TRANSIT PASSENGER SHELTERS:

BASIC DESIGN PRINCIPLES

DR. FRANK EHRENTHAL
VIRGINIA POLYTECHNIC INSTITUTE
BLACKSBURG, VIRGINIA

JANUARY 1973

Prepared for and edited by
URBAN MASS TRANSPORTATION ADMINISTRATION
U. S. DEPARTMENT OF TRANSPORTATION
WASHINGTON, D.C. 20591

Technical Report Documentation Page

1. Report No. UMTA-VA-06-0003-73-1	2. Government Accession No.	3. Recipient's Catalog No.
4. Title and Subtitle Transit Passenger Shelters Basic Design Principles		5. Report Date January 1973 6. Performing Organization Code
7. Author(s) Dr. Frank Ehrenthal		8. Performing Organization Report No.
9. Performing Organization Name and Address Virginia Polytechnic Institute Blacksburg, Virginia		10. Work Unit No. (TRAIS) 11. Contract or Grant No. VA-06-0003
12. Sponsoring Agency Name and Address Urban Mass Transportation Administration 400 7th Street, SW. Washington, D. C. 20590		13. Type of Report and Period Covered FINAL 14. Sponsoring Agency Code
15. Supplementary Notes		

16. Abstract

The report analyzes the problem of passenger shelter design with the object of maximizing user welfare while contending with the constraints of environmental fit and cost. Each element of welfare (comfort, safety, convenience) is considered separately in the light of the constraints imposed by fit and cost.

This analysis is used to develop a list of design criteria for shelters and a prototype shelter design is developed based on these criteria.

The report also contains information on other problems confronting the shelter designer and a report on the shelters in use in the United States in 1970.

17. Key Words Transit Shelters Passenger Shelters Bus Shelters Urban Transit Shelters		18. Distribution Statement Releasable to the Public. Available from NTIS Springfield, Va. 22151	
19. Security Classif. (of this report) UNCL	20. Security Classif. (of this page) UNCL	21. No. of Pages 98	22. Price

Form DOT F 1700.7 (8-72) Reproduction of completed page authorized

PROJECT STAFF

Principal Investigator:	Dr. Frank F. Ehrenthal
Investigators:	Dr. Michael C. Cunningham Dr. John W. Dickey Professor Gar Day Ding Mr. Charles W. Stegen, Jr.
Graphics:	Mark Orlind Robert Koch

This prototype passenger shelter was designed based on the principles developed in this report.

Transit Passenger Shelters: Basic Design Principles

Section I - The Problem

The problem of traffic congestion in most American cities has reached serious proportions. There is a growing realization that alternatives to automobile travel must be developed. In recent years cities have been improving transit networks for the purpose of providing greater overall mobility and to lessen the harmful impact of automobiles on the urban environment.

One of the drawbacks of transit usage, particularly bus transit, is the necessity to wait at a transit stop on the street exposed to the weather, traffic and crime.

Waiting in a public, open space should be a pleasing and desirable experience. Whether it is or not depends on the entire set of factors that constitute the local environment and only to a small extent on the design of the waiting area itself.

It is recognized that the best designed hardware cannot change what is basically a poorly designed environment; however, the primary purpose of this report is to focus on the basic principles for the design of passenger shelters to minimize the hazards faced by the transit passenger and make the total transit trip a more pleasant experience.

It can be seen in Figures I-1 through I-6 that the situation for the pedestrian/transit passenger is chaotic, unsafe and unpleasant. Moreover anyone waiting for a bus is often exposed to rain or snow and is a vulnerable target for violent crime.

To make matters worse, discussion of transit shelters assumes that the space for the shelter must be taken from the little remaining sidewalk area as if the possibility of intruding into the automobile domain were unthinkable.

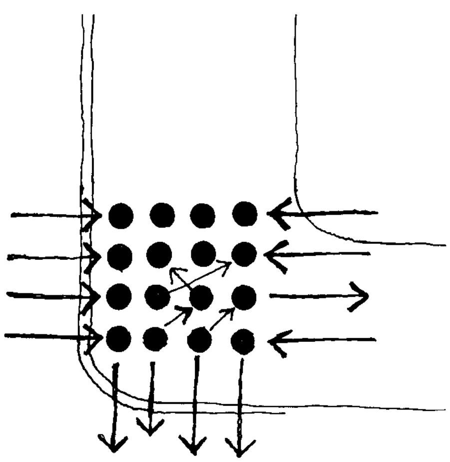
Because of the limited spaces available, it is necessary to consider the needs of those outside the shelter as well as those inside. A design must deal with the issues of health, welfare and safety and not just the physical attributes of the shelter. It must be remembered that intra-urban circulation involves both pedestrian and vehicular circulation, and it is at one of the interfaces of the two flows, the transit stop, that shelter is needed.

For the purposes of this report, we will define shelter as that which affords protection against a hazard, i.e., a peril to health, welfare and safety. The major hazards to transit passengers waiting in the street are; inclement weather, fatigue, lack of space and isolation.

In seeking a design that can best protect passengers against these hazards, we are confronted by a three part question:

1. How can those exposed to hazards of the urban street best be sheltered while waiting for a transit vehicle?
2. How can the shelter best fit into the limited pedestrian space among the great variety of activities and facilities?
3. How can it be done economically?

The third part of question is most crucial considering the limited funds available for transit improvements and the tendency of some to desire



pedestrian corner congestion

Figure I-1

the unexamined pedestrian street environment....what is going on?....
and where is the space for it?...

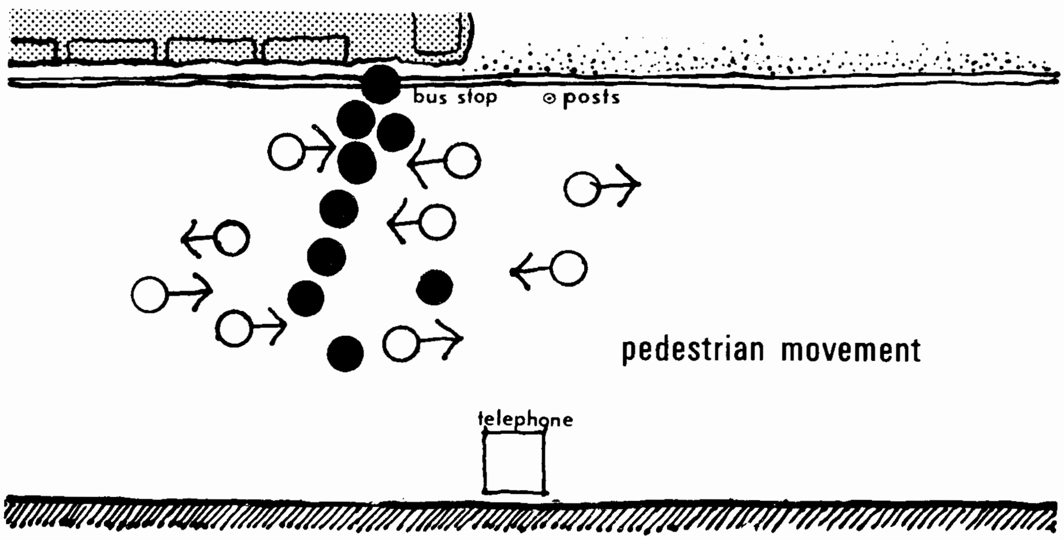


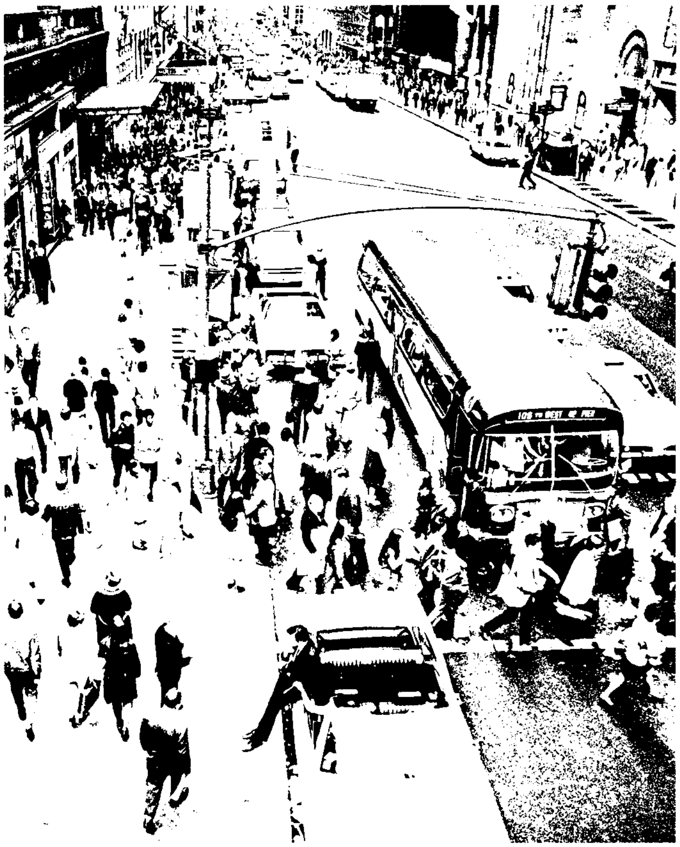
Figure I-2

VISUAL CHAOS:

where is the bus stop sign?...

is the bus coming?...

Figure I-3



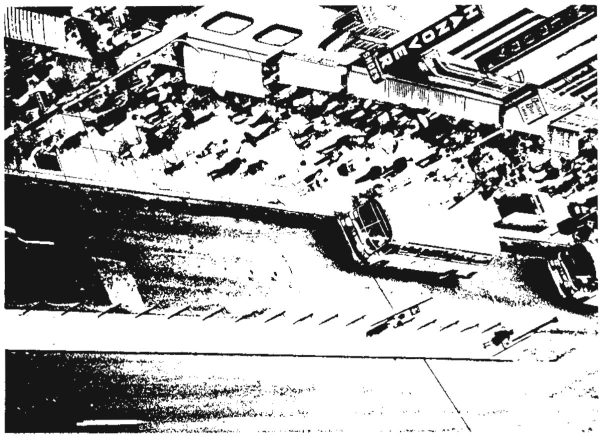
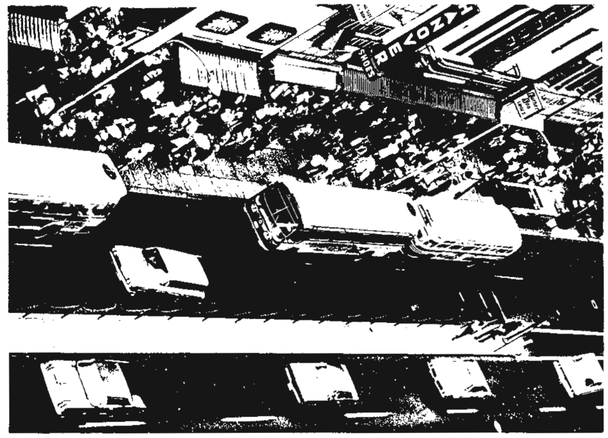
which bus is coming?

is it going to stop?

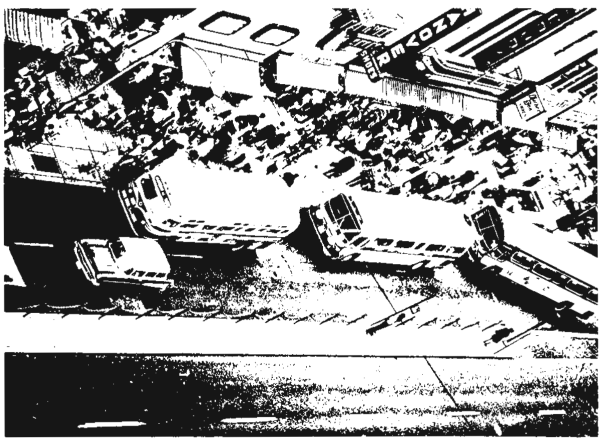
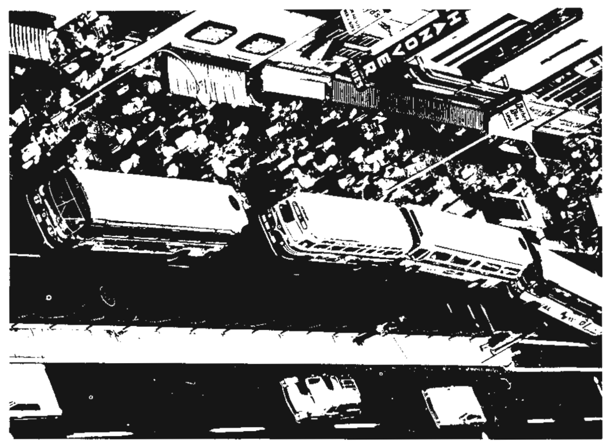
Figure I-4a

will it stop at the curb?

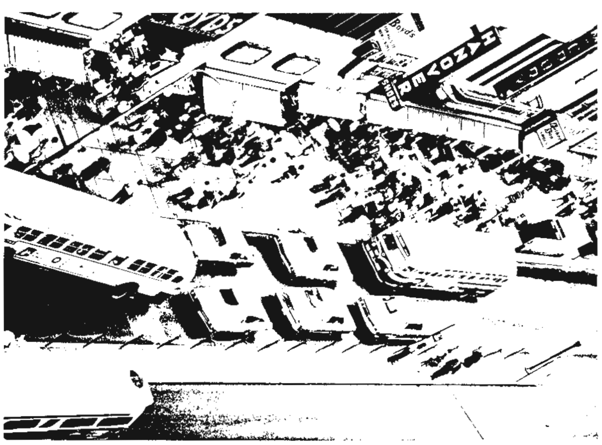
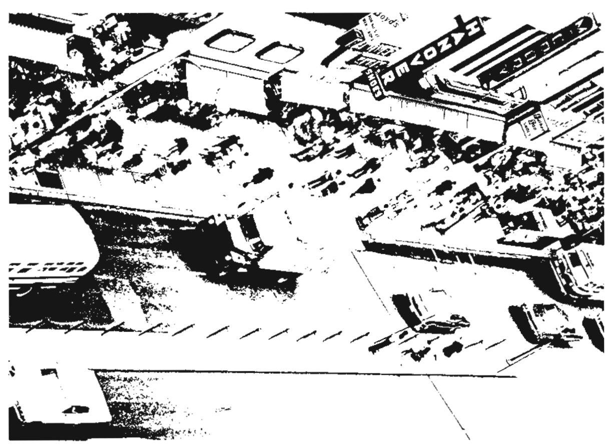
Figure I-4b

cut back the sidewalk! send pedestrians to an island!

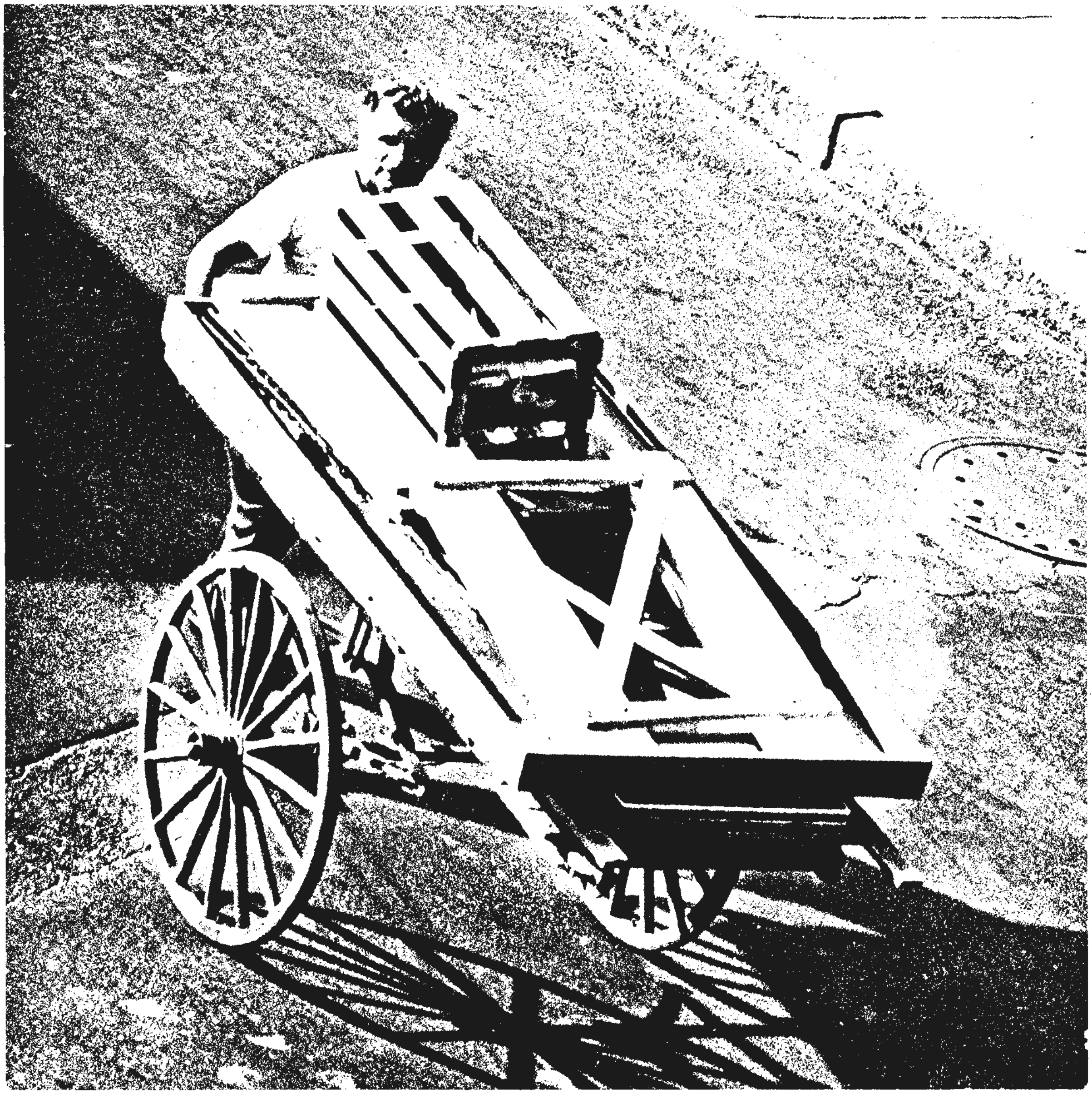



torture the bus driver! tie up the city!

make room for the private vehicle!

Figure I-5



where am i supposed to be?

Figure I-6

expensive structures designed not with the welfare of the passenger in mind, but to satisfy aesthetic tastes.

The main concern of the study is the welfare of the waiting passenger as affected by the constraints of environmental fit and costs.

In dealing with these elements the following must be considered:

- Urban management - cost - benefit analysis, priorities, quality of transit service.
- Urban design/product design - street and shelter spatial organization
- Urban micro-climate - wind, temperature, etc., at a particular street location
- Urban behavior - community values, individual values

With these in mind, the criteria for passenger shelters were developed. The analysis of shelter related problems is followed by the development of a prototype design which is a practical demonstration of the design principles and a flexible model which can be used in many areas of the country.

Section II - Data Collection

It is not surprising that so few shelters have been constructed considering the frustrations of obtaining funds and dealing with objections from public and private sources. The prevailing attitude toward shelters is reflected in the difficulty involved in collecting data concerning them. In general the records of shelter locations, cost and design could not be obtained from cities. Difficulty was also encountered in obtaining technical data from manufacturing organizations.

A. Cities Surveyed:

In 1969-70 forty-seven cities were surveyed concerning the number and type of shelters available (see Appendix A). Thirty-two confirmed that they had shelters in use. These varied widely in design, type of construction, degree of enclosure and condition. There were a total of 2622 shelters in the thirty-two cities. Three-fourths were less than five years old and 720 were funded with the assistance of the Urban Mass Transportation Administration's Capital Grant program.

B. Shelters In Use:

There seem to be as many different shelter designs as there are designers and fabricators. This situation tends to keep the price of shelters high and precludes the economies available from the production of standard units.

Shelters fall into two broad categories, open and partially enclosed. The open types do not have wall elements and generally afford less than adequate protection. Open shelters may be further classified by the type of support structure: post-and-beam, single or double cantilever, umbrella and canopy.

Few shelters have protection (enclosure) on all sides and none is fully enclosed (there are no doors on entrances and exits). Partially enclosed shelters are supported by a post-and-beam structure or paneled wall supports.

Some fabricators assemble shelters with varying degrees of enclosure with the use of metal or wood framed panels where the framework is load bearing or stock window walls or large sheet enclosure with a post-and-beam structure.

The types of materials used are as varied as the shelter designs. Fabricators often use shelter designs based on components designed for another use such as window walls, or curtain walls.

Panels are made of glass, acrylic, polycarbonate metal, transite, plywood, hardboard, porcelain enameled metal or sandwich types with metal, transite hardboard or other skin over styrofoam, gypsum, paper, wood or other core. There is an increasing tendency to use transparant wall panels and the use of most of the above materials will probably decrease.

Roofs are made of metal, transite, plastic sheet or a composite using a variety of materials.

Finishes used on the materials also vary. Wood, plywood and masonite are generally painted. Steel may be painted, have a baked enamal or porcelain enamel finish or have a stainless steel jacket. Transite is either painted or natural and glass and plastic have natural finishes.

Existing shelters may also provide other amenities such as artificial lighting, heating or ventilation. None provide cooling.

Figure II-1 through II-6 are examples of domestic shelters in use and Figure II-7 through II-11 show foreign shelters.

C. Shelter designers, fabricators and suppliers:

Thirty-eight shelter designers, fabricators and suppliers were surveyed. Only eight of twenty-five U.S. firms could furnish data sheets, price lists or consumer literature. None of these shelters was listed in the 1971 Sweets Catalogue Files[1]. Since the time of the survey, however, there has been a greater interest in shelters and the situation may have changed.

D. Costs:

Reported costs of shelters varied from $300 to $3,000 per unit, but most information was incomplete. Often it was impossible to isolate the shelter cost from the total cost of a larger project.

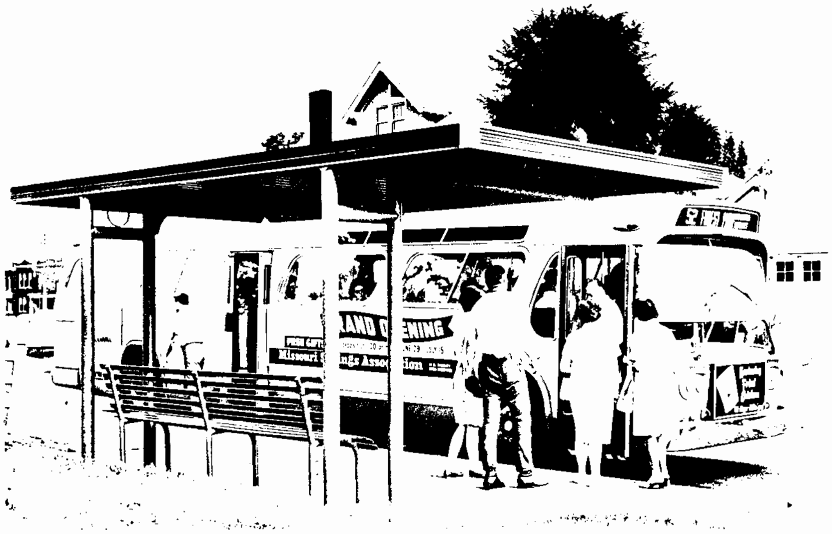
Cost figures vary greatly because of variations in size and design which respond to different environmental fits and service values.

E. Shelter related problems:

During the course of collecting data concerning shelters, several cities were visited and the problems relative to the use of shelters were observed firsthand. Two major problem areas are placement (location) and vandalism.

[1]Sweets Division, McGraw-Hill Information Systems Company, N.Y., N.Y. Architectural and Light Construction Catalogue Files

shelters in the U. S.



