contrasts, and rhythms of light are the qualities basic to a lighting structure of course, but their spatial patterns can perhaps be analyzed better in terms of two general
ways in which structural components may combine to produce them: patterns of overall illumination and patterns of physical characteristics.

In any lighting structure, brightness of illumination is one result of interrelation, and is determined mainly by the interaction of source brightness with form composition. Quality of illumination pertains to the textures, contrasts, and rhythms of brightness in the entire visual field; anything that changes the brightness pattern - textural reception of form, for example - affects the quality of illumination. This change in brightness is largely a change in the relative proportions of light and dark and, therefore, this brightness ratio becomes a determinant of how the observer will perceive the spatial aspects of the lighting structure.

The proportions of light and dark in the lighting structure may have strong textural effects where the interplay is of a very fine grain. A textured scene, random or ordered, could produce visual effects which might be useful in forming spatial expressions, from the very busy and complex interplay, to the orderly and simple distribution of brightness. The textural effect of the overall illumination becomes more apparent as there is an increase in the contrasts among its parts - the extremes of light to dark. There may be cases where a complex but low contrast distribution of brightness would not have so powerful an effect on the observer as a simple texture with high contrast (strong differentiation) among its lights and darks. High contrast is greatly responsible for the dominance and visibility of components in the lighting structure.
Although brightness may be "seen", as in the case of vistas, it is possible that it may hold more potential as a characteristic to be experienced by the observer on the move. In sequence, the lights and darks may form patterns, again random or ordered, creating a sensual response in the observer as he moves through them. The observer may sense recurring patterns, a rhythmic quality in the lighting structure which may have tempo and climax. Brightness is useful in delineating the shapes of objects and, in a city-scale sequence, differences in overall illumination may be a method useful to the observer in distinguishing among city areas or providing a series of focal points; abrupt changes in brightness may also allow for easy definition of the boundaries of city areas.

In addition to illumination characteristics, the lighting structure concept affords another means for describing how the observer organizes the visual field: the interrelation of components is often so complex that it is conceivable that two areas of equal qualities of illumination could evoke entirely different responses from the observer, depending on how he is able to organize the physical characteristics of each area's components.

Though the arrangement of components in an existing lighting structure is, for the most part, random and accidental, it is possible that through the perception of some set of common characteristics the observer may be able to group seemingly independent components into systems which simplify the task of mentally managing the complexities, new textures, contrasts, and rhythms may be formed which transmit an
unplanned expression of the space.

There are many examples of this. A line of streetlights will tend to read as a unit when viewed from a spot where they contrast with the background and appear to be at close intervals; this may give direction and a kinetic character to a space. It may also be possible to group according to a predominant color or a common motion of sources; shape may also be a key to joining components; perhaps providing a spatial characteristic totally unlike the effects of the components taken individually (random sizes and shapes, and close proximity of many advertising signs, each of which may be a quite formal and simple statement, may produce a textural effect which is very busy and quite confusing). On the other hand, there may be areas where the isolating of one component may take preference over the grouping of many: by virtue of possessing a unique characteristic, a single component may be all that is necessary for simplifying the interpretation of the lighting structure. Indeed, there seems to be great potential for "articulation and enrichment" when the component characteristics are used effectively by the planner. 5/.

The qualities of overall illumination and of component characteristics will combine into a higher order of spatial qualities - textures, contrasts, rhythms - that ultimately determines the visual form of the lighting structure. However, they are separated to facilitate analysis, for if the planner observes how each contributes to the whole, he is in effect looking at a dual role for each structural component: how it contributes to overall illumination, and how it might be visually integrated
with other components. By virtue of these two considerations the planner seems better equipped to use his design tools.

INTERACTION WITH THE OBSERVER: GOALS FOR AN EFFECTIVE STRUCTURE

The general framework as conceived so far is useful only as a convenient way for the planner to describe and explain city lighting. It does not permit him to evaluate his observations and, hence, provides no base for discovering and solving planning problems. Certainly, the detailed strategy will vary somewhat from case to case, but it seems possible in this framework to determine the general direction which he should take: a set of goals for the visual planning of an effective lighting structure, to be used as a guide to formulating specific objectives.

The concept of the lighting structure has drawn upon the processes of perceptual organization for its foundation, and this interaction with the observer can be carried further, to consider more fully the role which city lighting plays in the observer's relations with his environment.

Actually, the observer could make use of the lighting structure in two ways. The lighting could be part of a synthesis, inseparable from the other elements of the visual form, lending to the legibility and coherence of the whole: at times the observer may require of lighting that it be interpreted as an element of the environment, useful in clarifying the other elements and the interrelation among them all.

Or there may be times when the observer chooses to use lighting independent of the environment, for the delight or stimulus it can provide
him. Rather than be used in a synthetic role, the lighting may be abstracted from the visual form by the observer, to be appreciated and experienced for its own sake. Hence, the great delight at viewing the night skyline, if for no other reason than the sensual experience derived. This second "use" of lighting is made easier, of course, because of its dominance in the visual scene at night.

Most certainly, a lighting structure which provides for both uses is desirable, and some further exploration of these two aspects seems a reasonable way of determining, in a general way, just how this might be accomplished.

**Lighting as an Integrated Element.** In so complex a setting as the city, interpretations of the lighting structure many times must be meaningful and helpful to the observer in adapting correctly to the environment and in making easier his task of orientation:

> We are uncomfortable if what we see does not agree with our other senses or with our expectations...the information content of what we see influences our comfort, and what we are looking for determines whether the lighting condition is a help or a hindrance. [1]

A problem for the planner, then, is to insure a structure with the qualities to enable the observer to organize according to his needs, to provide for a lighting structure which corresponds with the observer's mental images of how it should work.

The most important uses of artificial lighting in the city are at night. Therefore, it seems logical to plan for a lighting structure
with emphasis on these uses, though this should not be construed as a
neglect of the lighting structure's potential during the day. Fixtures,
for example, should be considered at least as critical during the day as
at night.

At night, the observer tends to relate his perceptions of the
visual form to his recollections of the city by day. This should be
presumed as a major consideration in the visual planning of the lighting
structure: the structure should be a means through which this recall
is made easier and, in so doing, perhaps strengthen the day images
evoked. Lynch seems to imply the same thing when he notes the possi-
bility of using artificial lighting as a tool for providing a "strand of
continuity" in the total image.

In working towards the realization of such a lighting structure,
the concept of imageability, especially the need for image continuity,
should serve as the context in which to work. However, there are pre-
requisite considerations which must be explored, in order for the objec-
tives to be rational and to give the planner assurance that their ful-
fillment would in fact result in a highly satisfactory lighting struc-
ture in this respect.

Criteria for an Imageable Environment. The first consideration is
that of determining the qualities which are inherent in a good image in
general, so that the lighting structure might be working in a framework
which in itself is rational and consistent. Lynch's research into this
problem has led to the development of a set of principles which seem
useful in evaluating the image qualities of the city form. Briefly summarizing:

**Differentiation:** The elements of the image should be separable and identifiable, clear and distinct.

**Structuring:** The observer should be able to relate in his mind the differentiated elements; the connections and relations among them should be clear to him. The articulation and structuring of parts seems to be the major considerations in the way the observer can form strong images.

**Congruency:** The way the observer images the city should have a formal congruence with the way the city is used - it should fit with the way people actually move and work.

**Meaning:** The image should be meaningful in that it also expresses those aspects of the environment which have cultural, historical, etc., significance.

**Choice:** The image should be choiceful; the observer should be able to construct his image as he desires.

**Development:** The image should invite the observer to explore; it should not necessarily be grasped in its entirety upon first experience, but should grow as the observer becomes more familiar with his environment.

**Flexibility:** The image should be able to adapt to change. 8/

Meeting these criteria would be significant in evoking a basic image which is strong. If the lighting structure could be planned to continue the strong points, the relationship of the structure to the rest of the
form would prove effective. Whenever the structure is studied, a prerequisite would be an evaluation of the general framework (the basic image) in terms of these criteria.* Strengths should be noted, giving a basis for determining the role of the lighting structure. Weaknesses should also be noted, for the lighting structure, through imaginative use of its components, may prove a valuable tool in correcting any shortcomings in the basic image.

Resources for Image Continuity. The second consideration concerns the lighting structure itself - unique advantages which artificial lighting offers the planner. When these are compared with the criteria above, the relation between the two gives an indication of how well adapted is the lighting structure to work towards this general goal. Some idea of the potential is evident from preceding pages, but the practical advantages may be summarized: (1) the dominance of the lighting structure, particularly exposed sources, permitting virtually independent manipulation in order to obtain consistency with the image criteria; (2) the flexibility of the lighting structure, again with emphasis on source components, which allows the manipulation to be done in almost any way the

* It must be noted that different scales seem to make different criteria important. At the small scale, for example, studies have shown that structure, meaning, and congruency are more necessary to the image than other criteria, while image development seems almost automatic consideration at the very large scale because of the complexity and variation which normally would be expected. At some scales, the criteria of choice and flexibility seemed merely sub-categories of structure, inseparable in analysis. Although these qualifications do not seem to affect goal-setting in a conceptual framework, they might be very strong influences on the establishing of objectives specifically related to the lighting structure in an actual city area.
planner desires; (3) the relative economy of artificial lighting.

In general, it follows that the criteria for an effective structure should (and are able to) follow from those for an effective image. The articulation and interconnection of parts should be stressed as a first prerequisite of the structure's interaction with the observer; imaginative use of sources and forms in achieving spatial qualities might insure that these and other criteria will be handled successfully. Although its use at night has been emphasized, there are other considerations and, depending on the actual situation, they may prove at least as important as the goal of image continuity.

As a part of the visual form, the lighting structure should have some identity during the day and should contribute to the form qualities in daylight. Weather can vary from bright, sunny skies to cloudy, stormy conditions. The lighting structure should be employed to heighten or modify daylight wherever it is necessary to compensate for variations. It should also strengthen wherever possible the images of the form during the day.

Lighting as an Independent Element. Generally speaking, an effective lighting structure is one which makes best use of its resources in any situation where artificial lighting may enhance the sensuous qualities of the visual form. The true expression of a lighting structure may well stem from its inherent ability to enrich the environment by creating a character of its own, an architecture of light. It is true that existing city lighting is often visually impressive in its
chaotic arrangement (again, the night skyline is offered as the example) but perhaps, as Kepes suggests, the city today suffers more from the dangers of over-complexity than from those of monotony. 5/

A goal of a planned lighting structure should be to continue to provide a variety of sensual and aesthetic experiences, yet coordinate them such that they complement one another and combine in a comprehensible way to enrich the experience of the city as a whole. The structure should establish rhythmic sequences which give rise to a perceivable order, and should consciously form textures and contrasts in patterns which are intended not only to stimulate the observer but also to fit his moods or create new responses.

