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**Study of Alternative  
Approaches to Motor  
Vehicle Maintenance**

Wilmington Commerce Dept, Wilmington, DE

Prepared for

Department of Housing and Urban Development, Washington, DC Office of  
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As part of a productivity improvement effort, Wilmington, Del., experimented with various approaches to maintaining police patrol vehicles. Wilmington operated a demand driven system for its 31 police vehicles; i.e., with the exception of routine maintenance such as oil changes, the vehicles were driven until they broke down. Officials believed that maintenance could be improved by employing the following methods: (1) using planned preventive maintenance, (2) contracting with the private sector for maintenance work, or (3) holding individual officers responsible for maintaining their vehicles. Corresponding groups and a control group involving a total of 29 vehicles (mostly Belairs and Chevilles) were formed to test these hypotheses. A number of methodological problems, however, limited the usefulness of data obtained in the experiment: the sample was too small, there were no Belairs in the control group, the cars in the sample were not homogeneous, assignment to groups was probably not random, preventive maintenance schedules were not always followed, gas station, .....

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A STUDY OF ALTERNATIVE APPROACHES TO  
MOTOR VEHICLE MAINTENANCE

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A STUDY OF ALTERNATIVE APPROACHES TO  
MOTOR VEHICLE MAINTENANCE

JANUARY, 1979

BY

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FOR

OFFICE OF POLICY DEVELOPMENT AND RESEARCH  
DEPARTMENT OF HOUSING AND URBAN DEVELOPMENT

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## INTRODUCTION

One of the key elements in the costs and effectiveness of any police department is vehicle maintenance. Patrol vehicles are constantly in use and, as compared to private automobiles, require frequent and expensive maintenance. Maintenance-caused downtime of vehicles either reduces the effectiveness of the force, or must be compensated for by owning and maintaining additional vehicles. For these reasons, officials of the City of Wilmington were desirous of finding ways of improving the maintenance of police vehicles.

To this end, as part of a productivity improvement effort supported by the Federal Department of Housing and Urban Development, Wilmington officials decided to experiment with various maintenance approaches. The attempted experiment is an interesting one, primarily because of the size of the fleet involved. Wilmington police operate a total of only 81 vehicles, some of which are not patrol cars. In conducting a fleet maintenance experiment, Wilmington was, in part, seeking to answer the question of whether such an experiment could be successfully conducted by a city maintaining a small fleet.

For reasons discussed in detail below, Wilmington officials do not offer the results of their experiment as definitive for Wilmington nor for other cities seeking to decide among various maintenance approaches. However, they believe that they have succeeded in developing a transferable experimental design which, with the recommended improvements they have discovered, will provide a basis for similar experiments in other cities. This report provides the study methodology. Results are reported primarily to indicate the form that the resulting data could take.

The project was initiated by the Program Analysis Division of the Department of Planning and Development in cooperation with two other departments of Wilmington government. The Patrol Division of the Bureau of Police was responsible for the police operating the cars. The Department of Public Works performed the in-house maintenance of the vehicles.

## METHODOLOGY

Design of the Classes: The baseline Wilmington police vehicle maintenance system, with the exception of routine actions such as oil changes, was a demand driven system.

Vehicles were driven until they broke down; the cause of the breakdown was determined in the Public Works maintenance facility and corrected and the vehicle was returned to service. Wilmington officials adopted the hypotheses that maintenance could be improved by: (1) using planned preventive maintenance, (2) contracting out to the private sector, and/or (3) making individual identifiable officers responsible for the maintenance of particular vehicles. These hypotheses led to four separate classes for the experiment, namely:

- (1) Control: Continuation of present practice with repair service performed on an "as needed" basis;
- (2) Ownership Preventive: Maintenance was performed in-house but individual officers (two for each car) assigned to specific vehicles for preventive maintenance scheduling;
- (3) Non-Ownership Preventive: Preventive maintenance performed in-house without particular officers being assigned particular vehicles; and
- (4) Non-Ownership Preventive, Private: This class is identical to class (3), but uses private contractors rather than the Department of Public Works.

Selection of Vehicles: A total of twenty-nine vehicles were selected by the Department of Public Works for the experiment. These were divided by vehicle type as shown in Table 1.

