

7 Bus engineering and maintenance

Introduction

7.1. As we described in Chapter 2, Ulsterbus and Citybus have separate engineering organisations, each with its own Chief Engineer. In this chapter we examine the efficiency and effectiveness of the engineering organisations in maintaining their respective bus fleets so as to ensure that the required number of vehicles are available for service, that those failing in service for engineering reasons are kept to a minimum and that the numbers of spare vehicles over and above the peak vehicle requirement are kept as low as possible.

The vehicle fleet maintained

7.2. At March 1988 Ulsterbus had a total operational fleet of 895 (see Table 7.6), with a peak vehicle requirement of 795, giving 11 per cent 'engineering spares'. For Citybus the figures were 305 and 244 respectively, giving 20 per cent engineering spares. Both companies have sought to standardise on particular types as far as possible. In Ulsterbus some 77 per cent of the fleet comprised Leyland Tigers and Leopards, with the balance mainly Bristol RELL buses. In Citybus over 90 per cent of the fleet were Bristol RELL buses.

7.3. Approximately 4 per cent of Ulsterbus vehicles were over 14 years old, while the figure for Citybus was 16 per cent. This difference is explained by the fact that Citybus has lost some 600 vehicles (twice its current fleet) in the last 20 years due to civil disorder. Many of the losses have been replaced by second-hand vehicles or by extending the life of others. In 1988 Citybus took delivery of nine new Leyland Tigers and expects subsequently to take delivery of some 25 a year for the next four years thereby reducing the average age of its fleet. Citybus is also taking vehicles from the Ulsterbus fleet which are 9 to 11 years old. This helps to balance the average age.

7.4. In addition to the maintenance and repair of buses, both Ulsterbus and Citybus maintain other vehicles, not associated with stage carriage services, ie coaches, recovery vehicles and others. Ulsterbus has 211 such vehicles and Citybus has 60.

Engineering workforce

7.5. Despite the very different nature of operations in the two companies (see paragraphs 2.19 to 2.25), in terms of maintenance staff per vehicle (see paragraph 7.4) they are almost identical. The ratios of engineering employees to vehicles maintained at March 1988 are shown in Table 7.1.

TABLE 7.1 Ratios of engineering employees to vehicles maintained at March 1988

	<i>Engineering employees</i>	<i>Vehicles maintained</i>	<i>Engineering employees per vehicle maintained</i>
Ulsterbus	418	1,106	0.38
Citybus	134	365	0.37

Source: Ulsterbus and Citybus.

Bus engineering maintenance and repair policy

7.6. There is an absence in both companies of documentation formally stating what bus engineering maintenance and repair policy is. In essence such policy is promulgated by 'word of mouth' and within both companies amounts to a statement of what is required and expected by the Board as follows:

- (a) currently the planned life of a bus is 13 to 14 years, but where continued maintenance and/or some measure of overhaul remain economically sound, lives should be stretched. The replacement rate will, however, be reviewed and adjusted in the light of the trend in average age;
- (b) new buses will not be purchased in expectation of losses through malicious damage losses will be made good by stretching the life of existing buses and purchasing appropriate second-hand buses;
- (c) frequencies of inspection and preventive maintenance should be reviewed as an ongoing activity to reduce intervals out-of-service this to be achieved without sacrificing bus safety or overall quality of service to traffic operations;
- (d) the maintenance workload and associated labour resources and materials costs should be kept to a minimum; and
- (e) the optimum life should be obtained from major units such as engines and gearboxes.

Maintenance workload and execution

7.7. The engineering workloads of both companies are very similar in nature, but there is a significant difference in the volume of work, which relates both to the age profile and to the size of the respective fleets. Ulsterbus maintains three times as many vehicles as Citybus.

7.8. Both Ulsterbus and Citybus depots deal with periodic inspections and associated servicing of buses, rectification of defects reported by drivers and the removal and fitting of 'exchange' units (engines, gearboxes, differentials etc).

7.9. The 18 Ulsterbus depots carry out annual PSV recertification work and Ulsterbus calls in its buses every four or five years, depending on mileage and condition reports, to its central workshop for overhaul appraisal. The necessary work is carried out to see a bus through at least the following five years, when it will again be appraised. Citybus does not adopt this strategy: all its PSV recertification work is carried out at its central workshop where, in addition, any necessary overhaul work is carried out on a year-to-year basis.

7.10. Both companies plan PSV inspections one year ahead and annual programmes are produced detailing vehicle call-offs. Some four weeks' grace is allowed for PSV presentation by the DOE (NI), giving some planning flexibility.

