Bus Sketch Planning

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A sketch-planning technique to quickly and inexpensively evaluate a large number of transit service alternatives is described. The application and results for the Birmingham, Alabama, metropolitan area are presented. The transit system is defined in terms of service type (e.g., express and local) and coverage area rather than typical bus-route-specific data. Travel markets are divided into three broad components: central business district (CBD), non-CBD, and community. For each service type, parameters are established that relate both bus system supply and costs. No modal-split model is used; instead, different capture rates or modal splits are assumed, and the effects on patronage, revenue, and cost are computed. By use of these simple measures, the feasibility of various test situations is evaluated and poorly performing test systems are deleted from further analysis. Since the sketch-planning approach does not rely on a calibrated modal-split model or network coding, it is easy to use and apply. The approach is also readily computerized, which provides a quick and inexpensive analytic planning tool.

The transit planning process is an iterative approach in that alternatives are formulated and evaluated and the results are used to identify additional alternatives that are then subsequently evaluated. After several iterations of this procedure, a preferred plan is identified and recommended for implementation. Because much of the testing phase relies on the use of computerized travel simulation tools, such as the Urban Mass Transportation Administration's Urban Transportation Planning System, the transit planning process is time consuming and requires considerable resources. At the same time, many transit agencies have been charged with the responsibility for exploring a full range of options, and this results in a greatly increased number of alternatives for testing. In large part, this reflects an increased interest in public transportation as a result of energy and environmental concerns. Many public officials want quick answers to the consequences of major shifts in the use of public transit. In essence, these queries represent a series of "what if" questions. For these reasons, there is a need for analytic techniques that can quickly and inexpensively examine a large number of schemes at a less detailed level. The objective of these procedures, which are termed sketch planning, is not to select a single plan but to provide timely information on the feasibility and desirability of a wide range of transit operations. In this way, promising alternatives are quickly and inexpensively identified for closer scrutiny. Alternatives that do not prove workable or desirable during the sketch-planning analysis can then be eliminated from further testing. The use of a two-tier testing process (sketch planning and detailed) provides a cost-effective method for examining a wide range of transit options. Furthermore, this approach permits resources to be concentrated on only those options that are preferred.

This paper presents a sketch-planning procedure called parametric analysis and its application to the testing of various bus options in the Birmingham, Alabama, metropolitan area.

OUTLINE OF THE METHODOLOGY

The analytic technique used in parametric analysis of bus options is similar to the initial steps of the traditional transportation planning process. Socioeconomic and land use data in conjunction with trip generation equations are used to estimate future trip productions and attractions. By use of a gravity model, these point estimates of travel demand are then converted into a matrix of total person trips within the region. Unlike the traditional planning process, the analysis is performed at a larger areal scale than zones (e.g., census tracts). The allocation of demand to the transit system is accomplished by establishing various transit capture rates rather than applying a modal-split model to obtain a single demand estimate. Another major difference of this sketch-planning approach is that the analysis is not network-specific. Thus, transit service is identified in terms of type of service (e.g., local and express bus) or coverage (e.g., present service territory or various options for expansion). The primary reason for this difference is that the objective of the parametric analysis is to test the consequences in terms of patronage, revenue, and costs of different modal-split percentages. This information from the sketch-planning process can then be used to determine feasible dimensions for a future bus plan. Another reason for not specifying bus lines is that route alignment will depend on the highway concepts proposed for testing at a later study stage.

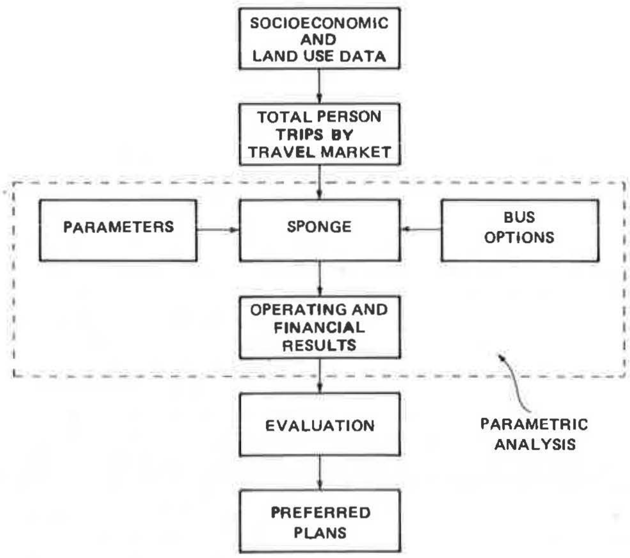
As noted above, the analysis is not network-specific and for this reason no transit assignment is performed. Instead, transit travel (capture rate times total person trips) is divided into three major travel-market components. The broad travel markets used in this analysis are (a) central business district (CBD) travel, which includes trips between the Birmingham core area and the remainder of the region; (b) non-CBD travel, which includes trips whose destinations lie outside the CBD and the community in which they originate; and (c) community travel, which is made up of trips both originating in and destined for the same community.