Table 1

Vehicle Types Used in Experiment

<u>Maintenance Approach</u>	<u>1974 Belair</u>	<u>1975 Chevelle</u>	<u>Total</u>
Control	0	11	11
Ownership Preventive	2	3	5
Non-Ownership Preventive	4	3	7
Non-Ownership Preventive, Private	3	3	6
<u>Total</u>	9	20	29

At the time of the experiment Belairs and Chevelles were the primary vehicles in the police fleet. When the experiment was designed, the study team did not anticipate that maintenance costs would vary significantly between the vehicle types.

Reporting System: The basic reporting system was a simple one. The report form and instructions to participants are shown as Appendix A. The report form and instructions were designed to yield data on the miles traveled by vehicles, the number of visits to the repair shop, total downtime per vehicle and cost of repairs and preventive maintenance.

Transmission Repairs: At the outset of the analysis, it became apparent that transmission repairs should be distinguished from other repairs. The average cost and downtime associated with transmissions was far in excess of any other maintenance item. Because the preventive maintenance programs placed little emphasis on the transmission and all transmission work is contracted to private shops, transmission repair incidents were considered random phenomenon which would distort an analysis of alternative maintenance strategies.

Problems With the Methodology: The methodology for the collection of data and analysis is viewed by city officials as being reasonable for this type of analysis. However, a number of problems limit the usefulness of data obtained in the experiment. These include:

(1) The number of cars involved was small and the time period of the experiment short (nine months). As a result, it would have been difficult to draw valid conclusions that would be generalizable for overall vehicle maintenance procedures in Wilmington even if no other problems had been encountered.

(2) The maintenance experience of the Belairs was quite different from the newer Chevelles and there were no Belairs in the control group. This meant that the number of cars where comparisons could be meaningfully made was limited to the 20 Chevelles.

(3) The cars themselves were not homogeneous -- cars were not new and had different maintenance histories and mileages.

(4) The assignment of vehicles to various classes was made by the Department of Public Works and was probably not random.

(5) Preventive maintenance schedules were not always followed because of operational priorities for use of vehicles by the Patrol Division.

(6) The use of gas stations performing preventive maintenance on a retail basis is not necessarily indicative of what would have happened if a garage performed preventive maintenance for an entire fleet.

(7) Cars in different groups were driven different mileages during the experiment.

(8) The project team was uncertain that the record keeping system accurately reported either costs or downtime for the in-house maintenance.

### THE RESULTS

Notwithstanding that the limitations above make the study of little value for deciding which maintenance routine to adopt, the analytical approach used by Wilmington should be useful for cities wishing to perform a similar analysis while avoiding the methodological problems.

Table 2 provides the summary statistics on Chevilles in terms of the average for each approach to maintenance. As noted earlier, the mileage on vehicles in each group was different at the onset of the project, as was the number of miles driven during the project. These differences arose from causes outside of the maintenance schedules, but could have affected the results.

The data in Table 2 suggest that the in-house preventive maintenance approach was clearly superior in terms of cost per mile, total cost, cost per incident, minimizing downtime and downtime per incident. The data in Table 2 are translated into maintenance costs for the entire Wilmington fleet of Chevilles on Table 3. This table suggests that significant differences are associated with the various maintenance approaches studied, with in-house preventive maintenance exhibiting the lowest cost.

### LESSONS LEARNED

A review of the data on Tables 2 and 3 suggests that studies of this type could provide useful information for city



TABLE 2  
SUMMARY STATISTICS  
CHEVELLE MODELS ONLY

	<u>Current System</u>	<u>In-House P.M.</u>	<u>Private Shop P.M.</u>	<u>Ownership P.M.</u>
Mileage/Vehicles	40,707 miles	40,711 miles	* 38,274 miles	o 42,314 miles
Distance/Vehicle	o 15,486 miles	14,053 miles	13,928 miles	* 12,660 miles
Cost/Mile	6.53¢	* 5.45¢	6.01¢	o 8.03¢
Down/Mile	.54 minutes	* .29 minutes	o .71 minutes	.66 minutes
Cost/Vehicle	\$1,012.00	* \$765.87	\$836.55	o \$1,016.49
Down/Vehicle	8,330 minutes	* 4,127 minutes	o 9,900 minutes	8,416 minutes
Cost/Incident	\$36.67	* \$22.53	o \$41.83	\$40.66
Down/Incident	301.8 minutes	* 121.4 minutes	o 495.0 minutes	336.6 minutes
Incidents/10,000 Miles	17.82	o 24.19	* 14.36	19.75
Incidents/Vehicle	o 27.6	11.3	* 6.7	8.3

