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GENERAL PLANNING CONSULTANT:

TECHNICAL MEMORANDUM 3.4.3

ANALYSIS OF WALK ACCESS IN CURRENT SCRTD TRANSIT NETWORKS

Prepared for:

Southern California Rapid Transit District

Prepared by:

Schimpeler-Corradino Associates

in association with
Barton-Aschman Associates
Cordoba Corporation
Deloitte, Haskins & Sells
Myra L. Frank & Associates
Robert J. Harmon & Associates
Manuel Padron
The Planning Group, Inc.

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1. DESCRIPTION OF THE ISSUES

In a memorandum dated December 7, 1984, UMTA staff outlined a problem that they perceive with the procedures used by SCRTD with respect to walk access to the transit network. The problem is described in the memo as follows:

> "SCRTD has proposed a coordinate based procedure for representing access to transit. This procedure represents walk access as the average distance of all links in a traffic analysis zone computed on the basis of zone centroid and bus transfer point coordinates. We believe this procedure may produce an unreasonably low estimate of average walk distances to Metro Rail stations and thus, the overestimated patronage for the Metro Rail alternatives."

UMTA then requested SCRTD to undertake an analysis aimed at determining the seriousness of the effect of this walk access issue. Specifically, UMTA requested:

> "...SCRTD's staff and consultants to undertake a sensitivity analysis of an alternative approach to representing Metro Rail station access. The recommended approach is to account for the actual distribution of trip-ends in a given zone with respect to Metro Rail station location. Rather than recode the networks for each of the TSM and Metro Rail alternatives, (UMTA) propose(s) an analysis of a sample of the zones most likely to be affected by a change in the access procedures to determine its impact. The benefit of this sensitivity analysis is to establish a reasonable range of error in the patronage forecasts with respect to mode of arrival."

This Technical Memorandum reports on the results of analyses aimed at satisfying UMTA's requests on this matter and determining the range of error likely in the patronage results from any alternative coding of walk access.

2. EXISTING MODEL CALIBRATION AND RESULTS

2.1 MODEL CALIBRATION

The Los Angeles Region is currently using a modal split model for home-based work trips that was developed for SCAG by CSI. In developing this model, the walk access in the transit networks was coded by connecting each zone centroid to all transit routes that are within 0.5 miles of the centroid. A uniform time and distance was coded on all links from a given centroid, representing the average walk to transit for the zone.

Because this method of coding was used in the network on which calibration was performed, observed proportions of trips accessing transit by walk were assigned this average distance and time as the access characteristics for calibration. Thus, the coefficient of out-of-vehicle time is based on these coded times and observed proportions of walk access to transit. If the walk access provides any form of bias with respect to "real" distance and time for walking, this is accounted for in the coefficients of the model.

In addition to the coding of walk access, there is also a market segmentation applied in the modal-split model. The population in each zone is segmented into four categories:

1. Households within walking distance of transit that own no automobiles;

2. Households within walking distance of transit that own one or more automobiles:

3. Households not within walking distance of transit that own no automobiles; and

4. Households not within walking distance of transit that own one or more automobiles.

Thus, in large zones, where a proportion of households will not be within walking distance of transit, that proportion will be segmented so that a choice of walk to transit is not available.

Again, it must be stressed that this is the basis on which calibration was performed, so that the existing model coefficients and constants are based on replicating observed shares of alternative modes against characteristics and available choices derived from these assumptions of segmentation.

Two calibration issues emerge as being of prime importance:

1. The existing modal-split model, built for SCAG by Cambridge Systematics Inc. in 1982, is based on average walk access from the zone centroid, with market segmentation on auto ownership and walk access to transit.

2. Calibration of the regional model was accomplished using these assumptions of walk access with observed mode shares for transit

and auto, but with transit provided by bus (local and express) only.

Any significant change to the walk access coding or to the market segmentation by auto ownership and walk access require both regional acceptance (through SCAG), and recalibration of the modal-split models.

2.2 MODEL RESULTS

First, it is appropriate to consider the order of magnitude of walk-access trips to rail produced in the current modeling efforts. As reported in the FEIS, (Page 2-60, Table 2-3), the total number of walk-access trips to the rail for the full 18.6-mile Locally-Preferred Alternative is 131,353 out of the total 364,137 rail trips forecast. This total represents 36.1 percent of rail trips. Of these, 46,285 or 35 percent of all walk-access trips, board at one of the four CBD stations. A further 35,492 board at the Alvarado and Vermont stations. The remaining 12 stations account for the balance of 49,576 walk-access trips.

Consider a highly implausible worst case in which the existing modeling procedure overestimates walk access trips by 50 percent, with none of those trips being likely to use rail if bus access were required. In such a case, the maximum reduction in walk-access trips would be about 65,000 trips, resulting in a rail ridership of 300,000. An error of this order of magnitude is highly improbable, leading to the conclusion that errors of overestimation in walk-access trips, if they exist, are unlikely to affect rail ridership estimates to any significant degree.

A detailed analysis of several stations reveals the data shown in Table 2-1. Several important conclusions can be drawn from this. First, only one of the stations -- Universal City -- has a walk connector as long as 0.5 miles. Most stations are typically of the nature shown by Crenshaw and Cahuenga, with four or five walk-access connectors, ranging between 0.1 and 0.4 miles in length. Second, the largest trip volumes, generally, occur on the shorter walk-access links. In the case of Universal City station, the decline in volume for the longest links is quite dramatic. In the case of the Cahuenga station, there is a fairly large volume of trips from the two zones at 0.4 miles, but this is the only case in which a large volume is found beyond 0.3 miles.

Because of the small size of most zones in the rail corridor (these zones having been split into multiple zones prior to any simulations of rail patronage for the FEIS and subsequent analyses), it is unlikely that there will be any long walk connectors except in the vicinity of stations between Hollywood/Cahuenga and North Hollywood, for which walk-access volumes are low anyway.

Actual distributions of trip ends in the zones of the Los Angeles region are not documented either for the base year or for the future. Therefore, an analysis of the sensitivity of the walk-access trip volumes by trip-end distribution is not feasible. For this reason, the next section of this document reports on a theoretical sensitivity analysis, the results of which are then applied to the stations detailed in Table 2-1.

TABLE 2-1

WALK ACCESS RESULTS FOR THE LPA SIMULATIONS -- SELECTED STATIONS

HOME-BASED WORK TRIPS

STATION	WALK ACCESS DISTANCE 0.1		0.2		0.3		0.4		0.5	
	No.	Trips	No.	Trips	No.	Trips	No.	Trips	No.	Trips
7th & Flower	6	1204* 8337*	0	- -	0	- -	0	- -	0	- -
Vermont	1	1382 706	2	1383 1966	1	869 32	0	- -	0	- -
Crenshaw	2	501 660	2	1028 1067	0	- -	0	- -	0	- -
Cahuenga	0	- -	3	1399 1870	1	110 118	2	1353 1477	0	- -
Universal City	0	- -	2	337 1912	0	- -	1	109 87	1	108 88

* The first line is productions (home-based work) and the second is attractions (home-based work)

3. A THEORETICAL ANALYSIS OF WALK SENSITIVITY TO TRIP-END DISTRIBUTION

3.1 DESCRIPTION OF THE METHODOLOGY

The purpose of this theoretical analysis is to determine the sensitivity of the walk-access modal split to alternative distributions of trip ends in a zone that is connected to a train station by an access link of 0.5 miles or less. The procedure used to investigate this is to apply an incremental logit model to increments of zonal trip ends from close to the station to the furthest point in the zone. For this purpose, two theoretical zones were constructed, one of which is square, while the other one is rectangular, with the long side twice as long as the short side. Each of these zones is divided into squares, with the square zone consisting of 100 equal-size squares and the rectangular zone of 50 equal-size squares, as shown in Figure 3-1.

