

Demand-Responsive Public Transport in Great Britain

Philip R. Oxley, Cranfield Institute of Technology, England

This paper reviews the development of demand-responsive public transport (dial-a-ride) in Great Britain, as well as describing some of the other innovative small bus systems currently in operation.

A paper on the Mansfield, Ohio, dial-a-ride (DAR) demonstration, published in July 1970 (1), was the first description in Britain of demand-responsive bus operation. This led to a number of inquiries from potential systems operators (2), and in June 1972 the first British DAR system started in Abingdon, operated by City of Oxford Motor Services Ltd., a subsidiary of the National Bus Company. This service was followed in September 1972 by the Maidstone service, run by private taxi and minibus operators, then the Harrogate Chauffeur Coach (October 1972), Eastbourne Corporation's service (November 1973), and finally the Carterton Dial-a-Bus service, which was also operated by City of Oxford (3). These early services were all small, used no more than two vehicles, and were limited in operation, since none of them ran throughout all normal bus operation hours.

The second generation of British dial-a-ride services started with the Harlow Pick-Me-Up service in September 1974, quickly followed by London Transport's Hampstead Garden Suburb Dial-a-Bus, the Sale Dial-a-Ride system, Milton Keynes' Woughton Dial-a-Bus, and most recently (December 1975) the West Midlands Passenger Transport Executives' Knowle and Dorridge Dial-a-Bus. These services are distinguished from the earlier ones by being rather larger operations, carrying considerably more passengers, and operating throughout the day and evening at least 6 days a week.

Of the first-generation services, Abingdon ceased operation in July 1973 and was replaced by a fixed-route hail-stop minibus service. Both the Harrogate and Eastbourne services are still in operation, though with changed service areas and times of operation. The Carterton service is also still in operation but will probably be replaced shortly by a revised routing of the conventional stage-carriage service, which also operates within the dial-a-ride service area. The Maidstone service continues to operate and, although a number of proposals have been made for its extension (4, 5), it is still running in its original form.

SECOND-GENERATION SYSTEMS

Harlow Pick-Me-Up

The Department of the Environment, through the Transport and Road Research Laboratory (TRRL), has taken an active interest in the development of demand-responsive bus services. A number of the services mentioned above have received some assistance, including funding from the department, but the principal demonstration project has been the Harlow service. The Centre for Transport Studies at Cranfield is under contract to TRRL to analyze and evaluate DAR in Britain, and, although all the systems in operation fall within the ambit of the research work, much the greater part of it has been devoted to the Harlow service.

Operational Characteristics

Detailed descriptions of the operation of the service have been given elsewhere (6, 7); briefly the system operates between a service area (Old Harlow) and a small number of important trip generators elsewhere in the new town. Old Harlow is primarily a residential area, though it has an attractive and fairly comprehensive local shopping center. The area contains approximately 5000 people in an area of 1.8 km² and is about 3 km to the northeast of the new town's principal shopping center (The High).

The Pick-Me-Up (PMU) service is operated by London Country Bus Services and runs from 7:00 a.m. to 11:40 p.m., Monday through Saturday, providing a many-to-many service within Old Harlow and a many-to-few service between Old Harlow and The High, the main railway station, a local shopping center, the principal hospital in the new town, a recreation area, and two schools. Three 16-seat Ford Transit buses are used during daytime hours and one in the evening. Two other similar vehicles are held in reserve as traffic and engineering spares. The control office for the service is located in the main bus station at The High, from which the PMU vehicles depart at regular intervals (in the daytime, approximately every 20 min; in the evening, every 45 min).

Passengers traveling out of the service area can book either in advance or on demand by telephone to the control

center, or they can place a standing order for regular pickup. Hail-stop travel is also permitted within the service area but, since there is no fixed route, this usually only occurs at one of the three points that each bus is required to pass on every tour through Old Harlow. Household telephone ownership within the service area is fairly high by British standards (66 percent versus below 50 percent nationwide), but, since there is a significant proportion of the population without immediate access to a telephone, 10 free direct-line street telephones were placed in the service area. Another 3 free lines are located at the railway station and at the local shopping center en route between Old Harlow and The High. To travel to Old Harlow a passenger can board the bus at the bus station in The High or telephone to arrange for a pickup from any one of the other principal locations served by PMU.

Prior to the introduction of PMU, Old Harlow was served by regular stage-carriage bus with three services per hour between the western side of Old Harlow and The High and a rather less frequent service from the eastern side. No changes were made to any of these regular services when PMU was brought into operation. At the start of the experimental services, the one-way fares charged were 10 pence (adult), 8 pence (child), and 5 pence (pensioner)—a difference of 1 or 2 pence over the fares charged on the regular services. Since then the fares of all services have increased, and, at the time of writing, the PMU fares, while remaining the same for journeys wholly within the service area, were 15 pence for adults traveling outside the service area. The one-way adult fare on the regular services has also risen and is now 12 pence. The PMU service covers about 30 percent of its total costs from fare-box receipts.

During the first full week of operation, the service carried approximately 3000 passengers. The ridership then rose to 3500, stabilized temporarily at that level (weeks 3 to 10), and then continued to rise, finally plateauing at a little more than 4000 passengers from week 23 onward. This represents an average of approximately 17 passenger-journeys/bus-h, a level significantly higher than anything achieved in the earlier British DAR systems and equivalent to between 50 and 60 percent of the system's passenger capacity.