7.11. Both companies carry out exchange unit rebuilds and repairs at their respective central workshops when the condition of units justifies such action. The condition of engines is monitored by analysing samples of lubrication oil at regular intervals. Some items such as injectors, compressors and air valves are dealt with on a time-elapsed basis. Both Ulsterbus and Citybus carry out major repairs of buses at their central workshops. Both maintain their own machine tools, housed mainly in the central workshops.

7.12. Both engineering staffs estimate maintenance workloads using current knowledge and past experience and Citybus also uses a standard time databank appropriate to its bus maintenance work.

7.13. Both engineering functions have well-documented schedules and check-lists for inspection routines and all work carried out is booked to appropriate job codes. While there are some

differences in inspection frequencies and working methods between Ulsterbus and Citybus, the number of days buses are off the road for maintenance purposes is the same on a yearly basis.

7.14. The companies' job codings are currently not compatible and there is no common system of costing. There is an absence of unit costing and vehicle whole-life costing in both engineering organisations. We were told that the companies are now taking steps to rectify these matters.

Stores and stock control

7.15. Both Ulsterbus and Citybus have main stores for engineering spare parts and materials at their central workshop sites. Minimum stock levels exist for all items held (but under continuous review) and reordering is effected automatically by the Central Purchasing Department.

7.16. Stock is held to support the standard buses in the fleets, ie Tigers, Leopards, and Bristol RELLs. The companies have a number of other buses. Generally the policy for these is not to hold stocks of parts for them, but to run the existing stocks down to zero and only order against a specific requirement or where a steady usage is established. The needs may be met by cannibalisation, improvisation, or residue of old stock held within the workshop.

7.17. Stock control is effected using a computer-based system, and follows closely the form of a previous manual bin system. It has a number of acknowledged deficiencies:

- (a) there is no distinction between different classifications of stock, either on the basis of usage value or value of stockholding. There is some informal distinction in that some items get more attention than others, and the companies try not to place orders, as a rule, for less than £25;
- (b) orders are placed without a specific delivery date;
- (c) no lead time is held on the computer;
- (d) there is no lead time monitoring; and
- (e) the computer holds a predetermined order level. It does not calculate the reorder level, although the companies have considered getting it to do so.

Nevertheless the system has been the means for the companies' successful attempts to improve stock turnover. Stock turnover (running at about 18 weeks for Ulsterbus and 21 weeks for Citybus) and service levels (defined by first pick analysis, currently about 93 per cent) are monitored, the latter only for Ulsterbus.

7.18. The Citybus and Ulsterbus stock control systems run in parallel. The Citybus system was designed along the same lines as that of Ulsterbus. However, we were told that information collected from the Citybus stores was not as complete, and therefore the system did not operate as well; in particular a first pick analysis was not available. In the Citybus system the reorder level is compared only with the stock level at the Falls Road stores, although the stock at the Short Strand and Ardoyne stores is held on the computer files.

7.19. At the third meeting of the Computer Steering Committee the priorities and requirements for extending the stock control system were outlined, as follows:

- (a) establish order-expediting system (ie to signal the requirement for a progress call when safety stock level was reached; safety stock levels would need to be established);
- (b) streamline the goods receiving system; and
- (c) generate orders by computer. At the moment only stock replenishment orders are prepared by the computer from information on file.

7.20. All Ulsterbus depots and both the Short Strand and Ardoyne Citybus depots carry imprest stock which is topped up from main stores approximately twice a week.

7.21. Both companies have unit exchange stores which, apart from the absence of computerisation, are managed in much the same way as main stores. Tyre store facilities are provided at all depots and at the Citybus central workshop, but control of tyre stocks together with tyre reprofiling and fitting responsibilities rests with contractors. The Depot Engineer can override contractor decisions if safety is in doubt.

7.22. There are regular stocktakes of all stores; main stores and imprest stores are internally audited every four weeks. The audits show value of stock checked and variance value in both financial terms and percentage of stock checked. There is an annual external audit of all stores. The audits of main stores and imprest stores revealed average four-weekly percentage variance values of 0.5 per cent.

7.23. A measure of stockholding efficiency is the stock turnover index (the value of issues over one year divided by the value of stock held). Table 7.2 shows comparative efficiencies of stores holdings for Ulsterbus and Citybus and demonstrates the improvements achieved since March 1986.

