DEMAND BUS FOR A NEW TOWN

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Columbia, Maryland, is a new town under construction in the Baltimore-Washington corridor. More than 10,000 persons now reside in Columbia, and its population is expected to be more than 100,000 by 1982. The acreage assembled for the development is larger than Manhattan Island.

Columbia was planned and is being built with a neighborhood-village-downtown hierarchy. Downtown will provide shopping, office, and other facilities typically located in a downtown. Each of the several villages will comprise a village center with shopping, office, educational, recreational, and religious facilities and several neighborhoods. A village will contain between 10,000 and 15,000 people. Each neighborhood will be the home of 1,500 to 2,000 people. About 25 percent of the land in Columbia will remain as permanent open space. The open space will include parks, bodies of water, pathways, and common areas. The street network consists of freeways, parkways, village loop roads, neighborhood loop roads, and local cul-de-sac streets.

A bus system operating on its own right-of-way was determined to be the most appropriate means of public transportation. Consequently a 50-ft exclusive public transit right-of-way was planned. The location of the right-of-way is being integrated into the land use plan such that 40 percent of the ultimate population will be within a 3-minute walk of the transit right-of-way. Figure 1 shows the location of the transit right-of-way.

Transit service was to be provided by small buses operating on short headways on the separate right-of-way. In general, the transit right-of-way parallels the village roads and crosses the neighborhood loop roads within a few feet of their intersections with the village roads. As more of the right-of-way was set aside, Columbia planners decided to reevaluate the decision on the means of providing transit.

To undertake this study, the Columbia Association (an association of the residents that collects dues in lieu of town taxes) applied to the U. S. Department of Transportation for a grant to operate a demonstration service and to make a technical study. The grant was approved, and the Columbia Association retained the Bendix Corporation to conduct the study and to assist in the demonstration program. Both of these programs included work on demand bus.

The demonstration program has a twofold objective: (a) to determine the optimum method of providing transit in a developing new town and (b) to provide inputs to the design of the ultimate Columbia transit system being developed in the Columbia transit program.

The current failure of public transportation to meet people's needs is well known. One need only observe declining ridership patterns on public transit systems in city after city. As a result of ridership declines, routes are cut and schedules are reduced. An innovative approach is required to remedy such spiraling deterioration in public transit operations.

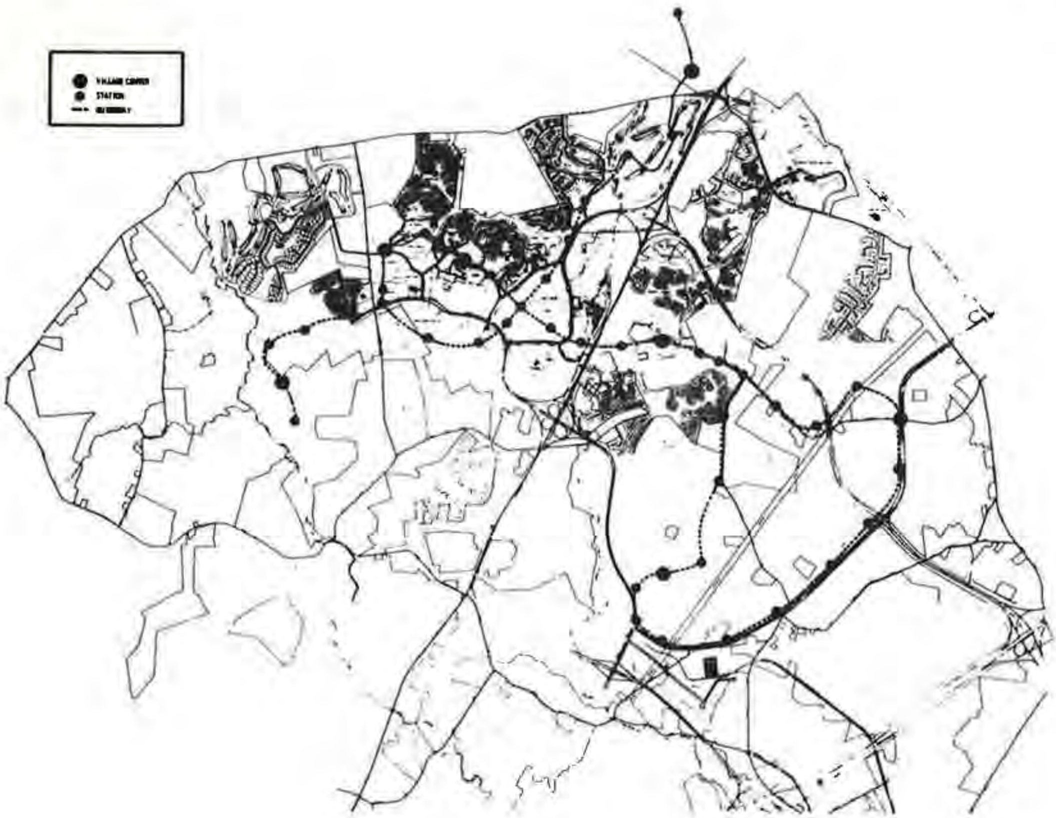

Figure 1. Transit right-of-way.