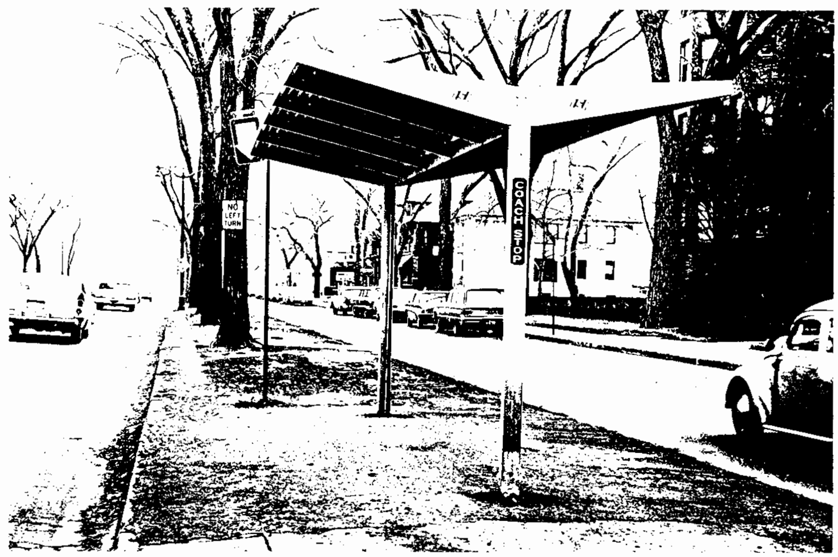


Figure II-1

Figure II-2

Figure II-3

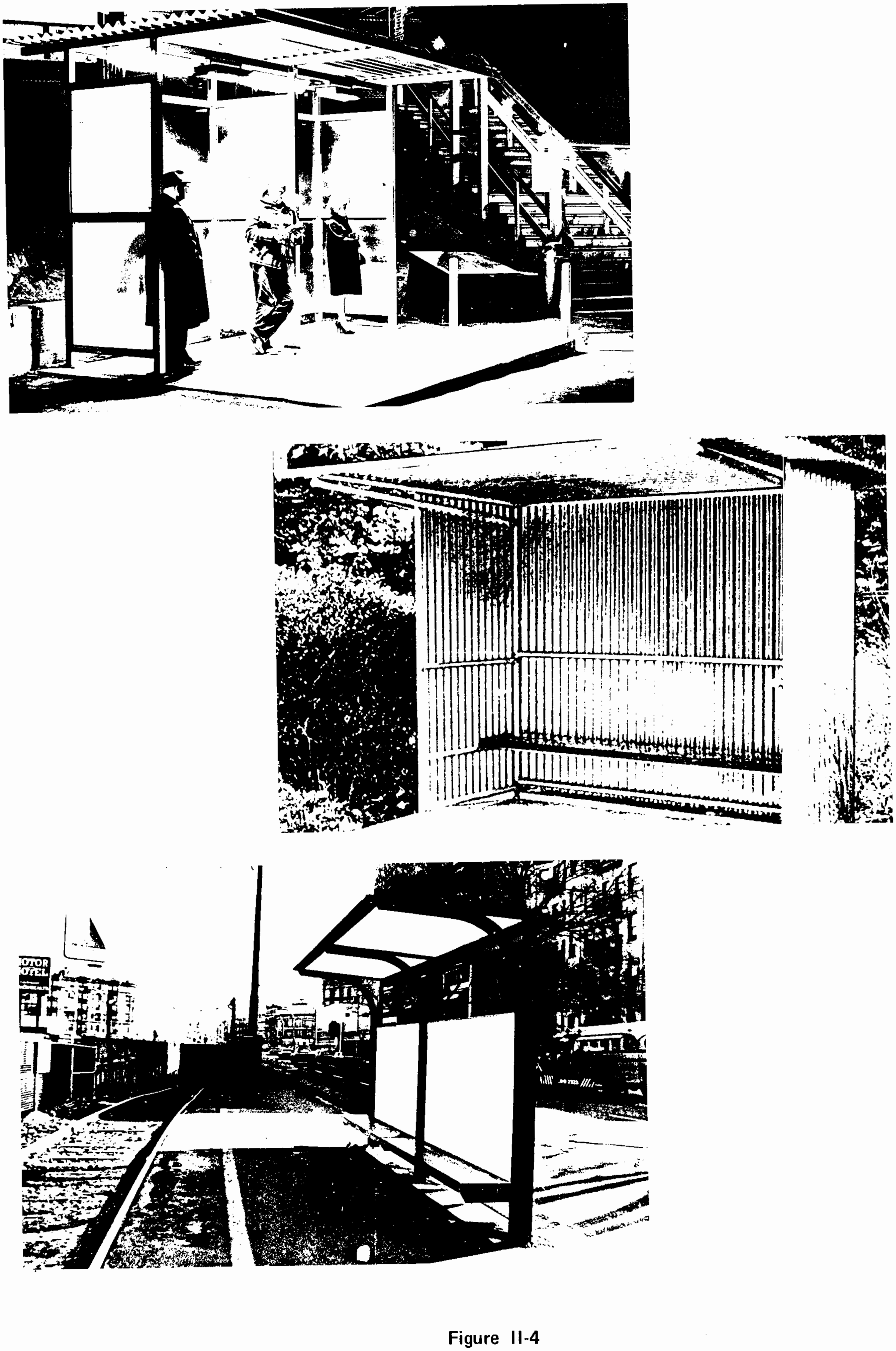


Figure II-4

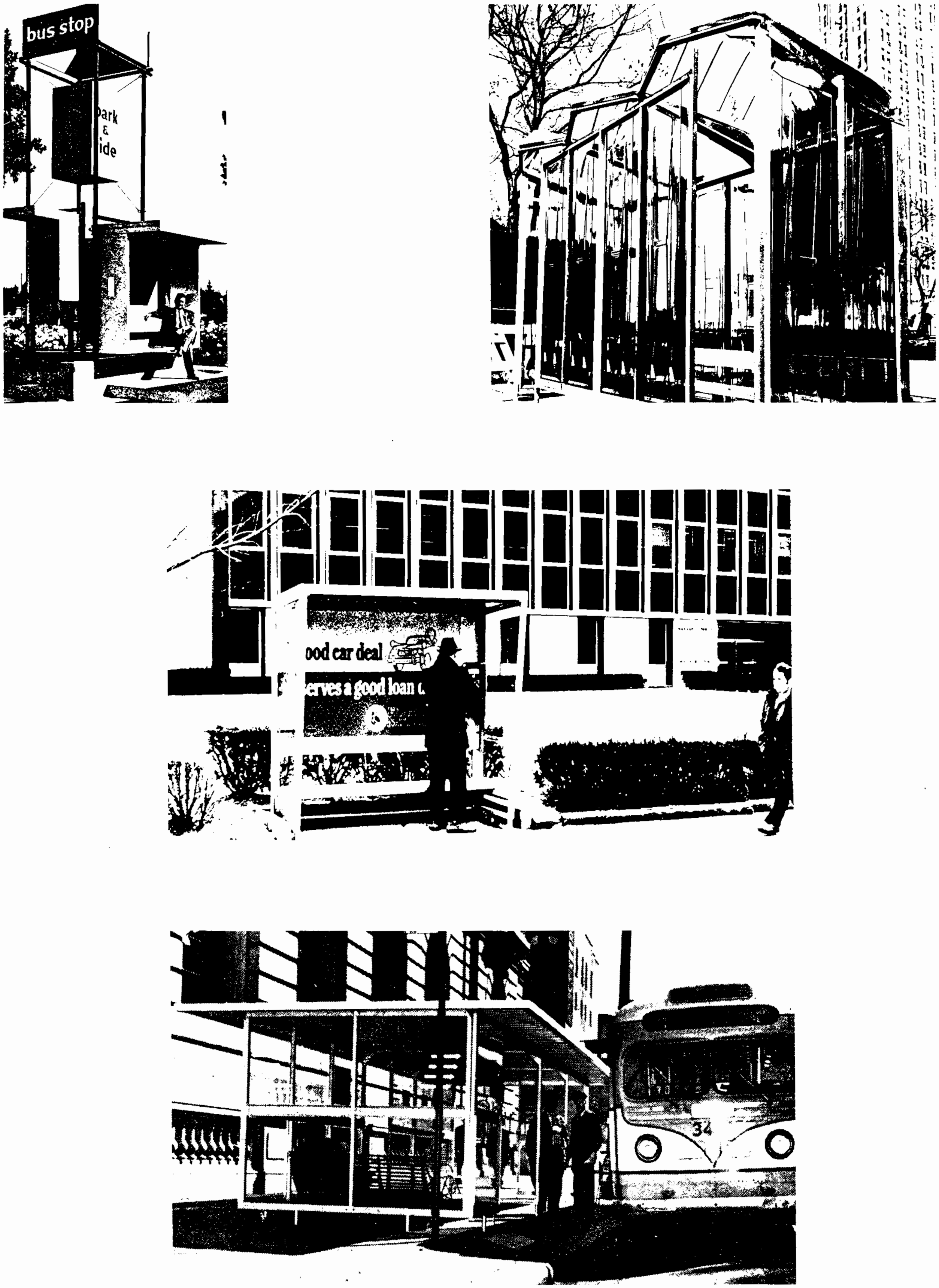


Figure II-5

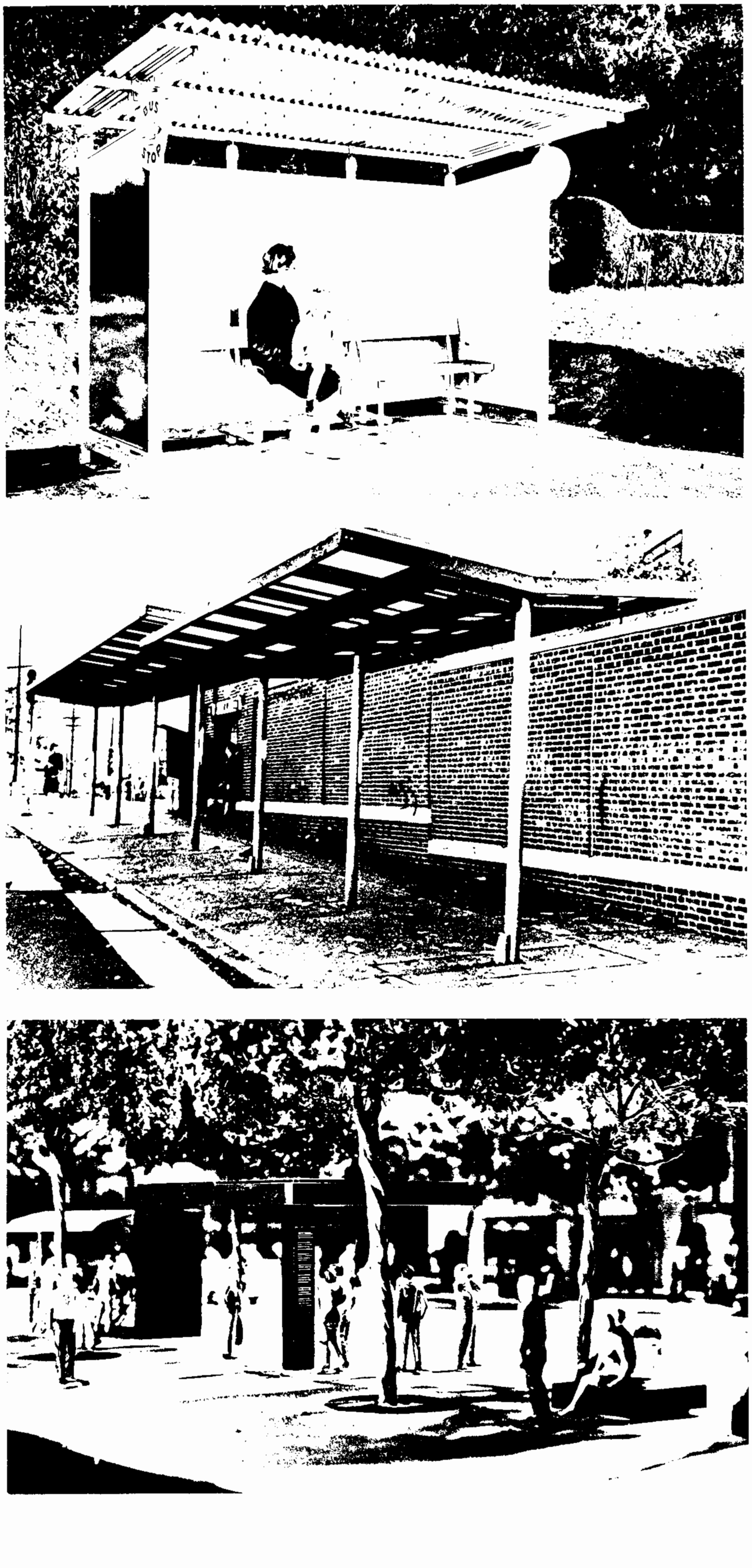
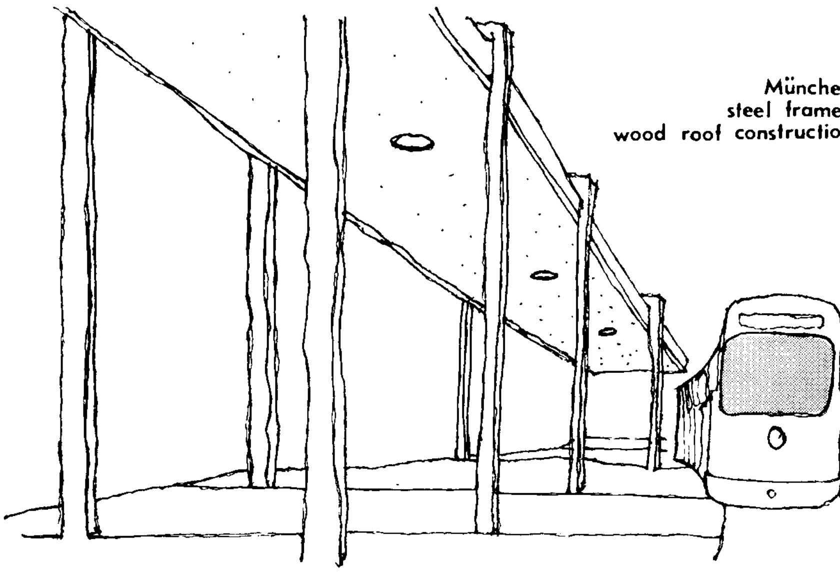
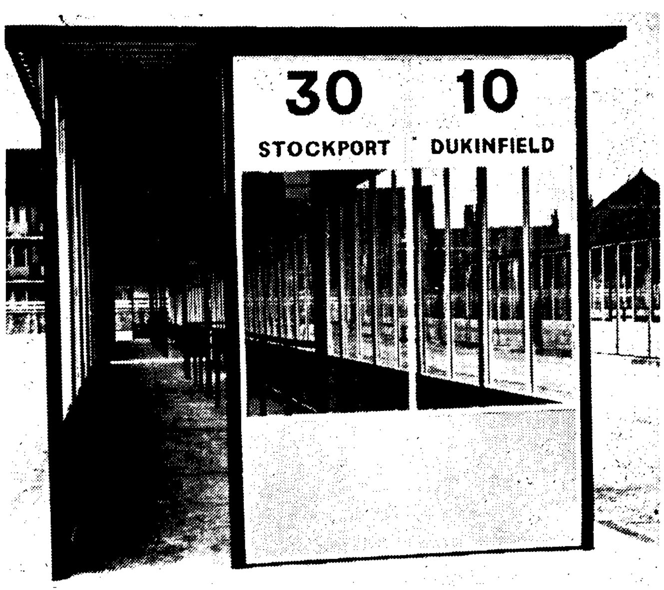


Figure II-6

foreign shelters

München
steel frames
wood roof construction





London
maintainance and repair by private advertizing company which erects shelters in return for advertizing rights

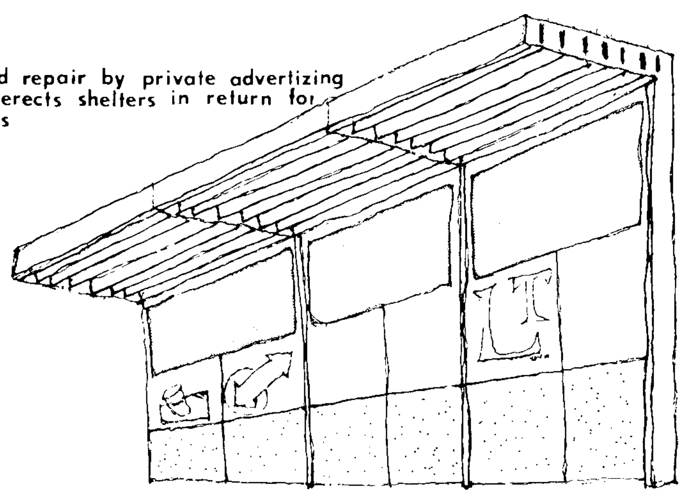
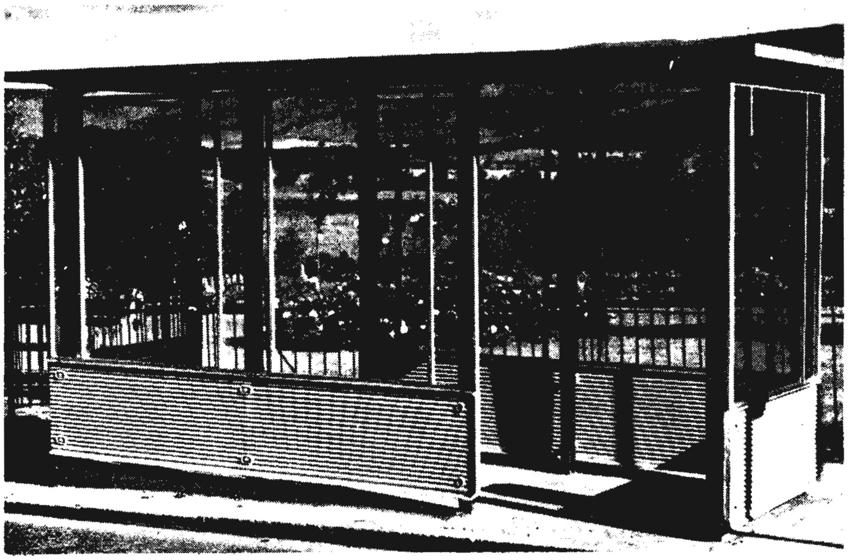
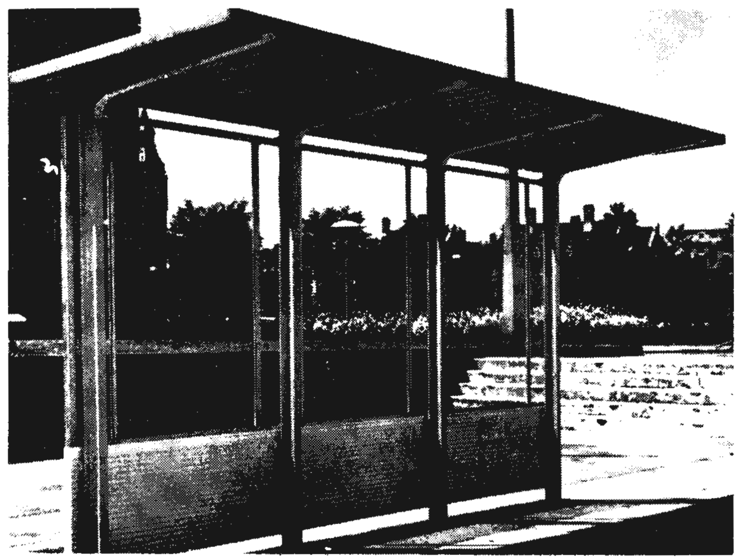


Figure II-7





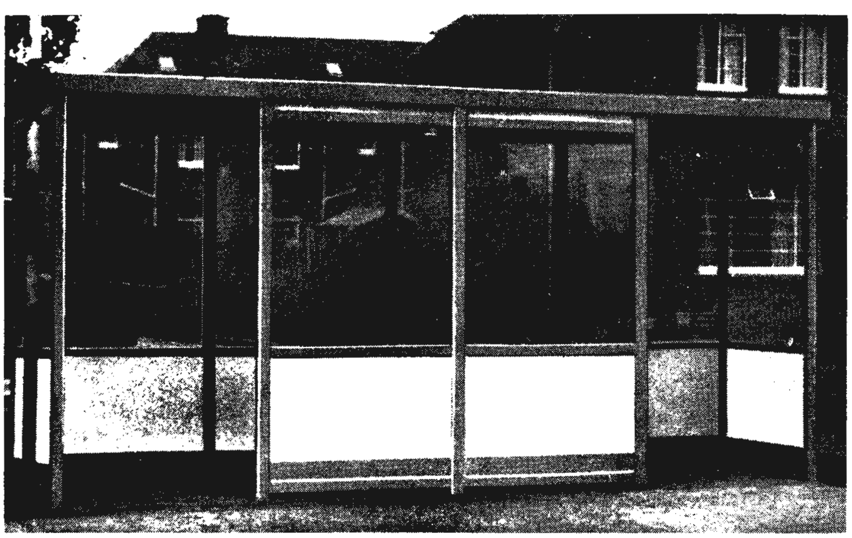


Figure II-8

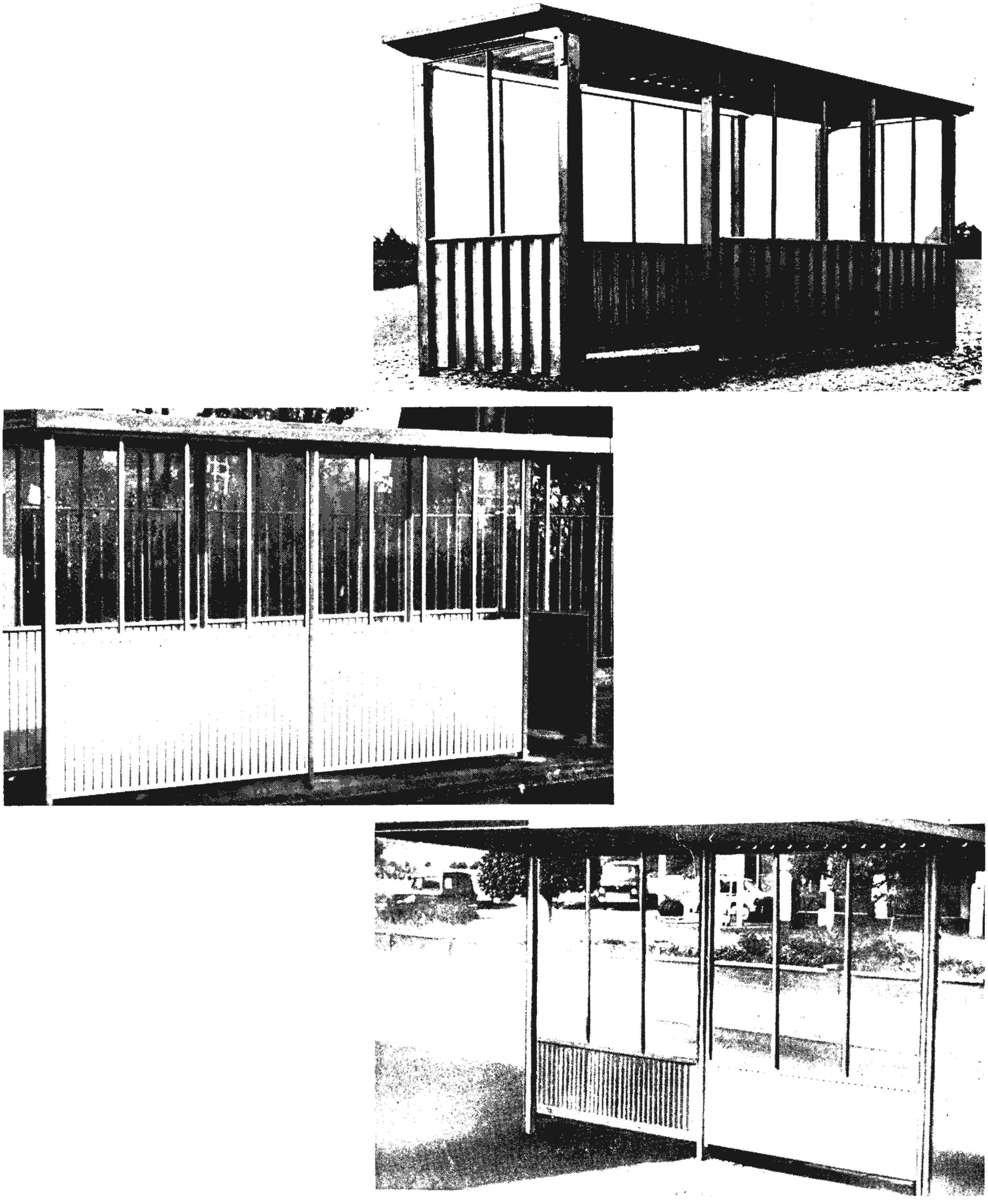
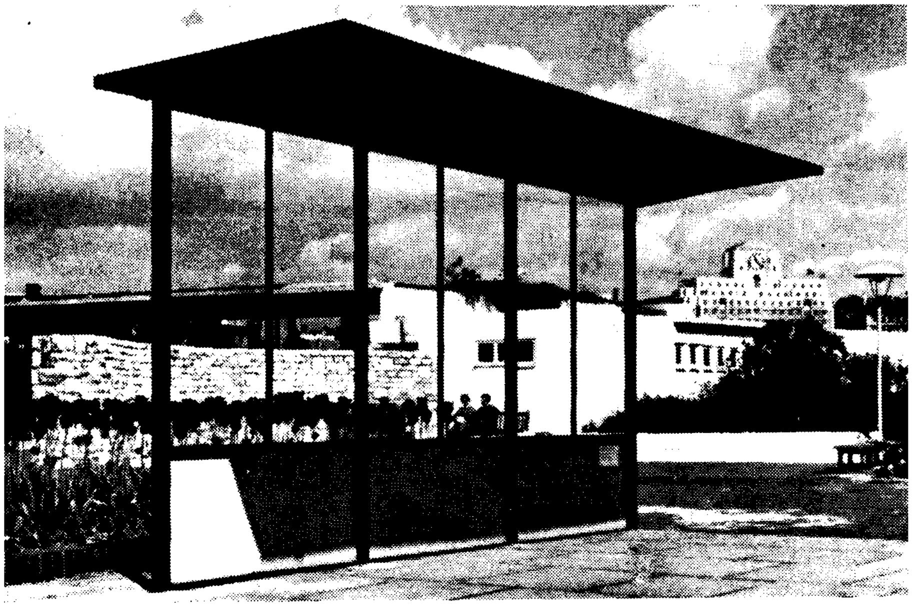


Figure II-9



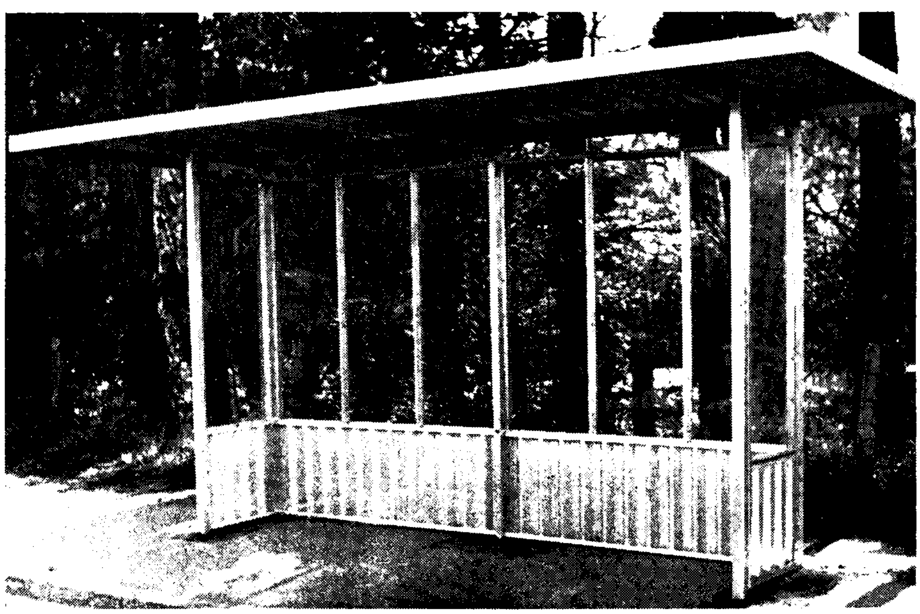


Figure II-10

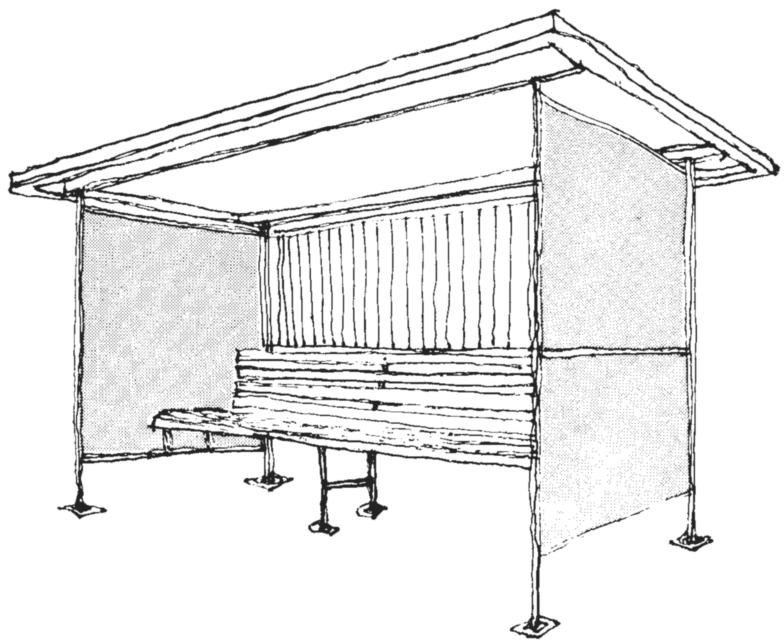


Figure II-11

Placement: Two major difficulties involved in locating shelter are limited sidewalk widths and objections from adjoining property owners.

Property Owners and Storekeepers: Property owners' reaction to the placement of transit stops and shelters varies. None likes to have anything in front of his property that will attract noisy, unruly activity or behavior, such as a transit stop and shelter serving a nearby school might do; nor do they like objects that permanently block the view of and/or from their property. Storekeepers welcome a transit stop close by, but preferably not in front of their premises, and object to whatever they see as a blockage affecting access to their shops or viewing of their displays and signs.

Conflicting Uses: There are no comprehensive, systematic studies of the functions and activities of the street system. Most arrangements are haphazard and do not resolve conflicting needs or wants. Transit system design is handicapped by crowded streets where transit vehicles must move and stop, and by inadequate sidewalks where vehicles load and unload.

Police departments have jurisdiction over movement in the streets and their major concern is to accommodate all vehicular movement. The pedestrian movement has to adjust to the situation as best it can. Sidewalks have been getting narrower to add width to the roadbed to satisfy increasing demands by vehicular movement and parking. Transit systems, therefore, have difficulty in securing sidewalk space for shelter. In the competition for right-of-way the pedestrian has been the loser.

Inadequate sidewalk widths are a public concern because of the inconvenience, discomfort, and hazards resulting from lack of space for and congestion created by various pedestrian street activities such as: access to adjacent activity spaces on both sides of the sidewalk, window-shopping, thru-movement, trees, street services (mailboxes, street lights, hydrants, signposts, benches, alarm-boxes, sidewalk elevators, subway and elevated structure stairways and escalators, waiting shelters, phone booths, vending kiosks for news, for flowers, etc.).

Physical Dangers: Poorly placed stops and shelters, such as at a difficult vehicular turn, exposes waiting passengers and shelters to a hazard from moving vehicles. Inadequate sidewalk width forces use of a shelter with shallow depth and less enclosure than is needed. (See Figure II-12)

Personal safety, especially at night, is easily threatened when a shelter is located in a dimly lit isolated area. Most problems are in the downtown and low-density residential areas.

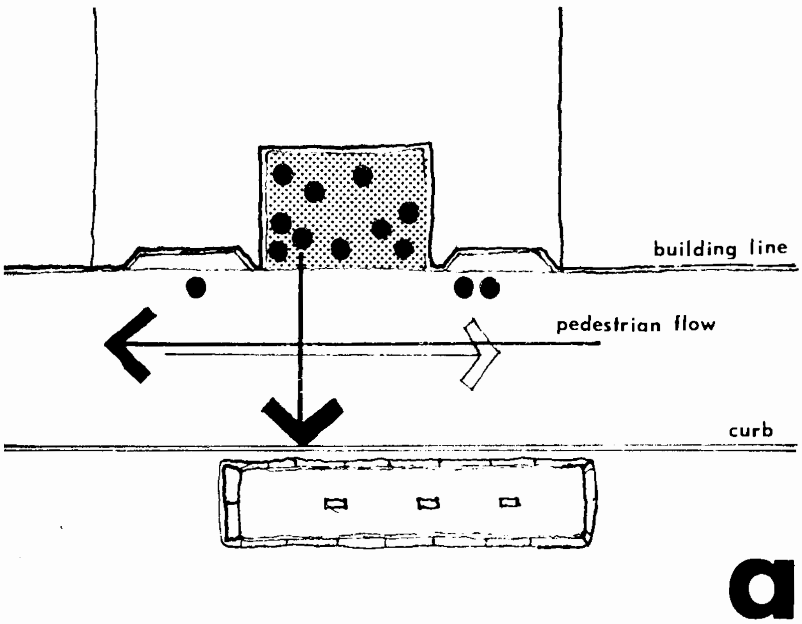
Shelters: Figures II-13 and II-16 show various ways that transit passengers may be sheltered. Figure II-17 is a sequence of photographs and drawings showing a technique to indicate sidewalk user behavior.

Street Clutter: Identification of transit stops from the distance of half a city-block is a problem for both users and drivers. The prevailing chaos is due to sign congestion and unsystematic and dis-functional sign design and placement.

a street shelter here? – or a sheltered sidewalk?

Figure II-12

WAITING FOR A BUS



(a) and (b) show poor visibility of approaching vehicle by those waiting in shelter. Sidewalk movement is obstructed by boarding passengers.

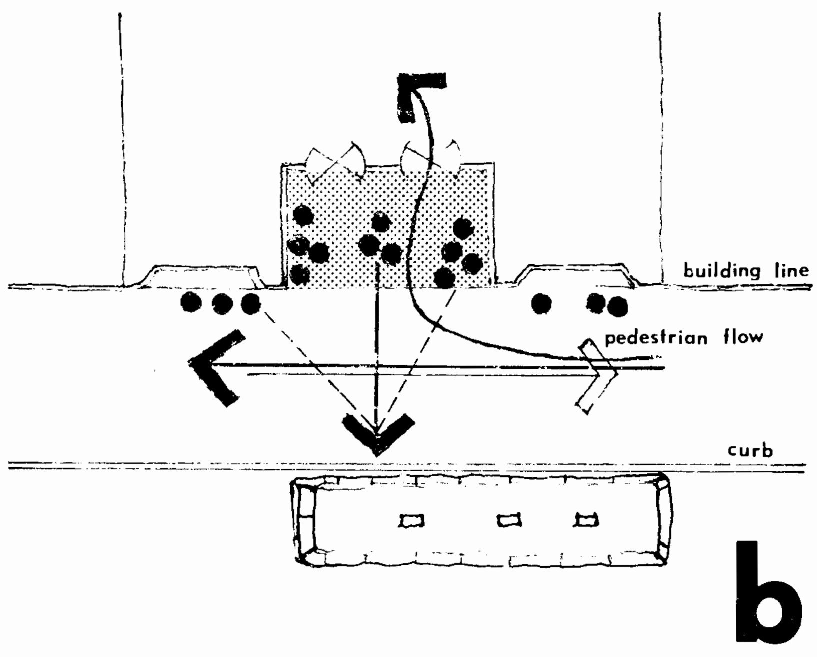
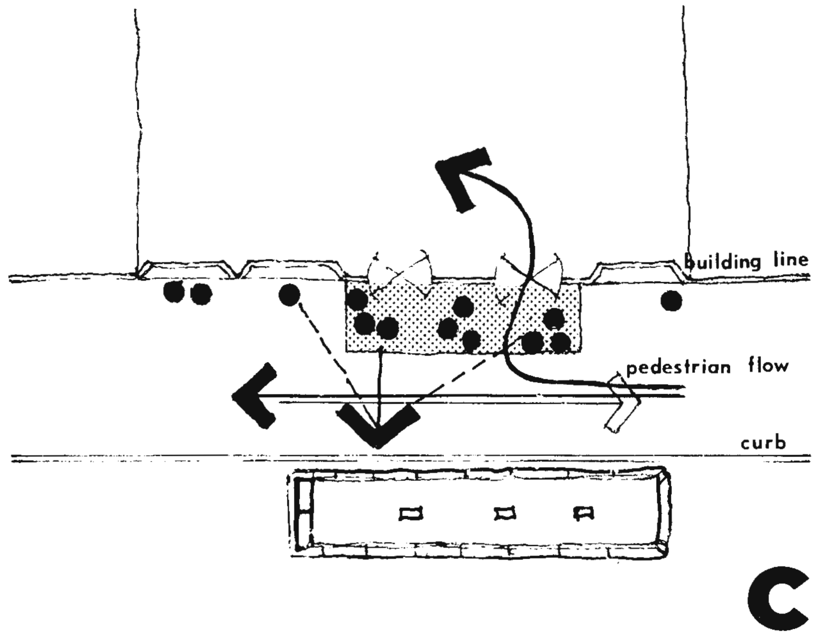


Figure II-13



(c) and (d) show sidewalk movement impeded by those waiting in or under shelter.

