

Summary: Research Needs in Transit Bus Maintenance

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ABSTRACT

Summarized in this Record are eleven areas in which research on transit bus maintenance would be beneficial. These eleven research areas were distilled from the papers and presentations offered at the 65th Annual Meeting of the Transportation Research Board in January 1986.

As a result of presentations made at the 65th Annual Meeting of the Transportation Research Board (TRB) in 1986, the Committee on Transit Bus Maintenance (A3C02) has identified areas in which additional research on bus maintenance would be useful. The Committee has also attempted to define research topics that (a) address the concerns of maintenance managers in the industry, and (b) address topics that are amenable to research by members of the transportation community who actively participate in the TRB. The Committee recognizes that other forums (such as the American Public Transit Association) are better able to address specific, day-to-day problems experienced by transit maintenance managers. The TRB provides a bridge between the transit industry and the academic-government-consultant community. As such, TRB-sponsored research should identify problems that take advantage of the research skills available to it.

Another theme that emerged during the Annual Meeting was the need to introduce to transit maintenance research the skills and methods of disciplines not traditionally associated with the industry. Many research issues revolve around people (e.g., training issues, motivation, quality control, and problem diagnosis). Researchers from fields such as industrial engineering, education, psychology, and management would have much to offer. Similarly, geographers possess skills in measurement of climate and terrain that can help explain the different maintenance requirements of transit properties. Sociologists and psychologists deal with the issues of community, belonging, motivation, and pride-in-performance that are so essential to a productive shop. It is the opinion of the Committee that an infusion of new people from different disciplines is important to the continuing vitality of research in this area.

It is recognized, however, that research conducted by those not in the transit industry must guard against the charge of irrelevance. The Committee has concluded that its proper role in maintenance research is to utilize the time and skills available to its members to identify basic principles, techniques, tools, and procedures that have merit. It is also the responsibility of the Committee to recruit talent from other fields and to clearly demonstrate the relevance of research and to suggest areas for implementation.

In the interest of relevance, the Committee has also concluded that research should avoid "data-hungry" techniques. The detailed empirical data required by some prior research efforts will probably never be available; if they are available, they will

always be subject to dispute. If the data are not acceptable to the industry, the research results cannot be acceptable either. Accordingly, as inputs to research models or simulations, the Committee encourages the use of industry measures that exhibit stability over time and between properties. Alternatively, input data should be obtainable by the maintenance managers who are to benefit from the research effort. In the light of this discussion, eleven areas have been identified in which productive research can be conducted by TRB members in the area of transit bus maintenance.

1. DEMONSTRATE THE IMPORTANCE OF MAINTENANCE

Maintenance is not a glamorous topic, yet it accounts for approximately 20 percent of bus operating costs (1) and is responsible for preserving billions of dollars in capital investments. Research synthesis efforts that demonstrate this point are valuable. The primary audience that needs to be exposed to these facts are transit agency boards of directors, city councils, and the public.

2. QUALITY OF CURRENT MAINTENANCE

Some research work done in military maintenance and recent work in transit maintenance indicates that the error rate in repair work is between 30 percent and 50 percent. These figures have been derived from time series analyses of repeat repairs on the same component on the same vehicle. A top research priority should be to find out why this is the case and identify potential corrective actions.

3. INFORMATION SYSTEMS

To address item 2 as well as some items that follow, good data are required. As maintenance information systems come on line in various properties, the following types of reports are needed:

- * Time series repair reports by vehicle,
 - * Total maintenance costs by vehicle,
 - * Repairs by type across all vehicles in a class,
- and
- * Time to repair by type of repair.

These inputs are vital to both problem identification and problem solution. Developing a model information system at some property and, from it, developing a maintenance data base available to researchers would be a beneficial step. These data may be available already. If so, identifying their loca-

tion and making the data available would be most beneficial.

4. MEASURES AND STANDARDS

It has been noted by others that the first step in advancing scientific knowledge in any area is the development of a measurement system. The transit maintenance industry has measures available to it, such as

- Miles between road calls (chargeable and non-chargeable),
- Mean time to repair,
- Incidence of repeat repair, and
- Average maintenance cost per vehicle.

Definitional problems plague attempts to use industry-wide data to develop standards of performance, however. Road call definitions vary from property to property; wage rates differ; maintenance policies differ; and the level of maintenance training also varies.

It may be unrealistic to expect the entire industry to adopt the same precise definitions, however, because the use of a term historically develops on a property and has meaning there but not necessarily somewhere else. Similarly, wage rate and maintenance policies will never be the same across the country. A positive advance in labor-related maintenance reporting would be the use of labor hours in place of dollars for cost items. Annual maintenance labor hours per vehicle is a more generic measure than cost per vehicle. Such data can be utilized by any transit property by applying prevailing local wage rates.

