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16. Abstract <p>This two-year study evaluated the Michigan checklane inspection system as a trial substitute for a periodic motor vehicle inspection program. Two counties served as the test areas. One county had a simulated PMVI, while the other had a checklane inspection of 15% of the cars. Random checklanes were used in 1975 and 1976 to estimate the condition of the cars in each county, with minimum sample sizes of 2000 cars for each study group.</p> <p>The rate of equipment outages was found to depend strongly on the age of the car. Charts of this relationship are presented for several safety components. After adjusting for the age of the car, no significant differences were found in comparing the previous 5% checklane program to the more intensive 15% checklane program. Cars in the simulated PMVI program proved to be a self-selecting sample of newer cars in better mechanical condition than average, making direct comparisons to the checklane population difficult. The 1975 sample of cars in the PMVI group estimated the effects of the 5% checklane inspection program; the 1976 sample of these cars estimated the effects of the simulated PMVI group, and these two samples did not differ significantly. Thus there was no evidence of differences among the PMVI, 15% checklane, or 5% checklane.</p> <p>A special study in 1975 compared a moving stopping test to a wheel-pull brake inspection. The conclusion was that the MST was more stringent and easier to perform. In 1976 the repair rates for vehicles in the PMVI group were also determined for several safety components and were reported.</p>					
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EVALUATION OF THE MICHIGAN TRIAL SUBSTITUTE
VEHICLE INSPECTION PROGRAM

SUMMARY

How effective is the checklane vehicle inspection conducted by the State of Michigan? How effective would a checklane inspection system be that inspected on the average 15% of the state's vehicles, coupled with an increased public awareness campaign? How would such a system compare with a periodic inspection? Which procedure--a moving stopping test or a wheel pull inspection--is better for evaluating the braking system? These are some of the questions addressed by the study conducted by HSRI jointly with the MSP and OHSP during 1975 and 1976.

To qualify for federal highway funds under existing federal law, the 50 states must conduct vehicle inspection programs. Thirty-six states employ periodic motor vehicle inspection (PMVI), under which all vehicles are inspected and certified, usually annually. Michigan conducts a year-round randomized roadside inspection program. State Police teams set up temporary checklane sites at random times and locations, order approaching motorists into them, inspect and test the vehicle, and issue citations to motorists whose vehicles are found with defects. The State Police have been inspecting about 300,000 vehicles each year, or about 6% of the passenger cars registered in Michigan.

The current study attempts to answer several questions relative to the Michigan checklane inspection program:

What is the current proportion of defective vehicles in the driving population?

Among the defective vehicles, what defects are most frequent?