The failure of public transit to approach the type of service offered by the private automobile is easily identified as its primary fault. Public transit is seldom chosen for its convenience, cleanliness, quiet and smooth ride, or the short walk and wait times at both ends of the trip. The objective of the demonstration program is to provide innovative transit service to minimize these objections.

The approach taken in the demonstration program was to formulate a series of postulates relating to public transit and then to outline a process to verify these postulates. The postulates included statements on fare options, management techniques, and types of service offered. The verification of the postulates is being accomplished by opinion surveys, mathematical analysis, and demonstration experiments.

The postulate relating to demand bus was stated as follows: "People would prefer to have an active role in the transit system, giving them some measure of control over the system response to their specific needs."

Thus, it was decided that 2 types of transit service should be tested in Columbia. The 2 kinds of operation were (a) a fixed route-fixed schedule service and (b) a demand-actuated service. Valid experimental results were obtained and the number of variables was reduced by designing the 2 types of service to provide the same frequency of service, the same hours of service, the same fare, and the same quality of ride by using new, clean, small, air-conditioned vehicles. The only real difference between the 2 services is the method of operating. The main question that requires an answer is whether travel patterns, street network of loops and cul-de-sacs, and neighborhoods of relatively low density in Columbia make it more conducive to scheduled or demand-operated transit or to no transit at all.

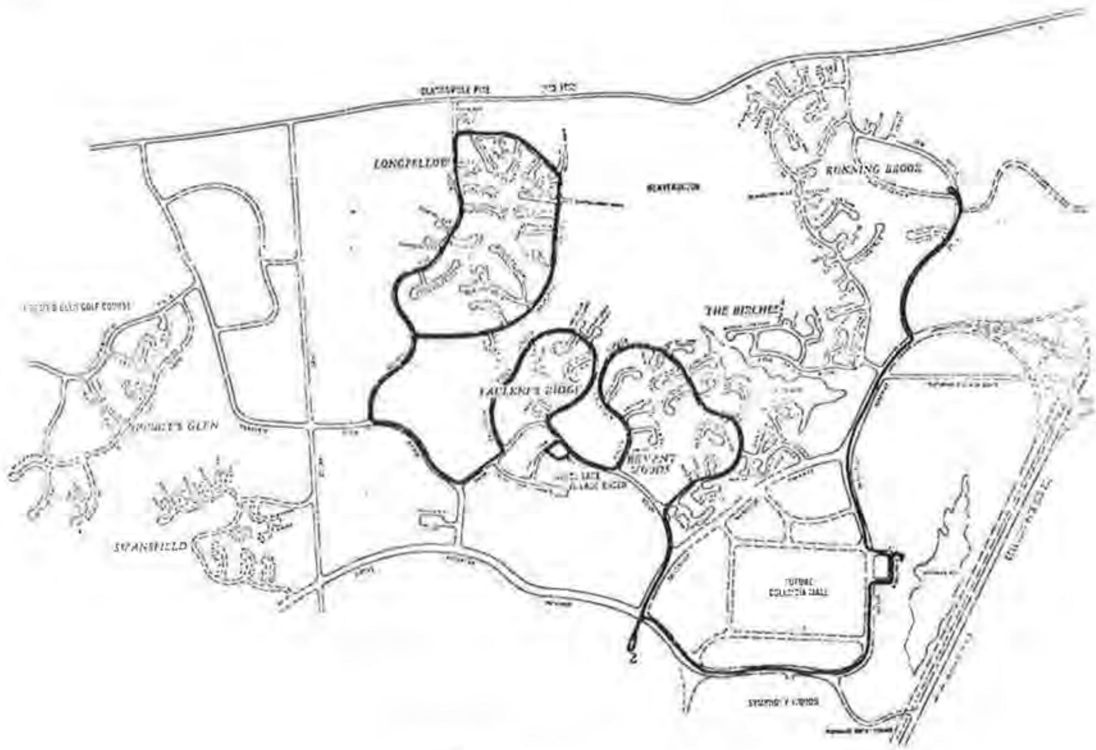

Figure 2. Scheduled bus route.