For these two zones, it is assumed that the station is either at one corner of the zone (the most common location, given that zone boundaries are usually on arterial streets and stations are at the intersection of arterial streets), or midway along one side of the zone (assumed to be the short side of the rectangular zone). An examination of the zones adjacent to stations along the entire rail line from Union Station to North Hollywood indicates that these two geometric shapes and station locations are by far the most common that actual zones approximate. In the CBD, all but two adjacent zones are rectangular, with the station at a corner, and the other two zones are approximately square, also with the station at the corner. A similar pattern appears along the rest of the line, with the only irregular zone shapes appearing for the Hollywood Bowl station, Universal City, and Crenshaw. For the remaining stations, most zones are rectangular with the station at the corner, but with some square zones and a location that is closer to a midpoint of the side of a zone for Wilshire/Alvarado, Fairfax/Santa Monica, Sunset/La Brea, and North Hollywood.

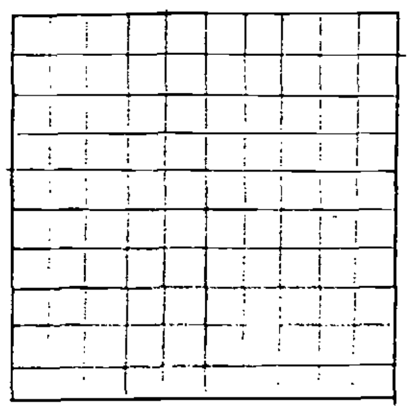
In each case, the walk-access distance is assumed to be the true length of the centroid connector to the station. This will tend to be an overestimate for the case of a station midway along the side of the zone, because the average distance will usually have been determined to the corner of the zone. Otherwise, the assumption is a good approximation to the actual coding in the network. Starting from the station, the 50 or 100 squares in the zone are grouped by increasing distance from the station, into 10 categories. For the two alternative zone shapes and the two alternative station locations, this categorization is shown in Figure 3-2. The access distance for each category is assumed to be the mid-point distance along the connector from the station to the furthest edge of each distance increment. Thus, in Figure 3-1(a), if the centroid distance is 0.5 miles, the first square is assumed to have an access distance of 0.05 miles, the three squares in the next increment are assumed to be 0.15 miles from the station, the 5 in the next increment are assumed to be 0.25 miles from the station, and so forth until the tenth category, containing 19 squares, which is assumed to be 0.95 miles from the station.

To use the incremental logit model, three alternative probabilities are assumed for the walk access mode to rail, based on the range found in the actual data from the LPA simulation. Varying with zone and station, the range of market shares for walk-to-rail was found to be from 0.01 to 0.08, with a majority of zones in the range of 0.05 to 0.075, where walk connectors exist. The three

FIGURE 3-1

SUBDIVISION OF ZONES

a) SQUARE



b) RECTANGULAR

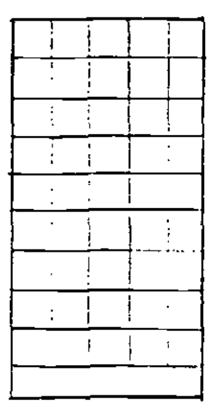
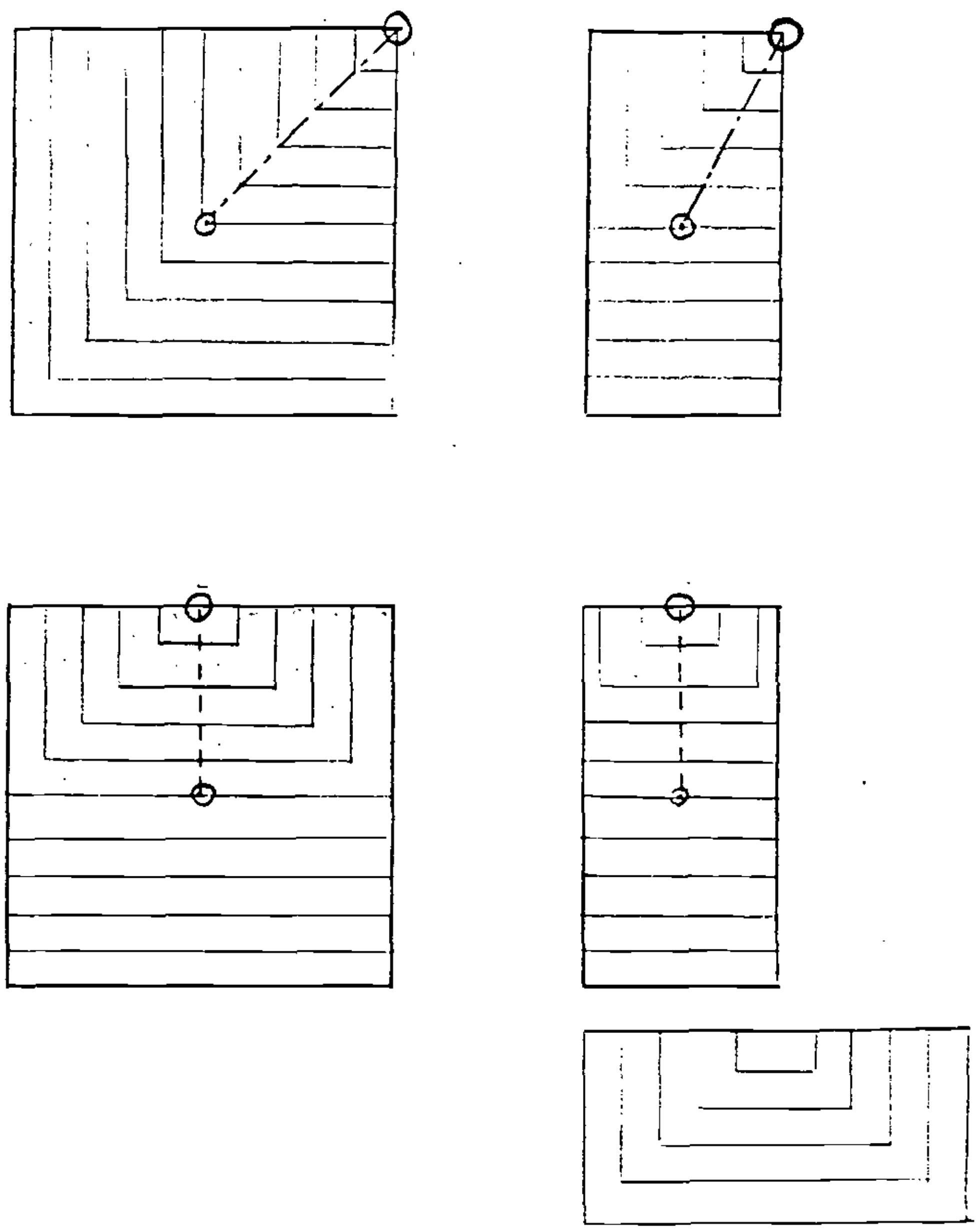


FIGURE 3-2

ZONE SHAPES AND STATION LOCATIONS



probabilities used are, therefore, 0.01, 0.05, and 0.08. Centroid connector distances were assumed to range from 0.1 miles through 0.5 miles.