The service exhibits peaking characteristics but to a much lesser extent than is usually the case with conventional urban services. In fact the evening peak emerged first, followed by a midday peak, and then, from about 3 months on, the morning peak (8). The relative lateness in the establishment of the morning peak suggests that users prefer to try the service at times and for journeys on which arrival time is not critical, until they feel secure enough to trust that the service really will perform satisfactorily in this respect. However, although peak periods are discernible in ridership levels, daytime off-peak hours are also well used, with more than 40 passengers/h, compared with 55 to 65 in the peak period. The evening period from 8:00 p.m. onward has remained at a much lower level (about 10 passengers/h), though it should be remembered that there is only one vehicle in operation during this time, which lowers the service standards. The daytime service was designed to give an average response time of approximately 15 min and a maximum time, under heavy load conditions, of less than 25 min. Analysis of estimated and actual pickup times for passengers boarding in the service area shows that these service standards have been met and that the accuracy of the estimated pickup times given by the PMU dispatchers is good: Between 85 and 90 percent of actual pickup times are within 15 min of the estimated time.

A series of surveys has been carried out on the ser-

vice and its users; among these were a before-and-after household and travel survey in the service area and in a control area elsewhere in Harlow, on-vehicle surveys on the PMU vehicles and passenger counts on the stage-carriage services, special travel surveys of elderly and handicapped persons in Old Harlow, operational measurement surveys, and a PMU driver-attitude survey.

User Characteristics

An On-Vehicle Quarterly Survey (9) was conducted on May 15 and May 20, 1975. The total ridership on May 15 was 633, of whom 502 were interviewed, and on May 20, 726, of whom 545 were interviewed (children under age 5 were not interviewed). Their ages are shown below.

Age Group	May 15, 1975			May 20, 1975		
	Male	Female	Total	Male	Female	Total
5 to 11	4	5	9	9	7	16
12 to 16	6	23	29	16	25	41
17 to 24	37	107	144	37	96	133
25 to 44	27	98	125	22	106	128
45 to 64	19	104	123	17	127	144
Over 65	29	43	72	28	51	79
Not known	0	0	0	1	3	4
Total	122	380	502	130	415	545

The patronage had a male-to-female ratio of approximately 1 to 3. The level of use by age cohort suggests fairly even use among the three cohorts in the 17-to-65 age band, but if these results are shown against the age structure of the population in the service area (using data from the 1971 census), differences become apparent.

Age Group	Percentage of Population	Percentage of PMU Users	
		May 15	May 20
5 to 16	23.0	7.6	10.5
17 to 24	11.4	28.7	24.4
25 to 44	27.2	24.9	23.5
45 to 64	26.8	24.5	26.4
Over 65	11.6	14.3	14.4
Not known	0.0	0.0	0.7

The difference in dates between the census information and the PMU survey makes it impossible to make an absolute comparison, but in general the service appears to draw a disproportionately high number of riders from the group aged 17 to 24 and, to a lesser extent, from the elderly, while children seem to be making relatively little use of it. The predominance of female riders occurs consistently throughout all the age groups except the youngest (5 to 11), in which the sexes are evenly split, and the oldest, in which females still predominate but to a lesser extent than in the intermediate age groups.

The purposes for which journeys were made on PMU showed the importance of work and shopping trips made inbound (Old Harlow toward The High).

Purpose	Inbound		Outbound	
	May 15	May 20	May 15	May 20
Work	66	50	33	31
Shopping	68	110	0	4
Education	14	16	2	1
Personal business	26	22	8	10
Social-recreational	35	34	11	23
Return journey	37	34	185	196
Other or unknown	13	10	4	4
Total	259	276	243	269

Of the 259 inbound passengers on May 15, 78 percent were coming from home and 9 percent were coming from

work; on May 20 the figures were 78 percent and 8 percent, respectively. Thus, although Old Harlow is predominantly residential, it does contain a number of employment sources and these are reflected in the pattern of service use. As would be expected, the predominant trip purpose on outbound trips was to return home. In the aggregate, the ridership was evenly distributed between inbound and outbound journeys, but, as the data for May 15 only shows below, there were distinctive changes throughout the day.

Time of Travel	Inbound		Outbound		Total	
	No.	%	No.	%	No.	%
7:00-8:00 a.m.	25	9.6	1	0.4	26	5.2
8:00-9:00	40	15.4	18	7.4	58	11.6
9:00-10:00	25	9.6	7	2.9	32	6.4
10:00-11:00	18	7.0	15	6.2	33	6.6
11:00-12:00	15	5.8	27	11.0	42	8.4
12:00-1:00 p.m.	18	7.0	16	6.6	34	6.8
1:00-2:00	26	10.0	13	5.4	39	7.8
2:00-3:00	18	7.0	21	8.6	39	7.8
3:00-4:00	16	6.2	20	8.2	36	7.2
4:00-5:00	20	7.7	18	7.4	38	7.6
5:00-6:00	1	0.4	37	15.3	38	7.6
6:00-7:00	19	7.3	30	12.4	49	9.8
7:00-8:00	8	3.1	1	0.4	9	1.7
8:00-9:00	3	1.1	9	3.7	12	2.4
9:00-10:00	5	1.9	2	0.8	7	1.4
10:00-11:00	0	0.0	3	1.2	3	0.6
11:00-12:00	2	0.8	5	2.1	7	1.4
Total	259		243		502	

Peak use was between 8:00 and 9:00 a.m., reflecting mainly work trips in both directions. Shopping journeys spread throughout the day and were followed by the evening peak outbound, returning from work. The two minor peaks at this time on inbound journeys probably reflect returning from work in Old Harlow (4:00 to 5:00 p.m.) and social-recreational trips to The High (6 to 7 p.m.). The time-of-travel data for May 20 (not reproduced here) presented similar characteristics, although the morning peak was less dominant and the hour of heaviest use was 1:00 to 2:00 p.m.

One area of concern at the introduction of DAR into Britain was the relatively low level (by North American standards) of telephone ownership. As stated previously, 66 percent of the households in the service area had a telephone. One item in the survey dealt with telephone ownership by PMU users.

Day	Percentage With Phone	Percentage Without Phone	Unknown
May 15	67.9	31.7	0.4
May 20	68.8	30.8	0.4

Thus it may reasonably be said that lack of a home telephone does not appear to inhibit the use of PMU, although there were free direct lines available on the street in the service area. The method passengers used to contact the PMU service is shown below in percentages.