For each travel market, various bus options are proposed, and a set of parameters is formulated for each bus concept. The evaluation is then performed by using travel-market data and bus performance parameters to determine the patronage, revenue, and cost associated with each test condition.

To facilitate the parametric analysis, a computer program [Sketch Planning of Non-Guideway Electives (SPONGE)] was developed to perform the numerous calculations necessary for sketch planning. The data input includes trip information for each travel market and the parameters specified for each test condition. The output of the program is various key transit statistics, such as miles of service and peak vehicle requirements, as well as financial results and other efficiency measures.

As Figure 1 shows, the sketch-planning approach is not complex in that the input data are rather limited. Travel forecasts readily available from ongoing planning efforts are one key input item. The other two inputs consist of the bus options and the parameters to be used in the analysis. The bus options include the full range of transit services to be evaluated. The bus parameters are specified for each option and include such items as capture rate, vehicle costs, and average fare and unit operating costs. All data items are input to the SPONGE program, which generates the necessary output for evaluation results. Because of the simplicity of the process and the limited data requirements, quick turnaround of numerous test schemes is possible. Furthermore, the parameters can be varied as part of a sensitivity or risk analysis to assess the conse-

Figure 1. Sketch-planning process.



quences of different parameter values.

Travel Markets and Bus Options

As noted previously, the travel market was segmented into three primary markets: CBD, non-CBD, and community. The next step was the identification of the various bus options that could be used to satisfy the travel needs of the region. Seven bus operating strategies, ranging from fixed-route service to demand-responsive systems, were considered in the analysis. The bus options tested in the parametric analysis include the following:

1. Option 1, local bus, represents the continuation of existing bus service in that transit vehicles would operate on surface streets in mixed traffic. Buses would pick up and discharge passengers along their entire route, which would result in relatively low operating speeds.
2. With option 2, arterial express in mixed traffic, the collection and distribution function of the route would be restricted through either skip-stop service (buses only, stopping at every third, fourth, and fifth block) or express zones. The reduced accessibility of the route would produce operating speeds greater than those on local streets. Buses would still be subject to congestion delays.
3. Option 3, arterial express on exclusive lane, would be similar to the previous one in that patron pickups and discharges would be restricted. Buses would operate on an exclusive lane, which would result in less delay and higher operating speeds.
4. With option 4, freeway express in mixed traffic, buses would use a freeway for the line-haul portion of the route. Buses would exhibit the higher operating speeds associated with this roadway type, but vehicles would still be subject to congestion delays.
5. Option 5, freeway express (metered), calls for the operation of buses on a metered freeway on which the flow of traffic is controlled so as to assure a satisfactory volume-capacity ratio and high operating speeds for all vehicles on the highway facility. Ramps would provide for the metering of automobile traffic and priority access of transit vehicles.
6. Option 6, freeway express on exclusive lane, would establish an exclusive lane for buses that would expedite bus movements notwithstanding congestion in the other lanes.
7. The previous bus options are similar to the extent that buses would operate on a fixed-route alignment at an established headway. With option 7, dial-a-ride, buses would operate on a demand-responsive basis similar to taxicab operation. Unlike taxicab service, this bus option would permit group or shared riding.

It is apparent that all bus options are not suited for each of the three travel markets. For example, a dial-a-ride scheme for CBD travel is obviously impractical in view of the small vehicle used and the relatively large patronage potential, and so it was deleted from further consideration. A total of nine mode-market combinations were considered in the parametric analysis. The CBD travel market was analyzed for six different bus options: local bus, two arterial, and three freeway express bus concepts. The non-CBD travel was tested for a single bus plan, local bus. The dispersion of these types of trips would suggest that the various types of express bus service are not suited to this travel market. The community travel component was tested for both local bus and dial-a-ride. Because of the relatively short length of these trips, the various express bus options oriented to line-haul service were deleted from further consideration. Although the stratification of the travel market into three components and the specification of seven bus concepts represent a simplification, the information provided by the nine mode-market test conditions should provide sufficient information for guidance in the formulation of options for further detailed testing.

