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EVALUATION OF THE MICHIGAN TRIAL SUBSTITUTE
VEHICLE INSPECTION PROGRAM

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First Year Interim Report
Executive Summary

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16. Abstract <p>In a two-year study, a checklane vehicle inspection program is being evaluated as a substitute for a periodic motor vehicle inspection program. The first year's effort, reported here, measured the percent of defective vehicles in two sampled counties and provided a baseline against which to measure the second-year results. The overall failure rate was 47.6%, but this was found to increase markedly with the age of the vehicle. Detailed tables of results for several vehicle systems are presented.</p> <p>As part of the study, a moving stopping test for braking capability was compared with a mechanic's inspection of the brakes. If failure by either type of inspection is considered to constitute deficient braking capability, then it is estimated that 6% of vehicles passed by the moving stopping test have deficient stopping capability, while 22% of vehicles passed by the wheel-pull brake inspection have deficient stopping capability.</p>					
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CONCLUSIONS AND RECOMMENDATIONS

The primary purposes of the study were to estimate the effect on the proportion of defective vehicles of a 15% checklane inspection program and to compare this with the estimated effect of a simulated PMVI inspection. Both of these require two years. Consequently no conclusions relative to the principle questions are possible at this time.

The average passing rates for the two study counties were 48.1% and 50.5% for Monroe and Jackson Counties, respectively. In this respect the vehicle populations of the two counties were quite similar. Large differences in the manufacturers of vehicles were found in the two counties, but this is not thought to be crucial to comparisons. Small differences in the age, mileage, and types of vehicles were observed. It appears currently that it will be possible to compare the results in the two counties directly--without adjustment. It is recommended that a sensitivity analysis of the possible effects of adjustments be tried to ensure that direct comparisons are valid.

Large differences between the population of vehicles sampled and the population of registered vehicles were observed in both counties. This was expected since sampling was done with probability proportional to usage on local feeder roads. As a result, the baseline failure rates are applicable only to the population sampled, not to the populations of registered vehicles as a whole. This restriction does not hinder the study's conclusions, since the same population will be sampled both years. It does indicate that checklane inspections do not reach all vehicles with equal probability. One interpretation of the differences between the population of registered vehicles and the population sampled is that the sampled population accurately represents those currently in use. If this is correct then

the checklane method would be more closely connected with accident prevention than PMVI, because the checklane would concentrate on those vehicles most used.

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 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.

At the end of the study the data should provide reliable estimates of the effects of a 15% checklane inspection system. Comparisons between the operational checklane and the simulated PMVI should provide reliable estimates of the difference in effect on the proportion of defective vehicles obtained by the two methods. This, in turn, will give a solid basis for a recommendation of the preferred inspection system.

EVALUATION OF THE MICHIGAN TRIAL SUBSTITUTE
VEHICLE INSPECTION PROGRAM: FIRST YEAR ACTIVITIES

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 a current study conducted by HSRI jointly with the MSP and OHSP.

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 a citation 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?

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

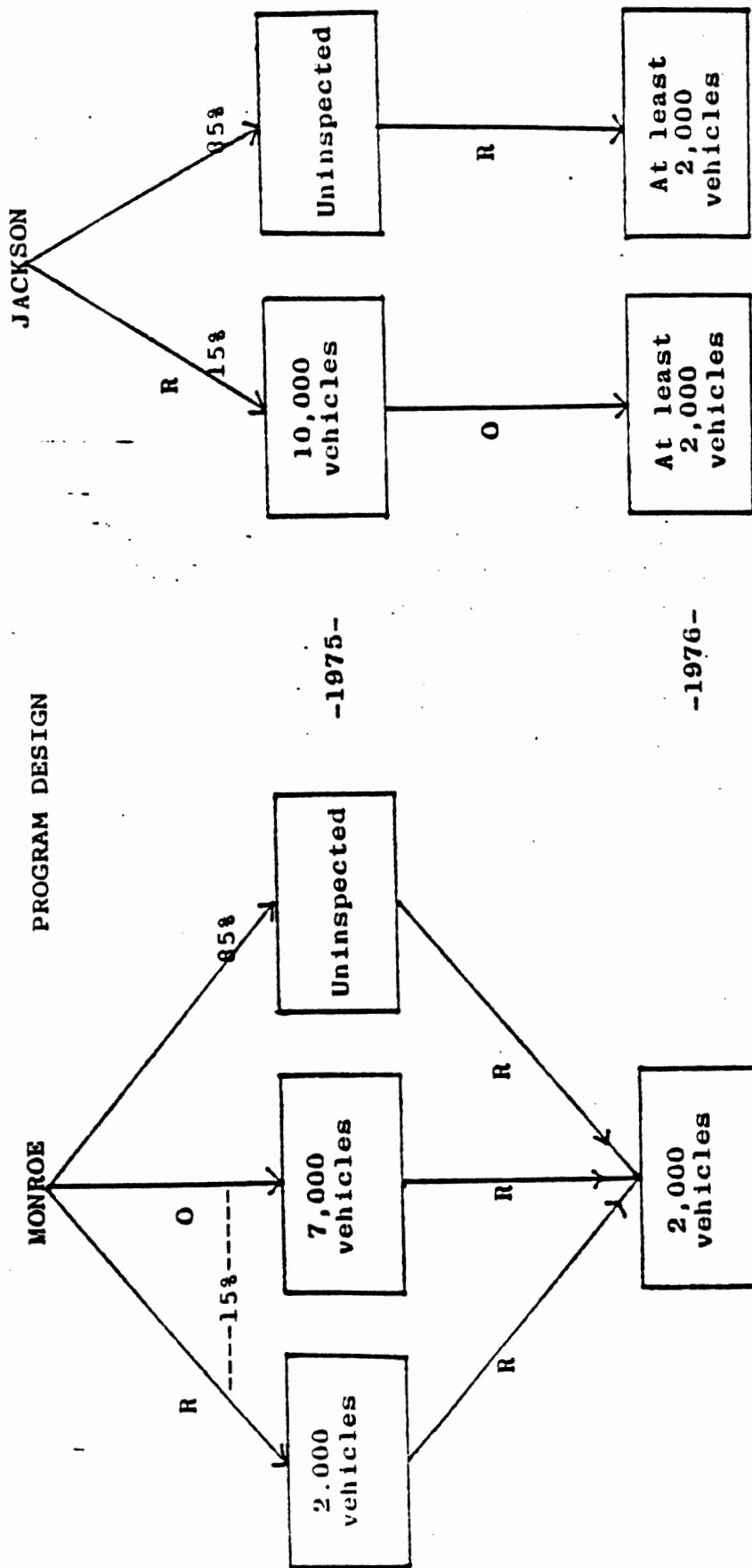
If the percent of inspected vehicles were raised to 15 percent and coupled with a public information campaign, how would the defect rate change?