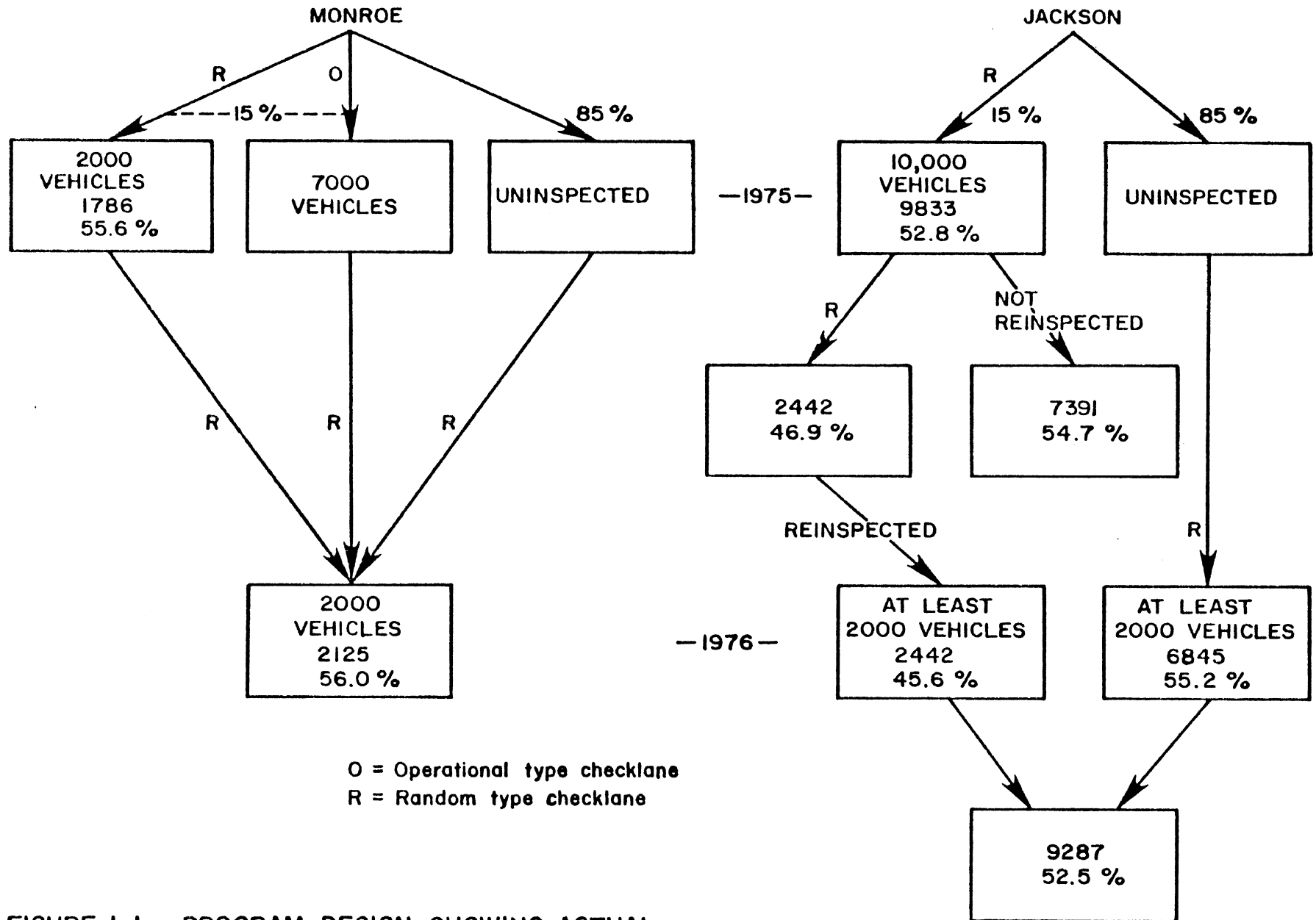


FIGURE I-1. PROGRAM DESIGN SHOWING ACTUAL SAMPLE SIZES AND ADJUSTED FAILURE RATES.

How do two different methods for testing the braking ability of vehicles compare?

If the percent of inspected vehicles were raised to 15 percent and coupled with a public information campaign, how would the defect rate change?

How would the defect rates under a 15% inspection program compare with those for a set of vehicles which had passed an inspection the previous year?

The general plan of the study is diagrammed in Figure 1.1. Two counties were selected for the trial program, Monroe and Jackson. The two counties have a similar number of registered vehicles, and each experienced approximately a 15 percent inspection rate during 1975. Two slightly different inspection methods were employed. The inspections denoted by "R" denote random inspections in which the sites were randomly visited and, on each site, a systematic sample of vehicles with a random start was inspected. The operational inspections, denoted by "O" in Figure 1-1, had a less rigid schedule for visiting the sites, and followed a somewhat judgmental system for selecting vehicles from the traffic flow for inspection. That is, a State Police officer would view each vehicle entering the inspection area and then order it into the inspection queue or allow it to proceed, depending on his initial impression. This results in generally a somewhat higher proportion of older vehicles actually being inspected, as well as vehicles with obvious defects, or defects suspected because of the vehicles' exterior appearance. Only the results of the random inspections were recorded for analysis.

Figure 1.1 also presents the proportion of defective vehicles in each group, adjusted for the age of the vehicle. That is, since the proportion of vehicles failing the inspection was found to increase with the age of the vehicle, and since the ages of vehicles in the different counties and different study groups were found to differ, it was necessary to remove the effect of age before comparing the proportions of defective vehicles. This was done using a direct adjust rate, and the adjusted proportions are reported in Figure 1.1. The number of vehicles actually inspected in each group is also noted on the figure.

The study plan was that Monroe County would serve as a test county for the higher level (15% of registered vehicles) of the checklane inspection, while Jackson County would serve as a test county for a simulated or pseudo-periodic inspection system. Thus, an additional sample of about 2000 vehicles during 1976 was sought from Monroe County to estimate any changes in the proportions of vehicles failing the inspection for various reasons in Monroe County. Such changes would presumably be associated with the increased level of checklane inspections (from 5% to 15%).

In Jackson County during 1976 the following sampling scheme was used. A systematic sample with a random start was applied to all vehicles. In addition, all vehicles with a sticker on the windshield indicating that they had been inspected in 1975 were selected for inspection. Again the sites were randomly rotated as to days and hours. Thus, in Jackson County a sample of the previously (in 1975) inspected cars was obtained. In addition, a sample of the previously uninspected cars was obtained. The reinspected cars formed the pseudo-periodic inspection group, while the previously uninspected cars formed a control group. The previously inspected cars were those which had either passed the inspection in 1975 or failed it and had their defects corrected. In this sense they form a pseudo-periodic inspection group. There are some differences: the owners of the cars inspected in 1975 did not know for sure whether their cars would be inspected in 1976 or when.

The previously uninspected cars sampled in 1976 provide a control group. These are vehicles which would only be influenced by the inspection program by public information campaigns and/or word-of-mouth. As such, they do not completely represent a checklane population, since they do not include the 5% or 15% of vehicles actually inspected (and repaired if failed) that a checklane inspection program affects. In addition, since the operational checklane selects those vehicles which are most likely to fail the inspection (based on age, apparent condition, etc.), the non-inspected group may not be as good as from a checklane inspection system.

The proportion of vehicles passing the inspection in the various groups can be seen on Figure 1.1 to range from about 46% to about 56%. The

proportion passing among all the randomly inspected cars in 1975 was 50.1% and in 1976 it was 44.0%. This compares with the proportion passing the operational checklanes in Michigan during the same two years: 38.0% in 1975 and 37.0% in 1976. The passing rates are similar to those reported from areas with annual PMVI, which range from 45% to 75%.^{1,2}

The proportion of cars passing the overall inspection was found to vary considerably with the age of the vehicle; older vehicles failed much more frequently. Indeed, an increasing failure rate with age of vehicle was noted for most specific components as well as for failure for any reason. The increase in proportion is approximated by a quadratic curve or parabola quite well, particularly for the latest 13 model years. The years earlier than that are based on very few cases. One interesting observation is that the failure rate is consistently over 80% for cars at least six years old, and appears to stabilize at about 90% or so for cars ten years old or older. The relationship between failure rate and age of vehicle may indicate that inspections may more profitably be concentrated in the population of older vehicles.