Akin to this, the relative ease and economy with which artificial lighting may be installed suggests a further goal. The use of this element can be carried beyond the bounds of image continuity and accommodation to the day form, to imply that the independent use of the lighting structure should help to develop new images of the environment in a quicker and more efficient manner than many of the other tools of the visual planner. These resources of lighting should be exploited fully, at all scales of space and time, such that the lighting structure might be useful as an element for creating a visual form; it can be master of the visual form as well as servant.

**Structural Unity.** In essence, effective city lighting occurs where the single structure of textures, contrasts, and rhythms is consciously planned to fulfill two functions simultaneously, so that the
observer is always free to choose the manner in which he will use the qualities of light. At times, achieving such a structure may not be an easy task for the planner.

Any difficulties in achieving an effective structure are compounded by the possible difficulties of maintaining that effectiveness. No matter the strategy ultimately chosen in his specific objectives, there must be careful consideration given to factors of the lighting structure which may not be within the province of the planner.

**External Modifications:** Strictly speaking, the lighting structure does not operate as a closed system. The natural lighting condition changes, just as during the day, often affecting the perceived spatial qualities. Therefore, an effective lighting structure should not only be able to continue a flexible basic image but should itself be flexible enough to compensate for changes in its background.

**Internal Modifications:** The lighting structure is susceptible to internal change also, since many of the components are not now subject to public control. Individual sources may be turned on or off, forms may be changed, all without regard to the visual operation of the total lighting structure. Consequently, the whole appearance of the structure may change, even within the same night, at the risk of losing its effectiveness. The lighting structure should be designed in such a way that this risk is minimized, with minimal, though effective controls where necessary.

There are ways for city lighting to achieve its goals. Part Three
of this paper will explore some of the available possibilities and, in a more general context, Part Four will look at the wider range of potentials which could come about under the highly desirable condition of a comprehensively planned lighting structure.
PART TWO

A CASE STUDY: PRELIMINARY INVESTIGATION

The first part of this paper has attempted to develop a conceptual framework for the visual analysis and design of the city lighting structure. Only a skeleton of ideas has been proposed so far, and in order to expand and refine the techniques of planning an effective lighting structure, it would be interesting at this time to examine the artificial lighting in an actual city area. Such a case study could prove valuable in strengthening the concepts and goals for city lighting as useful additions to the vocabulary of the visual planner.

To simplify the mechanics of this study the Copley Square area of Boston has been chosen: Lynch's studies show it to evoke a strong image, thus providing a convenient and firm basis on which to pursue work more pertinent to this specific thesis.

ANALYSIS OF THE BASIC IMAGE

Located near the middle of the Boston peninsula, Copley Square is a commercial and cultural area of about nine city blocks, with a landscaped open space - the Square itself - at its center, near the angled intersection of Boylston Street and Huntington Avenue (see Fig. 1). The area's physical layout resulted from the building of Boston's Back Bay area in the middle- and late-nineteenth century with a path orientation somewhat different from that of the adjoining, already existing South End district of the city. Although the Back Bay is generally conceived of as having Boylston Street as its southern boundary, that predominantly residential district bears a strong physical relation to
Copley Square because the north-south streets (Berkeley, Clarendon, Dartmouth) make for a strong tie across Boylston Street and through the study area. This connection is reinforced by two other physical characteristics of the path network. Topographically, Copley Square is flat, but there are very gentle rises to the west and south, along Huntington Avenue and Dartmouth Street, which tend to close off any vistas into the South End. Also, the north-south streets run to the Charles River Basin, giving some sense of connection through the Back Bay to the water as the observer looks north along these streets.

Functionally, the connection to the South End and the rest of the city via Huntington Avenue is vital to the movement system in Boston. Copley Square is one of two strategic points of connection between Boston's South End and the central city (Park Square is the other). Thus, Copley Square forms an entrance to and exit from the South End on Huntington Avenue. Further south on Huntington are also some of the major cultural institutions of Boston, including the Museum of Fine Arts and Northeastern University.

Boylston Street likewise plays a significant role in the city's circulation system. Besides receiving the Huntington Avenue traffic at Copley Square and carrying it into the heart of the city, Boylston is a busy thoroughfare in its own right, a major link between downtown and the north side of the peninsula, with connections across the Charles River Basin to Cambridge and points north.

Figure 2 shows the land uses and buildings in the Copley Square
area. Office uses predominate and include two large buildings which house the headquarters of nationally-known insurance companies. There are many small offices above first floor retail facilities throughout the area. Larger retail shops, like Bonwit Teller's and Brooks Brothers, tend to be at the east end of the district, off Berkeley Street. Many of the Square's other shops are small specialty types - bookstores, gift-shops, and art supply stores, for example - and are distributed throughout the area, though mostly on Boylston and on Newbury Streets. Newbury, the north edge of the study area, is also the location for some of Boston's largest and finest private art galleries, in addition to some of the City's more elegant dining places. On the Square itself are also some expensive restaurants (other eating places are found on Huntington Avenue), and the Sheraton-Plaza Hotel which has a long-standing reputation in a city which is graced with several nationally-known hotels. Most of the remaining uses around the open space are non-commercial and include the Public Library, Trinity Church, and Old South Church.

Because of the land uses, Copley Square is technically considered as part of the Boston Central Business District, but this visual association is not so easily made as it is with the Back Bay, and the structuring of Copley Square in the central city is made difficult. It is a long walk to the center of the CBD, and the major connecting paths (Boylston, Stuart) twist enough so as to distort the directions; the visual link is clear into Park Square along Stuart Street and, to a lesser extent, to the Public Garden along Boylston, but no further. Moreover, Boylston is one-way toward the CBD, east of clarendon Street, so this path is never experienced by the driver when traveling from the rest of downtown.
FIGURE 2
COPLEY SQUARE
EXISTING PLAN

- subway Kiosk
- indicates activity usually extends into evening hours
towards the Square.

The visual connection from the center of downtown is best made by locating the John Hancock Tower but, when in the Square, the weak association with the rest of the CBD is made more tenuous by the distinct functional character of Copley Square. Most certainly, the study area does not provide convenience shopping for nearby residents; for the most part, the retail uses either are oriented towards serving the workers in the district or, like Bonwit's, are one-of-a-kind shops which cater to the entire metropolis. Such unique places may be found elsewhere in the CBD, but the Copley Square shops are almost all of a higher quality and more expensive character than anywhere else in the CBD. The office uses are even more indicative of the fact that Copley Square functions as an area serving a very large region, and the large number of unique cultural institutions in so small an area reinforces Copley Square's distinctive functional character.

Therefore, as well as being a major node in the overall circulation network of Boston, Copley Square is a center for many specialized and unique activities of the city and for activities of regional and even national significance. Thus the area may appear as a separate district, the Square itself being a nodal point which, though not always the lone focus of activity, provides a convenient point around which to mentally organize an otherwise complex city area.

Copley Square evokes a strong image, due in part to distinct functional roles, and also because of two significant physical characteris-
tics:

A node like Copley Square...was very sharply imaged, and the connections of various paths were eminently clear. It was easily identified, principally in terms of its unique individual buildings: the Public Library, Trinity Church, the Copley Plaza Hotel (sic), and the sight of the John Hancock Building. It was less of a spatial whole than a concentration of activity and of some uniquely contrasting buildings. \(8/\)

To provide more information about the visual form of the study area, it seems advantageous to spend some time exploring its architectural contrasts and activity.

**Architectural Contrasts.** Of the six significant buildings in the Copley Square area, the towers of the John Hancock Building, New England Mutual, and Old South Church are prominent in the skyline, and their visibility helps to demarcate the Square from far away; on almost any approach one or a combination of these towers serves to guide the observer during the day. The Public Library, the Sheraton Plaza, and Trinity Church do not enjoy high visibility, but are elements which gradually appear along the approaches to the Square, bringing the eye of the observer down into the area. When the observer reaches the center he has visibility of all six major structures. At the lesser scale there are times when the immediate landmarks seem to replace the towers as the key features of the area. Perhaps a good example is found in the approach along Huntington Avenue, shown on the following page, where Trinity Church makes a stronger visual impression once in view than New England Mutual.

Though the immediate landmarks tend to be perceptually accented
Approaching center of Copley Square from southwest, along Huntington Avenue
Dartmouth Street

Approaching Square from North

Approaching Square from South

Approach along Boylston Street, from the West
Huntington and Blagden Streets, from Square

Back Bay, along Dartmouth from Boylston-Dartmouth intersection

View toward Public Garden, from Boylston-Clarendon intersection

Some Shopfronts, Boylston-on-the-Square

PLATE C
when in the Square itself, the prominence of the bigger buildings should not be overlooked, notably when entering the area at its northwest corner. John Hancock Building, especially, is strongly felt because of the extension of the open space of the Square itself into a parking lot which in turn provides a setting for that tower. This "setting" is new to the area; five years ago that lot did not exist, and the Square itself was much better defined. Whatever contrasts distinguish the group of immediate buildings is negated somewhat by this "leaking" of the Square into surrounding blocks.

The Copley Square area exhibits little homogeneity in building types or age, which stands in contrast with the South End and even parts of the Back Bay. The contrasts are made more apparent because the observer can see so much at a single glance when in the heart of the study area: standing at Dartmouth and Boylston, for example, the field of vision includes McKim's Library, the Sheraton Plaza with its partially-bowed facade, Richardson's Trinity Church as it is framed in the mass of the hugh Hancock Tower, and the curtain-walled IBM Building behind Trinity. However, the potpourri of shapes and sizes among these and other buildings does not prevent a common these - a formal elegance, perhaps - from prevailing throughout. The architecture is massive and formal; there is much masonry but though the details vary considerably, the fenestration seems to occur in an orderly fashion almost everywhere in the Square. Shop facades convey the same impression and the signs are, in general, unpretentious. In addition, some of the detail characteristics repeat themselves, and help to unify the area (see Figure 3). Along with their distinctive roles in the city perhaps the sense of formality is a major
FIGURE 3
COPLEY SQUARE

Arches, arch-framed windows
Spires, pinnacles, towers
Landscaping
Distinctive lighting fixtures

DETAIL CHARACTERISTICS
reason the landmarks can be properly imaged in the whole setting; their individual differences do not prevent them from acting in concert, to further distinguish Copley Square as a unique place.