Scheduled transit service was put into operation on a half-hour headway, later reduced to a one-hour headway, on a route that traverses each neighborhood loop road in Wilde Lake Village as shown in Figure 2. At the same time, work was initiated to develop an operating procedure for demand-actuated service in another village.

The rationale for considering demand bus for Columbia was based on the following demand service characteristics: (a) It only operates when required; (b) it only operates where required; (c) it provides door-to-door service; and (d) it gives people some measure of control over the system response to their specific travel needs.

The procedure used in designing the demand-actuated bus system for Columbia included an examination of the service area, vehicle characteristics, the trip-maker, the service procedure, and the command and control network.

Several desirable service area characteristics were delineated: (a) A low-density area not served well by scheduled service should be selected; (b) trips in the area should be collection or distribution oriented; (c) a single terminal should be the major trip destination; (d) streets and the street pattern should readily accommodate the vehicle; and (e) alternate routes should be available between various points in the area.

The vehicle should be low capacity (about 8 to 16 passengers), easy to handle and suitable for turning around in driveways on cul-de-sac streets, comfortable, and able to accommodate equipment necessary for the demand operation.

Service should be available to all residents, workers, and visitors in the service area on either a one-time or a precommittal basis. The service should accommodate any trip purpose including grocery shopping.

The service procedure is concerned with how service is provided including the method of routing and the hours and frequency of operation. The command and control network requirements were investigated to determine the most economical communication link among the potential user, the driver, and the dispatcher, if any. Communication systems investigated included two-way radio, mobile telephone, teletype, answering service, tape recorder, telephone, and computer.

The resulting demand bus service procedure for Columbia calls for an 8-passenger, club wagon vehicle that would operate to any house or business within the Oakland Mills Village service area shown in Figure 3. The vehicle would be based at the village center and depart hourly on demand, i.e., if there were at least one person to serve. Service between the village center and downtown would be on a scheduled basis. The route is shown in Figure 4. Service requests in the demand bus area would be made via telephone to a dispatcher. The dispatcher would transmit the requests to the driver via telephone at the village center just prior to the vehicle's scheduled departure time. Each residence and business in the service area would be provided an approximate vehicle arrival time at that location. The vehicle would depart the village center when a demand is registered and generally would follow the village road. Service would be provided to the door even on cul-de-sac streets. Driveways would be used to facilitate turning around and, thus, minimize travel time. The guaranteed time of arrival at houses in the first part of the service area would be within a 2-minute time interval. Residences near the end of the service area would have a 9-minute guaranteed service time interval.

Figure 3. Demand bus service area.