When one looks at the failure rate on specific vehicle components, the results are somewhat mixed. Although most components show an increasing trend in the failure rate with the age of the vehicle, some components have quite low failure rates and show little if any increase with age. These include horn, steering, mirrors, and vision-impaired windshields. On the other hand, several components--brakes, windshield washers and wipers, tires, lights, and exhaust--show marked increasing trends with age. The implications of these differences are not clear. They may indicate that most owners maintain those components that they perceive as essential to safe operation of the vehicle, while being more lax about maintaining the others. If this is the case, additional education about the danger of defects of particular components might be useful.

¹"Report of an Evaluation of Motor Vehicle Inspection," Coverdale and Colpitts, Consulting Engineers, 100 Wall Street, N.Y., April 1967, p. 5-6.

²"The Influence of Periodic Motor Vehicle Inspection on Mechanical Condition," R.W. McCutcheon and H.W. Sherman, HSRI, The University of Michigan, July, 1968, p.9.

Figure 1.2 illustrates the inspection results for cars in Monroe County. This provides a comparison of the 5% and 15% checklane inspection rates. The figure relates the proportion of cars which had one or more defects to the age of the vehicle. As can be observed in the figure the failure rates are quite similar. A test of significance to test whether the two curves are different failed to reject even at the 20% level. A similar comparison is provided by the failure rates adjusted for the age of the vehicle. For the 1975 data the adjusted failure rate was 55.6%, while in 1976 the rate was 56%. Clearly little change has occurred. As a result, there is no evidence to indicate that the 15% checklane inspection rate is any better than the 5% inspection rate at lowering the number of cars which fail the inspection.

Similar comparisons for each safety component showed the same general finding. That is, no differences were observed in the failure rates. One exception to this was the tires. In 1976 significantly more vehicles failed because of insufficient tire tread than failed in 1975. This difference persisted even after adjustments for age and mileage of vehicles were made. In 1975, 12% of the cars in Monroe County had insufficient tread; in 1976, 22% did. Adjusting these numbers to make the ages of the cars comparable results in the adjusted rates of 14% for 1975 and 21% for 1976--still a large difference. The reason for the difference is not known. It is possible that a more stringent inspection of the tires in 1976 was responsible for the difference.

Figure 1.3 illustrates the results for the vehicles which were inspected both in 1975 and 1976 in Jackson County.

This group was subject to the 5% checklane inspection prior to 1975, so the 1975 inspections represent the checklane population. In 1976, at the time of the reinspection, the group represents a simulated PMVI. Again, only slight differences are noted in the two curves. The differences are not statistically significant. As a summary comparison, the age-adjusted rates for the groups are 46.9% failures in 1975 and 45.6% failures in 1976. There is a slight reduction, but it is not statistically significant even at the 20% level. Thus, there is no evidence that the PMVI--as simulated by this experiment--is better than the 5% checklane inspection system.