Activity. Somewhat orderly and easily grasped in plan, the Square itself is a landscaped open space with buildings fronting on all sides, though separated from the green area by the elements of the supporting path system. Most probably, it is the relation of the streets to the open space which, though visually reinforcing it, is the major reason why the activity normally associated with a landscaped public area in a city is not present in the expected manner. There are people, as would be expected, but their activity tends toward the periphery, close to the buildings, rather than in the open center. Whatever pedestrian activity exists in the center is most noticeable in rush hours and consists of people moving across the Square rather than staying in it (there are no benches to invite people to sit). The only drawing card of the actual center is the bus tours which originate there. By far, the major activity in the center is vehicular - the traffic on Huntington Avenue as the line of that path diagonally divides the landscaped square into two triangular pieces.

The whole complex system of movement - vehicular and pedestrian - give an impression that the Square is less a destination point than a space to pass through on the way to somewhere else. This underscores its role as an element which is frequently experienced as a vital part of a dominant sequence to and from the central city, but there are other clues which indicate that people do come to the central area for its
own sake, or at least use it as a "secondary" destination point. The Public Library seems a prime attraction and some of the restaurants on the Square itself may invite special trips. But its role as a temporary destination - a place to change mode of travel - seems just as significant and hints at what perhaps is another reason for the area's imageability.

Two large parking lots flanking the Square to the south and a public garage behind Trinity Church receive people in cars and disperse them on foot, to walk through the area on their way to shops and offices in the vicinity. The Square, however, is probably more deeply felt by the area's shoppers and workers who come by subway, for their modal change is coupled with a change in environment, from the confines of the underground to a light, airy open space - a contrast which surely must heighten the effect of the latter and perhaps even makes it seem larger than it actually is. Since many of these MTA riders must then walk through the area on the way to their destinations, experiencing as well as seeing the space must lend greatly to its imageability for them.

There is change in activity patterns over time, especially visible sidewalk activity. During the day the area normally has a more or less even distribution of activity throughout, with a few points of slightly greater intensity, notably the vehicular activity at key intersections and the pedestrian activity along Boylston Street. During rush hours, there seems to be a proportional increase in intensity throughout, with slightly heavier concentrations of pedestrian activity developing at the kiosks and in the landscaped center. Generally speaking, the Square
itself is not always a point of climax, although its openness gives that impression since so much of the district's activity may be seen. Actually, the Square itself represents a larger district which appears to have an increase in activity in a city-scale sequence. The most noticeable drop in intensity occurs as one goes north along Clarendon and Dartmouth Streets, into residential Back Bay. From the south, along Dartmouth and Huntington, the intensity appears to build gradually to a high point in the Square itself, but continued movement east does not seem to diminish it. To the west, along Boylston Street, the activity level seems less, due in part to the lack of pedestrian movement around the excavation for the new Prudential Center.

At night the retail and office area to the east does not operate, but the central area continues at a relatively high level. As shown in Figure 2, this is primarily due to the land uses around the Square itself - the Library, hotel, restaurants, and theater - which are operating in the evening hours and continue to generate activity. The concentration of activity, mostly pedestrian, appears greater no matter from which approach, heightening the effectiveness of the open square as an independent and clearly defined nodal element at night.

Both day and night, Copley Square is a noisy area, and since so much of it is traffic noise, it seems to be in proportion to the activity patterns sketched above.

Other Visual Resources. That Copley Square is a strongly imaged element in Boston implies it meets the image criteria satisfactorily.
FIGURE 4
COPLEY SQUARE
FOCI OF VISIBLE DAY ACTIVITY

pedestrian vehicular

subway

Library

bus tours

John Hancock

CALLED NORTH

standing activity

destination points

moving activity
So far the discussion has concentrated on some of the tangible characteristics which underlie that image, but it is possible to expand the analysis, especially in relation to the more abstract criteria which were suggested earlier.

The Square does not have one central landmark on which to focus, and this may be beneficial. The observer has choice in establishing whichever landmark (or combination) as his key element and build his image from that, which still maintaining the Square itself as the principal focus of the larger district. Moreover, the central area may be imaged in a variety of sizes without damaging its role as a node - from the very small patch of green space on up to include all the major buildings around it and even contiguous sections of the district. To some extent, there are several ways to mentally relate the path system because there are several major connecting streets. The image structuring is not endangered because key intersections seem to knit together the network of paths; the only intersection which is without form is that of Huntington, Dartmouth and St. James.

However, the continuity of the major paths through and around the area seems critical to a well-structured image. This continuity breaks down on Dartmouth Street. The physical properties which give the other streets the character which allows them to retain continuity do not seem to be present here. That it can be imaged as a continuous path, as prior studies seem to indicate, is difficult to reconcile with its physical resources: it is narrower on the south side of the Square, broken by that tricky, formless intersection with Huntington Avenue, and has a different
building character and land use types; the north side is wide enough to have a median divider for part of its length. Also, the slight change in grade on the south side occurs coincident with the change in character, a quality which normally would increase the differentiation among parts. In this case, perhaps, the objective should be a physical unity instead, to reinforce the functional significance of Dartmouth Street as the major north-south artery through the area.

Blagden Street seems to be the lost street of Copley Square. The formless intersection with Huntington, the lack of activity, and a change in character (to residential) combine to make it lose its identification.

The Square is a meaningful place and its elements are expressive of this. To the Bostonian, it may signify a City Revitalized, for the area is experiencing a large amount of new building investment, to be climaxed with the construction of Prudential Center. The face of the area is changing in a way which reflects optimism in Boston's future.

This change may have pronounced effects on those elements of the area which remain, especially the landmarks; they may be treasured even more. They are probably treasured now, for they embody the values of the larger entity by representing the image of a proper, elite Boston. Strauss and Wohl refer to this as "cultural representation". 11/ Copley Square's shops make it the "Fifth Avenue" of Boston, and the buildings around the open Square exhibit in one place and at one time many symbols of the cultural heritage inherent in the Boston image.

Since Copley Square is an area of change, something should be said
FIGURE 5
Copley Square
Elements of the Image
of how its image can adapt. By virtue of having a strongly-imaged center, the area has a basic requirement for flexibility. To the north, there is no discernible boundary to the district, lest it be a dropping off of the activity associated with the Square as one goes further into residential Back Bay. To the south, the rail line would seem to be a definite edge. The eastern boundary is quite flexible now since it is difficult to determine a dividing line between Copley and Park Squares, though the bulky office buildings along Berkeley Street may set that path as the dividing line for some people. The west is somewhat open-ended. Except for the railroad, then, the existing boundaries are not so rigid as to defy changes which could be incorporated in the visual image of the district; change should not prevent the basic conceptions of Copley Square to remain.

**Potentials for Copley Square.** It is not irrelevant to delve even further into the future of a changing Copley Square to discover the new roles it could conceivably enjoy, even though some of the potentials may require great physical, social, or economic change and perhaps many decades to be realized, if realized at all. Imaginative use of lighting need not wait for the other changes to occur; it can begin now to gradually provide a visual form which conveys new possibilities of the Square in the Boston image, and might even be a catalyst for insuring that these potentials become reality.

For example, Copley Square might gain new significance if it could look as much like a place to be in as a place to pass through. The Square, particularly the open spaces, holds great potential for becoming an inviting place for people to gather, for seasonal art shows in con-
junction with the Newbury Street galleries, or just a place to sit. Maybe adjacent land uses might change such that the entire center becomes a large setting for unique institutions which draw people to the area. This will be happening somewhat, in the near future: the building of Prudential Center and civic auditorium can be as much a boon to Copley Square alone as it will be to the rest of the city. Indeed, Copley Square may eventually become the heart of a new downtown, a new regional core.

Or new roads may be planned - new sequences can be consciously developed which would have potentials for experiencing the Square at new scales, enriching its image. Or other redevelopment of the city, perhaps in the South End many years hence, may find Copley Square the ideal area on which to build a whole new visual form for this part of the city. When analyzing and designing its lighting structure, it is not too early to be thinking about these and other possibilities for the future of Copley Square.

SUMMARY: SPECIFIC CONSIDERATIONS IN EVALUATING THE LIGHTING STRUCTURE

The emphasis on landmarks and paths and the interrelations among them would seem to make these the prime considerations in Copley Square's lighting structure. Their articulation and unification are still the bases through which the image may be continued via the resources of artificial lighting. Consequently, these remain valid as major criteria in evaluating the existing structure. The spatial continuity of the paths should be exploited and, if possible, the structure should strengthen the weaknesses during the day in path identification and continuity which the preceding analysis has suggested, and correct these same deficiencies if they appear at night.
The common themes which unite the landmarks and give the area its singular qualities should be there when the lighting structure is in command. District character, its many entrances, and its variety in spatial experience seem to indicate the area is not dull, but encourages the observer to explore and develop his images. The richness in image qualities at this relatively small scale may be unique. In any case, the lighting structure should exhibit these same characteristics.

Image differentiation and structuring are also extremely important considerations at the larger scale. The lighting should help to identify Copley Square as a distinct district in the city. The lighting structure should be evaluated as to how well it gives indication of a focus, perhaps - a perceptual building-block, such as provided by the Square itself during the day. And once this organizational key is established, the lighting structure should also be evaluated for its ability to define the entire area around it.

There should be some sense of connection of Copley Square with other areas of the city; in particular, the lighting structure should give a sense of association with the rest of the CBD, with Back Bay, and with the South End and its cultural activities on Huntington Avenue.

The area is most often sensed by the observer who is in motion. For many people it is part of a larger sequence and should have a lighting structure which is conscious of people on the move; for many other people the modal change is important - the structure must provide continuity at several scales of movement and effectively link these scales, perhaps both above and below ground.
At the city scale as well as internally, image congruency is a significant criterion. The whole complex of activity patterns is important to conceptions of Copley Square, and should be considered in evaluating the lighting. The lighting structure may be a way to organize these patterns visually, and any shifts in the pattern through time might find some expression and resolution in the use of lighting.

The lighting structure should be expressive of an area in change. There are many temporary objects in the district - buildings being demolished, the Prudential excavation, construction fences - and the sense of new things to come should be reflected in the lighting. But the lighting should also hold the stability of the highly symbolic associations with the old, elite Boston which are there now and will remain. A lighting structure which can effectuate a blend of old and new, temporary and permanent, actualities and aspirations, would be a worthwhile achievement, it seems.

Summary. When reviewed in terms of the general goals for city lighting, then, it seems that the primary objectives for the lighting of Copley Square are readily apparent. Other considerations will no doubt appear on closer examination of the structure, especially those related to the use of lighting as an independent element, but the analysis of the basic image has provided one set of major considerations necessary to obtain a lighting structure of at least minimum effectiveness. In summary:

1. The lighting structure should continue the articulation and unification of the major paths and landmarks of Copley Square, and should provide for the
articulation and unification of the whole area in the city. Connections with neighboring areas should be clear, especially where this relation is essential to larger-scale sequences.