Method	May 15		May 20	
	Inbound	Outbound	Inbound	Outbound
Standing order	38.6	26.9	27.5	23.4
Home phone	19.3	3.7	31.1	6.7
Other private phone	5.8	3.3	7.6	1.9
Free phone	6.6	4.5	5.8	1.1
Public call box	2.3	0.8	1.5	3.0
Hail-stop	24.3	52.7	23.6	59.1
Personal call	0.0	7.8	0.4	4.1
Other or unknown	3.1	0.3	2.5	0.7

On inbound journeys the standing order or booking by home or other private phone, which might be considered the usual methods of contact for DAR, accounted for more than 60 percent of the users; the only other significant method was hail-stop, largely for passengers who boarded at one of the three points passed by the PMU bus on each tour. Similarly, on outbound journeys from The High, the hail-stop category mainly covered people who walked on at the town-center bus station. Even in this direction, however, the prebooked category accounted for about a quarter of the passengers. The free (direct-line) phones were relatively little used (about 60 calls per day). This would seem to imply that, provided there are a limited number of fixed pickup points that are reasonably accessible to residents of the service area, free on-street telephones are not of great value to the system.

Although there was little difference between home telephone ownership by PMU users and the average within the service area, there were clear differences in another household characteristic, automobile ownership. On May 15 almost 50 percent of those interviewed did not have an automobile (or private van) available for use in their household; on May 20 the figure was somewhat lower (43 percent). The following comparison with a household survey in Old Harlow shows the percentages of automobile ownership by household.

Category	No Car	One Car	More Than One Car	Unknown
PMU users				
May 15	49.4	39.0	11.6	0.0
May 20	43.1	44.4	11.9	0.6
1975 household survey	23.0	57.0	19.0	1.0

As would be expected, DAR drew more heavily from the non-automobile-owning households, but it also drew patronage more heavily from the stage-carriage bus services than from any other mode (shown below in percentages).

Mode Replaced	May 15	May 20
Car driver	1.4	2.0
Car passenger	4.0	4.8
Bus	68.3	61.5
Taxi	3.4	2.8
Motorcycle, bicycle	0.8	0.9
Walking	12.5	10.8
Would not have traveled	6.6	14.7
Other or no answer	3.0	2.5

The PMU draw from the private car was quite light. The percentages represent about 40 trips per average day, and in this respect DAR seems to have been less successful than was originally hoped. It does appear to generate a considerable number of trips (more than 80 on May 20), but there is little consistency in the percentage of those who would not otherwise have traveled shown by the various on-vehicle surveys. The actual range is from about 6 percent to more than 16 percent on the four surveys carried out to date. A response of "would not have traveled" can reasonably mean "would not have traveled at this time on this day," as well as "would not have traveled at all." Whatever the real meaning, it must be remembered that the figures are based on replies to a hypothetical question and must therefore be treated with caution.

The wider questions of trip generation and the effects that PMU might have on trip purpose and destination were addressed in the recently completed analysis of the before-and-after household and travel diary surveys (10). Extensive surveys were undertaken in Old Harlow in

April 1974, prior to the start of PMU, and in April 1975, by which time PMU had been in operation for more than 7 months. A similar survey was conducted in a control area (Latton Bush) in the new town to facilitate removing the effects of important externalities from the Old Harlow analysis. Among the more significant of these were sharp rises in the national retail price index and national average earnings, increases in the local level of unemployment, and a 16 percent rise in gasoline prices. Bus fares in the new town, which are on a flat-fare basis, also rose—off-peak fares by 25 percent (8 pence to 10 pence) and peak-hour fares by 11 percent (9 pence to 10 pence).

The analysis was based on the identification of similar-mobility groups:

- Employed youth, ages 12 to 24
- Full-time employees, ages 25 to 44
- Full-time employees, age 45 and over
- Housewives under age 65
- Students, ages 5 to 11
- Students, ages 12 to 16
- Students, ages 17 to 24
- Nonworking adults and housewives, age 65 and over
- Part-time employees, age 25 and over

It concluded that there was little evidence to suggest that the introduction of PMU had either improved the accessibility of facilities in the new town enough to make apparent changes in their use or had resulted in identifiable redistribution or generation of trips. The survey suggested that PMU carries approximately 5 percent of the total trips generated on an average weekday by the residents of Old Harlow. It is therefore overall very much a minority mode, and in these aggregate terms the possible generation of new trips referred to above cannot be regarded as very significant. However, the importance of PMU to the different similar-mobility groups does vary. Out of the nine similar-mobility groups identified, eight showed a modal split to PMU of 2 to 8 percent, with the lower levels recorded for full-time employed persons in both age groups and the higher levels for schoolchildren ages 12 to 16 and persons employed part-time. Nonworking adults and housewives over 65 had a 26 (±5) percent modal split to PMU. Clearly the older people in the community place much more reliance on the service than any other group, which probably stems from their appreciation of its doorstep pickup and drop-off and possibly from the fact that any extra travel time involved may be assumed to be of less importance to them than to a full-time worker.

Sale Dial-a-Ride

The Sale service started in October 1974 and is the only second-generation DAR that is privately owned. It is operated by Dial-a-Ride Ltd., a company jointly formed by the Godfrey Abbott Group (coach operators) and Greater Manchester Transport. The original service area covered some 6.5 km² with a population of 20 000 to 25 000, but this was extended in May 1975 to cover the whole of Sale (population 60 000 and area 14.6 km²).