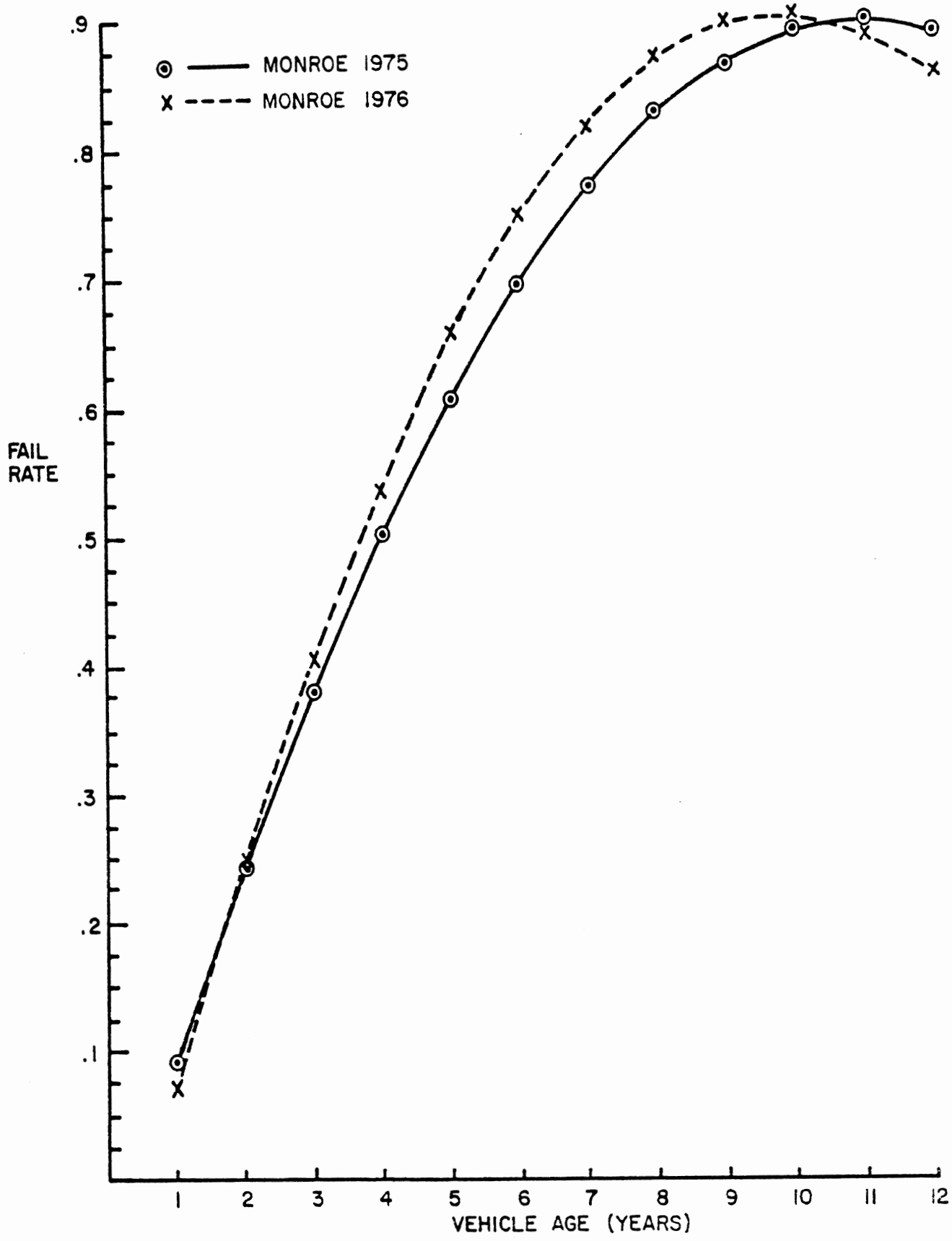


Figure 1-2 FITTED REGRESSIONS FOR FAILURE RATES BY VEHICLE AGE FOR THE 1975 AND 1976 MONROE COUNTY INSPECTIONS

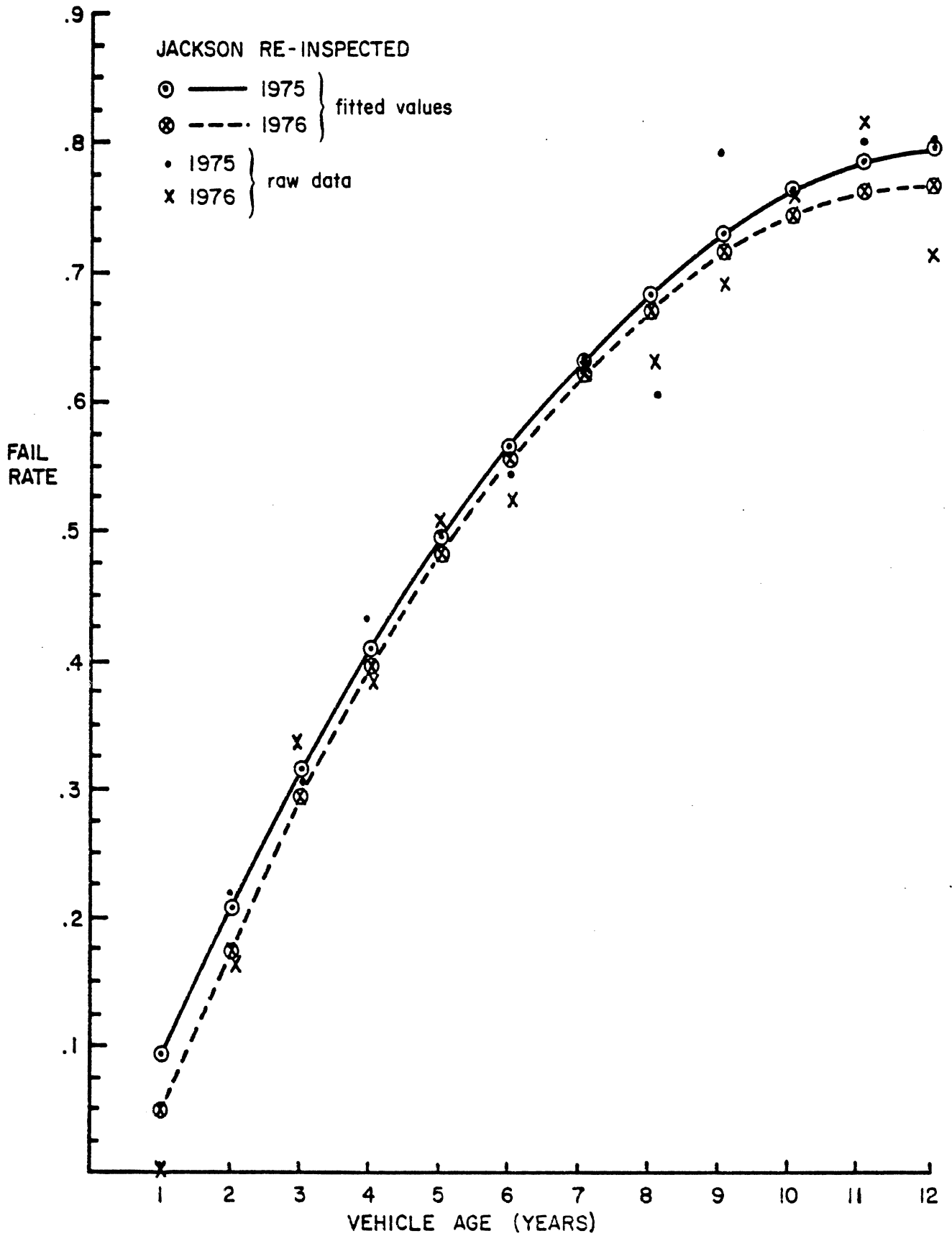


FIGURE 1-3. FITTED REGRESSIONS FOR FAILURE RATES BY VEHICLE AGE FOR THE 1975 AND 1976 JACKSON COUNTY INSPECTIONS.

Figure 1.1 gives the failure rates, adjusted for age of car, for each of the groups. It should be noted that direct comparisons between the two counties in 1976 are not appropriate. The reason for this is that the reinspected cars turned out to be a self-selecting sample. That is, the vehicles which were inspected both years were a special subgroups of the vehicles. This subgroup proved to be vehicles in better condition in 1975. This was not anticipated in the study design and could not be detected until the analysis of the second years' data was begun.

