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AN EVALUATION OF THE MICHIGAN TRIAL SUBSTITUTE MOTOR VEHICLE INSPECTION PROGRAM

FINAL REPORT

VOLUME II: TECHNICAL

by

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with the assistance of
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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.

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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 estalished. 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.

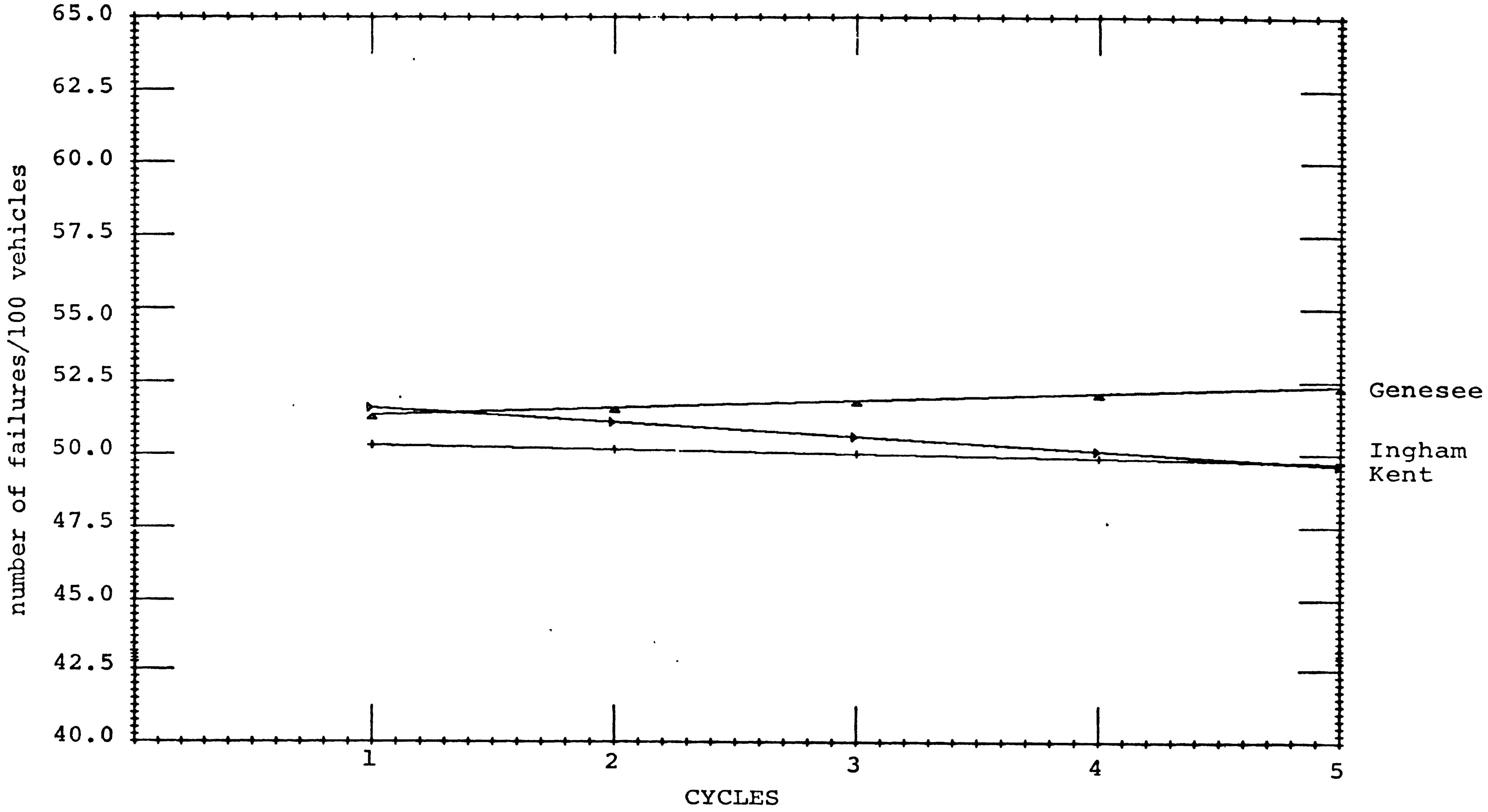

FIGURE I.1

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

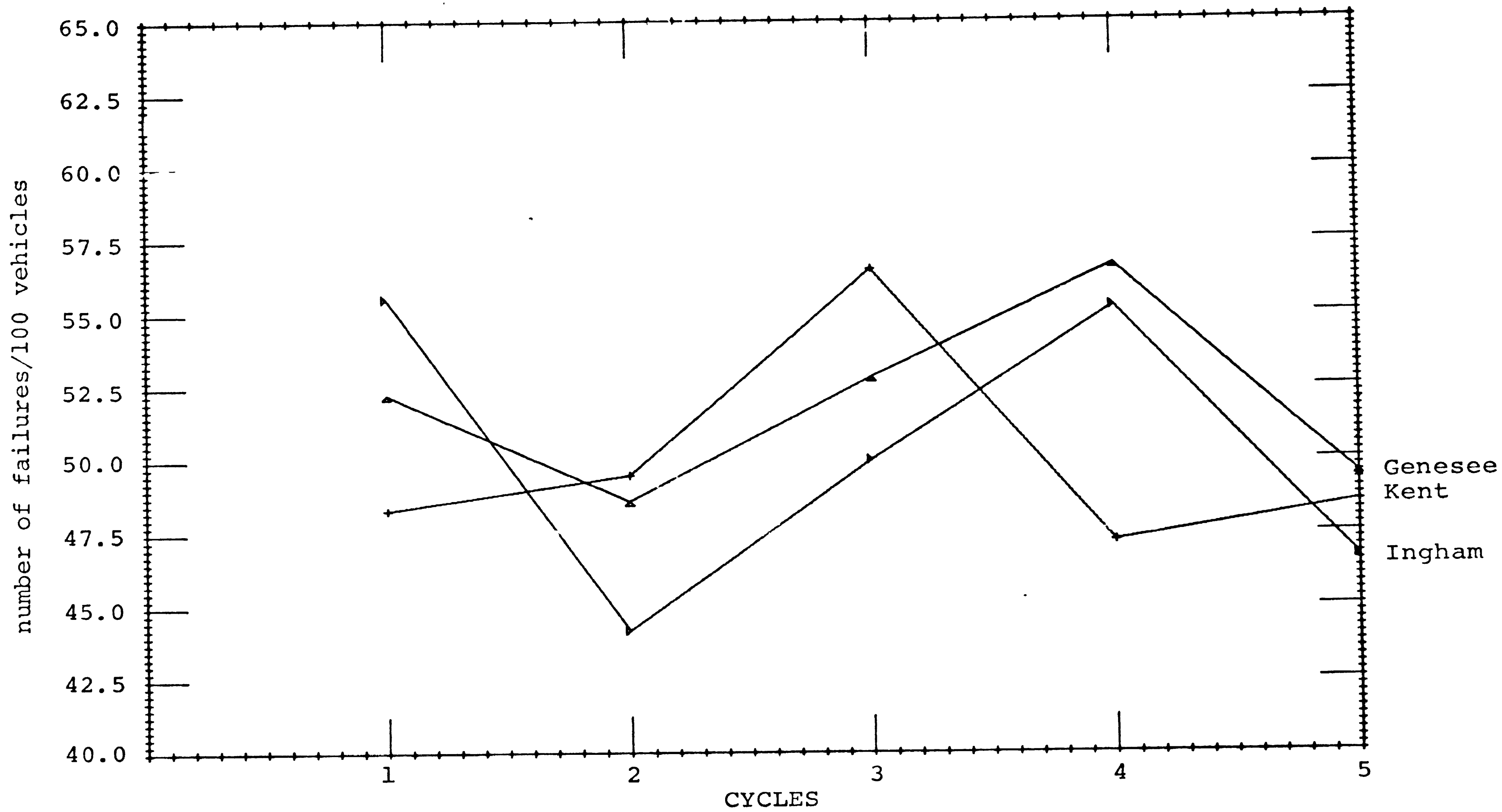

FIGURE I.2

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

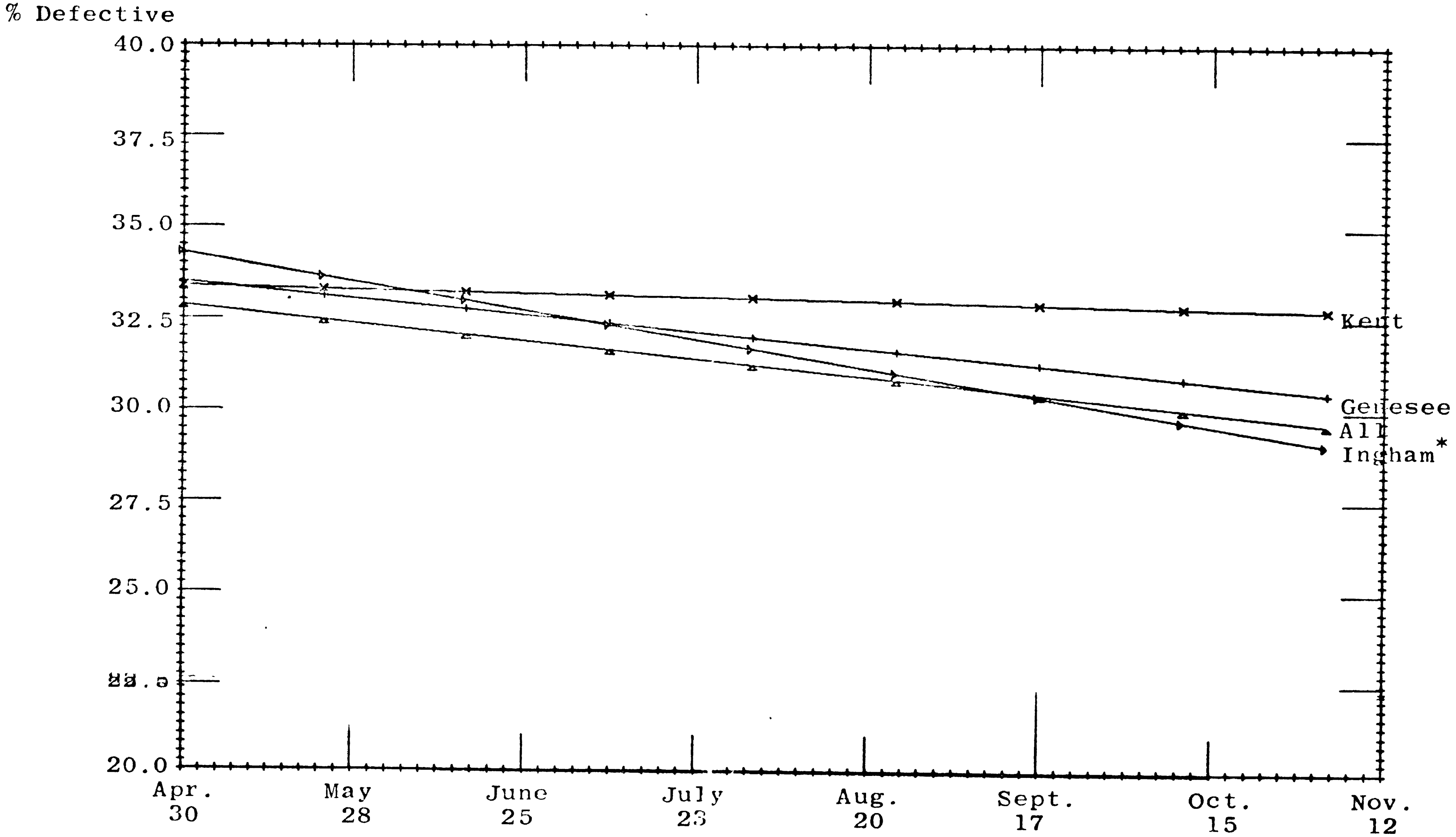

Figure I.3 Regression Lines

% 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	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 defecti 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

* 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.

II. THE PROGRAM, PLAN AND REALITY

A. Introduction

This chapter describes the Michigan Trial Substitute Motor Vehicle Inspection Program. The program was organized into two distinct activities: operations and evaluation. The operations concerned regular inspections. The evaluation concentrated on measuring changes in vehicle condition and owner attitude in the three experimental counties. Since the checklane program was well established prior to the present effort, the evaluation did not examine operations in depth. Rather, specific operational features were studied as questions arose. Consequently, this chapter will only highlight important features of operations. More specific detail can be found in Chapters VI and VII and in the references given below.* Most of the chapter concerns the evaluation plan and its implementation.

Operations were conducted quite successfully. Two aspects of operations can be considered separately: activities in the three experimental counties and those in the remainder of the state. The experimental counties had two unique features. A controlled fraction of the vehicle population was inspected in each county, 5% in Kent, 10% in Genesee, and 20% in Ingham. An administrative follow-up system was instituted to secure the repair of defective vehicles. The desired number of inspections were conducted, and the follow-up system generated a high response. In the remainder of the state, the number of inspections increased to some 8% of the vehicle population and several new police agencies were added to the program.

