AN EVALUATION OF THE MICHIGAN TRIAL SUBSTITUTE MOTOR VEHICLE INSPECTION PROGRAM

FINAL REPORT

VOLUME I: SUMMARY

by

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January, 1974

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This research was sponsored under contract with the Michigan Department of State Police with funds provided by the Office of Highway Safety Planning. The opinions, findings, and recommendations contained herein are those of the author alone and not necessarily those of the sponsoring agencies.

BIBLIOGRAPHIC DATA SHEET	1. Report No. UM-HSRI-SA-74-1	2.	3. Recipient's Accession No.

4. Title and Subtitle
An Evaluation of the Michigan Trial Substitute Motor Vehicle Inspection Program

5. Report Date
January, 1974

6.

7. Author(s)
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8. Performing Organization Rept No. UM-HSRI-SA-74-1

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10. Project/Task/Work Unit No.

11. Contract/Grant No.

12. Sponsoring Organization Name and Address
Michigan Department of State Police
714 South Harrison Road
East Lansing, Michigan 48823

13. Type of Report & Period Covered Final
5/1/72-12/31/73

14.

15. Supplementary Notes

16. Abstracts

This report examines the effectiveness of an on-road, spot check method of conducting vehicle inspections. The study concentrated on an enhanced program which was operated in three Michigan counties. The proportion of the vehicle popoulation inspected was systematically varied across counties with 5%, 10%, and 20% levels being used. Independent measurements were collected on vehicle condition, through a random sample of 6,000 vehicles, which were given a full inspection. An additional 43,000 vehicles were observed for lighting system outages, and 5,500 drivers were interviewed. For a six month observation period, a modest reduction in vehicle defects, between 5% and 10%, was obtained in the area with the heaviest concentration of inspection activity. Driver interviews showed no decrease in public acceptance of the program with increased police effort. Follow-up procedures were found to be quite effective in obtaining the repair of defective vehicles.

17. Key Words and Document Analysis. 17a. Descriptors

Vehicle inspection, Vehicle condition, Driver interviews, Police traffic activity, Performance measurement, Driver surveys, Vehicle surveys.

17b. Identifiers/Open-Ended Terms

17c. COSATI Field/Group

18. Availability Statement	19. Security Class (This Report) UNCLASSIFIED	21. No. of Pages
Available from reporting agency, sponsoring agency and NTIS.	20. Security Class (This Page UNCLASSIFIED	22. Price

This report is bound in two volumes. This volume is the summary of the report. The material in this volume is reproduced as Section I of the technical report.

TABLE OF CONTENTS

LIST OF FIGURES

LIST OF TABLES

LIST OF TABLES Continued

LIST OF TABLES Continued

LIST OF TABLES Continued

LIST OF TABLES Continued

FOREWORD

This report represents an attempt to measure the effect of a change in the highway safety system. Specifically, the study sought to determine whether an enhancement of the Michigan Vehicle-Driver Checklane would improve the mechanical condition of cars in the state. As a research effort, this represented a large challenge, both because of the extent of the project and because of the complexity of the underlying problem. Execution of the research plan required collection of information on thousands of vehicles over a wide geographic area and the application of techniques which were relatively new to highway safety. The complexity arose both from the nature of the changes made and from the fact that the condition of vehicles was strongly affected by factors which were neither easily measured nor well understood.

In the author's biased view, the research effort was largely successful. All major data collection goals were attained, and the information collected is a mostly unbiased representation of what happened to the population. In addition, the sample inspection team technique which was developed in the project provides a highly useful way of obtaining data on vehicle condition. Interpretation of the results was somewhat less satisfying from two perspectives. First, given the lack of well-developed baseline data, a great deal of caution had to be exercised in drawing conclusions. Second, the scope of the study had to be limited mostly to the examination of the effect of the particular program change, thus making comparisons with alternative programs less than complete.

Whether or not the program had an effect will be open to debate. The author confesses some ambivalent feelings on the matter. On the positive side, there were unmistakable indications of improvement in the area which received the most intensive effort, and the experimental follow-up system worked beyond anyone's

expectations. Yet, there are points at which biases or uncontrolled factors could have influenced the results, and therefore, caution must be exercised. Also, there are certain social problems inherent in any police operation about which the report is quite candid. The caution and candor can be interpreted negatively, and the absence of perfection can always be used as a grounds for rejecting a program. Hopefully though, the openness will strengthen the results, since the awareness of problems is the first requisite for their solution.

In summary, then, the author feels that this has been a successful effort. Most of the credit for the success lies with others. Captain John Amthor and Sgt. Jay Kennedy of the Michigan State Police Safety and Traffic Division deserve high praise for the fine job they did in organizing and administering the operational features of the program. Additionally, they were as receptive and as co-operative contract managers as any researcher could want. Troopers Peter LaCroix, Robert Brandt, William Stenbeck, and Maxwell Struble performed very admirably in what was often a difficult and unusual data-collection task. In all, the State Police's effort is as good an example of police participation in a research effort as I know of. Mr. Noel Bufe and his associates at the Office of Highway Safety Planning played an instrumental role in establishing the program and providing continuing support. At HSRI, my two associates Mr. David Damkot and Mr. Jimmie Wright contributed substantially to the understanding of the problem. Finally, three hard-working persons, Ms. Virginia Trubey, Ms. Leda Ricci, and Ms. Jo Moore, spent many long hours reducing an often totally indecipherable manuscript into a polished text. Any errors that remain are my own.

Jay S. Creswell, Jr.
January 4, 1974

I. SUMMARY

A. Introduction

In the summer and fall of 1972, Michigan instituted a trial, substitute motor vehicle inspection program. This trial represented an enhancement of the state's ongoing checklane activity. The ongoing program consisted of roadside inspections by police teams of vehicles selected from traffic. The enhanced trial activity included two major elements:

1. The fraction of the vehicle population inspected was experimentally varied across selected counties of the state in order to determine the most desirable activity level.

2. Follow-up procedures were instituted to insure that vehicles found defective upon inspection were repaired. This was intended to close a major gap in previous checklane efforts.

The program was developed in response to the mandate of the Highway Safety Act of 1966 that all states develop either a periodic inspection system covering all vehicles or an acceptable substitute program. This report contains HSRI's evaluation of Michigan's substitute program.

An overall assessment is that the program worked. All major operational objectives were met, and the follow-up procedures resulted in a high fraction (70% to 80%) of failed vehicles being repaired. Independent performance measures indicated a bettering of the vehicle population at the more intense levels of inspection activity. In most respects, the program was highly successful, and, judged by even highly stringent criteria, the program can be called a qualified success.