TABLE 7.2 **Ulsterbus and Citybus: efficiencies of stores holdings**

Date	Total issues for 1 year (£)		Stock valuation at year end (£)		Stock turnover	
	Ulsterbus	Citybus	Ulsterbus	Citybus	Ulsterbus	Citybus
29.3.86	1,912,014	554,986	695,529	264,279	2.74	2.10
29.3.87	1,763,511	596,078	638,232	248,366	2.76	2.40
27.3.88	1,925,834	657,978	654,977	263,191	2.94	2.50

Source: Ulsterbus and Citybus.

Maintenance performance

7.24. Meaningful comparison of maintenance performance with that of other bus undertakings is difficult since:

- except for the large authorities, statistics are difficult to obtain;
- operating conditions can be different;
- fleet compositions can vary widely;
- age profiles of fleets can be quite different;
- maintenance facilities can vary considerably; and
- the basis of figures used in calculating ratios is not always the same.

7.25. Even in Ulsterbus and Citybus, measures of engineering performance are not entirely the same due in part to the different productivity arrangements which exist. Ulsterbus operates a multifactor scheme of productivity assessment where achievement is determined from statistics relating to PSV recertification, vehicles off-service, quality audit of vehicle condition and man-hours per bus. By contrast Citybus operates a work-measured productivity assessment where achievement is determined from statistics relating to attendance hours, unmeasured work and standard hours produced.

7.26. However, some comparisons have been possible and the following areas of performance monitoring are highlighted as those most common to the two companies and most relevant to our inquiry.

PSV recertification

7.27. Table 7.3 shows PSV recertification achievement by Ulsterbus and Citybus.

TABLE 7.3 **Ulsterbus and Citybus: PSV recertification achievement**

	<i>Period</i>	<i>Total vehicles submitted</i>	<i>Vehicles refused</i>	<i>Failure percentage</i>
Ulsterbus	May 1987-Dec 1988	1,046	25	2.4
Citybus	1985-1988	1,259	27	2.1

Source: Ulsterbus and Citybus.

7.28. Table 7.4 shows PSV recertification achievement for all vehicles tested in Great Britain for the period 1984/85 to 1987/88.

TABLE 7.4 **Recertification achievement-Great Britain**

	<i>1984/85</i>	<i>1985/86</i>	<i>1986/87</i>	<i>1987/88</i>
Total tested	61,288	69,334	68,376	67,382
Total failed	11,747	13,251	13,634	14,986
Percentage failed	19.2	19.1	19.9	22.2

Source: DTpTransport Statistics (Great Britain) 1977-1987.

Maintenance and operating costs

7.29. Bus undertakings have traditionally monitored the relationship between total maintenance cost and total operating cost of vehicles maintained. A maintenance factor of between 19 and 21 per cent is generally thought to be an acceptable target. A figure below 19 per cent implies high operating costs and a figure above 21 per cent implies high maintenance costs.

7.30. Table 7.5 sets out maintenance and operating costs for both Ulsterbus and Citybus for the financial years 1986/87 and 1987/88. Operating costs exclude the cost of operating non-stage carriage vehicles (see paragraph 7.4) but maintenance costs do not. Making due allowance for this and for the greater number of drivers and inspectors required by Citybus, the companies' performance falls within acceptable limits.

TABLE 7.5 **Ulsterbus and Citybus: maintenance cost as percentage of total operating cost**

<i>Period</i>	<i>Operating cost (£'000)</i>		<i>Maintenance cost (£'000)</i>		<i>Maintenance/operating (%)</i>		
	<i>Ulsterbus</i>	<i>Citybus</i>	<i>Ulsterbus</i>	<i>Citybus</i>	<i>Ulsterbus</i>	<i>Citybus</i>	<i>Both</i>
1986/87	26,190	11,638	6,235	1,993	23.8	17.1	21.8
1987/88	27,981	12,306	6,500	2,056	23.2	16.7	21.2

Source: Ulsterbus and Citybus Annual Report and Accounts for 1986/87 and 1987/88.

Maintenance and repair costs

7.31. It is difficult to establish the number of buses in the operational fleets for the following reasons:

- (a) the position fluctuates with seasonal changes in the number of buses taxed;
- (b) bus replacements frequently overlap the withdrawal of vehicles they replace; and
- (c) some vehicles will inevitably be 'lying-off' for repair.

7.32. The companies were unable to separate the maintenance cost of stage carriage vehicles from the total maintenance cost of all vehicles (see paragraph 7.4). Thus we have been unable to calculate, as the Commission have in previous reports on other bus undertakings, a maintenance and repair cost per bus. Instead we have calculated a maintenance and repair cost per vehicle maintained.