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* Michigan Office of Highway Safety Planning, "Program Plan for the Michigan Trial Substitute Motor Vehicle Inspection System;" Michigan Department of State Police, "Motor Vehicle Inspection Manual." Michigan Department of State Police, "Vehicle-Driver Check Lane, Annual Report."

Evaluation data collection went quite smoothly. Three activities were undertaken: a controlled random sample inspection of the vehicle population, interviews of drivers being inspected, and a roadside observation of lighting defects in the evening hours. The sample inspection produced quite a representative picture of the vehicle population. Unfortunately though, an inadvertant change in sampling procedure may have obscured a time trend in vehicle condition. Driver interviews were conducted with a high response rate. The roadside observation apparently produced a very accurate and unbiased picture of vehicle condition. At HSRI, data processing and analysis proceeded without major difficulties.

B. Operations

The more innovative operational features occurred in the experimental counties. The experimental program tested two areas of the checklane effort. First, the fraction of the vehicle population inspected, or the inspection intensity, was varied across the three counties. Ingham County had 20% of its vehicles inspected, Genesee 10%, and Kent 5%. The intent was to determine which intensity yielded the most relative improvement in the vehicle population.

The second experimental aspect was the institution of a follow-up system to secure the repair of the vehicles failing inspection. Two degrees of follow-up were used. For vehicles which had serious, hazardous defects, operators were issued citations. Through arrangements with the courts, the operators were required to have the vehicle repaired and reinspected prior to disposition of the citation. For vehicles with less serious failures, operators were provided with return post cards to certify that repairs had been made. In addition, the vehicle's inspection status was entered into the state's Law Enforcement Information Network (LEIN) computer system, and a reinspection notice sticker was placed on the vehicle's windshield. If the vehicle again came to the attention of the police, LEIN was queried on the vehicle's inspection status. If items found previously defective were still inoperative and if the 21-day grace period had expired, the officer took suitable enforcement action.* Most of the follow-up effort came from checklane activities.