The qualifications that are expressed throughout this report, however, are those that would probably apply to any empirical study of this type. They are:

1. In some instances, the possibility that outside factors influenced the outcome could not be entirely precluded.

2. Certain performance measures did not display a high degree of consistency with other measurements.

While these points will be raised repeatedly in the interests of scientific conservatism, they should not obscure the overall pattern of the project. Namely, where the most inspection activity occurred, vehicles were progressively improving over time. This must be considered a remarkable result for two reasons. First, it is very rare in highway safety research for a carefully conducted investigation to show a positive effect. Second, the seven-month duration of the experiment provided people with a very short period in which to adjust their behavior. Thus, while the assessment must be properly qualified, it is still one of success.

Based on the experimental results and a review of other relavent factors, it is recommended that:

1. The state continue the checklane program. An immediate goal should be the inspection of 15% of the vehicles in the state each year.

2. Mandatory repair procedures should be established. This should follow the general pattern of the follow-up activity used in the experimental effort.

3. The state should have a continuing program of performance monitoring to insure continued high quality inspections.

4. Since the most effective inspection approach has not been conclusively determined, and since inspection technology is rapidly changing, the state should review from time to time the merits of alternative systems.

In the remaining portions of this summary, these points are covered in somewhat more detail, and a full exposition of them is found in Chapters II through VIII.

B. Objectives, Scope and Method

The investigation had three specific objectives:

1. To determine the effect of three levels of inspection activity on the mechanical condition of the entire vehicle population.

2. To assess the impact of the checklane on the motoring public.

3. To discover the effects of enhanced follow-up procedures on securing the repair of vehicles failing inspection.

Beyond these three specific goals, the Highway Safety Research Institute (HSRI), staff considered it their mandate to try to determine the most desirable inspection approach for the state, and to recommend a course of action to the appropriate state officials.

The experimental program which was conducted by the Michigan State Police (MSP) consisted of three major elements:

1. The intensity of inspection activity was systematically varied over three experimental counties. The three counties and the fraction of the vehicle population inspected in each were: Ingham (20%), Genesee (10%), and Kent (5%).

2. In the three experimental counties a four part administrative follow-up procedure was instituted to obtain the repair of vehicles failing inspection.

3. Outside the three experimental counties, normal checklane operations were maintained.

These tasks were performed from May to November of 1972.

The three experimental counties were selected, since they represented a wide cross-section of the state's vehicle population, and since they were roughly comparable in demographic characteristics. The three intensity levels were chosen to represent a range of possible activity for the checklane. The five percent level in Kent County served as a control, since it represented the ongoing level of activity in that area. The ten percent level in

Genesee County met the then current goal of the MSP for a statewide inspection level. The twenty percent figure was chosen to represent what could be achieved with a substantial increase in checklane activity. Elsewhere in the state, normal operations were maintained to insure continued safety benefits of the lane.

The administrative follow-up procedure was designed to close a major gap in checklane procedure. Prior to its institution, inspection teams had mostly relied upon the voluntary co-operation of motorists to secure repair of defects. Based on a previous pilot study and informal observation, a voluntary approach did not seem to be highly effective. The follow-up procedure consisted of four activities:

1. For vehicles with serious, hazardous defects, drivers received a traffic summons. Through arrangements with the District Courts, these persons were required to have the vehicle repaired and reinspected prior to disposition of the case.*

2. For vehicles with less serious defects, the driver of the vehicle was provided with a return postcard. He was instructed to repair the vehicle and to return the card certifying the repair.

3. All defective vehicles were marked with a "reinspect" sticker which notified checklane teams of the need to recheck the vehicle should they encounter it again.

4. The registration numbers of all defective vehicles were entered into the Law Enforcement Information Network computer. This was done so that the checklane, or other enforcement officer, could immediately determine the inspection status of the vehicle and take appropriate enforcement action if defects had not been repaired within a 21-day grace period.

HSRI based its evaluation on two major information sources, operational data and independent performance measures. Operational data came from inspection reports and other information generated

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* This provision, of course, only applied to those who chose to plead guilty, or who were found guilty. Those acquitted were naturally not required to meet these provisions.

in the usual course of lane operations. The independent performance measures were collected by a special MSP inspection team under the guidance of the HSRI evaluation staff. The guidance included continuous on-site monitoring of data collection by an experienced HSRI field investigator. The three independent performance measures were:

1. A random sample inspection was performed on some 6,000 vehicles in the three experimental counties. In each county, vehicles were sampled in equal numbers at eight sites scattered throughout the county. Sample locations were chosen to represent an even mix of high and low income and high and low population density areas. Each sample location was visited at five approximately equally-spaced intervals over the May-November period. Vehicles inspected included passenger cars, light trucks, and motorcycles registered in Michigan. Vehicles included in the sample were chosen strictly on the basis of their arrival at the sample site after a predetermined number of vehicles passed the site, e.g. every 5th, 10th, or 20th vehicle depending on traffic volume at the site.

2. Some 5,500 drivers whose vehicles were included in the sample inspection were interviewed. The interviews were conducted using a multiple-choice questionnaire, which the driver completed while awaiting inspection. The questionnaire was based on one used in a 1968 pilot study, and was further refined during the initial data-collection period.

3. Roadside observations were made during evening hours for lighting defects on some 43,000 vehicles. Observations were collected by stationing an observer at controlled intersections for a predetermined period of time. The observer recorded the condition of all vehicles passing the site. Sites were selected according to the same income/density criteria used for the sample inspection. Additionally, observations were balanced on the basis of week night and weekend observation periods, and as far as possible, sites were chosen to represent areas both near to and far from sample inspection sites.

Each measurement was designed, tested, and implemented according to strict statistical criteria. The goal was to produce a representative sample of the condition of the vehicles in the experimental counties and to measure changes over time accurately. The principal purpose of the measures was to determine the program's effect on mechanical failures in the vehicle population, and to assess the impact on the state's drivers.

C. Background

In 1966, the State Legislature amended the Michigan Motor Vehicle Code to permit the MSP and local police departments under the MSP's supervision to conduct on-the-road inspections. These checks covered both vehicles for mechanical defects and drivers for compliance with licensing and registration laws. The legislation came in response to two concerns. Of greatest importance was a desire to reduce the toll of highway crashes which apparently resulted from defective vehicles. Providing immediate impetus was the passage of the National Highway Traffic Safety Act which, among other elements, mandated the establishment either of a periodic motor vehicle inspection program or of an adequate substitute program.

