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The relationship between visual preference and spatial scale in outdoor urban plazas

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THE RELATIONSHIP BETWEEN VISUAL PREFERENCE AND SPATIAL SCALE IN OUTDOOR URBAN PLAZAS

by

Shawn Timothy Kelly

A Thesis Submitted to the Faculty of the

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In the Graduate College

THE UNIVERSITY OF ARIZONA

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I dedicate this thesis to Barbara Kelly, for I could not have done it without her.

TABLE OF CONTENTS

TABLE OF CONTENTS--Continued

LIST OF ILLUSTRATIONS

LIST OF TABLES

ABSTRACT

The focus of this thesis is on perception of human scale in urban plazas. The hypothesis tested is that preference for outdoor plaza spaces as measured by invitingness, comfortableness, and visual quality increases in relationship to an optimum viewing angle. Scale in the context of this thesis is defined as the ratio of the height of vertical elements to the distance between the observer and the vertical element. The visual angle reaches an optimum as the viewer approaches a distance equal to twice the height of a given structure. This hypothesis is tested by showing 120 color slides of urban plazas to viewers in a controlled viewing situation. The slides are rated by 115 observers for visual quality, invitingness, and comfortableness. Linear regression is used to test the relationship between the dependent variables and the independent variable of visual angle. Results of the test show that visual angle does not predict preference response for urban plazas.

CHAPTER 1

INTRODUCTION

This thesis is an investigation of traditional design notions of spatial scale to human preference for urban landscape spaces. The design literature shows an evolution of design principles in art, architecture, and landscape architecture to modern design guidelines. There is little design research to substantiate these design principles within the context of modern environmental psychology techniques.

As the cost of real estate has spiraled in both economic and social impact, the price of mistakes has also increased. Now more than ever the designer needs better guidelines to ensure success in the face of the rising costs of construction. It is the intent of this research to examine the empirical relationships between the perceptions of observers and vertical scale elements in the landscapes of urban plazas. In this study "scale" is defined as the size of objects relative to some normal value (Marsh 1964). Scale can, and has in the literature, implied two objects' relationship with each other, to some other value, or relative to a human observer. By defining scale relative to the human observer, we must consider whether the object's size is relative to the human's physical height (Ashihara 1970), to the human's perception of the object's height (Licklider 1966), or to some cognitive construct on the observer's experiential past (Zube, Sell, and Taylor 1982).

This thesis explores the evolution of the concept of scale in design. The literature review (Chapter 2) traces the historic development of the concept of scale in art, architecture, and landscape architecture up to the modern concepts of scale. These modern concepts include the notion of human scale. The literature review concludes with a definition of human scale as used in this thesis and the goals and objectives for this research. Chapter 3 describes the research methods along with definition of terms. Chapter 4 discusses the research results. Chapter 5 states the conclusions from this thesis.

CHAPTER 2

LITERATURE REVIEW

Garden History

The purpose of this review is to demonstrate the evolution of the notion of scale. This process follows the historical evolution of design concepts relating to scale from the early principles of proportion in art to the modern concept of human scale.

In the design of formal garden spaces there have been four major historical traditions leading the evolution of landscape architectural theory. Roughly in chronological order these traditions include: the Islamic influence; the Oriental garden; the Renaissance gardens; and the English design tradition. Within each tradition there have been countless adaptations of basic design tenets to conform to local circumstances and changing demands placed on spaces by co-evolutionary societies. In the literature of garden design, there has been little substantive information on the structure of the garden.

Man must first establish his relationship with the environment before there is a basis for analysis of scale. Walmsley (1975) argues that initial philosophy in garden structure removed man from nature, followed by the orientation of man in nature, to man superior to nature, and finally to man with nature. Each of these philosophical statements served as the basis for a participant's perception of the garden, for the psychological component of perception must involve man's picture of himself in relation to nature. The basis for these varying orientations in philosophy are evident in specific examination of the designs produced.

The Islamic garden was "paradise," the antithesis of the arid environment outside the garden wall. Man and garden were definitely removed from nature. The garden wall described the boundary of paradise (Walmsley 1975; Wilber 1962).

The Oriental garden concept reflected the integration of man and nature, and that harmonious relationship is evident in the designs of these gardens. These spaces often involved vistas of the surrounding landscape, placing both garden and man in a perspective (Walmsley 1975).

In the Renaissance man's faith in his new-found strengths and blossoming understanding of nature urged him to place himself above the natural. Man viewed himself as the anthropocentric center of the universe/global garden (Strong 1979). Late medieval and Renaissance architects embraced the "Pythagorean conception" that everything is numerically integrated and described (Wittkower 1952). The relative size of objects was formally addressed by the perfection of the perspective method. This method provided for predictable size relationships in space relative to a human observer. The design of landscapes responded with the expressions of ostensible power in the Henrician heraldic and Elizabethan emblematic gardens (Strong 1979). The use of screens and points de vue allowed the designer to enframe particular views and direct one's attention down linear perspectives to give a greater sense of scale to structure and garden alike. Though no specific references are made to scale issues, the skillful manipulation of perspective principles by designers clearly demonstrates their ability to manipulate scale elements to attain the desired perception of power. Another example is Henry VIII's Hampton Court. Here the "garden is made a symbol of the new monarchy's power and prestige" (Strong 1979, p. 10).

The English tradition approximates the Oriental concept, yet allies man with nature rather than equating the two. The prominent anthropocentric viewpoint will not allow man to re-enter the garden as an equal, for now he must understand the essence of nature and reproduce naturalistic scenes in the landscape. The English influence prompts the study of gardens and the natural with the egocentric idea of understanding and recreating the appearance or effect of nature. This philosophical basis predictably yields more information for this research on scale than have the previous traditions. This latest genre of landscapes used the strong Renaissance concept of scale and introduced it formally into garden design.

In the 1620s and 1630s, Inigo Jones stressed the unity of house and garden in his designs (Strong 1979). There is no record of any criteria for these designs accounting for differences in various elements' scale or the implicit integration of house scale to garden scale. However, these English landscapes indicate a strong idea of element size relationships within the garden. The principles of Renaissance scale were used in selecting sizes of plants and other elements, yet the theory was not referenced by the designers. The judgments of scale relationships were artistic and not quantifiable. It is important to remember that these Romantic gardens of the English design tradition were the product of a design genre begun by artists and writers. The landscape paintings of Claude Lorrain and Nicholas Poussin compelled the English designers to emulate nature (Kelly, Guillet, and Hern 1981). The canvas of Watteau along with the complex political situation in France prompted the French designers to the similar, simple landscapes of the Regence garden (Wiebenson 1978).

It was in the early eighteenth century that scale was first specifically addressed in the landscape design literature. In the writings of A. J. Downing, four subdivisions of the romantic style were described (Kelly, Guillet, and Hern 1981). In the first subdivision, the "Sublime," immense scale in the adjacent landscape was to be captured via the placement of viewpoints and framing elements of vegetation and structure. Scale was recognized and enframed, though never quantified. The categorization of elements by size-relative-to-observers indicates an understanding of the concept of scale.

In Downing's three remaining subdivisions, the "Beautiful," "Gardenesque," and "Picturesque" garden categories, he alludes to various elements' relationships to man. From the "bold" elements in the picturesque landscape to the "pastoral . . . flowing" elements in the beautiful garden, he expresses size and shape relationships of objects to man which affect his perception of the garden. The gardenesque landscape reflects the natural element of romantic landscapes, and as such dictates various arrangements of plantings and views to indicate the grandeur and power of nature. This literature marks an exciting point in the evolution of scale as a principle in garden design.

In the writings of Downing we find the first concrete references to scale issues in the garden. He writes,

> Grandeur and Sublimity are also expressions strongly marked in . . . the noblest portions of natural landscape. But, except in very rare instances, they are wholly beyond the powers of the landscape gardener, at least in the comparatively limited scale of his operations in this country. All that he has to do, is to respect them where they exist in natural landscape which forms part of his work of art, and so treat the latter, as to make it accord with, or at least not violate, the higher and predominant expression of the whole. (Downing 1967, p. 72.)

Taken alone it seems to indicate a moderate understanding of scale on a per-site basis, yet the same text yields the following: "When large poplars [Lombardy Poplars] of this kind are growing near a house of but moderate dimensions, they have a very bad effect by completely overpowering the building, without imparting any of that grandeur of character conferred by an old oak, or other spreading tree" (Downing 1967, p. 178). Here Downing cites the sixth principle of road construction by Henry Repton, which holds that the "house, unless very large and magnificent, should not be seen at so great a distance as to make it appear much less than it really is" (Downing 1967, p. 340). These references indicate that scalar issues were recognized by designers of mid-nineteenth century gardens. The quote also indicates a qualitative understanding of scale as derived from landscape painting. This observation is borne out by references "that Landscape Gardening and Painting are allied" (Downing 1967, p. 72).

The general landscapes preceding Downing relied extensively on the principles of composition used in the fine arts. The product was beautiful scenes in the landscape. Downing's explicit discussion of scale represents the beginning of the formalistic design training of the twentieth century. This marks the beginning of a rigorous notion of scale in the landscape. The recent writings of Waugh (1910) and Eckbo (1969) recognize the importance of identifying scale within the landscape. The work of Fairbrother (1974) recognizes the existence of fore, middle, and background scale. There is no testable notion in the literature of landscapes which identifies scale in terms of human perception. Once this relationship between perception and scale is identified, the rigorous approach to scale in design will be achieved.

Art and the Evolution of Garden Design Theory

The history of graphic art is almost three times longer than that of writing (Hall 1966). The scale relationship among objects is implicit in graphic representation of any scene. The history is vast, but prior to the Renaissance and the development of the perspective method in art, the decisions about scale relationships were primarily matters of religious significance, ceremonial decisions, or psychological expressions. We can infer that then, as now, man structures his own visual cosmos (Hall 1966). Much of the early art before the development of a bona fide perspective method confirms that scale was perceived as important, yet not understood.

In the landscapes of early Greek art there is little space for manmade elements (Gardner 1914). The Roman architect, Vitruvius, credited the Greeks with modeling their columns after similar proportions in the human form (foot length to body height) (Winckelmann 1895). While this notion has not been confirmed, the rules of proportion in art were probably adopted from the proportions of the human body. Sculptors were ostensibly the strongest force in promoting this canon. Later architects adopted the same proportional rules and thus ingrained the human scale notion into their art (Winckelmann 1895). Interestingly, the first record of the criterion for scalar decision making in the built environment was to come from these later architects. The Greek artists relied on their perceptions and religious doctrine for the depiction of proper scale, and its depiction became an expression of devotion to their deities (Dorra 1968).

As the strong Greek influence passed from art, the darkness of the middle ages pervaded. Medieval art often includes background figures which dwarf those in the foreground. This error in perspective/scale is based on what differentiates the visual field (that which the eye sees), and the visual world (the perceived image based on viewer information) (Hall 1966). The juxtaposition of visual image and perception are evident in much of the primitive art worldwide and culture independent. It is also obvious that no specific theory existed concerning the perception of scale and its representation in graphic form. The theory of the Golden Section, or Golden Mean, stands alone in this period as an advance in the investigation of size relationships of objects. The lack of communication common to this historic period limited the growth of this theory of proportion in both its scope and use.

In the Renaissance the representation of three-dimensional space as a function of linear perspective became the norm. With the codification of linear perspective rules came the differentiation of visual field and visual world (Hall 1966). The artist was now forced to identify the physical dimension and relate it to the perceptual dimension. By creating a perspective grid, complete with vanishing point and horizon line, the artist was required to consider scale relationships in reference to the viewer's field of vision and particular static positions in space. Since the eye flattens depth beyond sixteen feet (Hall 1966), it became tenable to express motion/dynamic perception in a two-dimensional representation. Late Renaissance art used the rules of perspective to portray relative importance of elements in the visual field by their location with respect to the vanishing point and the observer.

The rules of perspective were treated differently by various schools of art in the years to follow. With every movement in the art world some varying adherence was given to the rules established in the Renaissance. The Renaissance concept of scale was passed to landscape design by the landscape painters who prompted the Romantic, English design tradition.

The literature of landscape architecture is closely aligned with the notions of the fine arts. Change was imminent in the evolving field of design, as evidenced by an important message sent by the prominent Landscape Architect, F. R. Elliott. In his appeal to the profession to pursue study, he posited that "taste may be possessed in a greater or less degree, but without reference to principles it will fail to create a design of harmonious proportion or association. It is to be regretted that so little attention is given to the subject of principle and arrangement of tree, shrub, flower and path as a whole in the decoration of our homes" (Elliott 1885, p. 6). Contrary to the popular notion, he asserts, "It is not expected that every man will or can be a landscapist, any more than he can be a lawyer or physician, but he should . . . be able to appreciate the reasons for arrangements of designs submitted by a landscape artist" (Elliott 1885, p. 6). The beginning of the twentieth century marked a time of transition for the designer of landscapes which continues today. While landscape gardening "is a fine art because it produces organized beauty" (Waugh 1910, p. 103), it must provide the design ability common to a more scientific rigor. The literature of the fine arts shows an evolution in the development of the concept of scale beginning with the idea of proportion by the Greeks and Romans. The Renaissance brought on understanding of scale into a three-dimensional context. The emergence of formalized design concepts did not begin until late in the nineteenth century.

Architecture

The literature of architecture is similar to that of art in that the building far outdates the written word. Many of the great edifices have outlasted their plan or design literature. For example, only by careful measurement and re-creation of the structural elements have some of the scalar devices used by the architects of the Parthenon been revealed. In this one structure exists some of the most assiduous attention to detail in the legacy of architectural history. Here we find columns whose shape has been adjusted to appear straight, when perceptually they would not had they been built in a linear fashion. We find the depth and height perception biased by construction to make it seem as it should be, despite the caprice of eye and perception. Not only scale, but the perception of scale fell under the scrutiny of these designers (Licklider 1966).

In the literature up to the Renaissance we find little mention of scale or its use. Leone Alberti's treatise on design requires that "in number, size and situation the parts of a design answer each other, be matched, balanced, and set out with the greatest care" (Alberti 1955, p. 202). In more recent writings Sitte states that "it is difficult to determine the exact relationship that ought to exist between the magnitude of a square and the buildings which enclose it, but clearly it should be an harmonious balance" (Sitte 1945, p. 26). Sitte asserts the basic premise that "the nature of perception of space, upon which every architectural effect depends, should be the basis for resolving all of the conflicting factors in city building" (Sitte 1945, p. 89). This premise allows him to note the "proper" location of monumental buildings at the edges of plazas "where they are best perceived" (Sitte 1945, p. 17). In the context in which he measured plazas (old European cities) the location he describes puts these buildings at the greatest possible distance from a static viewer. Sitte represents one of the first attempts to define scale by taking measurements of existing built environments.

With the Bauhaus and its "form follows function" precept, the "human being himself, so much neglected during the early machine age, must become the focus of all reconstruction to come" (Sale 1982, p. 187). LeCorbusier, the prominent architect of the International style of the Bauhaus, developed a proportional system for measurement based on the human figure and the golden section. He was convinced that the human body is described by the golden section theory perfected in the Renaissance (LeCorbusier 1980). The use of his Modulor (system of measures) has received a mixed result, for while he proposed to develop a measure common world (and culture) wide, the perception of his work is very culturally-dependent. However, the development of a measure based on the human occupant/participant is a great advance in the evolving theories of design and scale.

Bauhaus architect Walter Gropius was well aware of scalar manipulation and its effect on perception. He chose to manipulate scale to maximize its illusion and variety to further the intent of his designs (Gropius 1943). Here it is worthwhile to note that perception of scale may well vary with the expectations of the viewer. When one expects a grand, human-dominating scale, as in courts of justice, places of worship, and arenas for spectacles, the introduction of human scale elements is contrary to expectations and alarming (Licklider 1966).

This juxtaposition of elements was explored by Gropius to some advantage, yet without better definition of perception of scale he was limited in its effective use.

The most quantitative work to this point in analysis of spatial scale has come in the form of relative height ratios. Several authors have supported the notion that the ideal viewing distance to observe a building is at a distance-to-height ratio of 2:1 (Ashihara 1970; Robinette 1972; Sale 1982; Booth 1983; Hegemann and Peets 1922; Zucker 1959; Blumenthal 1967). Ashihara (1970) has supported this enclosure ratio by asserting there is a sixty degree cone of vision, two-thirds of which lies above the horizontal. He then states that the visual angle of twenty-seven degrees allows one to see the building as a whole when "D/H = 2 (D being the distance from the building to the observer and H being the height of the building)" (Ashihara 1970, p. 42). This ratio represents the most recent product of the evolution of a design theory of scale. The literature of architecture evidences an evolution in the development of the concept of scale from the basic proportions of the Greeks to the human scale notion spawned by the Bauhaus. This body of literature indicates no reluctance to examine scale numerically. The latest turn in the evolution of scale results in a ratio based on human perception. This latest quantification of scale began in 1922 and has begun to gain support in the literature of landscape architecture. This thesis proposes a test of this ratio in the environment of urban plazas.

Modern Concept of Scale

Territoriality

The literature on human spatial behavior was analyzed to better illustrate the timeliness of this research on scale. While no works were discovered which examine scale in particular, several pervasive and related notions recurred.

The concept of territoriality was first credited to man by Hediger (1950). He associates this preference for the familiar environment to longer species life (Moran and Dolphin 1985). Since man has evolved in response to his ability as a species, it is obvious that he is largely a visual being. Within the familiar environment the legibility of elements is at a maximum. The four elements of legibility (complexity, focality, ground plain texture, and depth) (Ulrich 1977) implicitly involve the size of things as perceived by man.

Another aspect of territoriality is that of personal space (Sommer 1969; Hall 1966). This body of knowledge does much to describe the interactions of people and places. However, the behavioral components which comprise activity patterns within settings are not adequately understood (Lang 1974). It is logical that behavior does not exist without reference to its spatial context (Lang 1974). This context requires examination to better understand its impact on man.