The service runs 6 days a week (Monday through Saturday) from 7:00 a.m. to 7:00 p.m., using the Sale Town Hall in the town center as its principal origin-destination. The service area is divided into four zones, and during peak hours the buses operate on a basic many-to-one (morning) or one-to-many (evening) form, although many-to-many trips within any one zone can also be accommodated. During off-peak times the service operates as a full many-to-many system. Hail-stop service is not permitted, although there is a walk-on

facility at the Town Hall, so users have to rely on either telephoning the control center or arranging standing orders for pickups out in the service area. Household telephone ownership in Sale is approximately 70 percent, well above the national average.

Started with six 17-passenger Bedford CF Deansgate buses, the service now uses up to 8 during peak hours and 10 during the many-to-many operation. The fares were raised in mid-1975 to 10 pence (adult one-way) for intrazonal journeys and 15 pence (off-peak hours) or 20 pence (peak hours) for interzonal journeys. Concessionary fares (5 pence) are available for children.

The system was designed by DAVE Systems, Inc., and draws heavily on their experience gained in operating North American DAR services. The intention is that the service should be self-supporting, although it is understood that it has not yet reached the break-even point. As in Harlow, no modifications have been made to the existing stage-carriage services in Sale since the introduction of DAR, but (unlike the operators in Harlow) the operators can employ both part-time and women staff members and so have rather lower labor costs than other systems that employ only men as drivers on a full-time one-man-operation basis.

No detailed figures are currently available on ridership, but it is understood that the average level of vehicle productivity is approximately 12 passengers/bus-h on weekdays (Monday through Friday) and rather more than this on Saturdays. Before the expansion of the service area, average daily ridership was between 300 and 400. At the time of writing, in the larger area, it was about 600 per day. Unfortunately, like the other privately operated DAR service (Maidstone), Sale DAR is subject to some restrictions that probably reduce the number of passengers below the level that could be obtained with complete freedom of operation. In particular there are restrictions on the number of vehicles that can stand at the main origin-destination point in the town center. Originally only two buses were permitted at any one time; this has been increased to four, but the stand area is not designated for the exclusive use of the DAR buses, so that on occasions it is still not possible to get four vehicles there at the same time.

The operators of the service consider that, if the stand point were available at all times for their buses and if they were permitted to display details of the service on a notice board at the same place, which at present they cannot, then ridership could be further increased. In particular they consider that there is an untapped potential for more inbound journeys in general and for more commuter journeys in particular. In the future it is possible that the DAR services will be integrated with the scheduled stage-carriage services in Sale. If this were to happen, system ridership could be expected to rise and possibly bring the service closer to complete cost recovery.

Hampstead Garden Suburb (London) Dial-a-Bus

London Transport's DAR service started in Hampstead Garden Suburb on October 19, 1974 (11). The nature of the service area shows considerable differences from the one in Harlow. It comprises a portion of Hampstead that was planned and developed as part of the Garden Cities movement in the first decade of this century. Housing in the service area was developed between 1908 and the mid-1930s and is all privately owned (by comparison, 55 percent of Old Harlow's housing is publicly owned). Both automobile and telephone ownership are high: 42 percent of households own two or more auto-

mobiles, 36 percent own one, and 93 percent have a telephone available. Another distinguishing feature is that there are no conventional stage-carriage services within the 1.6-km² service area, although there are frequent services along the northern and western edges.

The DAR service operated as many-to-many within the service area and as many-to-one from there to the main local shopping center at Golders Green. At this point there is interchange with a large number of other bus services and with the Underground. As in Harlow, the DAR ran Monday through Saturday, but for slightly longer hours each day (7:15 a.m. to 12:45 a.m.), reflecting the operating hours of the Underground. Three vehicles [Ford Transit public service vehicles (PSVs) with 16 seats] were used throughout the day until approximately 7:00 p.m.; two vehicles were used thereafter. The control office was located at the Golders Green bus station and the facilities for prebooking, on-demand, and hail-stop service were similar to those described for Harlow.

Ridership started at 2790 in the first week and stabilized very quickly in the range of 3600 to 4000. As in Harlow, the hourly loadings were spread rather more evenly through the day than on most other public transport services, though Hampstead had a relatively higher peak in the late afternoon than Harlow. The evening loadings were also a little higher than those shown by the PMU service.

During the first 9 months of the service a flat one-way fare of 15 pence was charged for all passengers except old-age pensioners, who were allowed a concessionary fare of 5 pence during off-peak hours. A flat fare of 5 pence was also charged for the last 0.8 km of the (fixed) route into Golders Green, but this appears to have been little used. Part of the promotional campaign at the start of the service included distribution of 10-pence-off vouchers to all households in the service area. These were valid for 13 operational days; 3000 were distributed but only 154 were used in more than 7000 passenger journeys.

On July 14, 1975, the flat fare was raised to 25 pence (concessionary fares doubled to 10 pence), which compared with a fare of 7 pence for a journey of approximately equivalent length by London Transport stage-carriage bus services. Ridership dropped sharply to between 2000 and 2300 in the weeks following the fare rise, and, although some decrease in ridership was to be expected during the summer holidays, there can be little doubt that the fall was largely attributable to the fare rise. During autumn the ridership recovered, reaching 3000 per week by early December, and then fell back again slightly after Christmas to 2800, equivalent to a vehicle productivity of 10 to 11 passengers/bus-h. Even at this level, actual fare receipts were some 25 percent above the levels prevailing before the fare increase and covered approximately 30 percent of total service costs.

In February 1975 a home-interview survey was carried out for London Transport by Opinion Research Centre, following an on-vehicle sample survey of passengers. The on-vehicle survey gave the following breakdown of trip purposes.

Purpose	Percentage	Purpose	Percentage
Work	24	Entertainment-sport	7
Social visits	23	Employers' or personal business	8
Shopping	18	Other	7
Education	13		

Precise comparison with the Harlow data on trip purpose is not possible, but they are broadly similar, with perhaps slightly greater emphasis at Hampstead on work and education and rather less on shopping.