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 project is currently beginning its second year. The last two questions posed can only be answered after the data from both years have been collected and analyzed, but information pertinent to the first three questions is available from the data collected during the first year's effort.

The general frame 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 generally in 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.

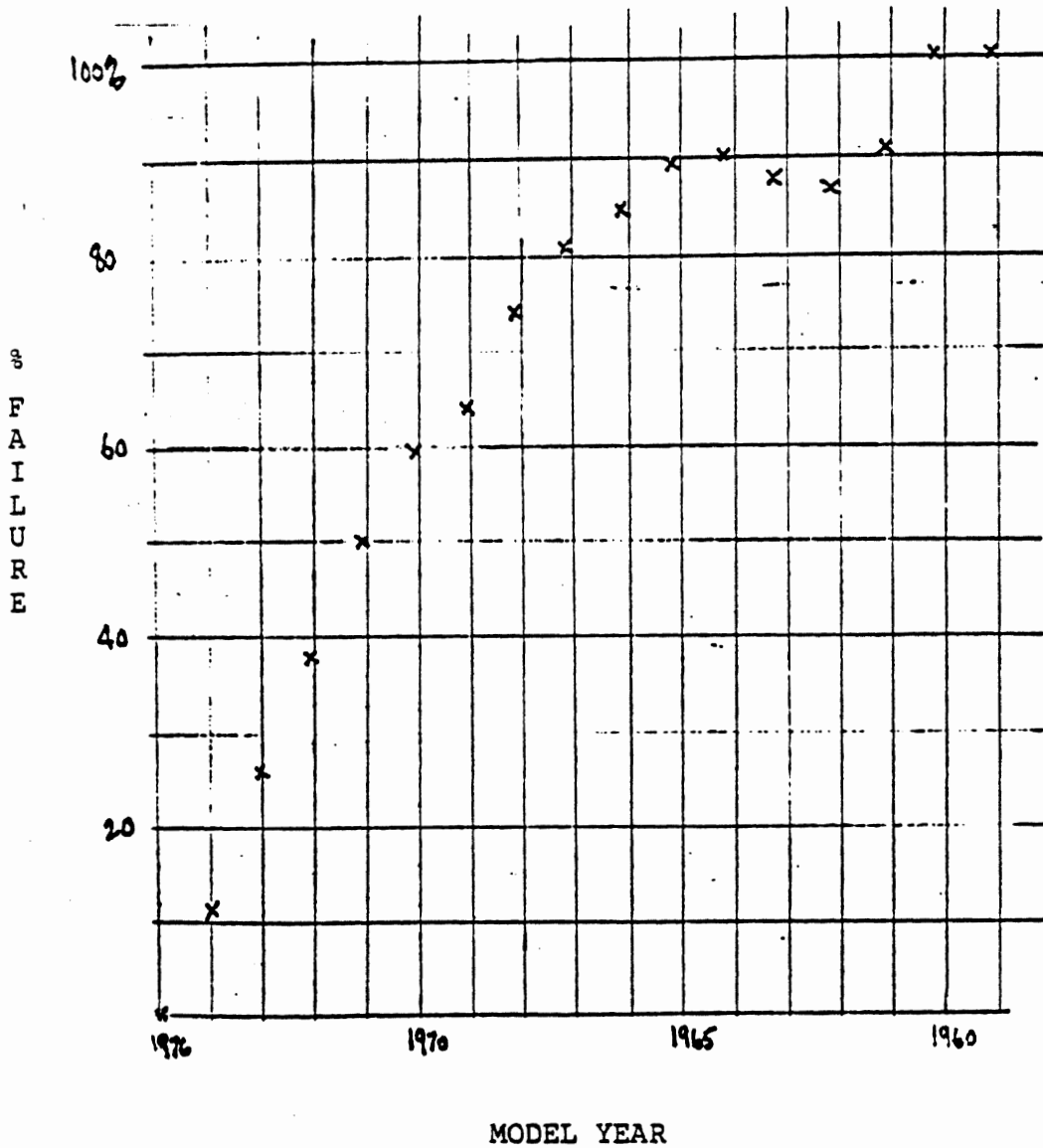
FIGURE 1-1
PROGRAM DESIGN



O - Operational type checklane
R - Random type checklane

FIGURE 1-2

PERCENT OF VEHICLES FAILING
INSPECTION, BY MODEL YEARS



The numbers of inspected cars by model year were:

1976: . 27	1970: 981	1963: 53
1975: 1,299	1969: 1,023	1962: 42
1974: 1,890	1968: 748	1961: 12
1973: 1,998	1967: 552	1960: 10
1972: 1,712	1966: 385	
1971: 1,169	1964: 144	

During the second year of the program, further random inspections will be conducted to investigate any changes in proportions of defective vehicles or patterns of defects. In addition, in Jackson County all--up to a maximum of 2,400 vehicles--of the vehicles which encounter the checklane sites and which were inspected in 1975 will be re-inspected. This group simulates a population of vehicles subjected to a PMVI, in that they will have been inspected (and presumably had defects corrected) the previous year. All drivers whose vehicles were inspected in the random checklane program in 1975 were given a windshield sticker and told that their vehicles were not subject to re-inspection for a year, but would be subject to re-inspection beginning in the summer (starting in May) of 1976. Although this group does not completely represent a population of vehicles subject to PMVI, it provides some comparisons of interest. If this group were found to have a substantially better defect rate than the general population (which was subject only to the operational checklane inspection), that might be taken as evidence that gains in reduced vehicle defect rates might be obtainable from PMVI in Michigan.

The overall rate of passing the inspection was 52.4% for both counties combined. Table 1-1 summarizes the overall passing experience for the two counties. This passing rate of 52.3% may be compared to passing rates reported from areas with annual PMVI which range from 45% to 75%.^{1,2}