In order to achieve predictive power over the behavioral response of individuals in various settings, it is imperative to account for their perceptual structure (Garling 1973). The basis for judgments about the environment, in particular scale judgments, must be defined to make a predictive model for preference in design (Greenbie 1987). The correlation of social and physical facts with spatial factors allows for their measure (Bogardus 1931).

The theory of human territoriality provides a framework for quantifying human responses to the environment. This growing body of knowledge is built on the quantification of observable actions. This field defines behavioral response specific to environmental factors. This thesis uses this framework to test perception of physical scale via preference ratings by respondents.

Human Scale

The notion of scale quantifies the relative sizes of things. Since most objects are constructed to serve man, it is not surprising that human scale becomes the standard reference for all objects in all cultures. Seaby (1928, p. 20) flatly states that buildings' proportions "should be related to those of human beings. A building is ill proportioned if the eye cannot take in the scale."

Frank Lloyd Wright incorporated a version of human scale into his "Usonian" architecture. His intent was to represent the rugged individualism of the American democracy by relating its structures to their occupants via scale (Licklider 1966). He wrote, "The human figure appeared to me, about 1893 or earlier, as the true Human scale of architecture" (Smetts 1986).

A landmark work in the literature of landscape architecture by Hubbard and Kimball (1929) suggests that "absolute scale is the relation of an object to the size of a man" (p. 101). While typically no elucidation is given to the proper relationships of objects to man, the noteworthy mention of a human-scaled norm is sufficient. No works of the time endeavored to deal with empirical relationships. It was enough that this body of literature noted the necessity of a guideline for scalar decision making. By selecting the human form as a yardstick, a volume of research was implied regarding perception of the environment. Garrett Eckbo identifies scale as "creating a sense of empathy in the people who experience it" (Eckbo 1969, p. 203). He further notes that proportion "creates a sense of scale by the proper sizing of all of the parts in relation to the size of the whole" (Eckbo 1969, p. 203). Eckbo defines human scale as the appropriate scale for a human environment; that our surroundings should be related in scale to our adult form (Eckbo 1969). He further notes the absence of scalar considerations in many past designs and the abysmal effect on the general environment.

Kirkpatrick Sale suggests that "man as the measure" has been the standard for civilizations for 15,000 years (Sale 1982). In this statement's defense he cites philosophy, religion, and the French Revolution, politics, evolution, and mythology.

Vitruvius proposed the analogy of the human figure and the relationship of its parts to the whole body as the building and its parts are related. He is suggested as having used a system of fractions of a building's length to form proportional sizes for particular rooms (Licklider, 1966). This premise is similar to that later defined by LeCorbusier's Modulor measurement. This measurement was based on man's height with upraised arms (LeCorbusier 1980). The rationale for the use of the Modulor was that man will better relate to objects in the built environment which proportionally compare with his body.

While many designers of landscapes and buildings have similar assertions about the appropriateness of human-sized reference, very little has been done to prove their contentions. The concept of human scale in this study relates to the perception of scale relative to the observer's position in a plaza. Human scale is hypothesized to exist at the point described by the 2:1 ratio noted earlier in the text.

Environmental Psychology

The field of environmental psychology, called "a dominant hybrid science" (Diffrient 1975, p. 10) of psychology, anthropology, and sociology, produces research that has potential utility for designers. In this field there exists the opportunity to define spaces by their relative affect on user groups. This link between preference and behavior is a concept which has evolved in the past 20 years.

Environmental psychology assumes that people respond to spaces and/or structures behaviorally and that their responses are quantifiable by observation. It has been determined that people frequent spaces they like, and, if major adjustment is not possible, they modify existing spaces to better suit their needs (Whyte 1980). People spending time in public spaces orient themselves in a manner so as to maximize the quality of their experience. This "quality of experience" is the central issue for this thesis. The ratio relationship tested proposes a maximum preference associated with a given value. This study is an examination of the preference-value relationship in the context of urban plazas.

Sommer (1969) and Whyte (1980) observed that particular spatial arrangements are the function of "personality, task, and environment" (Sommer 1969, p. 68). The focus of this research is the "environment" consideration, and, like Sommer, contends that "man himself . . . represents the yardstick by which design solutions must be measured" (Sommer 1969, p. 72).

Psychology

It is only with the growth of modern psychology and the birth of environmental psychology that the quantitative study of scale has emerged. The recent literature of psychology establishes the fact that research methods have been developed which have proven to be reliable means of looking at environmental perception.

In 1982 Zube, Sell, and Taylor arrived at four paradigms for the evaluation of landscapes. Two of these categories for assessment, the Expert and Experiential Paradigms, lie outside the realm of this research. This study focuses on the Psychophysical Paradigm for analyzing the scale component of landscape perception. The Cognitive Paradigm will be examined as a suggested alternate methodology for evaluating the effect of scale differences in urban plazas.

The psychophysical paradigm of landscape perception proposes a stimulus-response relationship between the respondent/observer and the landscape (Zube, Sell, and Taylor 1982). The result of this analysis is a picture of the landscape as a mutable, manipulable element which will produce quantifiable descriptors of landscape perception. This analysis has been taken to the built environment in a study by Im (1934). In his research Im established an heuristic for design of enclosed spaces by testing respondents with photographic representations of given scenes. He then used the Scenic Beauty Estimation method (Daniel and Boster 1976). By examining the aesthetic-visual quality of enclosed urban spaces, Im further established the framework for future studies of urban landscapes.

Conclusions

In terms of scale, the literature of art is the least objective of the fields reviewed. This is not surprising, given the basis for the practice in creation and production of art rather than in research. The literature of architecture is the most empirical and definite, yielding height-to-viewpoint distance ratios. Though seeming to gain support in the literature, the 2:1 ratio suggested has no research verification. Garden history overview indicates many de facto decisions about scale, yet no supporting literature. The result of this dearth of documentation has been an art progressing on the strengths of its successes. The growing body of information coming from psychology has begun to forge links between behavior and preference (Appleton 1975; Kaplan and Kaplan 1982). Environmental perception research has laid the groundwork for studying aesthetics in design. This research has given us the knowledge that we can measure visual preferences for landscape (Zube, Brush, and Fabos 1975). Also we know that there is a correlation between physical attributes of the environment and preference ratings

(Daniel and Boster 1976). The work of Zube, Sell, and Taylor (1982) provides a theoretical framework for the evaluation of landscapes. Im (1984) built on this earlier work to provide a quantitative approach to design.

The goal of this thesis is to use the framework established by psychology to test the "optimal" scale ratio sponsored by recent architectural literature. This study will examine the validity of the 2:1 viewing ratio, as expressed by viewer preference, in the context of urban environments.

CHAPTER 3

METHODOLOGY

While much of the literature on spatial scale does not define scale explicitly, the current notion is that human preference is optimum when the observation point is twice as far from an object as it is tall. This hypothesis proposes the value of the vertical visual angle of an object measured from top to bottom is 27 degrees. This 27-degree value is the approximation of the ARCTANGENT of the 2:1 ratio (ARCTAN 1:2 = 26.56^{o}). This research is designed to test the hypothesis that visual preference for outdoor urban environments is related directly to the spatial scale as it relates to human scale in a given space. The dependent variables are: visual quality, comfortableness, and invitingness as measures of preference for scenes. The independent variable is the vertical visual angle subtended by a focal structure in the space. While visual quality has been used in other environmental research (Im 1984), the other two perceptual dimensions are original to this study. By way of their definitions for this study, comfortableness and invitingness define other aspects of the environment which may qualify its preference. These and the following additional terms used in this research are defined below:

<u>Comfortableness</u>: (of a place) is a measure of the individual's willingness to spend time in the space; requires the individual to evaluate his/her willingness to linger in the scene.

Human scale: Based on Dreyfuss (1966, 1974) and Selkurt (1963), the cone of vision optimally extends 30 degrees above the horizontal, with a preferred angle of 27 degrees (Sale 1982; Ashihara 1970; Robinette 1972). Human scale exists at a position in space twice the distance from an object as it is tall.

Invitingness: (of a place) is a measure of the individual's willingness to enter a given scene; requires the individual to imagine him/herself passing by the given scene and evaluate his/her willingness to enter the scene.

Plaza: open area in an urban setting, not including streets or parking areas.

Scene: the surrogate representation of a plaza transect via slide presentation in a controlled viewing situation.

Space: a three-dimensional volume defined by the ground plane below and vertical elements at any or all sides, to include the overhead plane, surrounding the observer.

Spatial scale: the ratio of the height of vertical elements to their distance from an observer, measured in the ground plane before the observer, between the observer and the vertical element which may be gauged by the visual angle subtended by the element.

Transect: the lines of sight extending from vertical structures extending into the plaza space, along which, at given increments, photos were taken of the structure.

Visual angle: that angle taken at the eye of the observer, determined by the ratio of the height of the vertical structure observed and the distance between the observer and the structure. The optimum visual angle for this research is 26.56^{o} (rounded to 27 degrees) determined by the ARCTANGENT of the distance-to-height ratio 2:1.

Visual quality: (of a place) is the individual's preference for the visually (photographically) represented space in the study.

The object of this research is to test the hypothesis that visual preference for outdoor urban environments is a function of the relationship of the observer to the vertical elements in the space in which s/he stands. Testing of the "human scale" hypothesis requires a means of measuring visual preference as the dependent variable and spatial scale, as measured by the position of the viewer in a plaza relative to a given vertical facade as the independent variable. Similar to other landscape research this research design must consider:

1. the selection of sites
2. the method of displaying the environment
3. the selection of observers
4. the response format, and
5. the method of analysis (Craik 1972).

Selection of Sites

Fifteen urban plazas were used in this study to determine the relationship between human and architectural scale. A total of seventeen transects were run at these sites, beginning at either 10- or 20-foot distances from the vertical architectural facade which defines an edge of the plaza. The photographs for each plaza were taken at fixed increments extending into the plaza space from the edge (see Appendix A). The inter-photo spaces were either 10-foot intervals (for smaller structures in smaller plazas) or 20-foot intervals (for larger facades in larger plaza spaces). At each photo point on the transect the camera was refocused and leveled to maintain a similar display.

These photographs were taken at incremental distances reaching beyond the point where the vertical object was included completely in the photo frame. A minimum of six photographs was taken along each transect; however, the closest photos for two transect sets were rejected as providing too little information for observers to determine anything about the represented site. One hundred twenty photographs comprised the total test set to be evaluated by respondents.

The plazas and transects chosen for study include:

1. Three transects at 115 N. Church Street's El Presidio Park
2. One transect at the Tucson Museum of Art courtyard/Stevens House
3. One transect of a late modern structure at the Brittania Business Park
4. Two transects at different plazas in the Pima College West Campus complex
5. One transect at Doolen Junior High School
6. One transect at Donaldson Elementary School
7. One transect at Flowing Wells Junior High School
8. Seven transects in seven discrete plazas at the University of Arizona campus.

The selection of sites was intended to provide a range of types and sizes of spaces to test the generality of spatial scale effects.

Environmental Display

A set of 120 slides depicting facades in urban plaza settings taken at successive distances into each plaza were presented in six random orders and one sub-order. The viewers' positions were located to reproduce the same object visual angle as that measured in the field. Separate groups of subjects judged each slide on a ten-point scale for either visual quality, comfortableness, or invitingness (see Appendix D for Instruction Sets).

Photographic methods have been used as an experimental presentation method in many visual analysis studies and have been shown to be an excellent means for representing visual qualities of environments. In this context it has been shown that people will respond to photographs in a similar manner to their responses to the actual scene (Shafer and Brush 1977; Shuttleworth 1984; Daniel and Boster 1976; Coughlin and Goldstein 1970; Rabinowitz and Coughlin 1971; Woolwine 1973; Clamp 1975; Abello and Bernaldez 1986).

Each photo was focused on the same point on the structure from a constant height with similar aperture settings, using a 50mm lens and a skylight filter. The photos were taken on days of little to no activity and oriented to include as little extraneous human activity as possible. Each photograph represents different view points within a given urban plaza, with a constant lighting and shadow condition. All photos were taken over a three-day period between 1030 and 1530 hours.

Each slide view depicts a single scene oriented and focused at the same point on a major vertical structure within each urban plaza. Successive photographs represent the same views taken at given increments along a transect line extending from the structure into the plaza (see Appendix B, Plaza Sectional Elevations). A diversity of vertical facades was chosen to minimize the effect of individual preference for a given architectural style or site.

Stimulus Presentation and Observer Selection

Slides were shown one at a time to groups of six subjects seated in a room prepared for slide presentation. The six observers were seated at a distance of 13'6" plus-or-minus eight inches from the screen, a distance determined to reproduce the same visual field in the slide presentation room as in the field observations of the same scenes (see Figure 1). While greater horizontal viewing is possible in the field (given the physiological properties of the human eye), the vertical angle is of greatest concern in this study and was, therefore, the critical value to duplicate. The vertical angle is of primary importance to the the thesis tested, so the unit of width to distance was one of secondary concern. The critical quality in any photo shown the respondents was the amount of vertical building visible in the scene; a scene was "in scale" if the 27-degree angle included the entire vertical object from top to bottom.

All testing was done in a windowless room in the Psychology building at the University of Arizona campus. A description of the classroom arrangement is given in Figure 2. A total of 115 subjects were drawn from the undergraduate students enrolled for courses in psychology at the University of Arizona. Each student was awarded extra credit points for participating in this study.

A free-standing screen was placed at the front of the room with its image center located at 47 inches above the floor. The bottom of the image was located 25.5 inches above the floor, with an image height of 48 inches overall and image width of 64 inches. The chairs for subject seating were arranged in a bilaterally symmetrical relationship with three per side at a distance no greater than 13 feet 6 inches plus-or-minus 8 inches from the screen. The seats were arranged with four to

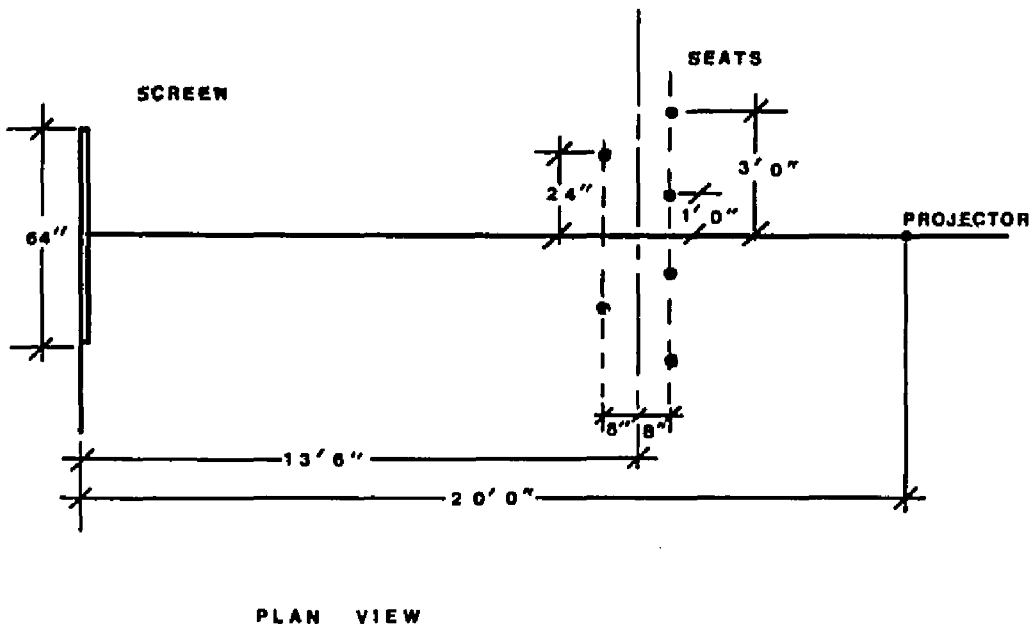


Figure 1. Seat locations for slide viewing.

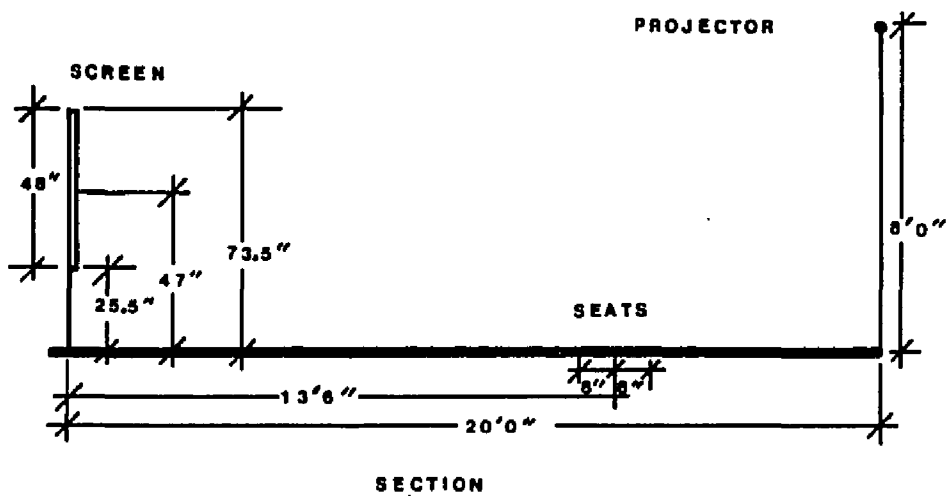


Figure 2. Classroom arrangement.

the rear and two to the front to allow for minimal visual obstruction for all observers.

The projectors were located 20 feet from the screen surface. One projector displayed a number sequence on the leftmost wall, allowing respondents a visual check to confirm slide and answer correspondence. The projector which displayed the slides of plazas on the screen was placed on a stand 96 inches above the floor to adequately project over the heads of the seated respondents. No correction for image distortion was necessary, as the suspected image parallax due to the tilted projected plane was minimal.

Response Format

Each respondent was provided a lap board, #2 pencil, and a computer-coded mark-sense sheet (see Appendix C). The photographs were shown in six different randomly sorted orders to statistically control for any bias due to slide order.