Parameter Identification

The next step in the analysis is the specification of parameters that influence transit performance. A single set of parameters was established for each bus option on the basis of available empirical data and subjective judgment. The parameters necessary for the bus testing, although substantial, are readily available for quantification. These parameters are listed below:

1. Capture rates of 1, 3, 5, 10, 15, 20, 25, 30, 50, 75, and 100 percent;
2. Annualization factor (equivalent weekdays per year) of 294;
3. Dial-a-ride operating statistics: vehicle miles per trip = -0.04 * trip density + 3.4 (vehicle miles per trip $\geq$ 1.0); speed = -0.25 * trip density + 22.5 (speed $\geq$ 10 miles/h);
4. Local and express bus operating statistics: passengers per mile = A + B * capture rate, where values of A and B are as given below:

Bus Option	A	B
1	1.970	0.065
2	1.379	0.045
3	1.379	0.045
4	0.788	0.026
5	0.788	0.026
6	0.788	0.026

5. Vehicle types and costs as follows:

Bus Option	Vehicle Type	Cost ($)	Life (years)
1	Bus	75 000	12
2	Bus	75 000	12
3	Bus	75 000	12
4	Bus	75 000	12

Bus Option	Vehicle Type	Cost ($)	Life (years)
5	Bus	75 000	12
6	Bus	75 000	12
7	Van	12 500	4

6. Average fare of $0.35, which reflects base, zone, and transfer charges as well as provisions for discount fares (e.g., senior citizen);
7. Interest rate of 8 percent;
8. Miles per peak vehicle = A + B * capture rate, where values of A and B are as given below:

Bus Option	A	B
1	32 700	150
2	33 700	140
3	35 300	124
4	37 600	101
5	39 200	85
6	40 000	77

9. Operating speeds as follows:

Bus Option	Speed (miles/h)
1	13.2
2	14.5
3	16.5
4	19.5
5	21.5
6	22.5

10. Operating cost: (a) local and express bus options = 9.342 * hours + 0.315 * miles + 3459 * peak vehicles; (b) dial-a-ride = 7.210 * hours + 0.230 * miles + 2243 * peak vehicles.

Many of the parameters, such as those for interest rate, annualization factor, and capture rate, have been established at the same value for all bus options. With the exception of the dial-a-ride service, which would rely on small vans, all options would use a conventional bus. The dial-a-ride operating statistics are related to trip density, which in turn is a function of the travel market and capture rate. Both vehicle miles per trip and speed are inversely proportional to trip density. Vehicle hours of operation and peak vehicle requirements are computed by applying the previous parameters to the test condition results.

The operating statistics for local and express bus are related to the assumed capture rate. Passengers per mile for all six fixed-route options is directly proportional to the capture rate, so that higher capture rates reflect increased efficiency. The value for passengers per mile is greater for local bus than for express operations since access to the transit system is possible over the entire route length. Similarly, express bus service on arterial streets exhibits superior performance in terms of passengers per mile than freeway service since access is greater. Obviously, buses that operate on freeways cannot pick up or discharge passengers for much of the route length. Patrons of this service typically ride to the end of the line (e.g., CBD) from their boarding location. In contrast, local bus service has the capacity of "turning over" seats, and the number of riders per mile is considerably greater.

Vehicle use, as measured by miles per peak vehicle, is directly proportional to the capture rate for all bus options. The higher values for express bus service are a function of the operating speed. Vehicles in express service can cover more miles during the service day than those that operate at lower speeds. The operating speeds for each bus option are the average for the entire route length--collection, distribution, and line-haul.

Two separate cost models were computed, one for more conventional bus service and another for the dial-a-ride option. The lower cost for dial-a-ride reflects the reduced unit cost with small vehicles as well as assumed reductions in driver labor rates that would accompany this concept.

SYSTEM EVALUATION

The intent of the nonguideway parametric analysis is not to select a single bus option for the Birmingham region in the year 2000. Instead, the goal at this stage of the analysis is to provide guidance in the formulation of alternatives for use in the detailed testing phase of the study. For this reason, one important consideration is the financial impact of each bus option for varying levels of ridership. Another issue addressed in the parametric analysis is the extent of the transit system in terms of route coverage. One plan would have the year-2000 bus system operating within the existing bus-service territory. Another plan would extend coverage to the entire region in the horizon year 2000. For purposes of simplification, only the results for the latter service area are reported in this paper.

As shown in Figure 2, the parametric analysis was performed for two different service-area plans and nine mode-market combinations and resulted in 18 unique analysis branches. Since the sketch-planning investigation was conducted for 11 assumed capture rates, a total of 198 test conditions were examined. Consistent with previous guideway analysis, all revenues and costs have been projected in 1976 dollars under the assumption of relative economic equilibrium.