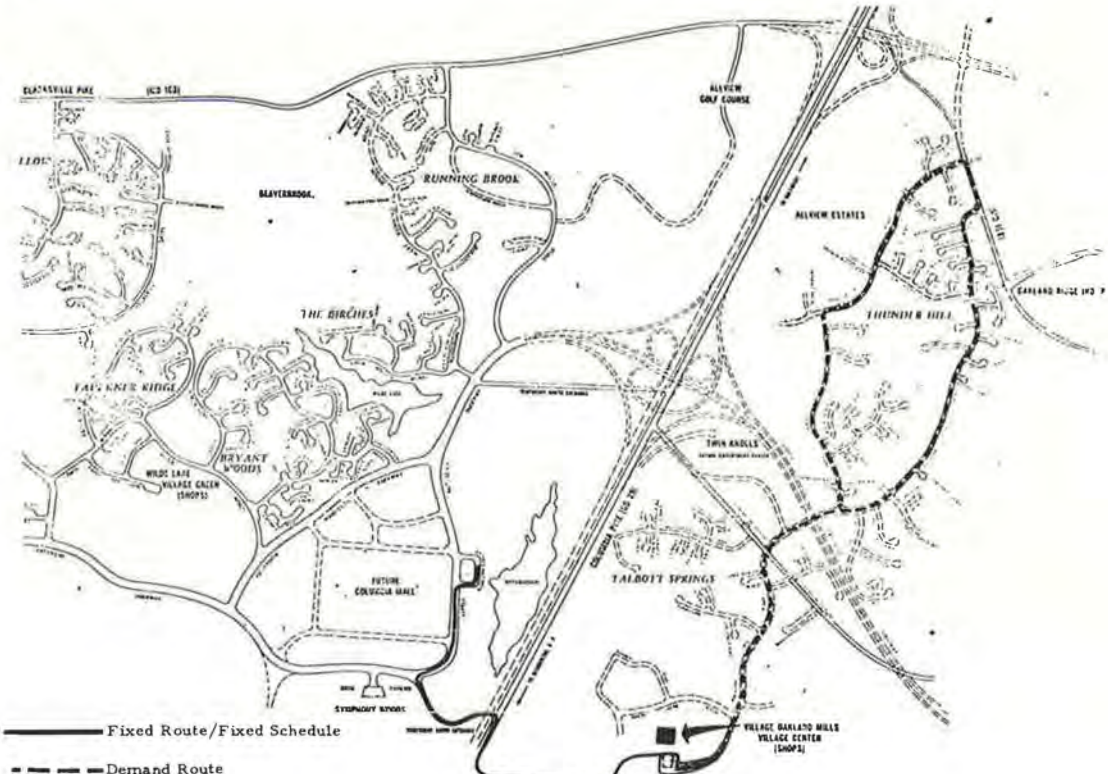

Figure 4. Demand bus route.

This type of demand-bus operation was simulated for Oakland Mills Village in Columbia by simulated vehicle runs and by actual vehicle runs based on randomly selected demands in accordance with the estimated demand level. The results indicated that such a service procedure was feasible.

Implementation of the service is now dependent on approval by the U. S. Department of Transportation of the second phase of the demonstration program. The service will go into operation upon approval. A schedule has been prepared for improving the demand bus operation in the field as experience is gained through actual operation.

After the demand bus has been operated for one year in Oakland Mills Village, the scheduled and demand service areas will be switched. Service will again be provided for a year. The ridership and costs associated with both types of service in the 2 villages will be analyzed, and the best operating method for neighborhood bus service in Columbia will be selected.

One reason for designing this comparison between demand and scheduled bus is to assist in the selection of an operating procedure for the ultimate Columbia transit system. The general characteristics of this system are being developed in the Columbia transit program. The methodology used in this program was to formulate a number of transit system configurations and then to evaluate their suitability for Columbia.

Eight transit configurations were synthesized. They varied from a scheduled bus operation on a street or roadway, to a demand bus on a roadway, to an automatic personal rapid transit system on an exclusive guideway. Each of these was considered (a) alone as a primary system utilizing the right-of-way to service the 40 percent of the residents who will live within walking distance of the right-of-way and (b) together with a scheduled or demand bus feeder system to serve all of Columbia. The system parameters associated with the 8 configurations are given in Table 1. A configuration that would use a paved roadway on the right-of-way is called "roadway," while one that would use an exclusive guideway on the right-of-way is called "guideway."

A demand analysis was made for Columbia to derive total person trips by purpose. Walk trips were then separated. Trips on transit were obtained by using selected system characteristics to perform the modal split. The ridership each configuration would attract was projected by a demand sensitivity analysis, taking into account travel speed, frequency of service, hours of operation, fare, and type of service. As a result of the demand projections, the number and the size of vehicles required for each configuration were developed. Ridership varied from a low of 1,300 per day on a low-frequency, scheduled bus to more than 40,000 on an automatic, personal, demand transit system.

One configuration, Roadway III, is a demand bus operation for all of Columbia. This configuration would use 15-passenger buses. A person would be guaranteed service within 10 minutes of a request for service. A given vehicle would take a person to any point in the same village, downtown, or any point along the route to downtown. Service to other points could require a transfer.

This demand-bus operation would attract more riders than any other bus system and would surpass all but one guideway configuration in projected ridership. Even though it would attract 10 percent more riders than the next best bus system, it would require 60 percent more miles of travel.

Demand bus was also considered for those configurations with feeder operations, namely, Guideways I and III and Roadways I and IV. Guideway I and Roadway I have a comprehensive or short-headway feeder operation, while Guideway III and Roadway IV have a nominal or long-headway feeder operation. Scheduled service and demand service were considered for these operations. At the present time, it appears that demand bus is not suitable for the nominal feeder operation primarily because the long headways and the low number of vehicles make it impossible to guarantee service within a reasonable time interval.

TABLE 1
SUMMARY OF SYSTEM PARAMETERS

Configuration	System	Density of Area Served	Days per Week	Service (hr/day)	Peak-Hour Headway (min)	Average Vehicle Speed (mph)	Number of Vehicles	Vehicle Capacity (seated passengers)	1985 Riders per Day
Guideway I	Primary	High	7	24	2	35	470	6	40,370
	Comp. feeder	Low	7	18	18	15	21	15	11,220
	Total	All Columbia					491		40,370
Guideway II	Primary	High	7	24	2	35	310	6	29,150
Guideway III	Primary	High	7	24	2	35	320	6	30,100
	Nominal feeder	Low	6	12	90	15	10	25	950
	Total	All Columbia					330		30,100
Roadway I	Primary	High	7	24	9	15	19	50	17,870[a]
	Comp. feeder	Low	7	18	18	15	45	15	9,580[a]
	Total	All Columbia					64		27,450
Roadway II	Primary	High	7	24	9	15	19	50	17,870
Roadway III	Demand bus	All Columbia	7	22	10	15	78	15	30,170
Roadway IV	Primary	High	7	24	9	15	19	50	18,620
	Nominal feeder	Low	6	12	90	15	10	25	750
	Total	All Columbia					29		18,620
Roadway V	Nominal single	All Columbia	6	12	90	15	17	25/50	1,360