The experimenter introduced the experiment at the front of the room and entertained questions before the experiment was to begin. A standard set of instructions was read to all participants with one of three response formats to elicit responses to one of the following: visual quality, comfortableness, or invitingness (see Appendix A). The lights in the laboratory were uniformly dimmed by rheostat before the preview slides were shown and remained at the same level of illumination throughout the remainder of the experiment. Fifteen preview slides were shown for three seconds each, and the subjects were instructed to observe these slides as representative of the range of areas they would later see in the actual presentation (Craik 1972). In the test the first five slides of those to be rated were shown for 15 seconds each. The announcement was made that the speed would increase and the next five slides were shown for eight seconds each. With the tenth slide, the announcement was made that there would be one final increment in speed, and the remainder of the slides were shown at five seconds each. Each scene was rated on the appropriate ten-point scale. The response forms were collected, and the subjects were debriefed by an oral overview of the thesis purpose, the explanation of the ratio tested, and the implication for designers.

Method of Analysis

The psychophysical paradigm for landscape analysis is being used in this research, and thus relationships between the perceptual responses and physical properties of environments are central to the analysis. Regression analysis is used to determine relationships between the principal independent variable (element scale relative to observer's position) and the dependent variable (preference, as measured by the variables of visual quality, invitingness, and comfortableness) (see Appendix E). The resulting analysis compares the independent variable (scale) with the dependent variables to test the validity of the 27-degree hypothesis. The regressions relate scale and preference for each slide and each of the three criteria.

Experimental Design

The dependent variable is preference for views. "Preference" as the dependent variable is used in this thesis to represent the dependent variables of visual quality, comfortableness, and invitingness, which yield preference ratings. The independent variable is human scalar relationship to the space presented. Each transect was photographed at standard intervals beginning at a point near the structure and ending at a point beyond twice the distance of the object's height. Respondents were shown slides in a controlled environment closely approximating the view angles in the field. Each of three groups was asked to rate slides on a scale of 1-10 (with 10 ranking highest) for one only: visual preference, invitingness, or comfortableness. This data provides the basis for the regression analysis. Also, the differences between "willingness to linger" in a space and "invitingness to pass through" that space will be examined.

Statistical tests are performed to determine the level of agreement among groups and the significance of scale relationships in the urban plazas represented.

The result of this approach is the correlation of viewer response (expressed in preference) to the various visual angles (height/distance relationship) represented. The paradigm of human scale and human response to scale in urban plazas is investigated with the intent of determining expressed preference for human scale relationship to buildings in the urban environment.

CHAPTER 4

RESULTS AND DISCUSSION

The premise that the optimum viewing position in a plaza occurs at a distance twice the height of the object observed is not borne out by this research. No consistent correlation was found to exist between building visual angles and preference ratings by respondents. The correlation values of -.054 (comfort and angle), -.093 (invitingness and angle), and -.102 (visual quality and angle) indicate poor overall correlation between visual angle and preference for the three criteria. The scatter plots for all three variables plotted against visual angle reveal no consistent pattern, linear or otherwise (see Appendix F). These scatter plots indicate no standard relationship in the data for spatial scale (as expressed by visual angle of the scene) as a predictor for mean preference values.

The regression information reveals r^2 values of .0087, .0215, and .0105, indicating no consistency for angle to predict preference. The high correlations among all three of the criteria for rating slides (visual quality, invitingness, and comfortableness with intercorrelations all greater than .90) indicate that respondents did distinguish among the scenes very consistently in this study (see Appendix E). This also indicates that the three perceptual dimensions are based upon the same visually perceived features of the represented urban plaza spaces. Examination of mean value trends in ratings indicates that respondents discriminated between transects, but did not consistently prefer any particular visual angle (height/distance ratio) within transects. The logical alternatives given the results of this experiment are:

1. The experimental method was ineffective and did not properly measure the variable desired; or
2. The premise tested was false, and distance-to-height ratio for viewing conditions is unrelated to perceptual preference.

Each of the above alternatives in terms of this experiment will now be examined.

Improper Method

The literature cited to arrive at this 27-degree angle of view (the ARCTANGENT of the distance-to-height ratio 2:1) indicates that at this optimal viewing location the entire facade of a structure is visible. To accurately test this premise, the angle of view should be replicated both in the field at each photo location and under the slide-viewing test conditions. The lens used to take the photographs was a Nikkor 50mm 1:1.4 standard lens with a skylight filter. The total visual angle captured by this lens was 46 degrees. All photographs were taken at an elevation 5'-0" above grade in a level configuration, focused on the same point for each complete transect. The 27-degree visual angle was never exactly reproduced in any given slide. However, the lens chosen for taking the slides did include the 27-degree angle within the 46-degree vertical field of view. Individual transects provided visual angles ranging from 4.72° to 68.59°, with each transect including values above and below the hypothesized optimum 27-degree value.

Another potential source of error exists in the dearth of information about urban plaza perception. No study has positively established the validity of measuring preference for urban plazas by the use of color photographs or slides. The work of Im (1984) examines scenes of urban areas, yet in content these scenes are typically different from those used in this study. The Im study did positively correlate color slides with visual quality estimates for his study sites.

False Premise

If the experiment worked and the data is accurate, the basic hypothesis of a standard optimal viewing angle to predict optimal preference for urban plazas is false. There are two levels of this hypothesis. The general hypothesis states that a human-scale increment exists which predicts preference for urban plazas. The specific hypothesis defines the predictor for preference for urban plazas to be a 27-degree angle relationship between observers and tops of vertical elements. This study proves that the specific hypothesis is not accurate.

The data was compared on a transect-by-transect basis, and no consistent relationship was discovered for a 27-degree optimum condition. In fact, no transect correlated the 27-degree angle with optimum preference values (see Appendix G).

This research does not indicate any significant differentiation among spaces attributable to visual angle (see Appendix E). The disparity in response maximums ranges from visual angles of 31.66° to 4.72° (see Table 1). A general tendency within the data is the preference for visual angles smaller than the 27-degree expected value. This suggests a general preference for scenes which provide greater viewer-to-structure separation than is provided by the 2:1 ratio tested. However, the variability of numeric values for preference does not indicate a standard optimum condition for observation. The scatter plots (Appendix F) and r^2 values (Appendix E) indicate no correlation between visual angle and the dependent variables in this experiment.

Based on the similarity of responses, there was little differentiation by the respondent sample regarding the three criteria for evaluation of slides (see Table 1). Subjects were very consistent in their perceptions of scenes as reflected by the intercorrelations of .9 or better among the three criteria for preference (see Appendix E). This suggests that either the respondents judged the scenes in terms of their personal definition of attractiveness (Coughlin and Goldstein 197) or that there is little difference among the variables visual quality, comfortableness, and invitingness.

This study also indicates that this experimental design is able to differentiate among spaces. The rating responses on a per-slide/scene basis (see Table 1) clearly indicate that certain scenes were rated higher in preference than others. The variation in responses both within a given transect and between transects indicates that this

Table 1. Respondent evaluation of slides for comfort, invitingness, and visual quality.

COMFORT				INVITINGNESS			VISUAL QUALITY		
Scene/Photo		Visual <°	Rating	Scene/Photo	Visual <°	Rating	Scene/Photo	Visual <°	Rating
A-1	#8	15.82	4.415	#8	15.82	4.556	#8	15.82	4.605
A-2	#9	15.82	5.098	#12	12.00	6.556	#13	11.10	6.105
A-3	#4	13.59	2.951	#4	13.59	2.361	#3	16.17	2.632
B-2	#5	13.13	5.000	#6	11.31	5.917	#6	11.31	6.053
D-1	#5	22.85	3.341	#6	20.24	3.833	#6	20.24	4.026
D-3	#5	16.26	3.951	#5	16.26	4.722	#5	16.26	4.500
E-2	#7	16.55	4.732	#7	16.55	5.417	#5	20.91	5.605
E-3	#9	15.64	5.780	#10	15.01	7.083	#10	15.01	6.921
E-4	#2	31.66	4.366	#6	14.80	4.833	#6	14.80	4.711
E-5	#8	13.70	5.317	#8	13.70	5.694	#8	13.70	5.211
E-6	#7	13.53	4.610	#7	13.53	5.139	#7	13.53	4.658
E-7	#3	14.71	4.829	#3	14.71	5.222	#2	19.29	4.921
G-1	#8	9.00	3.829	#8	9.00	3.361	#8	9.00	3.605
BP-1	#5	10.39	4.659	#6	8.93	6.667	#4	12.41	6.553
DN-1	#4	4.72	2.659	#4	4.72	2.750	#4	4.72	2.868
DY-2	#8	7.13	2.780	#7	8.13	2.528	#6	9.46	2.816
FW-1	#1	20.56	1.659	#3	10.62	1.861	#4	8.53	1.816

study effectively discriminates among spaces based on preference ratings by respondents.

CHAPTER 5

CONCLUSIONS

The evolution of a vocabulary of scale in the design professions has been long in coming. The process began with basic proportioning systems and has evolved to the current distance-to-height ratio tested in this thesis. In a built environment which is typically stretching upwards, the necessity for investigating the importance of scale increases daily.

The most recent literature (Ashihara 1970; Robinette 1972; Sale 1982; Hegemann and Peets 1922; Zucker 1959; Blumenthal 1967) proposes that optimal scale is defined by the distance-to-height ratio (2:1). This ratio (and its suggested visual angle of 27 degrees) is also mentioned in the recent literature of landscape architecture (Booth 1983). This thesis demonstrates that the 2:1 ratio is not an effective predictor of preference for scenes in urban plazas.

There are several implications for future research following from the conclusions of this study. Since this study examined only urban plaza spaces, other environments should be tested in a similar manner. The possibility exists that a scale other than the 27 degrees tested in this thesis may apply to public perception of urban plazas. It may well be that viewer expectations are different in urban plazas than in other environments.

This study also emphasized diversity in plazas as well as within each scene. Perhaps a less diverse perceptual stimulus would reveal more about the scale element. Computer-simulated scenes may provide a controlled environment from which scale elements are better identified. The use of models to represent scenes may also provide greater control of the specific elements within scenes to emphasize the scale consideration.

Another implication of the failure of the premise tested is that more and other information is required for the predictability of preference for urban plazas. The work of Im (1984) suggests a different group of physical measures which provide information about scenes. The concept of volume and amount of vegetation correlate positively with preference and suggest further research to quantify their effect on perception. The volumetric consideration in urban plazas could be investigated in this study by including the measures of width of scene into the regression analysis. This may indicate the necessity of including the elements of enclosure (suggesting volume) to evaluate the effect of scale on perception.

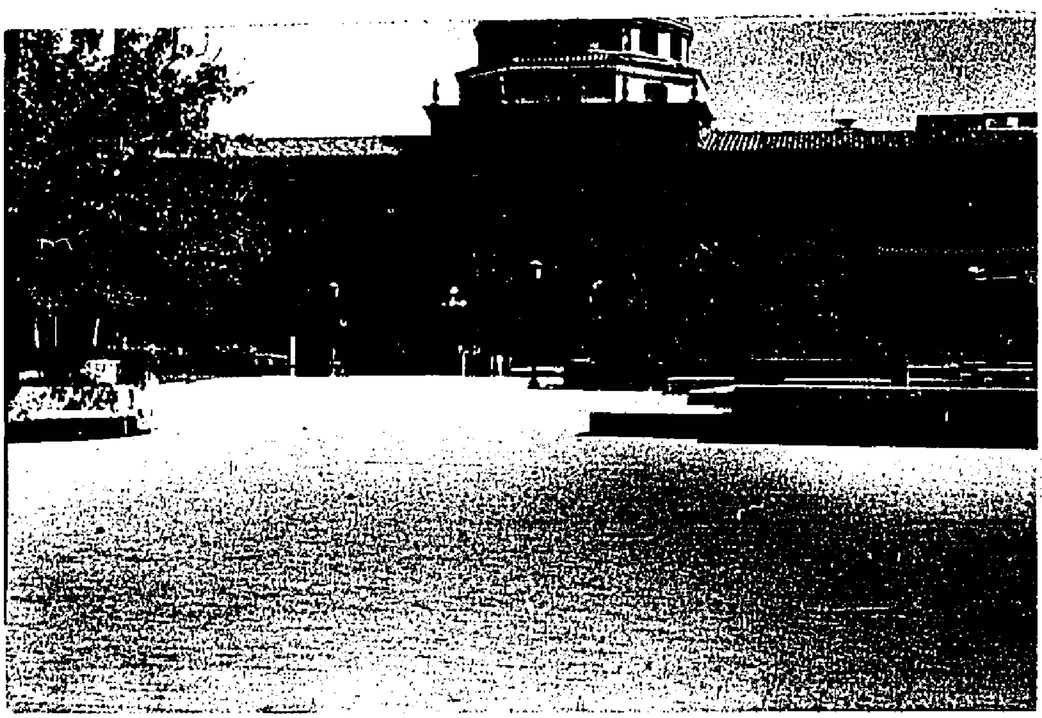
Taken together, this thesis and the recent work of Im suggest the investigation of more sophisticated measures to predict preference for scenes. The convergent evolution of the scientific aspect of landscape architecture and the means of evaluating outdoor spaces underscores the need for more detailed examination of the affective qualities of the outdoor environment.