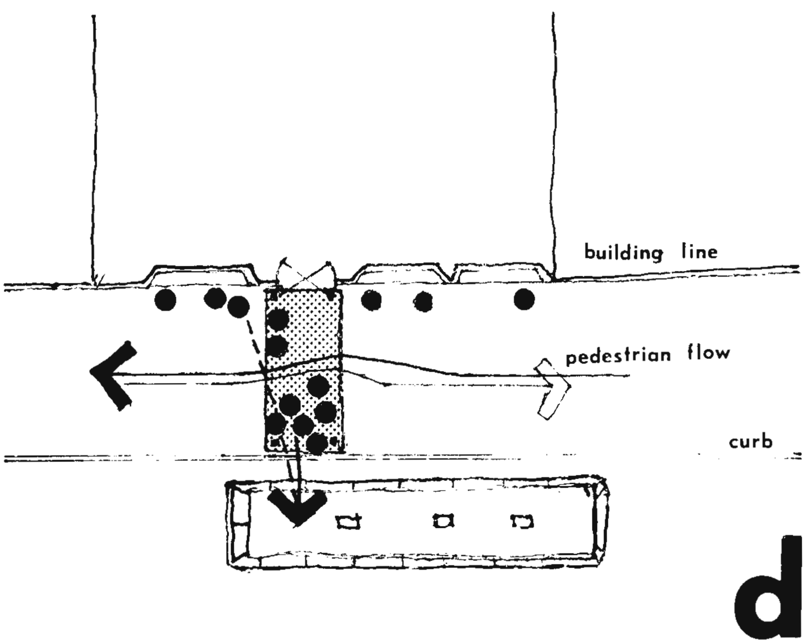
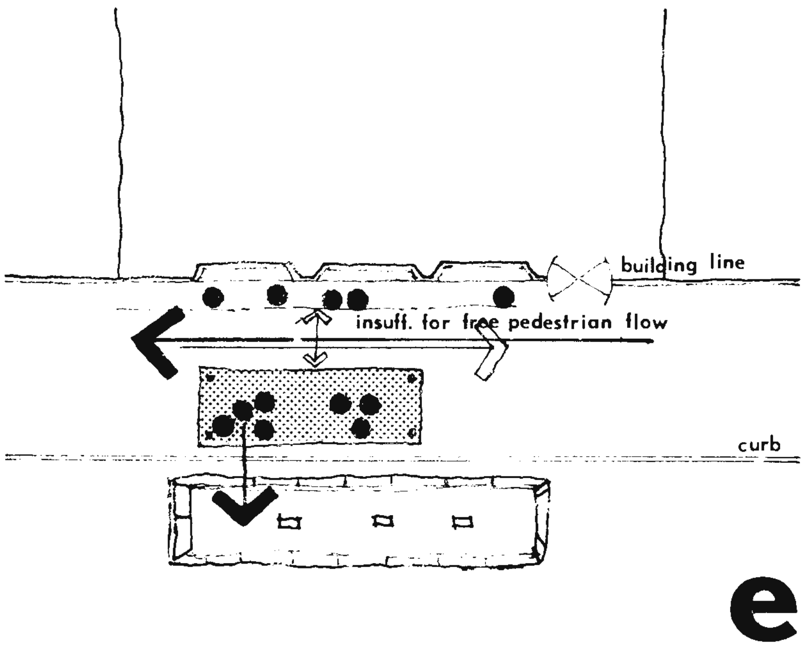
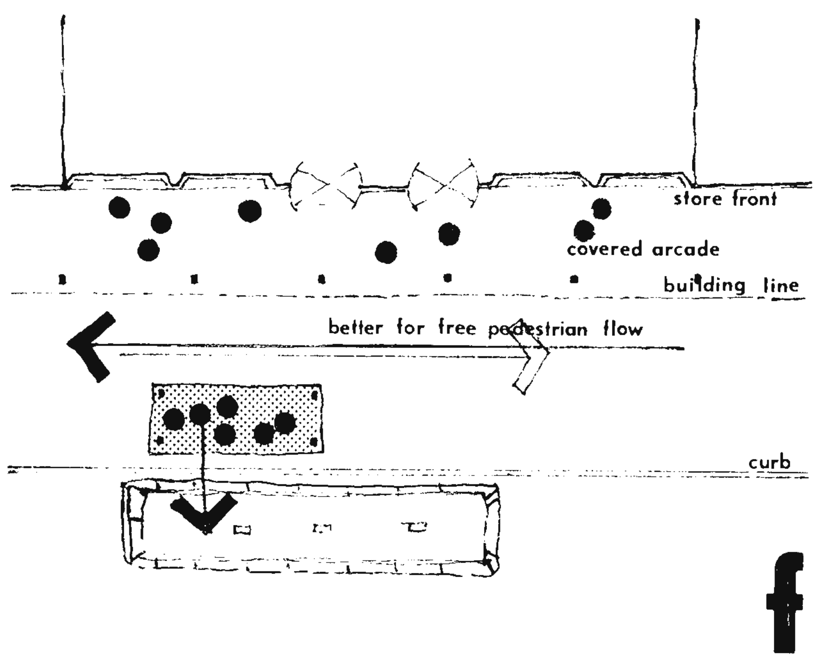


Figure II-14

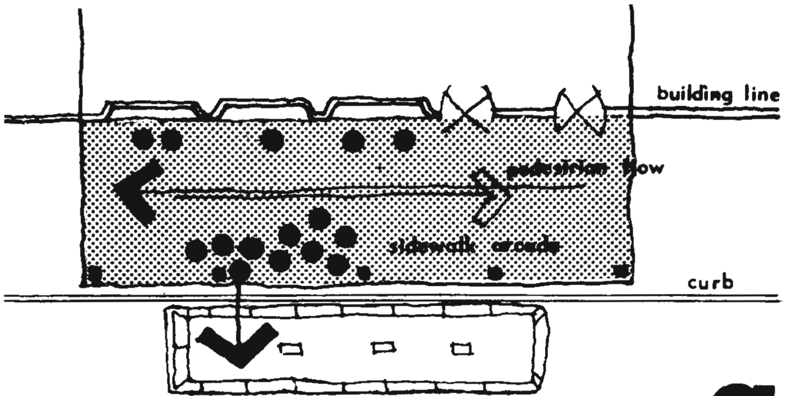


(e) reflects the prevailing situation.



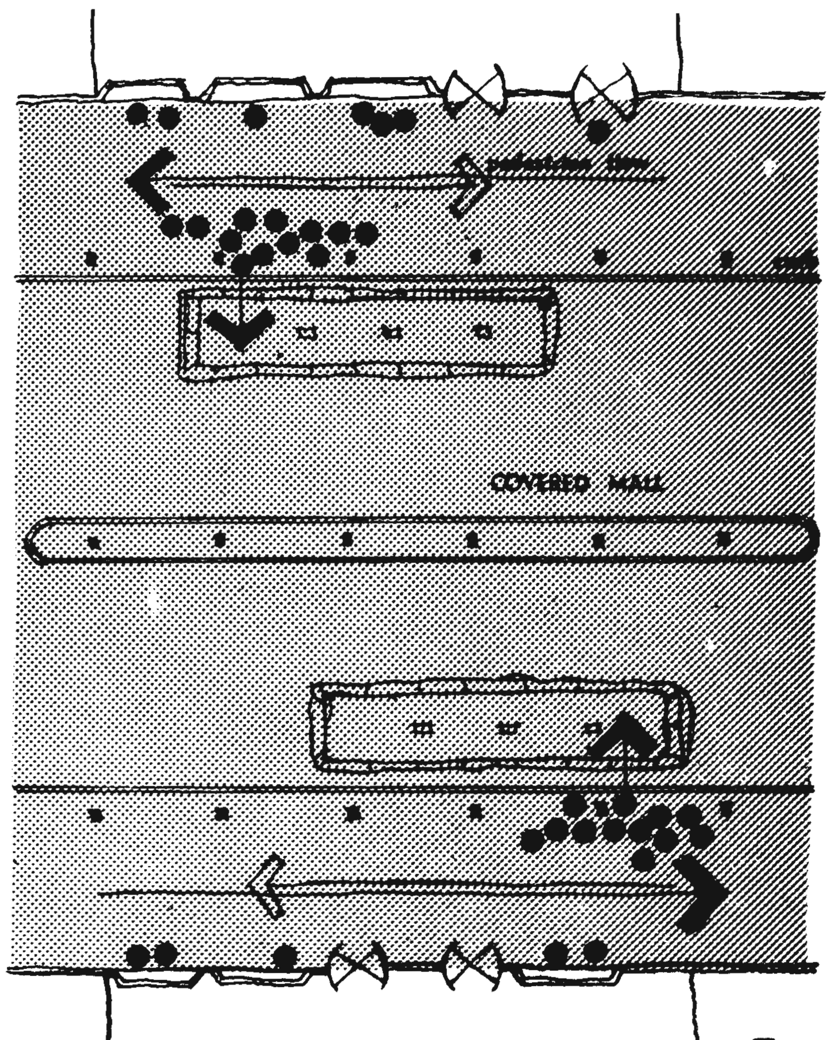
(f) is a proposed improvement;
recessed street level frontage
could be required by zoning ordiance

Figure II-15



g

(g) and (h) show no need for
a special sidewalk structure in
sidewalk archade on covered street.



h

Figure II-16

Sidewalk User Behavior

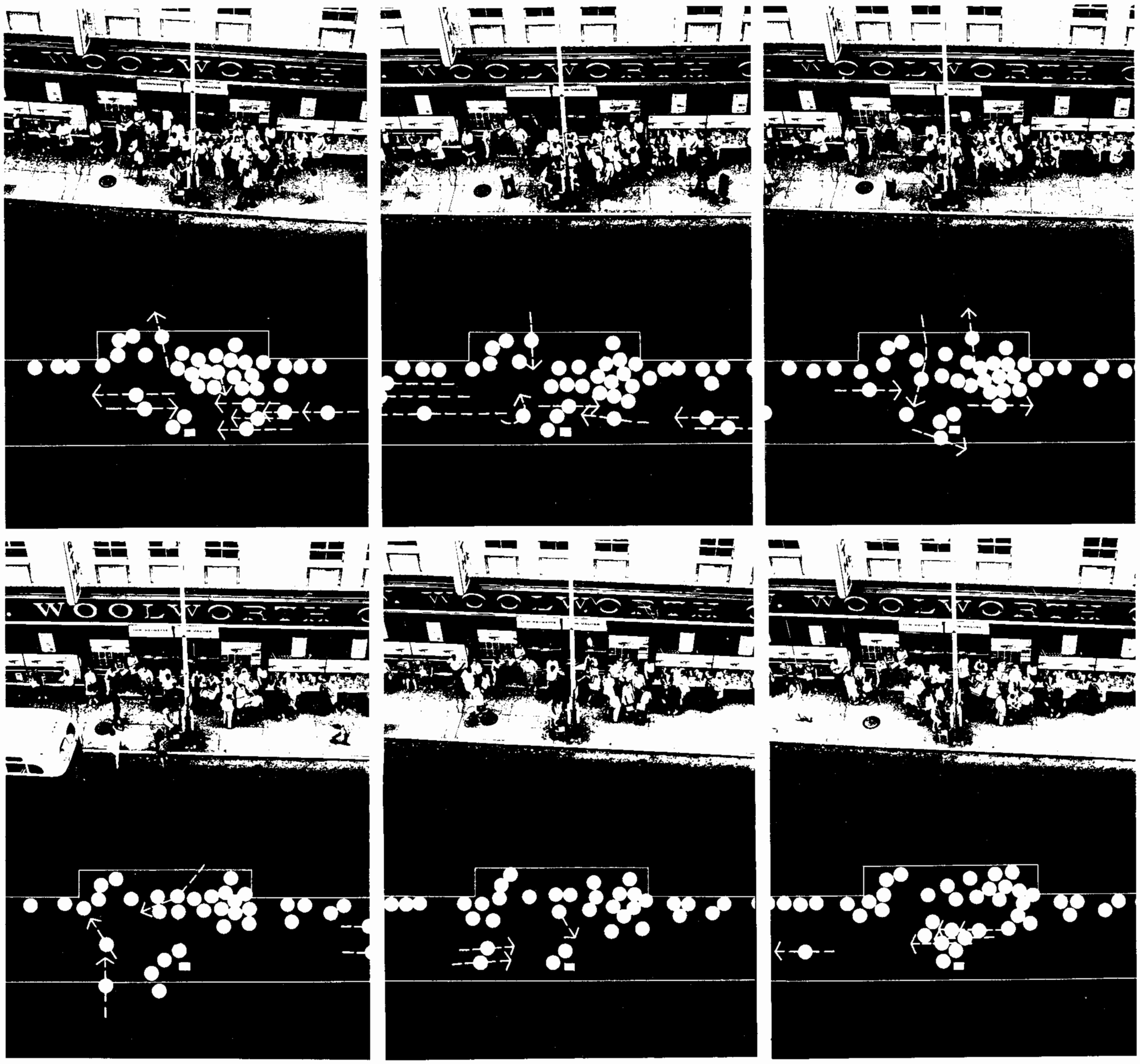


Figure II-17

Visability: Being hidden from view, even partially, particularly within a shelter which is poorly lighted and/or isolated from public activity, allows or encourages attack or molestation.

Trees in the street are beneficial in providing shade, minimizing hard-surface reflecting heat, breaking the wind, even offering shelter from precipitation, but they can interfere with vision of and from the shelter if care is not taken in placement, trimming, etc.

Wind Patterns: Within the same urban entity, wind behavioral patterns in the street may vary from location to location, influenced by the surrounding street layout, by the form of natural and man-made elements, or the configurations of the street canyon walls at each location.

Vandalism: The following comments are based upon observation in several cities:

In one city, a number of open all-steel shelters, included benches designed for wood but built of steel. The benches' overhanging, quarter inch steel seat slats were bent down, probably the result of a sledge-hammer.

Another city has an admirably large number of all-steel shelters, enclosed on three sides. They looked like toolsheds. They appeared "vandalized" on installation .

Shelters are often abused by being used as toilets and sleeping places by vagrants.

Abuse of convenience of the facility (seat, phone, etc.) often results in damage to the structure itself.

Section III - Analysis

The task of planning and designing shelter is to <u>optimize user welfare, while contending with two sets of constraints: A spatial one of environmental fit and an economic one of transit systems costs</u>.

For <u>environmental fit</u> three elements are important:

<u>Bulk</u>: Width, length, height, etc.,;

<u>Location</u>: Placement to fulfill transit needs as well as those of other sidewalk activities;

<u>Aesthetics</u>: Overall size, form, appearance, as part of the total scene or streetscape.

The primary elements of transit system <u>costs</u> are:

<u>Capital</u>: Initial investment in shelter proper and in ancillary installations.

<u>Operating and Maintenance</u>: Power, cleaning, servicing of ancillary installations such as light, heat, seats, information, and repairs, etc.

Welfare has three elements:

<u>Comfort</u>: Space, body support, weather protection.

<u>Safety</u>: Visibility, escape, location.

<u>Convenience</u>: Quality of town and streetscape, communication and other street services like shopping, first aid, comfort station.

The components of the element of comfort can be further divided into space, (amount and quality), body support (underfoot, hip and back) and a atmospheric protection (precipitation, air movement, light and temperature).

With the above sets in mind the interrelationships among the elements are investigated with the help of a diagram. It can be seen that welfare, our primary concern, is constrained by fit and cost. The subsequent discussion refers to this diagram and each interface is discussed in turn. The results are a list of all the items to be considered in performing an analysis of a shelter. The next section will develop criteria based upon this list.

Each element of welfare (comfort, safety, convenience) will be considered separately in light of the constraints imposed by the six elements of fit and cost.

AI/B1 - Comfort/Measurements

a. Enclosed space, "windowed" or fully transparent and less than 8 feet in any direction is uncomfortable for extended occupancy by more than one person;

* b. A minimum enclosed depth of 6 feet is needed to accommodate comfortably a seated person and others passing by;

c. Enclosed space less than 6 feet in any direction is inadequate for two-way passage;

d. Enclosed space of less than six feet depth induces claustrophobia, even if it the shelter is transparent and occupancy is of short duration;

* e. Seating is most comfortable with at least a depth of 7 feet;

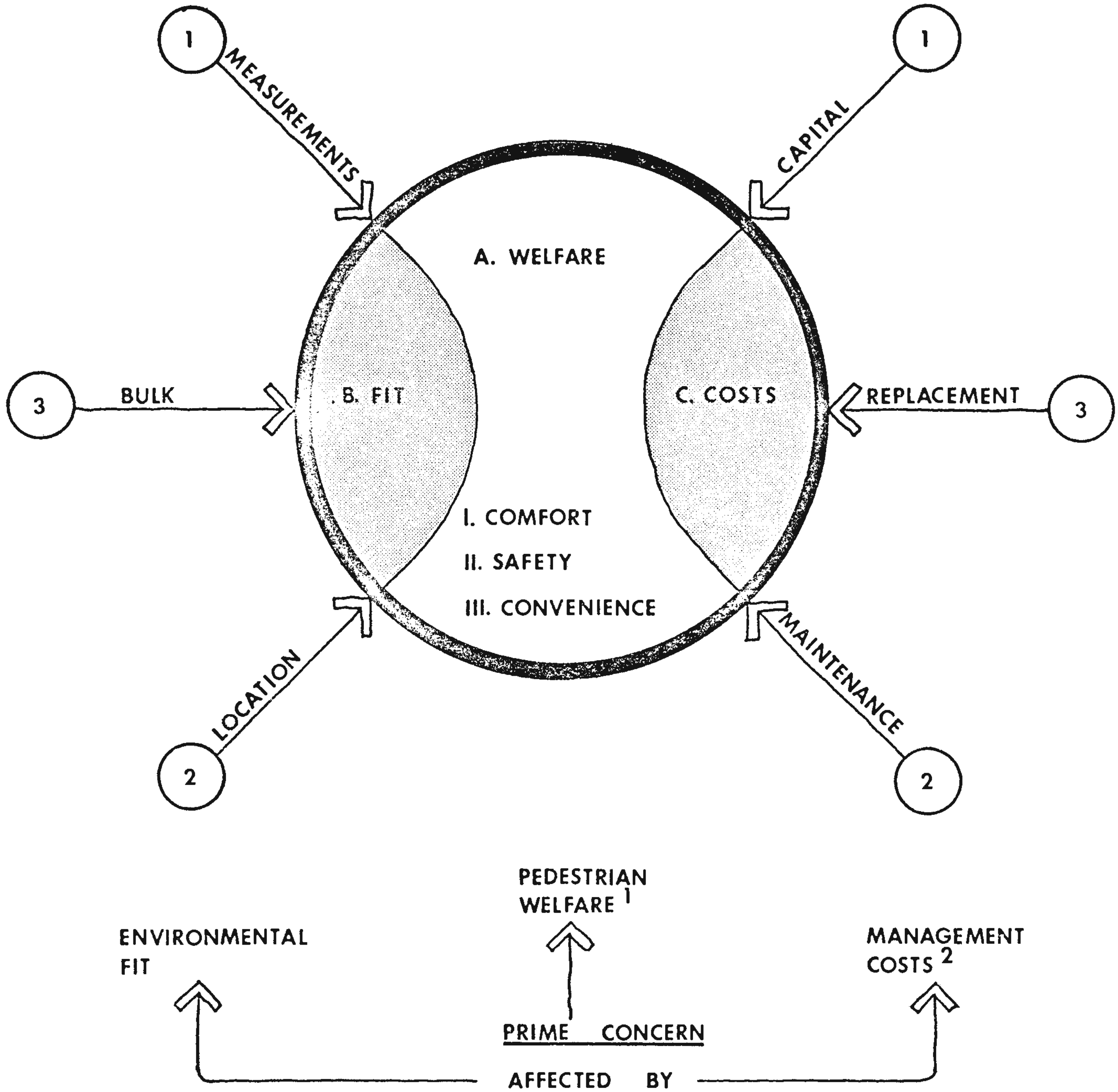
* f. A transparent enclosure tends to expand the space perceived;

g. A shelter which opens to the curb requires greater distance from the curb. On narrow sidewalks, units with insufficient depth have been frequently used. The question of sidewalk widths should be resolved within the comprehensive urban planning process;

h. Canopy and umbrella type cantilevered open, or partially open shelters can be more protective than those supported by their perimeter. Their roofs can be better insulated and projected over the sidewalk space beyond the line where supports could be placed;

i. A 8" wide rail 26' - 34" high will provide a bodyrest, handrail and bumper;

* j. Wheelchairs need a minimum of 32" wide clear openings for passage;



DEVELOPMENT OF DESIGN CRITERIA

[1] includes waiting transit user

[2] transit system management

Figure III-1

k. An electronic emergency signaling or monitoring system in the shelter is desirable, but as yet too costly, except for the conventional public telephone;

* l. Space requirements for a public phone and/or other conveniences within the shelter are incompatible with the space requirements of those waiting for transit vehicles, unless the shelter is larger than the separate facilities put together;

m. Public telephones, and kiosks for flowers, snacks, cigarettes, first-aid, comfort station, etc., can be located adjoining or near by using separate, basic shelter units adaptable to such uses. They would attract users other than transit users and decrease the isolation of the waiting passengers;

AI/B2 - Comfort/Location

a. Contaminants (noise, dust, fumes, humidity, glare, and vibration) are experienced in open and partially enclosed shelters, generally at the same levels as outside it; any substantial improvement through design would require full enclosure and artificial corrective systems;

b. Fumes, dust, and mud increase within the shelter when openings face the curb and roadbed;

c. Shelters with openings facing the curb require a greater distance between the two and thus reduce sidewalk width for pedestrian movement;

d. Shelters, which allow free pedestrian movement are necessary on narrow sidewalks; see also A III/B2;

e. Street layout, and orientation, pattern, and form of street enclosures help determine wind pattern and velocity and thus affect the micro-climate of the shelter environment;

f. Climatic variation in the U.S. calls for variation in the types of shelter provided. The variables of climate in individual cities are rain, snow, temperature, wind, excessive heat or humidity;

The combined effect of two or more elements increases the problem of weather-protecting the waiting transit user. The more difficult problems arise when wind is combined with any of the other variables. One can be protected from rain and snow by seeking overhead shielding; however, wind can virtually negate the effect of this shielding by "driving" rain or snow. In addition, skin temperature is reduced by increased wind velocity.

The range of the normal average temperatures in January for cities in the continental United States falls between 8° and 66° F. A normal individual can move about comfortably with relatively little protection until the temperature drops to approximately 50° F. Below this point the traveler adds heavy clothing in order to remain within the comfort range. At approximately 30° F., wind can cause a considerable degree of discomfort.

These three ranges are illustrated on the following continuum of the mean average January temperature:

70°	50°	30°
A roof is sufficient where wind is not excessive.	Enclosure is required to protect the user from wind so that the chill factor does not reduce the surface temperature of the user.	Heating is required in addition to enclosure; special consideration should be given to pavement surface temperature.

When the temperature range is between 0° and 30° F. and dampness persists, and protection from wind and precipitation is provided, the person waiting, still has one direct contact with a source of discomfort--his feet rest on the pavement. Where this condition exists, heating within the shelter is needed. The individual is probably dressed to protect himself from the cold, therefore, additional heat beyond that necessary to keep the pavement free of ice or snow and the feet warm might even make waiting uncomfortable.

Figure III-2 indicates the areas of the United States in which simple enclosures or enclosures with heating is recommended. Figures III-3 - III-5 indicate the effects of shelter on occupant comfort.

AI/B3 - Comfort/Bulk

* a. Integral structural support and enclosure systems (where vertical members both support the roof and serve as enclosure panel framing) are less adaptable to varying depths, degrees, arrangements and applications of enclosure and, thus, to a variety of spatial and climatic sidewalk situations;

b. Enclosures open at top and bottom have the advantage of providing good air circulation; preventing trash from piling up within and outside shelter;

c. A simple transparent enclosure increases heat within shelter--advantageous in cold season or climate, disadvantageous in warm season or climate; an opaque, reflective enclosure keeps shelter cooler;

d. A baffling insulating material under a simple sheet roof will decrease noise discomfort of hard rain, hail, etc.;

e. A hip-high rail prevents anyone from walking into transparent enclosure, provides support when leaning or sitting, and serves as a handrail;

f. A heat source placed low within the shelter is preferable to one placed overhead, because heat rises. A person remaining stationary feels cold most at his feet. Radiant floor heating keeps the floor dry, prevents formation of ice on the floor and keeps people's feet warm;

g. The need for seating within a shelter depends on waiting time. Except for the handicapped, most people do not sit down during the short waiting time and crowded conditions of rush hours. Shelter space is better utilized to provide more room for standees at crowded bus stops;

h. An unresolved problem remains: How to accommodate the person in a wheelchair on the bus? Work is being done to develop solutions in other projects;

i. Appropriately scaled and placed colored pictorial materials, including aesthically pleasing advertisments (i.e., an inside and outside strip at roof level) could minimize perceived waiting time, and produce revenue as well;

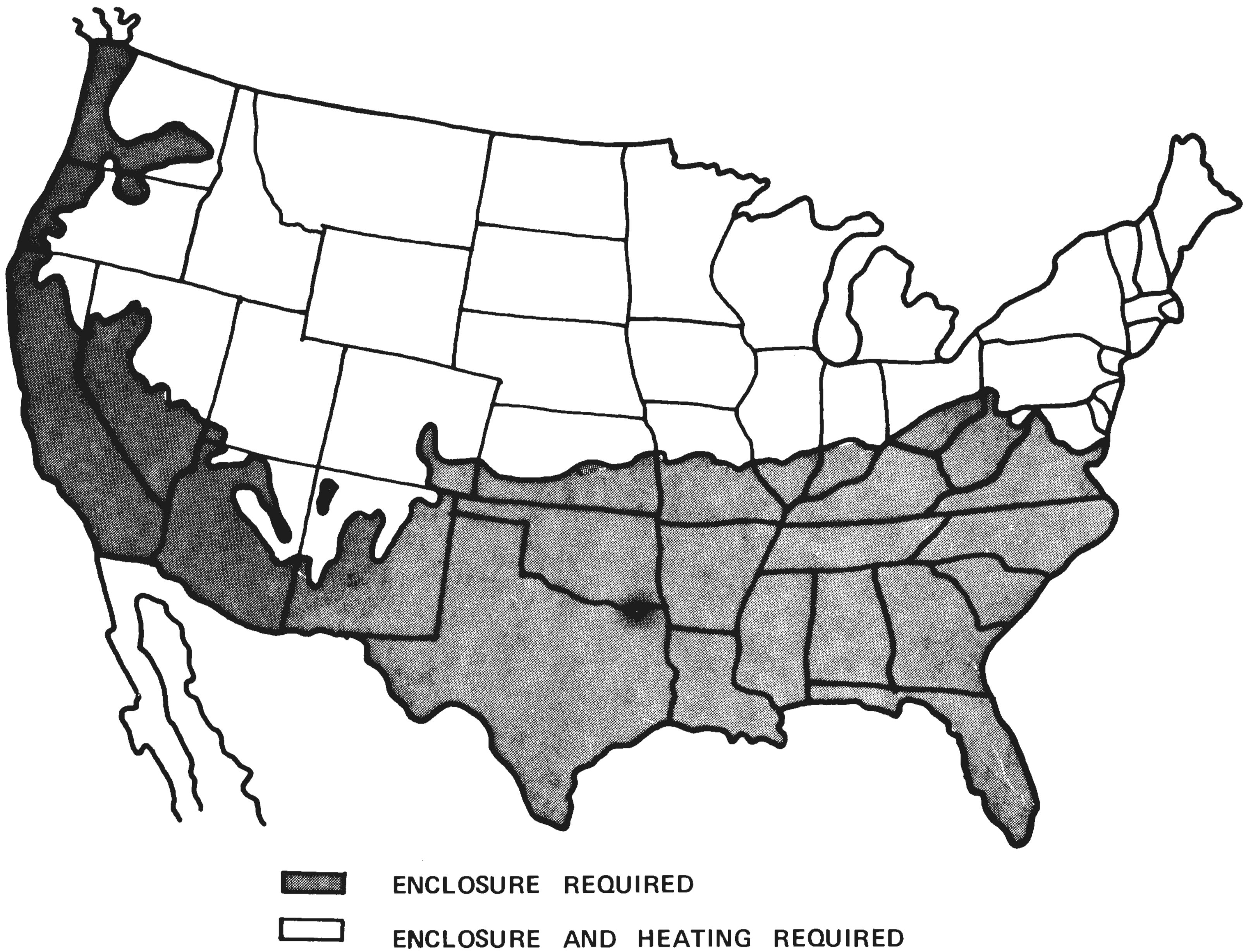
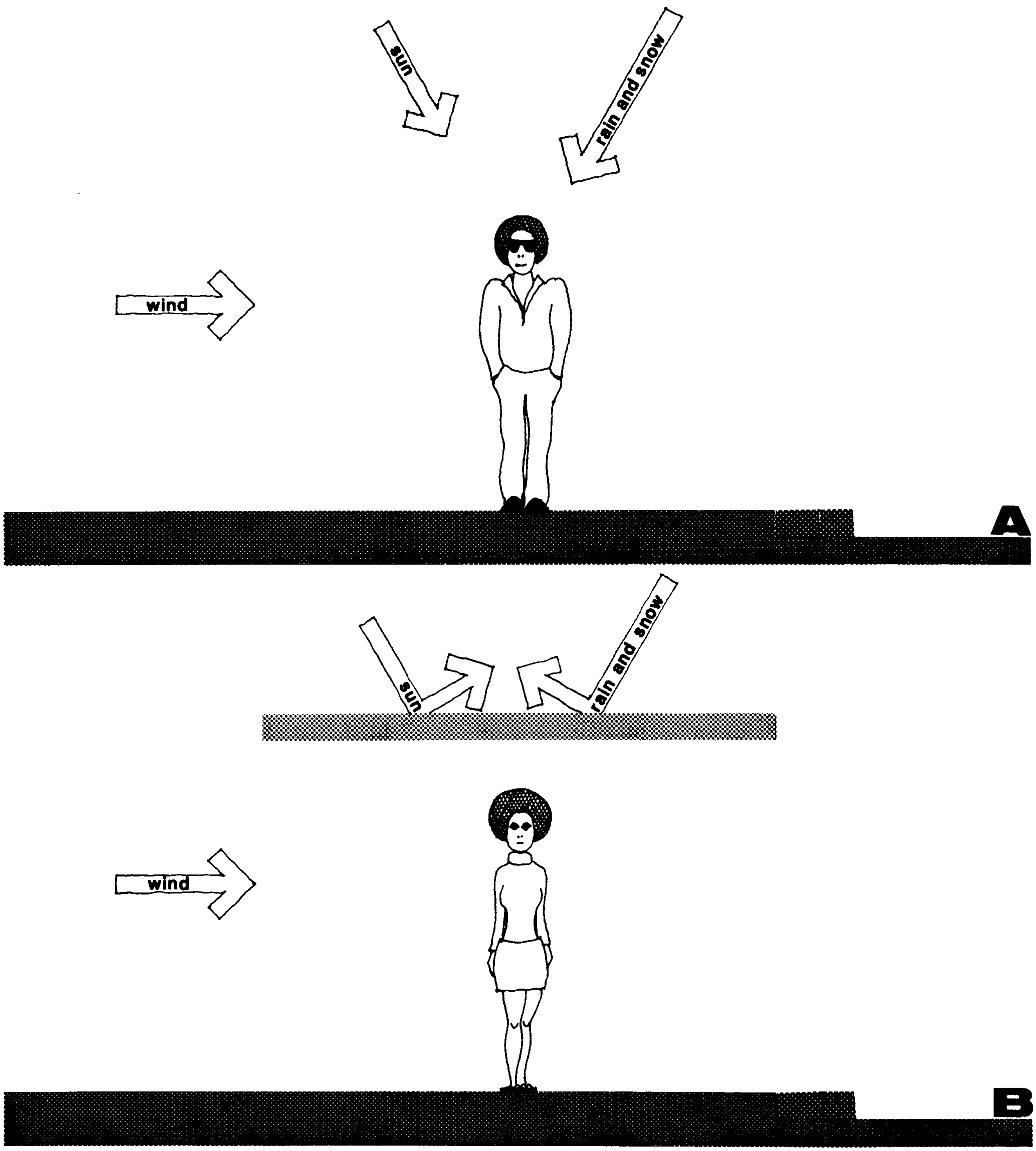
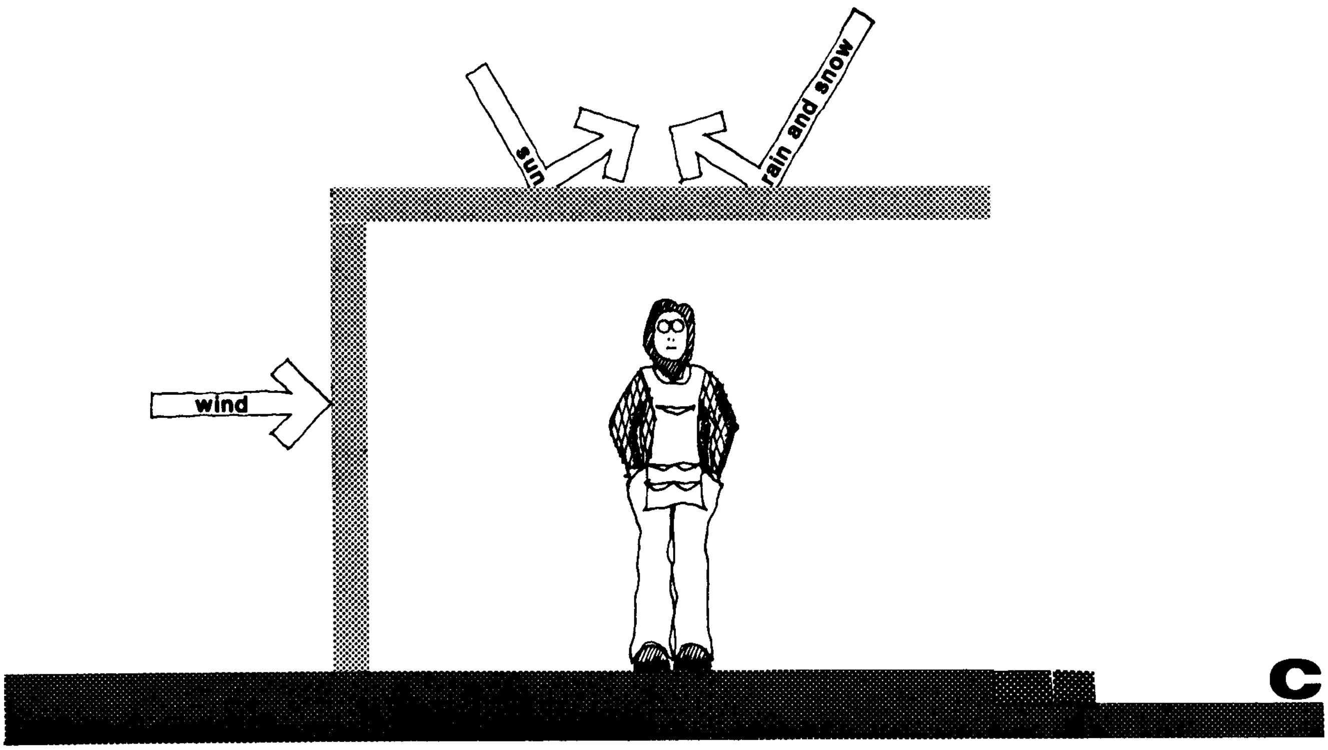