Michigan, along with several other of the nation's more populous states, notably California and Ohio, chose the checklane as a substitute program. This choice was made with the belief that most motorists are responsible in maintaining their vehicles in safe condition. Therefore, forcing everyone to undergo inspection would be a waste of citizen time and money.

The program started quite modestly. In the original year of 1967, the program involved part-time teams in each of the MSP's nine districts and four city police department teams. That year, about 3% of the state's vehicles were checked. Since then, the program has steadily grown in size and coverage. In 1972, twelve full-time MSP teams were operating along with thirty-three teams of other law enforcement agencies. Slightly more than 8% of the state's vehicles were checked, including 100% of the school buses.

In 1968, HSRI, with the MSP's cooperation, informally evaluated the progress of the checklane. The study was conducted as a pilot effort to gain experience in field evaluations. Consequently, no formal report was published. Still, the effort yielded some insights: the establishment of the checklane brought a marked surge in automobile repairs; the absence of follow-up procedures greatly reduced the lane's impact. More importantly, though, the experience led to a sound and smoothly executed research plan for the present study.

While the program was growing, the State's Office of Highway Safety Planning (OHSP) was seeking approval of Michigan's program from the National Highway Traffic Safety Administration. After protracted negotiations, the present plan received federal approval as a trial substitute inspection program in mid-March of 1972, with implementation following very rapidly. The approved plan was jointly developed by the MSP, OHSP, and HSRI. In conducting the program, the MSP had overall management responsibility and performed many inspections. The Lansing City Police Department made additional inspections to meet the 20% goal in Ingham County. HSRI was responsible for conducting the evaluation effort, and the OHSP maintained general oversight of the program as the state's principal highway safety agency.

D. Findings

Outcomes of the program can be classified under two general headings: operational results and performance measures. Each of the general groups can be broken down further into three specific areas. All three operational areas did quite well. The three performance measures presented a cloudier picture. One measurement indicated a very modest improvement in vehicle condition, the second gave a clear indication of improvement but in a somewhat unexpected fashion, and the third supported an underlying premise of the checklane approach, that a small minority of drivers account for a disproportionate share of the seriously defective vehicles.

The three areas for operational results can be classified as general operations, follow-up procedures, and evaluation operations. Specific conclusions for these three areas are:

1. General operations were conducted very successfully. Intensity targets were met in each of the three counties. Where necessary, activity levels were rapidly increased to meet program goals. The teams appeared quite adept at finding areas with heavy concentrations of defective vehicles. While some variation among teams occurred, inspections met state standards. Passing rates in all three counties were somewhat higher than in the state as a whole. The two lower intensity counties, Kent and Genesee, had nearly identical passing rates (46.6%). Ingham had a markedly higher passing rate (58.3%). This result possibly suggests some diminishing returns to inspection activity. (Chapters II and VII).

2. Follow-up procedures were the most successful aspect of the entire program. Over 15,000 postcards were returned, and several thousand reinspections were conducted. Approximately 75% of the defective vehicles participated in one of the two follow-up methods. Qualitatively, participating agencies reported frequent public inquires about compliance indicating a high degree of concern. The only negative aspect was the less than desired backup from regular patrol forces. (Chapters II and VI).

3. Evaluation procedures were executed quite smoothly. Sample locations and procedures were rapidly established. The MSP sample team performed in a highly

commendable fashion. The samples matched demographic characteristics of the state vehicle/driver population. One major problem was encountered in reinspecting vehicles which recently passed inspection, and a field modification of procedure to avoid this conflict by not inspecting these vehicles may have hidden a large improvement in the population. Finally, since the design stressed the measurement of the entire vehicle population, certain key, or target subgroups may have in retrospect, been undermeasured. (Chapter II).

The performance measures can also be classified into three areas: sample inspection results, roadside observation data, and driver interview information. Specific conclusions for these three areas are:

1. Sample inspection results showed no difference in overall passing rates, either among counties or over time. However, at the highest inspection level (20%), the average number of major mechanical defects and the average number of vision defects per car did drop significantly over time. These changes,moreover appeared most strongly in areas with heavier checklane activity. Unfortunately, sample inspection results did not exactly parallel the roadside observation data. Nevertheless, the measured improvements in Ingham County can be considered good evidence for an effect at the 20% level. This is true, since excluding recently passed vehicles from the sample could have masked a 5% to 10% improvement in the vehicle population. Estimated trend lines from the three counties are shown in Figures I.1 and I.2 (Chapter III)

2. Roadside observation data indicated a definite improvement in condition. In Ingham County, which had the most intense inspection activity, lighting defects dropped an average of 5%. Certain areas of Genesee County also improved. However, areas with strongest improvements were higher income neighborhoods which received relatively less inspection effort. The data also suggested a slight possibility of independent seasonal changes affecting light outage. The observed changes occurred mostly in license plate and taillight outages. Results, though, point to a 5% reduction in lighting problems in Ingham County. Estimated trend lines for the three counties are shown in Figure I.3.