o Denotes highest average

\* Denotes lowest average

TABLE 3  
ANNUALIZED FLEET OPERATING COST  
CHEVELLE MODEL VEHICLES ONLY

	<u>Current System</u>	<u>In-House P.M. Repair Costs</u>	<u>Private Shop P.M.</u>	<u>Ownership P.M.</u>
Cost/Mile	\$ .0653	\$ .0545	\$ .0601	\$ .0803
Miles/Veh/Yr	20,000	20,000	20,000	20,000
Cost/Veh/Yr of Veh	<u>\$ 1,306</u> 32	<u>\$ 1,090</u> 32	<u>\$ 1,202</u> 32	<u>\$ 1,606</u> 32
Annual Fleet Repair Costs	<u>\$ 41,792</u>	<u>\$ 34,880</u>	<u>\$ 38,464</u>	<u>\$ 51,392</u>
<u>COST OF DOWNTIME</u>				
Down/Mile	.54 minutes	.29 minutes	.71 minutes	.66 minutes
Miles/Veh/Yr	20,000	20,000	20,000	20,000
Down/Veh/Yr of Veh	<u>10,800</u> minutes 32	<u>5,800</u> minutes 32	<u>14,200</u> minutes 32	<u>13,200</u> minutes 32
Down/Fleet/Yr	<u>345,000</u> minutes	<u>185,600</u> minutes	<u>454,400</u> minutes	<u>422,400</u> minutes
Down/Fleet/Yr	240 days	129 days	316 days	293 days
Cost/Yr	<u>\$ 5.75</u>	<u>\$ 5.75</u>	<u>\$ 5.75</u>	<u>\$ 5.75</u>
Annual Cost of Downtime	<u>\$ 1,380</u>	<u>\$ 742</u>	<u>\$ 1,817</u>	<u>\$ 1,685</u>
TOTAL ANNUAL OPERATING COSTS	<u>\$ 43,172</u>	<u>\$ 35,662</u>	<u>\$ 40,281</u>	<u>\$ 53,077</u>

officials seeking to determine the most effective way to maintain vehicles. The limitations of those data could be eliminated in comparable studies in other cities by steps such as these:

(1) Care should be taken to make sure that factors likely to affect maintenance costs (such as vehicle type and number of miles driven before beginning the experiment) are controlled for in the experiment. For example, the distribution of types of cars and mileage should be the same, or nearly so, in each of the groups.

(2) Studies or experiments which require interdepartmental cooperation (e.g., with Police and Public Works) should be devised with a "bottom up" strategy. Input and cooperation should be sought from all levels at the inception of the planning stage as well as the implementation stage for such projects.

(3) The experiment should last long enough so that differences that materialize over a longer term, as would be expected to be the case in preventive maintenance, would occur during the study period.

APPENDIX A

EXAMPLE

FORM B

CAR NO.-----

DATE OF SHOP REPAIR-----

TIME OF DELIVERY-----

RECORDED MILEAGE-----

P. M. OR REPAIR

TYPE OF SERVICE-----

DATE AND TIME OF CALL FOR PICK-UP\_\_\_\_\_

DOWN TIME-----

CADET OR OFFICER DELIVERING CAR-----

DESIGNATED SERGEANT-----

INDIVIDUAL RESPONSIBILITIES IN PREVENTIVE  
MAINTENANCE EXPIREMENT

PATROLMAN OR CADET

A. MOTOR VEHICLE SHOP PREVENTIVE MAINTENANCE (GROUP 1)

1. Deliver car to Motor Vehicle Shop.
2. Fill out date and time of arrival at shop on Form B. Also record vehicle mileage on Form B.
3. Return to Bureau of Police. Give Form B to designated sergeant.
4. Pick up vehicle at shop.

EMERGENCY REPAIRS

5. In the case that a car needs repairs, notify designated sergeant that car is being taken to Motor Vehicle Shop.
6. Deliver car to a shop.
7. Fill out date and time of arrival at shop on Form B. Record vehicle mileage on Form B.
8. Return to Bureau of Police. Give Form B to designated sergeant.
9. Pick up vehicle at shop.