An additional comparison can be made among the vehicles in Jackson County which were newly inspected each year. This group represents the set of cars which would only be influenced by the information campaign and the knowledge that some cars were being inspected in the checklanes. That is, this group represents the "spillover" effect of a checklane. None of these cars was previously inspected and required to correct any defects. The age-adjusted rates of inspection failure for newly inspected vehicles in Jackson County in 1975 was 54.7%. In 1976 it was 55.2%. Again the difference is not statistically significant and is of no practical importance.

Table 1-1 presents failure rates by safety component for the various study groups and for both years of the inspection. One should recall that the reinspected cars are one year older in 1976, so that somewhat higher failure rates are to be expected. Also, the newly inspected cars averaged nearly one year older in 1976 than in 1975, so that one would expect slightly higher failure rates in those groups too. The one component which showed a marked increase in failures in 1976 was the tires.

Table 1-2 summarizes the failure rates by more detailed components. Cars reported in this table are grouped by the two counties rather than by study groups. This table presents the components which caused a car to fail the inspection so that one can determine which components are the most frequent cause of failure. These data represent samples from the two counties. The most frequent cause of failure is some light outage-- license plate light, headlight, directional signals, tail lights, stop lights, in order. The next most common problem was a vision defect, usually

Table 1-1

GROUP FAILURE RATES BY COMPONENT (%)

Component	Group					
	Re-inspected Cars-Jackson Co.		Newly Inspected Cars-Jackson Co.		Newly Inspected Cars-Monroe Co.	
	1975	1976	1975	1976	1975	1976
Wipers & Washers	12.4	11.8	17.6	20.1	21.4	24.2
Headlights	6.8	8.4	9.2	11.8	7.3	11.6
All Lights	25.3	28.3	32.6	40.0	31.1	38.4
Brakes	5.2	6.0	10.2	12.9	12.7	15.4
Tires	8.0	14.4	12.0	18.8	12.3	22.2

Table 1-2

FAILURE RATES BY COMPONENT (%)

Component	Monroe		Jackson		Total	
	1975	1976	1975	1976	1975	1976
Vision	23.8	28.8	21.1	22.3	21.5	23.5
Front Dir.	5.4	5.4	4.9	5.7	5.0	5.6
Rear Dir.	7.2	6.2	6.9	7.6	6.9	7.3
Headlights	7.3	11.6	9.2	11.0	8.9	11.1
Stop lights	6.4	7.2	7.4	8.2	7.2	8.0
Total lights	31.1	38.4	32.5	37.0	32.3	37.2
Steering	.1	.4	.4	.3	.3	.3
Horn	3.4	4.6	3.0	3.6	3.0	3.8
Tires	12.3	22.2	12.0	17.6	12.0	18.5
Exhaust	10.1	16.7	9.3	16.7	9.4	16.7
Brakes (static)	12.7	15.4	10.2	11.2	10.6	12.0
MST (fail to stop)					.9	.3

Table 1-3
 Passing Rates for Reinspected Vehicles by
 Number of Defects in 1975

# def. in 75	Post card Ret. Rate	% Passing in 76
0	NA	67.6
1	57.7%	43.6
2	54.1	30.2
3	49.2	20.3
4+	41.4	17.2

inadequate wipers or washers. Often the problem was caused by lack of fluid in the washer. Following these come tires--usually inadequate tread--and exhaust--usually excessive noise. A fairly large number of cars failed some portion of the brake test, but less than one percent actually could not stop in the required distance.

Cars which failed the inspection in 1975 were given a post card to sign and return certifying that they had repaired the outage. The set of cars which were reinspected in 1976 provides a check on the effectiveness of this effort. Table 1-3 gives the percents of drivers returning the post cards by the number of defects found in their cars as well as the percent of the cars which passed the inspection in 1976. In general, both the post card return rate and the percent passing the inspection in 1976 show a decreasing trend as the number of defects increases. The rate of passing in 1976 is considerably below the rate of return of the post cards. However, since nearly one-third of the cars which passed in 1975 did not pass in 1976, many of the failures may have been for different components in 1976 than in 1975. Table 1-4 gives the percent of cars passing both years, the percent of new failures in 1976, the percent of cars which passed in 1976, having failed in 1975, and the estimated repair rates. Most of the estimated repair rates are above 80% for single components. Two notable exceptions are the license plate light (64.8%), and the exhaust (56.2%). Possibly the license plate light is viewed as too minor to bother with by most people. The exhaust--which is usually too noisy--may not be fixed because it is expensive, or because the owner deliberately wants a loud exhaust. At any rate, the high repair rates for single components indicate that the check-lane inspection system was fairly successful in obtaining repair of defective equipment. At least this is true among those vehicles which were captured for reinspection the second year. The estimated repair rates are higher than the post card return rates, indicating that some of the drivers fixed the car, but neglected to return the post card.