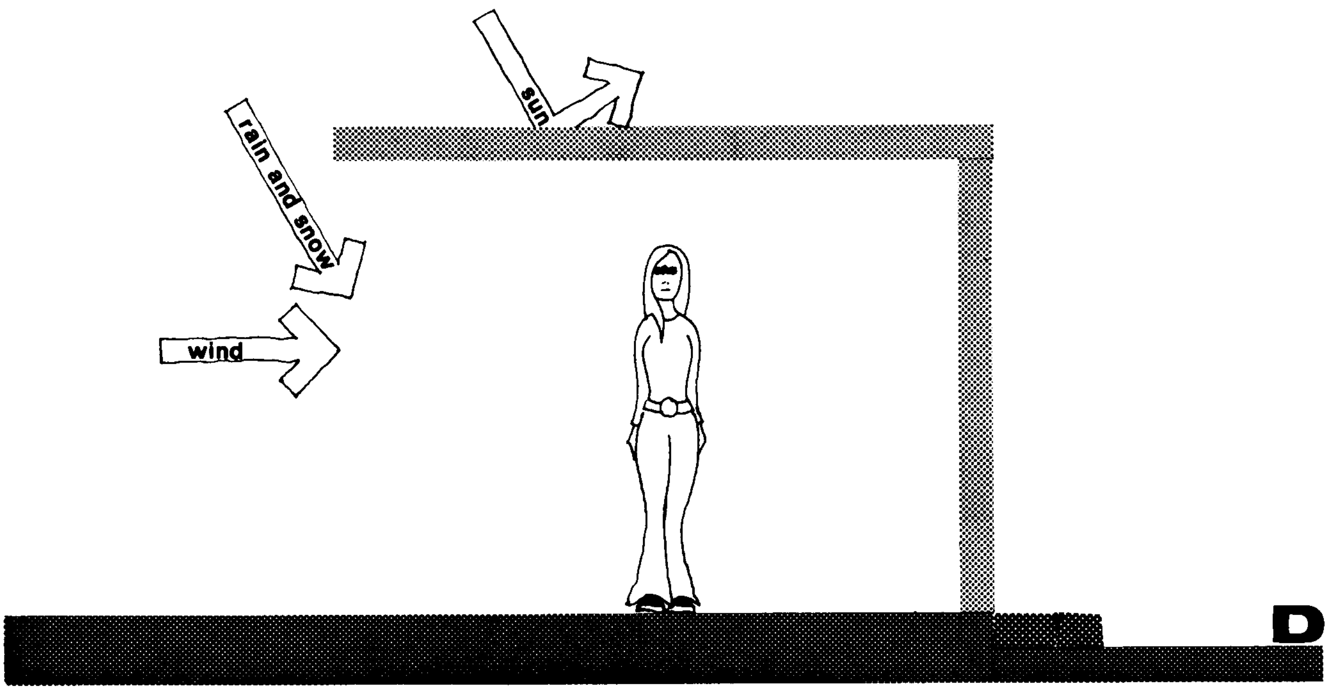
Figure III-2



effects of shelter on occupant's comfort

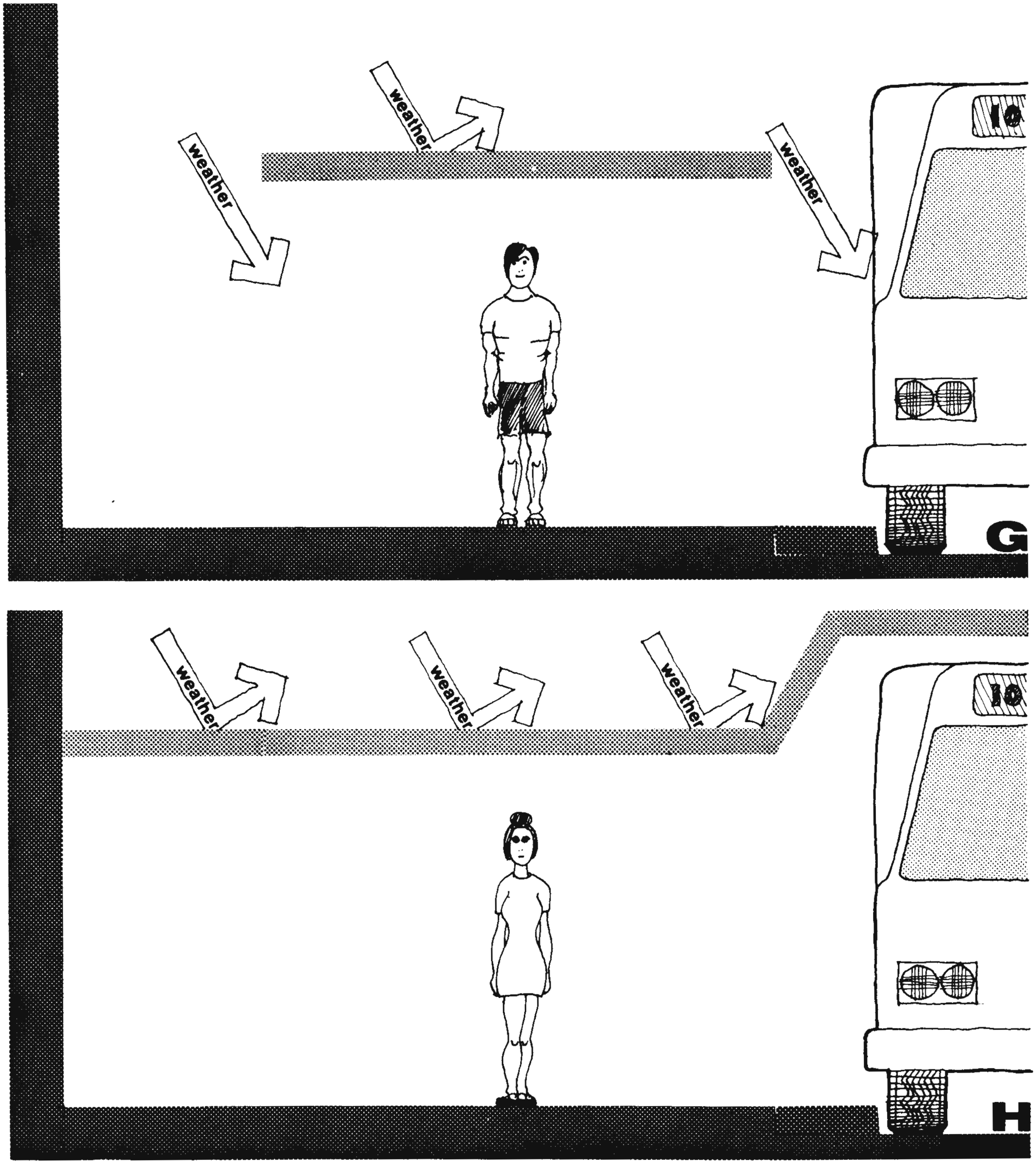
Figure III-3a





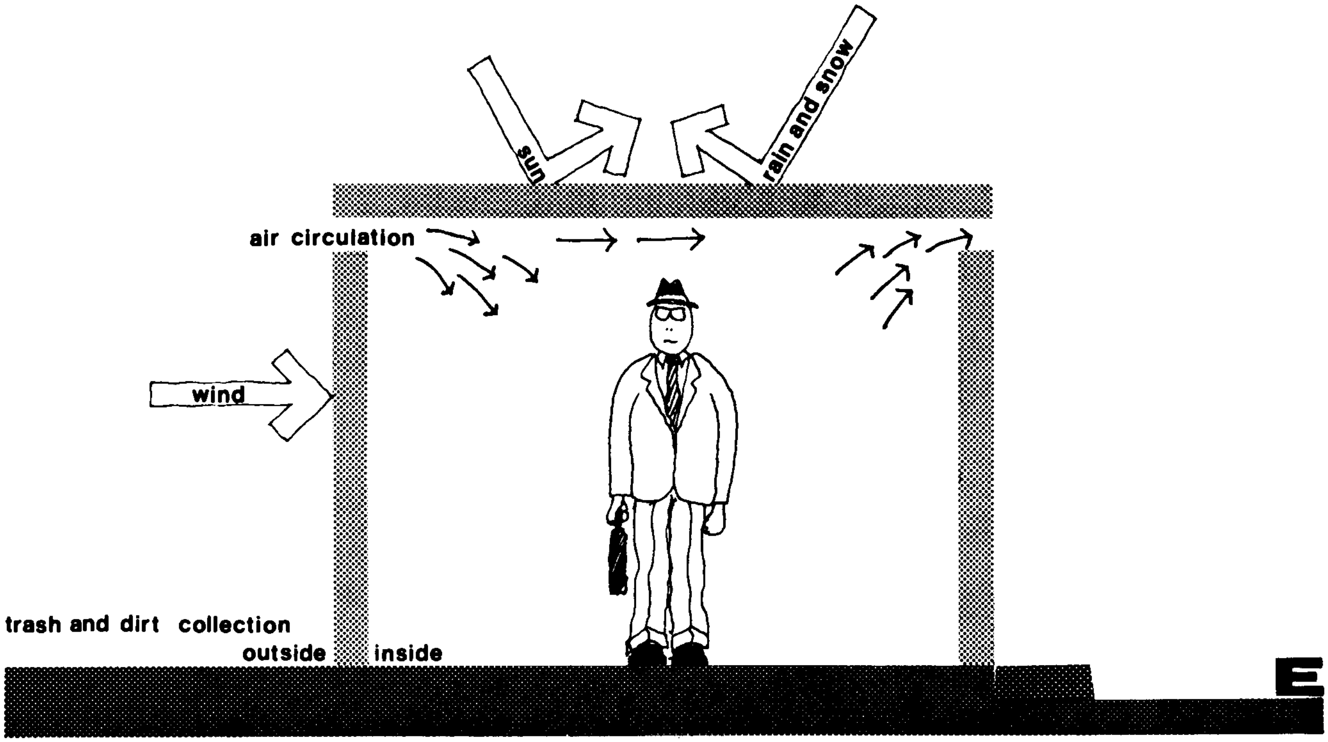
effects of shelter on occupant's comfort

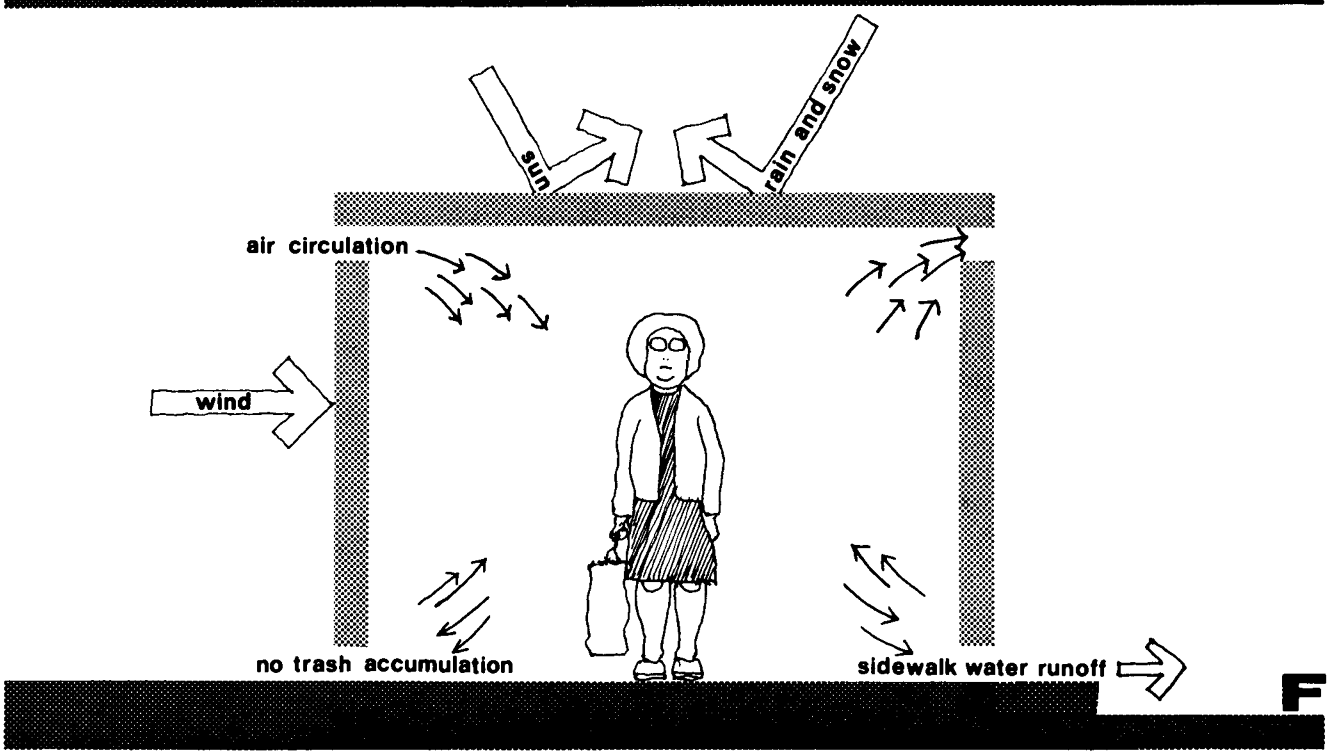
Figure III-3b



effects of structure on occupant's comfort

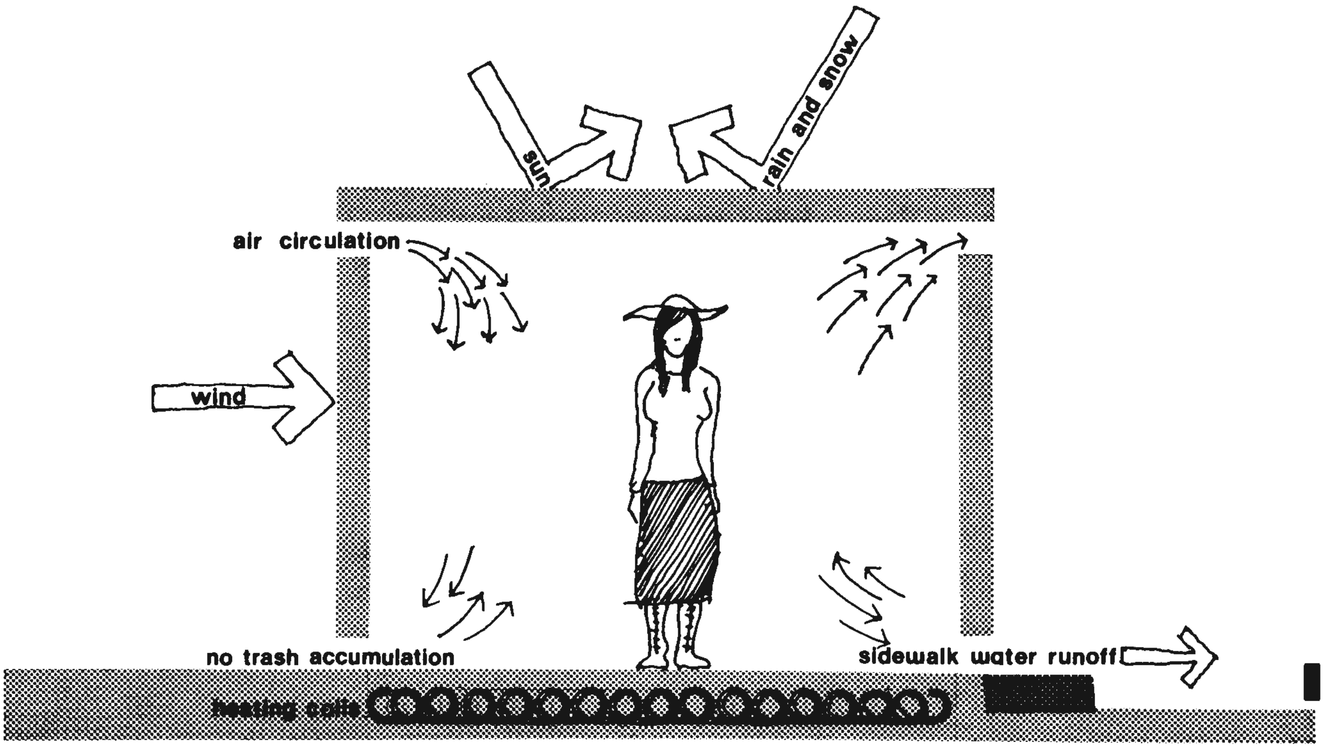
Figure III-4a





effects of structure on occupant's comfort

Figure III-4b



effects of shelter on occupant's comfort

A1/C1 - Comfort/Capital

a. How much space is needed to shelter one person?

A feeling of comfort depends on the following physical and psychological factors:

- The waiting period;
- The perceived total environment (type of enclosure, surroundings);
- The severity of the hazard;
- The personal space;
- The alternatives or choices available;

Shelters with transparent enclosure that provide five to eight square feet per person provide protection in inclement weather without physical and/or psychological discomfort, when waiting is 7 to 10 minutes.

b. For simple cost comparison without consideration of benefit--the following information is needed:

- Purchase price or complete unit;
- Packing and handling costs;
- Shipping costs;
- Size and type of unit (open or enclosed, artificially lighted and/or heated, etc.) with plans and specifications;
- Useful life expectancy of unit;
- Site preparation of unit;
- Installation costs;
- Yearly maintenance costs;
- Cost of repair due to vandalism;

A comparative analysis was made of shelters in various cities ranging in cost from $500 to $3,000 per unit. Differences in quality and environmental fit and service offered were compensated for by weighting. The results of the analysis are shown in Figure III-6.

The index (curved band) shown on the chart cannot supply precise information, but there is a strong indication that past the $35.00/ square foot cost for enclosed shelter, benefit decreased at an increasing rate. In a comparative sense, those who spend up to the $35.00/sq. foot cited above--generally received more value.

* Assuming an adequately sized basic unit shelter at all transit stops, ($23 per square foot) the total initial shelter cost divided by the total estimated trips during a fifteen year life period provides a useful, meaningful cost figure, per trip. The capital cost per trip is approximately two-thirds of one cent.

$$\frac{5{,}000 \text{ stops} \times 72 \text{ sq. ft.} \times \$23.00 \text{ per sq. ft}}{300{,}000 \text{ trips} \times 5.3 \text{ days} \times 52 \text{ wks.} \times 15 \text{ yrs.}} = 0.66¢^{1}$$

Another useful and meaningful figure is the percentage the cost of the sidewalk shelter (no stations) component represents compared with the total cost of the transit system. The initial cost figure to provide shelters for a proposed metro's[2] bus system component appears to be approximately ten percent (10%) of the bus system cost, with an estimated 1971 cost of $35.00 per square foot for a total of 105,000 square feet of maximally enclosed urban sidewalk type shelter space,

[1]Estimate by "VPI & SU" for a city comparable to Cleveland.

[2]Estimate by "VPI & SU" for a city comparable to Seattle.

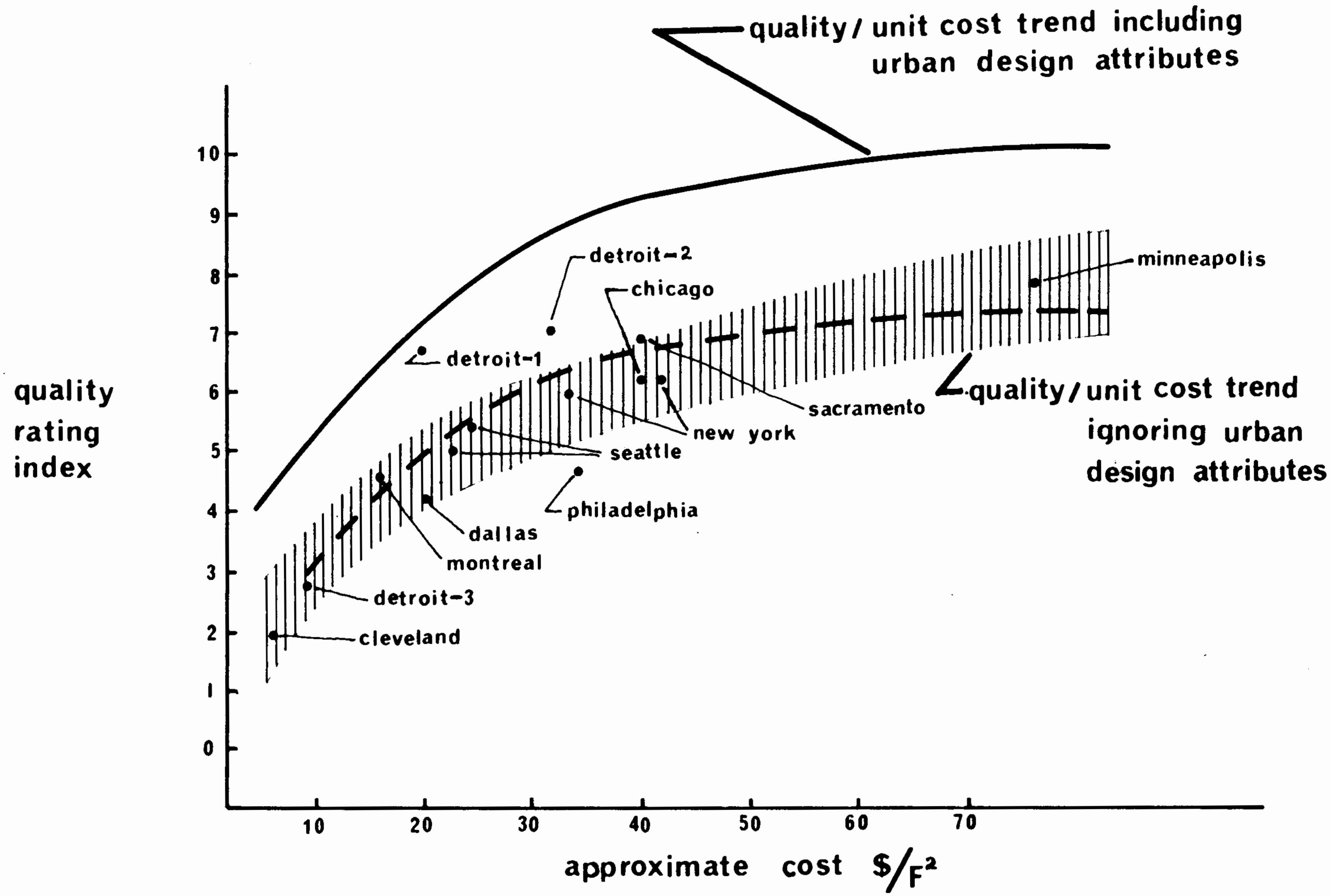

quality/ unit cost trend including urban design attributes
quality rating index
10
9
8
7
6
5
4
3
2
1
0
detroit-2
chicago
minneapolis
detroit-1
sacramento
quality/unit cost trend ignoring urban design attributes
new york
seattle
philadelphia
dallas
montreal
detroit-3
cleveland
10
20
30
40
50
60
70
approximate cost $/F²

Figure III-6

with seating and lighting. To provide shelter at every stop within this intra-urban system would require an estimated fifty percent (50%) increase in shelter space, thus raising the shelter cost to approximately fifteen percent (15%) of the bus system cost. A lower shelter square footage cost would correspondingly lower the percentage figures. Shelter and its costs should be dealt with in total system context;

* c. Working with a basic modular unit consisting of a roof and appropriate vertical structural support, shelters can be produced to a variety of degrees of completion and forms, to suit climates, seasons, requirements of comfort, and capital budgeting and financing;

d. Working as indicated under "c" makes it easy, moreover, to have user or citizen involvement in financing of seating and enclosure, thus completing the basic unit provided by the transit system, or municipality;

A1/C2 - Comfort/ Maintenance

* a. Seat support, if integral with shelter support structure, may unnecessarily transfer damage to the main structure if vandalized;

* b. Radiant floor heating installation is less likely to be subject to vandalism than exposed fixtures;

c. Two kinds of design seem to especially provoke hostility and a destructive urge in some people, regardless of socio-economic status:

- ° Self-centered and resource wastefulness on the part of the designer or owner;
- ° Patently cheap design, particularly resented by the underprivileged in their environment, because is suggests contempt;

AI/C3 - Comfort/Replacement

No interfacing found

AII/B1 - Safety/Measurements

* a. More than 6 feet clear width is required in a corridor space, with openings at opposite ends, to permit escape from molesters;

AII/B2 - Safety/Location

a. Shelter opening to curb may force person escaping from molesters into vehicular roadbed;

b. Shelter has to be a minimum 18 inches from curb for the following reasons:

- ° To avoid being touched or hit by transit vehicle (which leans slightly to curb);
- ° To provide minimal safety zone for pedestrians having to reach the sidewalk from the vehicular roadbed;

c. Shelter openings facing curb would require a minimum 42 inch distance from the curb to assure accessibility and safety;

d. The safest location for a transit stop and shelter is in a populated area, under the visual surveillance of people who could furnish aid, or alert others who could do so;

e. The danger of a vehicle jumping the curb at a shelter area is not substantially greater than elsewhere. Protection against vehicles should be no more in shelter areas that in other crowded sidewalk areas;

AII/B3 - Safety/Bulk

a. Structural support systems are whole systems and must be treated as such; parts of different designs are not interchangeable, and to make any changes in them requires analysis of the whole system;

* b. To be secure against elements shelter has to be designed to withstand vertical and lateral forces. Anchorage at ground and roof levels of a basic modular unit with minimal or no enclosure should be designed for maximum local wind velocity and uplift;

* c. A transparent enclosure allows vision into, through and from the shelter, an effective aid for personal safety;

d. Opaque ceilings facilitate indirect lighting;

e. Tall transparent planes at pedestrian movement levels can be invisible and dangerous; a marker is needed to alert pedestrians that they are approaching a solid obstacle;

f. Maximum comfortable openness offers comparable safety by letting any call for help be heard better and by facilitating escape. Shelter safety requires two openings, at opposite ends, for easy exit;

* g. Ice-free floor is highly desirable and can be obtained with radiant floor heating;

* h. Street light for shelter lighting at night is inadequate, even with translucent or transparent roof; higher level of lighting is needed for reading and to highlight shelter for greater safety;

* i. Exposed points, sharp edges, and sharp corners are dangerous and cause injuries;

AII/C1 - Safety/Capital

a. Underground power installation is safer but more costly;

b. Telecommunications installation for transit stops--which would greatly improve safety--may be expected in the future, as a necessary public expenditure;

AII/C2 - Safety/Maintenance

* a. Joining and securing of components should be either hidden or done using fasteners that can be manipulated only with special tools.