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* Normally, a citation was issued, which, as in the case of hazardous defects, required repair and reinspection. Officers were allowed some discretion in dealing with unusual cases such as the person's having to special order parts for foreign vehicles. These occurrences were probably expectional. Based on informal observation, operators of recent model, domestic vehicles who had exceeded the grace period promptly received summons.

In the remainder of the state the checklane program was conducted in the same fashion as in the past. The program continued its steady growth with a total of 234,000 vehicles inspected by 32 teams, seven of which entered the system for the first time.

In the experimental counties, the number of inspections met the intensity target. In the two counties with higher intensity, activity rapidly increased. In Ingham County, inspections were conducted both by the State Police and by two teams of the Lansing Police Department. The Lansing Police teams, which were specially established for the program, were organized without difficulty. These teams along with additional State Police effort in Ingham County slightly exceeded the 20% goal. In Genesee County, inspections were mostly conducted by the State Police, who met the 10% goal with the use of extra manpower. In Kent County, normal activity checked approximately 5% of the population. Procedures generally followed the established state guidelines. Slight variation among teams probably occurred in some subjective measurements, like exhaust noise, but on the whole inspections were of uniform quality.

In Ingham County, the passing rates of the operational teams had an obvious uptrend. The trend was not examined in detail. However, the change probably came from the teams moving from worse to better areas within the county. In early months, officers spent most of their effort in areas with a large concentration of defective vehicles. Once these areas had been saturated, effort shifted to other areas. The shift probably produced the upward trend. The pattern indicates police proficiency in identifying areas which require extensive inspection activity. The results also suggest that inspecting substantially more than 20% of the vehicles may result in sharply diminishing returns of hazardous vehicles removed from the road.

The follow-up system worked well. Courts readily cooperated with the mandatory repair and reinspection program. After having received a summons, a substantial number of motorists repaired and submitted their vehicles for reinspection. About 30% of the vehicles failing initial inspection were reinspected.* The post card return system worked extremely well. Some 15,250 repair certifications were received, which represented in excess of 60% of the vehicles failing initial inspection. In addition, the police received frequent inquiries about compliance. Both responses indicate substantial public concern with meeting inspection requirements. More information on the postcard returns is provided in Chapter VI.

The second part of the follow-up monitored compliance. The two activities involved were quickly implemented. A vehicle marked with the reinspection sticker merited special attention from the checklanes. If the grace period had expired, the vehicle was reinspected and appropriate action was taken if defects were not corrected. Many reinspections may have come from this source. The LEIN inspection file was widely used by checklane teams. The Lansing City Pólice teams, which had a special radio channel for the purpose, checked the inspection status of every vehicle. Other teams made regular use of the LEIN file. The practice was not universal, since at times regular channels were occupied with other police calls.**

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* On account of an unfortunate oversight in the brief implementation period, no mechanism was provided to capture exact figures on the number of mandatory reinspections performed. The relative magnitudes of the activity are indicated by the fact that 3250 citations were issued and 5700 full reinspections were performed. The figures are not strictly comparable though, since some citations were for driver-related violations such as no driver's license and some of the reinspections were voluntary. Balancing the voluntary reinspections to an unknown extent were cases where the vehicle was given a reinspection for the specific defect for which the citation was issued. In this case, no inspection report would have been completed, and no record is available in the data file for the case. Qualitatively though, the checklane teams and participating police departments reported a brisk business in conducting reinspections.

** Again, due to the short implementation period, no data could be gathered on the number of LEIN inquiries made, since special computer programming would have been required. However, this problem could be remedied simply in a permanent operational system.

In addition to the checklane teams' monitoring, it had been hoped that regular patrol forces would supplement the follow-up. This was to be done by having officers request or routinely receive the inspection status of vehicles. The check was to be part of the standard traffic stop procedure. However, informal contact with patrol force members indicated that this usually did not take place. The shortcoming probably reflect the newness of the system rather than unwillingness or inability to provide back-up. When the system was explained to individual officers, they expressed interest and a desire to use it. If the follow-up system became a permanent feature of the inspection program, regular patrol activity would probably provide some additional support. Yet, with the regular patrol's many other pressing duties, the checklane teams would carry the principal burden of monitoring compliance.

An evaluation of the follow-up must recognize two facts. First, a conclusion at this point is not based on full quantitative information. Second, regular patrol officers were not and, hopefully to a lesser degree, will not be able to pursue the follow-up as vigorously as would be desirable. Nevertheless, the follow-up procedures can be considered the most successful aspect of the program. As discussed in Chapter VI, the system apparently secured repair of over 70% of the vehicles failing initial inspection. A continuation of the checklane program should include a follow-up system with the general features of the experimental system. The most recent governor's recommendations include follow-up provisions. The follow-up procedure should be enacted into law. Mandatory reinspection should be extended to a broader range of components, and sufficient resources should be provided to insure that the reinspections can be conducted. Provision should still be made for voluntary compliance for truly minor defects, e.g., waterless windshield washers and a single bulb outage in a multi-bulb tail light unit. With both the mandatory reinspection and the voluntary compliance system, the LEIN inspection status files should be maintained, and adequate communication channels should be provided to access the information.

To these recommendations a qualifying note must be added. The authors are well aware of and indeed share an amount of sympathy with objections to some proposals on civil liberties grounds. Viewed most negatively, the LEIN files for follow-up could be abused. While this abuse may be improbable, the potential cannot be denied. The police will be maintaining records on a large number of otherwise presumably law-abiding citizens. The records could be used to justify a "stop and frisk" operation. Safeguards should be instituted for the LEIN files. Individual records should be purged from the files both after successful reinspection and at fixed time intervals even without reinspection. The annual expiration date of license plates would provide the opportunity for the second type of purge. Third, file use should be monitored to identify situations where abuses might be developing. Identification of repeated checks on a specific vehicle would merit particular attention since it could indicate cases of individual harrassment. Finally, it should be stressed that discussion of such concerns focuses on the potential,not the reality. In the experimental period, such abuse did not come to the evaluator's attention.

Concern about civil liberties problems is not limited to a specific aspect of the follow-up system. During the summer of 1972, at least three court tests of the lane's legality were mounted. The cases occurred in areas outside the experimental counties. The challenges were basically under the Fourth Amendment provisions against unreasonable search and seizure. In one case, the original court dismissed a ticket issued by a checklane team. The District Court based the decision on the lane's unconstitutionality. The county prosecutor appealed the dismissal to the Circuit Court, and the charge was reinstated. In two other cases in a second county, essentially the same challenge was made, but the District Court did not accept the defendant's argument. Prompted by these cases, an Attorney General's ruling was sought in order to have a full review of the lane's legality. The Attorney General ruled that the basic statute and the police's authority to enforce it were legal.