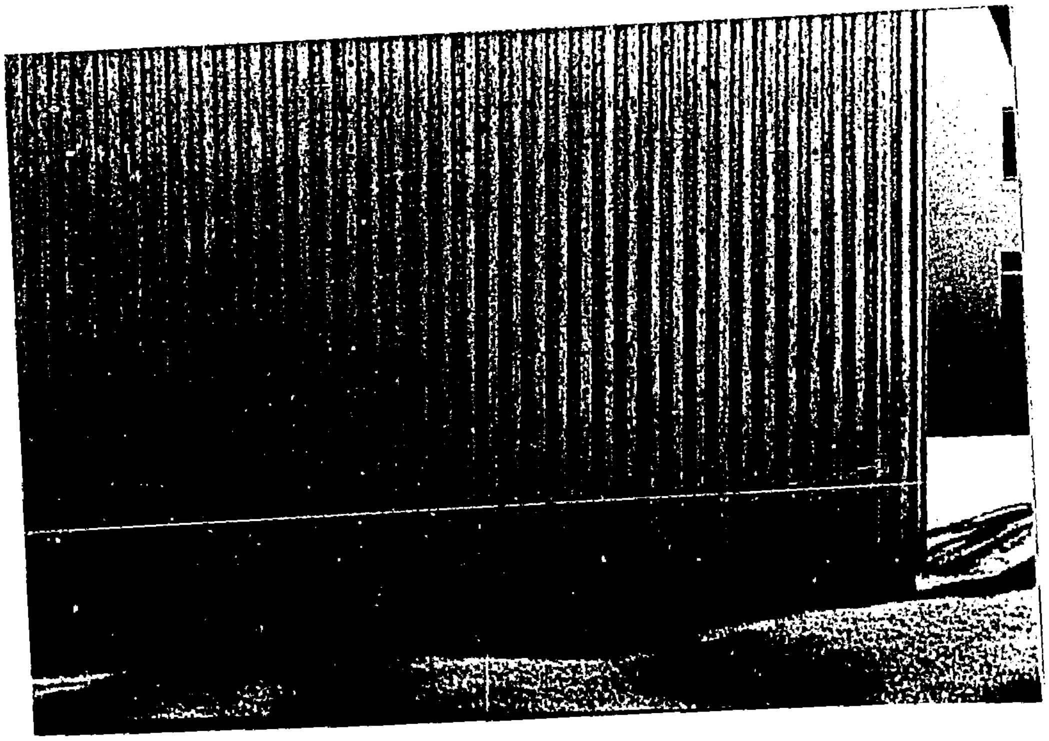
APPENDIX A

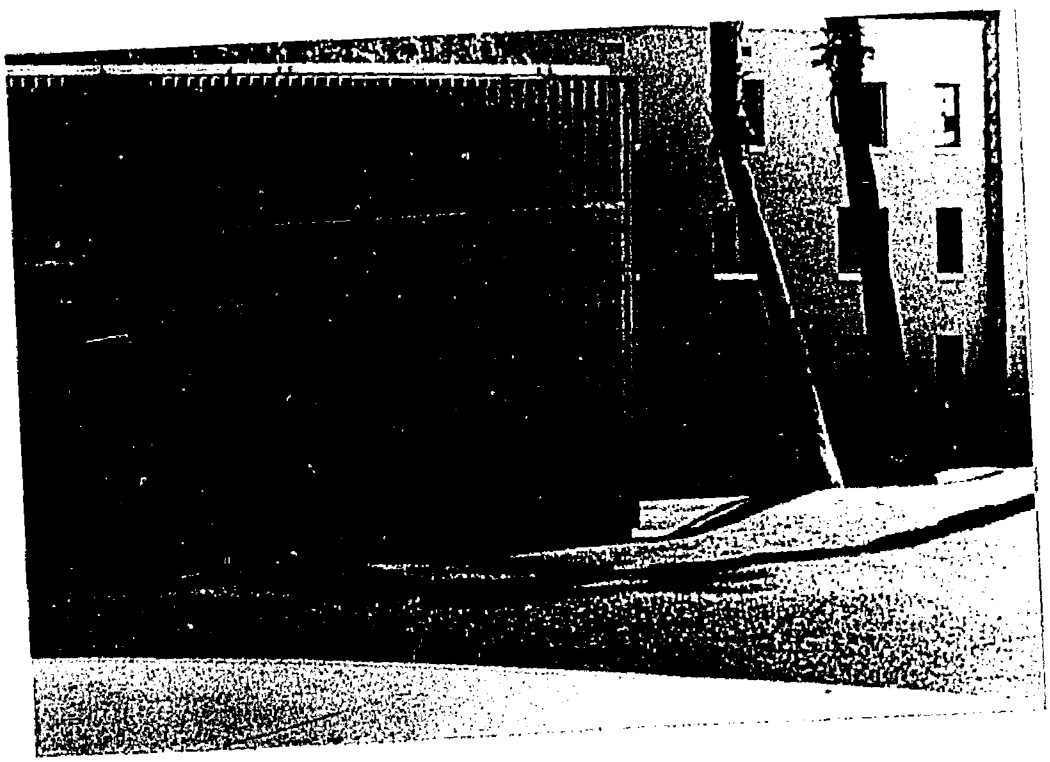
PHOTOGRAPHS OF TRANSECTS

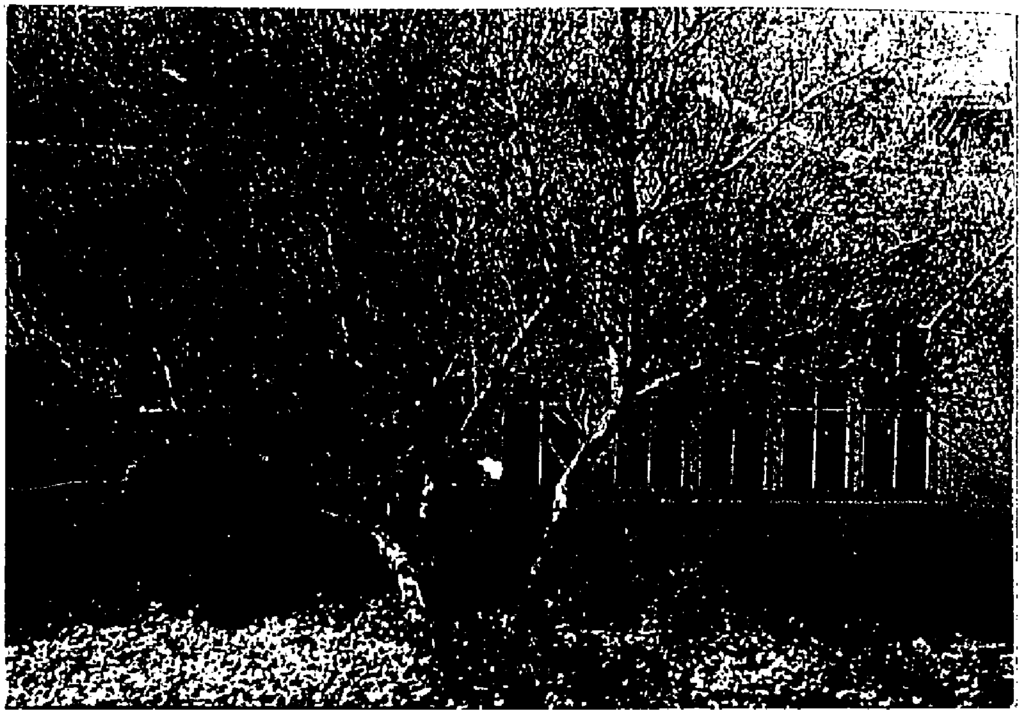
Index to Photographs

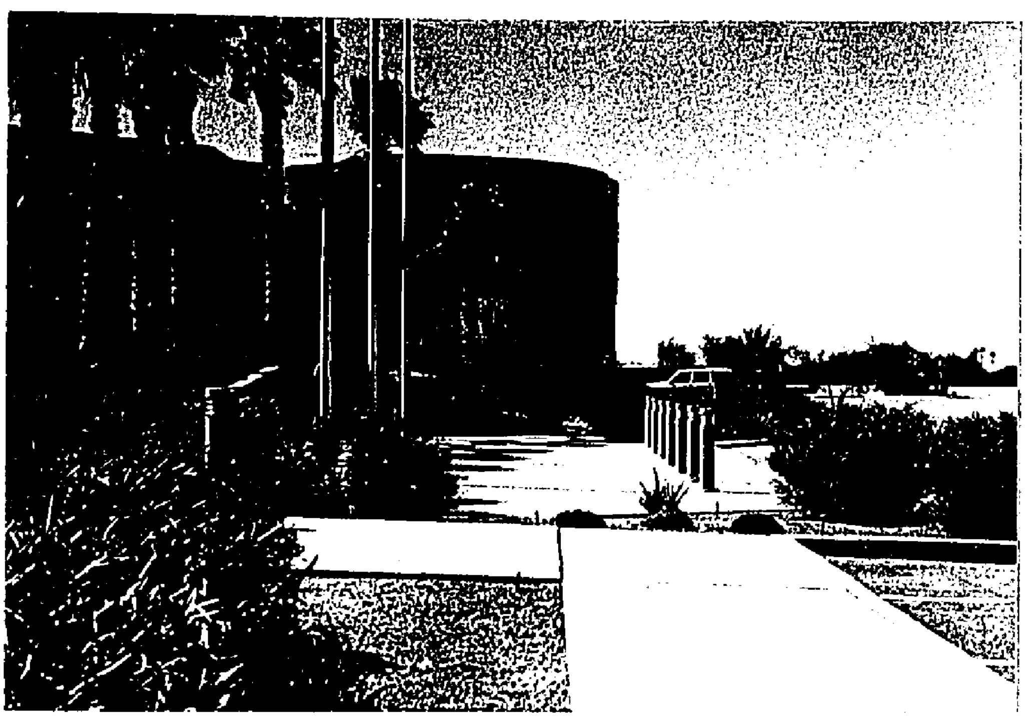
Plate 1	2 photographs of "Transect A.1"
Plate 2	2 photographs of "Transect A.2"
Plate 3	2 photographs of "Transect A.3"
Plate 4	2 photographs of "Transect B.2"
Plate 5	2 photographs of "Transect BP.1"
Plate 6	2 photographs of "Transect D.1"
Plate 7	2 photographs of "Transect D.3"
Plate 8	2 photographs of "Transect DN.1"
Plate 9	2 photographs of "Transect DY.2"
Plate 10	2 photographs of "Transect E.2"
Plate 11	2 photographs of "Transect E.3"
Plate 12	2 photographs of "Transect E.4"
Plate 13	2 photographs of "Transect E.5"
Plate 14	2 photographs of "Transect E.6"
Plate 15	2 photographs of "Transect E.7"
Plate 16	2 photographs of "Transect G.1"
Plate 17	2 photographs of "Transect FW.1"