AII/C3 - Safety/Replacement

No interfacing found

AIII/B1 - Convenience/Measurements

No interfacing found

AIII/B2 - Convenience/Location

a. A wide strip in the sidewalk area, next to the 18" safety zone at the curb, can accommodate any and all fixed furnishings, such as shelters, elevators, underpass and overpass stairways, escalators, kiosks, trees, etc ;

b. A study of sidewalk users' behavior and interaction would be of great interest for the study of shelter location, and an effective technique for it is time-lapse motion picture photography; Figure II-17 illustrates this.

AIII/B3 - Convenience/Bulk

a. Information on routing can be accommodated by even a single, basic waiting shelter unit. Information on the total transit system, or on the neighborhood street system should appear on waiting units if transparency, or comfort are not diminished. Otherwise, minor ancillary elements containing the information can be installed nearby;

b. Enclosure limits overlap sidewalk space use, and such overlap use is helpful on a narrow sidewalk;

c. Opaque enclosure at ground level hides from view persons sitting one the floor, reclining or bent over;

* d. Open area under enclosure permits hosing from outside and the free flow of water on the sidewalk; it keeps enclosure panels free of dirt, of corrosive chemicals used to clean, to melt ice and snow, and free of damage done with cleaning equipment;

e. Arrangement of opaque structural elements of shelter should facilitate visibility from shelter to permit identification of a transit vehicle;

* f. Lighting level sufficient for reading should be provided;

g. Overhead installation of power lines to the shelter is unsightly;

h. Compatibility with the streetscape required:

- ° Shelter to be part of, or act as a catalyst for design of integrated street furnishings;
- ° Transparency for lightness (to minimize bulk);
- ° Transparency for not hiding, obscuring parts of the street environment from view, especially storefronts;

* ° For universality: straightforward, unselfconscious, functional simplicity of line and form, neutrality of color except as accent in limited and well-selected area, to add to streetscape;

i. Good fit in the streetscape helps to promote civic pride, and facilitates identification with place and community;

AIII/C1 - Convenience/Capital

a. Basic unit structure with multi-use potential can aggregate market and reduce costs;

b. Designs with integral structural support, rather than component parts are less flexible and cannot take advantage of economies caused by a more flexible design;

* c. Enclosure to ground level means higher installation costs, because of sloping and uneven condition of sidewalks;

d. Opaque enclosure elements can be less expensive than transparent ones;

e. Molded, monolithic plastic shelter elements, or units, offer lower purchase and installation costs, but higher transport and maintenance (replacement) costs;

f. Minimal, well-designed, overhead advertising can produce some revenue, while adding a spot of change, color and interest;

g. Flat structural sub-assembly elements permit easy, economical handling, shipment to, and assembly on site;

h. To minimize field work, the anchorage of the vertical support can be designed, fabricated and installed to readily receive the standard preassembled structure for mounting and attachment above pavement level. Removal of the structure for reinstallation elsewhere should be just as easy;

i. Canopy type designs require subsurface footings, some other types do not; the simplest, least expensive anchorage types are ones that can be supported by the pavement. Foundation and anchorage require structural analysis in all cases;

AIII/C2 - Convenience/Maintenance

* a. Transparent or translucent roofs show accumulating dirt, trash, and surface damage on top and thus require more frequent cleaning and repair;

* b. Exposed surfaces need the hardest possible finish for economy of maintenance, and resistance to willful destruction;

c. Good environmental fit helps to promote civic pride, facilitates identification with place and community, and ultimately keeps down frustration, vandalism and maintenance costs;

d. The fuller the enclosure the higher not only the first cost, but also the maintenance and repair costs because vertical enclosing surfaces need regular cleaning and retouching. Most damage is suffered through sidepanel breakage; maintenance costs are thus much lower where, climate permitting, there is less side-shielding or enclosure. Where the design permits the ready removal of side screening it may be economical to do so at the beginning of the good weather season. This also allows movement of air during hot periods;

e. Annual maintenance and repair costs are reported to be $250 to $300 per enclosed shelter. Since these figures do not include salaries of managerial staff, trucks, cleaning equipment, etc., a more realistic estimate might be closer to $400, especially for glass-enclosed shelters;

f. Shelters should be designed and built to retain their effectiveness and attractiveness over a minimum lifespan of 15 years requiring twice-a-year wet-cleaning and bi-weekly sweeping. Otherwise, except for accidents and vandalism they should be maintenance free;

g. Roofs can be drained by the use of pipe members of the structural frame as leaders;

h. Sidewalk pavements are seldom level. Unless the fall is too steep--more than 1:15--attempts at providing a level floor will require costly special work and possibly more sidewalk space;

i. Power for heat and light should be brought to the shelter underground; controls should be remote;

AIII/C3 - Convenience/Replacement

a. Transparent or translucent roofs are more easily damaged by falling objects, etc., and require more frequent replacement;

Section IV - Criteria for Shelter Design

A large number of analytical considerations were presented in the preceding sections. The problem is to determine which of these often conflicting statements are the most important in developing criteria for a shelter which maximizes comfort, convenience and safety while staying within economical limits.

In making the value judgements required for criteria development, personal safety is the overriding consideration followed by comfort, then convenience. The asterisked items in Section III are considered to be the most important in developing design criteria. Based upon these analytical elements, the following design criteria have been developed:

<u>Recommended Design Criteria</u>

That shelters be provided in large numbers, with public funds, in the public urban open space and should have the following characteristics:

- Flexibility in size and arrangement of enclosure walls
- Maximum possible transparency of enclosure on all sides
- Modular unit approximately 50 square feet; a 6 foot minimum depth; 7 feet between enclosed sides
- Heat reflecting opaque roof
- Bottom of enclosure a minimum of 9 inches above the floor
- A minimum of two access openings, at opposite ends of the enclosed space; minimum clear opening width 32 inches.
- Provision for reading level artificial lighting within shelter
- Radiant floor heating for snow and ice removal, and for ambient warmth

- Unit support structure as free as possible of ancillary furnishings, and equipment; seats supported on floor
- Engineering of structure designed for all local weather conditions.
- Shelter space free of convenience facilities (telephone, news, etc.)
- Avoidance of exposed sharp corners and edges
- Use of durable finishes
- Concealment of non-permanent assembly jointing
- Straightforward, functional appearance
- A cost range of $20 to $30 per unit square foot, F.O.B. site, and a minimum useful life of 15 years.

Section V - Prototype Shelter

Prototype "A" as shown on the following construction and perspective drawings, is a design for a basic, modular unit, satisfying the recommended criteria for transit stop shelter design, plus the following additional requirements:

- Additional use potential, for other functions, to reduce unit purchase price through market aggregation:
- Additional use potential for other street functions to help improve the organization of street furnishings.

See Figures V-1 - V-8.

A sidewalk zone of some seven feet width will properly accommodate all kinds of street functions, activities and their facilities. One consideration, three feet of clear space is maintained between posts on all sides of the octagon (a wheelchair requires 32" clear width).

The basic, modular unit provides protection against sun and rain, and to a lesser degree against wind; as a more enclosed unit, with the use of additional vertical metal frames and additional transparent filler panels, it meets greater wind protection needs; singly it meets minimal space needs, coupled in series or clusters, with or without the use of roof panel fillers, it meets greater space needs.

The basic, modular unit accommodates two system line diagrams or charts, without seriously reducing transparency and good vision; it roofs over eight and a half feet width of sidewalk, but encroaches on movement three and a half feet only. It can do this as a cantilevered roof structure and it does it economically with the use of wide base (frame) support and balanced (double) cantilever. With greater enclosure (more frame supports) cantilever action is being reduced and anchorage at ground level is less critical. The more enclosed unit, according to degree of enclosure encroaches five feet-ten to eight feet-one inches. A minimal foot and a half clear sidewalk safety zone between roadbed (curbline) and shelter support at ground level is needed for pedestrians, and a minimal fourteen inch clear safety zone is being provided at roof level for approaching and loading transit vehicles.

Enclosure may be octagonal or rectangular with a variety of patterns, through the simple use of additional standard elements (vertical metal frames, filler panels (octagon) or framed corner panels (rectangle). The latter could be molded plastic elements. (Figures V-9, V-12 and V-13)

An alternate of the basic unit, modified by omission of one overhang (cantilevered roof section), reducing its width to little over six feet, could be used for very narrow sidewalks. (see ceiling plan)

This basic, modular unit, with such simple modifications as the use of greater enclosure, different enclosure panels, regular or dutch doors, interior furnishings and fixtures, varied fascias, lends itself to a large number of variations in overall appearance through detail, color, texture and such street uses as:

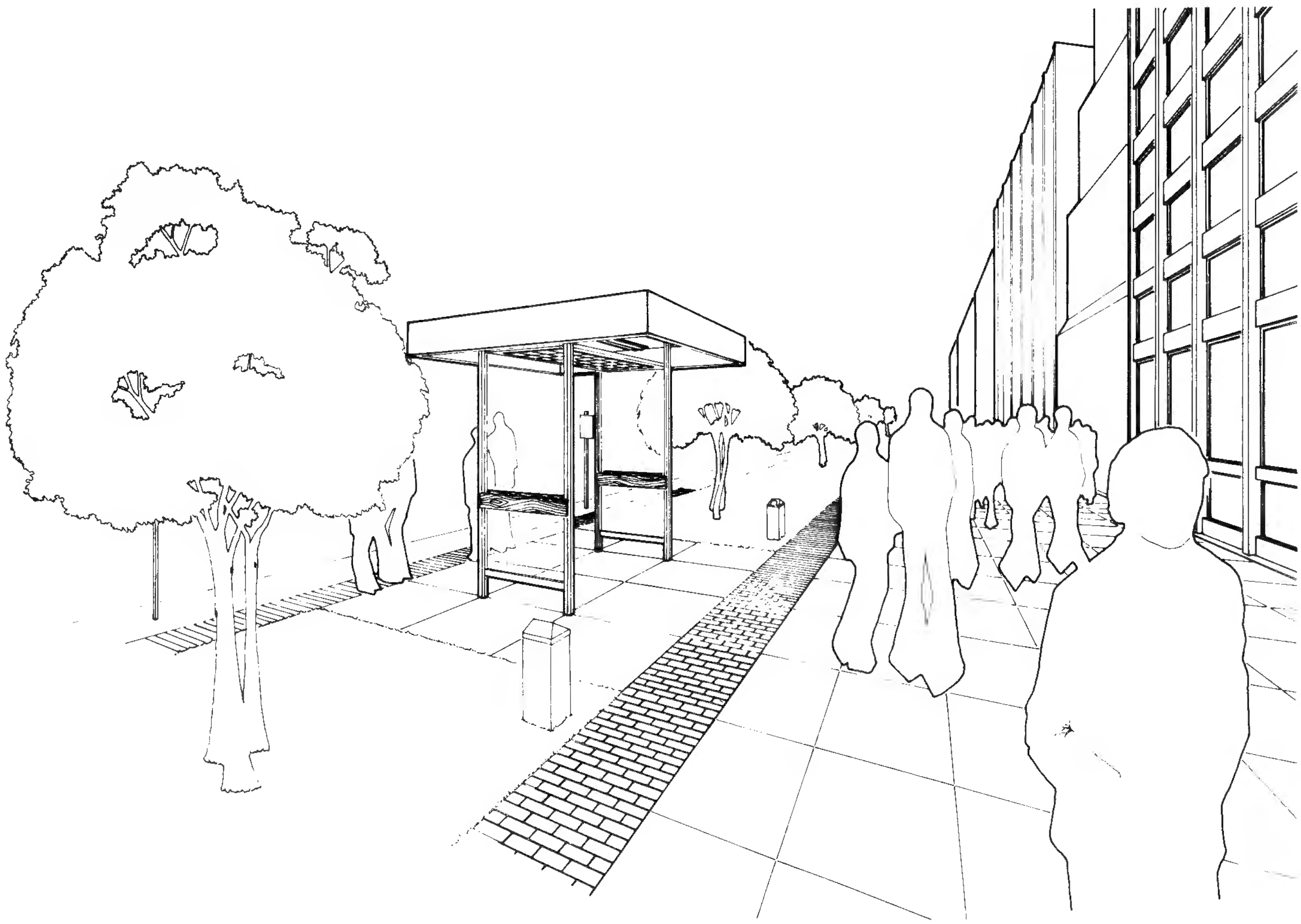
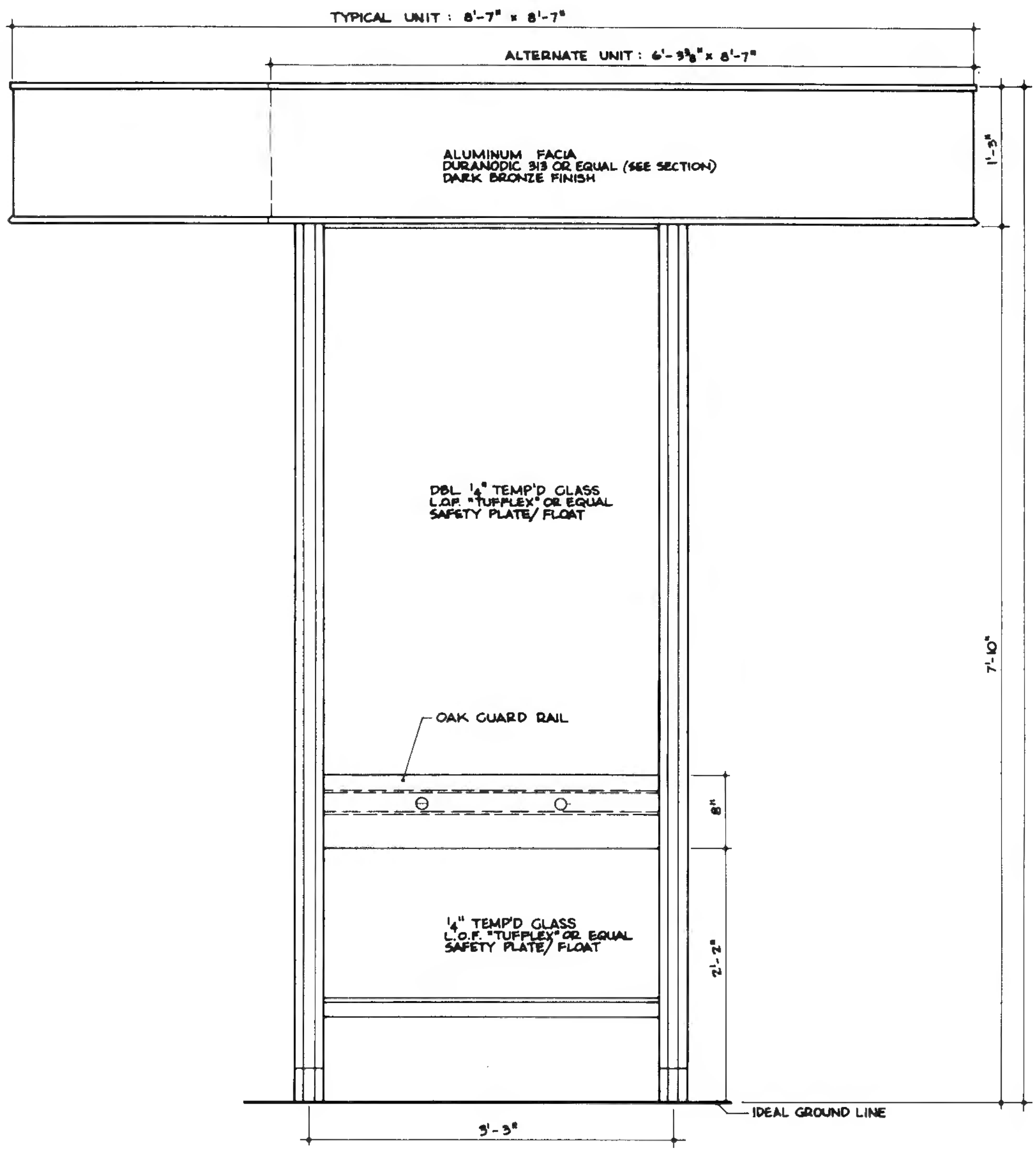
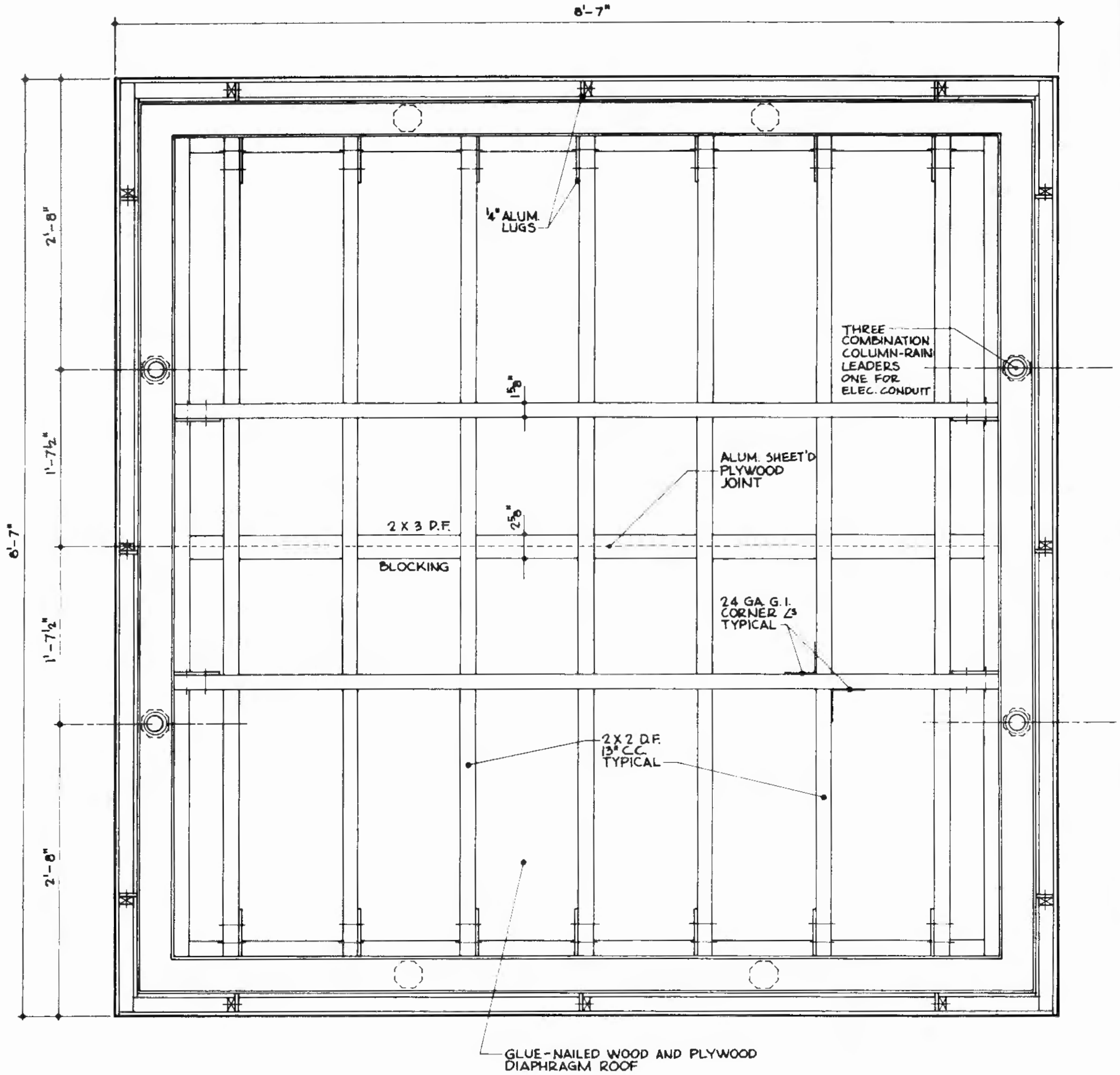


Figure V-1



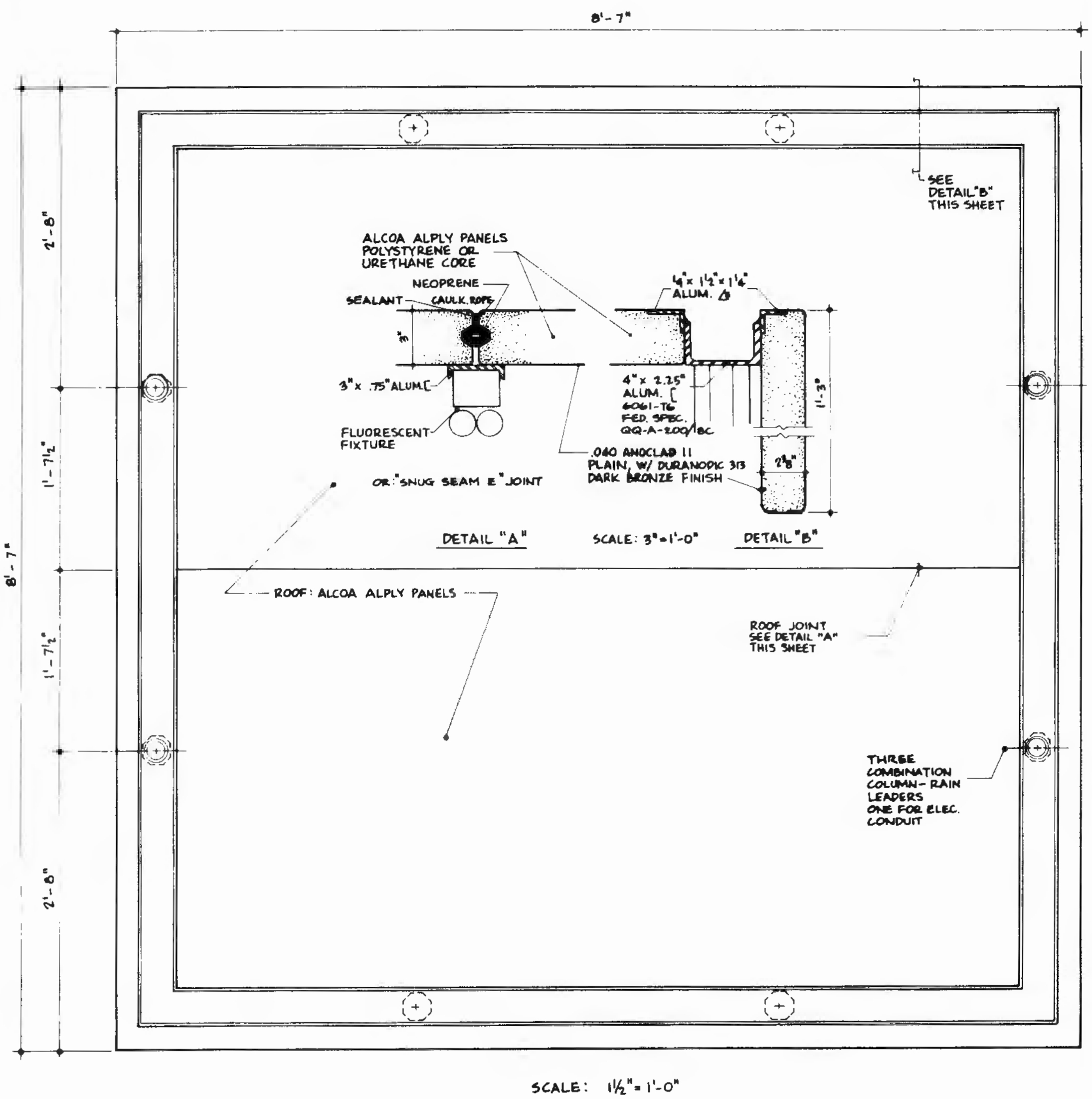
PROTOTYPE -A-	SCALE: 1½"=1'-0"	ELEVATION
INTRA-URBAN MASS TRANSIT STREET SHELTER	DATE: DEC., 1971	PROJECT DIR. : FRANK F. EHRENTHAL
UNITED STATES DEPARTMENT OF TRANSPORTATION URBAN MASS TRANSPORTATION ADMINISTRATION	PROJECT NO. VA-MTD-3	VIRGINIA POLYTECHNIC INSTITUTE AND STATE UNIVERSITY

Figure V-2



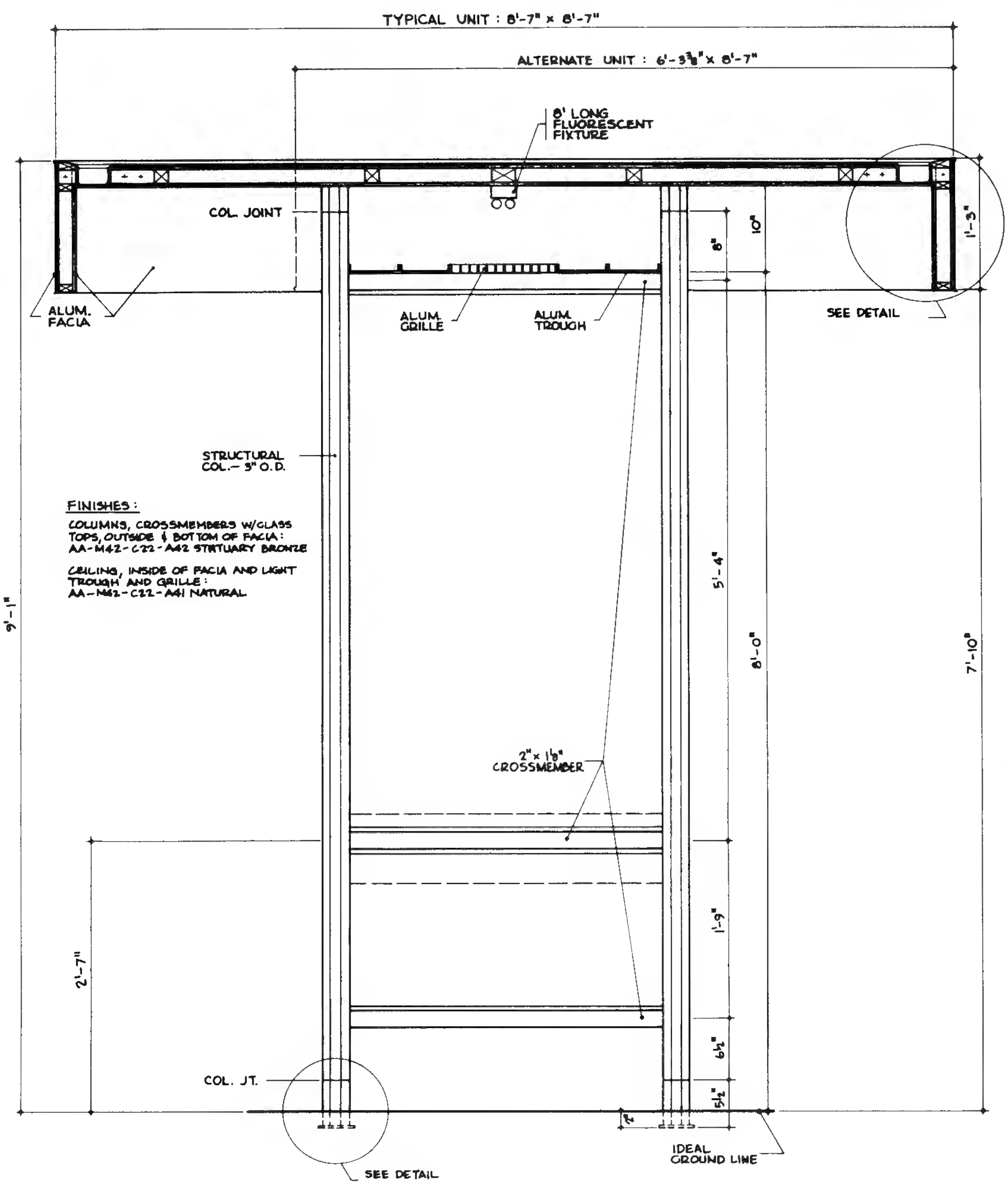
PROTOTYPE -A-	SCALE : 1½" = 1'-0"	ROOF PLAN- ALT. 1.
INTRA-URBAN MASS TRANSIT STREET SHELTER	DATE : DEC., 1971	PROJECT DIR. : FRANK F. EHRENTHAL
UNITED STATES DEPARTMENT OF TRANSPORTATION URBAN MASS TRANSPORTATION ADMINISTRATION	PROJECT NO. VA - MTD - 3	VIRGINIA POLYTECHNIC INSTITUTE AND STATE UNIVERSITY

Figure V-3



PROTOTYPE -A-	SCALE: AS NOTED	ROOF PLAN - ALT. 2. W/ DETAILS
INTRA-URBAN MASS TRANSIT STREET SHELTER	DATE: DEC., 1971	PROJECT DIR.: FRANK F. EHRENTHAL
UNITED STATES DEPARTMENT OF TRANSPORTATION URBAN MASS TRANSPORTATION ADMINISTRATION	PROJECT NO. VA - MTD - 3	VIRGINIA POLYTECHNIC INSTITUTE AND STATE UNIVERSITY

Figure V-4



PROTOTYPE –A–	SCALE : 1½"=1'-0"	SECTION
INTRA-URBAN MASS TRANSIT STREET SHELTER	DATE: DEC, 1971	PROJECT DIR. : FRANK F. EHRENTHAL
UNITED STATES DEPARTMENT OF TRANSPORTATION URBAN MASS TRANSPORTATION ADMINISTRATION	PROJECT NO. VA-MTD-3	VIRGINIA POLYTECHNIC INSTITUTE AND STATE UNIVERSITY