As in Harlow, the Hampstead DAR was much more heavily used by females than by males—a ratio of 74 females to 26 males, compared with a ratio of 57 to 43 in the service-area population. However, the age pattern of the users was much closer to that of the population, with the elderly (age 65 and over) and the younger (under age 35) forming only marginally more of the riders than they do of the population as a whole. Again, as in Harlow, Hampstead DAR drew patronage more heavily from households that did not own automobiles (shown below in percentages).

Category	No Car	One Car	More Than One Car
DAR users	37	31	32
Service-area population	21	36	42

As in the Harlow on-vehicle surveys, a question on the mode of travel replaced was asked; the results are shown below.

Mode Replaced	Percentage	Mode Replaced	Percentage
Car driver	3	Walking	35
Car passenger	4	Would not have traveled	5
Bus	38	Other	2
Taxi	13		

Comparing these results with those from Harlow shows significant differences that are attributable to the absence of any conventional intraservice-area bus service in Hampstead, the shorter distances involved (i.e., more walking trips), and (partly as a reflection of the former and partly because of the general affluence of the area) a high draw from taxi service. The apparent 5 percent trip generation is rather lower than that at Harlow.

The home-interview survey was used to probe more deeply into the attitudes of the service-area residents toward the service. The main findings were

1. The then-current fare of 15 pence represented good value for the money,
2. There was little interest in reduced fares for children (normally available on other London Transport services),
3. There was considerable interest in reduced-rate season tickets (also available on other London Transport services),
4. More than 90 percent of service-area residents (including nonusers) thought DAR was a very good idea, and
5. There was no hostility on environmental grounds to the DAR vehicles running through the area (previous suggestions for scheduled services using larger vehicles had been strongly resisted by residents of the suburb).

Although the fare increase referred to above did produce an increase in total revenue, the service still continued to show a substantial loss (approximately \$75 000 a year on a fully accounted basis at mid-1975 prices). Given the effect of the fare increase on ridership, it was considered that any further rise would be unlikely to improve the financial situation; therefore the Greater London Council (which had been underwriting the service) and London Transport decided to replace it with a fixed-route hail-stop minibus service beginning March 1, 1976.

This service uses two (of the three) former DAR buses and, with associated savings in control staff and radio equipment, is expected to reduce the annual loss to about \$34 000. The hours of operation are similar to those of the DAR service, and the route used runs through those parts of the service area that produced the heaviest

ridership. The fare has been reduced back to 15 pence (adult one-way) to bring it in line with other minibuses and midibus services in London, and pensioners are able to ride free at off-peak times, as on other London Transport bus services. Early indications are that ridership is being maintained at about the same level as on the DAR service.

Woughton (Milton Keynes) Dial-a-Bus

This service, operated by United Counties Omnibus Company for Milton Keynes Development Corporation, started on March 10, 1975. Woughton is an area in the southern part of the new city that contains largely new residential development and had, at the start of the service, a population of about 3500. Since that time further residential and related development has taken place; in March 1976 the population was 6500 within an area of 10.2 km². More than 80 percent of the service-area population lives in rented public housing.

The DAR provides a many-to-many service within Woughton and many-to-few between it and the major shopping and employment center at Bletchley (approximately 3.5 km to the west), the Open University, and Milton Keynes Development Corporation offices in the old-established village of Wavendon. The latter two are to the east of the service area. Six Mercedes L406D 15-passenger buses were made available to the service at its inception, with up to five in use during peak periods. The service operates 7 days a week (Monday through Thursday 6:30 a.m. to 11:30 p.m., Friday and Saturday 6:00 a.m. to midnight, Sunday 9:30 a.m. to 11:30 p.m.) with fares of 8 pence (adult one-way) for journeys wholly within the service area and 15 pence for journeys to or from any of the external destinations. All the usual demand-responsive facilities of standing order, prebooking, on-demand, and hail-stop service are available. The southern and eastern parts of the area are also served by conventional stage-carriage services; a new fixed-route service that penetrates into the southwestern part of the area was started recently.

Ridership started at approximately 2350 in the first week of operation and is currently running about 4000 per week. The weekday average is 625, while on Sundays the average is 200 passengers. This is the only DAR service currently operating that runs on Sundays, although the first service (at Abingdon) also did.

The Milton Keynes Development Corporation carried out an on-vehicle passenger survey of the service in November 1975 (12). The user characteristics were much like those for Harlow and Hampstead. Sixty-nine percent of the passengers in the survey were female, from children to the elderly. Within the service area 53 percent of the population are females, and they account for 49 percent of all trips (all modes) made by service-area residents. A comparison of the ages and sex of the DAB users and service-area residents by percentages is shown below.

Age Group	DAB Users		Service-Area Residents	
	Male	Female	Male	Female
5 to 16	2.3	3.9	11.2	13.8
17 to 24	9.4	26.3	6.8	9.7
25 to 44	11.8	25.0	21.6	20.9
45 to 64	3.8	8.4	5.4	5.6
Over 65	4.0	5.1	2.0	3.0

Females from age 17 on clearly make disproportionately heavy use of the service, particularly so in the 17 to 24 group. This mirrors the Harlow experience, as does the relatively low level of use by the youngest group.

The general difference in the age structure of the two areas, with an older population in Harlow, reflects the very recent development of Woughton, with its emphasis on the younger females.

The purpose for 1880 of the surveyed trips (42 percent) was to return home. Excluding these, the predominant purposes were work and shopping, as shown below.

Purpose	Trips Recorded	
	Number	Percent
Work	800	31.4
Shopping	760	29.9
Education	59	2.3
Personal business	293	11.5
Social	571	22.5
Other	62	2.4
Total	2545	

As in Harlow, trips for educational purposes were relatively trivial in number, but the social trips (visiting friends, entertainment) were of considerable significance. A comparison was made with the trip purposes of users of the stage-carriage services prior to the start of the DAR, which showed that the conventional bus was more heavily used for shopping (46 percent) and less well used for work (25 percent) and social purposes (11.5 percent); all these figures exclude trips to return home.