7.33. Table 7.6 shows trends in vehicle maintenance and repair costs for the companies using end of financial year cost and fleet data for the years 1986/87 and 1987/88.

TABLE 7.6 **Ulsterbus and Citybus: vehicle maintenance and repair costs**

	1986/87		1987/88		% change	
	Ulsterbus	Citybus	Ulsterbus	Citybus	Ulsterbus	Citybus
Total vehicle maintenance and repair cost (£'000)	6,235*	1,993	6,500*	2,056	+ 4.0	+ 3.2
Stage carriage vehicles (operational fleet)	899	297	895	305	-0.4	+ 2.7
Total vehicles maintained (includes non-stage carriage vehicles)	1,078 (1,055)**	360	1,106 (1,069)**	365	+ 2.6	+ 1.4
Cost per vehicle maintained (£)	5,910	5,536	5,877	5,633	-0.6	+ 1.8

Source: Ulsterbus and Citybus Annual Report and Accounts for 1986/87 and 1987/88.

*Excludes maintenance cost of Flexibus vehicles.

**Figures adjusted to exclude Flexibus vehicles.

Notes:

1. Vehicles as at March 1987 and March 1988.
2. Flexibus vehicles maintained by Ulsterbus and costs transferred to Flexibus account.

7.34. Table 7.6 shows the following:

- (a) Ulsterbus and Citybus total vehicle maintenance costs increased by 4.0 per cent and 3.2 per cent respectively between 1986/87 and 1987/88. Over the same period the general index of retail prices and the index of average earnings increased by 4.3 per cent and 5.8 per cent respectively;
- (b) both companies have experienced increases in the total number of vehicles they maintain Ulsterbus by 2.6 per cent and Citybus by 1.4 per cent; and
- (c) Ulsterbus and Citybus costs per vehicle maintained changed in 1987/88 by -0.6 per cent and + 1.8 per cent respectively on the previous year, demonstrating an improvement in efficiency by Ulsterbus.

The difference in cost per vehicle maintained between the companies for the two financial years in question is accounted for by the higher proportion of Depot Engineers and skilled personnel employed by Ulsterbus, with its greater number of depots, and by the high proportion of engineering spares and reserves which Citybus has to carry.

Buses off-service

7.35. A proportion of the buses in each company's fleet will be off-service for inspection, maintenance, overhaul or repair. These buses are termed engineering spares and form part of the total of buses off-service for all reasons. Both companies monitor buses off-service against predetermined limits and data relating to some 200 days of operation in 1987/88 revealed that both generally achieved performances within the limits set and that the limit was exceeded only exceptionally.

7.36. In mid-1986 Ulsterbus designed an engineering cost audit to determine the cost of premature failure due to engineering reasons. This has subsequently been used to check periodically costs of various types of failure including costs of regular maintenance and those associated with accidents, vandalism and malicious damage.

7.37. The results of 16 audits undertaken between April 1987 and April 1988 revealed that the labour and material costs of premature failures for engineering reasons amounted to no more than 0.1 per cent of total vehicle maintenance and repair costs.

Man-hours per bus

7.38. As part of its multifactor productivity scheme Ulsterbus has set a target of 62.7 man-hours per bus in each four-week reporting period. Since 1983 the number of man-hours per bus has been consistently lower.

7.39. Citybus monitors the standard hours earned against actual hours worked. For the purpose of comparison the company calculated that for 1987/88 the average man-hours per bus were, in Ulsterbus terms, 53 man-hours per period per bus.

Maintenance productivity

7.40. As we noted in paragraph 7.25, the two companies have different productivity schemes in operation for their engineering employees. The scheme for Citybus is based on work-measured standards and was introduced in 1968/69 at which time a reduction of 31 per cent was achieved in the engineering workforce. In 1979 a reduction of 10 per cent in the standard hours earned was negotiated with the trades unions. More recently greater discipline has been imposed on the completion of job sheets and greater use made of estimated times for certain types of work.

7.41. Our own observations of work carried out within Ulsterbus and Citybus, including both central workshops and 14 of the depots, indicated that the average employee performance index (PI) was certainly in excess of standard. Individual productivity performances are currently averaging out at 117 PI. Standard performance (100 PI) would normally be expected from experienced maintenance staff as a minimum requirement.