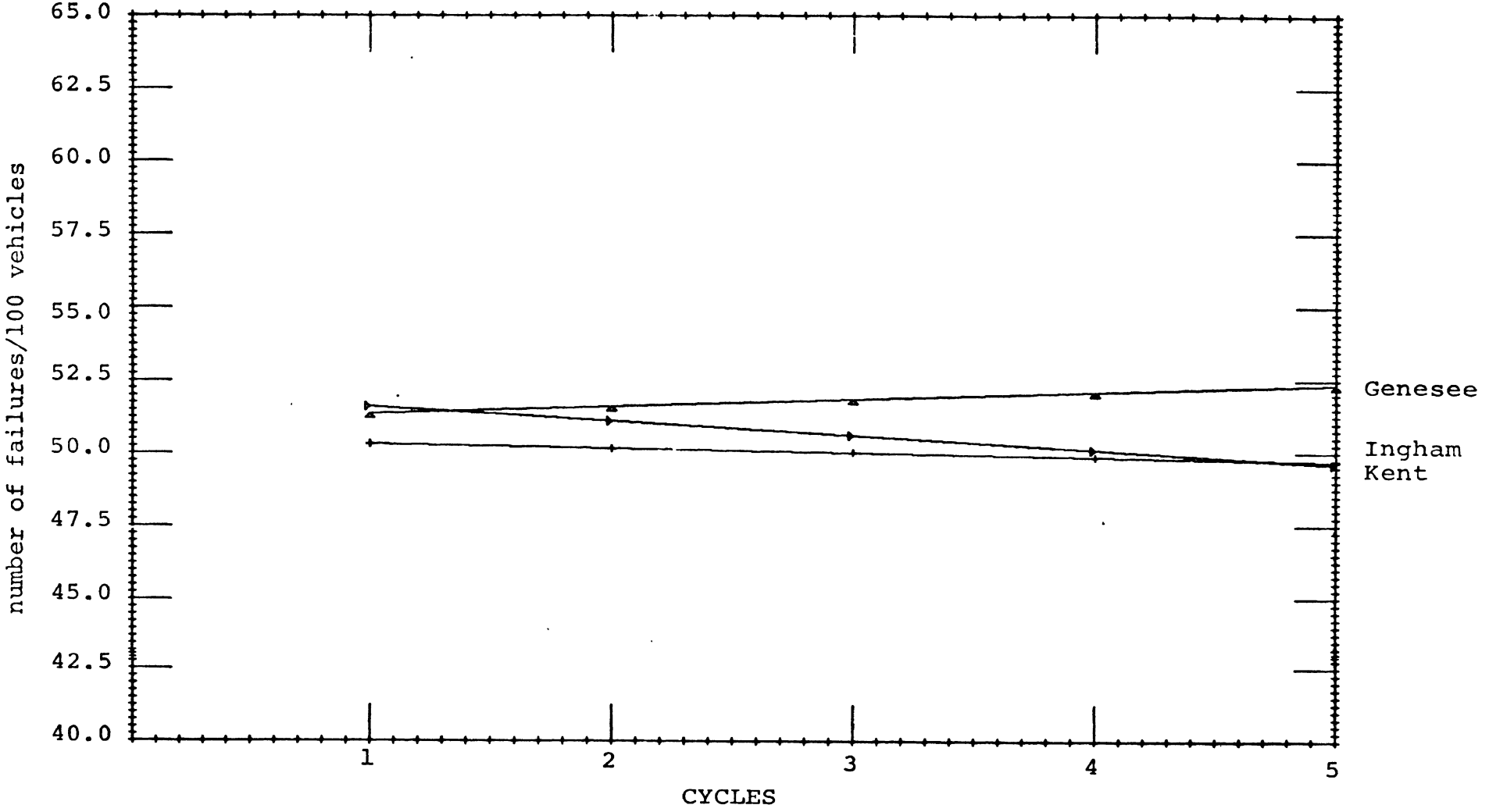

FIGURE I.1

Vehicle All - Fitted Regression Lines:
number of failures per 100 vehicles inspected