Finally, to complete the theoretical problem, five alternative distributions were assumed for trip ends in a zone. The first assumption is of a uniform trip-end density over the entire zone. The second and third are of approximately normal distributions, centered on the zone centroid, with significantly different standard deviations assumed, relative to the zone dimensions. The fourth distribution is skewed to a side of the zone that includes the station. The fifth distribution is the same degree of skewness, but to a side of the zone as far away from the station as possible. These distributions are shown in Figures 3-3 through 3-7.

3.2 SUMMARY OF RESULTS

Tables 3-1 and 3-2 summarize the results of applying the incremental logit model to varying zone shapes, station locations, centroid distances, mode shares, and trip-end distributions. Table 3-1 presents the results for a station located at the corner of a zone. The following conclusions can be drawn from this Table:

1. For a <u>square</u> zone and a symmetrical distribution of trip ends (i.e., <u>uniform</u>, normal1 or normal2), the error of using the mean probability for all trips concentrated at the centroid increases with zone size, from a minimum of about 2 percent of the transit share to a maximum of 13 percent of the transit share.

2. For a <u>square</u> zone and a skewed distribution, the error again <u>increases with</u> zone size, and is much larger when the distribution is skewed to the zone side furthest from the station. In this case, the error varies between 6 and 25 percent. When the trip-end distribution is skewed to the side closest to the station, the error ranges between 1 and 3 percent.

3. For a <u>square</u> zone, the errors are always overestimates.

4. For a <u>rectangular</u> zone with a symmetrical distribution, the error <u>is invariant with</u> zone size and ranges between 0 and 1 percent for all cases. It is always an overestimate.

5. For a <u>rectangular</u> zone with a skewed distribution towards the <u>station, the transit</u> share is always underestimated by an amount that increases with zone size from 3 percent to 18 percent.

6. For a <u>rectangular</u> zone with a skewed distribution away from the <u>station, the transit</u> share is always overestimated by an amount that increases with zone size from 5 percent to 20 percent.