7.42. We believe there is merit in approaching the subject of engineering productivity from an alternative vantage point by examining value for money. Our analysis of wages paid to employees in both companies revealed that in addition to basic wage, all craftsmen receive a bonus payment of some £26 a week, bringing their total weekly wage up to approximately £160. In return for this we found, as described above:

- (a) the number of engineering employees per vehicle maintained is less than the Commission found in previous studies of other bus undertakings;
- (b) maintenance costs as a proportion of total operating costs are within acceptable limits and increases have been well within inflation;
- (c) PSV recertification failures for both Ulsterbus and Citybus (2.2 per cent) are considerably less than the national average of some 22.0 per cent;
- (d) vehicles off-service are well within targets;
- (e) the cost of premature failure due to engineering is only 0.1 per cent of total maintenance cost;
- (f) man-hours per bus maintained are consistently better than target; and
- (g) a 10 per cent reduction in standard hours earned has been achieved by Citybus by negotiation.

We also found a flexible use of engineering labour in the two companies and well motivated engineering workforces, willing and able to respond to pressure and changes in priority.

7.43. The companies' new Monkstown depot (see paragraph 6.44) is intended to house both Ulsterbus and Citybus engineering staff servicing a common fleet of buses. The companies told us that some rationalisation of maintenance procedures and productivity assessments would be necessary.

Central workshop costs

7.44. The absence of a common system of central workshops costing embodying unit costing has prevented us from making cost comparisons between the two workshops or with external competitors.

7.45. The cost of work carried out by both workshops, on behalf of their respective depots, is charged monthly as a lump sum to those depots. No detailed costing of specific types of jobs, eg engine and gearbox rebuild, is currently available. Workshop charges to depots consist of time spent on jobs valued at appropriate wage rates and workshop overheads allocated to work in proportion to the wages charged. The companies told us that the advantage of this method was that each month's workshop costs were fully charged to the depots. In fact there is an end of financial year reconciliation which particularly distorts the costs for the month of March.

7.46. The disadvantages of the companies' present systems of workshop costing are that:

- (a) both companies have been unable adequately to compare the cost performance of their workshops either with each other or with outside contractors with a view to identifying potential cost savings;
- (b) the cost to depots of identical jobs can vary from month to month, limiting the Depot Engineers' ability to forecast maintenance costs; and
- (c) there is no workshop financial report identifying levels of workshop efficiency.

CONCLUSIONS AND RECOMMENDATIONS

Engineering stores and stock control

7.47. The existing stock control system has proved effective and satisfactory, despite minor deficiencies, and has facilitated an acceptable improvement in stock turnover.

PSV recertification

7.48. The PSV recertification performances achieved by both companies, for the years 1985 to 1988, are considerably better than the national averages quoted by the DTp for the same period.

Vehicle maintenance costs

7.49. Ulsterbus and Citybus total vehicle maintenance costs increased by 4.0 per cent and 3.2 per cent respectively between 1986/87 and 1987/88. Over the same period the general index of retail prices and the index of average earnings increased by 4.3 per cent and 5.8 per cent respectively. Taking the two companies together we find that maintenance cost as a proportion of operating cost for 1986/87 and 1987/88 is within acceptable limits.

Vehicle maintenance and associated productivity

7.50. The housing of both Ulsterbus and Citybus maintenance staff under one roof at the new Monkstown depot to maintain a common fleet of buses will bring to the fore different operating arrangements existing between the two companies' engineering functions. The current arrangements in Ulsterbus and Citybus for the execution of PSV recertification and overhaul work and the systems of assessing productivity performance are quite different. There is an opportunity to rationalise these arrangements at Monkstown but full account will have to be taken of the impact on current working arrangements and staff at the companies' other depots. We recommend that comprehensive consideration should be given to how best, in practical and cost-effective terms, the maintenance, overhaul and repair work can be carried out for the total fleet of buses to be based at Monkstown.

7.51. The results achieved by both Ulsterbus and Citybus, through their respective bonus incentive schemes, show that they have been successful in matching engineering labour resources to the maintenance workload and have achieved good levels of productivity.

Workshop costing

7.52. The companies have not developed a common costing system for their workshops nor any system of unit costing. They have therefore been unable adequately to compare the cost performance of their workshops either with each other or with outside contractors with a view to identifying potential cost savings. Such comparisons might, for example, indicate that savings could be made by concentrating the repair and overhaul of exchange units on one site. Accordingly we recommend that the companies should develop and implement a common costing system including unit costing for their workshops. The unit costing system should include agreed labour times and material costs with a standard wage and an overhead recovery rate per hour which is recalculated annually.