One special question investigated by the random checklanes during 1975 was the relative performance of a moving-stopping test compared to an inspection of the brakes, including removal of a wheel for a mechanical

Table 1-4

Repair and New Failure Rates for Reinspected Vehicles

Component	Percent Passing	P [fail '76 Pass '75]	P [pass '76 fail '75]	Estimated Repair Rate
	Both Years	% New Failures in '76	% State Convicted in '76	
Washers	81.8	8.9	79.4	87.2
Wipers	78.8	10.1	76.2	84.8
Front Turns	94.2	3.2	88.1	91.0
Rear Turns	91.4	4.6	78.6	82.4
Headlights	86.6	7.2	74.5	80.3
High Beam	88.9	6.2	76.6	81.7
Tail Lights	91.2	4.6	71.3	74.7
Stop Lights	90.3	4.3	74.8	78.2
License Plates	79.3	9.0	59.0	64.8
Tire Tread	80.0	13.1	71.5	82.3
Parking Brake	90.9	4.3	68.0	75.3
Stop	90.8	3.9	90.9	94.6
Pull to Side	96.0	3.3	87.6	90.6
Combined	81.8	7.7	83.3	90.2
Exhaust	86.6	8.4	51.5	56.2
All Lights	59.7	20.0	47.5	59.4
Major Mechanical	49.3	28.6	39.6	55.5
Total Inspection	41.6	32.4	34.5	51.0

inspection of the braking system. The moving-stopping test was conducted as follows. The vehicle was turned over to a regular state police trooper. The trooper accelerated the vehicle to twenty miles per hour, and attempted to stop in a lane twenty-five feet long and ten feet wide. A vehicle was judged to fail if it failed to stop, pulled to either side, if there was an unusual sound from the brakes, or if the pedal pressure required to stop was not within safe bounds.

A random subset of the vehicles in the random checklane were also given the "wheel-pull" brake inspection. In this inspection the right front wheel of the vehicle was removed to permit inspection of the condition of the brakes. A vehicle was judged to fail this inspection if any of the following conditions were found: lining on the brake shoe or pad less than 1/32 inch, cracked rotor or drum, defective or leaking wheel cylinder, low master cylinder fluid level. This inspection was conducted independently and without knowledge of the results of the stopping test.

A total of 2465 vehicles were given both types of brake inspections/ stopping tests in the two counties combined. The results are shown in Table 1-5. The two testing procedures agreed on 75.0% of the vehicles. There were 617 cases of disagreement as to pass or fail between the two methods. If the disagreements were symmetric--that is, if a vehicle was equally likely to pass the wheel pull and fail the stopping test as it was to pass the stopping test and fail the wheel pull--then approximately equal numbers of each type of disagreement would be expected. In fact, the numbers are quite unequal and the difference is statistically significant beyond the .001 level by McNemar's test.

Table 1-5
Comparison of Braking Test Results

		Wheel Pull Inspection		
		Pass	Fail	Total
Moving Stopping Test	Pass	1773	114	1887
	Fail	503	75	578
	Total	2276	189	2465

The disagreements in the two methods of evaluating the braking system of the vehicle raise the policy question of which method should be preferred. The moving-stopping test requires less equipment and is cheaper and faster to conduct than the wheel-pull inspection. It also does not require the presence of one or more mechanics. On the other hand, the wheel-pull inspection provides a more definitive statement of the mechanical condition of the braking system--at least of the right front wheel. This might indicate vehicles which currently could stop, but which might need repairs to the brakes in the near future.

One useful comparison of the results of the two tests is to assume that vehicles which failed either test are deficient in braking capability. One can then estimate what proportion of the vehicles passed by either criterion would actually be defective. Formally this is the conditional probability that a vehicle which passes the moving-stopping test actually has defective brakes (as judged by the wheel pull). The similar quantity is the conditional probability that a vehicle which passes the wheel-pull inspection actually is deficient in stopping capability (as judged by the moving stopping test).

From Table 1-5 the estimate of the proportion of vehicles which would pass the moving stopping test but yet have defective brakes is found to be $\frac{114}{1887} = 0.060$. A 95% confidence interval for this proportion is from 0.043 to 0.077.

On the other hand, the estimate of the vehicles which would be deficient in stopping capability, given that they passed the wheel pull inspection, is $\frac{503}{2276} = 0.221$. A 95% confidence interval for this proportion is from 0.200 to 0.242.

The comparison of the two proportions in the preceding paragraphs may be viewed as comparing the expected proportions of vehicles with defective stopping capabilities which would not be detected if only one of the two brake inspection techniques were used. Thus, if only the wheel-pull inspection were used, one might expect over 20% of the vehicles which passed the inspection to be deficient in stopping capability. On the other hand, if only the moving stopping test were used, one would expect only about 6% of the vehicles which passed to actually have deficient braking capability.

This comparison, coupled with the ease and economy of performing the moving-stopping test, would seem to argue that it is the superior test procedure.

Note that only one wheel was inspected in the wheel pull inspection. Presumably more vehicles with deficient braking systems would be detected if two or more wheels were to be inspected. However, this would markedly increase the difficulty and cost of performing the wheel-pull inspection. Also, the usual practice is to reline brakes on all four wheels at the same time, so the condition of one brake is generally regarded as a good indicator of the others. It seems doubtful that one wheel would be in much better condition than the others, though brakes are sometimes repaired in pairs (i.e., both front or both back wheels). Thus it seems unlikely that even if the wheel-pull inspection were to be extended to more wheels, a much better rate of detection of vehicles with deficient braking capability would be obtained.

Driver interviews were conducted for the subsample of vehicles selected for the wheel-pull inspection. This population of drivers was selected to represent local traffic rather than long trip and interstate traffic, so responses may not represent the population of drivers. Drivers in Jackson County demonstrated a greater knowledge of the vehicle inspection program in Michigan than did drivers in Monroe County. Jackson County drivers gave 32% more correct responses to questions dealing with knowledge of the check-lane. This seems to have been due to the more intensive media campaign in Jackson County, since 75% of the drivers there learned of the program through the media as compared with only 52% in Monroe County.