Trip End Distributions - Square Zone Normal 1

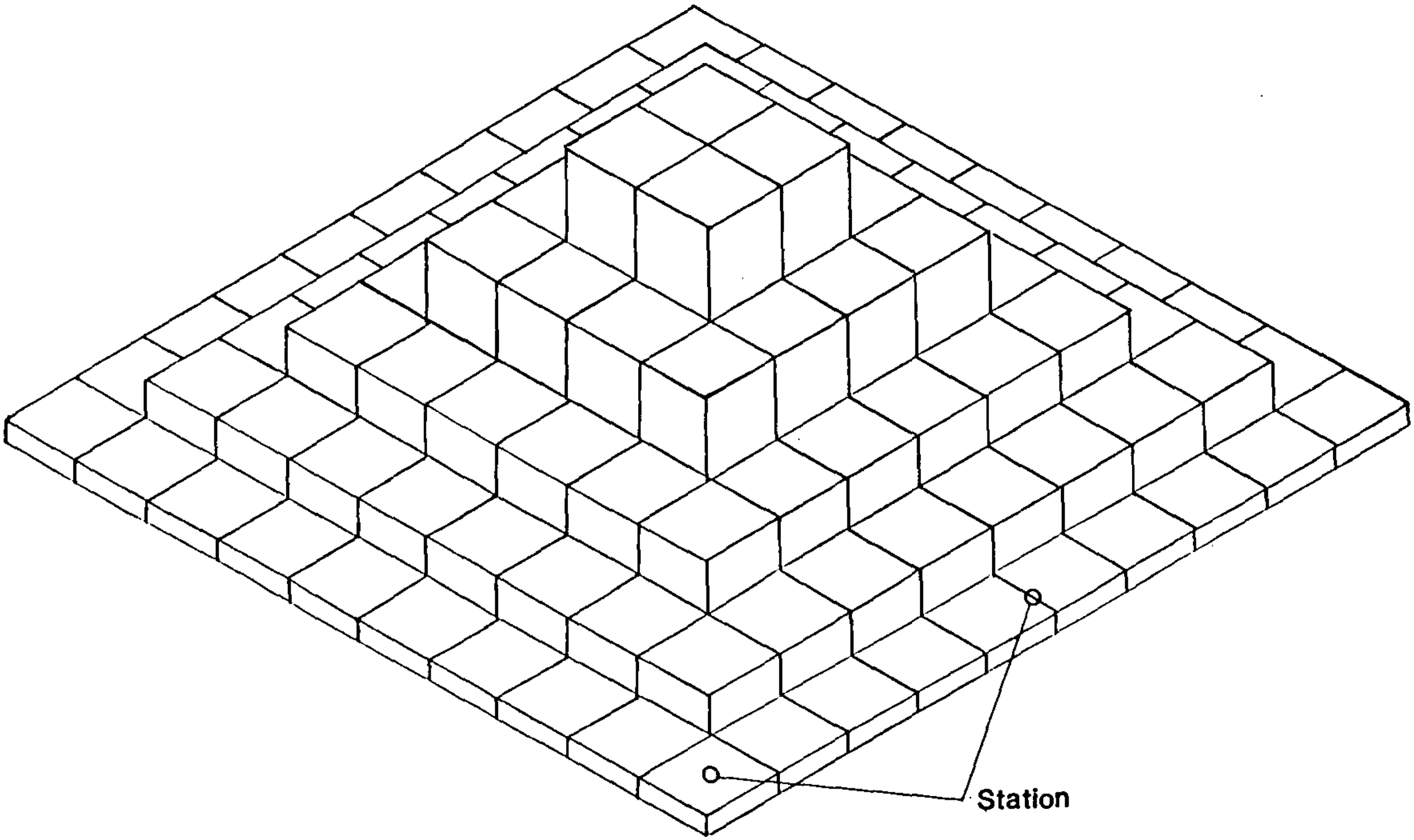


Figure 3-3

Trip End Distribution - Square Zone Normal 2

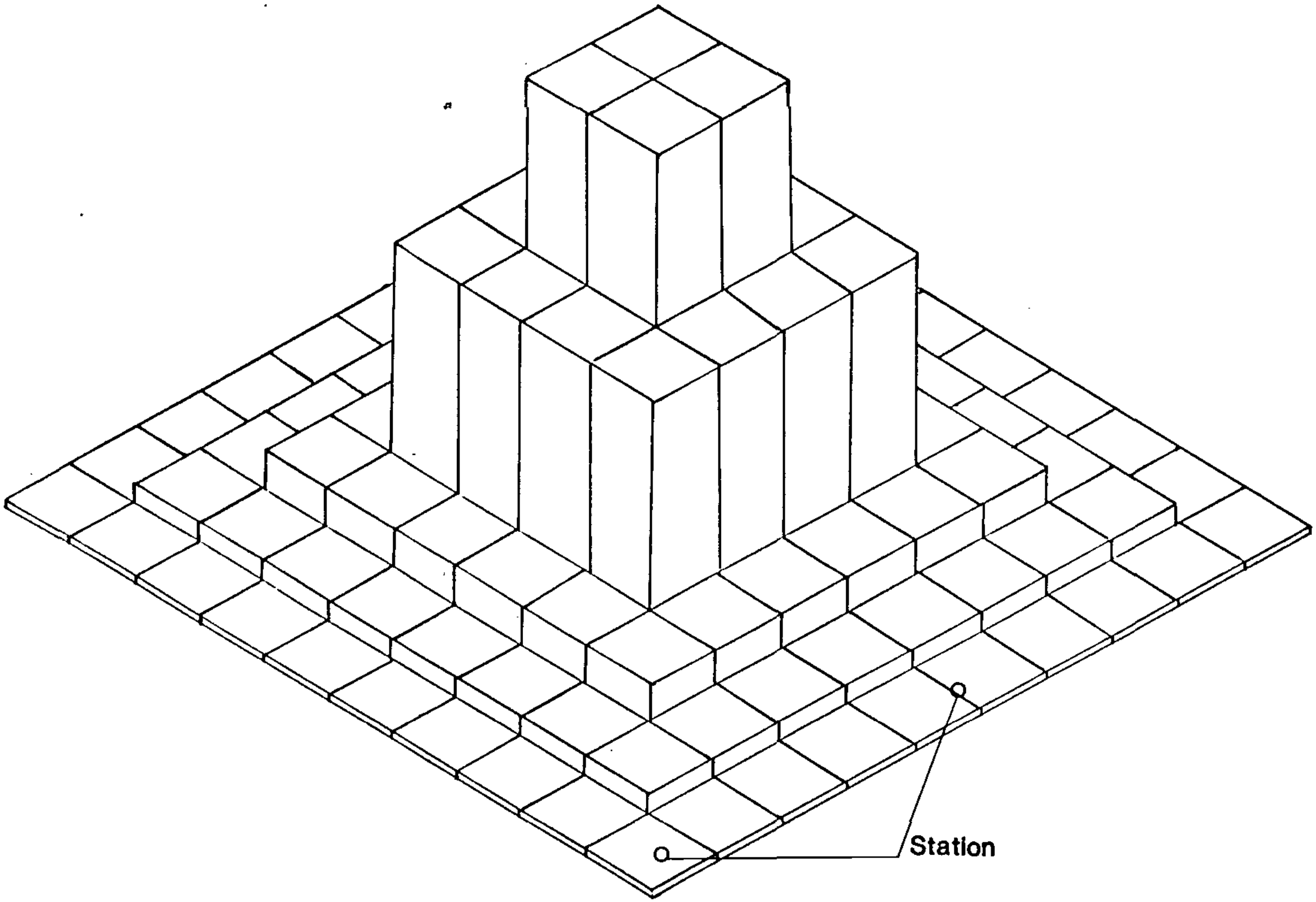


Figure 3-4

Trip End Distribution - Square Zone Skew 1

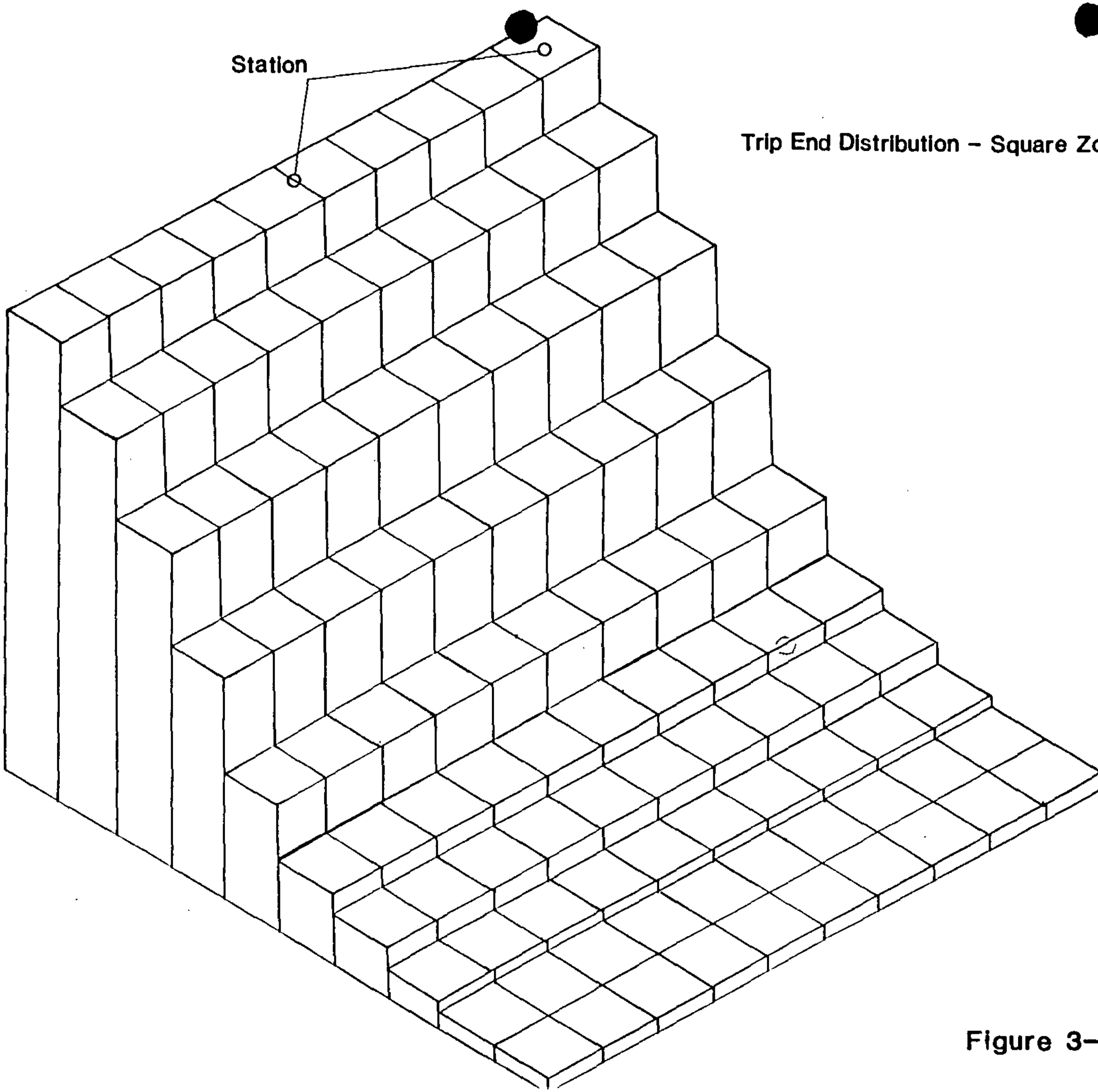


Figure 3-5

Trip End Distribution - Square Zone Skew 2

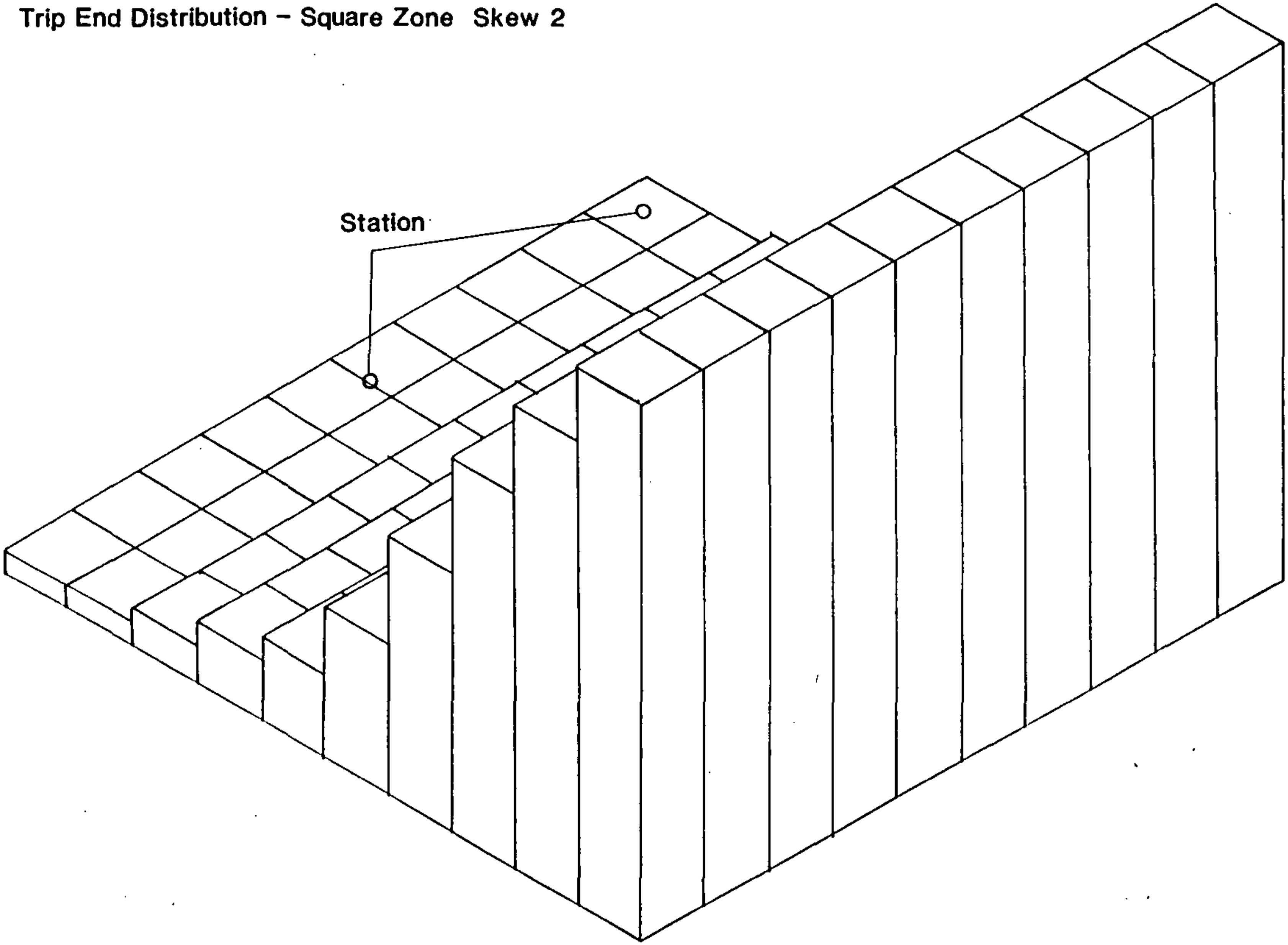


Figure 3-6

Trip End Distribution – Rectangle Zone Normal 1

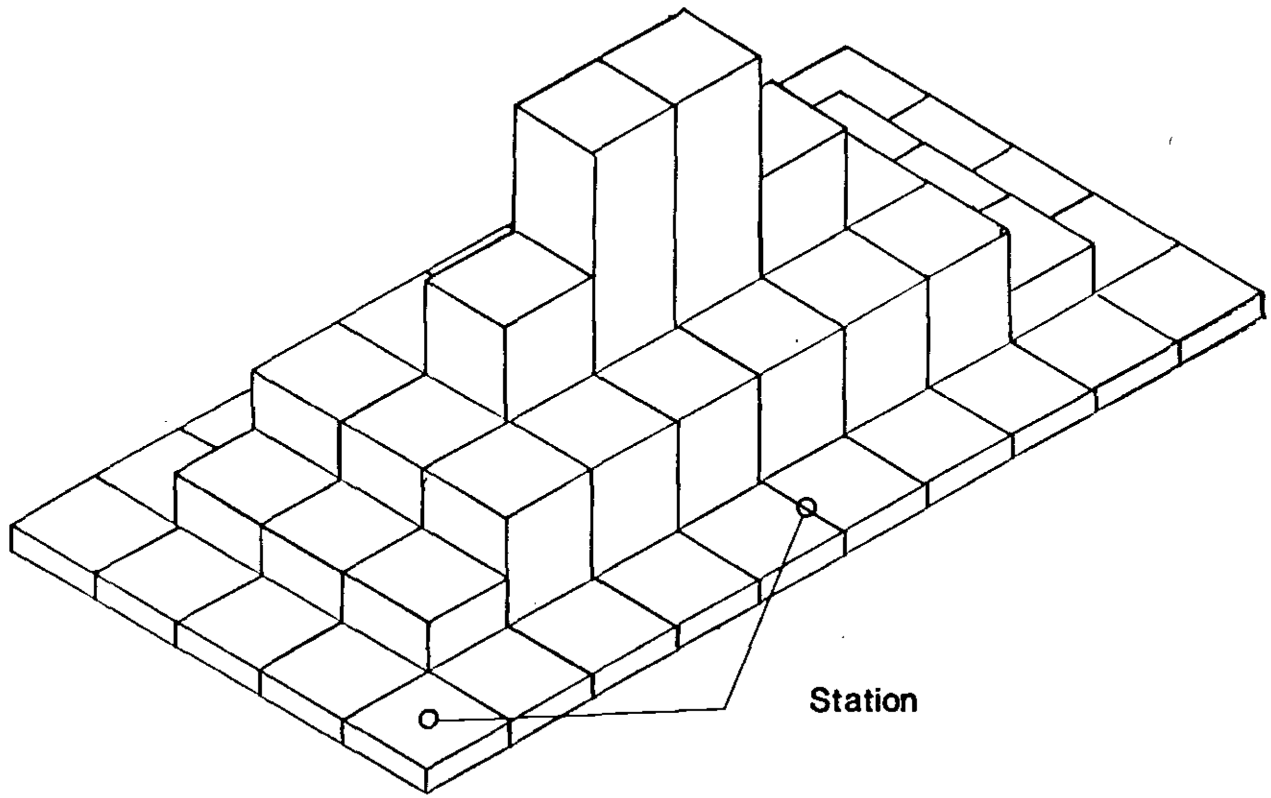


Figure 3–7

Trip End Distribution - Rectangle Normal 2

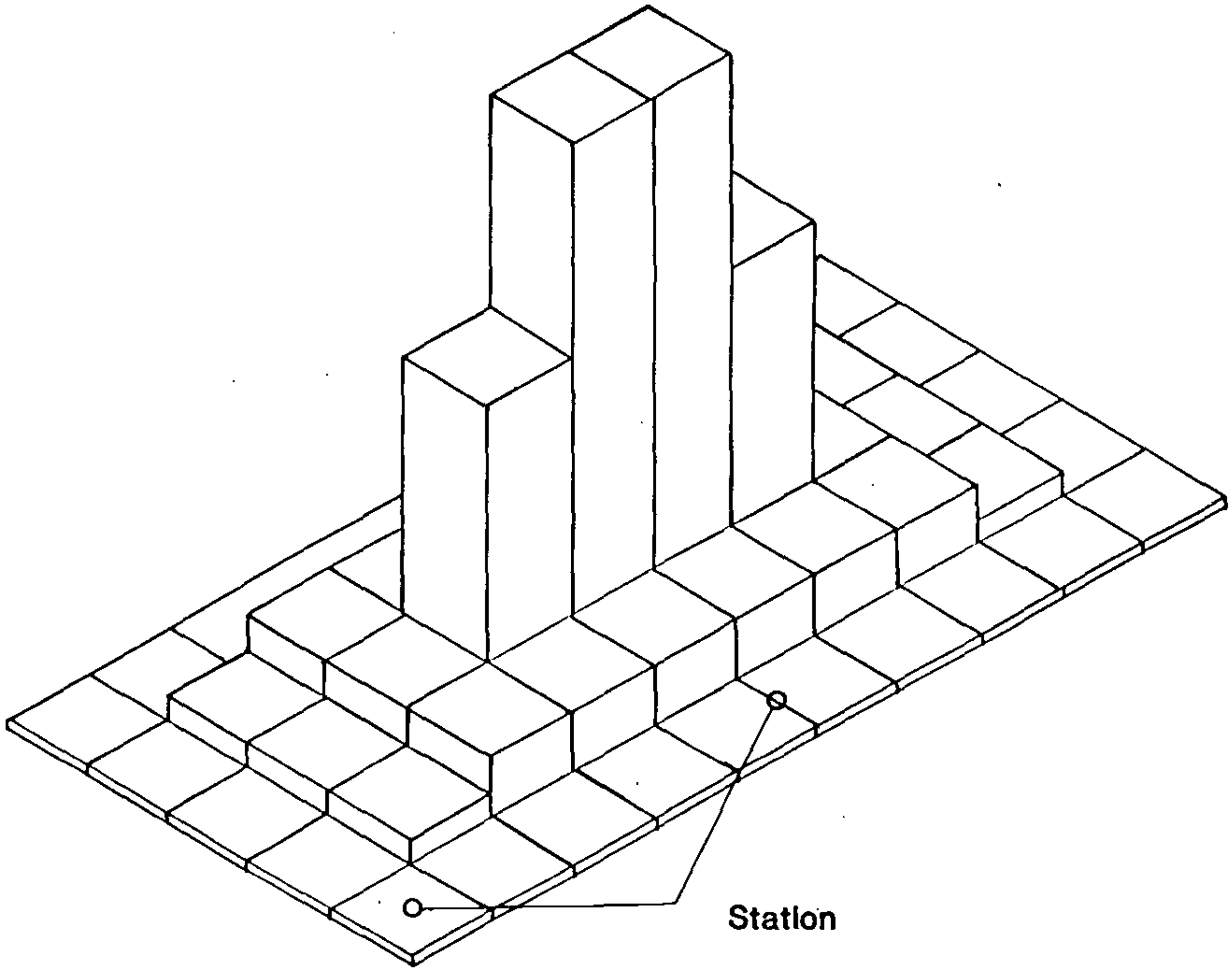


Figure 3-8

Trip End Distribution - Rectangle Skew 1

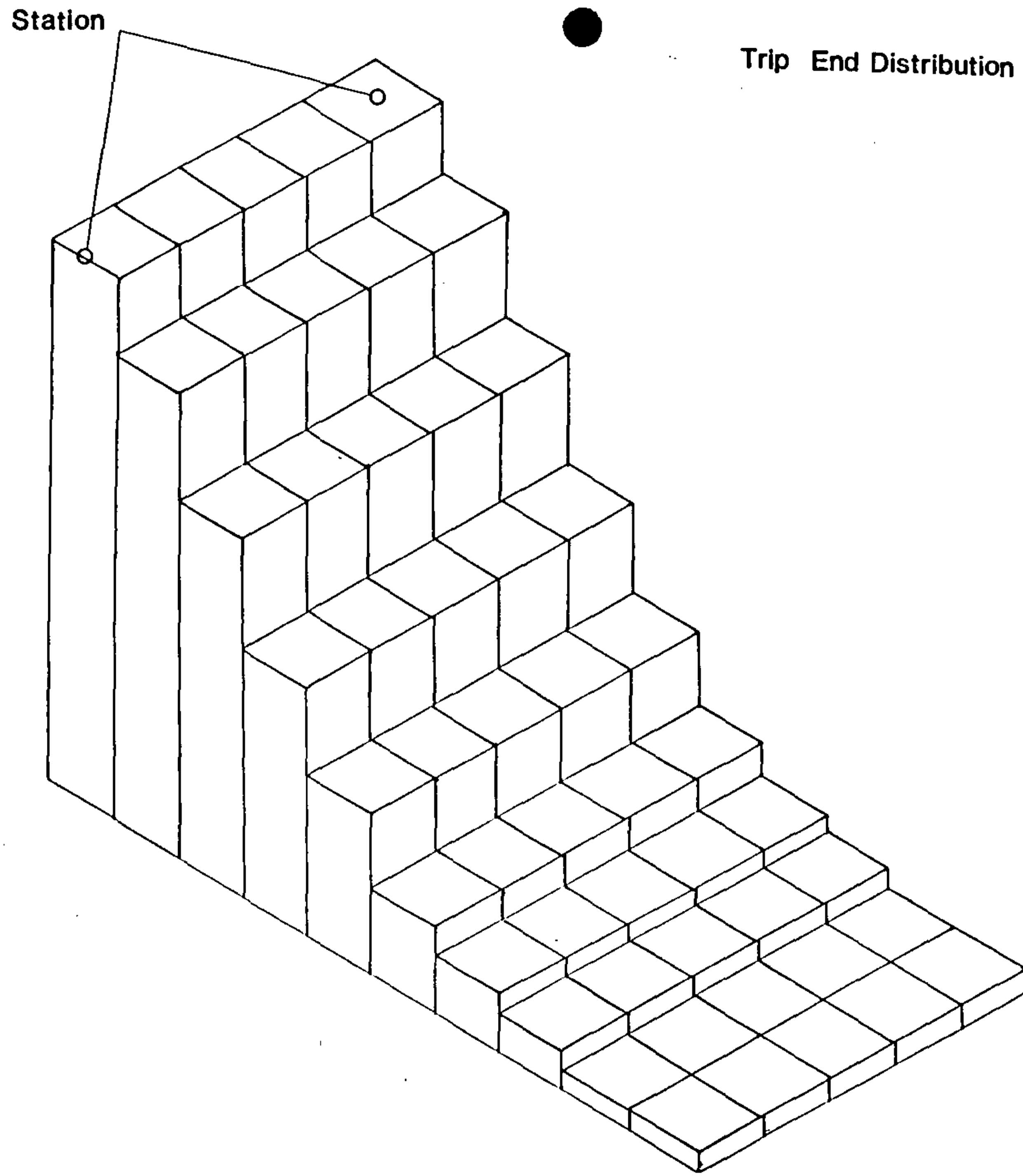


Figure 3-9

Trip End Distribution - Rectangle Skew 2

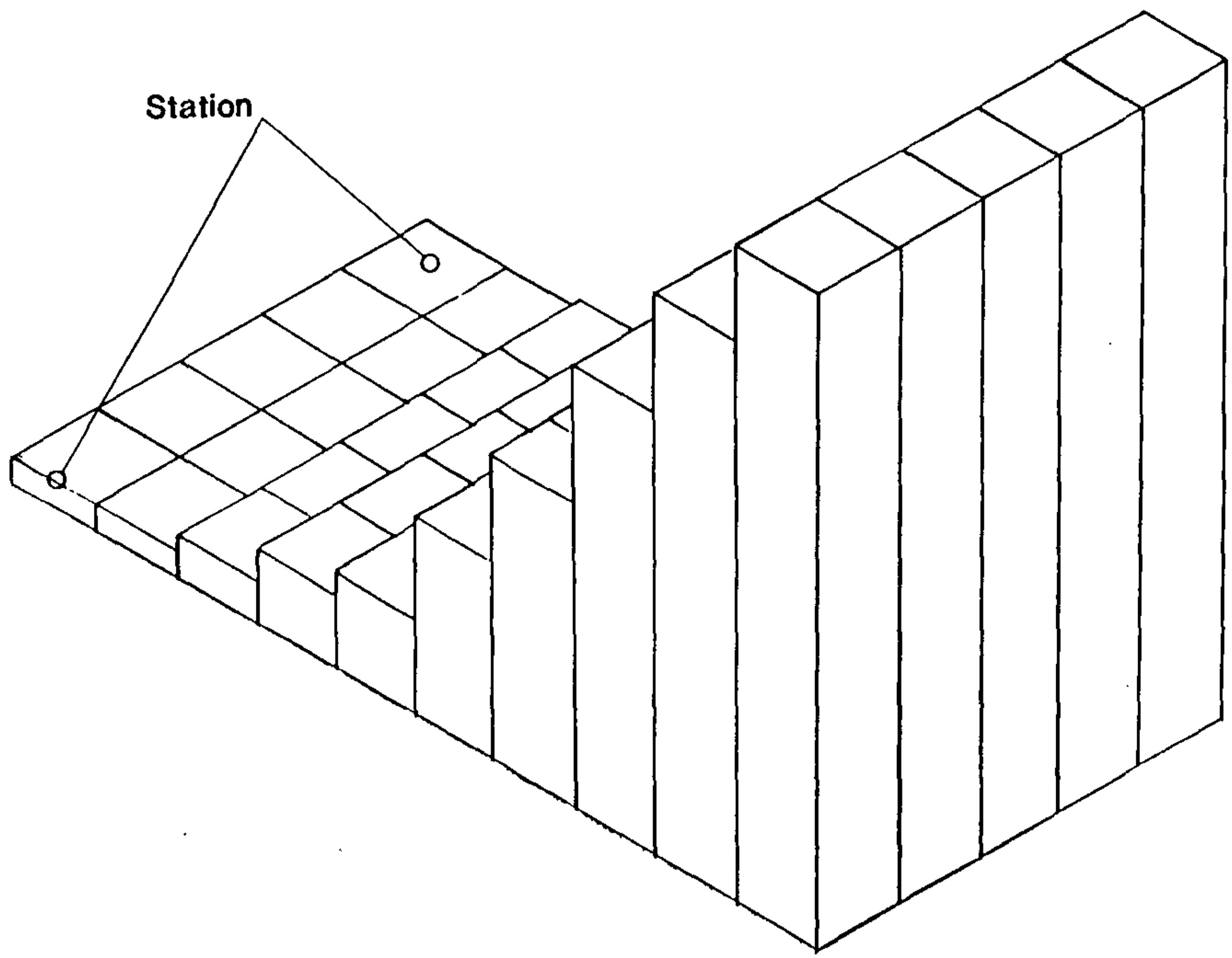


Figure 3-10

TABLE 3-1

SENSITIVITY OF WALK ACCESS TO TRIP-END DISTRIBUTION