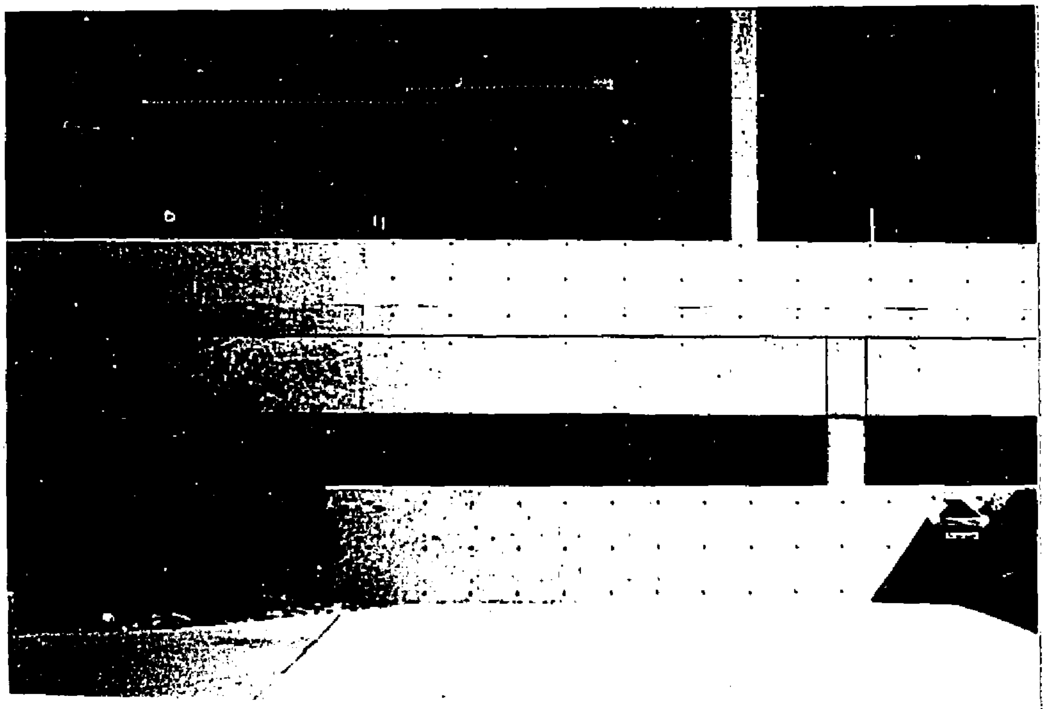


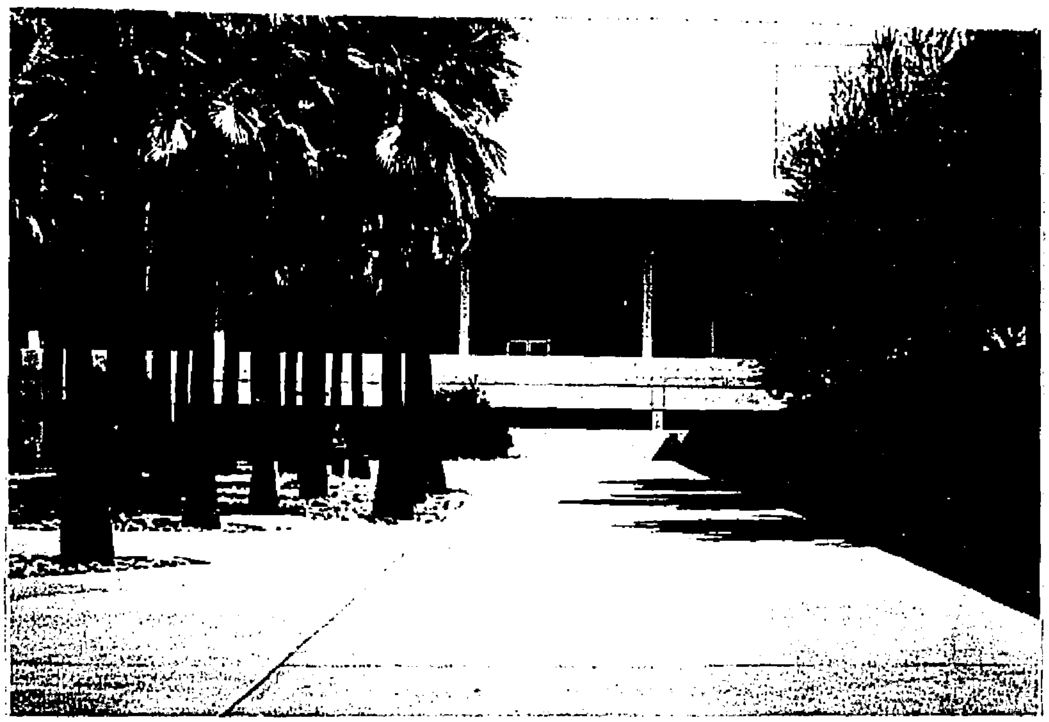


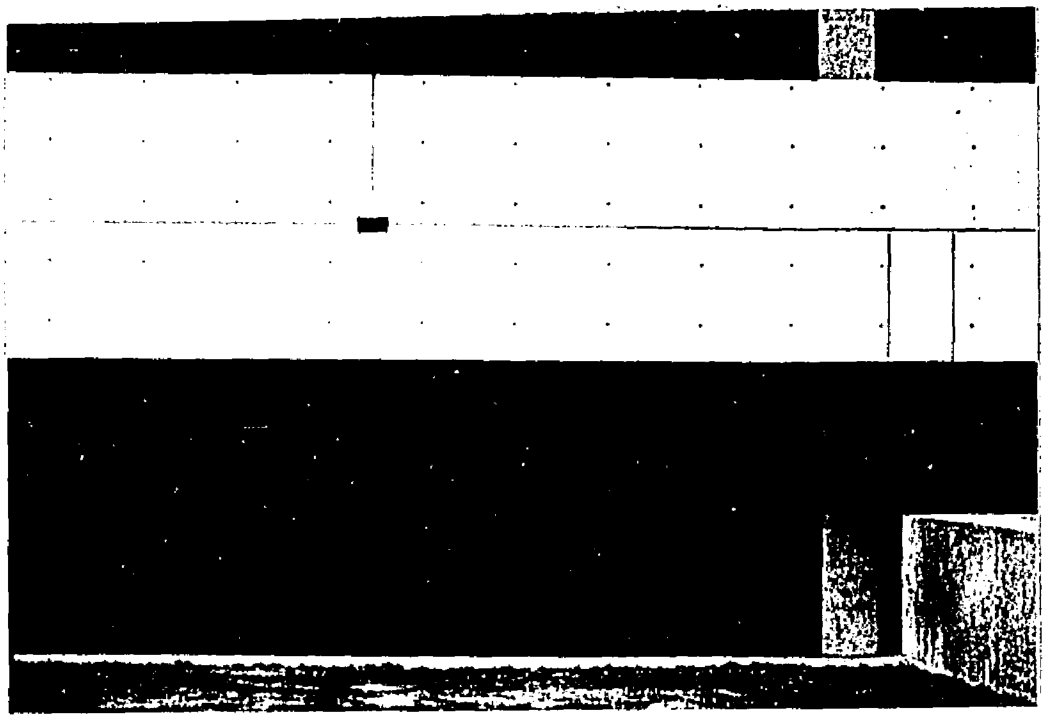


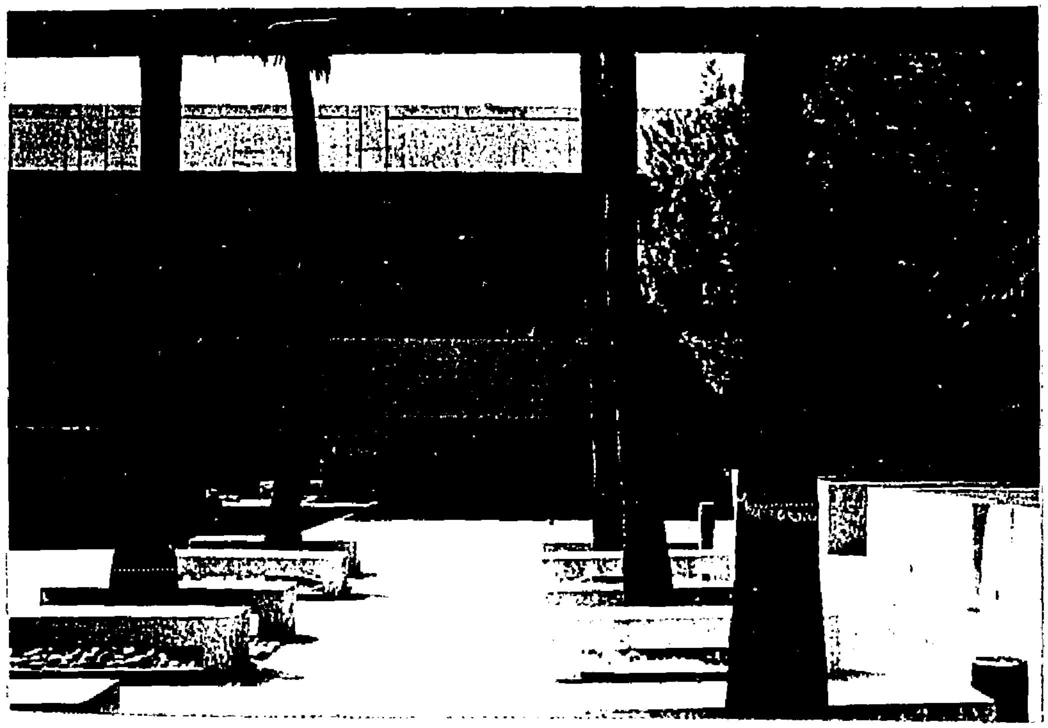


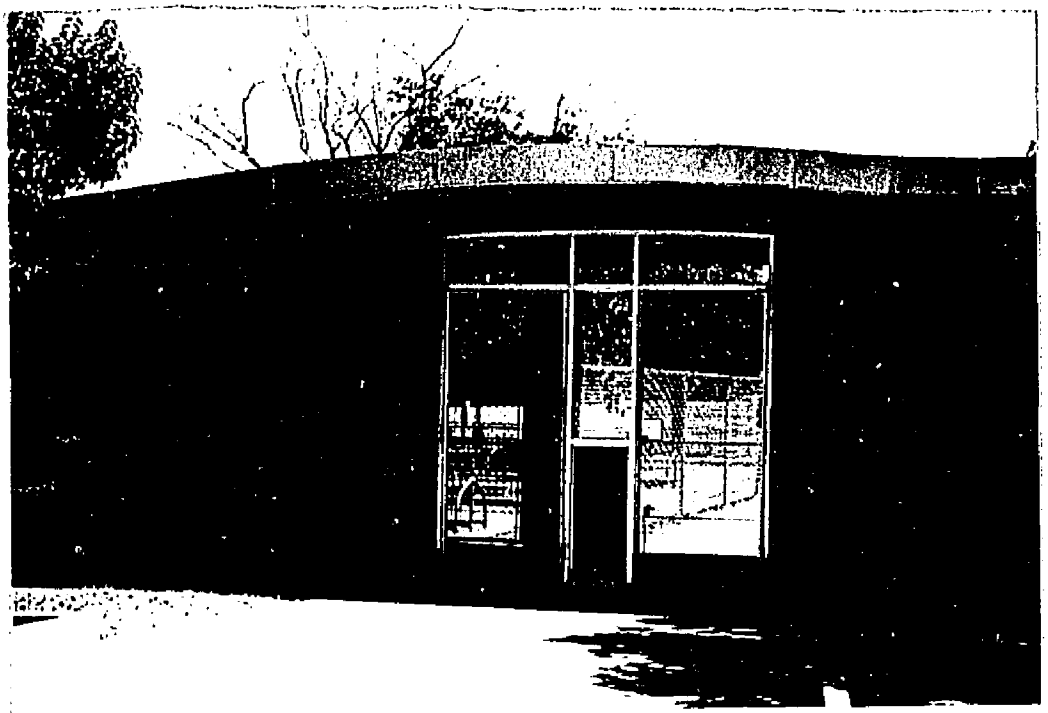


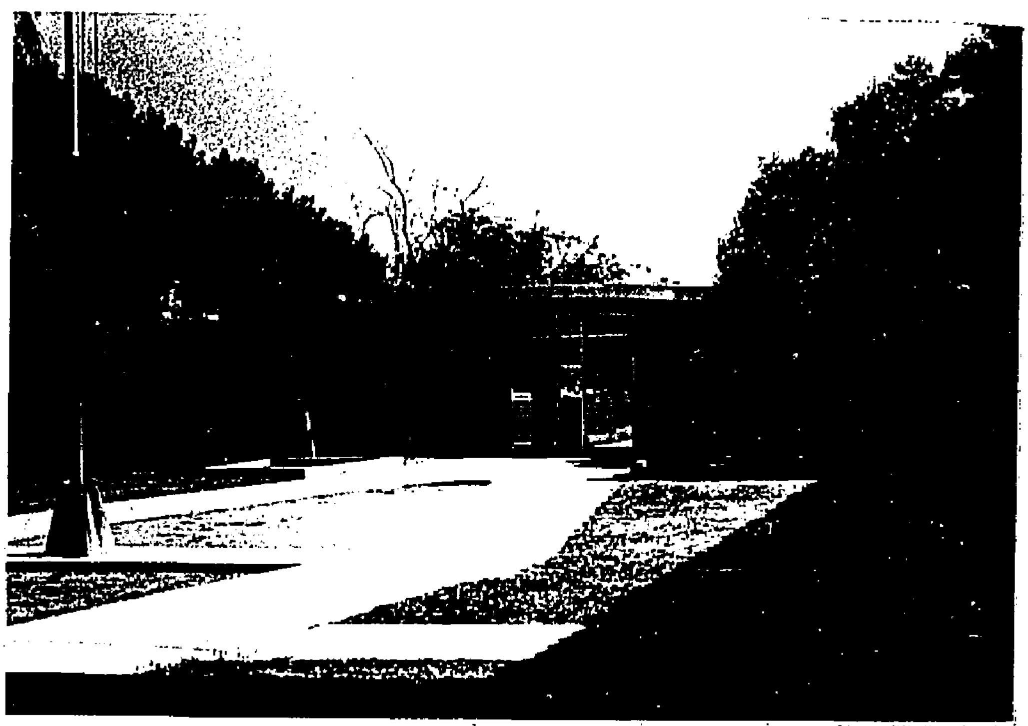


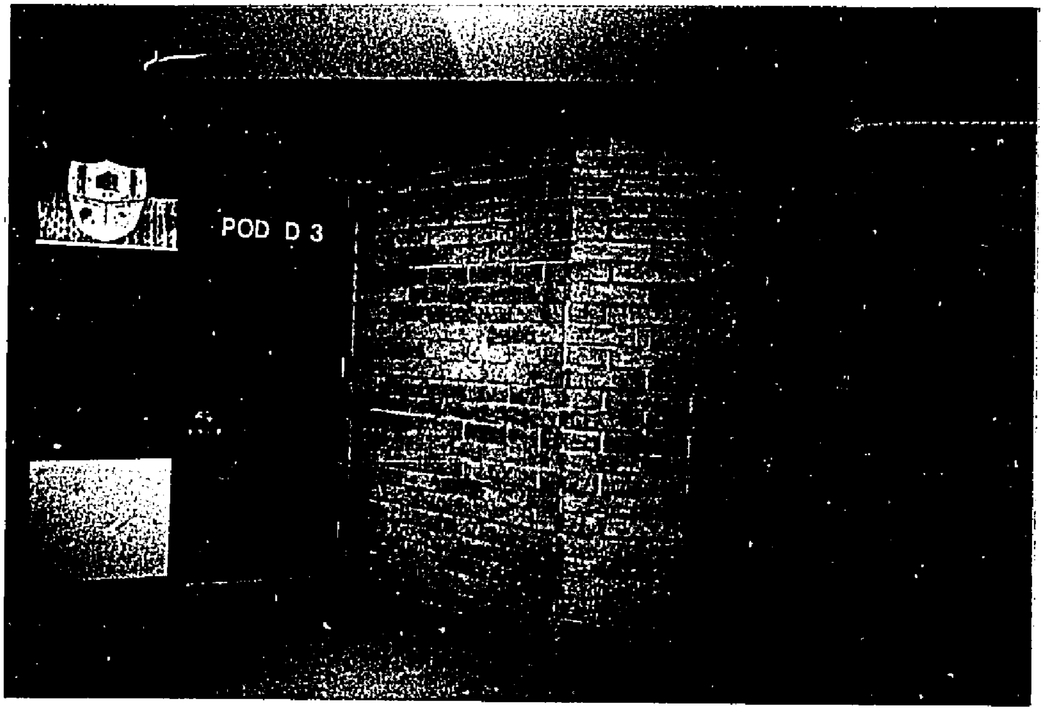








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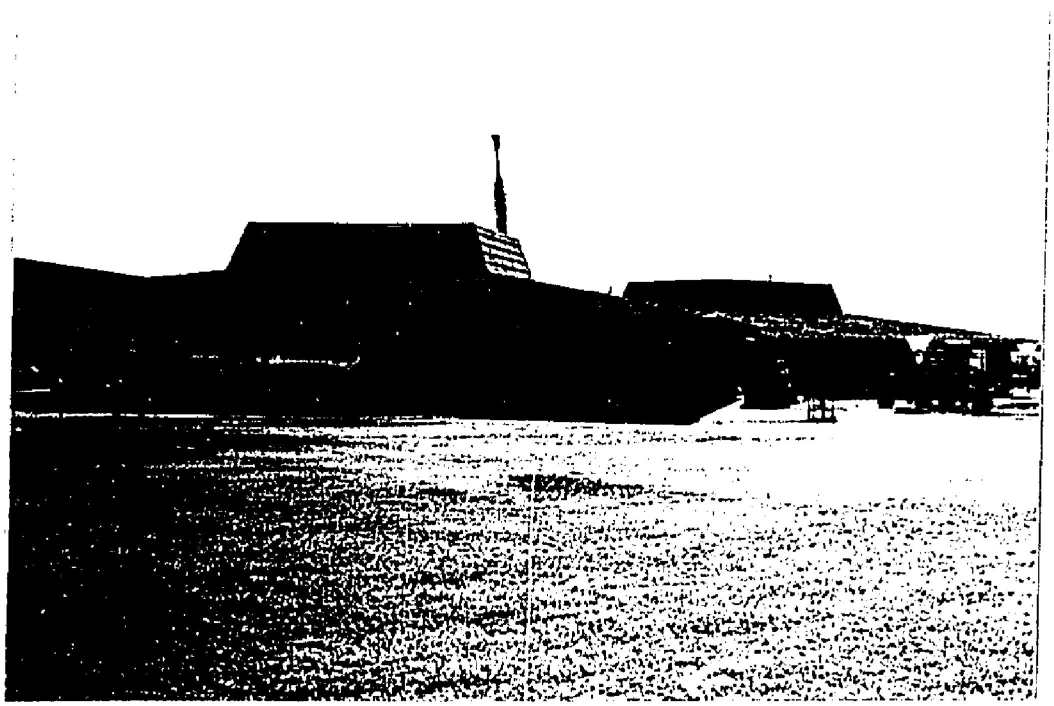
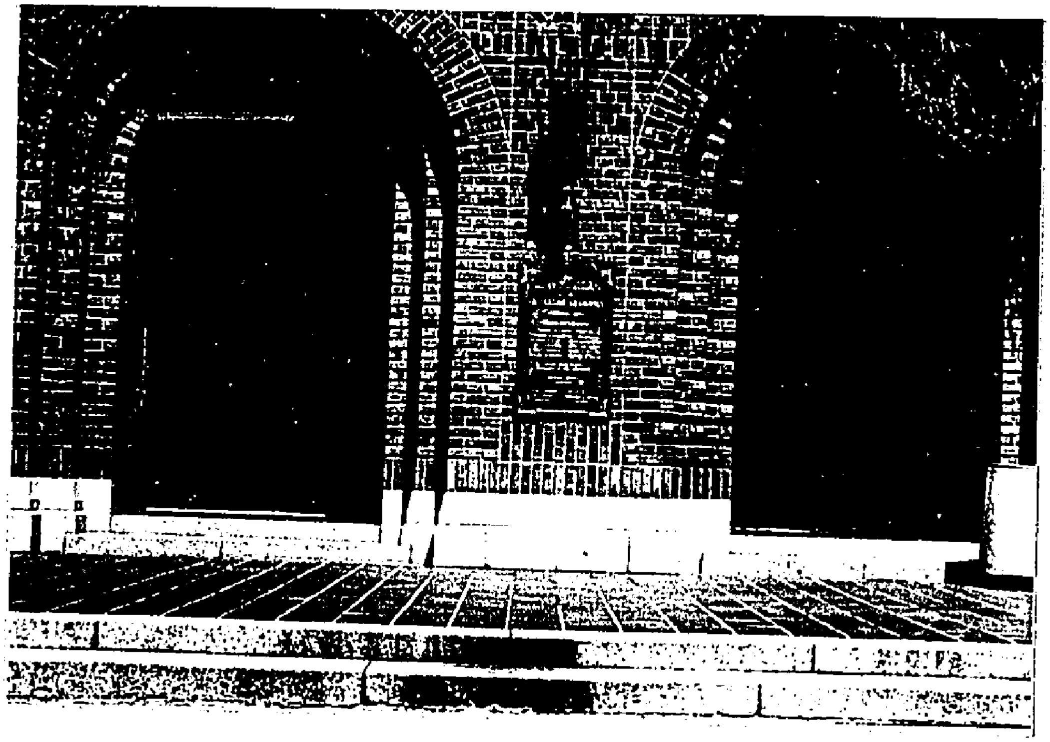
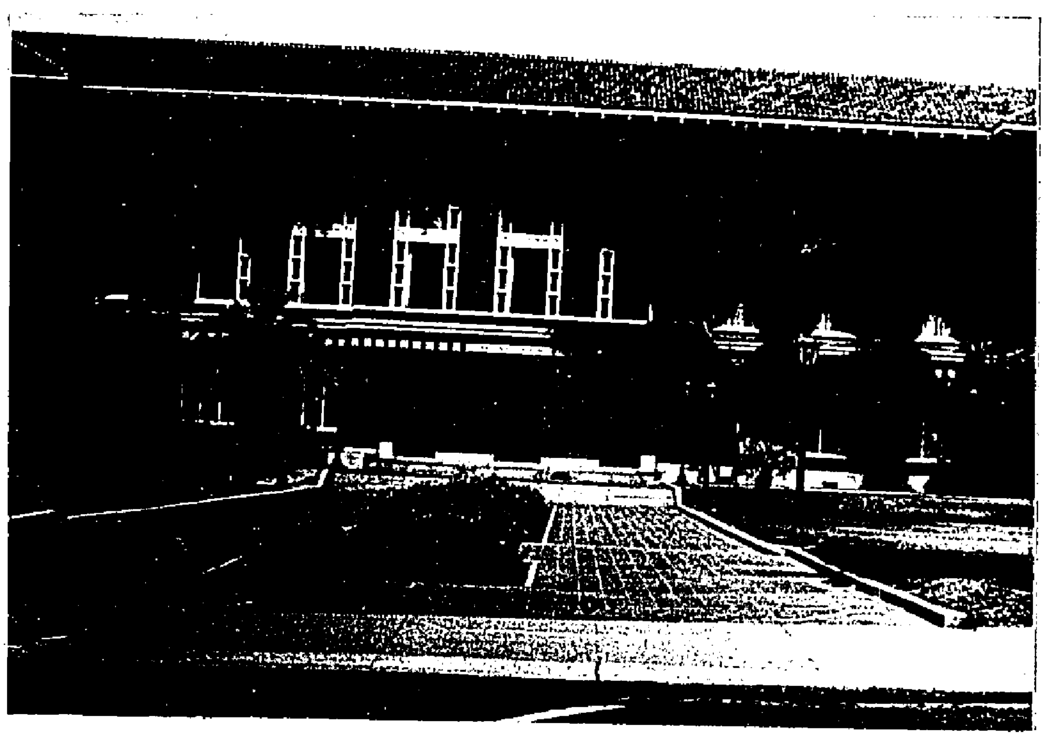
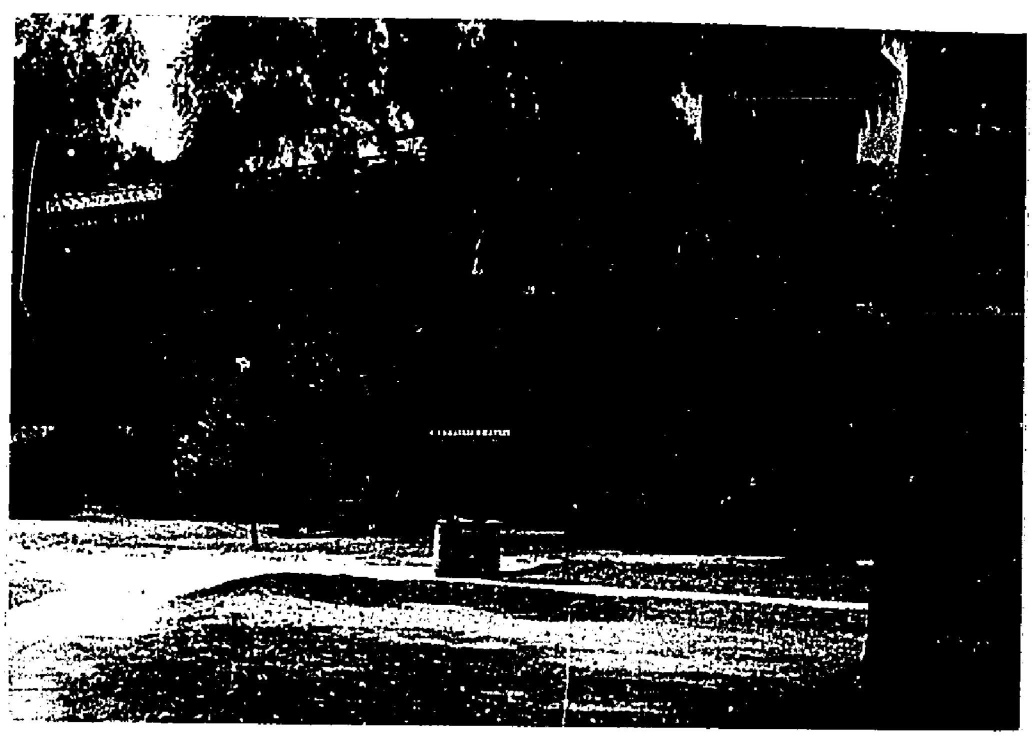
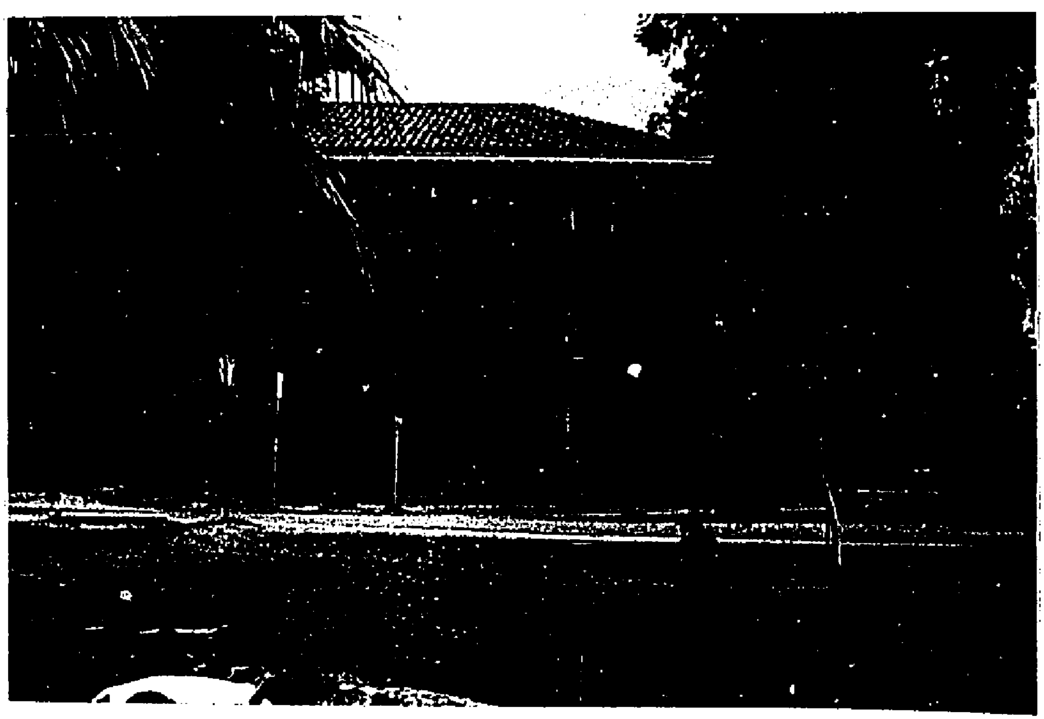
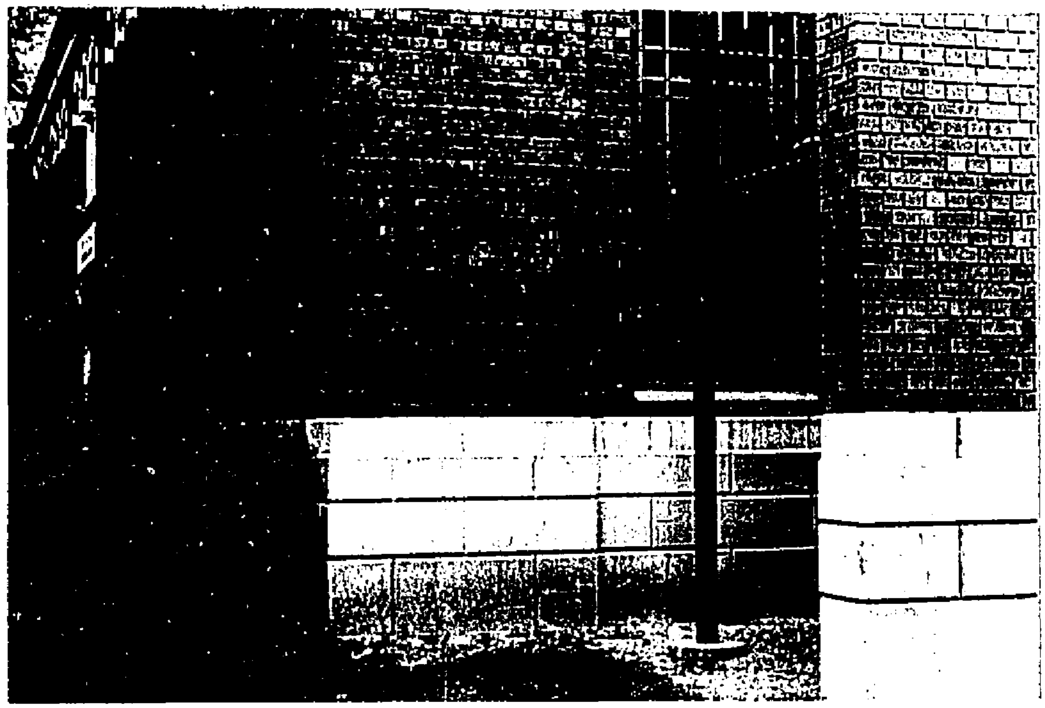