2. The lighting should coordinate with the movement of individuals, and organize and express the complex nature of the activity of the area.

3. The lighting structure should be expressive of an area in change, of planned and potential uses, while still maintaining some sense of the existing associations made with the Square.

4. In any specific consideration of Copley Square's lighting structure, its use during the day should not be overlooked; how well it contributes (or can contribute) to the basic form must be evaluated.
PART THREE

A CASE STUDY: EVALUATION AND DESIGN

Some understanding of the functional and visual resources of Copley Square has provided a set of major considerations for its lighting, within the framework of general goals for a lighting structure. This part of the paper is perhaps the most pertinent to the thesis that city lighting can be planned logically and comprehensively to fulfill a role in the visual form. Hopefully, the reader will find sufficient evidence that this is true.

OBSERVATIONS OF THE LIGHTING STRUCTURE DURING THE DAY

Weather and sky conditions change, as do activity patterns, during the course of one day and from day to day. But in Copley Square there is no appreciable use of artificial lighting, no matter what the conditions, if the period when these observations were made can be assumed as a representative example. True, many offices and shops are lighted internally but this seems to have little visual effect on the form of the area, even on the cloudiest days. The lighting structure during the day is at present mostly one of fixtures, with very few source or other form components contributing to it. However, the fixtures (especially public streetlighting) seem to be quite critical to the visual form, as shown in Figure 6.

Three major types of public streetlighting fixtures are used. They do not mix but, rather, the different types may be readily associated with different sections of the district: double lamp, topmounted fixtures in the Square itself, single lamp fixtures (also with sources mounted directly on top of the poles) on all connecting streets except Huntington
Avenue west of Dartmouth, which has tall cast stone poles with double overhanging lamps on aluminum supports. During the day the presence of the Huntington fixtures is felt both when in the space and when viewing it from the Square itself, partly because of their color and height and partly because they are located in the center of the street. By being removed from the walls of the space, they are silhouetted against the sky in any vistas from the center of the study area, and will seem to be at relatively close intervals, the orderliness of their spacing being in contrast to the randomness of building sizes, signs, and other street furniture along this part of Huntington Avenue. These fixtures are new, having replaced a group of streetlights which were more in character with the surroundings but were inadequate in the amount of light they gave. In looking at the impropriety of the new fixtures, it seems unfortunate that brightness requirements at night could not have been better reconciled with visual considerations during the day.

The other types of public streetlighting fixtures are less pretentious. They are not so tall, more in scale and character with immediate surroundings, and tend to blend in with these surroundings. Moreover, especially in the Square itself, they do not seem to have a regular spacing to make them independent of the rest of the space, but seem to be at locations which demark edges and corners, being very compatible with the plan of the district. It seems that their logical placement helps the observer to sense the unity of the central area of the district.

Fixtures attached to walls are not frequent in the study area except, of course, for signs which are lit at night (a major exception
FIGURE 6
COPLEY SQUARE
THE LIGHTING STRUCTURE DURING THE DAY

- public streetlighting fixtures
- wall-mounted fixture
- advertising signs
- canopy
- theater marquee
- traffic signal

CALLED NORTH
is the fixtures on the library, which become points of visual interest as one gets nearer the building because of their unique shapes). Figure 6 locates the signs which, during the day, are generally less impressive and lack the visibility that they possess at night.

OBSERVATIONS OF THE LIGHTING STRUCTURE AT NIGHT

Some Impressions of the General Character. The casual observer of Copley Square may get several strong impressions of the lighting at night and the spatial effects created. Though it is somewhat darker and less active than the neighboring Park Square and theater district, Copley Square is still among the brightest areas of central Boston. From many distant points which command a view of the central area, the beacon of the John Hancock Building is the major feature of the night skyline and in early evening the interior light will help define the rest of that building. Thus, Copley Square has a characteristic element which helps to dramatically locate the area in the urban panorama.

When in the district itself, the observer is presented with a variety of visual experiences. For example, the district has a variety of light and dark sub-areas and, depending on the sequence being experienced, has several points of climax. The central open space is not very bright or busy relative to parts of its periphery, and major paths which connect with the periphery are either very bright and quite dominant or don't seem to exist at all.

Some parts of the area seem busier at night than others. The lighting on Boylston Street gives the illusion of great activity, as does the Huntington Avenue strip. But there is a difference in character between
View from Cambridge (at right is a Back Bay Apt. Tower)

Looking Southwest along Huntington

Looking East, along St. James, to Park Square

View of Clarendon Street behind Trinity Church
the two: Boylston, though being bright, lends itself to an interpretation of a more orderly and restrained activity; parts of Huntington seem darker than Boylston, but the entire avenue seems more lively and informal, with much more movement. Actually, there is a sense of motion throughout much of the area because of the automobile traffic, but there are also many parts where there is often a good bit of traffic which seem quiet: St. James Avenue, Boylston Street west, and (at times) the Back Bay streets exhibit this quality.

These variations in spatial effects often stand in abrupt contrast with one another, often seeming to change from one side of an intersection to the other, such that the area has some dramatic parts. Even though there is variety the observer may not have trouble in interpreting and organizing the character of the whole district, because of the strong sense of distinctive parts knitted together by a formal pattern of activity.

Observations in the General Framework for Analysis and Design. What do any such general impressions mean, in terms of the interrelationships which comprise a lighting structure? Figure 7, which studies the lighting structure in more detail as a series of sequences, gives some indication of how the textures, contrasts, and rhythms that underlie any reactions to the light which is seen may be expressed in terms of the patterns of overall illumination and patterns of physical characteristics. This diagram is primarily intended to record lighting as an independent element - its sensuous character -- but also proves useful as a base for studying the relation of lighting to the rest of the visual form. Since the city is to a great extent sensed in motion, sequential studies such
KEY TO FIGURE 7

sense of bright object or space ahead

abrupt change in overall illumination

sense of wall
FINE-GRAIN TEXTURE ORDERLY PATTERN

sense of floor pattern
FINE-GRAIN TEXTURE BUSY EFFECT

(bright)

(dark)

level of illumination in space

dominant spatial accents in each direction

overall effect on observer; spatial quality of lighting structure in each direction

point of contrast; strong response in observer

point of impact; strong awareness of dominant object

awareness of bright source

sense of motion ahead
FIGURE 7
Copley Square
Sequences Through the Existing Lighting Structure at Night
as this seem particularly relevant. Individual parts of the area may be interpreted directly from the diagram, but some generalizations should be made about the lighting structure of the entire area, as if it were a nodal element of the larger city form.

Qualities of illumination seem useful in interpreting and defining Copley Square at this larger scale. In general, the approaches into the Square itself are not marked with gradual increases or decreases in brightness; when change occurs it is of high contrast, tending toward the sharp end of the scale rather than the subtle. The streets in the Back Bay give the best example for they are quite dark, but change emphatically at their intersections with Boylston Street. Dartmouth changes again on the south side of the open square, and there is a significant decrease in the level of intensity just beyond the Stuart Street intersection.

Boylston Street also exhibits this quality. It is relatively bright just before entering the study area from the west, but is dark from Exeter Street to the Square. At the Dartmouth Street intersection the illumination level jumps again, jumping once more as the observer passes the IBM building on the Clarendon Street corner.

On the other hand, Huntington Avenue actually decreases in illumination upon entering the open square, and the change can easily be remembered as the intersection with Dartmouth. This intersection seems to be visually stronger at night than during the day.

St. James and Blagden Streets are the possible exception to this
generalization on contrasts in illumination. There seems to be a gradual building up of brightness west from Clarendon, as the observer moves into the square and past the hotel, reaching a high point at the Dartmouth intersection.

The rate of change, i.e., texture of lights and darks is large scale when moving by car. Except for Clarendon, a general level of illumination will hold, often for a block, before a significant change is sensed. Apparently, the rhythm would be experienced best in a fast-moving automobile, because of the distances involved.

At the lesser scale, the qualities of physical characteristics seem more important to the spatial experiences in Copley Square than do the brightness patterns. (Actually, it is presumed that the two patterns are interacting at all scales to produce the total effect; it just seems fairly easy to determine which of the patterns is the greater influence, at least at this scale in this study area.)

The relation of sources to forms seems to be a determinant of most of the impression of activity which the lighting structure conveys, and also is significant in the various types of activity expressed. Only parts of Boylston, Huntington, and Clarendon exhibit "lines" of dominant features, groupings of common characteristics, and they tend to be the places of expressed activity.

On the other hand, there are cases where a single component is a key feature in the visual field; the Hancock beacon from a distance is
the obvious example. The nature of these "accent points" is diverse -
sometimes the floor, sometimes a wall or a single source, sometimes a
building in silhouette - and it is difficult to determine any general
pattern from this. Views of spaces and objects ahead perhaps comes
closest to generalizing on any theme among accents and these views help
to give the district an extroverted character at night. On the western
approaches, especially Boylston and Blagden, there is a sense of motion
ahead, while the eastern approaches seem more oriented to views of single,
estationary objects in the upcoming spaces.

The contribution of each component to the quality of light in the
lighting structure is shown in Figure 8. This diagram seems particularly
meaningful once the spatial patterns of the qualities of interrelationship
shown in Figure 7 are grasped, and the presumption that a single component
may indeed have a double role in forming these patterns is understood.
As with Figure 7, some general statements about the lighting structure
may be made here, this time directly concerning its manipulative aspects,
the sources and forms:

Much of the change in brightness in the district is due to the
textural effects on (and in) containing wall surfaces. Even certain
lesser buildings such as IBM gain prominence at night due to the composi-
tion of their form components. In general, textural reception of indivi-
dual forms comes from their interior lighting, but there are exceptions:
Trinity Church gets some from external sources, while New England Mutual
must rely quite heavily for identification on the light it receives
from the buildings across the street on Boylston. Textures of forms
throughout the study area are not often "busy", but dependence upon interior sources may often mean that whatever character is exhibited by the form is subject to extremely wide variation. John Hancock Building is an example of this, changing from an orderly texture of lights and darks when all windows are lighted early on a winter evening, to a more random pattern as one by one the interior sources are turned off, to a very dark form late at night.

Clarity of forms varies throughout the area, though of the immediate landmarks only the shape of Old South Church is difficult to comprehend. Trinity gains its shape identification from silhouette, this being most clear from Trinity Place and Clarendon Street to the south. There are cases where form clarity of a building seems to be discontinuous, i.e., one facade (usually the front) gains ready identification while other sides of the building are more obscured. The Public Library and New England Mutual are the best examples among the major buildings. Roof tops have a tendency not to be defined, especially on dark nights, and the fact that the district is often without its "ceiling line" may be an influence on the general spatial qualities.