STATION LOCATED AT ZONE CORNER

Zone Geometry	Centroid Distance	Ave. Prob.	Distribution				
			Uniform	Normal1	Normal2	Skew1	Skew2
Square	0.1	0.01	.0097(3%)	.0098(2%)	.0098(2%)	.0099(1%)	.0094(6%)
Square	0.1	0.05	.0483(3%)	.0488(2%)	.0491(2%)	.0494(1%)	.0471(6%)
Square	0.1	0.08	.0774(3%)	.0782(2%)	.0785(2%)	.0791(1%)	.0755(6%)
Rectangular	0.1	0.01	.0099(1%)	.0100(0%)	.0100(0%)	.0103(3%)	.0095(5%)
Rectangular	0.1	0.05	.0496(1%)	.0499(0%)	.0499(0%)	.0515(3%)	.0477(5%)
Rectangular	0.1	0.08	.0794(1%)	.0798(0%)	.0799(0%)	.0823(3%)	.0764(5%)
Square	0.2	-	(6%)	(5%)	(4%)	(2%)	(11%)
Rectangular	0.2	-	(1%)	(0%)	(0%)	(7%)	(9%)
Square	0.3	-	(9%)	(7%)	(5%)	(3%)	(16%)
Rectangular	0.3	-	(1%)	(0%)	(0%)	(13%)	(17%)
Square	0.4	-	(11%)	(8%)	(7%)	(3%)	(21%)
Rectangular	0.4	-	(1%)	(0%)	(0%)	(13%)	(17%)