The apparent ability of DAR to generate off-peak travel and so to produce a relatively even hourly ridership profile is again shown in the Woughton service.

Time of Travel	No.	%	Time of Travel	No.	%
6:00-7:00 a.m.	77	4.3	3:00-4:00	117	6.5
7:00-8:00	135	7.5	4:00-5:00	143	8.0
8:00-9:00	125	7.0	5:00-6:00	129	7.2
9:00-10:00	117	6.5	6:00-7:00	97	5.4
10:00-11:00	124	6.9	7:00-8:00	67	3.7
11:00-12:00	136	7.6	8:00-9:00	65	3.6
12:00-1:00 p.m.	121	6.8	9:00-10:00	28	1.6
1:00-2:00	146	8.1	10:00-on	36	2.0
2:00-3:00	131	7.3			

In fact the time profile at Woughton is even flatter than that for Harlow, with barely discernible peaks in the morning, at lunchtime, and in the late afternoon. It should, however, be borne in mind that the evenness of hourly use may to some extent reflect a reduced supply at peak periods.

As in Harlow, there are a number of free direct-line telephones within the service area; 40 are planned in total, so located as to ensure that no residential development is more than approximately 225 m away from one. The use of these phones is considerable; after hail-stop, which includes walk-on facilities at the main destinations outside the service area, the free phones are the most heavily used method of contacting the service. A comparison with the average figures for Harlow (in percentages) is shown below.

Method	Woughton	Harlow (avg)
Standing order	18	29.0
Private phone	11	20.2
Free phone	23	4.5
Public call box	13	1.9
Hail-stop	29	39.6
Other	6	4.8

The contrast with Harlow is very clear and may be taken to reflect the much lower level of private telephone ownership (approximately 32 percent of the households in Woughton, compared with 66 percent in Old Harlow), the fewer possibilities for hailing or walking on within the

service area, and the greater number of free phones per capita.

The heavier use of this free facility no doubt helps to account for the fact that, as elsewhere, lack of a private telephone apparently does not inhibit the use of the service; 73 percent of the trips made in the survey period were by passengers from households without a telephone. However there is a relationship between telephone ownership and automobile ownership (for example, in Woughton only 15 percent of households without an automobile had a telephone), both being to some extent related to income, and it may be that the use of the service by those who do not own telephones is a reflection of the need to use whatever public transport is available. There is a clear relationship between automobile ownership and use of the DAR service (shown below in percentages).

Category	No Car	One Car	More Than One Car
Woughton DAB users	66.0	31.0	3.0
Service-area residents	32.5	58.5	10.0

The area is, of course, still a long way from completion (the new city's present population of 70 000 is planned to grow to 250 000), and the public transport services, both present and planned, are therefore under constant review. One of the goals formulated at the inception of the new city was to provide good-quality public transport, from the beginning, for both captive patrons and patrons by choice. Given the land use and demographic structure planned (relatively low density with dispersed main trip generators and a basic grid of principal roads at approximately 1-km intervals), it seems reasonable to suppose that demand-responsive public transport has a part to play in the future transport system of the city. This may evolve as a series of DAR services that operate as a complete mode of travel during off-peak times and during peak hours as feeders to the fixed-route stage-carriage buses that are routed largely on the principal roads. It is also possible that peak-hour subscription services will be introduced; this is being considered for the present DAR area in which peak demand exceeds present DAR capacity.

Knowle and Dorridge (Solihull) Dial-a-Bus

The good sense of integrating DAR with conventional services rather than treating it simply as an overlay in addition to existing services was recognized by the West Midlands Passenger Transport Executive (WMPTE) when planning its Knowle and Dorridge service, which started on December 15, 1975. It currently provides a many-to-many off-peak service within the suburban area of Knowle and Dorridge. During peak hours (6:45 to 9:00 a.m. and 4:45 to 7:00 p.m.) the buses run on a fixed route through the same areas. Up to four midibuses (23-passenger Alexander S-Type on Ford A-series chassis) are used in the service, although WMPTE purchased eight, since it is planned to extend the DAR operation at a later date.

The service area is 4.2 km², with a resident population of approximately 12 500. In character the area is similar to Hampstead Garden Suburb and consists of predominantly middle-class private housing. Dorridge railway station, toward the western end of the service area, is used as the principal waiting point for the buses, with a temporary control office situated in the station approach. The only other fixed point through which all buses pass on every tour is in Knowle's town center. The service area is divided into two approx-

imately equal parts, with a zoned flat-fare system of 5 pence (adult one-way) for any trip wholly within one zone and 10 pence (adult one-way) for journeys from one zone to another. Children's fares are 3 and 5 pence respectively, and the concessionary passes for the elderly can be used on the service, as can the WMPTE's four weekly travel cards. Provision for standing orders, prebooking, on-demand calls, and hail-stops is the same as in Hampstead. The service operates 6 days a week from 6:45 a.m. to 11:45 p.m. and connects with the frequent suburban train services from Dorridge into Birmingham.

Although both Knowle and Dorridge have small shopping and business areas, the principal commercial center in their vicinity is Solihull, approximately 5 km to the north. Three stage-carriage bus services connected the service area with Solihull and also provided for local movements. When DAR was introduced, one of these services was taken off, and the remaining two are likely to be modified when the DAR service is extended as planned to encompass journeys between the service area and Solihull.

It is still too early to judge what the steady-state ridership will be, but the service has already carried higher weekly and daily loads than any other British DAR. During the first 7 weeks of 1976 (January 5 to February 21) the weekly average was approximately 5500, with a peak of 5900, and daily figures varied within the range of 700 to 1150. Bus productivity measured in passenger journeys per bus-hour is also higher than elsewhere (present average is 25 per bus-hour). Round-trip travel times vary from as little as 25 min under light load conditions to approximately 60 min.