Patronage

Patronage for the various bus options was computed by applying various capture rates to the total person-travel statistics. Approximately 2.5 million daily trips will be made within the region in the year 2000. The largest single travel market is non-CBD travel, which is the most difficult to serve by transit efficiently because of the dispersion of travel throughout the metropolitan area. Daily travel statistics are converted to annual patronage and revenue results for the expanded regional service area in Table 1.

Although the consequences of the full spectrum of capture rates are explored in parametric analysis, it would be helpful to identify a reasonable range of capture rates. Since the bus options vary from fixed-route to demand-responsive systems with an accompanying wide variation in speed, the reasonable range of capture rates would be from 1 to 10 percent. The daily patronage would range from 25 000 to 250 000 daily trips when service is provided throughout the entire region at the reasonable range of capture rates.

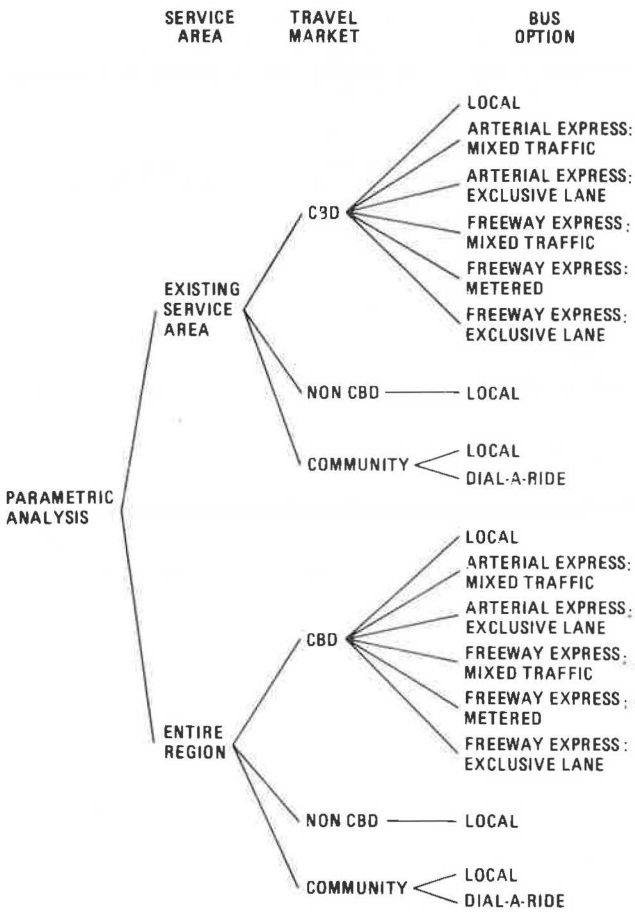
Revenue

Revenue projections for the parametric analysis were prepared for each service coverage option, travel market, and capture rate at a $0.35 fare. Annual revenue in the year 2000 with bus service extended throughout the region would be from $2.58 million at a 1 percent capture rate to $25.78 million when 1 in every 10 trips was made by public transportation.

Costs

Having established the revenue potential of various travel markets, the next step was to develop both capital and operating costs to provide bus service to satisfy this transit demand. Since no right-of-way or structures would be required to implement any of the bus options, the capital costs would only cover the cost of vehicles. As data given in Table 2 show, peak vehicle requirements vary significantly by travel market and bus option. For the CBD travel market, the local bus option would require the least number of vehicles at all capture rates. These results reflect the greater accessibility of the system under the local bus option than under the various express options, which more than offsets the impact of lower operating speeds. The express bus options would require more miles of service to be operated but would provide a higher quality of service because of the limited collection and distribution portion of the route and the higher operating speed. The community travel-market results are attributable to the smaller vehicle that would be operated with the dial-a-ride bus option. For all bus options, the number of vehicles required would increase at a slower pace than ridership because increased vehicle use would occur at higher capture rates.

Figure 2. Test conditions for parametric analysis.



The annualized costs for vehicles under each option and travel market, with the exception of the dial-a-ride option, were computed based on the same vehicle acquisition costs and economic life (see Table 3). For this reason, the relative capital cost of each option is the same as the number of vehicles. The dial-a-ride option at all capture rates would require considerably more vehicles to serve the community travel market than local bus, whereas the annual capital cost differential would be somewhat mitigated because of a less expensive vehicle. At a 10 percent capture rate, the dial-a-ride option would require nearly four times as many vehicles; however, the annual capital costs would only be about one-half greater.