Square	0.5	0.01	.0086(14%)	.0090(10%)	.0092(8%)	.0097(3%)	.0075(25%)
Square	0.5	0.05	.0433(13%)	.0450(10%)	.0459(8%)	.0486(3%)	.0376(25%)
Square	0.5	0.08	.0694(13%)	.0721(10%)	.0736(8%)	.0776(3%)	.0606(24%)
Rectangular	0.5	0.01	.0099(1%)	.0100(0%)	.0101(1%)	.0118(18%)	.0080(20%)
Rectangular	0.5	0.05	.0495(1%)	.0501(0%)	.0502(0%)	.0587(17%)	.0400(20%)
Rectangular	0.5	0.08	.0790(1%)	.0800(0%)	.0803(0%)	.0933(17%)	.0644(20%)

TABLE 3-2

SENSITIVITY OF WALK ACCESS TO TRIP-END DISTRIBUTION

STATION LOCATED AT MIDWAY ALONG ZONE SIDE

Zone Geometry	Centroid Distance	Ave. Prob.	Distribution				
			Uniform	Normal1	Normal2	Skew1	Skew2
Square	0.1	0.01	.0099(1%)	.0100(0%)	.0098(2%)	.0103(3%)	.0095(5%)
Square	0.1	0.05	.0496(1%)	.0499(0%)	.0491(2%)	.0515(3%)	.0477(5%)
Square	0.1	0.08	.0794(1%)	.0798(0%)	.0786(2%)	.0823(3%)	.0764(5%)
Rectangular	0.1	0.01	.0100(0%)	.0100(0%)	.0100(0%)	.0105(5%)	.0095(5%)