While the authors and, indeed, many thoughtful police officers share the concern with potential abuses, recognition of the concern should not be interpreted as a negative assessment of the program. In perspective, some citizens may view the checklane as an unjust imposition, and on occasion the lane might have been used for non-traffic law enforcement purposes. However, despite the publicity given the court tests and the most intense level of effort ever made including the follow-up procedures, the issue never arose in the experimental counties. Moreover, recognition of the potential problem should lead to safeguards to prevent abuses. Beyond that, the matter becomes essentially a political/legal problem. So far the legislature, the executive, and the courts have indicated that the safety benefits of the checklane outweigh the potential abuses.

Overall assessment of the operational aspects of the program is quite positive. In the experimental areas, a sizeable expansion of activity occurred with a minimum of difficulty. The follow-up procedure generated quite high response from the public. In the remainder of the state, the number of inspections and the number of inspecting agencies grew. Some controversy did arise about operations, but the extent seemed rather small in light of the hundreds of thousands of public contacts made.

C. Evaluation Plan

The evaluation was organized into three activities: a random sample inspection of vehicles in the experimental counties, observation of vehicles during evening hours for common lighting defects, and interviews of drivers in the vehicle sample. The first two activities were planned to produce an unbiased picture of vehicle condition and to measure any changes over time. The third activity, driver interviews, was intended to check the representativeness of the sample inspections and to measure the public's attitude about vehicle inspection. Data collection was performed by a special Michigan State Police team, and data analysis was completed by HSRI. This section describes the plan for each activity. Subsequent sections cover the execution of the design and the statistical representativeness of the sample.

For the sample inspection, five sets of 400 vehicles were checked in each county at approximately equally spaced time intervals over the project period. For each time period, the samples were collected in three consecutive weeks from each county. This produced a total of 1200 vehicles in each sample inspection cycle and a total of 6000 vehicles over the five complete cycles. The number of vehicles sampled was established on statistical grounds. The 400 vehicles in each set for a county insured that a difference of plus or minus 3% from a 50% base could be measured with 95% accuracy. Relatively small differences between different time periods in the same county or between counties could be established with some confidence.

Eight locations were used in each county for the sample. The same locations were used for every sampling cycle, to insure consistent measurements over time. Locations were selected in areas which were stratified on income and on urbanization. Four high income areas and four low income areas were chosen using census data. Within each income group, two locations were in suburban areas and two were in central city areas. The income classification was based on the knowledge that vehicles in higher income areas were in better condition. The urbanization classification was established to scatter the sites over the county.

Within an area, a specific location was chosen on several criteria. Streets had to carry a moderate volume of predominantly local traffic. Where possible, heavily traveled through routes and strictly single-neighborhood residential streets were to be avoided. In traffic engineering terminology, collector streets were to be used and arterials and local service routes were to be avoided. In addition, sites had to meet the normal checklane criteria for safety and for avoidance of undue traffic congestion.

At each site, fifty vehicles were inspected over a three hour period. After allowing a predetermined number of vehicles to pass the site, the next vehicle in the traffic was inspected. If this vehicle were ineligible, i.e., an out-of-state, large truck, or emergency vehicle, the next car was chosen. The interval was varied with traffic volume to meet the 50 vehicles in three hours goal. No more than 20% of the vehicles passing the site were to be selected. This was to prevent the sampling procedure from saturating the area. Hours of operation were varied across the day from 7:00 a.m. to 6:00 p.m.. Normal daytime traffic and rush-hour traffic was covered.

A second measurement of vehicle condition was obtained by observing the vehicle lights during the evening hours. This provided an independent check on the results of the sample inspection. An observer, stationed at an intersection, tallied the outages of lights on all vehicles stopping for the traffic control device at the intersection. Again,eight sites were used in each county, and these sites were selected on the same criteria as the sample inspections. A minimum of 300 vehicles per site per observation was established as a goal. Seven sets of observations per site were planned. Further details are provided in Chapter IV.

Driver interviews were conducted in parallel with the sample inspection. A questionnaire was given to drivers awaiting inspection. The questionnaire was based on a previous unpublished HSRI study. After two weeks experience, the questionnaire was modified to provide more accurate information. The final version of the form is shown in Figure II.1. The questionnaire was intended to determine the demographic characteristics of the sample, to explore knowledge about vehicle inspection, and to measure public acceptance of the checklane program.

For all three activities, the final plan was to conduct them in the three experimental counties for the seven month duration of the operational inspections. The seven month period was determined by climatic conditions favorable to checklane operation. Original plans had intended a slightly longer data collection period, but the contingencies of project approval and operational feasibility compressed this to the period of operational inspections.

Use of the three counties was determined by population characteristics. Since it was desired to represent a broad cross-section of the major population groups in the state, large population centers had to be used. The counties were the three largest metropolitan areas in the state outside of Detroit. They had the requisite population diversity to be representative, and at the same time were of manageable size. In addition, the areas were roughly similar in size, population density, industrialization, and income. Thus, they were almost natural choices as comparable and representative areas.

D. Evaluation Activity

Evaluation activity proceeded quite smoothly. The successful operation is to the credit of the State Police troopers who performed the data collection tasks. These officers, the sample team, were quickly trained in the procedures for data collection, adhered to the procedures throughout the project, and in general carried out an unusual and sometimes difficult assignment in a very competent fashion. Good working relations were quickly established among team members, other State Police personnel, and HSRI staff members. All major design criteria were met. Sample inspection and roadside observation sites were chosen with a minimum of difficulty. Only minor changes were required from original selections. Sample size targets and data collection schedules were met. Public acceptance of the sample inspection activity was in general good with a high completion rate on the interview questionnaire.

Some problems did occur. Early in the project, a conflict between law enforcement and scientific data collection objectives arose, which was resolved in favor of science. Some persons objected to particular personal questions in the interview. Responses to these items were somewhat less complete. Certain drivers, who had recently passed a regular inspection, objected strenuously to being reinspected. Selection criteria were unfortunately modified to excuse these individuals. These points will be discussed in the following paragraphs.

Still,despite some problems, the evaluation activity can be considered to have been highly successful. The procedures yielded a very representative sample of the three counties, and the operation demonstrated exceptional police/civilian cooperation to produce a soundly based and scientifically conducted evaluation.

A team of State Police troopers was selected to work exclusively on the experimental effort. The sample team was composed of four regular members and one relief member. The team supervisor had seventeen years of service with the State Police. Four of those years were in checklane activity. The other troopers had several years' experience, the majority of which was in road patrol activities. One other trooper had a year's experience on the checklane. The relief man was a trooper whose primary duty to train the checklane teams in police departments throughout the state. The team was then composed of veteran police officers who had both the knowledge and maturity to participate in the program.

Team members received approximately one week's training in the data collection procedures. They learned quickly and apparently well. Troopers were given an initial briefing in the program's scope and objectives. Following the briefing, four days of field practice were undertaken in an area outside the experimental counties. Field practice included instruction in inspection procedures for the two troopers without checklane experience, development of the best way to administer the questionnaire, and constant drill in selecting vehicles strictly according to the traffic count. The last point was crucial in obtaining an unbiased sample. Taking such a sample required the officers to overcome a quite natural instinct to look for vehicles which apparently needed inspection. However, once the team members realized that not choosing vehicles that they would have preferred to inspect yielded a better cross-section of cars, they readily accepted the procedure. One evening was devoted to training in observation of lighting defects. In all, the training's usefulness was enhanced by allowing the officers to help develop the detail of the procedures and to participate in decision making.