[a]This is the only case where riders on primary and feeder systems are additive.

The trade-offs made to select the recommended configurations primarily involved the ridership projections and the financial analysis. Some results of the financial analysis are given in Table 2. Roadway IV would require the lowest percentage of capital support, and Guideway III would reach a peak debt at the earliest time. Roadway V is the least-cost configuration, while Roadway III, the Columbia-wide demand bus, is the highest.

Alternate financing assumptions were considered. These resulted in different percentages of capital support being required for the guideway configurations. As a result, 3 configurations were selected: (a) Guideway III with its automatic primary system and nominal, scheduled bus feeder system, (b) Roadway IV with its scheduled bus primary system and nominal feeder system, and (c) Roadway V with its nominal scheduled Columbia-wide bus system. The characteristics of these 3 configurations are given in Table 3.

Demand bus operation did not survive the selection process primarily because (a) on a Columbia-wide basis it required too many miles of operation and too many vehicles and (b) on a feeder basis it could not provide an acceptable service-time interval without requiring a considerable increase in the number of vehicles over a scheduled service.

TABLE 2

SUMMARY OF FINANCIAL ANALYSIS

Configuration	Cost			Annual Revenue and Cost at Full Development		Capital Support Required, Including Land (percent)	Total Support Required During Development Period		Peak Cumulative Capital and Operating Cash Required	
	Capital	Land	Total	Revenue	Operation and Maintenance Costs		Operating	Capital	Year	Amount
Guideway I	36,827.6	4,295.0	41,122.6	2,542.0	2,439.3	86	5,742.4	41,832.0	1983	42,180.6
Guideway II	33,893.0	4,295.0	38,188.0	1,916.4	1,360.0	78	667.0	30,541.4	1979	32,947.8
Guideway III	30,221.0	4,295.0	34,516.0	1,476.7	622.1	69	33.8	23,993.9	1977	26,446.6
Roadway I	12,416.2	4,295.0	16,711.2	1,887.0	3,863.9	74	23,352.3	35,768.5	1985	35,768.5
Roadway II	9,852.7	4,295.0	14,147.7	1,397.7	1,708.9	70	6,852.1	16,704.8	1985	16,704.8
Roadway III	13,667.3	4,295.0	17,962.3	2,022.7	6,464.2	76	36,640.8	50,308.1	1985	50,308.1
Roadway IV	7,033.2	4,295.0	11,328.2	947.8	1,028.9	62	3,850.2	10,883.4	1985	10,863.4
Roadway V	2,228.6	–	2,228.6	66.2	244.4	100	2,163.4	4,414.0	1985	4,414.0

Note: Amounts are in thousands of 1970 dollars.

TABLE 3

SUMMARY OF ALTERNATE CONFIGURATIONS

Configuration	Vehicle Concept		Service Concept		Capital Cost (millions of dollars)	Capital Required (percent)	Net Revenue	Technical Risk	Ridership	
	Primary Right-of-Way	Low-Density Areas	Primary Right-of-Way	Low-Density Areas					Daily Trips	Relative (percent)
Guideway III	6-passenger automated	25-passenger bus	Nonstop, personal operation	90-min headway	34.5	53 to 69[a]	Sufficient to amortize 31 to 47 percent of capital cost	Significant	30,100	100
Roadway IV	50-passenger bus	25-passenger bus	90-min headway	90-min headway	11.3	62	Sustained annual deficit of $81,000	Minimal	18,620	62
Roadway V	50-passenger bus[b]	25-passenger bus	90-min headway	90-min headway	2.2	100	Sustained annual deficit of $178,200	Minimal	1,360	4.5

[a]Percentage of capital required depends on financing. [b]Does not own right-of-way.

Thus, demand bus does not appear to be the best form of transit for Columbia either on a city-wide basis or as a feeder service. Although a demand bus system does not appear feasible for Columbia, one of the recommended configurations is a demand-actuated system with small vehicles operated automatically on an exclusive guideway.