No detailed surveys have yet been carried out on the service, though an on-vehicle survey is currently being planned, so it is not possible at this stage to say to what extent the service has drawn from the remaining stage-carriage services or has generated additional journeys. The only figures currently available show that a substantial proportion of the passengers are pass-holders (including the elderly and schoolchildren) and that their use of the system has grown much more rapidly than has that of direct fare-paying passengers. In the first 3 weeks of operation, pass-holders accounted for a little less than 25 percent of all users; in weeks 8 to 10, they accounted for almost 40 percent. This obviously has a depressive effect on the revenue from fares taken in by the service; fares have risen since service began, but by a much smaller proportion than total ridership.

DAR STUDY PROGRAM

As mentioned, the Centre for Transport Studies has been engaged by TRRL to do an extensive study and evaluation of DAR in Britain. Some of the reports produced as part of this work have already been noted above. Other reports cover topics from preparatory planning reports (13) to industrial-sociological studies of the attitudes of DAR and conventional bus staff (14, 15) and the reliability of the vehicles themselves. The survey analysis studies are supplemented by continuing work on demand (16) and supply modeling at TRRL and at Cranfield, with the intention of producing a comprehensive view of the attributes, performance, and value of DAR to the community. It would however, be wrong to give the impression either that interest in DAR is limited to the essentially urban-suburban systems described above or that DAR represents the only form of experimental small-bus system current in Great Britain.

Probably the most widely used innovation in small-bus services is the Postbus. This type of service, of which there are now approximately 100 in operation, has developed as a means of providing at least minimal pub-

lic transport in sparsely populated rural areas. The delivery and collection of mail require that the Post Office must be able to get to virtually every part of the country at least once each weekday. A variety of vehicles are used for this purpose but, since the driver-postman represents the primary cost, it makes relatively little difference to the total service costs to permit fare-paying passengers to be carried. Thus it is possible to provide a public transport service to parts of the country that are otherwise remote from bus services. For obvious reasons, the levels of service provided by this means in terms of frequency and journey time are not high, but in some areas even this is a great deal better than nothing.

The majority of the Postbus services are in Scotland, and typically each service provides two journeys each day Monday through Friday and one on Saturday. In summer months, when patronage tends to be higher, some services are duplicated. A variety of vehicles is used, from 4-seat Landrovers to 25-passenger midibuses, but for the most part 11-passenger Commer vehicles are employed. Postbuses in Scotland now serve more than 1600 km of roads with an annual total of more than 1 million bus-km; in 1974 they carried 35 000 to 40 000 passengers. There is every indication that the network of these services will continue to expand in rural areas.

There is also considerable interest in rural areas in such systems as community bus services and automobile sharing. In Norfolk a community bus system was started in November 1975 to provide a service in six villages at the eastern end of the county that were too small to support a conventional service. One 12-seat Ford Transit minibus is used, with a team of volunteer drivers drawn from residents of the six villages. The schedule of the bus provides for school journeys, shopping journeys 3 days a week, and a once-a-month connection to Eastern Counties' existing service to Norwich. The fares charged range from 5 pence to 25 pence, with concessionary fares for children, and it is calculated that, given volunteer drivers, the service will need to take in about \$36 per week in fares to cover its costs. The volunteer drivers have all been trained to PSV standards by Eastern Counties, and 12 have now obtained PSV licenses.

The Oxfordshire County Council has encouraged the establishment of automobile-sharing schemes and three are now operating, although it is reported that there has not been a great rush of participants. The County Council is also considering further experiments, including one that involves staggered work hours for council employees, with a special reduced bus fare for those who adopt the less regular hours, and another that permits groups of parishes to run school buses during those times of the day that they are not required for the school-children.

In a much more urban setting, Westminster City Council (London) is considering setting up a jitney service in the West End of London using a 12-seat Maxi-Taxi. The service is planned to have fixed starting and destination points but flexibility within the service area, according to demand, between those two points. A fixed fare would be charged and revenue from parking meters would be used to launch the scheme, the cost of which is reported to be \$500 000. To date the service remains no more than a proposal.

There are other examples of the experimental use of small buses in both urban and rural areas, ranging from city-center precinct services to holiday or recreation-area services. Most are designed with the objectives of providing relatively low-cost services for people who are not currently well served, to give a measure of

basic mobility to all, and to encourage those with automobiles available to make either less use or more effective use of them.

EUROPEAN DAR APPLICATION

It would also be misleading to imagine that Britain is the only country in Europe in which DAR has been implemented. The Dutch were very early on the scene with the Emmen service (17), and more recently services have started in France and Sweden.

The French system started September 29, 1975, in St. Cloud, a town near Paris of 28 000 persons and covering a built-up area of some 3.6 km². The service, run by the Paris Regional Transport Authority, operates 7:00 a.m. to 8:30 p.m., Monday through Friday, with up to four buses in operation (one is held as a spare). The vehicles used are Saviem SB2 buses with a capacity for 12 seated passengers and 8 standees. Fares are 2.00 F (adult one-way) or 1.40 F for regular standing-order journeys. Ridership has risen since the service started; it is currently about 2100 passengers per week (equivalent to approximately 10 passengers per hour) with revenues of a little less than 30 percent of total system costs. The French Ministry of Transport's Institute of Transport Research is monitoring the progress of the service and expected to publish a report on the first on-vehicle survey in April 1976.

A number of municipal authorities in France have expressed interest in DAR but, to my knowledge, the only other system in operation is a privately owned service in Andresy (25 km northwest of Paris). Few details are available, but the service area encompasses some 25 000 people, two small vehicles are used, and daily ridership is approximately 180 passengers. The fare structure is analogous to that for taxi fare and is based on journey length measured in stages of 800 to 900 m (0.50 F minimum fare up to 4.50 F maximum). The present daily revenue is about 350 F with direct daily operating costs (fuel and drivers' and telephone operators' wages) amounting to 250 F. Fully accounted costs are not known, but it would appear that this service is operating at about the break-even point. The owner of the service, a former taxi operator, plans to introduce three 12-seat minibuses and to operate with a flat fare of 3.00 F.