Operating expenditures exceed capital outlays at all capture rates for each travel market and capture rate, which reflects the labor-intensive nature of bus operations. As data given in Table 4 show, the lowest operating cost for the CBD travel market would be obtained with the local bus options. These results are attributable to two countervailing impacts: (a) The bus option, with its greater accessibility, would require fewer miles to be operated to carry the same number of patrons, and (b) bus schemes with higher operating speeds would exhibit lower unit operating costs. The consequences of the first impact are greater than that attributable to speed. For this reason, the freeway express options are more costly than the arterial express schemes, which in turn have higher operating costs than the local service. Within each broad category of bus options (arterial and freeway express), the faster transit plans exhibit lower operating costs. The demand-responsive system, which affords point-to-point service, is substantially more expensive than local bus service in spite of the lower parameters used in the cost model for dial-a-ride.

The total annual costs for both capital and operating expenditures for each test condition are given in Table 5. The CBD travel market can be served at the least cost by local bus at all capture rates; this is consistent with the cost results described previously. The freeway express bus options are the most expensive schemes, and the arterial express option attains an intermediate position. The cost of

Table 1. Annual patronage and revenue by travel market.

Capture Rate (%)	Patronage (000 000s)				Revenue[a] ($000 000s)			
	CBD	Non-CBD	Community	Total	CBD	Non-CBD	Community	Total
1	2.11	4.40	0.86	7.37	0.74	1.54	0.30	2.58
3	6.33	13.19	2.58	22.10	2.22	4.61	0.90	7.73
5	10.55	21.98	4.30	36.83	3.70	7.69	1.50	12.89
10	21.11	43.95	8.60	73.66	7.39	15.38	3.01	25.78
15	31.67	65.93	12.89	110.49	11.08	23.07	4.52	38.67
20	42.23	87.90	17.19	147.32	14.78	30.76	6.02	51.56
25	52.78	109.88	21.49	184.15	18.47	38.46	7.52	64.45
30	63.34	131.85	25.79	220.98	22.17	46.15	9.02	77.34
50	105.56	219.75	42.99	368.30	36.95	76.91	15.04	128.90
75	158.34	329.63	64.47	552.44	55.42	115.37	22.57	193.36
100	211.12	439.50	85.97	736.59	73.89	153.83	30.09	257.81

[a]Based on average fare of $0.35.

providing bus service at each capture rate is generally directly proportional to the quality of service offered. The non-CBD travel market served by the local bus option would require relatively substantial outlays, but the cost would not increase at the same pace as ridership at increasing values of modal split. This is attributable to the higher efficiency and use of transit vehicles with increasing system demand. The community travel market is served at the lowest cost by local bus service at all capture rates. The dial-a-ride option provides door-to-door service and incurs substantially higher costs. In fact, the performance of dial-a-ride costs diminishes with increasing capture rates. For example, the cost of the dial-a-ride system at a 10 percent capture rate is approximately double the total cost for local bus, and at a 100 percent market share the dial-a-ride scheme is about eight times as

Table 2. Peak vehicle requirements by travel market.

	No. of Vehicles								
	CBD								
		Arterial Express		Freeway Express				Community	
Capture Rate (%)	Local	Mixed Traffic	Exclusive Lane	Mixed Traffic	Metered	Exclusive Lane	Non-CBD, Local	Local	Dial-a-Ride
1	32	44	42	69	67	65	66	13	132
3	89	123	118	193	186	182	184	36	185
5	138	192	184	302	291	285	287	56	245
10	236	329	316	522	503	495	491	96	393
15	308	431	415	688	665	654	641	126	548
20	362	508	491	815	790	778	753	148	701
25	403	567	549	915	889	876	839	165	856
30	435	613	595	995	968	955	905	177	1000
50	504	715	701	1186	1164	1153	1048	205	1599
75	527	754	747	1281	1269	1264	1069	215	2309
100	523	753	753	1307	1307	1307	1088	213	3022

Table 3. Annual capital cost by travel market.