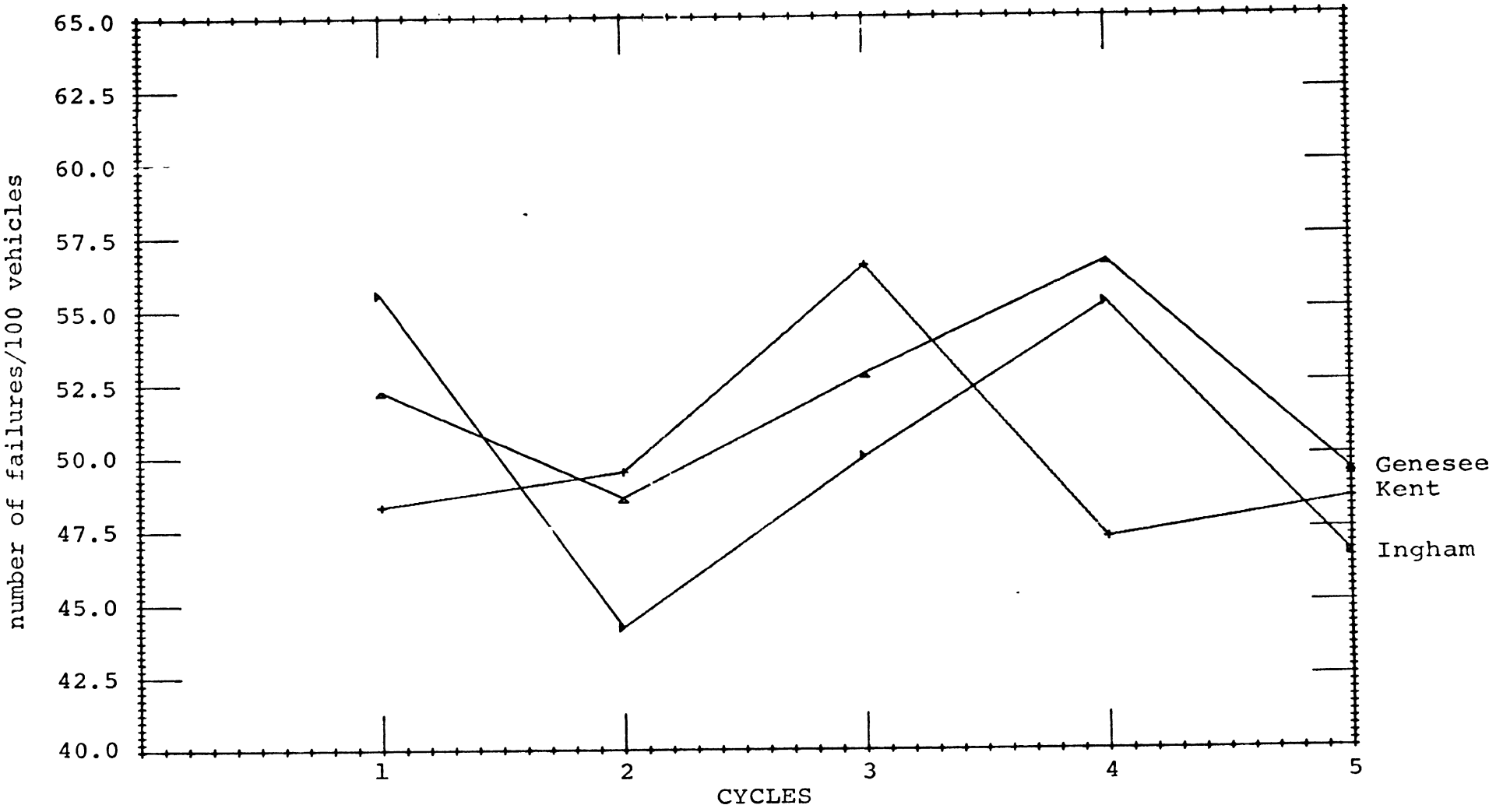

FIGURE I.2

Vehicle All - Raw Data:
number of failures per 100 vehicles inspected

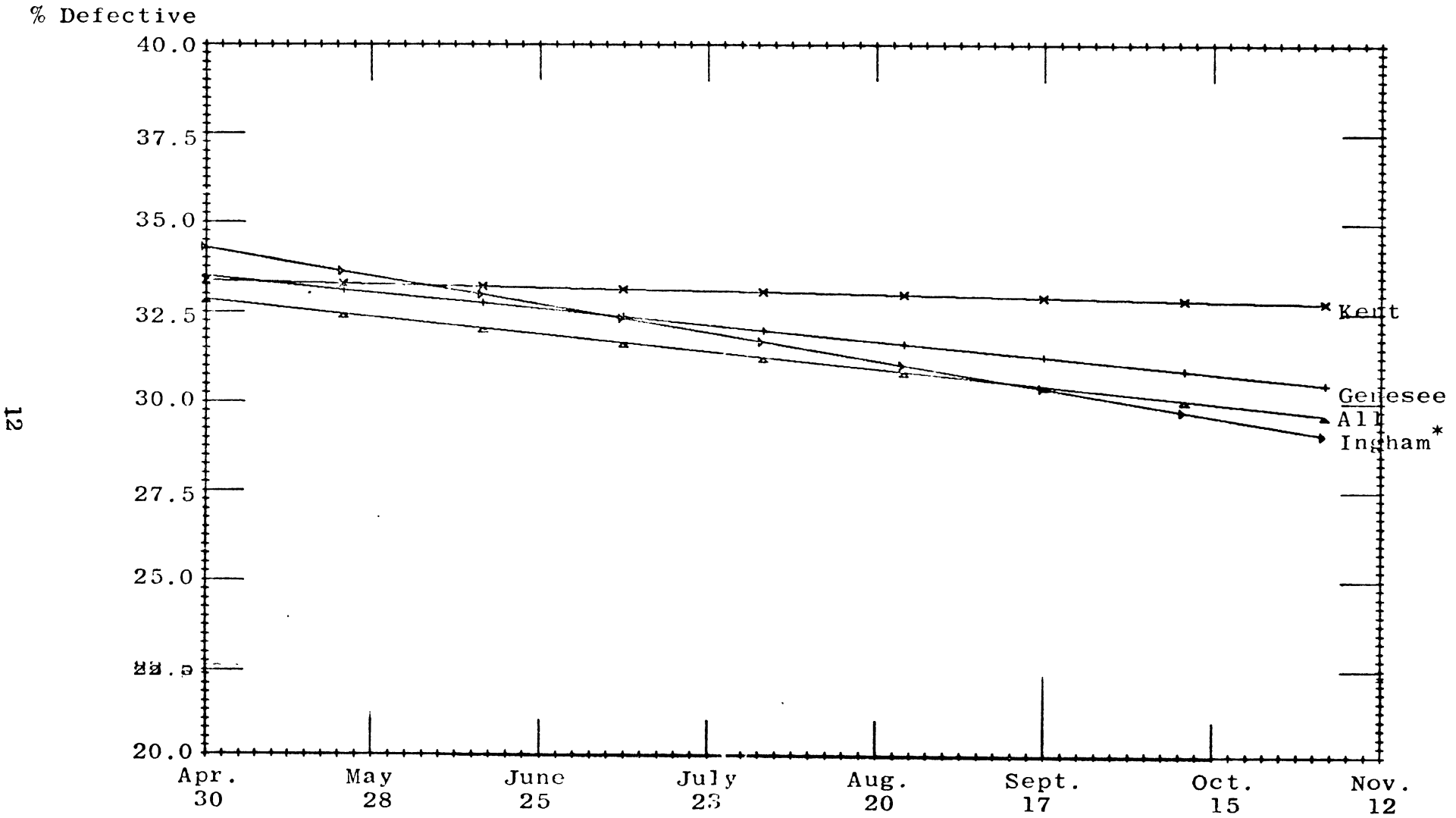

Figure I.3 Regression Lines

% Defective Vehicles vs Time;
by County

* Significant at the 90%
confidance level or better

TABLE I.1

Changes in Attitude over Time

ALL COUNTRIES

Cycle	Number Responding	Avg. Response	%Unhappy*	%Neutral*	%Happy*
1	422	2.95	32.9	41.7	25.4
2	1188	3.05	28.9	43.1	28.0
3	1189	3.07	26.5	46.3	27.2
4	1175	2.96	34.9	39.0	26.1
5	1107	2.90	35.0	41.1	23.9
Overall	5081	2.99	31.4	42.3	26.3

*Categories condensed from original.

INDIVIDUAL COUNTRIES

	Cycle 1-3			Cycle 4-5		
County	N	Avg. Response	%Unhappy	N	Avg. Response	%Unhappy
Genesee	805	3.14	24.7	781	3.01*	30.4*
Ingham	811	2.99	30.2	798	2.90	36.8*
Kent	1183	3.01	29.8	703	2.90*	37.8*
All	2799	3.04	28.5	2282	2.93*	34.9*

*Differs significantly from cycle 1 to 3 value at 95% confidence level or higher.

Responses were given on a five-point scale hanging from one for very displeased at being stopped to five for very pleased.

3. Driver interview information pointed to younger, poorer, less well-informed, and possibly more alienated operators of older vehicles being very overrepresented among those failing inspection. General public awareness of the program was high (80% apparently had heard of it), but specific knowledge of the program details was much lower (30% to 40%). The most frequent response on attitude was a neutral "not inconvenienced." A slight deterioration in attitude over time was noted. Yet, this seemed unassociated with the level of activity and was small relative to other determinants of attitude like trip purpose, condition of vehicle, driver age, and driver sex. The data on attitude by time are shown in Table I.1 (Chapter V).

E. Interpretation

Similar to many highway safety projects, results of the present effort came out like a bachelor's wash--slightly gray. At face value, the performance measures indicate that the program positively influenced vehicle condition at the 20% inspection level. Yet, certain ambiguities are present in the data. Such ambiguities are probably inevitable in any empirical study of this sort, and their presence should not be interpreted as necessarily vitiating the results. Nonetheless, objectivity requires their examination to preclude the possibility that the observed effects were produced by factors other than the inspection program.

Both sample inspections and roadside observations point to an improvement in Ingham County. Unfortunately, the two measures disagree on which components changed and on which areas improved. For sample inspections, average number of major mechanical failures per vehicle declined over time, but the overall passing rate remained unchanged. Quite expectedly, major mechanical items changed most in lower income areas where regular inspection forces concentrated their efforts.* This does represent a very positive change, given the sample's bias against finding improvement. The roadside observations, on the contrary, found lights getting better in high income areas of both Ingham and Genesee Counties. Yet, lights remained the same in low income areas. Standard statistical tests on both sets of data determined that such changes were unlikely to happen by chance. These inconsistencies raise the possibility either that chance effects, despite the tests, or that non-obvious phenomena produced the differences.