The overall passing rate was found to vary considerably with the age of the vehicle; older vehicles failed much more frequently. Figure 1-2 plots the proportion of vehicles failing the inspection--at least one mechanical defect found--as a function of year of manufacture of the vehicle. The rise in the proportion failing is

¹"Report of an Evaluation of Motor Vehicle Inspection," Coverdane 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 & H.W. Sherman, HSRI, The University of Michigan, July, 1968, p. 9.

evident. The data fit 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 from the figure 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.

TABLE 1-1
NUMBER OF DEFECTS FOUND

Number Defects	Monroe Co.		Jackson Co.		Total	
	Count	%	Count	%	Count	%
0 (Pass)	904	50.6	5206	52.8	6110	52.4
1	389	21.8	2000	20.3	2389	20.5
2	226	12.7	1211	12.3	1437	12.3
3 or more	266	14.9	1448	14.6	1714	14.8
Total	1786	100.0	9865	100.0	11651	100.0

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.

Table 1-2 gives the percent of vehicles failing on each of several vehicle systems. Note that since some vehicles failed on several components, the individual failure rates do not add to the overall failure rates.

TABLE 1-2
VEHICLE FAILURE RATES BY VEHICLE SYSTEM

Vehicle System		Monroe Co.		Jackson Co.		Total	
		Count	%	Count	%	Count	%
Vision Defects	Pass	1361	76.2	7782	78.9	9143	78.5
	Fail	425	23.8	2083	21.1	2508	24.5
Total Lights	Pass	1230	68.9	6655	67.5	7885	67.7
	Fail	556	31.1	3210	32.5	3766	32.3
Tires	Pass	1566	87.7	8684	88.0	10250	88.0
	Fail	220	12.3	1181	12.0	1401	12.0
Exhaust	Pass	1605	89.9	8947	90.7	10552	90.6
	Fail	181	10.1	918	9.3	1099	9.4
Brakes	Pass	1340	75.0	8195	83.1	9535	81.8
	Fail	446	25.0	1670	16.9	2116	18.2
Total		1786		9865		11651	

One of the questions 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 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 1-3. 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 1-3
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 1-3 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 were 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 checklane. 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. 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

inconvenienced from seat belts (43% not inconvenienced) than did Monroe County drivers (34% not inconvenienced).

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.