	Cost ($000 000s)								
	CBD								
		Arterial Express		Freeway Express				Community	
Capture Rate (%)	Local	Mixed Traffic	Exclusive Lane	Mixed Traffic	Metered	Exclusive Lane	Non-CBD, Local	Local	Dial-a-Ride
1	0.32	0.44	0.42	0.69	0.67	0.65	0.66	0.13	0.50
3	0.89	1.22	1.77	1.92	1.85	1.81	1.83	0.36	0.70
5	1.37	1.91	1.83	3.01	2.90	2.84	2.86	0.56	0.92
10	2.35	3.27	3.14	5.20	5.01	4.93	4.89	0.96	1.48
15	3.07	4.29	4.13	6.85	6.62	6.51	6.38	1.25	2.07
20	3.60	5.06	4.89	8.11	7.86	7.74	7.49	1.47	2.65
25	4.01	5.64	5.46	9.11	8.85	8.72	8.35	1.64	3.23
30	4.33	6.10	5.92	9.90	9.63	9.50	9.01	1.76	3.77
50	5.02	7.12	6.98	11.80	11.58	11.47	10.43	2.04	6.03
75	5.24	7.50	7.43	12.75	12.63	12.58	10.91	2.14	8.71
100	5.20	7.49	7.49	13.01	13.01	13.01	10.83	2.12	11.41

Table 4. Annual operating cost by travel market.

	Cost ($000 000s)								
	CBD								
		Arterial Express		Freeway Express				Community	
Capture Rate (%)	Local	Mixed Traffic	Exclusive Lane	Mixed Traffic	Metered	Exclusive Lane	Non-CBD, Local	Local	Dial-a-Ride
1	1.17	1.57	1.45	2.30	2.18	2.12	2.44	0.48	1.56
3	3.30	4.44	4.09	6.48	6.13	5.97	6.87	1.34	3.73
5	5.18	6.98	6.44	10.18	9.63	9.38	10.79	2.11	5.84
10	9.06	12.21	11.26	17.80	16.84	16.42	18.85	3.69	10.74
15	12.06	16.28	15.02	23.73	22.45	21.89	25.11	4.91	15.46
20	14.46	19.53	18.02	28.45	26.93	26.26	30.10	5.88	20.17
25	16.41	22.18	20.47	32.31	30.58	29.83	34.16	6.69	24.82
30	18.03	24.38	22.51	35.52	33.62	32.80	37.53	7.34	29.36
50	22.42	30.38	28.06	44.25	41.92	40.90	46.68	9.13	47.11
75	25.48	34.56	31.93	50.35	47.73	46.60	53.04	10.38	68.37
100	27.30	37.05	34.25	54.00	51.23	50.02	56.83	11.12	89.77

Table 5. Total annual cost by travel market.

		Cost ($000 000s)								
		CBD								
			Arterial Express		Freeway Express				Community	
Capture Rate (%)	Cost Category	Local	Mixed Traffic	Exclusive Lane	Mixed Traffic	Metered	Exclusive Lane	Non-CBD, Local	Local	Dial-a-Ride
1	Capital	0.32	0.44	0.42	0.69	0.67	0.65	0.66	0.13	0.50
	Operating	1.17	1.57	1.45	2.30	2.18	2.12	2.14	0.48	1.56
	Total	1.49	2.01	1.87	2.99	2.85	2.77	3.10	0.61	2.06
3	Capital	0.89	1.22	1.17	1.92	1.85	1.81	1.83	0.36	0.70
	Operating	3.30	4.44	4.09	6.48	6.13	5.97	6.87	1.34	3.73
	Total	4.19	5.66	5.26	8.40	7.98	7.78	8.70	1.70	4.43
5	Capital	1.37	1.91	1.83	3.01	2.90	2.84	2.86	0.56	0.92
	Operating	5.18	6.98	6.44	10.18	9.63	9.38	10.79	2.11	5.84
	Total	6.55	8.89	8.27	13.19	12.53	12.22	13.65	2.67	6.76
10	Capital	2.35	3.27	3.14	5.20	5.01	4.93	4.89	0.96	1.48
	Operating	9.06	12.21	11.26	17.80	16.84	16.42	18.85	3.69	10.74
	Total	11.41	15.48	14.40	23.00	21.85	21.35	23.74	4.65	12.22
15	Capital	3.07	4.29	4.13	6.85	6.62	6.51	6.38	1.25	2.07
	Operating	12.06	16.28	15.02	23.73	22.45	21.89	25.11	4.91	15.46
	Total	15.13	20.57	19.15	30.58	29.07	28.40	31.49	6.16	17.53
20	Capital	3.60	5.06	4.89	8.11	7.86	7.74	7.49	1.47	2.65
	Operating	14.46	19.53	18.02	28.45	26.93	26.26	30.10	5.89	20.17
	Total	18.06	24.59	22.91	36.56	34.79	34.00	37.59	7.36	22.82
25	Capital	4.01	5.64	5.46	9.11	8.85	8.72	8.35	1.64	3.23
	Operating	16.41	22.18	20.47	32.31	30.58	29.83	34.16	6.69	24.82
	Total	20.42	27.82	25.93	41.42	39.43	38.55	42.51	8.33	28.05
30	Capital	4.33	6.10	5.92	9.90	9.63	9.50	9.01	1.76	3.77
	Operating	18.03	24.38	22.51	35.52	33.62	32.80	37.53	7.34	29.36
	Total	22.36	30.48	28.43	45.42	43.25	42.30	46.54	9.10	33.12
50	Capital	5.02	7.12	6.98	11.80	11.58	11.47	10.43	2.04	6.03
	Operating	22.42	30.38	28.06	44.25	41.92	40.90	46.68	9.13	47.11
	Total	27.44	37.50	35.04	56.05	53.50	52.37	57.11	11.17	53.14
75	Capital	5.24	7.50	7.43	12.75	12.63	12.58	10.91	2.14	8.71
	Operating	25.48	34.56	31.93	50.35	47.73	46.60	53.04	10.38	68.37
	Total	30.72	42.06	39.36	63.10	60.36	59.18	63.95	12.52	77.08
100	Capital	5.20	7.49	7.49	13.01	13.01	13.01	10.83	2.12	11.41
	Operating	27.30	37.05	34.25	54.00	51.23	50.02	56.83	11.12	89.77
	Total	32.50	44.54	41.74	67.01	64.24	63.03	67.66	13.24	101.18