B. PRIVATE SHOP PREVENTIVE MAINTENANCE (GROUP 1)

1. Deliver car to private shop.
2. Fill out date and time of arrival at shop on Form B. Also record vehicle mileage on Form B.
3. Return to Bureau of Police. Give Form C to designated sergeant.
4. Pick-up vehicle at private shop.

EMERGENCY REPAIRS

5. In the case that a car needs repairs, notify the designated sergeant that car is being taken to the Motor Vehicle Shop.
6. Deliver car to a shop.
7. Fill out date and time of arrival at shop on Form B. Re-

EMERGENCY REPAIRS CONTINUED

cord vehicle mileage on Form B.

8. Return to Bureau of Police. Give Form B to designated sergeant.
9. Pick up vehicle at shop.

C. NON-MAINTENANCE GROUP CARS (GROUP 11)

1. Deliver car to Motor Vehicle Shop only, if it needs repairs (not for preventive maintenance).
2. Fill out date and time of arrival at shop on Form B. Record vehicle mileage on Form B.
3. Notify designated sergeant that car is being taken to Motor Vehicles to be repaired.
4. Give Form B to sergeant.
5. Pick up vehicle at shop.

D OWNERSHIP/MAINTENANCE CARS (GROUP 111)

1. Drivers are assigned to vehicles.
2. Drivers should notify sergeant when cars are ready to be taken in for preventive maintenance.
3. Deliver car to Motor Vehicle Shop.
4. Fill out date and time of arrival at shop on Form B. Record vehicle mileage on Form B.
5. Give Form B to designated sergeant.
6. Sergeant will notify officer when car is ready. Pick up car at Motor Vehicle Shop.

EMERGENCY REPAIRS

7. Notify designated sergeant that car is being taken to Motor Vehicles to be repaired.
8. Deliver car to Motor Vehicle Shop.
9. Fill out date and time of arrival at shop on Form B. Record vehicle mileage on Form B.
10. Give Form B to sergeant.
11. Pick up vehicle at shop.

INDIVIDUAL RESPONSIBILITIES IN PREVENTIVE  
MAINTENANCE EXPERIMENT

PRIVATE SHOP MANAGER

B. PRIVATE SHOP PREVENTIVE MAINTENANCE (GROUP 1)

1. Receive and give car preventive maintenance check-off Form C.
2. Notify head of Motor Vehicles of any additional work needs to be done on vehicle.
3. Call designated sergeant when vehicle is ready for operation.
4. Send service billing and Form C to designated sergeant.

INDIVIDUAL RESPONSIBILITIES IN PREVENTIVE  
MAINTENANCE EXPERIMENT

HEAD OF MOTOR VEHICLES

A. MOTOR VEHICLE PREVENTIVE MAINTENANCE (GROUP I)

1. Receive and give car preventive maintenance check-up Form C.
2. Call designated sergeant when vehicle is ready for operation.
3. Send service billing and Form C to designated sergeant.

EMERGENCY REPAIRS

4. Receive car and give necessary repairs.
5. Decide whether P. M. work should be done if the mileage is near the next check-up date.
6. Call sergeant when car is ready.
7. Send service billing to designated sergeant.

ADDITIONAL AND EMERGENCY REPAIRS

1. Receive calls from private shop manager if car needs additional repairs.
2. Send employee to private shop to evaluate the need for further work on vehicle.
3. After conversation with employee , approve or disapprove further work.

B. NON-MAINTENANCE GROUP CARS (GROUP II)

1. Receive and repair car as needed.
2. Call designated sergeant when vehicle is ready for operation.
3. Send service billing to sergeant.

C. OWNERSHIP/PREVENTIVE MAINTENANCE (GROUP III)

1. Receive and give car preventive maintenance check-up Form C.
2. Call designated sergeant when vehicle is ready for operation.



C. OWNERSHIP/PREVENTIVE MAINTENANCE (GROUP III CONTINUED)

3. Send service billing and Form C to sergeant.

EMERGENCY REPAIRS

4. Receive car and give necessary repairs.
5. Decide whether P. M. should be done if the mileage is near the next check-up date.
6. Call sergeant when car is ready.
7. Send service billing to sergeant.