Three possible alternative explanations can be offered: seasonal changes in maintenance practice, introduction of new vehicles into the population, and saturation of neighborhoods

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* A major stratification criteria in the sample design was neighborhood income.

by the sample inspection team. Each of these will be considered in turn, and each will be dismissed in favor of a hypothesis of differential reactions among neighborhoods to increased inspection activity.

The data were collected from May through November; this could have introduced a seasonal effect in the roadside observation results. As darkness came earlier in the fall, people used their lights more frequently. Consequently, motorists would have a greater opportunity to detect and to repair light failures independently of checklane activity. However, three considerations argue against the seasonal hypothesis. First, significant declines in defects came only in higher income areas of Ingham and Genesee Counties. As pervasive a phenomena as the coming of fall more likely would have a far more uniform effect. Secondly, an analysis of light outage by time of day did not reveal any tendency for vehicles observed in the early evening hours to be in better condition. If increased light usage led to more repair activity, vehicles seen in the early evening would be expected to change the most, and they did not. Finally, changes occurred most predominantly in the taillight and license plate categories, while headlights remained constant. Since headlight failures are most susceptible to repair through casual observation, failure of this component to change suggests an absence of seasonal effect.*

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* Certain technical statistical problems, which are discussed in Chapter IV, affect each one of the three considerations. For example, the absence of statistically significant trends, except in the higher income areas of Genesee and Ingham Counties, does not necessarily imply that a time trend was not present. Such an implication is valid only if the other areas are proper experimental controls, and unfortunately, the statistical evidence on this point is not entirely unambiguous. Similarly, the low fraction to headlight failures, about 1% would require rather large shifts to yield a statistically significant change. Thus, a seasonal effect could have been present in headlights, but the data might not have shown it. Technicalities aside, the cumulative effect of the three considerations points more plausibly to an absence of seasonal effects.

Introduction of new model vehicles into the population could also have affected the outcome, particularly in the sample inspection. Since brand new cars were on the road a relatively short period of time, and since these vehicles were unlikely to be inspected by operational teams, they would be more likely to be included in the sample inspection, when the sample team began excluding vehicles with current passing stickers. Since new cars are relatively free of defects, their appearance could have caused an upward trend in the sample inspection passing rates. However, this is not likely to have been the case. First, the significant trends in the sample inspection results appeared in low income areas. New vehicles are less likely to predominate in such neighborhoods. Second, new vehicles constituted approximately 5% of the sample, whereas the opposite bias of excluding vehicles with current passing stickers affected over 20% of the last Ingham County sample. Since the bias against finding an improvement far outweighs the slight overrepresentation of newer vehicles, any improvement discovered must still be considered to be quite important.

The final source of distortion could have been the saturation of neighborhoods by the sample inspection team. If an area were very small, five visits by the sample team could have forced repair of virtually all the vehicles in that area. If a roadside observation were conducted in the same areas, the roadside observation would reflect the change in the particular area from 100% inspection, rather than a general shift due to checklane activity. However, the experiment controlled for the possibility in two ways. First, almost all locations for both measurements were on relatively high-volume, collector streets. Thus, the traffic passing by a site rarely came from an isolated area. Second, roadside observation sites were placed both near-to and far-from sample inspection locations, and a proximity factor was explicitly incorporated into the roadside observation analysis. In Kent and Ingham Counties, proximity and hence, by inference, saturation did not affect the outcomes. In fact, "close" locations in Ingham County performed

slightly worse than did "far" locations. Unfortunately, despite the care exercised, one high income location in Genesee County suffered saturation and, thereby, distorts the result for that county. When that location was removed from the analysis, Genesee County roadside observations no longer displayed a significant downtrend in failure rates. Thus, only at the 20% level, in Ingham County, can it be definitely stated that an improvement occurred.

Several alternative hypotheses which might explain the data have been considered, and in general, they do not seem persuasive. This brings one back to the fact that the only thing known to be systematically different about these counties was the program's operation. When statistically significant change occurred, it was associated with higher levels of checklane effort, and even when results were not statistically significant, the rank ordering of effects consistently followed the pattern of the smallest estimated changes in Kent County and the largest in Ingham County.

Nonetheless, the evidence would be more persuasive if the changes among areas in Ingham County had been consistent, but they were not. Some explanation needs to be offered. The two area type's differing reactions yield the most plausible explanation. Both sample inspections and roadside observations show marked differences in vehicle condition between high and low income areas. Additionally, on the driver interviews, personal income, age, knowledge, and other driver characteristics strongly affected inspection outcome. Such differences among population groups far exceeded differences among the counties or over time. At much risk of oversimplifying and painting a "good vs. bad guys" picture, differences in sensitivity to inspection among population groups can be postulated, and neighborhood income can be used as a crude proxy for such differences.* On the average, people in higher income areas might react more quickly to the checklane. Since vehicles in these areas were in better condition initially,

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* Footnote on next page

repairing common, minor defects like lights would not impose a serious burden. The roadside observation would readily detect such changes. Yet, the sample inspection might not show this effect.**

Conversely, people in low income areas on the average might react more slowly. Since the finances are limited, efforts understandably might be concentrated on the more serious problems, when they were present, and more minor defects, like lights, might be relatively neglected. Application of mandatory repair requirements for major defects would amplify this tendency. A broadly based measure of all major defects might detect such changes, while simple pass/fail measures for the entire vehicle or checks of specific component groups, like lights, might not. In short, people in both areas reacted to the program but in different ways, depending on the problems they faced.

Summing up the interpretation, people in lower income areas probably reacted more slowly to the lane's impact than did those living in higher income areas. This differential reaction, combined with the peculiarities of the two measurement approaches, provides the most plausible explanation for the apparent inconsistencies in the results. While such ambiguities do qualify the conclusions, they do not obscure the basic implication of the data. Where the most intense checklane effort was made, there was an observable improvement in the condition of vehicles.

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* The authors do not feel that low income neighborhood residents are less responsible motorists. Many in these areas are quite dedicated to safe maintenance practice. The problems are older vehicles and the cost of maintaining them. Since the situation, on the average, occurs more frequently in lower income areas, the statistical association provides a convenient description. This is analogous to youth's statistical overinvolvement in accidents. The true difficulty might be impetuousness, regardless of age. Lacking direct measures of this, age often is used as an analytical device, even though many young persons are exemplary, prudent drivers. In a similar fashion, neighborhood income is used as a proxy for responsiveness to inspection.