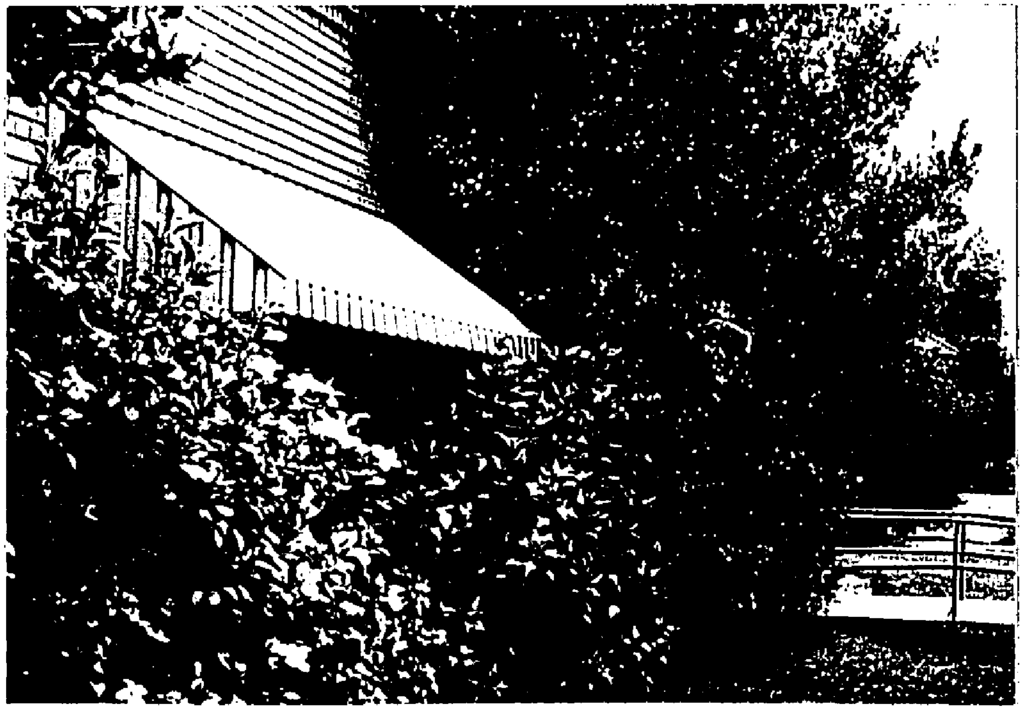


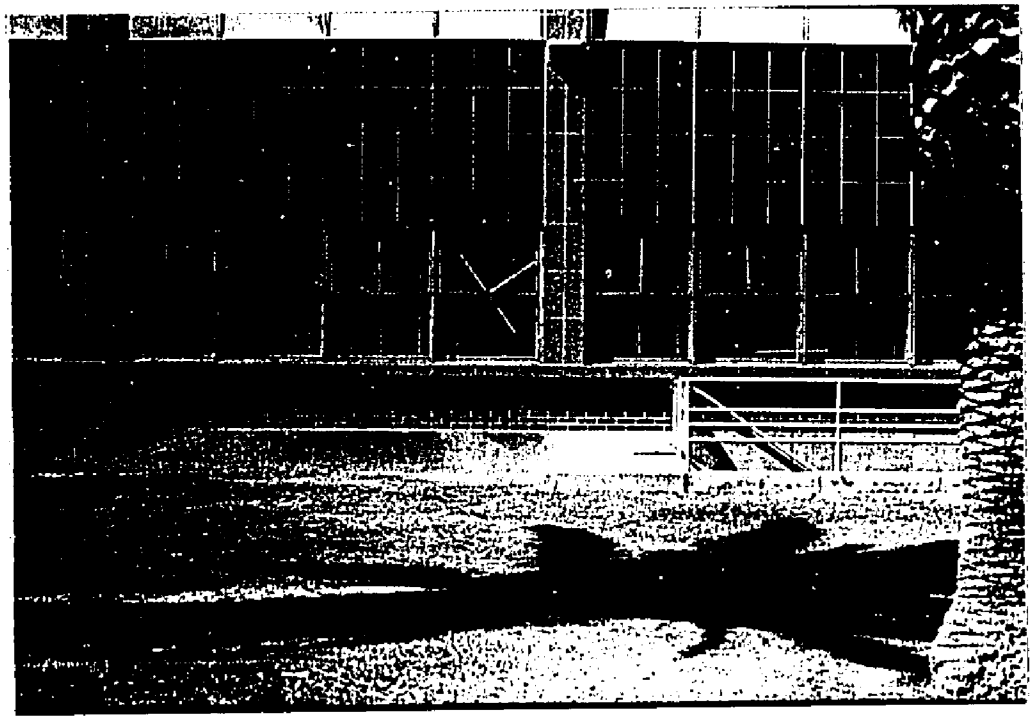


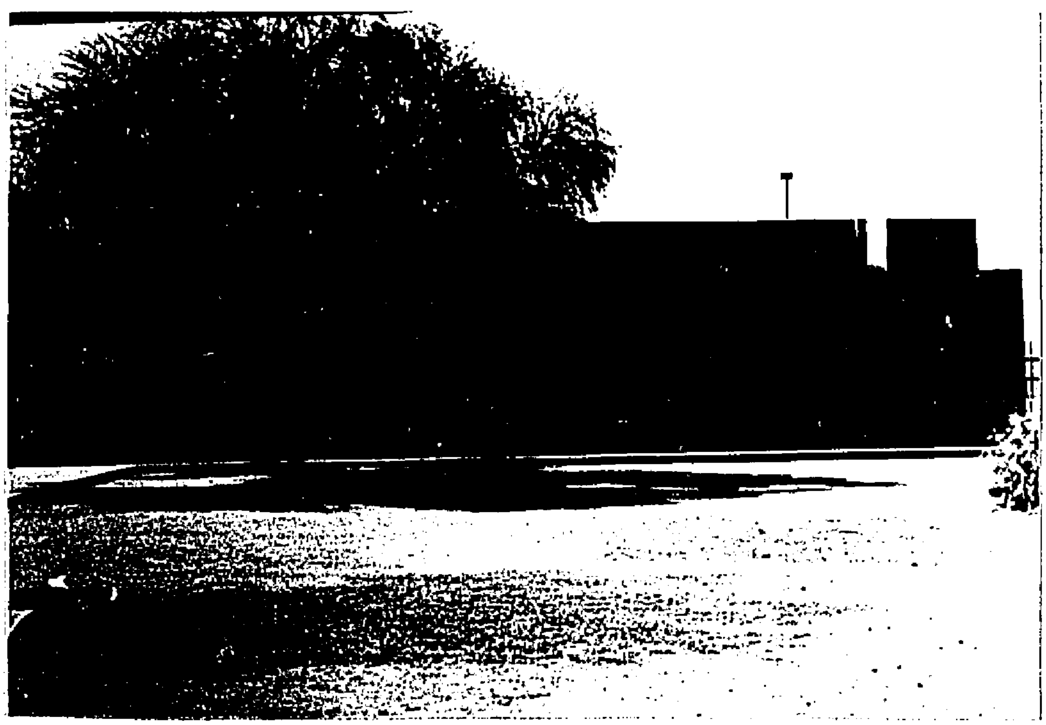






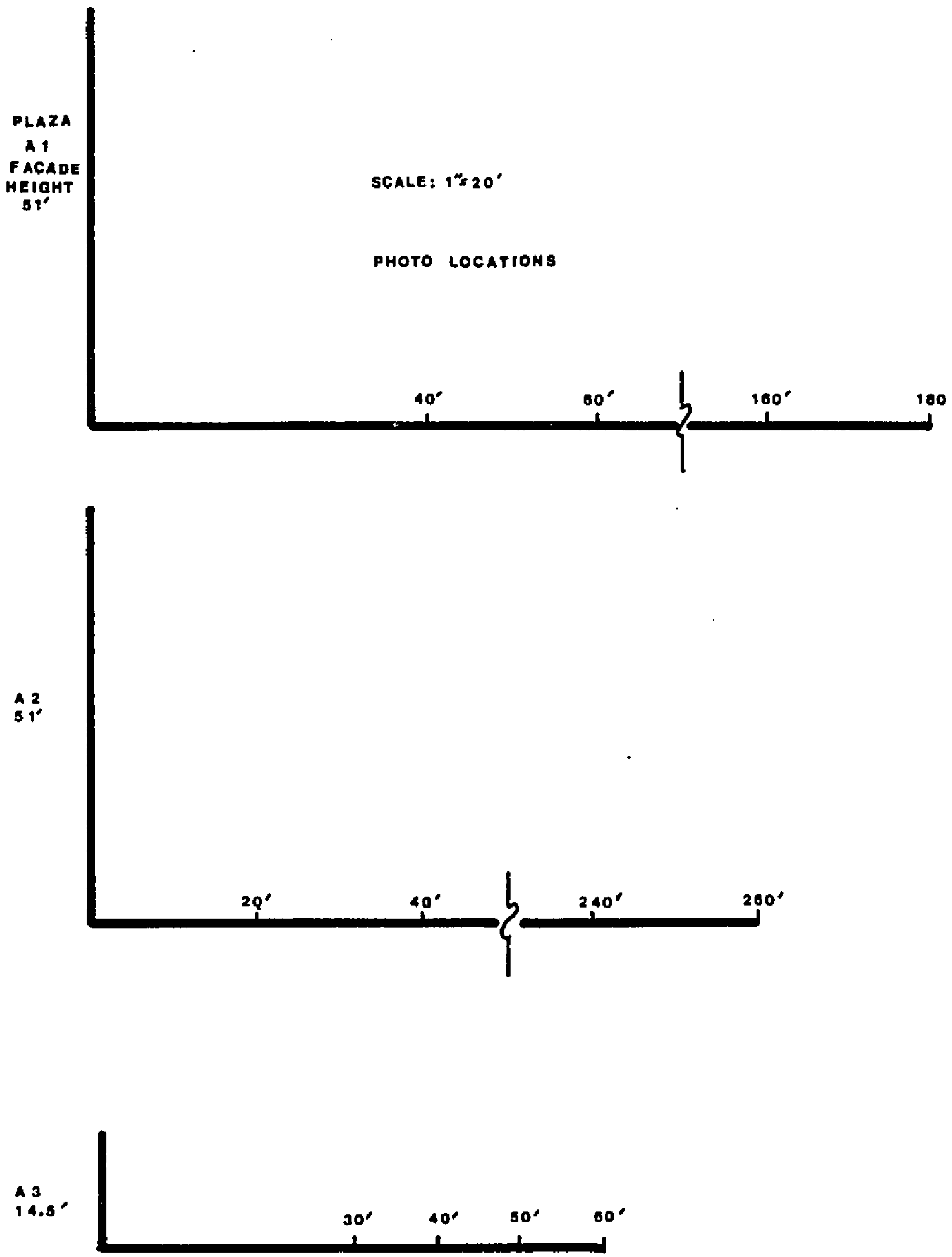






APPENDIX B

PLAZA ELEVATIONS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FAÇADE
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A 2
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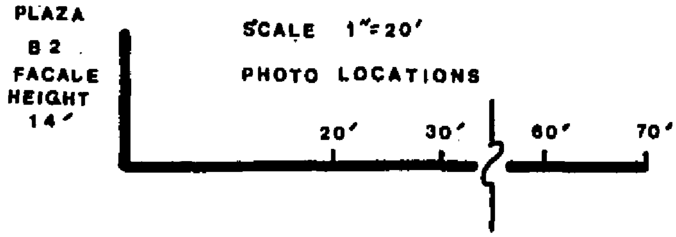
30′
40′
50′
60′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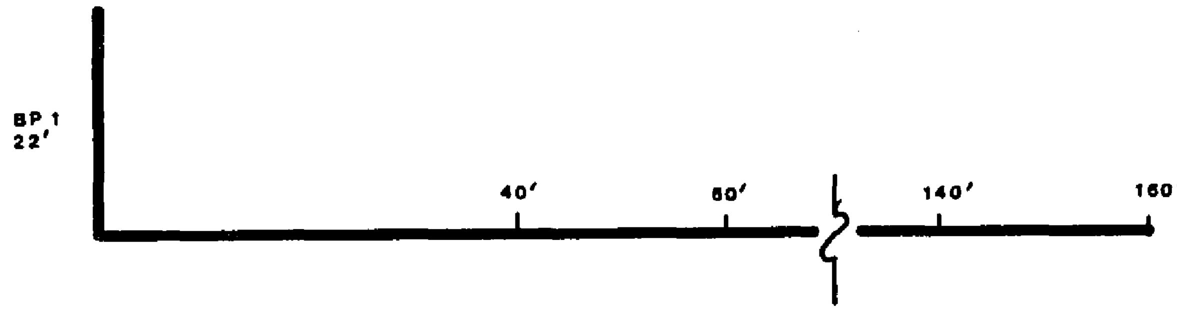
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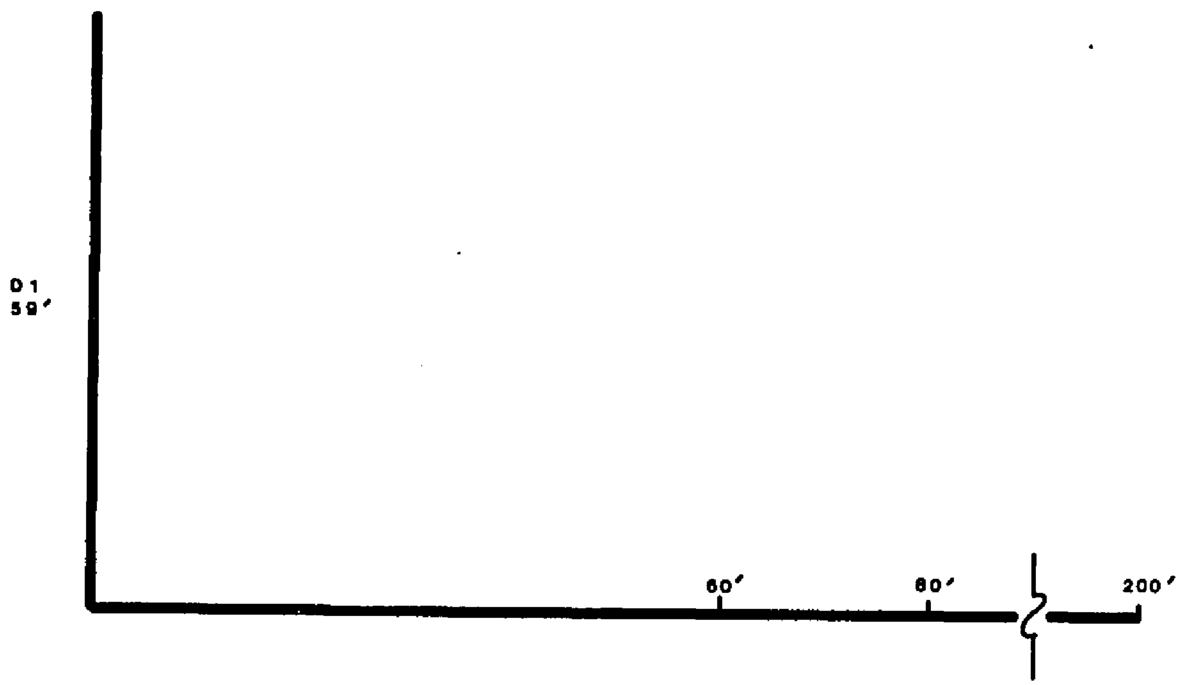
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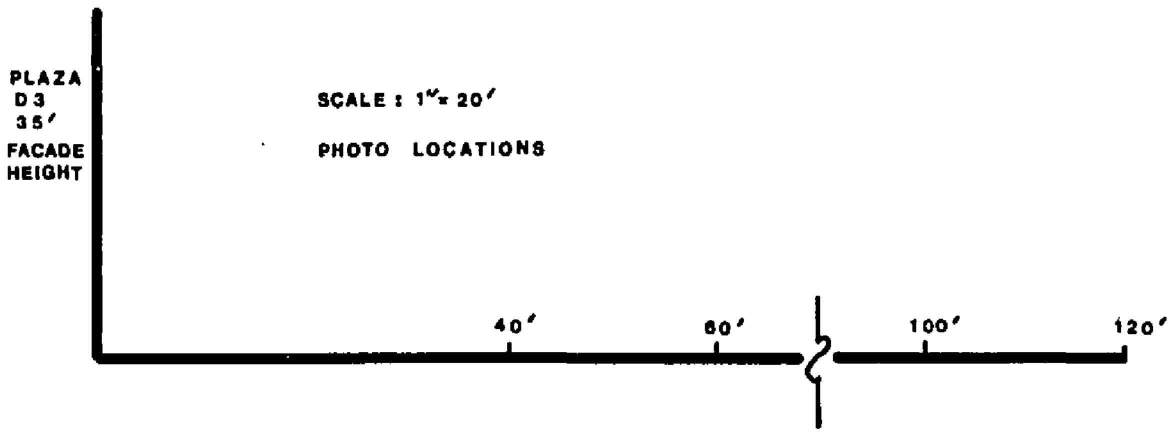
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D 3
35'
FACADE
HEIGHT
SCALE : 1" = 20'
PHOTO LOCATIONS
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60'
100'
120'