At each of three parts of the study area where the structure gives an illusion of busy activity, the way in which the components provide for this effect differs somewhat: Boylston-on-the-Square gets this character from the juxtaposition of bright sources primarily, and their interaction with the buildings; Huntington Avenue adds to this the fact that its most dominant source is a moving one; Boylston east of Clarendon relies primarily on internal lighting of forms such as IBM and the locational characteristics of the shop windows in that block, rather than the inter-
action of exposed sources. As stated earlier, the entire central part
of the area appears busy to some extent, due to the sense of the headlights
of automobiles moving in a variety of directions.

Much of the external accent comes from highly visible sources such
as the Hancock beacon, the light atop the Sheraton Hotel, and the theater
marquee and streetlighting on Huntington Avenue. Colored sources are used
much more on Huntington than anywhere else, helping to establish its
distinctive character. Signs in general have message characteristics
which relate to activities in the Square; the exception among dominant
components is the billboard display in the parking lot south of Trinity
Church.

Since the lighting structure is, in part, a device used by the obser-
ver for relating day to night, the technique of observing a lighting struc-
ture can be expanded further, by comparative studies of aspects of the
visual form which are additional aids to conceptual organization. Figure 9
examines two of these aspects - activity and landmark visibility. These
were chosen because they are especially important considerations in Copley
Square since so much of its image depends on them, but perhaps they are
equally important in any area. The change in activity pattern for example,
may be useful to know because people and autos, like any objects in space,
may determine spatial scale. Also, on a larger scale, the perception of
a threshold of visible activity could influence the virtual size or ex-
tent of a node or district. It may also be generally useful to compare
visibility in the lighting structure of important objects with their nor-
mal visibility. Principal features might have to be highly identifiable
threshold of visible activity.
indicates point from which corresponding landmark is first visible.
at all times; the conception of, and orientation in, a large area may
in part depend on the visibility of its landmarks. Also, an area may tie
to other areas by virtue of the ease with which features associated with
it may be seen, and if there is a decided shift in the points from which
significant elements are first perceived, it should be noted.

In Copley Square, Figure 9 shows that the line which defines the
perceived threshold of activity contracts considerably at night, center-
ing more on the open square and its immediate environs. This sense of
a much smaller district seems to be reinforced by a general decrease
in the visibility of the Square's immediate landmarks. At night the
observer has to almost be in the Square itself in order to see clearly
some of these buildings. Leaving the district, the Public Garden gains
no recognition at night and very little during the day. Park Square,
however, sometimes seemed more dominant along St. James Avenue at night
than during the day, its brightness contrasting with the darker avenue.

EVALUATION OF THE LIGHTING STRUCTURE: A STATEMENT OF KEY PROBLEMS

Copley Square, with its strong image qualities and its potentials,
proves to be a good test for its lighting structure. In general the
lighting scores well in fulfilling the goals and objectives put forth
earlier in this paper, but it has its weak points too. These weaknesses
sometimes are not faults of the lighting structure so much as they are the
results of weaknesses in the basic physical form of the study area: the
tenuous relation with the rest of downtown, the failure to express what
is perhaps the most dynamic area of the central city, and so on. These
problems carry over into the lighting structure, sometimes at critical
points, a seemingly good indication that existing lighting often has a tendency to adapt itself to the physical form, its objects and activities.

Though Copley Square holds great potentials for its lighting, it should not be forgotten that the lighting may hold potential for the area, and the evaluation shows the lighting structure ignoring many of these potentials simply by not capitalizing on its own inherent capabilities.

This section of the paper will look more closely at the key areas of criticism; they may serve as a basis for future design considerations.

The Structure During the Day. There were several times during the period of observation when the introduction of artificial lighting into the day form of Copley Square would have contributed to the enrichment of the visual form. The strong shadows which give the Square a part of its character should be reinforced when the natural lighting conditions are poor. This includes details such as the arches on Trinity Church, the Public Library, and the Sheraton Plaza, but the lighting should also work with entire forms in the district, modeling entire buildings or accenting the space between buildings, perhaps.

The relation of fixtures, forms, and sources to perspective and sequential accents, such as vistas and landmarks does not seem to be a general problem in the lighting structure during the day. The strong point is the harmony of the fixtures in the square itself with the surrounding buildings. However, a criticism of propriety concerns the
fixtures on Huntington Avenue. They are expressive of the kinetic character of that spatial corridor and little else, deterring from the view ahead, into the square, and devoid of any association with either the square or the cultural institutions in the other direction. At night the brightness of the streetlighting sources makes this even more critical.

The Structure at Night. In relating itself to the image qualities of Copley Square, the differentiation of major paths seems to be the strongest asset of the lighting structure. This is done either through change in the character of light sources, as along Huntington, or through emphasis on forms, such as the buildings and shops which line Boylston Street east of the square itself. Brightness patterns seem to be the key to larger scale identity of the node - the rhythm of light and darks along Boylston and Huntington is accentuated by the void of the Prudential excavation; this helps, no doubt, to clearly define the square itself when approaching along these two western entranceways. This is true also along the northern approaches and, to a lesser extent, to the south and east.

The normal articulation of landmarks is very strong - so vivid that even with a minimum amount of effort the lighting structure for the most part succeeds in continuing this differentiation. For example, one distinctive quality of Trinity Church is its shape, and it is only necessary to put this building in silhouette for the lighting structure to reinforce this quality.

There are deficiencies in the lighting structure which seem to make
mentally relating the parts of the physical form a difficult task at night, especially at the larger scale; from a distance the recollection of the day form is not without effort. The general decrease in visibility does not seem so important to structuring the image in the case of identifying immediate landmarks (except where a now more-emphatic sense of awareness might destroy the spatial continuity of paths), but the lack of distant identification of Old South Church and New England Mutual impairs a customary method of orientating to the Square. Some attempt should be made to reinforce their identity since they do help to define the open space of the square itself, and reinforce the locus of the square vis-a-vis the most prominent landmark, John Hancock. At present there are several distant views of this building in which the beacon "floats" with little sense of connection with the Square. The importance of the Hancock Building is continued in the lighting structure, but at times the beacon seems too bright for the area. Its proper role in the skyline, however, is something which would perhaps be analyzed better in a study of the entire downtown area.

At the larger scale the sense of connection with Park Square seems more clear at night because the brightness of that node contrasts with the dark corridor of St. James Avenue. The connection would be better yet if St. James could give a better sense of the distance between the two nodes. The Back Bay connections are weak because there are no vistas down Dartmouth and Clarendon as during the day, and what little visual relation existed with the Public Garden is lost completely at night. The potentials of the Public Garden as a key to unifying this end of the CBD should be explored, both day and night.
The interconnection of parts is weak in other respects. The discontinuity in Dartmouth which seems to appear during the day remains in the lighting structure, perhaps made more noticeable due to the lighted facades and signs which face the square from the parking lot on the Huntington Avenue corner and seem to mark the end of the spatial corridor and, secondly, the change in level of illumination on either side of the central square area. Boylston's change in brightness, coupled with a decrease in the number of highly visible landmarks ahead hurt the continuity along this path.

Although the lighting structure expresses a great deal of activity, some of it is misplaced. The problems of maintaining a lighting structure of Copley Square which is congruent with function are compounded by the fact that at night there is a tendency for the complex of activity to change. In-building activity does not change appreciably in the square itself - the library, hotel, and eating places maintain their levels of use - nor does it seem to change along Huntington, and the fact that the lighting is there at night to permit this activity makes automatic a congruence with the characteristic areas of most building activity during the day.

A bigger problem is congruence with visible street activity, and if Copley Square is any gauge, city lighting poses this problem in an unusual way. The lights of vehicular traffic help to define night patterns of movement, sometimes well enough so that the remainder of the lighting structure can concentrate on other problems of congruence. The major one seems to be inconsistency in formal fit with pedestrian activity. The
FIGURE 10
COPLEYSQUARE
MAJOR PROBLEMS IN
THE EXISTING LIGHTING STRUCTURE

- Lack of relation
- Impropriety of component
- Poor identification of space
- "Floating" source
- Inadequate definition of form; "facadism"
- Lighting causes spatial discontinuity
- Variable form component
- Inconsistency between lighting and activity
structure seems very often to express correctly where there is activity in Copley Square at night and the way in which it functions. Other places, however, do not have the same level of activity but the sidewalk and building lighting gives that impression. Sometimes, such as at the MTA kiosks, there is no fit between the lighting and either the day or night activity, the lighting being almost non-existent while the activity seems omnipresent. In terms of larger scale considerations such as conceptualizing the entire district, the "shrinking" of the district's lighting structure does not consistently correspond, even proportionally, with the "shrinking" of the perceived threshold of visible pedestrian activity. If activity patterns are important to an area like Copley Square, these apparent inconsistencies - sometimes fitting the day pattern, sometimes the night, sometimes not quite either - may be confusing and may hinder the observer as he tries to form his recollections of the day form, or tries to organize the night scene. There should be some organization of the lighting structure which clearly conveys one or the other or, if this is not desirable or practical, should at least clearly distinguish which parts of the structure are to be congruent with what type of activity.

In an area which seems to need some key organizing features, the lighting structure gives little sense of a principal focus which would strengthen the identity of Copley Square; at present, the central part of the study area presents a confusing pattern at night, made more difficult to organize because of the complex network of autos and pedestrians. One reason for this additional lack of organization might be the fact that the lighting is not so well integrated with explicit clues for orientation at night - the structure fails to be used to define key directions or points of decision in major sequences. There is no inter-
relation with public signs and other guides to orientation, especially since the lighting is not consciously used to separate and organize vehicular from pedestrian areas.

Where people move is inseparable from how they move, and the problem of mode and modal change must be considered. The Copley Square MTA station gives no indication that this is Copley Square, with its openness and many points of interest. It is suggested that this identification below ground be made, as well as the identification above ground with the fact that below the Square exists an entirely different but very essential part of this district.

Since much of the expressiveness of the Copley Square area is in its buildings, their identity in the lighting structure should make for continuity of the meanings associated with the study area. However, an equally important concern of the lighting structure is the type of expression which results from total interaction - the general character - and whether this corresponds with the conceptual attitudes of the observer. Except for the Huntington Avenue portion of the area, the absence of moving sources makes the area seem quieter. There is "order" in the rest of the structure, to varying degrees, most exemplified in form components (there is more order in that part of the lighting structure on Boylston east of Clarendon than Boylston on the Square, for example), and this reinforces the formal elegance which is associated with much of the district. Continuity of the expressive qualities of the basic image is incomplete: the floor pattern seems a significant contribution but is de-emphasized in the lighting structure. The landscaped area, the brick paving around the library, the steps of the library and of Trinity Church,
the trees around Bonwit's - these are all subtle ways of reinforcing the associations which can be made with the landmarks, and should receive some consideration in a revised lighting structure. Even though the green space of the center is not visible many times because of the parked cars around it, the image of an open space, a meaningful space, does exist; its articulation would not only strengthen the physical center of the area but would enhance the expressiveness of the lighting structure as a whole, adding to its aesthetic qualities.