This is an area in which researchers with expertise from outside the transit industry can make a real contribution. Climate and terrain are noted by transit operators as reasons for differing maintenance practices. In informal discussions, transportation professionals talk of the "rust belt" and the "sun belt" and understand that maintaining a fleet of buses in these environments requires different procedures. Quantifying these terms in a useful way is not easy, but this problem can be addressed through geographical research. Measurement tools do exist to specify climatic and terrain variables that may, in turn, assist in the development of useful standards.

5. MAINTENANCE CONTRACTING

The development of internal standards of performance is essential if increased use is made of outside maintenance contractors as part of the privatization initiative. Acceptance testing of components rebuilt or repaired by outside contractors is essential. Clear specifications must be included in contracts if acceptable results are to be obtained. Performance standards developed for in-house performance evaluation become a tool for assuring satisfactory performance by contractors. A valuable research contribution can be made by synthesizing detailed standards used by the industry and making them available.

6. INCENTIVES

A critical management problem in maintenance facilities is the provision of personnel incentives. How should work be organized and good performance rewarded? How can pride be instilled for a job well done? How can the fear of failure on the part of

junior personnel be overcome? The tools of management science and psychology could well be brought to bear on this issue.

This is an area that traditional transportation research has not covered, yet it is critical to achieving the elusive goal of improved productivity, the measurement of which has been the subject of extensive research and many papers. Productivity measurement does not suggest what to do if a problem is discovered; it simply provides a method of identifying the problem. Motivating the work force through a planned management program is possible and desirable. Research from other fields should be sought in this area.

7. TRAINING

Related to the provision of incentives is training. People like to do what they do well and they take pride in what they do well. Providing the training to enable people to perform well and to advance is an essential part of an incentive program and an essential part of addressing the problem of repair errors. Information is needed on effective training and incentive programs.

Training is the province of education, and there are some real educational research issues here. How can complex manual skills be effectively taught? Are manuals plus on-the-job training more effective than classroom work? What is the most effective mix of classroom and on-the-job training? The field of maintenance research would benefit from participation by professional educators.

State departments of transportation are beginning to play a role in maintenance training in some states in order to protect their financial investment in rolling stock (according to a statewide transit maintenance training plan being prepared by the Virginia Department of Highways and Transportation's Rail and Public Transportation Division). This is a new area that would benefit from information dissemination on model programs. The issues here involve the organization of maintenance training at the state level.

8. PROGRAMMED COMPONENT REPLACEMENT VERSUS FIX-ON-FAILURE

Programmed component replacement based on vehicle miles or hours of service is not a commonly used maintenance system in the transit industry because the fix-on-failure system is perceived as cheaper. Programmed replacement requires a comprehensive maintenance data system to identify the optimum replacement intervals. Even if such data were available, it is not clear if the programmed replacement system would be more economical than the fix-on-failure system. The failure rate of individual components can vary over such a wide range of service hours that a programmed replacement program runs the risk of increasing cost by replacing components that have considerable service life remaining. Definitive research on this topic would be welcome.

9. COMPUTERIZED SMART SYSTEMS

Correct problem diagnosis requires skilled personnel; personnel that are not always available. "Smart" systems aid mechanics in diagnosis by incorporating the knowledge of senior mechanics in computerized diagnostic routines. This makes maintenance shop performance less dependent on the skills of particular individuals. Retirement or job changes by senior

personnel would have less of an impact on shop performance. An extension is electronic monitoring of vehicles coupled with problem diagnosis assisted by smart systems. Demonstrations have been conducted in this area with mixed success (2,3). Further development work is needed.

10. APPROPRIATE SCALE OF MAINTENANCE MANAGEMENT SYSTEMS

It is easy to conclude from this discussion that every maintenance shop should invest in the most advanced management systems. This is not the case, however. In small shops, mechanics know the idiosyncrasies of individual vehicles and mechanics often perform a wider variety of tasks. Very specialized tasks are often contracted to outside vendors. As maintenance shop size increases, so does specialization because (a) mechanics are less able to know vehicle idiosyncrasies and (b) the need for analytical management techniques increases. Research on what degree of maintenance management is appropriate for properties of various sizes would be beneficial.

11. INFORMATION SHARING

Finally, information sharing is important. Personal contact among managers cannot be replaced as a means of communication, but it can be enhanced by micro-computer information networks and by making data

available to researchers. Any work that facilitates information sharing is useful.

These research topics emerged as priority items during the course of the 1986 TRB Annual Meeting. Individuals interested in conducting research in the area of transit bus maintenance should review the literature to see what has been done to date on these topics and then focus their efforts on developing tools, procedures, or guidelines that would be useful to maintenance managers.

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