In both counties, over two-thirds of the drivers agreed that "seat belts save lives." However, officers observed only eleven percent of the drivers actually wearing them (in 1975). Reported use of seat belts was higher in Jackson County than in Monroe County. Twenty-one percent of the drivers in Jackson County reported they "always" wore seat belts and twenty-seven percent that they "often" wore seat belts. The corresponding figures for Monroe County were 17 percent and 22 percent. Jackson County drivers reported less inconvenience from seat belts (43% not inconvenienced) than did Monroe County drivers (34% not inconvenienced).

The proportion of drivers observed to be wearing safety belts increased in the 1976 inspections. In Monroe County 21.6% of drivers were wearing their safety belts at the time of the inspection. In Jackson County 34% wore safety belts. Combined, 31.7% of the drivers wore safety belts in 1976 compared with only 11% in 1975. The reasons for this increase are unknown. The most likely explanation is that, while some increase occurred, belt wearing was underreported in 1975. This may have occurred because drivers removed belts in order to reach their operators licenses before the trooper observed the belt wearing.

A large proportion of drivers (84% in Monroe, 91% in Jackson) agreed that the 55 mph speed limit reduced traffic fatalities. Slightly fewer (76% in Monroe; 74% in Jackson) agreed that higher limits should not be reinstated on all state highways. Over half of the drivers (58% and 60% in Monroe and Jackson) were also opposed to reinstating a higher speed limit only on interstates. A majority (56% in Monroe, 53% in Jackson) of the drivers interviewed felt that points should be given on a drivers license for speeding violations between 55 and 70 mph.

At the end of this year the data should provide a good estimate of the percent of vehicles in acceptable condition to be obtained by a 15% operational checklane inspection rate coupled with a public information campaign. Also, the comparison between the operational checklane inspection populations and the simulated PMVI population will provide additional evidence about the possible benefits of a PMVI in Michigan. This evidence can be coupled with estimates of the relative costs of the two inspection systems to aid administrators and the legislature in selecting the most cost-beneficial system for Michigan.

CONCLUSIONS AND RECOMMENDATIONS

The primary purposes of this study were to estimate the effect on the proportion of vehicles with outages in safety equipment of a 15% checklane inspection program and to compare this with the estimated effect of a simulated periodic (annual) motor vehicle inspection program. From the data collected the first year it became apparent that the safety component outage rates were strongly influenced by the age of the vehicle. As a result, comparisons among the groups of interest were adjusted for the ages of the vehicles involved. In addition to the conclusions relating to the two principal purposes of the study, some ancillary conclusions about the type of stopping test to be used, the relative outage rates of various components, and the repair rates are reported.

Effect of the 15% Checklane Inspection Program

The 15% random checklane operated in Monroe County. The crude proportion of cars failing the inspection in 1975 in Monroe County was 51.9% while in 1976 this rate climbed to 62%. However, the sample of cars obtained in 1976 was generally older than the sample obtained in 1975. The average difference in ages of cars was 0.9 years, or nearly one year. Comparing the individual outage rates for each age of car revealed that little difference in outage rates remained after age of car had been taken into account. The age distribution of cars in the State of Michigan (truncated at twelve years) was used as a standard population and the standardized rates of cars failing the inspection were calculated. The age-adjusted rate of failure of cars in 1975 in Monroe County was 55.6%. In 1976 the age-adjusted failure rate was 56.0%. Thus the rates of failures in Monroe

County remained essentially the same. This leads to the conclusion that the increase in the rate of inspection from a level of about 5% (statewide) to a level of 15% did not change the overall rate of failure of the inspection.

A similar experience was obtained in Jackson County. In Jackson County, the newly inspected vehicles in 1975 represent a sample from the approximately 5% random checklane inspection program. The newly inspected vehicles in 1976 represent a sample from a population subject to a 15% checklane inspection program, but with the re-inspected vehicles removed from the population. That is, the newly inspected vehicles in Jackson County in 1976 represent a sample from the vehicles which were not inspected the previous year. Thus, presumably they might be somewhat biased toward higher failure rates. The crude failure rates for Jackson County were 49.6% in 1975 and 57.9% in 1976 (for newly inspected vehicles). Again, most of the difference appears to be in the age of the vehicles. After adjusting for the different age distributions in the samples, the age-adjusted rates are 54.7% in 1975 and 55.2% in 1976, again indicating that no significant change has occurred. If one pools all the cars inspected in Jackson County, one should have a sample which is slightly biased toward fewer inspection failures, since it would include a higher percentage of the cars which were inspected in 1975 that would be due to chance. If this is done, the age-adjusted rates are 52.8% in 1975 and 52.5% in 1976. Again, no significant change is observed. The conclusion seems to be that the increase from a 5% to a 15% inspection rate has not influenced the overall failure rates.

The same pattern persisted when individual components were considered instead of the overall passing or failure of the entire vehicle. With few exceptions, the change from a 5% to 15% inspection rate failed to produce any changes in the outage rates of the vehicle population. Thus, no particular advantage can be claimed for the higher effort.

Effect of the Simulated PMVI

In Jackson County, a subsample of previously (in 1975) inspected vehicles was obtained during 1976. This subsample represents a simulated

PMVI group. The overall outage rate among these vehicles in 1976 was only 45.2%, apparently better than the other groups. However, this group turned out to be a self-selecting sample of the better and newer vehicles. The same cars were also better on the average than the other cars inspected in 1975. The overall failure rate in 1975 for this group of cars was only 38.5%. As a result, comparisons across groups appear to be invalid because of the self-selecting nature of the reinspected vehicles.

Comparisons within the reinspected vehicles can give insight into the effect of the PMVI as compared to the previous 5% checklane inspection program. Of course the reinspected cars are all (approximately) one year older than they were in 1975, so the age must be adjusted for. When the age-adjustment rates were calculated, the rate among this group in 1975 was found to be 46.9% and in 1976 it decreased slightly to 45.6%. Thus there was slight improvement in the overall failure rate. The difference was not statistically significant, however, giving a p-value of only 0.2, one-sided.