Continuity of image qualities is necessary, of course, but this does not mean that total continuity is essential to any area, even Copley Square. However, the nature of Copley Square is such that its strong image and strategic functional role are very important, when considered relative to the whole - to the larger visual and functional forms of the city - and that these characteristics should be reinforced for a minimally effective structure. Still, there is room in the Copley Square lighting structure for expanding its effectiveness in the formation of new images and potentials in independent use.

The lighting structure is not expressing the changes in the district, or at least not relating these changes to the total environment. The darkness of the Prudential excavation, though perhaps a dominant sequential feature, does not appear essentially darker or lighter than the area did when it was in use as railroad yards. Moreover, Copley Square's lighting structure does not relate to the proposed new Center and, thus, does not express the new potentials of the study area. Blagden Street and Boylston Street hold great opportunities for doing this, paths on which the structure may show the relation and connection between old and new.
The lighting structure misses entirely the possibilities for independent use in consciously planned experiences intended for sensual delight and the formation of unique areas. The lighting should be used to provide experiences in rhythm, texture, and contrast in presently dark, little used areas, as a way to encourage use and as a possible first step in using lighting to provide specially planned networks of sequences throughout this part of the city.

Finally, some evaluation of the intrinsic characteristics of the lighting structure should be noted, in accordance with the goals established for that purpose in Part One.

A light sky is of benefit to the district because it will tend to silhouette the distinctive shapes of the landmarks and increase their visibility. In the absence of such a condition of natural light, contrastingly-bright sources must assume much of this burden, especially from a distance. The John Hancock Building plays a major role in permitting the lighting structure to adapt to any such external modifications.

The lighting structure is not subject to much internal change in its source components: advertising signs which are first lighted at dusk remain lighted well into the night, long past the hours of intense night activity; where dominant sources are turned off (as on the theater marquee on Huntington Avenue) the streetlighting tends to maintain the role of sources in the spatial character of those areas.

Effectiveness of the lighting structure in this study area depends greatly on the reliability of its form components which, in turn, are often
lighted from inside. John Hancock, IBM, the library, and many of the shop fronts are examples of this, and some of them may in turn affect other forms, like New England Mutual. The variations in the New England Mutual Building are most critical to the lighting structure, because that building acts as an anchor point of a major sequence (Huntington Avenue). The instability of this form seems a problem. This is probably the most difficult part of a lighting structure to control, however, as will be discussed later.

SOME SUGGESTIONS ON REVISING THE LIGHTING STRUCTURE

Further Notes on the Lighting Structure as a Framework for Design.
With the almost unlimited resources of lighting, there may be several ways to accomplish a given objective. For example, it may be possible to define a form, emphasize an activity, rearrange certain source characteristics, or change an overall illumination quality, any of which in a given case may satisfy the specific objective set forth. In recommending changes to the lighting structure, therefore, something should be said about how the planner might make firm his decision on a specific proposal; he must have a further means for determining which alternate solution is best if several will satisfactorily meet a specific visual objective. What are the criteria, then, by which the planner might make his final judgements on the methods of effectuation?

His prime concern, if he has worked in this framework, is to evaluate his alternatives in terms of the entire lighting structure. The implications on other aspects are important - the types of new interrelationships which are formed - and the planner should go through the entire lighting structure on each one of the alternatives and measure its impact.
on the goals for an overall structure as well as its fulfillment of objects for part of the structure. In short, he should maintain the consistency of the structure.

He should also weigh the possibilities of changes, planned or unplanned, which might occur in the specific area of the visual form for which he is making this decision on lighting. If he is assured of permanence, this may allow him to choose a more permanent type of lighting; if it seems as if the area or activity is not to be so permanent a part of the district, the planner may desire to give priority to a lighting alternative which is inexpensive, can be easily installed, and can be removed or changed in favor of another with equal ease and economy.

The planner may want to know how strategic the area is to the visual form - whether it is a key part of the area. If so, he may desire the alternative solution which minimizes the risk of internal change in the structure, or can be held constant in the structure with a minimum amount of control, perhaps.

**Major Proposals.** Figure 11 shows a series of revisions to the Copley Square lighting structure, suggested as possible ways for correcting the structural deficiencies which the previous analysis has uncovered. The following numbered outline of proposals corresponds with the numbers on Figure 11:

(1) It is recommended that the lighting structure strengthen the visual connection between Copley Square and the remainder of the CBD. In particular, the structure should show some connection of the square itself with the Public Garden, along Boylston Street. Since the common
theme of the two areas is landscaping, this element should be exploited. By doing this there is the additional opportunity of reinforcing this theme by defining some landscaping in the lighting structure at the midpoint between the two areas, the corner of Boylston and Berkeley Streets. Because this problem is primarily one which is manifested at night, the use of distinctive fixtures seems unnecessary. Their use may also be difficult to integrate with the fixtures in the square and could do damage to the character of the square itself during the day. Colored sources are not advantageous either, since they have a tendency to distort delicate foliage colors. Most probably, an orderly grouping of sources which in each area would evoke an identical response in the observer would suffice.

Also, the relating of these areas would give some common element in a time series, making it a good way to differentiate and continue Boylston Street, now suffering from that in the lighting structure. On a larger scale the landscaping around Prudential Center could eventually be included in this sequence; if the major entrance to the new project is to be on Boylston Street, the relation of this path to the rest of downtown may be strengthened through the introduction of this common theme running from Prudential Center to the Public Garden.

(2) St. James Avenue and its use as the functional link between Copley and Park Squares, both day and night, should be made clear. To raise the overall level of illumination seems unwise, since the contrast of the presently dark street with the nodes at either end heightens the effectiveness of the latter by providing strong differentiation between them. Rather, this could be reinforced by using placement of sources and
for key to symbols see figures 7 and 8
for description of numbered suggestions see text

FIGURE 11
COPLEY SQUARE
SUGGESTED REVISIONS
fixtures, spacing them at increasingly closer intervals as one approaches either node, or increasing their height.

St. James Avenue should eventually have a sense of continuity beyond the ambiguous intersection with Dartmouth and Huntington, to Blagden Street and to Prudential Center. Its termination at the excavation site should be marked with some sort of lighting to define this as the other end of a spatial corridor which begins in Park Square and continues through Copley Square. An unusual type of form component, a "wall" of light, may be best, to eventually be replaced by the brightness of Prudential Center itself. Blagden Street should have some identifiable character which would reinforce it as a part of this visual link among key nodal points. This street should be a visual extension of St. James (perhaps giving some coherence to the intersection with Dartmouth and Huntington) and it is suggested that it should not differ in level of illumination. Its limited use at this time would seem to reinforce this suggestion. For now, temporary sources might be employed, rather than the permanent street-lights, perhaps growing in permanence in stages corresponding with the construction of Prudential Center. This light should be pedestrian in character (a lower height, perhaps) to indicate that Blagden is now mostly residential in character.

It is possible that colored sources could be planned for the entire length of the sequence. With a little effort, St. James - Blagden holds great potential for being a consciously-planned lighting sequence, to articulate and connect Copley Square with its immediate neighbors.

(3) It is suggested that the silhouette of the distinctive shape
of Trinity Church be strengthened. From the south, already its most distinctive side at night, the silhouette could be helped by either removing or dimming the lighted billboards which obstruct part of the view into the square from Stuart Street. From the square itself and the western approaches, the silhouette could be made more impressive if Clarendon, behind Trinity, is made brighter. IBM is a good start and it is suggested that the monolithic west facade of the public garage be made brighter to act as a background for the church edifice. Actually the balance of illumination that such strategy would produce in this block along Clarendon may help to unify that space and, by eliminating an illogical break in brightness patterns, may produce a rhythm more conducive to a continuity of that path in a vehicular-type sequence. Most certainly, this delineation of its shape would make it easier to image Trinity Church in the square itself, for those would prefer to make it their most meaningful landmark.

(4) Strengthening of other landmarks is necessary and possible. The Public Library is located at a key intersection and, because it is viewed from several directions, should be easily identified from any side. The important considerations in its physical form are its fenestration and its roof, and the method employed in achieving their continuity seems incidental, providing it does not conflict with desired brightness patterns along the surrounding paths.

It is recommended that the visibility of Old South Church and New England Mutual be continued into the night. This may be accomplished by the customary method of floodlighting, of course, but other ways are possible which would do less harm to the rich texture of the architectural
materials, especially on Old South. The tower of that landmark may be lighted internally and still be quite distinctive. The base can be related to the tower through more intense illumination of the entrances than now, because their architectural character is similar to that of the tower. Colored sources are a good possibility, perhaps repeating the color of the major landmark, John Hancock, thus tying together these three significant landmarks to explicitly define the square in the skyline of Boston. The emphasis on Old South Church should not be a dominant feature in the skyline, but should be more in keeping with its limited intensity of use. Perhaps on Sunday evenings it could become a brighter element in the scene.

(5) Dartmouth Street should be strengthened. It is suggested that the level of illumination could gradually increase from both directions as the observer approaches the square, reaching a climax at the Huntington intersection. Besides providing a new rhythmic pattern which would heighten a sense of expectation, this may be one way making clear the strong north-south connections of the Copley Square area by providing partial penetration, especially into Back Bay, rather than a distinct threshold of brightness. The same effect might be duplicated on other Back Bay streets since there is significant difference in the character of perceptual accents to permit similar brightness patterns without destroying individual identity.

There should be changes made in certain spatial accents along Dartmouth. The unity of the street is seriously impaired by the form components on the south side of Dartmouth, in the parking lot, which seem
to end the path as one approaches from the north. It is recommended they be removed, or at least have their visibility greatly reduced. Quite possibly, the elimination of these dissonant elements may have an additional implication, in that the narrower street may appear wider as a result, and more in keeping with the section of Dartmouth Street that goes through the Back Bay.

(6) Aside from identification and continuity of individual elements, and connection of the district with its neighbors, the character of the entire area should receive an articulation in light. It is suggested that lighting be employed to give a sense of organization of the whole district, its physical form and its activity patterns, using the principal feature - the landscaped center - as the key element. The floor pattern of the center should gain identification and, if parking could be eliminated, curb lighting may be an effective way of orienting the center to pedestrian use. In addition, trees might be planted to become new form components at night. Pedestrian crossings and points of concentration should be identified throughout the area. Floor material with high reflectance quality should be installed to interact with existing lighting, such that these new form components may do the job without requiring changes in overall illumination or introducing new sources. The brick pavement in front of the library and the library steps merit particular attention. Better use of the potential of the floor as a useful form component of the lighting structure may be the best method of using the lighting structure to organize activity patterns.