Rectangular	0.1	0.05	.0500(0%)	.0500(0%)	.0500(0%)	.0522(4%)	.0477(5%)
Rectangular	0.1	0.08	.0800(0%)	.0800(0%)	.0800(0%)	.0834(4%)	.0765(5%)
Square	0.2	-	(1%)	(0%)	(4%)	(6%)	(9%)
Rectangular	0.2	-	(0%)	(0%)	(0%)	(9%)	(9%)
Square	0.3	-	(1%)	(0%)	(5%)	(10%)	(13%)
Rectangular	0.3	-	(1%)	(1%)	(0%)	(14%)	(12%)
Square	0.4	-	(1%)	(0%)	(7%)	(13%)	(16%)
Rectangular	0.4	-	(2%)	(1%)	(0%)	(20%)	(16%)
Square	0.5	0.01	.0099(1%)	.0101(1%)	.0092(8%)	.0118(18%)	.0080(20%)
Square	0.5	0.05	.0495(1%)	.0503(1%)	.0460(8%)	.0587(17%)	.0400(20%)
Square	0.5	0.08	.0790(1%)	.0803(1%)	.0737(8%)	.0933(17%)	.0644(20%)
Rectangular	0.5	0.01	.0103(3%)	.0102(2%)	.0101(1%)	.0127(27%)	.0080(20%)
Rectangular	0.5	0.05	.0515(3%)	.0511(2%)	.0504(1%)	.0628(26%)	.0404(19%)
Rectangular	0.5	0.08	.0820(3%)	.0815(2%)	.0805(1%)	.0996(25%)	.0649(19%)