INDIVIDUAL RESPONSIBILITIES IN PREVENTIVE MAINTENANCE  
EXPERIMENT

DESIGNATED SERGEANT

A. MOTOR VEHICLE PREVENTIVE MAINTENANCE (GROUP I)

1. Check starting mileage on all cars.
2. Record mileage on Form A.
3. Log in expected check-up mileages based on average daily patrol mileage.
4. Check mileage on patrol car before estimated check-up date.
5. Notify Motor Vehicle that car will be coming in.
6. Assign cadet or officer to deliver car.
7. Make sure that Form B is filled out.
8. Log in time of telephone call from Motor Vehicle Shop on Form B. Complete Form A.
9. Dispatch cadet or officer to pick-up car.
10. Compute down time. Place forms in folder.

EMERGENCY REPAIRS

11. In the case of emergency repairs, make sure that Form B is completed and forms are placed in the correct folder.

B. PRIVATE SHOP PREVENTIVE MAINTENANCE (GROUP II)

1. Check starting mileage on all cars in group.
2. Record mileage on Form A.
3. Log in expected check-up mileages based on average daily patrol mileages.
4. Check mileage on patrol car before estimated check-up date.
5. Notify private garage or gas station that car will be coming in.

DESIGNATED SERGEANT

B. PRIVATE SHOP PREVENTIVE MAINTENANCE (GROUP II CONTINUED)

6. Assign cadet or officer to deliver car.
7. Make sure that Form B is filled out.
8. Log in time of telephone call from private shop on Form B.
9. Dispatch cadet to pick up car.
10. Compute down time. Place forms in folder.

ADDITIONAL REPAIRS

11. Must be notified that vehicle is being towed or driven from private garage to Motor Vehicle Shop.

EMERGENCY REPAIRS

12. Make sure that Form B is completed and forms are placed in the correct folder.

C. VEHICLES NOT RECEIVING SPECIAL ATTENTION (GROUP III)

1. Check starting mileage on all patrol cars in group. Record mileage on Form A.
2. Make sure that Form B is completed for each time car is brought in.
3. Log in time of telephone call from Motor Vehicle Department. Complete Form B.
4. Dispatch cadet or officer to pick-up car.
5. File repair billing and Forms B & C in individual car folder.

D. OWNERSHIP/PREVENTIVE MAINTENANCE (GROUP IV)

1. Check starting mileage on all patrol cars in group. Record mileage on Form A.
2. Log in expected check-up mileages on Form A.
3. Instruct officers to check mileage on their vehicles a day or two before estimated check-up date.

DESIGNATED SERGEANT

D. OWNERSHIP/PREVENTIVE MAINTENANCE (GROUP IV)

4. Notify Motor Vehicle that the car is being brought down to the shop.
5. Assign cadet or officer to deliver car.
6. Make sure that Form B is completed.
7. Log in time of telephone call from Motor Vehicle Shop on Form B. Complete Form A.
8. Dispatch cadet or assigned officer to pick-up car.
9. Compute down time and file forms B & C and service billings.

EMERGENCY REPAIRS

10. Make sure that Form B is completed for each emergency repairs.

### RESPONSIBILITIES OF PATROL OFFICER

1. You will be assigned a marked vehicle for a (7) month period. During your off-duty hours this vehicle will be utilized by only one other officer.
2. At the roll call before each shift the sergeant will give you the keys for this vehicle. Under all but emergency situations, this will be your vehicle.
3. Every 2000 miles you should notify Sgt. DeCusatis that the car is ready to be taken to the Motor Vehicle Shop for preventive maintenance. The preventive maintenance to be performed as indicated on Form C.
4. After delivering your car to the Motor Vehicle Shop, fill out the date and time of arrival at the Shop on Form B. Also record vehicle mileage on Form B.
5. Give Form B to Sgt. DeCusatis.
6. Sergeant DeCusatis will notify you when the car is ready. Pick up the car at the Motor Vehicle Shop.

### EMERGENCY

1. Notify Sergeant DeCusatis that the car is being taken to the Motor Vehicle Shop to be repaired.
2. Deliver car to Motor Vehicle Shop.
3. Fill out date and time of arrival at shop on Form B. Record vehicle mileage on Form B.
4. Give form B to Sergeant DeCusatis.
5. Pick up vehicle at shop.

END

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