** Recall again the general bias of the sample inspection against detecting change. Additionally, since vehicles in higher income areas were better to begin with, smaller samples from inspection would be less likely to detect changes.

F. Alternatives

Prior to making recommendations, HSRI reviewed alternative approaches to maintaining vehicles in safe mechanical condition. The review is covered in Chapter VII and is sketched here. The review examined the presently available evidence on the mechanical condition/accident problem and considered the merits of four alternative programs: (1) the enhanced checklane procedure considered in this study, (2) a limited form of conventional inspection, (3) a full conventional inspection system, and (4) a diagnostic inspection approach. Of the four alternatives, the checkland program and diagnostic approaches appeared more attractive, and conventional approaches, either limited or full, rated less highly.*

Only limited evidence is available on the problem. Most investigations have tackled only one half of the problem. The first half, determining what factors influence the mechanical condition of the vehicle, is in somewhat better shape. Vehicle age and mileage clearly have a strong impact, and owner maintenance practice, inherent component quality, and operating environment have also been found to be important determinants of vehicle condition.

Inspection procedures have also been found to improve vehicle condition. The degree of improvement varies greatly from component to component. Items which infrequently fail, and which are quickly repaired independently of inspection, are only slightly affected by inspection systems. Comparisons of vehicles in states with and without conventional inspections have indicated that cars in conventional states are in somewhat better condition. The differences,however, are most marked in relatively less safety critical

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* Neither review of alternative programs nor formulation of recommendations was included in HSRI's specific responsibilities. However, HSRI felt obligated to provide such an analysis in order to enhance the value of the report to the sponsors. Since ranking alternatives and making recommendations concerns matters of opinion as well as fact, it should again be stressed that the views expressed are those of HSRI and the author, and not necessarily those of the sponsors.

areas, like headlight aim and license plate lights. Only slight, if any differences were found for more safety critical components such as brakes. Given such evidence, it is natural to ask, "How does Michigan compare?". Qualitatively, one is tempted to say "not badly." However, the present study differed sufficiently in scope, method, inspection techniques, and sampling procedures, so that comparison of the present results with those from other studies would not be valid.

Finding a relationship between faulty condition and crashes has been the more difficult half of the problem. Statistical analyses have produced results which often seem more dependent on the data source used and the technique applied than on the existence of a strong causal effect. Accident investigations to find the role of defects in specific crashes have also had problems. The difficulties included establishing the condition of the vehicle prior to the crash, when many critical components may have been damaged in the crash, and assigning the relative importance of a particular factor, when many may have contributed to the accident. The most carefully conducted study of this sort indicated that about 6% of the crashes were caused mainly by defects, and another 8% were associated with defects. A companion attempt to measure the relative incidence of defects in the overall population, as compared with the crash-involved defects, showed only a quite modest association. Hence, at present it would seem difficult, if not impossible, to say with any degree of certainty that a reduction of x percent in the incidence of a specific component failure would yield a reduction of y percent in crashes.*

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* If one takes the most generous estimate of crash involvement related to defective vehicles, 14%, and the most generous estimate of the improvement in overall vehicle condition attributable to a rigorous inspection program, 33% one could conclude that slightly over 4% of the crashes could be prevented by conventional inspection programs. In the author's opinion, the 4% figure is too high for two reasons. First, few crashes result from any one cause so that eliminating defects would save only some portion of the 14%. Second, conventional inspection systems are relatively less effective in bringing improvements in more safety critical components, since these tend to be those that are long-lived and are repaired relatively quickly once they occur,

Since present knowledge does not show how effective particular inspection programs might be in reducing crashes, ranking alternatives on strictly objective criteria is not possible. Rather, an informed judgement must be made after considering the merits of the alternatives.

Checklane approaches have three advantages: low cost (at most, $5.00 to $7.00 per inspection for a small number of inspections), specificity, and continuous presence.* Specificity refers to the fact that the checklane can concentrate on the portion of the vehicle population which is most likely to display serious defects. The continuous presence of the lane may foster a continuing concern among motorists to maintain their vehicles in safe condition, rather than simply making an effort at long intervals to comply with an inspection deadline. Specificity combined with continuous presence may substantially decrease the time between when a defect occurs and when it is repaired. The disadvantages of the lane are the difficulties of follow-up, the inconvenience of being stopped while enroute, and the possibilities that some, particularly economically disadvantaged persons, may view it as discriminatory. An unresolved problem at this time is whether the checklane will produce a vehicle population which overall is in as good condition as one subjected to conventional inspection procedures.** Since comparable data from other areas are not available, the question may be more procedural than substantive.

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* A fourth advantage of the lane is the continuing driver contact, which may help to reduce the numbers of suspended license violations.

** A partial answer is that the lane might be better in some respects and worse in others. Since the lane directs continued and specific pressure on problem vehicles, it might be more successful in eliminating the most serious hazards. At the same time, minor defects might be more prevalent. In a broader perspective, the "as good as" question might be irrelevant. If the lane were to provide as much protection against crashes as was cost/beneficial, achieving an even better level of vehicle condition would be inefficient, since the effort in inspection could be better made in other areas.

Conventional inspection systems have the primary advantage of certainty. Under such systems, it is known that all or some designated classes of vehicles will be brought to an inspection facility at periodic intervals. Additionally, inspections may be more thorough than is possible in the checklane. The primary disadvantages are high cost (easily between $10 and $15 per inspection) and inability to encourage sound maintenance practice between inspections. Further, if private garage systems are used, extensive state supervision is required to prevent abuses. Two types of conventional inspection systems were considered,full and limited. The full system would require that all vehicles be inspected at least annually, while the limited system would require only certain vehicles, those sold as used cars and those more than five years old, to be inspected. The limited system would allow substantial cost savings over the full system while attacking the major source of the problem, older higher-mileage vehicles. Still both systems would be more costly than the checkland system, and very generous estimates of benefits and quite persimonious cost calculations are required to make conventional systems appear even marginally cost/beneficial.

Finally there are diagnostic systems. This term covers an array of inspection approaches, most of which would employ electronic condition sensing devices. Such sensors either could be checked by on-board monitors, which would flash a warning of dangerous conditions, or could be read by a computer during regular servicing. Such systems could reduce costs and improve inspection quality. Use of on-board warning devices would serve to bridge the time gap between when a dangerous condition occurs and when it is repaired. Diagnostic systems have received increasing federal support, and funding for states to implement them is being made available. Since the technology is still being developed, it is difficult to assess its ultimate merits. Nonetheless, diagnostic approaches seem to have much promise for eliminating many of the problems associated with other inspection approaches.