Table 3-2 presents the results for a station located on the side of a zone. The following conclusions can be drawn from this Table:

1. For a square zone and a symmetrical distribution of trip ends (i.e., uniform, normal1 or normal2), the error of using the mean probability for all trips concentrated at the centroid is invariant with zone size (except for the normal2 distribution), and is around 1 percent. In the case of the steeper normal distribution, the error varies from 2 percent in a small zone to 8 percent in a large zone. These distributions give rise to the mean probability being an overestimate in all cases.

2. For a square zone and a skewed distribution, the error increases with zone size, and is much larger when the distribution is skewed to the zone side furthest from the station. In this case, the error varies between 5 and 20 percent and shows that the mean is an overestimate. When the trip-end distribution is skewed to the side closest to the station, the error ranges between 3 and 18 percent and is an underestimate.

3. For a rectangular zone with a symmetrical distribution, the error increases with zone size and ranges between 0 and 3 percent with an overestimate in the smallest zones to an underestimate for zones larger than 0.2 miles for the centroid connector.

4. For a rectangular zone with a skewed distribution towards the station, the transit share is always underestimated by an amount that increases with zone size from 5 percent to 27 percent.

5. For a rectangular zone with a skewed distribution away from the station, the transit share is always overestimated by an amount that increases with zone size from 5 percent to 20 percent.

In general, the Tables indicate that only the extreme distributions (skewed) for the larger zone sizes produce errors in excess of 10 percent of the transit market share. Further, if the trip ends in a zone are skewed to the side of the zone nearest to the station, then use of the average walk distance will underestimate the transit share of trips in all cases.

4. EXTENSION OF THE THEORETICAL RESULTS TO ACTUAL ZONES

The implications of the theoretical work in the preceding section are seen most clearly by applying them to the selected stations described in section 2. Accordingly, the zones around those stations have been classified to approximate the theoretical shapes and distributions, and the approximate errors in trips computed. The results of this are shown in Table 4-1.

In all cases in Table 4-1, the worst case has been assumed, whenever there is any question of the appropriate case to apply to a zone. Thus, when a zone is an irregular shape, a square zone is assumed because the errors for a square zone are generally larger than for a rectangular zone. When the station is not on the boundary of a connected zone, it is assumed that the most appropriate locational pattern is represented by the corner station, which has larger errors than the side station. Distributions of trip ends are assumed on the basis of the development patterns of the zones. Generally, CBD zones are approximately uniform, while zones along a major arterial, such as Wilshire Boulevard, have a trip-end distribution that is skewed to the arterial. In only one or two cases are zones assumed to have some other distribution than this.

The five stations analyzed here have 28,103 home-based work, walk-access trips reported in Table 2-1. This represents 21.14 percent of the total walk-access transit trips projected for the Locally-Preferred Alternative. Table 4-1 shows a total error of -314 walk access trips, indicating that the method of using the zone centroid with no distributional information on trip ends and access to the station has resulted in an overestimate of approximately 314 trips, or 1.117 percent of the projected walk-access trips. Applying that error to the total of walk-access trips indicates a potential error of 1,468 walk-access trips, which in turn suggests a maximum overestimate of rail patronage by this figure. In fact, the overestimate is probably less than this, because, under a different access treatment, some of the trips estimated to be walk access from the current coding convention would have occurred as bus access, while the balance probably would not be rail trips. It should also be noted that the method used by SCRTD for walk-access coding underestimated walk-access trips in two cases (Vermont and Crenshaw), overestimated in two cases ((7th & Flower and Hollywood/Cahuenga), and gave a mixed result in one case (Universal City). Therefore, the simple expansion of the results of these five stations is somewhat questionable and the reality mya be of a smaller overestimate of walk-access trips.

TABLE 4-1

APPLICATION OF THE THEORETICAL RESULTS TO SAMPLED STATION ZONES

Station	Zone	Dist.	Approx. Shape	Station Location	Distribution	%Error	Error in Trips Ps	As
7th & Flower	715	0.1	Rect.	Corner	Uniform	-1	-6	-12
	716	0.1	Square	Corner	Uniform	-3	-1	-96
	1563	0.1	Square	Corner	Uniform	-3	-12	-43
	1567	0.1	Rect.	Corner+	Uniform	-1	*	-12
	1568	0.1	Rect.	Corner	Uniform	-1	-1	-13
Station Total							-20	-176
Vermont	394	0.1	Square	Corner	Skewl	-1	-14	-7
	1409	0.3	Rect.	Corner+	Uniform	-1	*	-9
	1410	0.2	Rect.	Corner	Skewl	+7	+34	+63
	1427	0.2	Square	Corner	Skewl	-2	-18	-21
Station Total							+2	+26
Crenshaw	391	0.2	Rect.	Corner	Skewl	+7	+49	+34
	392	0.2	Rect.	Corner	Skewl	+7	+23	+40
	1403	0.1	Rect.	Corner+	Skewl	+3	+7	+10
	1424	0.1	Square	Corner	Skewl	-1	-3	-3
Station Total							+76	+81
Holly-wood/	343	0.3	Irreg.	Corner+	Normall	-2	-2	-2
Cahuenga	352	0.2	Irreg.	Corner+	Uniform	-6	-7	-7
	353	0.2	Square	Corner+	Uniform	-6	-51	-62
	1383	0.4	Irreg.	Corner	Uniform	-9	-91	-50
	1384	0.4	Rect.	Corner	Uniform	-1	-3	-9
	1386	0.2	Rect.	Corner	Uniform	-1	-4	-7
Station Total							-158	-137

* Less than 1 trip
\+ No station on zone boundary -- corner assumed for error calculation

TABLE 4-1 (Cont.)

APPLICATION OF THE THEORETICAL RESULTS TO SAMPLED STATION ZONES

Station	Zone	Dist.	Approx. Shape	Station Location	Distribution	%Error	Error in Trips Ps	Error in Trips As
Universal City	276	0.5	Irreg.	Corner	Skewl	-3	-3	-3
	1364	0.2	Rect.	Side	Skewl	+9	+30	+18
	1365	0.2	Irreg.	Corner	Skewl	-2	0	-34
	1366	0.4	Irreg.	Corner+	Uniform	-14	-14	-12
Station Total							+13	-21

* Less than 1 trip
\+ No station on zone boundary -- corner assumed for error calculation