The character of the area would be strengthened through a common lighting of all arches and arched windows, such that these shapes would
become a thematic accent throughout the district. Color of illumination may be useful here, though not so intense as to destroy the individuality of each building.

The articulation of Copley Square from Park Square is weak, and it may be helpful to the distinct functional roles of each if the visual form provided some boundary between them. If Berkeley Street is assumed as a dividing line, the rhythm of lights and darks could have a greater tempo than either Arlington or Clarendon, its immediate neighbors. Moreover, the intersections of Berkeley with both Boylston and St. James might be accented. In order not to disturb the illumination levels proposed for these streets as a method for their spatial continuance and for structuring the larger-scale image, these intersections could have a slight change in the color of the overall wash of illumination.

(7) Revisions should be made to the source and fixture components on Huntington Avenue. There is little which can be done during the day to correct the disruption of the vista except replacing the existing streetlighting fixtures or otherwise decreasing their spatial impact. At night there is more chance to reduce the disruption once New England Mutual gains better identification in the view into the square, such that the present contrast between the streetlighting sources and the view ahead is not so great. Reducing the brightness of the sources would, of course, solve the problem but technical considerations forced the installation of these bright sources in the first place and may have to take precedence over this visual consideration, unfortunately.

A bigger challenge to the lighting structure is expressing the
educational, religious, and cultural institutions associated with Huntington Avenue further south, and there are a variety of ways this association may be strengthened. Similarity of sources and fixtures, and color definition may work well to strengthen this image of Huntington all along its route, with climax points in the lighting structure where the institutions occur, such as the intersection with Dartmouth in front of the Public Library. More refined techniques of using distinctive rhythms of light and dark are very possible, but should only be designed after studying that street well beyond the limits of the area of this case study.

(8) The lighting structure should relate the rapid transit station to the area above it. The station should have distinctive lighting, perhaps with distinctive fixtures, which will indicate the character of the district above. The wall and platforms are the form components below ground and, as in the Square, should be emphasized in this part of the lighting structure. Orderly but distinct patterns of light and dark are recommended; shadow patterns on the walls, perhaps, which are arched-shaped to express the significant detail of the area. Advertising signs which relate to uses and activities directly above should be specially illuminated.

(9) Special sequences are proposed for several of the alleys in the area. These are service alleys during the day but, typical of such minor paths in a city, are dead, unused areas at night. Rather than suggest specific lighting plans here, it is hoped that these alleys could serve as prototypes for wider application of lighting as an independent element of the visual form, creating sensual effects which invite the observer to explore city lighting for its own sake. These paths in
Copley Square could perhaps serve as lighting laboratories, where the sequences could be changed periodically, trying new ideas and at the same time providing the observer with new forms of delight in his city.

(10) During the day, the details of the area and the lighting structure already suggested for defining the Square and relating it to its neighbors should be used in adverse daylight conditions. Moreover, a system of coding should be devised for use both day and night, whereby many directional signs may be visually reinforced, e.g., one type of color to indicate the rest route to Cambridge, another to point the way to Scollay Square. Symbolic characteristics are seldom used consciously in Copley Square.

Beginning at twilight, or the early evening rush hour, the public streetlights in the square itself, should be the first components to appear. They should be lighted first, to full intensity, while other public sources are equipped with dimmer controls which permit a gradual building up of intensity which reaches a climax at the peak time of the evening activity around the Square. Other thematic accents which serve to characterize the district, such as the arch lighting and the Hancock beacon, should also come on very early.

Gradually the rest of structure could fill out, now concentrating on general patterns rather than details: the busy textures of light, where they correspond with night activity, could increase in complexity or brightness at the same time that those textures which relate to day activity (e.g., Boylston east of Clarendon) gradually simplify in pattern.
The high point of the first should watch the low point of the second at the height of the evening activity (or at midnight, perhaps) and then this sequence could gradually reverse itself, to be completed at dawn.

A coordinated time order for a lighting structure can be an additional source of enjoyment for the observer and, as these simple recommendations demonstrate, such an order is possible without impinging on the overall effectiveness of the structure.
PART FOUR
THE PROBLEMS AND POTENTIALS OF CITY LIGHTING

THE CASE STUDY AS A BASIS FOR GENERALIZATIONS

Review of the General Framework for Analysis and Design. The basic classification of structural components seemed adequate to observe and analyze the lighting structure of Copley Square. Forms were especially useful to single out and, because they eventually were found to be so important in the district's lighting, it might prove valuable in other studies to divide them into several sub-categories for analytical purposes. Building forms, for example, might be better analyzed in terms of those which receive light externally, like New England Mutual, and those which are predominately internally lighted, such as the Public Library. Other ways might be to distinguish between manipulative and non-manipulative forms, or to make clear the distinction between stable forms and those whose light patterns are subject to constant variation.

But Copley Square may not be typical in its reliance on form components. It might prove important for analysis, then, to observe which general classification of components is critical to the lighting in any given case, and make adaptations and refinements to the analytical technique accordingly.

The scale at which a lighting structure is studied may determine which interrelationships are critical to its functioning, and how easily they may be observed and analyzed. Contrasts, of course, are the key to providing strong spatial effects at any scale and could be studied quite easily. Rhythmic effects, however, seem more difficult to examine here. Some attempt at conscious rhythms of light to dark to light,
or from active to quiet to active again was implied by the design proposals wherever a complete analysis was possible. But rhythms over time, especially in automobile sequences, could not be studied fully at this scale. In this respect, the suggestions for revising the lighting structure are inadequate; the size of area chosen for study could not give indications of the full implications of any proposal on the more comprehensive considerations of automobile sequences. Larger-scale studies may well find the rhythmic interrelationships as the best way to develop an effective lighting structure, and a later discussion will cite some possibilities.

On the Problems of City Lighting. The conceptual framework suggested can be refined to suit the planner's needs, and any further general discussion seems unnecessary; given this skeleton, the planner can proceed on his own. It is important to this study, however, to speculate on how useful is Copley Square as a model having a typical range of problems which the planner may expect to appear elsewhere in a city lighting structure, and thus be looking for in his analysis.

It is difficult on the strength of one empirical study to state conclusively whether the key problems in Copley Square are applicable to all parts of the city lighting structure. With some areas - residential districts, for example - the Square is probably an inadequate model. But if Copley Square is assumed as more or less typical of central city business and commercial areas, some of its problems in lighting may also be typical of these areas. Congruency with activity may prove important and, with the impact of urban renewal in American cities, the whole problem of the proper role of a lighting structure in a changing environment would seem
a general consideration. Connections with other downtown areas is not a problem unique to Copley Square either, and better articulation and unification of image elements may well benefit any complex city area. To a greater or lesser extent, therefore, it appears as if every area of a central city will exhibit problems similar to those encountered in the lighting structure of Copley Square.

STRUCTURAL UNITY AND THE PROBLEM OF CONTROL

Though other problems may be less readily generalized, it is possible to perceive a difficulty in the internal structure of Copley Square's lighting which would hold true in all cases and, therefore, is worthy of special note. Even the limited number of changes suggested for the lighting in Copley Square indicates that much of the planning is not so much a technical problem for the engineer (though this should not be negated) as it is a problem of determining an effective mechanism for insuring that the structure be consistent and reliable in its role in the environmental image. This problem of control seems very important.

If a lighting structure is to be consciously planned, special attention would have to be given to privately-operated components. In particular, this attention must focus on the role of form components in the design, especially those which depend on interior illumination for their exterior appearance. It seems risky to depend upon these as the backbone of the lighting structure (especially where interior functions might change) unless ways are found to control them. Cooperation from the private domain seems essential. Even exposed sources, because of their frequency of use and critical message qualities, are important; perhaps new advertising displays could be checked against the total
lighting structure before their installation is approved. Sign control is already a consideration in many zoning ordinances, and some of them have included control over the lighting of signs. The courts have been increasingly receptive to legislation intended to promote the public welfare through aesthetic and visual considerations provided they are in accordance with a comprehensive plan. The concept of a planned lighting structure may provide the vehicle through which city lighting controls may gain favorable judicial reception.

The planner should be aware of where he needs control in a lighting structure. Some places, such as private buildings around intersections important as nodal elements, may not be entirely controllable. Legislation is a solution, but there are others. Incentives might be offered which could accomplish the same thing – in Copley Square, for example, it may be possible to encourage critical buildings such as New England Mutual to be lighted in certain ways by granting tax reduction in proportion to the cost of providing this illumination. An imaginative planner could avoid even this, perhaps. Carefully conceived arrangements of new public sources and forms at these critical points could take the emphasis off the "unstable" components of the lighting structure, and be a way of circumventing the problem.

For example, the planner should be aware beforehand of where he has a chance of control for visual purposes. Much trouble could be avoided if he is able to exploit these key elements. Sign control has been suggested, public parks and buildings are also available, as are streetlights and pavements. The new role in the lighting structure which has been proposed for the central landscaped area of Copley Square may eventually prove to
be a good example of how a shift in visual emphasis from private buildings around the green area to the green area itself might lead to a more stable structure. Another key to a successful lighting structure can be the new buildings in an area: their form qualities in a larger setting of city lighting could be given consideration while still in the architectural design stage.

At the larger scale, it may be necessary to devise new ways of handling the control of planned sequences of light (especially critical points of contrasting change), or maintaining a general texture of light throughout an area. Such controls are not available, however, until general policies are set down for what an area's structure should look like. And more sophisticated treatment of the lighting structure brings more complex problems of control: if the planner did desire the lighting structure to change in a coordinated pattern during the course of an evening - even a whole city to get brighter and darker in alternate hours - he might be faced with a new set of difficulties. Most certainly, the time pattern suggested for Copley Square is a ready example.

All this does not imply that controls should lead to a rigid structure. A flexible structure is encouraged because the city itself changes. But some things do not change, and are necessarily maintained in an orderly fashion. The lighting structure should focus on these key problems, and face the need for control, if it is necessary. In the long run, however, it is hoped that "cooperation" rather than "control" becomes the word associated with the city lighting structure.

POTENTIALS FOR ARTIFICIAL LIGHTING AT OTHER DIMENSIONS
This paper has studied the artificial lighting structure of the city in a very limited setting in space and time: the area studied was that of a small city district (or large node, perhaps) and the time span was the simple change from day to night. There exist other scales, perhaps even other objectives towards which to work, and it would be interesting to look briefly at some potentials of artificial lighting in a broader context.