In parallel with the team's selection and training, site finding activities were undertaken in the three counties. A total of twenty-four sample inspection locations were selected after a careful study of demographic characteristics of potential areas. After consultation with evaluation staff members, selection was made by HSRI's staff geographer using published census data on demography, discussion with local officials, and observation of potential sites. The sites were stratified on the income and urbanization factors. Ideally, the plan indicated that the sites should be balanced across factors, but the clustering of potential sites along the central city/suburban dimension precluded an ideal stratification. It was quite difficult to locate high income areas in the central city and somewhat hard to find low income suburban areas. If high income, central city areas were located, they usually were so small that an adequate sample would be impossible to gather without necessary duplication of respondents. The income stratification was followed strictly. For the urban/suburban factor, sites were selected as closely as possible to the desired stratification, but when this was not sufficient, sites were chosen to be as widely dispersed as possible to give full coverage to the county. A similar procedure was followed for the roadside observation site selections. Particular locations' characteristics are discussed in Appendix E.

Once data collection began, the field work was carried on with a minimal number of operational difficulties. In general, the entire seven month period in the field was not unduly plagued with circumstantial events that could have precluded gathering sound data. In early weeks some problems were found in blending law enforcement and data collection activities. Certain sites had to be modified due to unsatisfactory conditions. Both team members and HSRI staff would have preferred a long enough training period to allow a full dry run over all 24 sites. From time to time, isolated individuals would complain about being selected for inspection. This was particularly true of those who had recently passed regular inspection, and these complaints led to an unfortunate procedural modification which might have obscured an improvement in vehicle condition over time. Yet, the problems were not major, and their existence should not hide the great usefulness of the techniques in obtaining an accurate picture of the overall vehicle population in an area.

A usual feature of the regular checklane procedure is on-site enforcement of violations of the vehicle safety specifications set forth in the Michigan Motor Vehicle Inspection Manual. During the course of inspection, if a gross defect was noted the usual procedure was to issue the driver a traffic summons with the requirement to repair or replace the defective component. The enforcement feature was a part of the sample survey team for the first three weeks. The procedure was to take enforcement action against sample operators who would have been issued a summons in a regular checklane. In addition, non-sample vehicles which seemed to merit particular attention were taken into the lane. Data for these vehicles were kept separate from sampled vehicles. A regular officer from the police department in the jurisdiction where the team was working was used for enforcement duties. This officer's sole purpose was to write traffic summons for defective vehicles and to pursue vehicles which blatantly attempted to avoid the inspection lane. The presence of the extra officer on the inspection site to handle the enforcement activities freed the sample team members to perform the primary activity of survey data gathering. However, due to the nature of the sample, enforcement activity was so low that assignment of a fifth officer did not seem justified. The enforcement man was dropped, and his duties were taken over by a sample team member. The added enforcement duty and the blending of sample and non-sample vehicles threatened to undermine the integrity of the data. Faced with this problem, the command officers of the State Police Safety and Traffic Division decided that the primary function of the survey team was to gather sound scientific data, and that the enforcement function was secondary in this instance. This is not to say that the sample team officers were not performing in their enforcement role at all, but rather that the most important task was to gather the most accurate and precise data for the purposes of the study. Consequently, enforcement action was taken only when the team observed conditions which posed an immediate threat to the public's safety.

Following the first sample at each site, the data gathered were carefully given an "eyeball" analysis to determine the match between expected demographic parameters and data which the sample site produced. A second consideration was the sites' acceptability based on personnel safety, traffic impedance and location adequacy for lane setup and vehicle storate. Of the 24 original sites only two had to be changed due to deficiencies in these areas. In the night lighting survey, the change of location after original selection was somewhat higher. Four sites were changed primarily because of extremely low traffic volume or as in one case, the traffic light at the original site switched from full cycle to flashing yellow in the middle of the evening and hence did not allow observation of vehicle stop lights.

Once the initial problems were resolved, a smoothly working procedure was established. This worked quite well in attaining the desired number of vehicles at each site and at yielding a representative picture of the vehicles in the county.

The vehicles were selected by a well controlled method, which yielded a sample that was very representative of the total Michigan driver and vehicle population. The specific procedure utilized was to make an estimate of the traffic flow at the sample site and then to select an appropriate number of vehicles allowed to pass by before a sample vehicle was drawn from the traffic stream. For example, if the traffic volume was moderate (average of 10 vehicles per minute) the ratio or "count" would be set so that every tenth vehicle would be inspected. The ratio would be altered occasionally with changes in traffic volume. Such changes were made immediately after selecting a vehicle, and without looking to determine the nature of the oncoming vehicles. If a vehicle was not eligible for inspection, the car immediately following was sampled. The selection rules were strictly adhered to throughout the project.

Once the sample vehicle was directed into the inspection lane, the first task was to complete the questionnaire. The senior trooper dispensed the questionnaires and assisted the driver when necessary. The questionnaires were attached to clipboards and handed to the driver with a pencil. The driver was told that the questionnaire was voluntary, rather than made to believe that completion was mandatory. Still, presentation by a trooper and a three to five minute wait prior to inspection probably accounted for the very high response rate (over 99%).

After the questionnaire was completed, the vehicle was inspected using standard Michigan inspection procedure. Data was recorded on mark sense forms and was transmitted to State Police headquarters for processing. Sample inspection sites received unique identification numbers so that the data could be isolated for later analysis. At the end of the inspection period, a special summary sheet was prepared and sent to HSRI. This allowed monitoring of the program's progress. More background information is presented in Appendix E.

At times problems arose, such as the weather. Unusually frequent precipitation, both rain and snow, were experienced in the summer and fall of 1972. Adverse weather conditions were encountered on 12 of the 60 sampling days. Despite this, only one full day and three half-days had to be rescheduled. Dedication of the sample team is well displayed in their perseverence in gathering the data, even in extreme weather.

A continuing concern was that of maintaining public acceptance of the sample inspection. Most individuals readily cooperated with the sample, and some even seemed pleased to be included in a special sample. Still, since inspection was involuntary, particular individuals expressed varying degrees of unhappiness over being sampled. To a certain degree, this problem is probably inherent in any police/citizen contact, or in the general operation of the checklane.

The sample selection procedure may have somewhat amplified these problems. In regular checklane operations, drivers occasionally question or dispute their inclusion even when their vehicles make them obvious candidates for inspection. Since the sample procedure included a large number of non-defective vehicles, the question was raised more often. On occasion, the driver of a newer vehicle would express particular displeasure when he could readily observe vehicles with obvious defects being passed by after he had been selected. On most occasions, explanation of the program's purpose and the sampling procedure resolved the difficulty.

Occasionally, a driver would request dismissal from the lane. The request was granted only in cases where remaining could have seriously affected the driver's or passenger's health or welfare. On two separate occasions, a passenger was being transported to a hospital for emergency treatment. These vehicles were quickly excused. More routinely, a variety of reasons were given in asking for dismissal: e.g., late for work, short lunch period, routine doctor's appointment. Such requests were courteously denied with the assurance to the motorist that the delay would be less than ten minutes. All requests for exemption represented some amount of preference for avoiding inspection, but the proportion of cases which involved actual hardship was probably very small. Although no specific data were collected on those that asked to be excused, subjectively it appeared to be a rather small fraction, and probably corresponds to the proportion of drivers indicating "greatly inconvenienced" on the driver questionnaire.