DN 1
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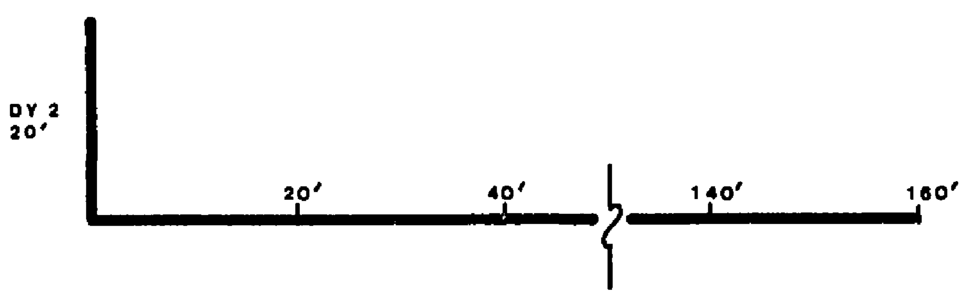
40'
60'
80'
100'


DY 2
20'
20'
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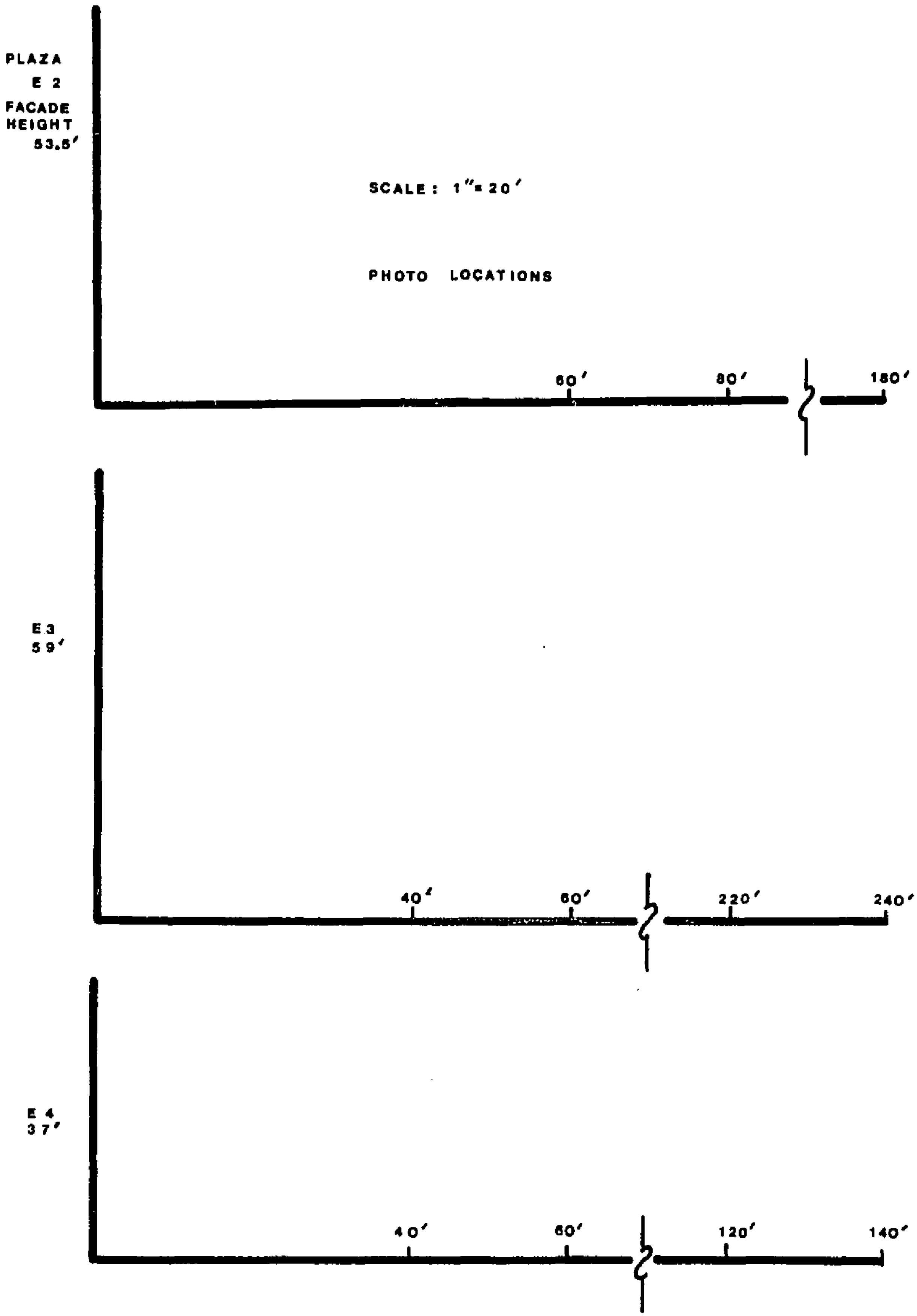
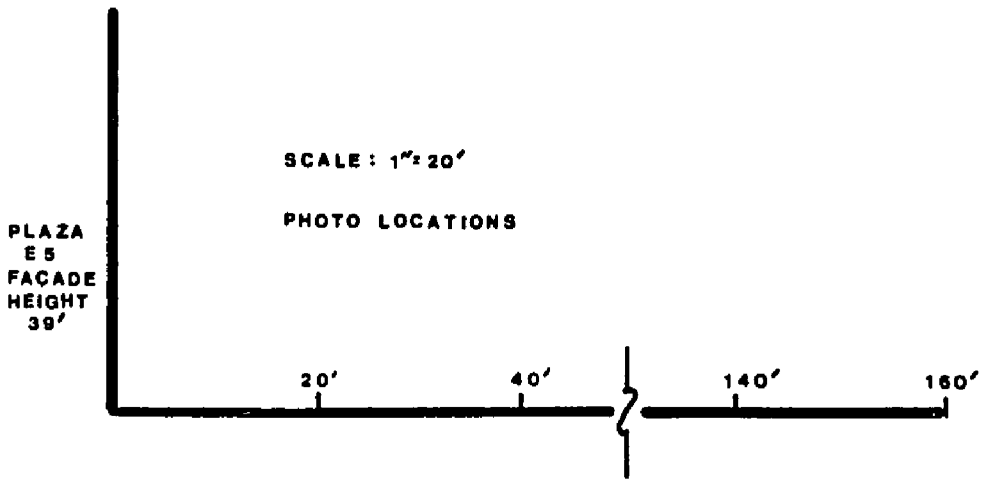
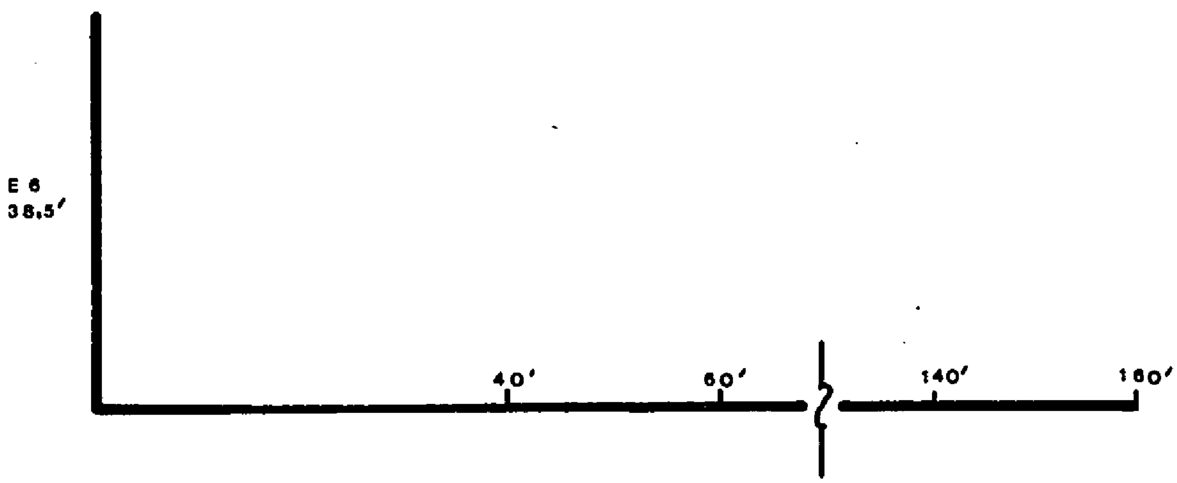
140'
160'

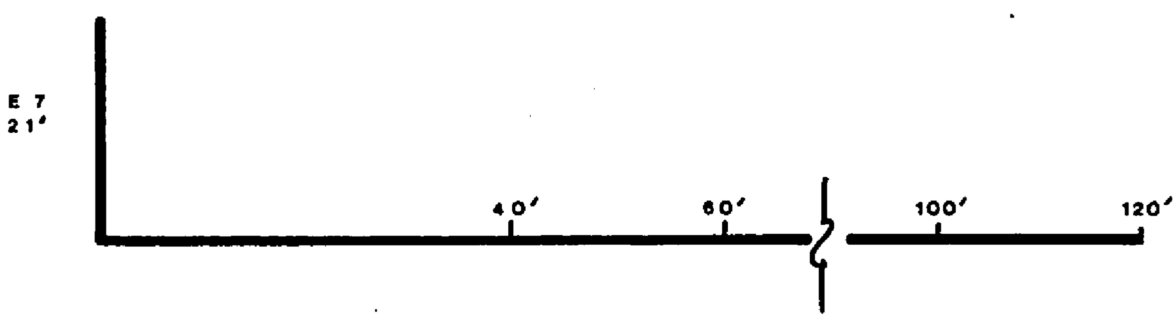

PLAZA
E 2
FACADE
HEIGHT
53.5'
SCALE: 1"=20'
PHOTO LOCATIONS
60'
80'
180'
E 3
59'
40'
60'
220'
240'
E 4
37'
40'
60'
120'
140'

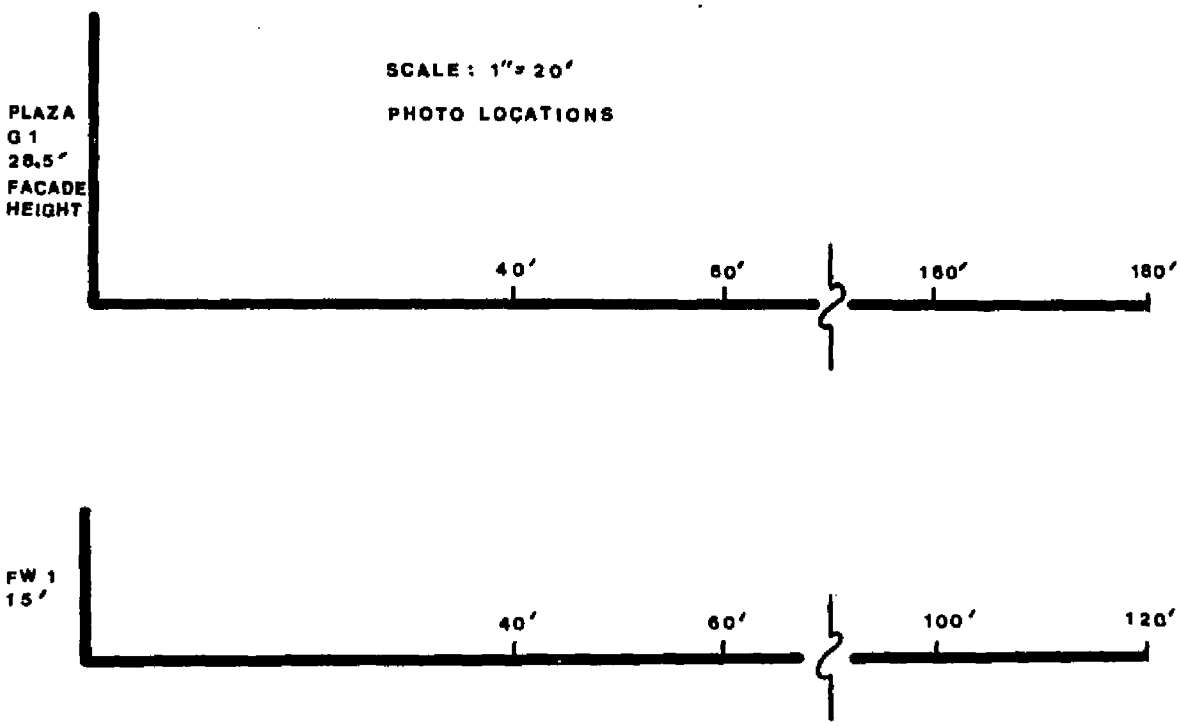
SCALE: 1"=20'

PHOTO LOCATIONS








SCALE: 1"=20'
PHOTO LOCATIONS
PLAZA
G 1
28.5'
FACADE
HEIGHT
40'
60'
160'
180'
FW 1
15'
40'
60'
100'
120'

APPENDIX C

RESPONSE SHEET INSTRUCTIONS

SIDE ONE

ENVIRONMENT PERCEPTION RESEARCH

UNIVERSITY OF ARIZONA

TODAY'S DATE: YEAR, MONTH

TEST FORM

IDENTIFICATION NUMBER: 1 2 3 4 5 6 7 8 9 (0 1 2 3 4 5 6 7 8 9)

SCORE 1: 1 2 3

SCORE 2: 1 2 3

RESPONSE SHEET INSTRUCTIONS:

USE PENCIL ONLY. ERASE COMPLETELY WHEN NECESSARY. MAKE YOUR MARKS FIRM AND CLEAR.

EXAMPLE: 1 2 3 4 5 6 7 8 9 10

RATING SCALE

LOW									HIGH
1	2	3	4	5	6	7	8	9	10

1	1 2 3 4 5 6 7 8 9 10	21	1 2 3 4 5 6 7 8 9 10	41	1 2 3 4 5 6 7 8 9 10	61	1 2 3 4 5 6 7 8 9 10
2	1 2 3 4 5 6 7 8 9 10	22	1 2 3 4 5 6 7 8 9 10	42	1 2 3 4 5 6 7 8 9 10	62	1 2 3 4 5 6 7 8 9 10
3	1 2 3 4 5 6 7 8 9 10	23	1 2 3 4 5 6 7 8 9 10	43	1 2 3 4 5 6 7 8 9 10	63	1 2 3 4 5 6 7 8 9 10
4	1 2 3 4 5 6 7 8 9 10	24	1 2 3 4 5 6 7 8 9 10	44	1 2 3 4 5 6 7 8 9 10	64	1 2 3 4 5 6 7 8 9 10
5	1 2 3 4 5 6 7 8 9 10	25	1 2 3 4 5 6 7 8 9 10	45	1 2 3 4 5 6 7 8 9 10	65	1 2 3 4 5 6 7 8 9 10
6	1 2 3 4 5 6 7 8 9 10	26	1 2 3 4 5 6 7 8 9 10	46	1 2 3 4 5 6 7 8 9 10	66	1 2 3 4 5 6 7 8 9 10
7	1 2 3 4 5 6 7 8 9 10	27	1 2 3 4 5 6 7 8 9 10	47	1 2 3 4 5 6 7 8 9 10	67	1 2 3 4 5 6 7 8 9 10
8	1 2 3 4 5 6 7 8 9 10	28	1 2 3 4 5 6 7 8 9 10	48	1 2 3 4 5 6 7 8 9 10	68	1 2 3 4 5 6 7 8 9 10
9	1 2 3 4 5 6 7 8 9 10	29	1 2 3 4 5 6 7 8 9 10	49	1 2 3 4 5 6 7 8 9 10	69	1 2 3 4 5 6 7 8 9 10
10	1 2 3 4 5 6 7 8 9 10	30	1 2 3 4 5 6 7 8 9 10	50	1 2 3 4 5 6 7 8 9 10	70	1 2 3 4 5 6 7 8 9 10
11	1 2 3 4 5 6 7 8 9 10	31	1 2 3 4 5 6 7 8 9 10	51	1 2 3 4 5 6 7 8 9 10	71	1 2 3 4 5 6 7 8 9 10
12	1 2 3 4 5 6 7 8 9 10	32	1 2 3 4 5 6 7 8 9 10	52	1 2 3 4 5 6 7 8 9 10	72	1 2 3 4 5 6 7 8 9 10
13	1 2 3 4 5 6 7 8 9 10	33	1 2 3 4 5 6 7 8 9 10	53	1 2 3 4 5 6 7 8 9 10	73	1 2 3 4 5 6 7 8 9 10
14	1 2 3 4 5 6 7 8 9 10	34	1 2 3 4 5 6 7 8 9 10	54	1 2 3 4 5 6 7 8 9 10	74	1 2 3 4 5 6 7 8 9 10
15	1 2 3 4 5 6 7 8 9 10	35	1 2 3 4 5 6 7 8 9 10	55	1 2 3 4 5 6 7 8 9 10	75	1 2 3 4 5 6 7 8 9 10
16	1 2 3 4 5 6 7 8 9 10	36	1 2 3 4 5 6 7 8 9 10	56	1 2 3 4 5 6 7 8 9 10	76	1 2 3 4 5 6 7 8 9 10
17	1 2 3 4 5 6 7 8 9 10	37	1 2 3 4 5 6 7 8 9 10	57	1 2 3 4 5 6 7 8 9 10	77	1 2 3 4 5 6 7 8 9 10
18	1 2 3 4 5 6 7 8 9 10	38	1 2 3 4 5 6 7 8 9 10	58	1 2 3 4 5 6 7 8 9 10	78	1 2 3 4 5 6 7 8 9 10
19	1 2 3 4 5 6 7 8 9 10	39	1 2 3 4 5 6 7 8 9 10	59	1 2 3 4 5 6 7 8 9 10	79	1 2 3 4 5 6 7 8 9 10
20	1 2 3 4 5 6 7 8 9 10	40	1 2 3 4 5 6 7 8 9 10	60	1 2 3 4 5 6 7 8 9 10	80	1 2 3 4 5 6 7 8 9 10

APPENDIX D

INSTRUCTION SETS

I am going to read some standardized instructions, so that everyone participating in these experiments will have the same information.