Figure V-5

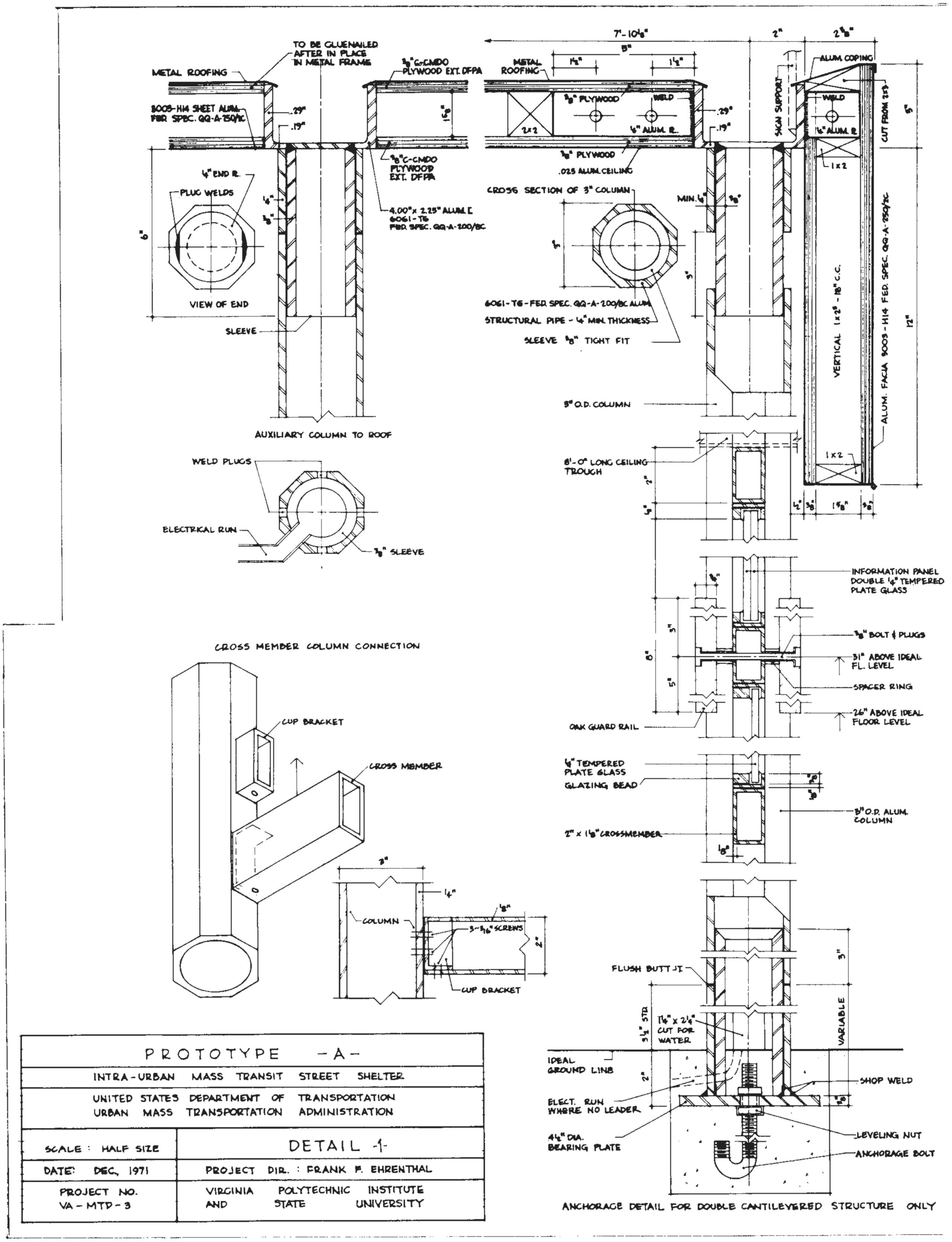
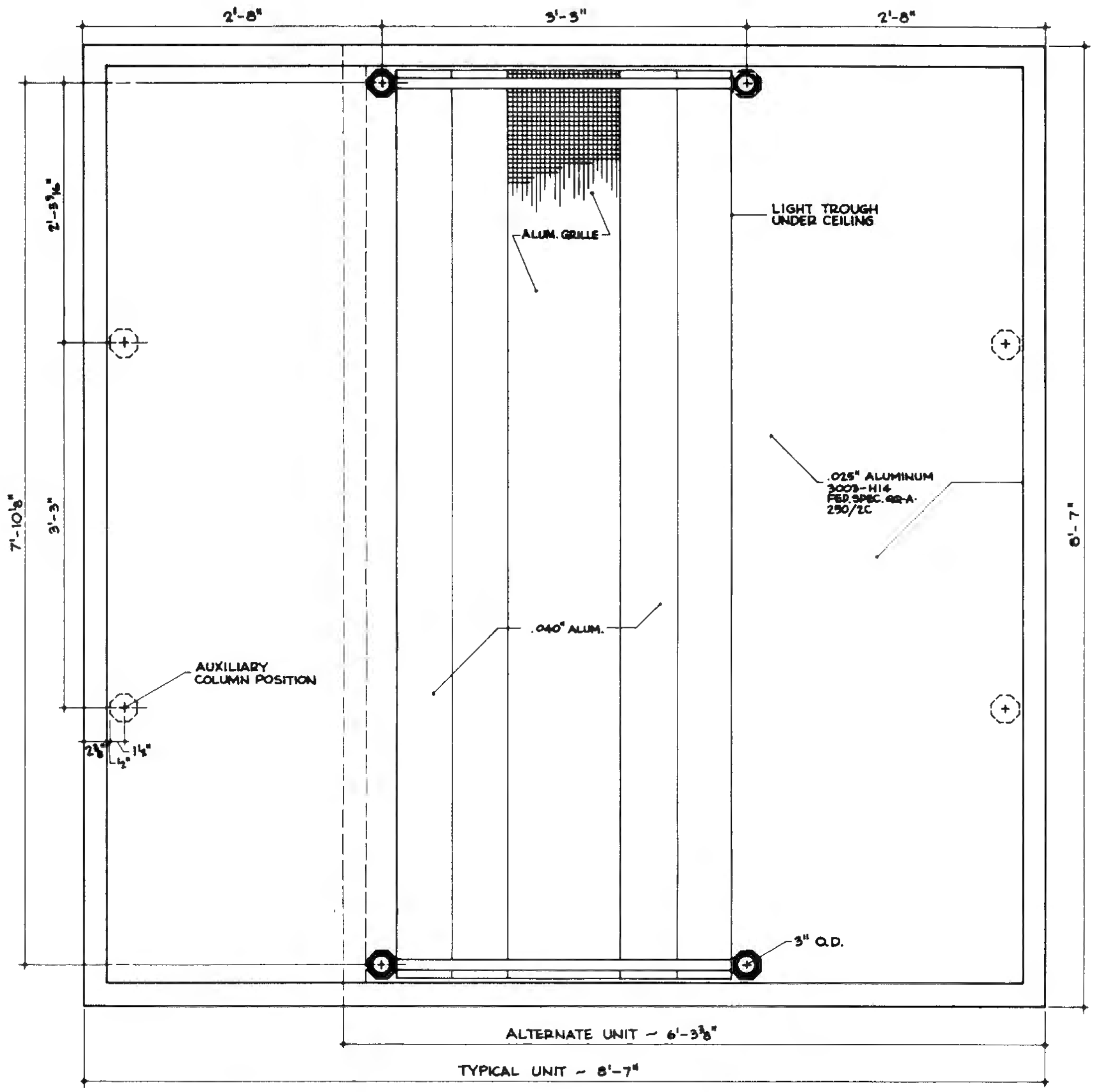
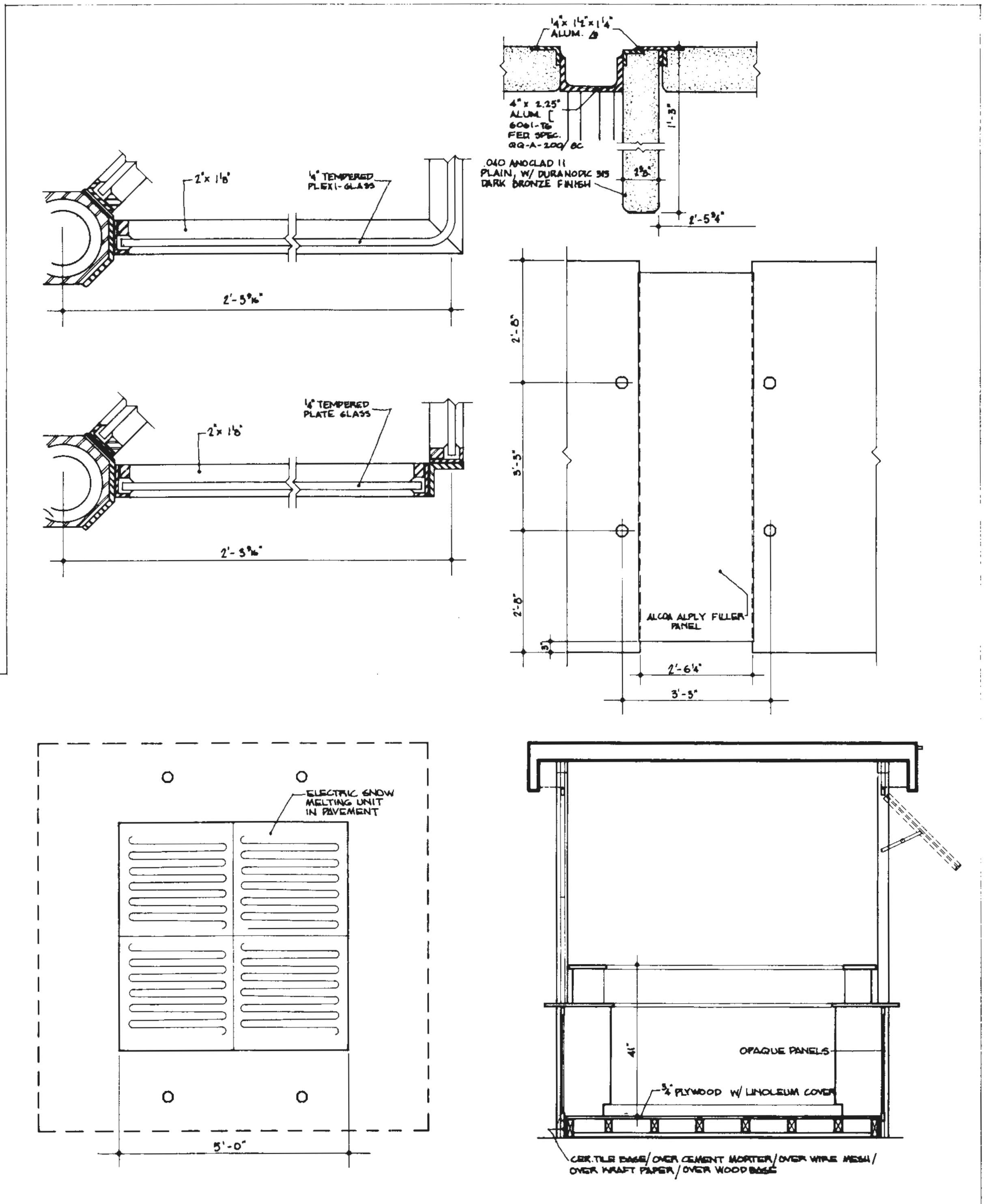

PROTOTYPE -A-
INTRA-URBAN MASS TRANSIT STREET SHELTER
UNITED STATES DEPARTMENT OF TRANSPORTATION
URBAN MASS TRANSPORTATION ADMINISTRATION
SCALE: HALF SIZE
DETAIL -1-
DATE: DEC, 1971
PROJECT DIR.: FRANK F. EHRENTHAL
PROJECT NO. VA-MTD-3
VIRGINIA POLYTECHNIC INSTITUTE AND STATE UNIVERSITY
METAL ROOFING
TO BE GLUENAILED AFTER IN PLACE IN METAL FRAME
3003-H14 SHEET ALUM. FED. SPEC. QQ-A-250/2C
PLYWOOD EXT. DFPA
4" END R.
PLUG WELDS
VIEW OF END
SLEEVE
4.00" x 2.25" ALUM. E 6061-T6 FED. SPEC. QQ-A-200/8C
AUXILIARY COLUMN TO ROOF
WELD PLUGS
ELECTRICAL RUN
CROSS MEMBER COLUMN CONNECTION
CUP BRACKET
CROSS MEMBER
COLUMN
SCREWS
METAL ROOFING
WELD
.025 ALUM. CEILING
CROSS SECTION OF 3" COLUMN
6061-T6-FED. SPEC. QQ-A-200/8C ALUM.
STRUCTURAL PIPE - 1/4" MIN. THICKNESS
3" O.D. COLUMN
8'-0" LONG CEILING TROUGH
ALUM. COPING
SIGN SUPPORT
CUT FROM 2x3
VERTICAL 1x2 - 18" C.C.
ALUM. FACIA 3003-H14 FED. SPEC. QQ-A-250/2C
INFORMATION PANEL DOUBLE 1/4" TEMPERED PLATE GLASS
BOLT & PLUGS
31" ABOVE IDEAL FL. LEVEL
SPACER RING
26" ABOVE IDEAL FLOOR LEVEL
OAK GUARD RAIL
1/4" TEMPERED PLATE GLASS
GLAZING BEAD
3" O.D. ALUM. COLUMN
2" x 1 1/2" CROSSMEMBER
FLUSH BUTT JT.
VARIABLE
CUT FOR WATER
IDEAL GROUND LINE
SHOP WELD
ELECT. RUN WHERE NO LEADER
4 1/2" DIA. BEARING PLATE
LEVELING NUT
ANCHORAGE BOLT
ANCHORAGE DETAIL FOR DOUBLE CANTILEVERED STRUCTURE ONLY

Figure V-6



PROTOTYPE -A-	SCALE: 1½" = 1'-0"	CEILING PLAN
INTRA-URBAN MASS TRANSIT STREET SHELTER	DATE: DEC, 1971	PROJECT DIR.: FRANK F. EHRENTHAL
UNITED STATES DEPARTMENT OF TRANSPORTATION URBAN MASS TRANSPORTATION ADMINISTRATION	PROJECT NO. VA - MTD - 3	VIRGINIA POLYTECHNIC INSTITUTE AND STATE UNIVERSITY

Figure V-7



PROTOTYPE -A-	SCALE: AS NOTED	DETAIL -2-
INTRA-URBAN MASS TRANSIT STREET SHELTER	DATE: DEC., 1971	PROJECT DIR: FRANK F. EHRENTHAL
UNITED STATES DEPARTMENT OF TRANSPORTATION URBAN MASS TRANSPORTATION ADMINISTRATION	PROJECT NO. VA - MTD - 3	VIRGINIA POLYTECHNIC INSTITUTE AND STATE UNIVERSITY

Figure V-8

Information

Telephones

Postal Service

Express Banking

Transit Ticket & Token Sales

Sports, Cultural Events Promotion, Tickets

Comfort Stations

First Aid Stations

Street Artists (Portraits, etc.)

Crafts Assistance

News, Magazines, Cigars

Paperbacks, Cards

Flowers

Snacks and Drinks

Ice Creams, Fruits

Roasted Chestnuts, Baked Apples

Novelty Toys, Games (Sales)

Shoe Shine

Key Duplicating

Table Top Games (Chess, etc.) Playing

Exhibits

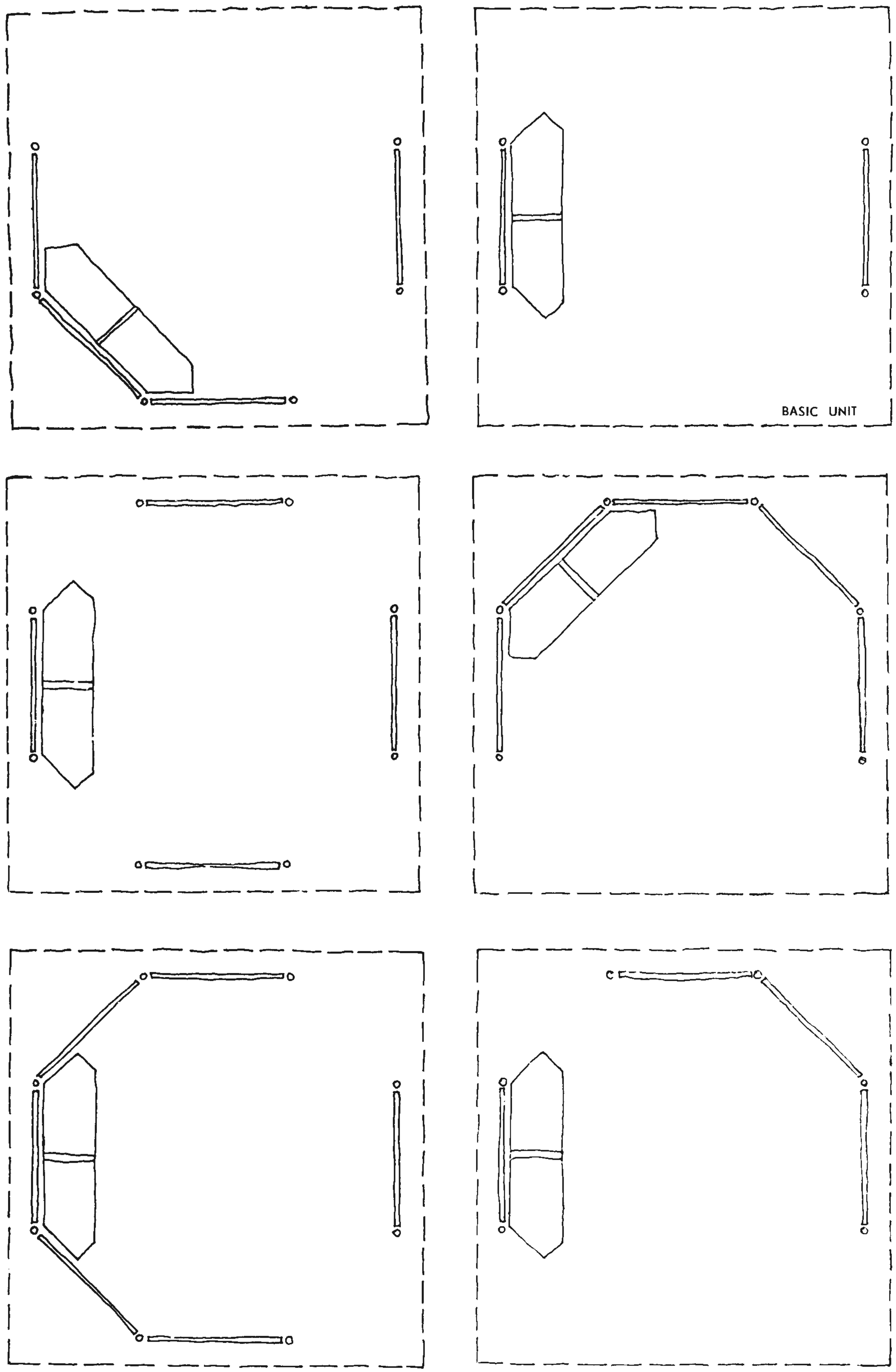
Poster Kiosks (Storage, Sidewalk Elevator Inside)

In a straight line or free flow series, or in clusters the unit lends itself to the creation of such spaces as park pavilions, exhibits, terrace cafes, various uses at expositions, fairs, etc. See Figure V-10 and V-11.

Section VI

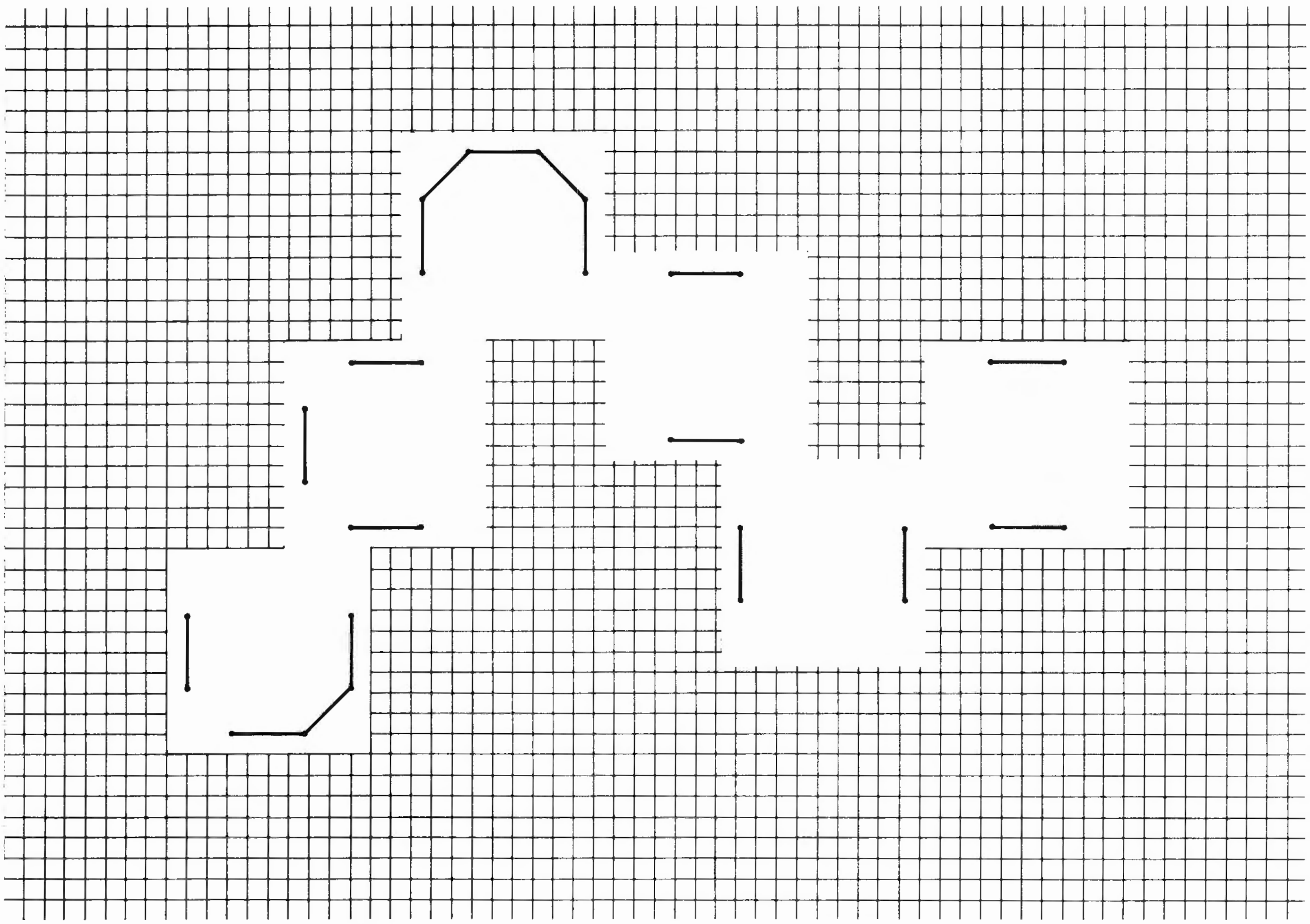
Appendices

Shelters - Variations to Suit Climate



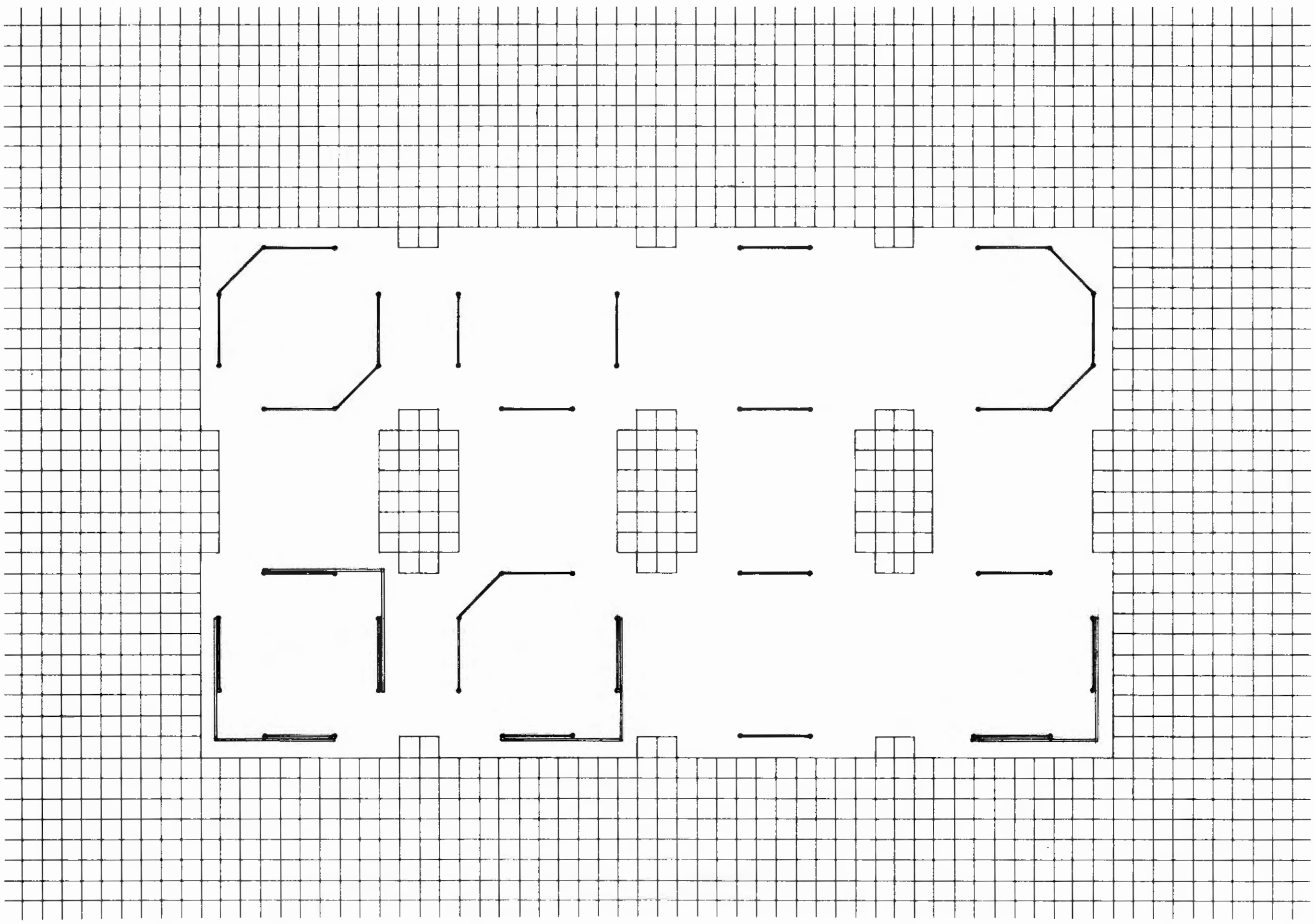
——— indicates walk enclosure line   — — — — indicates roof line

Figure V-9



park pavilion type shelter combinations

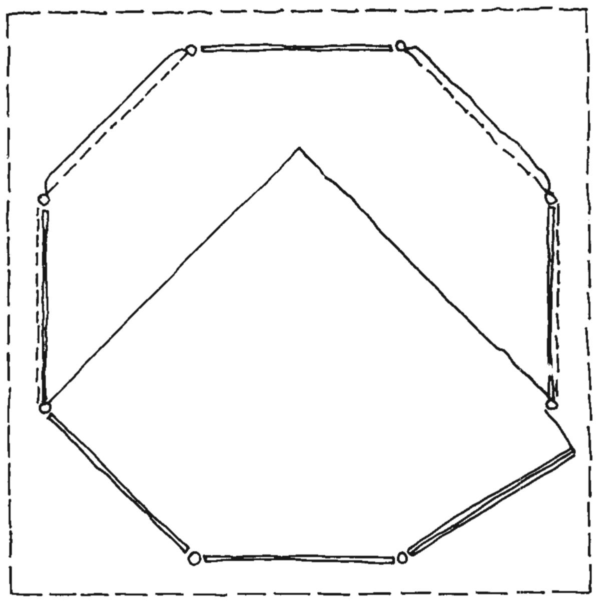
Figure V-10



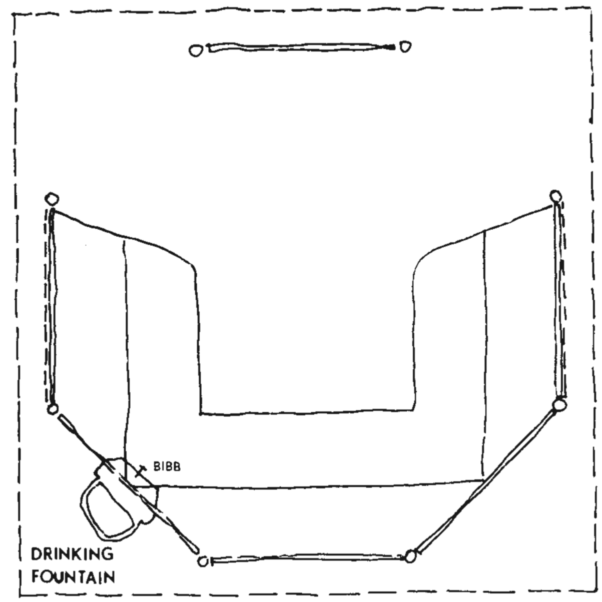
shelter combinations and variations with filler roof units

Other Uses for Kiosk Design

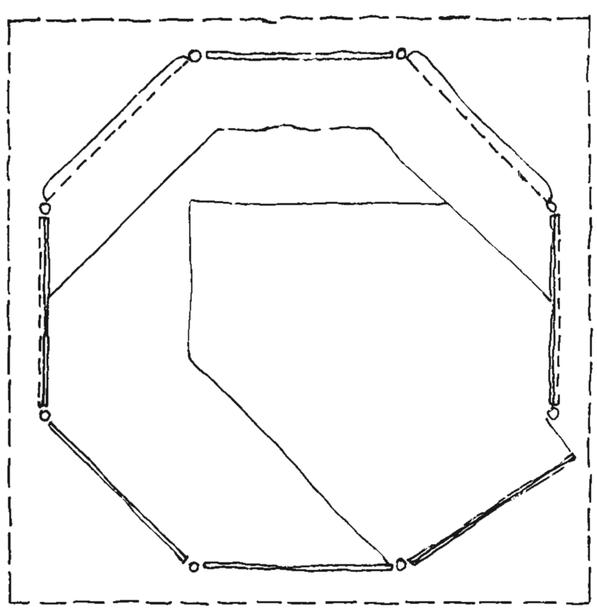
NEWS, MAGAZINES



FLOWERS



SNACKS



BANK DEPOSITS - STAMPS

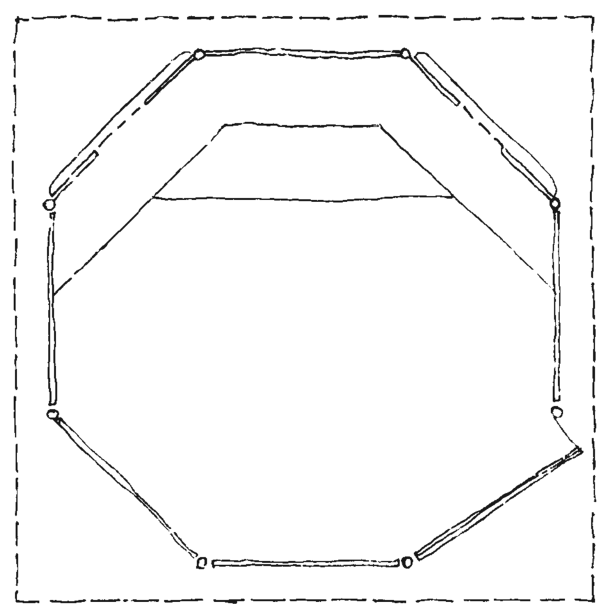
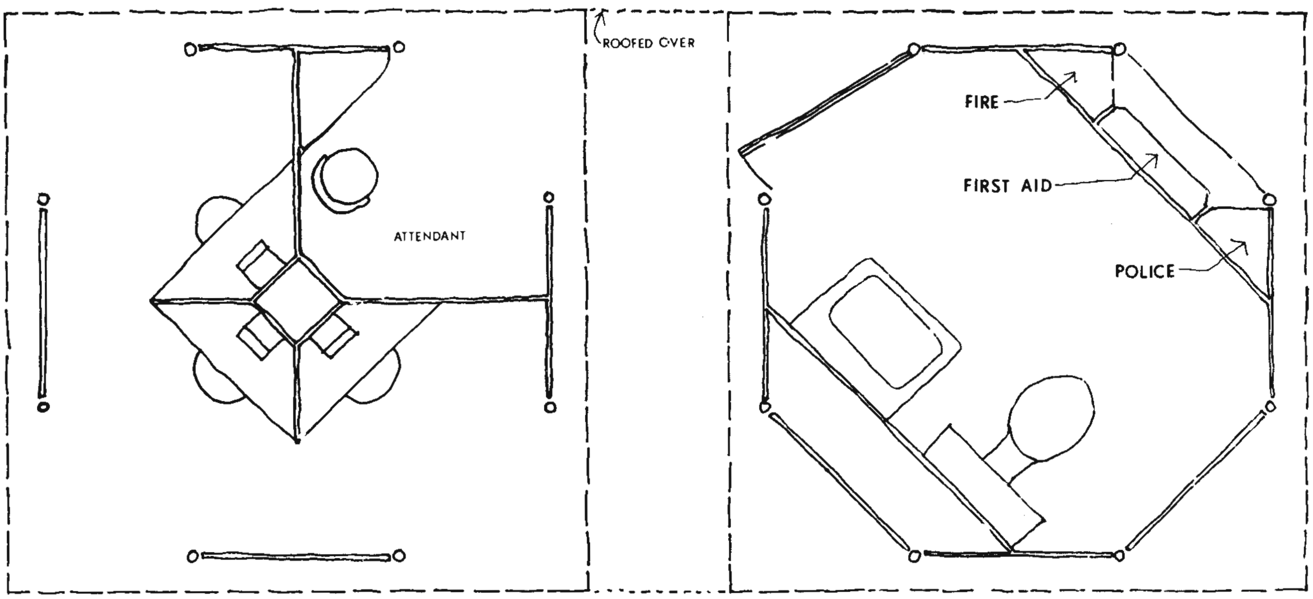