A more serious problem involved drivers who had recently passed inspection. Many objected to be reinspected. Complaints were quite justified, even though the law specified a vehicle could be inspected at any time. When the car passed inspection, the driver was informed that he would be excused from further inspection for an extended period, nominally to the end of the current calendar year. This was reinforced by issuing a passing sticker with a year-end expiration date. Normal checklane practice was to exempt these vehicles. Consequently, these persons became quite upset when they were stopped.and reinspected. Some even filed formal complaints. The problem became more serious as the project continued. With more activity in experimental areas, the number of passing motorists constantly increased.

Faced with a growing and potentially serious problem, the team members, in consultation with the HSRI field representative, decided to exempt cars with current passing stickers. This occurred midway in the third cycle, but was not conveyed to more senior individuals until the end of that cycle. Once the problem became known, discussions were conducted between HSRI and the State Police on how to deal with the matter. It was decided to continue exempting cars with current passing stickers, rather than risk the entire data collection effort through the complaints of aroused citizens.*

Since the exemption represented a potential bias in the data, the team was instructed to count the cars being excused. This information was collected for the fourth and fifth cycles for Genesee and Kent Counties, and for only the fifth cycle in Ingham County.** As can be seen in Table II.1, the extent of the problem was substantial. In Ingham County, 23.5% of the cars were excused, and at one location the exemptions were 44% of the vehicles originally selected. If it is assumed that all exempted cars were still in perfect condition, then the passing rate in Ingham County could have increased by as much as 11.75%. The increase would have been hidden by the failure to include cars with passing stickers in the sample.

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* The problem arose about the same time as the court challenges to the checklane procedure. Those persons associated with the program were very sensitive to adverse public reaction.

** The decision to collect this data was unfortunately not made and implemented until the fourth cycle for Ingham had been completed.

Table II.1

Proportion of Original Sample of 400 Vehicles per County Excused for Having Current Passing Inspection Sticker

County	Fourth Cycle	Fifth Cycle
Genesee	12.00	13.75
Ingham	---	23.50
Kent	5.75	11.25

When the exemption data were first collected, it had been hoped to use them to correct the original data and thereby remove the bias. However, after careful consideration, the modification was not attempted. Two factors weighted heavily in the decision. Complete exemption data were available for only the fifth cycle, while the policy had been operating to an unknown extent for the previous two cycles. More importantly, some excused vehicles might have been inspected as much as six months previously. It could not be safely assumed, therefore, that all excused vehicles would have passed reinspection. Rather, the inspection data were used without correction. This greatly hampered testing the check-lane's effectiveness. The main tests were for improvement in vehicle condition over time. Systematic exclusion of progressively larger numbers of better vehicles from the sample could have easily cancelled any positive time trends. Basically, it is very hard to find success when large numbers of presumably successful cases are deliberately ignored. Therefore, in interpreting the data, any positive change over time was considered to be strong evidence for the lane's effectiveness. Absence of change was treated as being neutral.* This seems to be the most sound position,

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* Given the size of the biases, a stronger position would state that anything short of a negative change would be counted as a positive result. However, since the situation is one of incomplete information, the neutral position seems more sound.

since large changes might still appear despite the biases and since moderate changes might not have been detectable, in any event.

Reinspecting vehicles which had recently passed inspection presented substantial problems. For future use of the sample team technique, several steps can be taken to ameliorate the situation. First, passing stickers should be clearly worded to indicate that the vehicle is not exempt from further inspection. Second, passing stickers should have a clearly indicated expiration date. This would provide operational teams with a better means of differentiation between more and less recently inspected vehicles, and would allow more useful data to be recorded for the sample. Third a written explanation of the sample inspection procedure should be given to all drivers. A clear understanding by the recently inspected individuals that their being stopped represented a special situation might lessen their concern. Fourth, a civilian from the technical organization should be present at all times. The HSRI field representative, when he was present on the lane, was often able to handle the complaints. This was probably not due to the person's superior tactfulness. Rather, he had more time to explain the program, and his civilian status lent credence to the sample's purpose.

Finally, some compromise in the selection procedure could be developed to handle recently inspected vehicles. If the compromise procedure were systematically followed, and if it produced at least some data on the condition of the vehicles in question, then appropriate inferences could be drawn about the population. It was the lack of a systematic procedure and of consistent data which prevented the present observations from being corrected. One such compromise would be to stop all vehicles with current passing stickers. After the person had been stopped, the purpose of the sample would be quickly explained to him and his voluntary participation requested. If the person declined, he could be promptly excused after the date of his last inspection had been recorded. Results for those who cooperated could be correlated with the number of refusals, and the effect on the total sample could be reasonably inferred. An alternative compromise would be to stop only some small fraction of the cars with current passing stickers and subject them to inspection in the normal procedure. For example, none of the cars which had been inspected in the last month, 25% of those checked in the past two to four months, and 50% of those checked in the past five to six months might be checked. Since the degree of annoyance is probably quite highly correlated with the time since last inspection, the staggered procedure would eliminate many of those who would feel most acutely burdened. Data for these individuals could then be used to adjust the sample results to reflect excused vehicles.

Extensive consideration has been given to the problems of public acceptance. Any method which requires the involuntary participation of subjects must be used with extreme care, even when the outcome does not materially affect their welfare.* All concerned were quite sensitive to this and did not want the sampling procedure to be an undue burden on the public. Hence, any expression of unhappiness was viewed as a matter of high importance. Yet, those who were extremely unhappy or substantially burdened were probably very few in number. A somewhat larger group probably would have preferred not to participate but were not acutely discomforted. Finally, the majority were either neutral or pleased that they were given a chance to participate. The inclusion of the questionnaire substantially helped in this respect. The modifications suggested above will ameliorate the problems for recently inspected persons. For those who previously failed or who had not been inspected, the problem of acceptance should be of less concern, since they would be liable to inspection

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* It should be recalled that many government information-gathering programs require the participation of the individual. The Census is the most wide spread example. The issue on the checklane is still sensitive, though, due to police involvement, and the very low level of enforcement activity during the sample ought to be continued to prevent serious problems.

under any circumstances. After having taken the necessary steps to minimize the burden, the sample inspection procedure should be continued, since it produces the most accurate and unbiased samples of vehicle condition available.

Moving to other evaluation activities, driver interviews went quite well. In fact, the interview probably increased public acceptance. Many seemed pleased to express their opinions, and the questionnaire lent credibility to the statement that they had been stopped for a special survey. Response was voluntary, but some respondents doubtlessly felt some compulsion, given the circumstances. Less than 50 out of over 6000 drivers refused to complete the questionnaire. This is an unusually high response rate.

In the first two weeks of the evaluation period, a draft questionnaire was utilized to pretest the final form. The pretest questionnaire yielded 769 respondents and provided the opportunity to sort out obviously deficient items and to improve the overall quality of the questionnaire. Since the final questionnaire was in simple multiple-choice format, most persons were able to complete it without difficulty. On occasion when the person had problems in completing the form, the interviewer would read the questions aloud and enter the appropriate response. Such problems were limited to a few senior citizens and to one neighborhood with a heavy Chicano population.

One item did cause some difficulty. A question on family income was included to test the site characteristics. A number of people felt the question was an invasion of privacy. When they questioned the time, they were told a reply was voluntary. If the person inquired further, he was informed that the researchers needed to know what type of neighborhoods were being most strongly affected by the checklane, and that the question was the simplest way of finding out. About 18% of the people declined to answer this question. In all, the questionnaires went smoothly and yielded highly useful information.