The preceding paragraphs have reviewed current inspection alternatives in a very cursory way. From an academic viewpoint, a call for more research would seem most warranted. Still, as a practical matter, decisions must be made, and the value of alternatives must be assessed. Conventional inspection programs, either full or limited, would seem to be relatively unattractive for Michigan. High costs and the likelihood of quick obsolescence argue against following the conventional approach. For the immediate future, an enhanced checklane seems most desirable. This is based on the lane's demonstrated effectiveness and on its economy. At the same time, Michigan should remain alert to the rapidly changing inspection technology so that the state can take advantage of the latest techniques as they mature.

G. Recommendations

It is recommended that Michigan continue the checklane inspection system. This recommendation incorporates four specific features:

1. An immediate goal of inspecting 15% of the state's vehicles should be established and rapidly met.

2. Mandatory repair and reinspection legislation and procedures should be established.

3. MSP should maintain one special inspection team to monitor performance on a state-wide basis and to experiment with advanced inspection techniques.

4. Michigan should review from time to time alternative inspection approaches as additional evidence on their relative merits becomes available.

The first two recommendations cover the substance of the program, and the second two suggest management techniques which will be useful in maintaining a quality operation.

The program's continuation is recommended by its demonstrated usefulness in the present experimental program. While subject to some technical qualifications, the force of the evidence points to a solid effect at the 20% inspection level, and the experimental data provide some limited indications of success at the 10% level. The recommendation for a 15% coverage as the immediate goal represents a judgemental compromise between what can be proven and operational considerations. Operational data, as illustrated in Table I.2, indicate a substantial increase in passing rates between the 10% and 20% levels. This suggests a zone of diminishing returns, in which the teams must inspect progressively larger numbers of passing and minor defect vehicles in order to locate those with serious multiple defects. Whether this effect occurs at 12.5%, at 17.5% or at 20% cannot be established from the present data, since only the end points of 10% and 20% were measured.

Table I.2

Comparison of Passing Rates
Operational Team Results
Ingham vs. Kent and Genesee Counties

Month	% of Vehicles Passing in Ingham	% of Vehicles Passing in Kent and Genesee
May	54.4	51.8
June	56.1	51.7
July	59.2	50.4
August	58.4	44.0
September	60.1	49.1
October	---*	45.0
November	62.4	37.0
December	58.1	47.1
	23,000 inspection	20,000 inspections

* Data unavailable due to data processing problems.

The other operational consideration deals with the magnitude of the program. Increasing the coverage to 15% would approximately double the number of inspections over present levels, and imposition of mandatory repair and reinspection procedures at the 15% level would more than double the amount of effort required. In short, the 15% immediate goal, while not being precisely determined, appears to represent a reasonable balance between established effectiveness levels and maintaining a quality inspection program.

Mandatory reinspection legislation and procedures are needed to make the program fully effective. The administrative follow-up procedures were clearly successful. For state-wide application, legislation is required. Mandatory reinspection seems necessary, since some who have failed to maintain their vehicles will require more than a warning. Still, some form of self-certification should be permitted for repair of very minor defects, like fluidless windshield washers, which do not evidence a pattern of neglect. The legislation should be phrased in such a fashion as to allow the MSP to establish the criteria under which mandatory reinspection or self-certification should be used. Requirements can then be readily

adjusted as experience dictates. Overall, self-certification will reduce the burden on both citizens and agencies for very minor problems. Follow-up procedures will also require several other features. "Reinspect" stickers must continue to be placed on rejected vehicles. Some sort of penalty must be assessed against those who fail to comply with the reinspection requirements, and most likely this will be a citation under the motor vehicle code. However, enforcement will have to be structured to take account of conditions where the driver is not responsible for the vehicle's maintenance such as commercial vehicles and rental cars. In general, with the institution of mandatory reinspection, criminal sanctions for defective equipment should continue to be used sparingly, since the primary purpose of the program should be to secure the repair of defective vehicles. Limiting equipment citations to cases of willful neglect and failure to comply with the inspection requirements will focus attention on the program's primary purpose and will ameliorate the punitive aspects of reinspection procedures.* Finally adequate computer and communications facilities will have to be provided. The inspection status of a vehicle can then be rapidly determined by checklane teams and appropriate action can be taken in the event of non-compliance with reinspection or certification requirements.

The MSP should operate a special inspection team on a regular basis. This team should be controlled from MSP headquarters and would serve two functions. First, using the standard inspection procedures, the team should conduct regular samples of vehicle condition on a statewide basis. The sampling technique should be essentially that developed in the current project. This will provide a continuing measure of the overall vehicle quality in the state based on a standard reference point. This can be used as a continuing measure of program effectiveness. The sample will

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* This is not to say that officers should ignore violations other than defective equipment.

provide a form of quality control on operational team efforts by indicating areas of great discrepancy between population conditions and operational results. Additionally, the special team can be used for testing new procedures and improved techniques to demonstrate their effectiveness before adoption on a statewide basis.

Finally, the state should from time-to-time review the merits of alternative inspection procedures. This is not to say that the checklane is to be continued on a trial as opposed to permanent basis. Since the best means of inspection has not been conclusively determined,the wise course of action is to review periodically to insure that the checklane continues to be the most attractive alternative. Among alternatives to be considered are: annual inspection of all older vehicles and of used car sales, conventional annual inspections, and the "diagnostic" inspections envisioned under the Motor Vehicle Cost Savings Act of 1972. As discussed in Chapter VIII, the checklane currently appears to be the most attractive approach, but conditions could change in the future. Consequently, occasional re-examinations are necessary.

H. Overview

The remainder of the report elaborates points covered in this chapter. Chapter II discusses the program plan and operation in more detail and examines the statistical properties of the data gathered. The next three chapters cover the three performance measures: Chapter III, Sample Inspections; Chapter IV, Roadside Observations; Chapter V, Driver Interviews. The next two chapters deal with operational aspects: Chapter VI, Follow-up Procedures; Chapter VII, Regular Inspection Data. The final chapter, VIII, is an essay on program alternatives which discusses some of the issues involved in designing the most cost/effective inspection system. Each chapter has been structured to contain a summary section which provides a quick grasp of its contents. More detailed analysis is then presented. Certain sections which are for technical readers are clearly indicated, and these may be omitted by the general reader without loss of meaning.