It is conceivable that the entire city or a metropolitan area could have an organized, cohesive lighting structure, one which can be integrated with the visual form and at the same time be a coordinated independent source of delight and stimulus. Distinct changes in brightness may be employed to differentiate one element from another, or changes in the source colors, or fixture character, or even imaginative combinations of patterns of illumination with patterns of component characteristics - there seem to be a variety of ways to take apart and put together a city with light. Since it is sensed in motion, much can be made of effects like organizing sequences in lights and darks: extreme brightness to define key points or entrances to special areas, and extreme darkness around them to highlight these points from a distance, for example. Brightness patterns could be the key to sequentially connecting the parts at the very large city scale, thematic accents might define the city at the level of the district (such as the order and formality of Copley Square), and special accents of illumination or of a characteristic of a component could handle smaller areas and key nodes.

Such a refined lighting structure could play with rhythmic sequences along high-speed highway routes. Busy, active areas through which the
road passes could be expressed with a very quick and intense rhythm of lights and darks which would be experienced by the driver. Color could be used to express the uses (or even historical and cultural meanings) by which the area is identified, or color can be used to differentiate the exits on a limited access road at night; indeed, the potential of color coding in time sequence throughout the metropolitan area should be explored further.

The sense of the observer's motion could be intensified in other ways, such as walls of light at curves in the path, lighting under bridges to accentuate the experience of being "above" something, or a kinetic line of dominant sources.

Topography and natural features of the metropolitan environment might be enhanced with artificial lighting. Orientation could be improved where dominant hills or changes in slope or landscape could be defined, directly or indirectly, using care not to distort their natural qualities; natural features with distinctive shapes might be particularly impressive if the lighting could put them in silhouette. Water—large bodies of water—holds great potential also. Reflecting lights could be consciously planned as a way of achieving certain objectives (in Copley Square there was not that opportunity), and exposed sources floating on the water is another possibility. As an unusual example of the potential of artificial lighting and water, there was one experimentation during World War II with large-scale lighting effects to simulate the shoreline and downtown lighting of Chicago some five miles out into Lake Michigan, as a novel defense against night bombing.*

* This incident was mentioned to the author by Professor Kepes.
It is also possible for lighting to be coordinated with city noises, smells, breezes, earth and other textures under foot, in conscious arrangements intended to delight several senses of the observer simultaneously and, in some old areas of a city, may be a new way to exploit some of the unique characteristics which have been built into their micro-climates over many years.

There may be places in the city where the lighting structure may operate even more independent of any other visual form considerations than has been considered so far. In Copley Square it is hoped that back alleys could be used in this respect. Melodic sequences also seem possible along paths through parks, or on pedestrian malls: pools of light, spots of color, or even an entrie pattern which is changing as the observer walks through it, e.g., first being all blue, then going into yellow, and so on. Lights may be coordinated to blink or move in an increasing tempo as the observer proceeds towards his destination. Such sequence specialties need not have to be experienced, but just seen; wall surfaces could be employed which change their lighting, where the observer is sitting or otherwise not himself moving. Indeed, it is conceivable that the lighting structure in these independent areas may evoke a vivid image of its own, such that the normal process of image continuity may have to be reversed, with the day form acting in support of the artificial lighting.

New concepts for fixture would also be important. On the Pont du Carrousel in Paris, the streetlighting fixtures are recessed in the bridge structure during the day, so as not to detract from the view, being raised mechanically at night to provide the necessary light. 3/ (This might prove an interesting way to solve the Huntington Avenue problem in
the Copley Square study.) Some work has been done in placing lighting in
handrails and, as proposed for Copley Square, at curb level, 4/ but this
design field is still open to further ideas.

Continuity of the image over longer periods of time, through season-
al change perhaps, should be considered. Dramatic and expressive effect
through conscious adjustment of the lighting structure when there is snow
on the ground, and when the landscape undergoes seasonal changes are
potentials not yet really exploited. Displays of holiday lighting would be
a good test of the structure's internal flexibility.

The relation of subway systems to other lines of communication and
to the form of the city above seems a natural potential for artificial
lighting, even further than already demonstrated in Copley Square.
Stations could be differentiated all along the route through lighting
which is expressive of the uses and activity above each station. Above
ground lighting could also be employed not only to direct the traveler
to the nearest kiosk but also to define the underground system of tunnels
in relation to the street system, affording a continuous visual link
among all the arteries of the city.

The entire metropolitan lighting structure might well enhance the
visual form if a meaningful order in which the lighting is turned on at
dusk could be devised. Major traffic routes, key nodal-points, and
specific clues for orientation could be lighted first, throughout the
structure, to coordinate with rush-hour activity early in the evening.
Sign control might be extended such that restaurants and stores which
cater to early evening activity could be lighted before other, later-evening
activities. Rhythms along a path could change tempo, from a very textural pattern of lights and darks early in the evening when people are coming into an entertainment district, thus heightening the excitement and anticipation of an evening in town, to a much quieter pattern later at night, indicative of a leisurely drive home. If a stimulating contrast is desired between the drive and the destination, the planner might desire instead to reverse this procedure of tempo change.

Finally, the lighting structure may be able to attain a level of refinement which is beyond conceptualization at this time. The technical advances in light continue (recently scientists shone a light from the earth to the moon, illuminating part of its surface. 12/). Thus it seems the challenges to the visual planner will continue to increase if he intends to make proper use of new potentials of light. He too must find potentials and techniques in his own domain.
CONCLUDING REMARKS

This thesis has dealt with the visual analysis and design of artificial lighting in the city, working with the concept of studying lighting as a whole, as a structure of lighting, rather than in isolated parts. Based on the application of this concept to a case study, it seems quite plausible that this type of approach is ultimately the most fruitful way of making effective use of this element of the physical form of cities. There is no claim to a complete study within these pages, but it seems that the limited intentions of this paper have been realized: a complex lighting structure can be observed, analyzed, and designed through simple techniques.

It might be best to summarize this thesis in terms of the process which is used in the planning of city lighting - the methodological technique which the planner must employ. He should be concerned with establishing general goals for a planned lighting structure. Continuity of image qualities is a prime consideration, as is exploitation of artificial lighting as an independent element to perform new visual tasks, at all scales of time and space. In preparation for analysis and design of city lighting, the planner must study and evaluate the total visual form of his area, as was done in Copley Square, to find strengths, weaknesses, problems, and potentials. This will enable him to set specific lighting objectives within the framework of the general goals.

The planner should be surveying the existing lighting at the same time, observing its parts, and its roles in the visual and functional forms of the area. He should get a sense of the lighting in broad characterization and translate these qualities into the language of the lighting
structure; he should record textures, contrasts, and rhythms in terms relative to the components with which he must eventually work. There may be other characteristics, but this paper has suggested that understanding the qualities which are formed by patterns of overall illumination and by physical characteristics of components are convenient to interpreting the nature of the interrelationships in the lighting structure; the case study has shown that if these characteristics can be recorded they are useful in analysis and design. The planner may find, as in Copley Square, that he must record these effects as a series of sequences. It may also be useful to him to undertake comparative analyses where relations with other aspects of the visual form and with other points in time are to be considered.

From his analysis of interrelations in the lighting structure, the planner must proceed to the details of sources, forms, and fixtures, because these are the components whose manipulation will produce the structure desired. The critical components are made manifest during evaluations of the characteristics of the overall structure. For example, certain form components were found to be determinants of a large part of the spatial effect of the lighting in Copley Square. The designer then operates on these components, adding and subtracting, accentuating or diminishing, etc., until he has produced a lighting structure in accordance with his goals and objectives. He should be able to justify his choice of one alternate design solution over another; throughout this design stage, the planner should be constantly checking his decisions on lighting against criteria for insuring that his solution will maintain itself through any external and internal changes which he cannot otherwise control.
This paper also implies that this planning of the lighting structure could be a part of the total visual planning process; many of the diagrams and all of the preliminary research included here would have had to be done anyway in the normal course of a visual planning problem. The classifications and methodology suggested for the planning of city lighting are, in effect, simply-integrated and necessary additions to the concepts already available for operation on the environmental image. In fact, it must be done this way; comprehensive visual planning must include considerations of the lighting structure.

There were ways in which this thesis could have been refined, and these must now constitute the basis for further research. Most certainly it would have been advantageous to study Copley Square over a longer period of time and in various weather conditions, in order to discover more about it and its lighting structure. A year's duration seems the only way of getting a comprehensive analysis. As for the technique of recoding the observation, there are limits on a two-dimensional diagram which can best be resolved through studying the lighting structure in a three-dimensional model. The model would be an excellent device for examining the effects of lighting on the actual physical scale of an area. A model would also be a more effective design tool, whereby new ideas could be inserted and studied in a reasonable simulation of actual conditions. But before a model could be constructed, some form of observation and mapping would be necessary, such as was done in this paper.

There are other unanswered questions in city lighting, many of them made manifest in Part Four. Even by narrowing the range of possibilities through the constraints injected into the general framework, the design
choices may still be numerous; the case study often proved this. The constraints help to insure decisions which are in accord with objectives by eliminating many specific choices which might impair the effectiveness of the whole. That decisions on Copley Square may not always seem to choose an alternative satisfactory to the reader, might be due to limits on imagination, rather than shortcomings in the general framework. More areas should be analyzed, both similar to and different from Copley Square, both in size and character, to make firm some of the generalizations made, test the applicability and limitations of the concepts, and to discover new problems and potentials. Much more precise determination of the total visual effects of interrelating components also seems necessary.

The considerations of the metropolitan form might come next, in order to discover the problems and potentials inherent in a total lighting structure. And, concurrent with research into these and other aspects of artificial lighting in the city, the problems of effectuation and control must be granted equal and immediate priority.
APPENDIX

ADDITIONAL NOTES ON MAPPING THE LIGHTING STRUCTURE

The study area was observed by the author on various occasions in March and April, 1962. However, in actually drawing Figures 7, 8, and 9, it was decided to record only those observations which were made under the condition of no moon (absence of natural night lighting). This would provide information for planning a lighting structure which would be effective in somewhat adverse external conditions. The purpose of a large number of observations was that the general framework indicated the usefulness of studying variations caused by night of week and time of night, in order to check the internal consistency of the lighting structure. Additional diagrams were to show the variations, but since the area did not exhibit much change except in two buildings, a verbal note was substituted for the diagram.

Since the apparent brightness of a space depends more on the relative proportions of light and dark than the measured intensity, a light meter was not used in recording the level of illumination in Figure 7, this information being based instead on the observations of the author.

The photographs were taken in May. They were not used in actually studying the area and thus are not considered part of the analytical technique; they are included only for the convenience of those readers not acquainted with the study area.
SELECTED BIBLIOGRAPHY


2/ Boston Sunday Herald, April 1, 1962, Article on the Historic Development of the Back Bay.