Roadside observation for lighting defects was the most smoothly conducted evaluation activity. Since no public contact was necessary, no difficulties were encountered in data collection. Furthermore, the data collected were highly unbiased, since every vehicle passing the location was included in the observation. Additional details on roadside observations can be found in Chapter IV.

In all the evaluation activities can be considered successful. The design targets were fully met. As will be discussed in the next section, the procedure produced a very representative sample of the vehicle/driver population, even though some biases were induced in measuring changes over time. Public acceptance was a bothersome problem, but the method produced a degree of response on volunteers. In retrospect, those who were seriously annoyed at being sampled were a relatively small minority. Consequently, the techniques used here can be strongly recommended for further use.

E. Sample Representativeness

The major test of any sample is how well it represents the population. Much effort is often necessary to achieve a representative sample. Many problems will be encountered, and it is almost axiomatic that hastily done, rather painless data collection yields poor information. As should be apparent from the last section, much work was devoted to making the study quite representative. Analysis of the available data indicates that the efforts were largely successful.

The random sample of vehicles selected for inspection in the evaluation was found to be highly representative of the driver and vehicle population of Michigan. Family income, driver age, and driver sex matched closely the overall population distributions. Vehicle make and age distributions were in good accord with registration lists. Analysis was based on driver interview information. The total interview sample numbered 6273 with 6245 drivers either fully or partially completing the questionnaire.* A total of 796 drivers attempted or completed the pre-test version, while 5449 drivers participated in the final version of the questionnaire.

Income level of the participants was a key design variable. The design was balanced across income levels with equal numbers of sites located in low and high income areas. The validity of the sites in meeting this criteria was tested through the use of the question concerning the driver's family income. In each of the three counties, the majority of drivers reported their income in the middle-to-high range ($12,500 to $20,000). The validity of the selected sites in terms of income characteristics was measured by the fraction of drivers in the lower (0 - $7,500) range and in the high range (over $20,000). This information is presented in Table II.2. At all low income sites, individuals in the lower income

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* Numbers presented here differ slightly from those in Chapter III, due to the inclusion of certain reinspected vehicles in the vehicle data.

range were found more frequently than were persons in the high income range. Conversely, at most high income sites, persons in the high range outnumbered those in the low income range. One site in Genesee, one in Ingham, and two in Kent reversed this pattern. At these four high income sites, many service workers in the neighborhood could have been stopped, or traffic could have included a high number of non-local vehicles. Overall, selected sites matched the income criteria quite well.

Table II.2

Site Income Classifications vs. Percent of Drivers Falling in Low and High Income Categories by County

County:	Genesee		Ingham		Kent	
Income group:	High	Low	High	Low	High	Low
Site type:						
Low	3.3	21.8	1.4	31.9	4.1	25.6
Low	7.7	20.0	7.1	18.9	2.5	25.4
Low	4.0	21.8	6.9	21.3	4.2	23.1
Low	3.8	25.9	4.2	29.9	3.9	29.0
High	18.0	12.7	14.5	17.5*	15.9	17.4*
High	8.0	22.3*	27.3	11.0	8.7	18.3*
High	19.1	13.6	25.1	16.6	19.8	15.2
High	19.3	17.8	21.9	20.0	23.4	11.3

* Indicates site with reversed income pattern.

Considering individuals rather than sites, there is good agreement between census data and other information on family income and the responses on the questionnaire. The distribution of family income as reported on the questionnaire is illustrated in Tables II.3a and II.3b. Comparison of these two tables with the income data generated by the 1970 Census reveals a close similarity between the aggregate income groupings represented by the sample and those of the Michigan and sample county populations. Since the categories used in the two measures are not identical, exact comparisons are not possible, but, as can be seen in Table II.4a, the distributions are similar. Another comparison of income groupings is shown in Table II.4b. It can be noted that the below poverty level and above $15,000 categories of Table II.4b are of the same order of magnitude as the under $5,000 category and over $12,500 group in Tables II.3a and II.3b. It was,therefore,concluded that the sample was reasonably representative of the income groups in the state and in the experimental counties.

Table II.3a

Frequency Distribution of Annual Family Income
in Total Sample

	under $5000	$5000 to $7500	$7500 to $12,500	$12,500 to $20,000	over $20,000
Frequency	468	642	1572	1157	622
Percentage	8.6	11.8	28.8	21.2	11.4

* Missing data = 988 (18.1%)

Table II.3b

Frequency Distribution of Annual Family Income
by County in Sample Questionnaire

	$5000 or under	$5000 to $7500	$7500 to $12,500	$12,500 to $20,000	$20,000 and up
Genesee	8.6%	11.0%	30.0%	22.5%	10.3%
Ingham	9.0%	11.5%	28.9%	24.0%	13.7%
Kent	8.2%	12.7%	27.8%	17.8%	10.4%

* Missing data = 988 (18.1%)

Table II.4a

Family Income in 1969 in Metropolitan
Areas of Michigan

under 5000	5000 to 6999	7000 to 9999	10,000 to 24,999	25,000 and up
15%	10%	19%	53%	3%

* Michigan Statistical Abstract. Division of Research, Graduate School of Business Administration, Michigan State University, Ninth Edition, 1972.

Table II.4b

Percent of Families with Low and High Incomes - 1969**
(by county)

	Genesee	Ingham	Kent
Below poverty level*	6.7%	6.5%	6.6%
$15,000 or more	27.1%	27.5%	22.7%
	Median income 11,255	Median income 11,193	Median income 10,692

* Poverty level is defined as a family of four living on less than $4,137 (in 1971) annual income.

** U.S. Bureau of the Census, Current Population Reports, P-60, No. 86, "Characteristics of the Low-Income Population 1971", U.S. Government Printing Office, Washington, D.C. 1972.

A second demographic characteristic surveyed by the questionnaire was that of driver sex. The percent of male drivers responding to the final version of the questionnaire was 56.6% (3082); female drivers were 42.3% of the sample. Missing data on sex was recorded for only 1.1%. The distribution by sex of licensed drivers in Michigan in 1971 was 54.66% for males and 45.33% for females.*

The close similarity between licensed drivers and sampled drivers can be explained by the hours of coverage designed into the experiment. The design stipulated operating times extending from 7:30 a.m. until 6:00 p.m. Coverage was provided over the 12:00 - 1:00 p.m. lunch hour, as well as during both "rush hours", thus including male workers as well as housewives in the sample.

The age of the driver was gathered for 99% of the sample. The range of ages was from age fifteen (0.1%) to the oldest driver, age 86. The mean age was 38.34 years with a standard deviation of 15.79

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* Michigan Driver Statistics Report No. 4, Michigan Department of State, Bureau of Field Services, Lansing, Michigan, November 1971.

Table II.5

Comparison of Driver Age in 10-Year Groups
Sample vs. State Distribution

Age Group	Sample Number	Sample %	Michigan* %
15-24	1326	24.3	24.3
25-34	1202	20.9	21.0
35-44	1002	18.5	17.0
45-54	892	16.4	17.0
55-64	573	10.4	12.2
65-74	329	6.1	6.3
75 and older	63	1.1	2.1

* Source: Michigan Department of State, Michigan Driver Statistics.

In Table II.5 the distribution of drivers by age in Michigan matches the sample very closely when ages are arranged in ten year groupings. The sample is quite representative of the overall driver population in terms of age.