In Sweden very detailed proposals have been produced for the Projekt Taxibuss DAR system in Gothenburg (18), but the plans are in abeyance while awaiting a government decision on funding for the service. In the meantime an experimental DAR system was implemented in Borås in October 1975, planned initially to run for 6 months. The system is operated jointly by Volvo and Borås Public Transport and provides for journeys to and from an industrial estate in the town 5 days a week (no weekend service). One bus is used, operating on approximately 30-min headways, and its ridership 2 months from inception was about 500 passengers per week.

The interesting feature of this service is that it has an automatic control system. When a prospective passenger dials the service number, an automatic answering device acknowledges the call and directs the caller to another number that connects him to the bus stop at which he wishes to be picked up. Each bus stop in the system has a unique identification number, and, when a request for pickup is made, that number is processed by a computer to appear on the bus driver's running schedule, which is printed out at each terminus. This print-out tells the driver at which bus stops passengers are waiting, so that he can then determine his route. If there are no requests for service, the bus tour is not made.

There is interest in DAR in other European countries, including Germany and Switzerland (where the city of Zurich is currently planning a service), but no operational systems have been reported. To an even greater extent than in Great Britain, most public transport operators in Western Europe are facing substantial deficits (19), and therefore the climate for innovation, even on a relatively small scale, is not a good one.

RURAL APPLICATION OF DAR

The potential value of DAR to rural communities has not been ignored; currently Cranfield and TRRL are jointly seeking appropriate areas in which small-scale rural DAR could be operated. Rural public transport, in common with many other public services, has suffered from recent cost inflation. The majority of truly rural bus services operated by the National Bus Company do not cover their fully accounted costs from fare-box revenue. Reduced frequencies and service withdrawals are to be expected in a period when national economic considerations determine that public expenditure cannot be permitted to rise. The rural application of DAR is therefore being considered from the point of view of realizing some savings over conventional bus operation in a given area, as well as providing an improvement in accessibility.

Two possible operational forms of DAR have been identified as offering at least the possibility of achieving these two objectives: a route-diversion service and an area-coverage service. The former is designed to replace an existing bus service between (for example) two small towns. It would follow a basic fixed route with diversion from this to pick up or set down passengers on demand only, thus reducing unproductive diversions to a minimum (20). The area-coverage service is applicable in districts where a wide scattering of the population makes it difficult to select a single fixed route that serves even the majority of settlements.

In both cases it is probable that the DAR service offered will not be immediately responsive to demand in the way that the current urban services are. Since cost saving is an important element in the exercise it is likely that only standing orders and prebooked requests for pickup will be handled. Thus it should be possible to manage the system without a formal control office and staff and without vehicle-based radio equipment. Passengers boarding the vehicle would be able to tell the driver their destinations, and he would be responsible for selecting his own route around the various pickup and setting-down points. It is TRRL's intention to mount a rural DAR experiment in late 1976, probably as part of a wider investigation into bus-service options in rural areas.

Some guidance on the value of DAR to rural communities will be obtained from a service operated by Eastern Counties in an area southwest of Peterborough. One 22-seat midibus will be used to provide a mixture of school, fixed-route, and on-demand services to a scattering of small villages and will link them with the neighboring towns of Peterborough and Huntingdon.

FUTURE OF DIAL-A-RIDE IN GREAT BRITAIN

Two patterns appear to be developing for the future of the existing British DAR services. Those systems that have been added onto existing services with no changes made in the routing and scheduling of the stage-carriage services seem likely either to become more conventional fixed-route minibus services or possibly to disappear in a reorganization of the scheduled services, triggered at

least in part by the demand patterns shown by DAR. Hampstead has already become a fixed-route hail-stop service, as did the first DAR in Abingdon, and Harlow seems (to me) to be likely to develop in much the same way, though perhaps with an option for dropoff when the experiment is concluded (August 1976). The Carterton DAR will probably be replaced shortly by a revised stage-carriage service using larger conventional buses.

The two systems that have been specifically integrated with stage-carriage service (Woughton and Solihull) both appear to have a better chance of remaining demand responsive and of extending their areas of operation. However, it has to be said that DAR, because it is so labor intensive, is an expensive form of public transport to operate. Typically the second generation DAR services cover about 30 percent of their total costs from fare-box revenue, the only notable exception being the Sale service. Although there is clear evidence that this type of service is popular, particularly with those groups of people (the elderly and housewives) who are less likely to have a car available, there is very real doubt whether people are prepared to pay the true costs for such a service. It can be said that this applies to conventional bus services as well, since an increasing number are running at a deficit. In 1974 the National Bus Company had an operating deficit of \$11.7 million, compared with a surplus ranging from \$2.6 to \$6.5 million in the three previous years. Most urban bus services operated either by passenger transport executives or by local authorities also operate at a deficit. However, the fact remains that, although DAR can generate some new traffic, it does so at a unit cost that is too high for many operators (or local authorities) to sustain during a period of financial stringency.

It cannot be said, therefore, that in the near future Britain is likely to see anything comparable to the recent growth in DAR systems in North America. What seems most likely is the further, but slow, development of integrated DAR, as in Woughton and Solihull, and the establishment of a number of relatively small-scale rural services as part of a wider program designed to evaluate alternative ways of meeting rural transport needs. If it is to be successful and to develop in the longer term, urban DAR will have to demonstrate that, integrated as a significant part of an urban transport system, it can offer economies of scale as well as increased attractiveness to the passenger that will bring its costs per passenger down much closer to those of conventional bus services. If rural DAR is to develop, it will probably have to demonstrate that it is a least cost method of providing for rural travel demands.

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