costly as local bus service. Obviously, small-vehicle transit service is not designed to accommodate relatively large transit volumes.

Subsidy Requirements

Decisions regarding the amount of transit service provided in an area should not be governed strictly by the subsidy required to support such service. However, there are limitations on the funds available to underwrite the cost of public transportation. For this reason, both the operating margin and the total margin for each bus option and travel market were examined. This information will provide necessary information on the system dimensions for further detailed testing.

For the CBD travel market and service operated within the existing coverage area, the local bus option would cover operating expenses from the farebox at about a 20 percent capture rate (see Figure 3). The arterial express options would require subsidy until about a 30-40 percent market share is attained. With the more expensive freeway express services, approximately three of every four CBD trips would have to be made by transit to cover operating expenditures. The non-CBD travel market would require subsidy at all reasonable ranges of modal split (1-10 percent). Similar results are obtained for the local bus option serving community desires. The small-vehicle dial-a-ride system would never attain "break-even" operations (Figure 3).

When total costs including capital outlays are compared with farebox revenue, the subsidy requirements increase substantially. As Figure 4 shows, the market share for break-even operations is higher and the deficits incurred are larger. Some caution should be exercised in reviewing the relative financial performance of each bus option, since the transit patronage potential of each bus concept varies. For example, local bus service for the CBD travel market might only capture a 1 percent market share whereas the most costly metered freeway option could attract 10 percent of all trips.

Results

As noted earlier, the intent of the parameteric analysis was not to delineate specific route alignments and frequencies but rather to provide guidance in system dimensions and which surface bus options warrant further scrutiny. Obviously, future test networks will depend substantially on proposed highway plans and their ability to accommodate traffic. For the CBD travel market, a bus system composed of local service to those areas adjacent to the core area and express service in the outlying areas appears a feasible plan. The exact type of express service will depend on the type of available roadways. The penetration of the bus system beyond the current service area should be limited to those areas where concentrations of development will occur in the year 2000. The substantial increase in the total deficit with expansion of service coverage throughout the region would confirm the need for

Figure 3. Travel-market break-even capture rates: operating margin.