Comparisons by the specific components revealed essentially the same results: little change in the outage rates. There was one exception to the general pattern. Failure of the inspection because of insufficient tire tread was significantly higher in 1976 than in 1975. This persisted after the age of the vehicle was adjusted for. A similar adjustment, adjusting for the mileage of the vehicle also failed to remove the differences in the failure rates caused by insufficient tire tread. So there appeared to be a higher failure rate for insufficient in 1976 than in 1975. The other safety components showed slight--but non-significant--improvements. However, the worsening of the component tires balanced out the accumulated slight improvements in the other components to result in an overall insignificant change.

In conclusion, the simulated PMVI group did not experience a significant improvement rate in passing the inspection. Because of a previously unknown self-selection of the PMVI group, direct comparisons of outage rates with the checklane populations are not appropriate. Neither the simulated

PMVI group nor the checklane groups at the higher inspection rate showed an improvement over the operational checklane inspection program operating at approximately 5% of the vehicles. All of the random groups, however, exhibited a lower failure rate for the inspection than is reported from the operational checklanes. This may be interpreted to mean that the operational lanes are relatively successful in selecting vehicles from the traffic stream which are defective. In this sense, the operational checklanes seem to be rather effective at identifying the vehicles with mechanical defects.

Other Conclusions from the Study

Although in general no significant changes in the outage rates were found, one consistent exception was the condition of the tires. The level of tread on the tires was insufficient in a larger proportion of the cars inspected in 1976 than in 1975, even after adjustments for age and mileage were made. This was consistent in all groups. The adjusted rates were as follows. In the reinspected cars (simulated PMVI), the failure rate increased from 9.97% to 14.86%. In the newly inspected cars in Jackson County, the adjusted rate increased from 13.52% to 17.51%, and among the newly inspected cars in Monroe County the adjusted rate increased from 14.15% to 21.05%. Thus the data reflect a consistent worsening of the condition of the tires in the vehicle population. The reasons for are not known.

In general the adjusted rates for other components showed minor improvements, none of which were statistically significant or large enough to be of practical importance. The increased failure rate for tires more than balanced the minor gains in other components, resulting in no significant change in the overall rates. Had tires remained the same or shown a minor improvement, the overall rates of failure would have shown a slight improvement in all study groups--on the order of 4 or 5 percentage points. While this would probably have been statistically significant--that is, not due to chance--its practical significance is open to question.

A comparison of two types of braking tests--a moving stopping test (MST) and a wheel pull inspection (WPI)--was performed as part of the study. The

general conclusion was that the moving stopping test appeared to have advantages in terms of detecting vehicles which were deficient in current stopping capabilities, while the wheel pull inspection might be more diagnostic of future stopping difficulties. Although definite associations among components inspected in the WPI and performance measured in the MST were found, these were too weak to be used in a predictive sense. For example, although poor pedal pressure and low brake fluid levels were associated, the association was too weak to suggest that poor pedal pressure was due to low brake fluid levels.

The repair rates for components found inoperative among the reinspected vehicles were estimated. In most cases these were rather high--between eighty and ninety percent. One notable exception was the exhaust (noise) which had an estimated repair rate of only 56%. Another was the license plate light with a repair rate estimated at only 65%. Ability to stop (MST) was repaired at an estimated 95%. In general, the items which had low estimated repair rates tended to be the items perceived as minor by the motorists--or possibly in the case of exhaust noise as an item they did not wish to repair.

Neither the simulated PMVI nor the more intensive checklane inspection programs produced a significant reduction in the proportion of vehicles failing the inspection. As a result, continuation of the checklane inspection program at the current level of about 5% seems recommended.

Not surprisingly, defect rates were found to increase with the age of the vehicle. This adds credence to the contention that the operational checklane is highly efficient at detecting vehicles with safety defects.

Drivers with defective vehicles were issued a post card to return certifying that the repairs had been made within 21 days. A low rate of return--sixty percent--was observed. There was some indication that the return rate was lower for vehicles with several defects or with the more serious defects. Although the rate of return of the post cards may not completely reflect the rate of repair, it causes concern for the efficacy of this system for effecting repair of

defective vehicles. We would recommend that efforts to strengthen the repair incidence be considered.

The comparison of the moving stopping test with the wheel pull brake inspection indicated that the moving stopping test more accurately determines the car's braking capability. It is also quicker and easier to perform. For these reasons we recommend that it be adopted as the inspection procedure for braking capability.

Inferences from the driver interviews which were conducted only in 1975 are necessarily restricted to drivers in primarily local traffic. In particular, drivers on interstate roads and on long trips were excluded. Thus the results are not generalizable to the population of Michigan drivers.

Drivers generally thought that the 55 mph speed limit had reduced traffic fatalities and were opposed to raising the limit for all state highways. They were less opposed to increasing the speed limit on interstates and to instituting points for speeding violations in the 55 to 70 mph range.

Drivers in Jackson County showed a greater knowledge and awareness of the checklane inspection program than did those in Monroe County. This coincides with a more intensive information campaign there. It is recommended that public information campaigns be continued.

Two thirds of the drivers believe that seat belts save lives. However only 43 percent reported that they often or always wore seat belts. Only eleven percent of the drivers were observed to be wearing belts by the inspecting officers. This indicates that there may be a bias in the interview results. In the future, it is recommended that randomized response techniques be considered to reduce this potential bias.