Figure V-12

TELEPHONES AND TOILET

WITH ATTENDANT

(TOILET KEY MAY BE WITH PHONE ATTENDANT, AT NEWS KIOSK OR SNACK KIOSK)



POSTER KIOSK

WITH SIDEWALK ELEVATOR TO SUBWAY

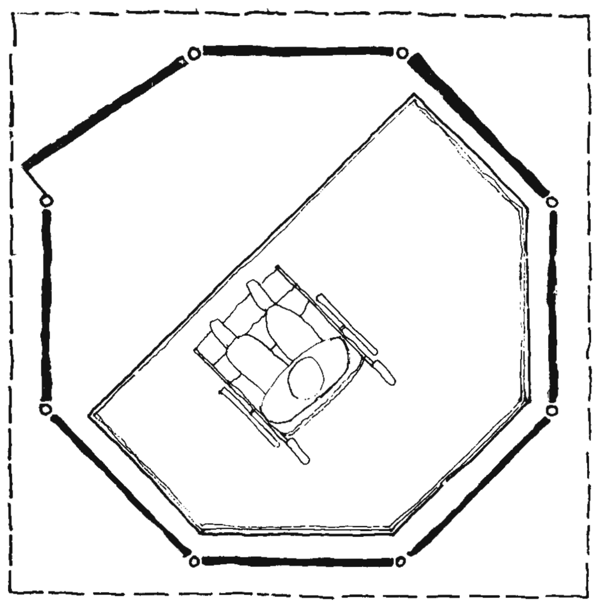


Figure V-13

Appendix A

Cities Surveyed

List of Cities Surveyed

City	Agency & Address	Previously Reported Shelters*	Presently Have Shelters In Use	Active Shelter Program	Remarks
1. Akron	Metropolitan Transit Authority 416 Kenmore Blvd. Akron, Ohio	no	no	no	
2. Atlanta	Atlanta Transit System P.O. Box 1592 125 Pine Street, N.W. Atlanta, Ga. 30301	no	1	no	
3. Baltimore	Baltimore Transit System Baltimore, Maryland	no	?	yes	60 shelters funded by UMTA Capital Grant program
4. Bangor	Hudson Bus Lines, Inc. Bangor, Maine	yes (2)	?	?	
5. Boston	Mass. Bay Trans. Auth. 150 Causeway St. Boston, Mass. 02114	yes (46)	yes	yes	
6. Brisbane	Brisbane Dept. of Transportation Brisbane, Alabama	yes (284)	yes	yes	
7. Chicago	Chicago Transit Auth. Merchandise Mart Plaza P. O. Box 3055 Chicago, Ill. 60654	no	1	no	
8. Christchurch	Christchurch Transport Board Christchurch, N. Z.	yes (45)	?	?	no other information
9. Cincinnati	Cincinnati Transit Co. Cincinnati, Ohio	yes	yes	yes	experimental pro

	City	Agency & Address	Previously Reported Shelters*	Presently Have Shelters In Use	Active Shelter Program	Remarks
10.	Cleveland	Cleveland Transit System 1404 E. 9th Street Cleveland, Ohio 44114	yes (1093)	1200	yes	
11.	Dallas	Dalles Transit System 101 N. Peak Dallas, Texas	no	no	no	
12.	Danville	Danville Transit System Danville, Virginia	no	no	no	
13.	Dayton	City Transit of Dayton Dayton, Ohio	yes	200	yes	
14.	Decauter	Decauter City Lines, Inc. Decauter, Illinois	yes (1)	?	?	no further information
15.	Duluth	Superior Transit Co. Duluth, Minn.	yes (8)	?	yes	5 shelters funded by UMTA Capital Grant program
16.	Detroit	Detroit Dept. of Street, Railways 14130 - 3rd Avenue Highland Park, Mich. 48203	yes (217)	270	yes	47l shelters funded by UMTA Capital Grant program
17.	Fitchburg	Fitchburg & Leominster Street Railway Co. R1427 Water Street Fitchburg, Mass. 01420	yes (2)	yes	no	
18.	Fresno	Fresno Transit System Fresno, California	no	?	yes	12 shelters funded by UMTA Capital Grant program
19.	Honolulu	Honolulu Dept. of Traffic City & Cty. of Honolulu Honolulu, Hawaii 96813	yes (1)	?	no	

	City	Agency & Address	Previously Reported Shelters*	Presently Have Shelters In Use	Active Shelter Program	Remarks
20.	Kansas City	Kansas City Area Trans. Authority 1627 Main Street Kansas City, Mo.	no	no	no	reported shelters previously
21.	Los Angeles	Southern Calif. Rapid Transit Co. 1060 S. Broadway L. A., California	no	no	no	
22.	Memphis	Memphis Transit Mgmt. Company Memphis, Tenn.	yes	?	?	no further information
23.	Montreal	Urban Community Transit Commission 159 Craig St., W. Montreal 126, Quebec	yes (125)	177	yes	
24.	Nashville	Nashville Transit Co. Nashville, Tenn.	yes (5)			no further information
25.	Nassau County	Dept. of Transportation Nassau County Office Bldg. 240 Old Country Road Minsola, New York 11501	no	no	yes	Nassau County recently contracted with Community Bus Shelters, Inc. for minimum of 500 shelters over 5 yr. period.
26.	New Orleans	Public Service, Inc. P. O. Box 60340 New Orleans, La. 70160	yes (17)	15	yes	limited
27.	New York	New York City Trans. Administration 51 Chambers Street New York, New York	no	50	yes	
28.	Norfolk	Va. Transit Co. 509 E. 10th Street Norfolk, Virginia	no	no	no	
29.	Pittsburgh	Port Authority Pittsburgh, Pa.	no	1	no	shelter donated

	City	Agency & Address	Previously Reported Shelters*	Presently Have Shelters In Use	Active Shelter Program	Remarks
30.	Philadelphia	Southeast Penna. Transp. Authority 200 W. Wyoming Avenue Philadelphia, Pa. 19140	no	yes	yes	
31.	Pueblo	Pueblo Transit System Pueblo, Colorado	no	?	yes	90 shelters funded by UMTA Capital Grant program
32.	Richmond	Va. Transit Co. 101 S. Davis Avenue P. O. Box 1635 Richmond, Va.	no	1	no	
33.	Sacramento	Transit Authority P.O. Box 2110 Sacramento, Calif. 95810	no	1	no	
34.	St. Louis	Bi-State Transit System 3869 Park Avenue St. Louis, Mo. 63110	no	42	no	UMTA Grant application unsuccessful; 125 shelters
35.	St. Paul	Twin Cities Area Metrop. Trans. Comm. 106 Capital Sq. Bldg. St. Paul, Minn. 55101	no	no	yes	31 shelters funded by UMTA Capital Grant program (currently testing several)
36.	St. Petersburg	St. Petersburg Transit System St. Petersburg, Florida	no	?	yes	4 shelters funded by UMTA Capital Grant program
37.	San Antonio	Transit System Tower-Life Bldg. San Antonio, Texas 78205	no	1	no	
38.	San Francisco	Municipal Railway 949 Presidio Ave. S. F., Calif. 94115	no	23	no	
39.	San Juan	Autoridad Metropolitana de Autobuses Arpadado 1029 Hato Ray, Puerto Rico 00919	yes (50)	88	yes	15 shelters funded by UMTA Capital Grant program
40.	Seattle	Transit System 1333 Airport Way S. Seattle, Wash. 98134	yes (58)	yes	yes	

City	Agency & Address	Previously Reported Shelters*	Presently Have Shelters In Use	Active Shelter Program	Remarks
41. Stockton	Stockton Transit System Stockton, California	no	?	yes	20 shelters funded by UMTA Capital Grant program
42. Toledo	Community Traction Co. Toledo, Ohio	yes (1)	?	?	no further information
43. Trenton	Trenton Transit System Trenton, New Jersey	no	?	yes	12 shelters funded by UMTA Capital Grant program
44. Vancouver	British Columbia Hydro & Power Auth. Vancouver, B. C.	yes (20)	yes	yes	
45. Washington, D. C.	D. C. Transit System Washington, D. C.	yes (8)	no	no	
46. Winnepeg	Metropolitan Corp. of Greater Winnepeg Winnepeg, Manitoba	yes (71)	?	?	no further information

*See American Transit Association report entitled SPECIAL INQUIRY – PASSENGER SHELTERS AT BUS STOPS (Circulated February 13, 1968, to Selected Companies Who Had Previously Reported Having Shelters).

Appendix B

Prototype Structural Analysis

Description of Structure

The basic structural components of the shelter are two aluminum frames, each consisting of two octagonal metal tubes with a 3-0" cross section, connected by three rectangular tube cross members, each 2-0" x 1-1/8" and a square 4-0" x 2-1/4" aluminum channel frame. The two vertical tubular frames are attached to the horizontal channel frame with fixed joints.

The combined action of the above creates a rigid roof which can sustain the moderate eccentric loading even when it occurs on the cantilevered portions of the roof. Additional rigidity is provided by the facia beams.

The two additional vertical frames which can be added, when more enclosure is desired, function structurally only in the sense that they transfer wind loads etc., on the filler panels to the primary skeleton and provide increased rigidity to the overall structure of the shelter.

The critical joints in the design occur at the four connection points with the ground. It is essential that these points be rigid.

Assumptions for Approximate Structural Analysis

Because of variations in climate and in sidewalk conditions an analysis will be made for each specific locality;

A simplified, minimal structural frame is assumed (without cross members, glazing);

Column to roof and column to ground joints are considered fully rigid;

Composite stiffening effects of cross members and of glazing not considered;

The continuity in the roof structure achieved by bolting the structural metal frame to the wood or alply diaphragm is acknowledged in the calculations (thus no torsional effects being considered).

Roof Area and Assumed Loads

Roof area = 8' -7" x 8' -7" = 73 square feet

Dead Load: 10lb/sq. ft. and 10lb/L. ft. (Facia); live load: 20lb/sq. ft.

Design Wind Pressure: 25lb/sq. ft. (Low structure)

See additional material (Figures B1 - B4) for detailed analysis.

THE MINIMAL STRUCTURAL FRAME

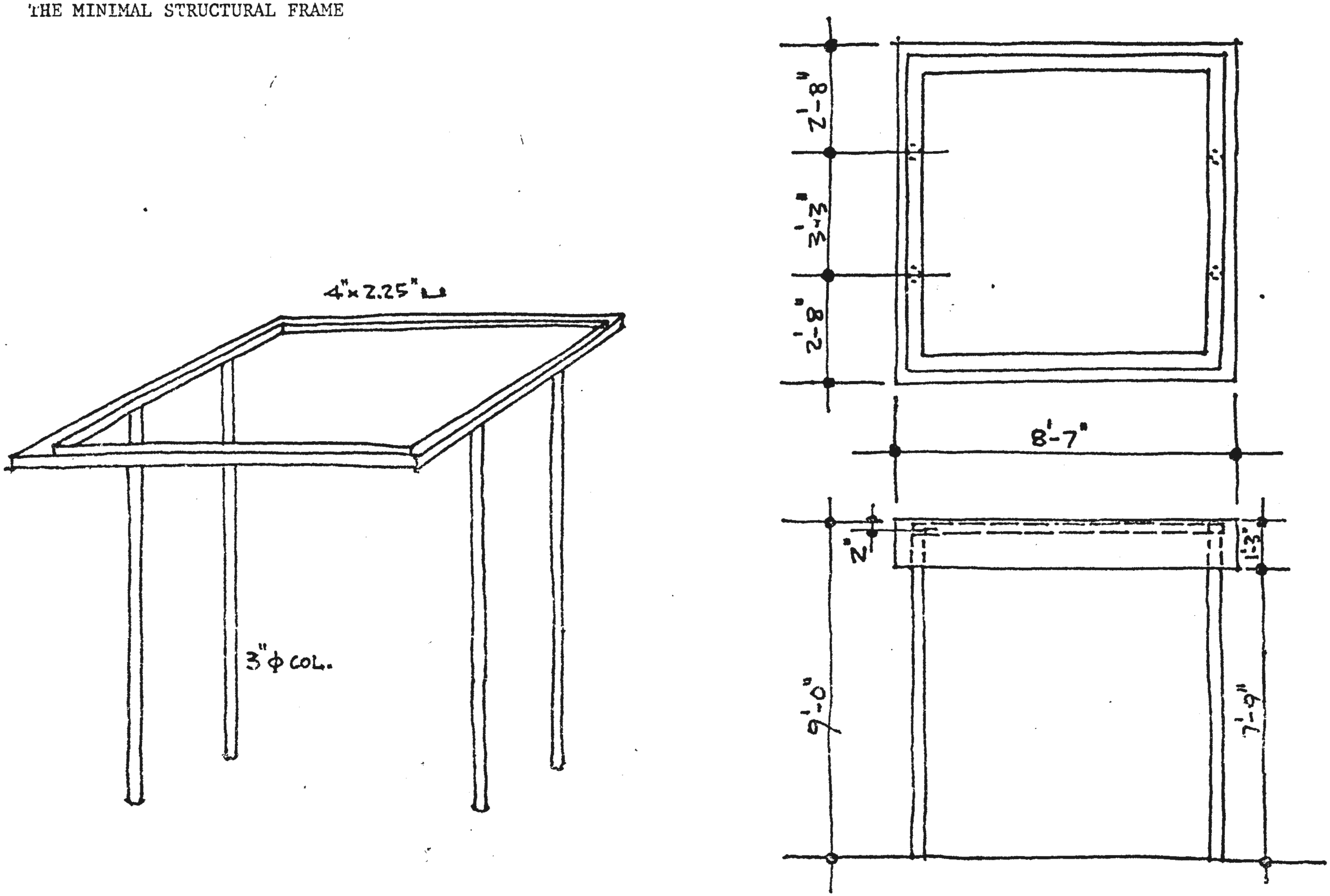


Figure B-1

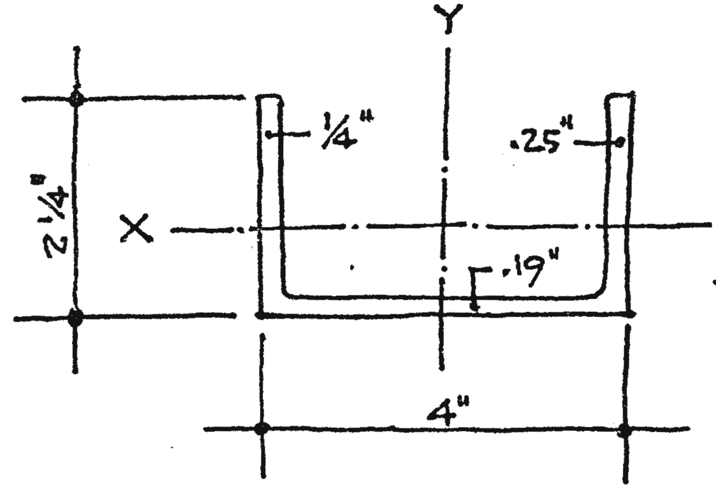
SECTIONAL PROPERTIES

ROOF FRAMING SECTION

$I_x = 1.02$

$S_x = 0.69$

$r_x = 0.72$



COLUMN SECTION

ASSUME SECTION EQUIVALENT TO 3-0" O.D. TUBE, 1/4" IN THICKNESS (CONSERVATIVE);

$A = \pi D t = (3.14)(3.00)(0.25) = 2.36$

$I = 0.39 D^3 t = (0.39)(3.00)^3(0.25) = 2.63$

$S = \frac{2.63}{1.50} = 1.75$

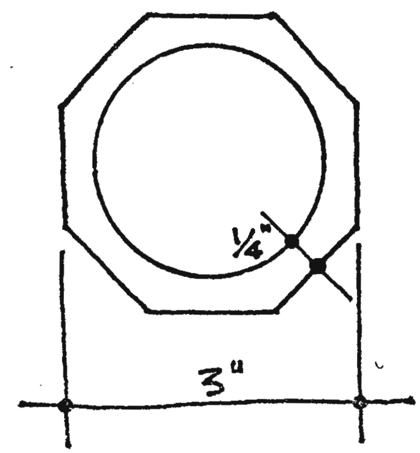
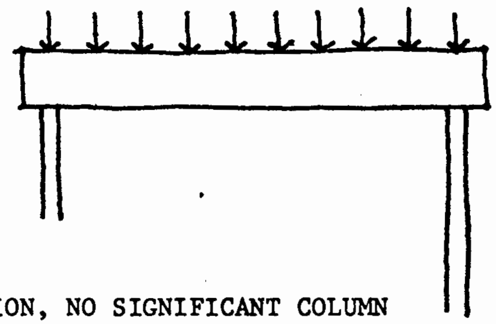


Figure B-2

VERTICAL LOADING ON COLUMNS

TOTAL DOWNWARD ROOF LOAD:

$$(20+10)(73)+(10)(4)(8.5) = 2530 \text{ LBS.}$$



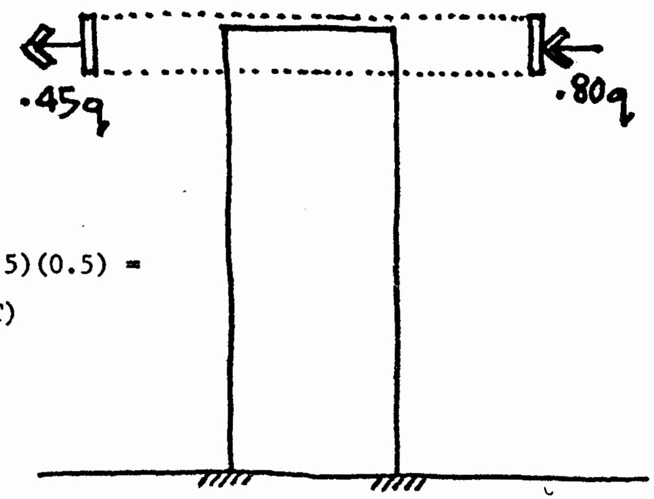
VERTICAL COLUMN COMPRESSION:

$$\frac{2530}{(4)(2.36)} = 266 \text{ PSI}$$

BECAUSE OF RIGIDITY IN ROOF DIAPHRAGM CONSTRUCTION, NO SIGNIFICANT COLUMN BENDING IS INDUCED BY VERTICAL LOADS.

SLENDERNESS RATIO FOR COLUMN: 100 (INSIGNIFICANT)

PORTAL ACTION UNDER WIND



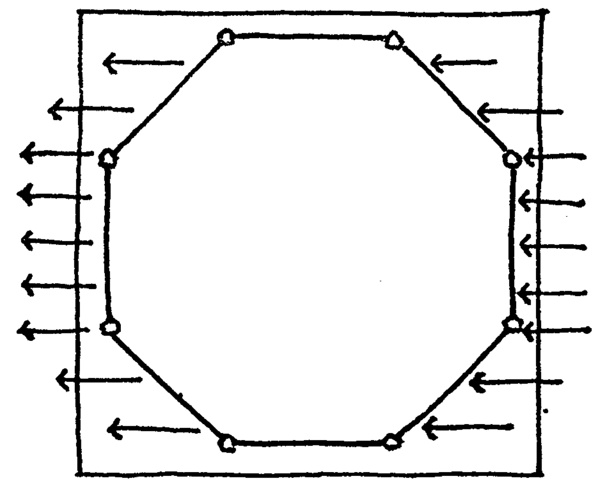
a.) MINIMAL FRAME UNDER WIND ON FACIA:

TOTAL FORCE = (0.80+).45)(25)(1.25)(8.5)(0.5) =

= 166 LBS. (INSIGNIFICANT)

Figure B-3

PORTAL ACTION UNDER WIND continued



b.) MINIMAL FRAME WITH WIND ON "CLOSED" SHELTER

(EXTREME CONDITION WHEN ADDITIONAL COLUMNS ARE NON-LOADBEARING)

TOTAL WIND FORCE = (7.83)(9)(25)(0.80+0.45) =

= 2,213 LBS.

WIND ON ONE PORTAL = 2,213/2 = 1,107 LBS.

P ACTING ON FACIA LEVEL = 1,107/2 = 554 LBS.

MAX. BEND. MOM. $= (\frac{P}{2})(\frac{h}{2}) = \frac{(554)(9)}{2} =$

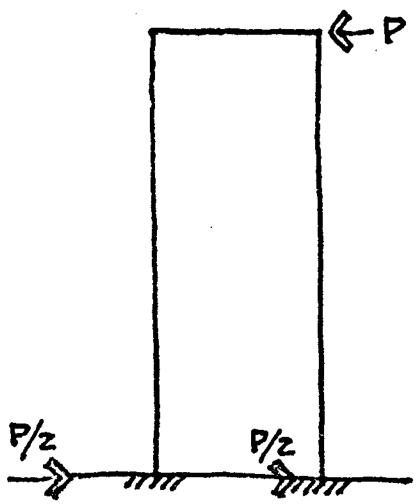
= 1,246 LB.FT.

MAX. STRESS $= \frac{(1,246)(12)}{1.75} = 8,500$ PSI

MAX. DEFLEC. $= K\,(\frac{Ph^3}{12\ EI}) = \frac{(0.59)(554)(106)^3}{(12)(2.63)(10)^7} =$

= 1.23"

HENCE, STRESS LEVEL IS SAFE AND 1.23" CAN BE CONSIDERED A VERY SAFE UPPER BOUND FOR HORIZONTAL DISPLACEMENT.



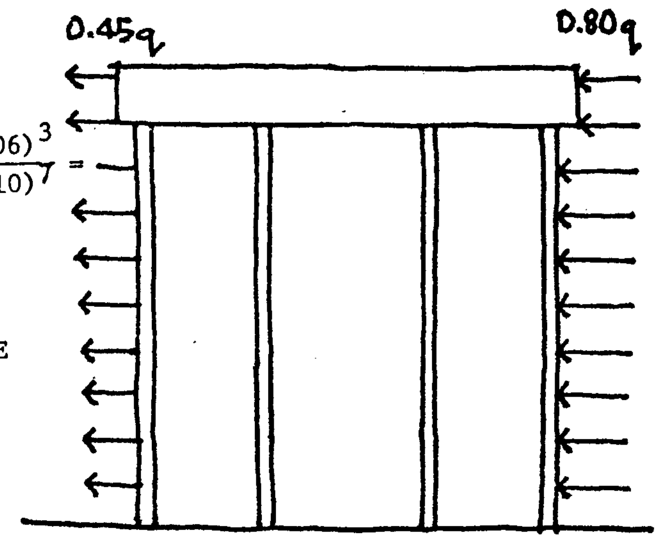


Figure B-4

Section VII

Bibliography

BIBLIOGRAPHY

General Reference

Appleyard, Donald; Lynch, Kevin; et al. The View from the Road. Cambridge: The MIT Press, 1966.

Bacon, Edmund. Design of Cities. New York: Viking Press, 1967. Offers historical perspective and comments on city design.

Briggs, Martin S. "Town Planning from the Ancient World to the Renaissance." A History of Technology. Vol. 3. Edited by Charles Singer; E.J. Holmyard; A.R. Hall; and T.I. Williams. New York: Oxford University Press, 1957.

C.I.A.M. (International Congress of Modern Architecture). The Heart of the City. London: Lund Humphries, 1952. Excellent comments by Walter Gropius concerning scale in urban architecture.

Crosby, Theo. Architecture: City Sense. New York: Reinhold Publishing Corporation, 1965.

Cullen, Gordon. Townscape. New York: Reinhold Publishing Company, 1961. A sketchbook of innovative designs written with the sensitivity of a landscape architect.

Dober, Richard P. Environmental Design. New York: Van Nostrand Reinhold Company, 1969. This is a general work of the subject.

Gallion, A.B., and Eisner, S. The Urban Pattern. Princeton, N.J.: Van Nostrand, 1963. This revised second edition offers a historical survey of city planning and development.

Gibbered, Fredrick. Town Design. Revised edition. London: Architectural Press, 1955.

Giedion, Sigfried. Space, Time and Architecture. Cambridge: Harvard University Press, 1941. A general textbook on architectural history with reference to urban development.

Gruen, Victor. The Greater Fort Worth Plan. Texas: Fort Worth City Planning Office, 1956.

. The Heart of our Cities. New York: Simon and Schuster, 1964. An example of the ecological analogy applied to city design, yet offers a good treatment of the city center problem.

Halprin, Lawrence. Cities. New York: Reinhold Publishing Company, 1963. This publication offers analysis of streets with particular emphasis to shopping streets, and deals with types of street furniture.

Hegemann, W., and Peets, E. The American Vitruvius: An Architects Handbook in Civic Art. New York: Architectural Book Publishing Company, 1922.

Hilberseimer, L. Entfaltang Einer Planningsidee. Berlin: Ullstein, 1963. Refer also to his book on the nature of cities.

Jacobs, Jane. Death and Life of Great American Cities. New York: Random House, 1961. Although the text is often sensational in nature it does offer an understanding of the manifold functions of city streets and the rich contributions they do, or could, make to urban life.

Kuper, L. Living in Towns. London, 1953.

London County Council Architect's Office. The Planning of a New Town. London: Greater London Council, 1965. One of the best available works on the planning and design of a new town; Hook.

Mayer, Harold M., and Wade, Richard C. Chicago: Growth of a Metropolis. Chicago: University of Chicago Press, 1969. An excellent account of the growth of metropolitan Chicago using pictorial documentation. Of particular interest are late nineteenth century street scenes.

Michaelides, Constantine. Hydra: A Greek Island Town. Chicago: University of Chicago Press, 1967. Offers interesting examples of street development and morphology (p. 70 ff.).

Nairn, Ian. The American Landscape. New York: Random House, 1965. A good, critical urban design view.

Norberg-Schulz, Christian. Intentions in Architecture. Cambridge, Mass.: The MIT Press, 1968. This book points out that analysis in architecture is impossible without theoretically determined dimensions of comparison (p. 209 ff.).

Sharp, Thomas. "English Tradition in the Town." Architectural Review, Vol. 78 (November, 1935), pp. 179-187.

Sitte, Ca millo. City Planning According to Artistic Principles. Translated by George Collins, and Christiane Collins. New York: Random House, 1965. This book offers insight into Medieval and Renaissance planning in particular. Of particular interest is the discussion by the translator in Chapter VII-A.

Spreiregen, Paul D. Urban Design: The Architecture of Towns and Cities. New York: McGraw-Hill, 1965. Includes some discussion on the nature of streets.

Tyrwhitt, Jacqueline, et al. The Heart of the City: Towards Humanization of Urban Life. New York: Farrar, Straus and Giroux Inc., 1952.

Streets

Historical Development

Burke, Thomas. The Streets of London through the Centuries. London: Charles Scribners, 1940.

David, A.C. "Street Architecture of Paris." Architectural Record, Vol. 24 (August, 1908), pp. 109-128.

Davis, Richard Harding, et al. The Great Streets of the World. London: Charles Scribner, 1892.

Goodman, Paul, and Percival Goodman. Communitas: Means of Livelihood and Ways of Life. 2nd ed. New York: Vintage Books, 1960. See especially the chapter entitled "The Evolution of Streets from Village to City", pp. 39-49.

Lassig, K.; Linke, R.; Rietdorf, W.; and Wessel, G. Strassen und Platye. Munchen: Callwey, 1968. Good historical treatment of the street.

Osman, M. "City Streets." American Institute of Architects Journal, Vol. 54 (December, 1970), p. 25. Brief discussion of the manner in which streets have changed and need to improve them.

Pogarry, Frigyes. Terek es Utcals Muveszete. Budapest: Musyaki Konyulsiado, 1960. Offers a good historical treatment of the street.

Rauda, Wolfgang. Raumprobleme im Europaischen Stadtebau. Munchen: Callwey, 1956. Traces the historical development of the street.

Reilly, C.H. "Street by Street: A Critical Tour of Famous Throughfares." Architectural Review, Vol. 79, No. 470 (January, 1936), pp. 35-37. cf. No. 472 (April, 1936), pp. 134-136, and Vol. 79, No. 473.

Robinson, Charles Mulford. "The Evolution of the Street." House and Garden, Nov.-Dec., 1903 and Jan.-Feb., 1904.

Streets

General Information

Addams, Jane. The Spirit of Youth and the City Streets.

Alexander, Christopher. "Patterns of Streets." American Institute of Planners Journal, Vol. 32 (September, 1966), pp. 273-278. A follow up article in the same journal Vol. 33 (November, 1967) includes replies and a rejoinder by D.H. Carson and P.H. Roosen-Runger.

Allison, J.R. et al. "A Method of Analysis of the Pedestrian System of a Town Center (Nottingham City)." Journal of Town Planning Institute, Vol. 56, No. 8 (Sept.-Oct., 1970), pp. 352-356. Article describes most important causes of inconvenience and discomfort to pedestrians and indicates levels of congestion at which the conditions could be said to be unacceptable. The pedestrian network capacity is analyzed with techniques similar to those used by traffic planners to test the capacity of road systems.