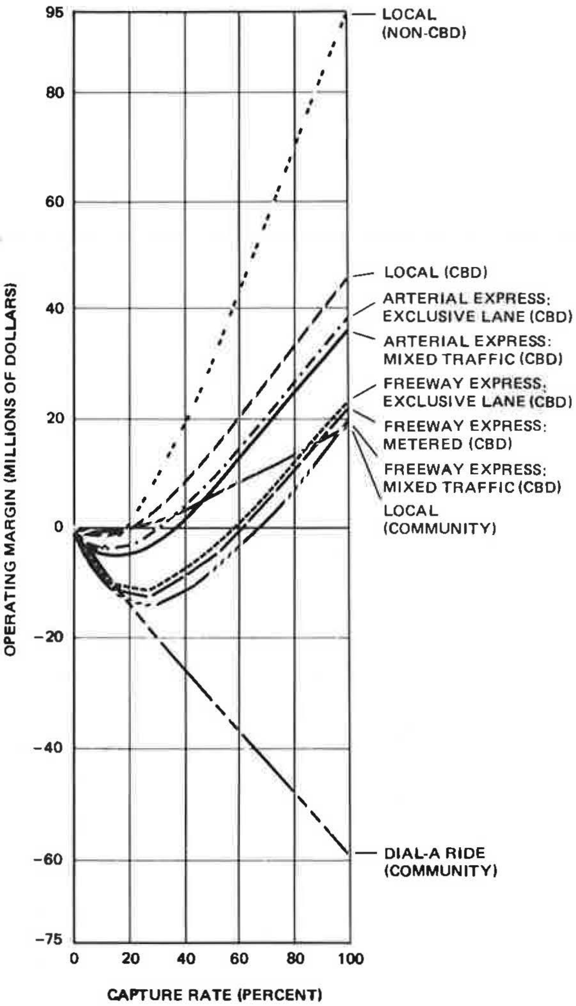
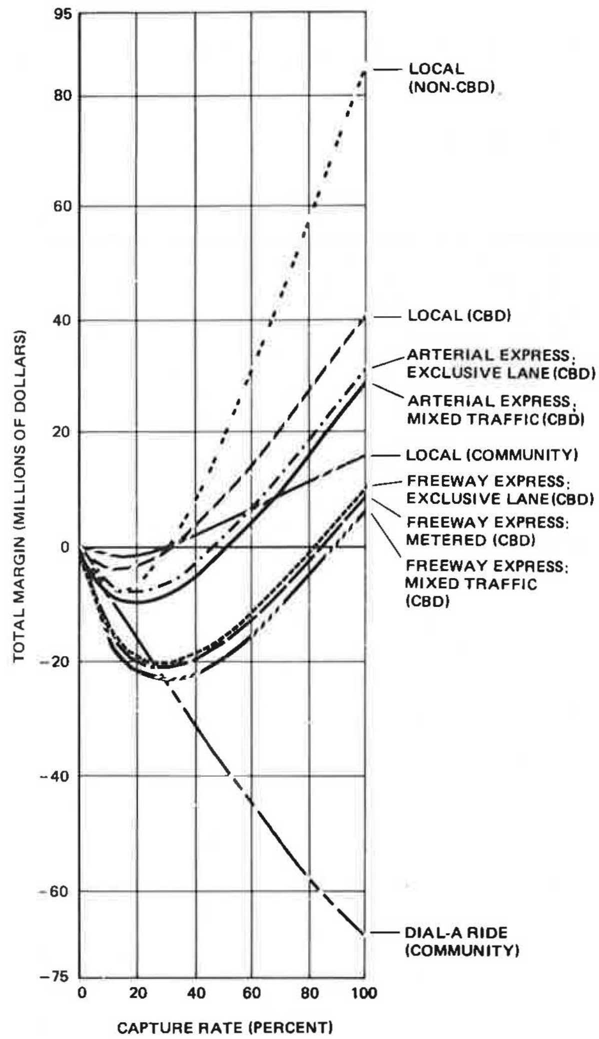


Figure 4. Travel-market break-even capture rates: total margin.



limiting the extent of new service areas. Park-and-ride lots at the periphery of the existing service area might enable some travelers from the more distant portions of the region to use public transportation. The non-CBD travel market can best be served by local bus operations, which ensure the greatest accessibility for the least cost. The dispersion of the travel demand makes it difficult to provide other types of bus service. For this reason, only the local bus option was examined in the parametric analysis. The results of the sketch planning clearly indicate that a dial-a-ride system serving community travel desires is not a financially feasible bus option and should be subjected to detailed testing only if local policies are financially supportive of such service concepts.

CONCLUSIONS

The analysis in Birmingham provides useful guidance in the formulation of preferred bus plans for detailed testing. Although the results represent only a single case, certain conclusions can be drawn about parametric analysis:

1. Because of the need for evaluating a broad range of transit options, the use of a two-tier testing process (sketch planning and detailed) appears appropriate.
2. Since parametric analysis does not rely on a modal-split model but assumes various capture rates, it permits the evaluation of alternatives to proceed concurrently with model calibration.
3. By not requiring network-specific information and relying on broad definitions of service territory and bus service type, transit planning can proceed independently of the highway network analysis.
4. Parametric analysis represents a simple and inexpensive technique for defining the dimensions of feasible bus options for detailed testing.
5. The parametric sketch-planning technique lends itself to sensitivity analysis where the values of parameters can be varied to test their implications on system performance.
6. Because parametric analysis is readily adaptable to computer processing, it represents a simple, quick, and inexpensive transit planning tool.

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