The scientific aspect of Landscape Architecture is relatively new. As with any emerging field many basic relationships need to be established. This research is a logical step in the progressive understanding of how urban plaza spaces are perceived. Thank you for your participation in this process.

Today we will evaluate several urban plazas based on (visual quality, comfortableness, invitingness). For the purpose of this study:

"Visual quality" means your preference for the space represented by each slide. Imagine yourself in each scene and evaluate your like or dislike for the space before you.

"Comfortableness" is a measure of your willingness to spend time in the plaza. Imagine you were to spend some time in the space represented by each slide and evaluate your willingness to linger there.

"Invitingness" is a measure of your willingness to enter the scene represented by each slide. Imagine yourself passing by the given scene and evaluate your willingness to enter that scene.

I am going to show you, one at a time, some color slides taken at different points in several urban plazas. Please think about the place in which each slide was taken rather than about the photographic quality of the slide itself.

The first preview slides will be shown very quickly just to give you an idea of the kinds of areas we will be evaluating. Try to imagine how you would rate these spaces, using the "rating response scale" at the top of your scoring sheet. Please note that the scale ranges from one, meaning you rate the scene to be very low in (visual quality, comfortableness, invitingness) to ten, indicating a very high degree of (visual quality, comfortableness, invitingness). Then, after these preview slides, I will announce that you are to begin rating the next set of slides. You should then indicate your judgment of the (visual quality, comfortableness, invitingness) of the space represented by the slide. Please use the full range of numbers if you possibly can, and please respond to each slide by clearly marking the appropriate space on your sheet.

When we have completed the front of the page, please turn the response sheet over and continue until the last slide is shown. Are there any questions? (Answer any questions by repeating instructions or defer them until after the experiment is done.)

These are the preview slides. Do no rate these slides. Use them to get an idea of the range of areas you will see. (Show preview slides.)

Now, rate the following slides, using the one to ten rating scale. A number will appear where the X is now to help you keep track of which slide is being shown. (Show slides for rating.)

APPENDIX E

CORRELATION MATRIX

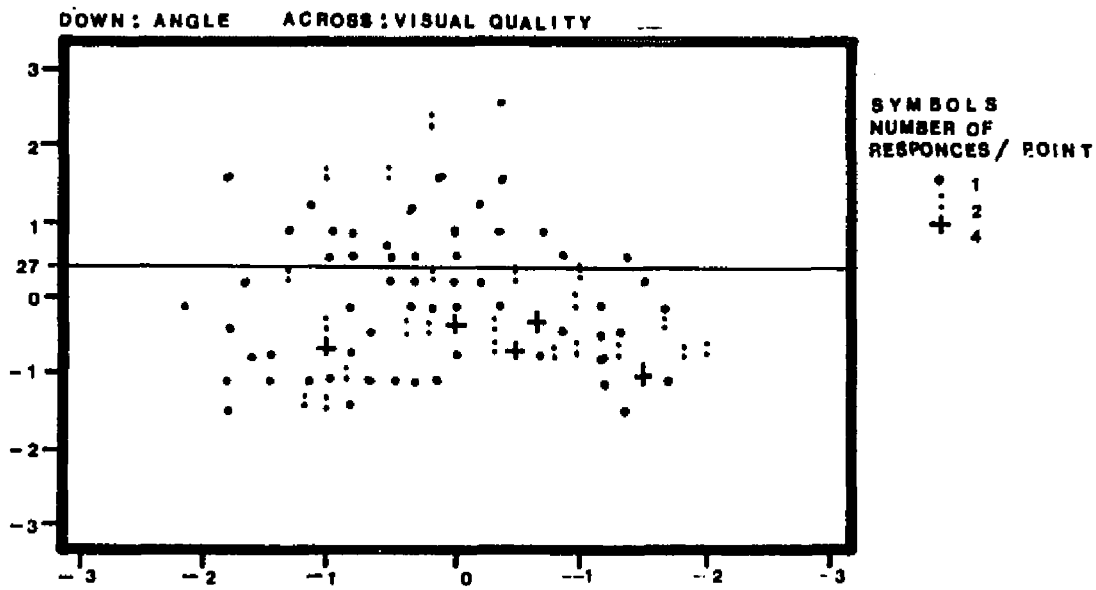
Dependent Var.	Indep. Var.	r^2
VQ	Angle	.01046
Inv.	Angle	.00870
Comf.	Angle	.00297
Angle	VQ, Inv., Comf.	.02151

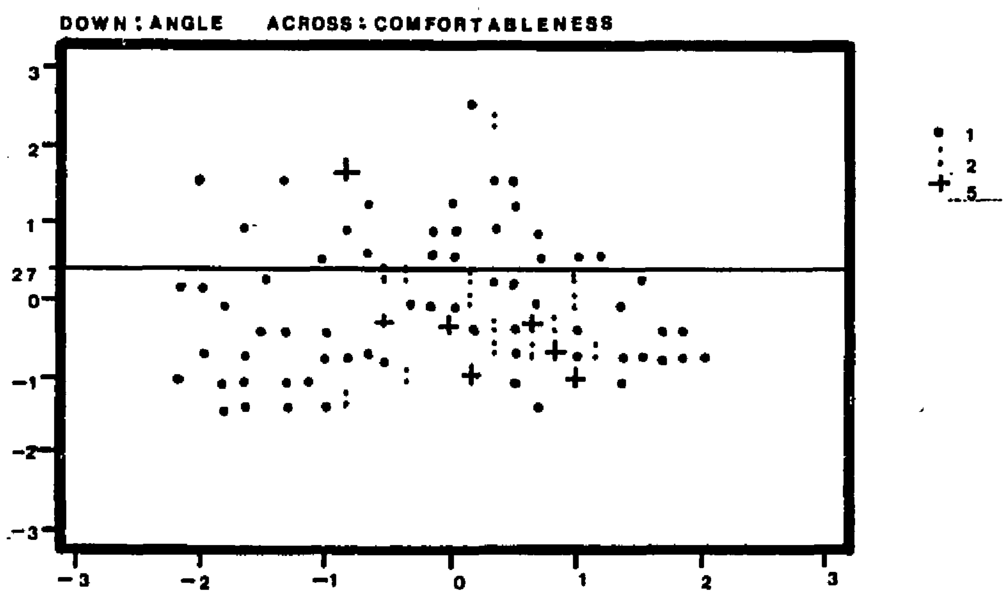
		VQ	Comf.	Inv.
VQ	-.102			
Comf.	-.054	.916		
Inv.	-.093	.956	.935	

APPENDIX F

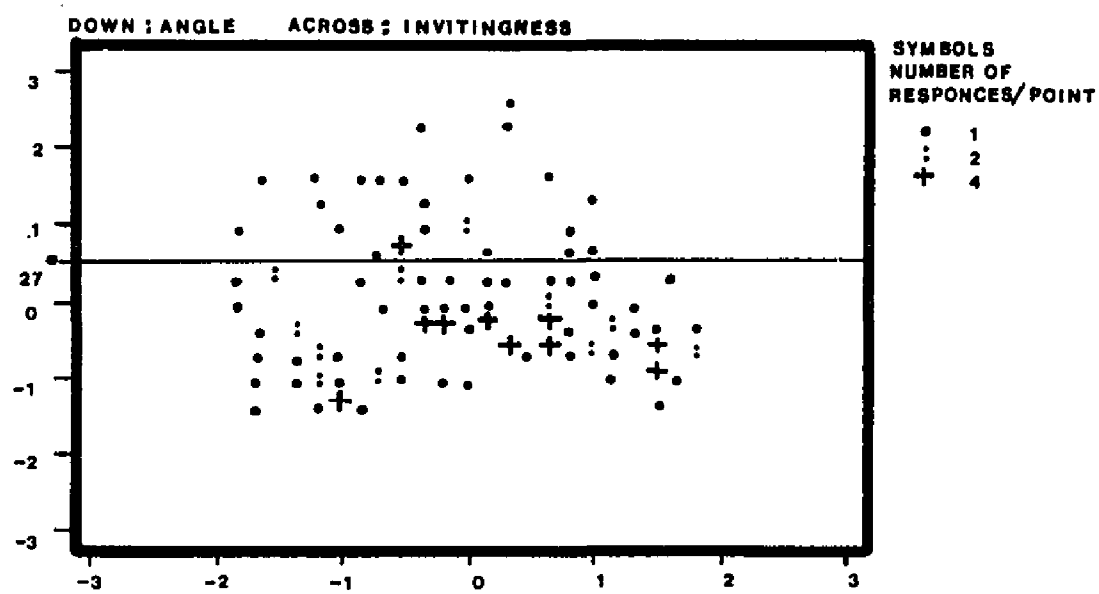
SCATTER PLOTS

STANDARDIZED SCATTERPLOTS





STANDARDIZED SCATTERPLOTS



APPENDIX G

RAW DATA

Transect	Photo No.	Distance	Height	Angle°	Means/Photo VISUAL	COMFORT	INVITE
A1	1	40	51	51.89	3.816	3.951	3.556
	2	60	51	40.36	3.579	3.634	3.611
	3	80	51	32.52	3.474	3.366	3.306
	4	100	51	27.02	3.842	3.146	2.861
	5	120	51	23.03	3.447	3.707	3.167
	6	140	51	20.02	3.974	3.659	3.500
	7	160	51	17.68	3.632	3.659	3.750
	8	180	51	15.82	4.605	4.415	4.556
A2	9	20	51	68.59	4.447	3.585	4.444
	10	40	51	51.89	3.658	3.976	4.528
	11	60	51	40.36	4.237	4.268	5.750
	12	80	51	32.52	5.132	4.659	5.611
	13	100	51	27.02	5.289	4.683	5.333
	14	120	51	23.03	5.368	4.683	5.806
	15	140	51	20.02	4.553	4.341	5.833
	16	160	51	17.68	5.553	4.537	5.833
	17	180	51	15.82	5.500	5.098	6.389
	18	200	51	14.30	5.105	4.585	5.694
	19	220	51	13.05	5.789	4.902	6.083

Transect	Photo No.	Distance	Height	Angle°	Means/Photo VISUAL	COMFORT	INVITE
	20	240	51	12.00	5.526	5.073	6.556
	21	260	51	11.10	6.105	4.659	6.361
A3	22	30	14.5	25.80	1.605	1.293	1.194
	23	40	14.5	19.93	1.395	1.927	1.500
	24	50	14.5	16.17	2.632	2.561	2.000
	25	60	14.5	13.59	2.526	2.951	2.361
	26	20	14	34.99	4.553	4.000	4.139
	27	30	14	25.02	4.789	4.805	5.083
	28	40	14	19.29	4.947	4.390	5.028
	29	50	14	15.64	5.526	4.366	5.083
	30	60	14	13.13	5.500	5.000	5.361
	31	70	14	11.31	6.053	4.756	5.917
D1	32	60	59	44.52	2.605	2.098	2.250
	33	80	59	36.41	2.684	2.756	2.639
	34	100	59	30.54	3.237	2.585	3.000
	35	120	59	26.18	3.947	3.024	3.417
	36	140	59	22.85	3.763	3.341	3.667
	37	160	59	20.24	4.026	3.122	3.833
	38	180	59	18.15	3.974	3.098	3.694
	39	200	59	16.44	3.763	3.073	3.806
D3	40	40	35	41.19	2.289	2.927	2.278
	41	60	35	30.26	2.842	3.561	3.389
	42	80	35	23.63	2.711	3.439	3.806
	43	100	35	19.29	3.474	3.951	4.028

Transect	Photo No.	Distance	Height	Angle°	Means/Photo VISUAL	COMFORT	INVITE
	44	120	35	16.26	4.500	3.951	4.722
E2	45	60	53.5	41.72	3.184	2.732	3.361
	46	80	53.5	33.77	3.921	3.390	3.472
	47	100	53.5	28.15	4.158	3.976	4.639
	48	120	53.5	24.03	5.503	4.293	5.111
	49	140	53.5	20.91	5.605	4.659	5.167
	50	160	53.5	18.49	4.974	4.317	5.083
	51	180	53.5	16.55	5.132	4.732	5.417
E3	52	40	59	55.86	4.421	3.805	4.694
	53	60	59	44.52	4.474	3.951	5.222
	54	80	59	36.41	4.816	4.463	5.528
	55	100	59	30.54	5.763	4.927	5.472
	56	120	59	26.18	6.158	5.341	6.861
	57	140	59	22.85	6.237	5.171	6.278
	58	160	59	20.24	6.395	5.659	6.500
	59	180	59	18.15	6.395	5.415	6.917
	60	200	59	15.64	6.711	5.780	6.944
	61	220	59	15.01	6.921	5.756	7.083
	62	240	59	13.81	6.474	5.537	6.472
E4	63	40	37	42.77	2.605	2.732	2.889
	64	60	37	31.66	4.079	4.366	4.306
	65	80	37	24.82	3.632	3.293	3.361
	66	100	37	20.30	2.500	3.610	4.250
	67	120	37	17.14	3.921	3.732	4.278

Transect	Photo No.	Distance	Height	Angle°	Means/Photo VISUAL	COMFORT	INVITE
	68	140	37	14.80	4.711	4.220	4.833
E5	69	20	39	62.85	3.289	3.171	3.056
	70	40	39	44.27	3.842	4.195	4.111
	71	60	39	33.02	2.868	3.585	4.056
	72	80	39	25.99	3.342	3.780	3.778
	73	100	39	21.31	4.395	3.780	4.278
	74	120	39	18.00	4.526	4.415	4.417
	75	140	39	15.57	5.026	4.634	4.722
	76	160	39	13.70	5.211	5.317	5.694
E6	77	40	38.5	43.91	3.184	2.707	2.944
	78	60	38.5	32.69	2.684	2.902	3.278
	79	80	38.5	25.70	3.605	3.317	3.639
	80	100	38.5	21.06	3.921	3.732	4.028
	81	120	38.5	17.79	3.605	4.049	3.694
	82	140	38.5	15.38	3.868	3.951	4.583
	83	160	38.5	13.53	4.658	4.610	5.139
E7	84	40	21	27.70	4.684	4.195	4.472
	85	60	21	19.29	4.921	4.561	5.167
	86	80	21	14.71	4.421	4.829	5.222
	87	100	21	11.86	3.316	3.805	3.917
	88	120	21	9.93	3.789	3.829	4.028
G1	89	40	28.5	35.47	2.000	1.829	1.139
	90	60	28.5	25.41	2.211	1.927	1.667
	91	80	28.5	19.61	2.974	2.561	2.111

Transect	Photo No.	Distance	Height	Angle°	Means/Photo VISUAL	COMFORT	INVITE
	92	100	28.5	15.91	2.605	2.780	2.389
	93	120	28.5	13.36	2.868	3.098	3.333
	94	140	28.5	11.51	2.526	3.195	2.917
	95	160	28.5	10.10	3.026	3.244	2.917
	96	180	28.5	9.00	3.605	3.829	3.361
BP1	97	40	22	28.81	5.447	3.756	5.806
	98	60	22	20.14	5.868	4.195	6.222
	99	80	22	15.38	5.974	4.561	6.528
	100	100	22	12.41	6.553	4.585	6.583
	101	120	22	10.39	6.293	4.659	6.417
	102	140	22	8.93	6.132	4.220	6.667
	103	160	22	7.83	5.921	4.439	6.611
DN1	104	40	8.25	11.65	2.342	1.732	2.306
	105	60	8.25	7.83	2.579	1.829	2.194
	106	80	8.25	5.89	2.632	2.146	2.639
	107	100	8.25	4.72	2.868	2.659	2.750
DY2	108	20	20	45	1.500	1.488	1.361
	109	40	20	26.57	2.184	1.415	1.750
	110	60	20	18.43	2.500	2.122	1.917
	111	80	20	14.04	1.789	1.829	2.250
	112	100	20	11.31	2.763	2.366	2.472
	113	120	20	9.46	2.816	2.220	2.333
	114	140	20	8.13	2.447	2.488	2.528
	115	160	20	7.13	2.395	2.780	2.500

Transect	Photo No.	Distance	Height	Angle°	Means/Photo VISUAL	COMFORT	INVITE
FW1	116	40	15	20.56	1.026	1.659	1.139
	117	60	15	14.04	1.658	1.317	1.361
	118	80	15	10.62	1.474	1.171	1.861
	119	100	15	8.53	1.816	1.537	1.500
	120	120	15	7.13	1.500	1.585	1.528

KEY:

Transect	Location
A1,A2,A3	El Presidio Park
B2	Tucson Museum of Art courtyard
D1	Pima Community College West Campus
D3	Pima Community College West Campus
E2	University of Arizona Old Chemistry
E3	University of Arizona, Arizona State Museum
E4	University of Arizona Old Anthropology Building
E5	University of Arizona Gila Dormitory
E6	University of Arizona Center for English as a Second Language Building
E7	University of Arizona Aerospace and Mechanical Engineering Building
G1	University of Arizona Gittings Building
BP1	Britannia Business Park
DN1	Doolen Junior High School
DY2	Donaldson Elementary School
FW1	Flowing Wells Junior High School

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