Ancrum, E. "Austrailan Arcades." Architectural Review, Vol. 133 (June, 1963), pp. 441-444.

Antonious, J. "Planning of the Pedestrian: Access Networks." Official Architecture and Planning, Vol. 33 (1970), pp. 510-526. This article sets out the basic requirements in planning for pedestrians in urban areas as response to substantial increase in need for such provisions over the next ten years. This article examines both design and management aspects of network. Some examples of planning "pedway" are discussed.

Bassett, E.M. "What is a Street." City Planning, Vol. 9, No. 1 (January, 1933), pp. 34-35.

Black, Russell van West. Streets.

Cambridge Seven Associates, Inc. Report of the U.S. Commission of Fine Arts on the Environmental Design of Streets in Washington, D.C. Cambridge, Mass.: Cambridge Seven Associates, 1967.

Candilis, G. "Rue Commerciale, Barcares-Leucate." L' Architecture d' Aujourd' hui, No. 144 (June, 1969), pp. 62-63.

City of Canterbury. Saint Peter's Street Improvement Scheme. 1962.

Doxiadis, C. A. "Life in the Cities of Tomorrow." Ekistics, Vol. 28, No. 165 (August, 1969), pp. 92 ff. This article includes comments about the sizes of streets.

Foley, Donald L. "The Daily Movement of Population into the Central Business District." American Sociological Review, Vol. 17 (October, 1952), pp. 538-543.

Greeley, Roger. "Definitions of a Street." City Planning, Vol. 3, No. 2 (April, 1927), pp. 108-109.

"Is a Street a Public Place." American City, Vol. 38, No. 4 (April, 1928), pp. 177-179.

Jeanneret-Gris, C. E. (Le Corbusier). "Mort de la Rue." L'Architecture d'Aujourd'hui, 1933.

Lewis, David. The Pedestrian in the City. Princeton, N. J.: D. van Nostrand Company, 1966. The article by Jane Jacobs entitled "Do not separate Pedestrians and Automobiles," pp. 109-110 is especially relevant.

Maurer, F. "Gestaltung der Strasse." Werk, Vol. 47 (November, 1960), pp. 404-407.

National Committee on Urban Transportation and the U. S. Bureau of Public Roads. Determining Street Use (Transportation Procedure Manual 1-A). Washington, D. C.: Public Administration Service, 1958.

Nations Cities. Selected issues include articles on center city circulation. October, November and December 1967 and February 1970 issues include good discussions of pedestrians and vehicular circulation problems.

Okamato, R. Y., and Williams. F. F. Urban Design Manhattan. New York: Viking Press, a Studio Book, 1969. Presents planning by the Regional Plan Association which treats the Manhattan CBD Circulation Planning.

Petersen, Stephen G. "Walking Distances to Bus Stops in Washington, D. C. Residential Areas." Traffic Engineering, December 1968, pp. 28-34. This presents a good treatment of the topic but does not mention the shelters at stops.

Pick, Frank. "The Street," Architectural Review, Vol. 74, No. 445 (December, 1933), pp. 215-219. The Article includes photographs of various street situations.

Rudofski, B. Streets for People. Cambridge: The MIT Press, 1969.

Scully, Vincent, Jr. "Death of the Street." Perspecta, No. 8 (1963), pp. 91-102. Included in the issue is also an article by R. Roth entitled, "Forces that Shaped Park Avenue." Both articles deal with the mutation of Park Avenue.

Wolfe, M. R. "Shopping Streets and the Pedestrian Rediscovered." Journal of the American Institute of Architects, May, 1962.

Wolf, P. "Structure of the Motion in the City," Art in America, Vol. 57 (January, 1969), pp. 66-75.

York, Everett M. "The Function of a Street." Community Builder.

Zion, R. "Design for the Pedestrian." A paper delivered at the International Design Conference in Aspen, Colorado. Arts and Architecture, Vol. 81 (June, 1964), pp. 26-27. Very brief comments on the subject.

Streets

Street Aesthetics

Ellis, F. W. "Squalor in our Streets." Community Planning Review, Vol. 13, No. 2, pp. 7-10.

Erwin, A. T. "Streets from Landscape Point of View." American City, Vol. 4 (February, 1911), pp. 76-77.

Lorenz, H. Aesthetische und Praktische Linienführung der Strasse. XI Internationaler Strassenkongress, Rio de Janeiro, 1959.

Malt, Harold Lewis. "Getting Rid of Junk in the Streets." Landscape Architecture, Vol. 58 (April, 1968), pp. 207-209. A reply by R. C. Weinberg to the issues raised by Malt are included in the October 1968 issue.

Middleton, M. "Clutter in the Streets." Design, No. 166 (October, 1962), pp. 40-49. This short article deals with street furniture.

Streets

Street Embellishments

Akron City Planning Commission. Sidewalks for Akron. Akron: City Planning Commission, 1963.

"Big Ideas that Give Downtown a New Look." Business Week, February 25, 1967, pp. 100-104.

"Boston Edison's Pole Goal: 'Beautility'." Home Builder News, July 7, 1969, p. 4.

Brookes, M. J. "Street Lighting and People." Industrial Design, Vol. 10 (June, 1963), pp. 48-55.

"City Easing Rules on Sidewalk Cafes to Encourage Idea." New York Times, December 5, 1967.

Dickey, John W. Traffic Control Systems for Urban Areas. Exchange Bibliography No. 81, Monticello: Council of Planning Librarians, 1969.

Doxiadis Associates, Inc. Downtown Streets and Places. Report prepared for Downtown Progress; National Capital Downtown Committee, Inc., Washington, D. C., 1962. Report contains sketches of proposed improvements for selected streets and squares in Washington, D. C.

Edison Electric Institute. Street Lighting Manual., 2nd. Edition, New York: Edison Electric Institute, 1969.

Edison Electric Institute, National Shade Tree Conference, and Illuminating Engineering Society. Our Streets Can Be Beautiful--And Useful: Proceedings of the First Shade Tree and Utility Conference. Cleveland, Ohio, 1955.

"Electrical Utility Industrial Task Force Makes Recommendations." Land, Washington, D. C.: American Society of Landscape Architects, 1968, pp. 5-6.

Evans, Henry K., ed. Traffic Engineering Handbook; 2nd. Edition, New Haven: Institute of Traffic Engineers, 1950. See index: Traffic Signs.

Gomme, Andor. "Street Decoration," Architectural Review, Vol. 127 (January, 1960), p. 70 ff.

Halprin, Lawrence. The RSVP Cycles: Creative Processes in the Human Environment. New York: George Braziller, Inc., 1969. See especially pp. 68-77 for details of Nicollet Mall project in Minneapolis.

"Help Coming for Main Street: New Federal Aids in Traffic Control." Nation's Cities, May, 1968, pp. 7-9.

Hoftiezer, G. J. "Combating the Crime of the Streets: The Sidewalks of New York are a Visual Nightmare." Industrial Design, Vol. 16 (January, 1969), pp. 44-47.

Houck, John W., ed. Outdoor Advertizing: History and Regulation. South Bend: University of Notre Dame Press, 1969.

Linn, K. "Ecology of Cities: Are we Making Space for Consumers Only." Landscape Architecture, Vol. 51, No. 1 (Fall, 1960), pp. 46-46. This article deals with trees in cities.

McKeever, J. Ross, ed. Community Builders Handbook. Washington, D. C.: Urban Land Institute, 1968.

Malt, Harold Lewis. Furnishing the City. New York: McGraw-Hill Book Company, 1970. This book shows general concern for pedestrian environment, but describes dysfunctions rather simplistically in terms of the automobile.

____________. "Public Street Clutter . . . Controlled." Journal of Housing (October, 1969), pp. 543-548. Author discusses importance of public improvements and problems associated with them. His work in the City of Cincinnati is used as an example.

Milnes, L. W. "A New Downtown." American City, Vol. 81, No. 6 (June, 1966), pp. 86-87. This is about Fresno, California.

Morris, Robert L. "The Pedestrian: Downtown's Forgotten Man (and Woman)." Nation's Cities, December, 1967, pp. 11-14.

____________. "Traffic Control." Nation's Cities, January, 1969, pp. 16-19.

"New Styles for Streets." Newsweek, June 16, 1969. This is a brief discussion of several cities' attempts to improve street furniture design.

Antonio Piva and Luciano Grugni. "Microstrutture di Servizio e di Comunicazione." Casabella, No. 339/340 (August-September, 1969). This is an illustrated discussion of street service facilities--especially Stevenage and Washington, D. C.

"A Plan for Street Classifications and Major Intersections." Wichita-Sedgwick County Newsletter, February, 1969, pp. 2-3.

"Portable Park Built in Little Rock." Journal of Housing, April, 1969, p. 195.

Sessions, Gordon. Getting the Most from City Streets. Washington, D. C.: Highway Research Board, 1968.

Smith, Albert E. Street Signs. Unpublished Master's Thesis, Virginia Polytechnic Institute, Blacksburg, Virginia, 1961.

"Sign Control Bulletin." Downtown Idea Exchange. Article issued in parts: No. 1 (August 15, 1967), No. 2 (March 15, 1968), No. 3 (October 15, 1968), No. 4 (December 15, 1968), No. 5 (February 15, 1969), No. 6 (April 15, 1969), No. 7 (June 15, 1969).

"Urban Beautification Memo." Downtown Idea Exchange, Article issued in parts: No. 1 (November 15, 1968), No. 2 (January 15, 1969), No. 3 (March 15, 1969), No. 4 (May 15, 1969).

Zion, R. "Who's Minding the Floor?" Architectural Forum, Vol. 117 (December, 1962), pp. 116-119.

Streets

Photographic Essays

American City, Vol. 12 (January, 1915). A Series of photos and an article concerning the types of city streets and pavements.

"The Street" (la Rue) Camera, Vol. 48 (March, 1969), pp. 5-49. This entire issue is devoted to photographs by Robert Frank, Klein, Ralph Nybvist, Pepi Meriso, Max Jacoby, Willi Glasuer and Marlis Glasuer.

Urban Spaces and Aesthetics

Bacon, Edmund N. "The Space Between Buildings," Harvard, April 14, 1962.

Beazley, E. Design and Detail of the Space Between Buildings. London, 1961.

Blumenfeld, H. "Scale in Civic Design." Town Planning Review, Vol. 24, No. 1 (April, 1953), pp. 35-46.

Liston, Robert A. Downtown. New York: Dell, 1965. This short book offers a good treatment of city center problems.

Lynch, Kevin. "City Design and City Appearance." Principles and Practice of Urban Planning. Edited by W. I. Goodman and E. C. Freund. Washington, D. C.: International City Managers Association, 1968.

__________. "Quality in City Design," Who Designs America? Edited by L. B. Holland, Garden City, N. Y.: Doubleday Anchor, 1966.

Robinson, Charles M. City Planning: with Special Reference to the Planning of Streets and Lots. New York: G. P. Putnams' Sons, 1919. This book includes a reissue of "The Width and Arrangement of Streets," and deals with "platting," zoning and similar topics.

Smithson, Alison, and Smithson, Peter. Urban Structuring. New York: Reinhold Publishing Company, 1967. This book deals with patterns of association in streets and treats city districts as distinct "elements" of the city.

Webber, Melvin. "The Urban Place and Nonplace Urban Realm." Explorations in Urban Structure. Edited by M. Webber, et. al. Philadelphia, Penna.: University of Pennsylvania, 1964.

Wolfe, Ivor de. The Italian Townscape. London: The Architectural Press, 1963. Excellent examples of "streets" as opposed to "roads" are presented in a style not unlike Sitte's work (pp. 43-76).

Planning for Pedestrians

Bird, Arthur D. "How to Plan for the Pedestrian." American City, Vol. 84, No. 7 (July, 1969), pp. 76-77, 136-137.

"Forgotten Man in the City:" Architectural Forum, Vol. 128 (Jan.-Feb., 1968). Contains illustrated examples of pedestrian planning: Proposed Urban Strollway System for Manhattan: Skyway in St. Paul: Europea Center in Berlin: Skymart in Morristown, Tenn.

Martin, Albert C. "How to Plan for the Urban Spirit." American City, Vol. 85, No. 2 (February, 1970). Author proposes Fort Worth-like scheme as means of humanizing urban cores.

Martin, Ann. "Bibliography: Pedestrians in the City." Ekistics, Vol. 28, No. 166 (September, 1969), p. 212

A. Miller and J. A. Cook. "Pedestrians and Vehicles on Housing Estates." The Architect's Journal, Vol. 146, No. 25 (November, 1967).

R. L. Morris and S. B. Zisman. "The Pedestrian, Downtown, and the Planner." American Institute of Planners Journal, Vol. 28 (August, 1962).

"Skyways for Minneapolis." Metropolitan Area Digest, March-April, 1970, p. 6. Skyways are " . . . glass-enclosed, carpeted and air-conditioned . . . at the second-story level in the downtown sector." They serve to separate pedestrians from traffic.

Stuart, Darwin G. "Planning for Pedestrians." American Institute of Planners Journal, Vol. 34, No. 1 (January, 1968). Author proposes framework for pedestrian planning in terms of circulation planning and urban design.

Urban Transportation

General

ABT Associates. Qualitative Aspects of Urban Personal Travel Demand (a proposal for the U. S. Department of Housing and Urban Development). Washington, D. C.: ABT Associates, Inc., August, 1968.

____________. Transportation Needs of the Handicapped. Report prepared under Contract Number T8-304 for the U. S. Department of Transportation, Office of Economics, August, 1969.

Bendtsen, P. H. Town and Traffic in the Motor Age. Copenhagen: Danish Technical Press, 1961. This book deals with the issue of "environmental capacity" versus "crude capacity" (pp. 50 ff. and 130 ff.).

Buchanan, Colin. et. al. Traffic in Towns. London: Her Majesty's Stationery Office, 1963. This is one of the major reference works in the field of urban transportation.

Canty, Eugene T. Transportation and Urban Scale. (Res. Pub. GMR—843) Warren, Michigan: General Motors Corporation, January, 1969. A factual discussion of the topic is presented.

Committee of Urban Conservation. Freeways and our City. Washington, D. C.: Committee of Urban Conservation, n.d. National Capital Region transportation facts are presented in a concise manner.

Committee for Economic Development. Developing Metropolitan Transportation Policies: A Guide for Local Leadership. New York: Committee for Economic Development, 1965.

"The Cost of Getting to Work." Changing Times, May, 1961. Article describes costs involved in trips to work and suggests means of reducing them.

Highway Research Board. Highway Capacity Manual (Report No. 87). Washington, D. C.: Highway Research Board, National Academy of Science. Traffic flow theory and practical calculations are major considerations of this report. p. 111 deals with at grade intersections.

Labatut, Jean, and Lane, J., eds. Highways in our National Life. Princeton, N. J.: Princeton University Press, 1950. The paper entitled "The influence of Highways and Transportation in the Structure and Growth of Cities and Urban Land Values," by Homer Hoyt is of special significance.

Lisco, T. E. "Mass Transportation: Cinderella of our Cities." The Public Interest, No. 18 (Winter, 1970).

Maki, Fumihiko. "Movement Systems in the City." Connection (Winter, 1965), pp. 6-13. The author presents a simplistic [illegible] of open-ended and closed systems, and suggests several spatial configurations to accommodate the former.

Meyer, John R. "Urban Transportation." The Metropolitan Enigma. Edited by James Q. Wilson. New York: Anchor, 1970. The article presents relevant observations on pedestrian movement.

__________. et. al. "Urban Transport Costs." Transport. Edited by D. Munby. New York: Penguin, 1968. Evaluation of travel nodes for overall transport between home and downtown is presented.

__________.; Kain, J. F.; and Wohl, M. The Urban Transportation Problem. Cambridge, Mass.: Harvard University Press, 1965.

Mitchell, Robert B., and Rapkin, C. Urban Traffic: A Function of Land Use. New York: Columbia University Press, 1954.

Minister of Transport. Cars for Cities. London: Her Majesty's Stationery Office, 1967. Means of restraint of traffic on urban roads is dealt with in this excellent book.

Owen, Wilfred. The Metropolitan Transportation Problem. Garden City, N. Y.: Anchor, 1966. This book offers a good comprehensive treatment of the topic.

Ritter, Paul. Planning for Man and Motor. London: Pergamon, 1964. An excellent treatment of the problems of pedestrian and vehicular circulation is presented. pp. 75-79 presents information on types of roads; pp. 93 ff. deals with public transportation especially buses; pp. 35 covers the subject of road character while p. 36 deals with pedestrian movement and rest.

"Sick Transit." The Humble Way, (First Quarter, 1970), pp. 20-23. An interview with Dr. Richard I. Evans regarding the psychological aspects of transit acceptability.

Tetlow, J., and Goss, A. Homes, Towns and Traffic. New York: Frederick A. Praeger. The book deals mainly with the subject of urban centers.

Urban America, Inc. Center City Transportation Project Workshop Reports. Washington, D. C.: Urban America, Inc., 1969.

Wyum, F. Article dealing with trip status and bus transport. Highway Research Board, No. 97, p. 1 ff.

Washington State University. A Study of the Social Economic and Environmental Impact of Highway Transportation Facilities on Urban Communities. Washington State University, Highway Research Section, Engineering Research Division, 1968.

Jason C. Yu and Wilbert E. Wilhelm, Jr. Transportation Terminal System Optimization. Report prepared under Grant No. GK4742 for the National Science Foundation, December, 1970. Authors develop a method of optimizing a terminal network to provide transport service to urban areas considering cost function and social benefits.

Urban Transportation

Mass Transit

"Bus Reliability." Downtown Idea Exchange, September, 1969, p. 3. Unreliability factors such as lack of schedule dependability, rush-hour slowdowns, and load variations deter people from riding buses.

"Eight Easy Ways to Make Downtown Better." Downtown Idea Exchange, March, 1970, p. 2. Article suggests how downtowns must plan to maximize services in optimum service areas.

George, Patricia Conway, ed. "Mass Transit: Problems and Promise." Minneapolis, 1968. Design Quarterly, Vol. 71. This article includes a good discussion of advanced transit systems.

Kain, A.C. "Omnibus Stopping Places." The Surveyor and Municipal and County Engineer, August 11, 1956. This article deals with stopping places but makes no mention of shelters.

Kain, J.F., and Meyer, J.R. "Transportation and Poverty." The Public Interest, No. 18 (Winter 1970). This article is part of a special issue entitled, "The Future of Urban Transportation.

Petersen, Stephen G. "Walking Distances to Bus Stops." Traffic Engineering, (December, 1968), pp. 28-34. Study to determine how far people will walk from their home to a bus stop considering car ownership and socio-economic status.

Sharp, C.H. "Choice between Cars and Buses on Urban Roads." Journal of Transport Economics and Policy, Vol. 1 (January, 1967), pp. 105-111.

Stanford Research Institute and University of California. Report prepared for AC Transit and U.S. Department of Transportation. Reduction of Robberies and Assaults of Bus Drivers: Demonstration Project Number CAL-MTD-11, December, 1970.

Swift, H.L. "Merchandising a Bus Service." Traffic Quarterly, January, 1955.

Washington Metropolitan Area Transit Commission. Report prepared for the U.S. Department of Transportation. A Report: Transit Information Aids, Mass Transportation Demonstration Project INT-MDT-10, January 1971. Report includes initial survey, design, production, testing, and evaluation information.

Urban Transportation

Future Urban Transportation System

Hanson, Mark E., ed. Project Metran: An Integrated, Evolutionary Transportation System for Urban Areas. Cambridge, Mass.: The MIT Press, Report No. 8, 1966. Presents the findings of a very good student project.

Harr, Charles M.; Cole, L.M.; and Merritt, Harold W. "Tomorrow's Transportation: New Systems for the Future." Ekistics, Vol. 27, No. 159 (February, 1969), pp. 108-123.

Leis, R.D. The Development and Demonstration of a Family of Practical Moving-Way Transport Systems for Pedestrians. Report prepared for the U.S. Department of Housing and Urban Development (Project No. 9-8532).

Richards, Brian. New Movement in Cities. New York: Reinhold Publishing Company, 1966. Innovative systems from the past as well as a survey of new proposed systems and hardware make this small book one of the better introductory works.

Urban Transportation Administration. Tomorrow's Transportation: New Systems for the Urban Future. Washington, D.C.: Urban Transportation Administration, Department of Housing and Urban Development, 1968. This report presents a good, comprehensive treatment in capsule, of urbanization and urban transportation, and deals with the federal role and responsibility in developing a strategy for action through the application of research and development.

Warburton, Ralph, ed. "New Concepts in Urban Transportation Systems." Journal of the Franklin Institute, Vol. 286, No. 5 Along with many fine illustrations, this article offers a good compilation of articles on systems design and component design.

Urban Transportation

Bus Shelters

American City. "Heated Bus-Stop Shelters." (March, 1970). Article includes brief description of Detroit's passenger waiting shelters — especially the infra-red heaters employed experimentally to maintain comfort, retard dampness, and prevent ice formation.

American Transit Association. Special Inquiry into Passenger Shelters at Bus Stops. Washington, D.C.: The American Transit Association, April 9, 1968. This report presents a compilation of pertinent shelter information by 24 municipal and private transit authorities.

Architectural Forum, Vol. 97, No. 1 (July, 1952), presents a poor example of a bus shelter in New Orleans; Freret and Wolf, Architects.

Architect's Journal, Vol. 86 (October 14, 1937), p. 566 and pp. 578-579, includes a photograph and commentary on a new bus shelter recently built by London Transport.

Architectural Record, Vol. 112, No. 2 (August, 1952), p. 14, presents a bus shelter which received an AIA Honor Award in 1952. The shelter, designed by Freret and Wolf, Architects, located at Pontchartrain Beach.

"A Complete System of Street Furniture." Domus, No. 498 (May, 1971), p. 29. This is a brief illustrated note on "Streets Ahead", an exhibition of street furniture in London. Designers are Butler, Isherwood, and Bartlett.

Dudding, John, and Partners. "Bus Shelters for Blidworth and Rainworth." Architect and Building News, Vol. 203 (January, 1953), p. 26.

Grobli, K., et. al. "Bushaltestelle." Werk, Vol. 55 (June, 1968), pp. 364-365. This article presents information on the winner of the German Bus Shelter Competition, which is also published in Casabella, April-June, 1968.

________, et. al. "Elementi per l'arredo Urbano." Casabella, No. 325 (April-June, 1968), pp. 29-31. cf. supra.

New York City Department of Traffic, Bus Shelter Study. New York: The New York City Department of Traffic, September, 1967.

Sanden, E. "Commemorative Bus Shelters." (letter to the editor) Country Life, Vol. 119 (January 5, 1956), p. 25.

Urban Environment

Behavioral Aspects

Axelrod, Morris. "Urban Structure and Social Participation." American Sociological Review, Vol. 21 (February, 1956), pp. 13-18.

Brown, Robert M. The Dynamic Spectrum: Man, Health and Environment. Ann Arbor, Mich.: National Sanitation Foundation, 1966.

Brodey, W.H. "Sound in Space." Journal of the American Institute of Architects, Vol. 42, No. 1 (July, 1964).

Carson, R., and Driver, D. "Environmental Stress." Resource Paper for the American Institute of Planners Conference, 1967.

Case, H.W.; Hubert, S.F.; Mount, G.E.; and Brenner, R. "Effect of a Roadside Structure on the Lateral Placement of Motor Vehicles." Highway Research Board Proceedings, Vol. 32 (1953), pp. 364-376.

Craik, K.H. "The Comprehension of the Everyday Physical Environment." Journal of the American Institute of Planners, January, 1968.

Fuller, R.W., and Putman, P. "The Origin of Order in Behavior." In General Systems, Vol. 11 (1966), pp. 99-115.

Gibson, James. The Perception of the Visual World. Boston: Houghton Mifflin, 1950.

Goffman, Erving. Behavior in Public Places: Notes on the Social Organization of Gatherings. New York: The Free Press of Glencoe, 1963.

Goldfinger, E. "The Sensation of Space, Urbanism and Spatial Order." Architectural Review, No. 41, pp. 129-131.

Hall, E.T. "A System for the Notation of Proxemic Behavior." American Anthropologist, Vol. 65, No. 5, 1963.

Hamilton, J.R., and Thurstone, L.L. Safe Driving: Human Limitations in Automobile Driving. Garden City: Doubleday, Doran and Co., Inc., 1938. Classic study of human psysiological response to changing speeds while driving an automobile.

Heyman, M. "Space and Behavior." Landscape, Vol. 13 (Spring, 1964), pp. 4-10.

Hille, Stanley J., and Martin, Theodore K. "Consumer Preference in Transportation." Highway Research Record, No. 197, 1967, pp. 36-41. Similar references are contained in the Council of Planning Librarians Exchange Bibliography No. 65.

Horowitz, M.H. "Human Spatial Behavior." American Journal of Psychotherapy, Vol. 19, 1965, pp. 20-28.

Karr, S., and Lynch, Kevin. "Where Learning Happens in the Conscience of the City. Daedalus, (Fall, 1968). This article contains a good discussion of perception and learning in the urban public space.

Kates, R.W., and Wohlwill, J.F., eds. "Man's Response to the Physical Environment." Journal of Social Issues, Vol. 22 (October, 1966). This entire issue is devoted to a presentation of recent findings in the application of psychological methodologies to the understanding of behavior in space.

Klein, George Stuart. "The Relation between Motion and Form Activity in Para-Foveal and Peripheral Vision." Archives of Psychology, Vol. 39 (1942), pp. 5-70.

Luce, R. Duncan. Individual Choice Behavior: A Theoretical Framework. New York: John Wiley and Sons, Inc., 1959.

Lynch, Kevin. "Environmental Adaptability." Journal of the American Institute of Planners, Vol. 24, No. 1 (1958), pp. 16-24.

McHarg, Ian. "Man and His Environment." The Urban Condition. Edited by Leonard J. Duhl.

McMonagle, J. Carl. "Traffic Accidents and Roadside Features." Traffic Research Bulletin, No. 55 (1952), pp. 29-41.

Parr, A.E. "Design for Eye and Mind." Industrial Design, Vol. 16, No. 7 (September, 1969).

_______. "Environmental Design and Psychology." Landscape, Vol. 14, No. 2 (Winter, 1964).

_______. "Lessons of an Urban Childhood." American Montessori Society Bulletin, Vol. 7, No. 4 (1969).

Parr, A.E. "Problems of Reason, Feelings and Habitat." Architecture Association Quarterly, Vol. 1, No. 3 (1969).

________. "Psychological Aspects of Urbanology." Journal of Social Sciences, Vol. 22, No. 4 (1966).

Rausch, W.A. "Highway Accident Rate as Related to Roadside Business Advertising." Highway Research Bulletin 30, (1951), pp. 46-50.

Simeon, D. "Energy and Movement." ATO-ACE Newsletter, Vol. 7 (March, 1971), pp. 1-3.

Skinner, B.F. Science and Human Behavior. New York: The Free Press, 1968. A recent work of the behaviorist branch of psychology dealing with shaping and maintaining operant behavior.

"Some Pedestrian Observations." Time (May 11, 1970), p. 66. Discussion of pedestrian behaviorial patterns based on observations by Michael Wolff and Verena Hirsch.

Sommer, Robert. Personal Space. Englewood Cliffs, N.J.: Prentice-Hall, Inc., 1968. Presents an amplification of the studies of E.T. Hall and deals with the psychology of space, in particular the element of privacy.

Vigier, Francois C. "A Tachistoscopic Study of the Sequential Emergence of Urban Forms." Cambridge. 1962. (Mimeographed) The author applies experimental psychology techniques in order to test the relative importance of architectural elements in the streetscape.

Wohwill, J.F. "The Physical Environment: A Problem for the Psychology of Stimulation." Journal of Social Sciences, Vol. 22, No. 4 (1966). The author describes six dimensions of stimulation; intensity, novelty, complexity, variation, surprise, incongruity.

The Urban Environment

Literary and Artistic Expressions

Literature

Ginsberg, Allen. Howl. A poem written in 1956 depicting addicts dragging themselves through the street.

Hodgson, Ralph. (1871-1962) Stupidity Street. A reference to the closing of shops on the street and the hunger and deprivation which exists therein.

Hugo, Victor. Notre-Dame de Paris. Vol. 1. New York: President Publishing Company. Book two, Chapter IV, entitled "The Inconvenience of Following a Pretty Woman in the Street at Night," and Book III, Chapter II, "A Birds-eye View of Paris," are especially interesting in view of their perspective on urban developments in Paris from the fourteenth through to the nineteenth centuries.

Kaufmann, Walter, ed. Philosophic Classics. Englewood Cliffs, N.J.: Prentice-Hall, Inc., 1961, pp. 14-15. The Iamblichus by Protagorus (fragment 21: R275) is interesting in its instructions to pedestrians to stay away from the highways.

Rouse, W.H.D.; Warrington, Eric H.; and Rouse, P.G., eds. Great Dialogues of Plato. Translated by W.H.D. Rouse. New York: New American Library, 1956, pp. 327-347. Book II of the Republic offers an interesting insight into an intellecturals view of the ideal city.

Zola, Emile. l'Assommoir. Translated by A.H. Townsend. New York: The New American Library, 1962. This book, written in 1877, gives a first hand account of Hausmann's transformation of Paris.

Painting

Brueghel, Pieter. Lent and Fasting, 1560. A painting depicting a festival celebration in the Street. Art and Architecture in Europe. Edited by Jan Krofta. London: Batchworth Press, 1960.

Raushenberg, Robert. "Bus Stop." (Combine drawing) Drawings of American Masters. Edited by Bartlett H. Hayes, Jr. New York: Shorewood Publishers, Inc. 1965.

Vallotton, Felix. "A Street Scene in Paris." (Pastel on brown paper) New York: Shorewood Publishers, Inc. 1962. cit. cf. supra.

Shelter References (not complete)

American City, November, 1959, p. 127 and June 1967, p. 138. Articles contain examples of Canopy-type waiting shelters, with benches, located in Beverley Hills, California and Detroit, Michigan.

Engineering, February 1955, p. 219. Examples of the canopy-type waiting shelter (cantilevered steel support and aluminum roof panels) in Birmingham, Great Britain.

Highways and Bridges, September, 1960, p. 18. This article presents shelters constructed of steel (2" X 2" angles) and glass. Several of the units are coupled.

Indiana Concrete Journal, January, 1950, p. 28. Presents information on a canopy-type waiting shelter constructed out of cantilevered precast concrete.

Passenger Transport, December, 1967. Semi-open, compartmentalized waiting shelters with aluminum supports and fiberglass side panels and roof, including infrared heaters and lighting an illustrater.

Transport World, May, 1969. This article presents information on canopy type waiting shelters which are cantilevered. There are three variations in use including: all concrete; aluminum and plastic; aluminum and glass.