Comparison of the sample with vehicle registration figures for the three counties indicates close correspondence. Vehicle make information is presented in Table II.6a. For most of the major makes, the differences between the sample and the registration lists are quite small. Buicks are underrepresented in the sample. This might be accounted for by a large number of corporate registrations of the Buick Motor Division vehicles in Genesee County, the location of Buick's headquarters. These cars might be operated elsewhere. Conversely, the overrepresentation of "other" makes, mostly foreign cars, might arise from the large student population in Ingham County. Students often operate cars at school but register them elsewhere. Vehicle model year distributions for the sample and for the three counties are given in Table II.6b. 1971 model year vehicles are the most frequent, both in the sample and in the registration data. 1972 and 1973 vehicles are slightly more prevalent in the sample, since registration lists were compiled as of July 1, 1972. Consequently, not all 1972 and no 1973 vehicles appear in the registration data. From 1970 backwards, the fraction of vehicles in each model year declines more or less regularly. Through 1967, the figures are in close accord. The sample picked up slightly fewer 1963 through 1966 vehicles and more pre-1963 cars than existed in the population. Overall, the sample included slightly fewer pre-1967 vehicles than did the registration figures (29.1% vs. 31.2%). This may be explained by the differences in mileage driven by older as opposed to newer vehicles. In all, the sample appears to have produced a quite representative distribution of vehicles, particularly when possible discrepancies between registration numbers and miles driven in a particular area are considered.

Table II.6a

Comparison of Vehicle Makes in Sample and County Registrations

Make	% of Registrations**	% of Sample
AMC	2.3	2.0
Buick	14.8	12.8*
Cadillac	1.6	1.6
Chevrolet	25.7	25.3
Chrysler	1.6	1.3
Dodge	3.6	4.2
Ford	15.8	18.0*
Oldsmobile	11.4	11.3
Plymouth	5.7	5.4
Pontiac	8.2	7.3
Others	9.3	10.8*

* Differences significant at 95% confidence level or higher.

** Source: R.L. Polk and Company

Table II.6b

Comparison of Vehicle Model Year in Sample and County Registrations (% of Vehicles)

	Sample	County		Sample	County
1973	0.8	N.A.**	1967	8.4	8.9
1972	12.1	11.4	1966	6.6	8.8
1971	14.8	14.3	1965	6.0	8.4
1970	11.9	11.1	1964	4.0	5.6
1969	12.0	11.7	1963	2.6	3.4
1968	10.9	11.1	pre 1963	9.9	5.0

* Source: R.L. Polk Company

** Registration figures as of July 1.

F. Conclusion

Implementation of both the operational and evaluation phases of Michigan's trial substitute motor vehicle inspection program was largely successful. In the operational area, the target number of inspections was easily achieved, and the follow-up system was implemented with an extremely high public response. In the evaluation phase, a harmonious police/civilian co-operative effort was made, and the experimental design was quite successful in producing a sound data base. Much of the credit for this is due to the experience and open-minded approach of the Michigan State Police's Safety and Traffic Division. Judged on the basis of how well the job was done, which is the criteria by which a good number of programs are measured, the Michigan program can be rated very highly.

In this chapter, a number of problems have been discussed quite openly and candidly. These should be kept in perspective. Most of the problems were related to public acceptability. It must be recognized that in dealing with many thousands of individuals a certain fraction will be alienated. Considering the nature of the checklane, the number of unhappy persons was quite small and probably close to the irreducible minimum. Discussion of the problem was motivated by two concerns. First ,only by recognizing and acknowledging a problem can continuing efforts be made to minimize it. Second, the present program, in scope and degree of experimental control, is unique in the motor vehicle inspection area and rather rare in the general field of highway safety. Therefore, the problems were discussed so that others could benefit from Michigan's experience.

III. SAMPLE INSPECTION RESULTS

Vehicle inspection checklanes were operated in this project to attain three levels of coverage for the vehicles registered in a given county. In Kent County approximately 5% of the vehicles were inspected, 10% of the registered vehicles in Genesee County were inspected, and approximately 20% of Ingham County's vehicle population were stopped for inspection.

Inspection locations were carefully selected such that half of the vehicles stopped were either operating in, entering, or leaving suburban or fringe areas, and half of the data were collected from vehicles in more central urban areas. Also, half the locations were in or near low income areas, while the other half were located in high income neighborhoods.

Checklanes were operated for one week in each county on a rotating basis for each of five cycles. The sequence was one week each in Ingham, then Genesee, and then Kent County for a given three week cycle with repetition in the same order for the next cycle. Cycle dates were: Cycle 1, May 8-24; Cycle 2, June 12-30; Cycle 3, July 31-August 18; Cycle 4, September 11-29; and Cycle 5, October 23-November 10.

The Michigan State Police vehicle inspection team (referred to herein as the Sample Team), which gathered the vehicle defects data for this project, inspected a large number of components on each vehicle. The inspection included all lights, brake pedal depression, mirrors, operator's license, etc. Thus, the inspection included vehicle components considered related to safety as well as such non-vehicle components as valid driver's license and vehicle registration. Each item was recorded individually as pass-fail.

These component scores were then coded for computer analysis, as were a number of other variables such as county number, make of vehicle, model year, and so on, which were necessary for analyses. In addition, component sub-system categories were built into the computer file which included a number of the specific components. For example, a category of total lights was designated to include all of the lights checked such that a failure on any one or more lights resulted in that vehicle being coded as "fail" for total lights. Similarly, a category called "Total Number Defect Lights" was used to sum the failures on lights for each vehicle, so that a vehicle with a defective headlamp and a defective tail lamp would receive a code of 2 for this category. The computer dictionary is shown in Table III.1. Specific variable codes will be defined as analyses for those categories are discussed in this section.

This large array of variables could be analyzed in many different ways, of course, with numerous statistical tests. However, such a shotgun approach is not the most efficient, and greatly increases the chance of falsely detecting an unreal effect. Rather, a more workable approach is to determine if significant changes occurred for the sub-system categories and, based on these analyses, to search out changes in specific component defects and/or county characteristics such as differences between low and high income areas.

Utilizing this heuristic approach, an initial consideration is whether or not the vehicle failure rate changed in any of the sample counties across the inspection cycles of the project. The Vehicle All variable (V59) represents the composite pass-fail result for all components inspected. That is, any vehicle which passed inspection on all components was scored as pass for this variable whereas failure on any or all components was scored simply as fail. It can be seen in Table III.2 that regression analyses revealed no significant change in the failure rate across the five inspection cycles for Kent (5%), Genesee (10%), or Ingham (20%) Counties. It is apparent that none of the counties exhibited a change in failure rate that even came close to being statistically significant. Indeed, Figure III.1 shows the plotted regression lines to be virtually flat.

TABLE III.1
COMPUTER DICTIONARY

Variable Number	Variable Name	Variable Number	Variable Name
1	HSRI Sequence Number	32	Headlight Operation
2	MSP Location Number	33	Tail Light
3	MSP Team Number	34	Brake Light
4	HSRI County Code	35	Rear Directional
5	HSRI Location Code	36	Plate Light
6	Location Income	37	Beam Indicator
7	Location Urbanization	38	Total Major Lights
8	Location Type	39	Total Number Defects - Lights
9	Month	40	Total Lights
10	Day	41	Horn
11	Year	42	Steering
12	Week of Year	43	Foot Brakes
13	Cycle	44	Emergency Brakes
14	Make	45	Brakes - All
15	Model Year	46	Tires Bulge or Break
16	Type of Vehicle	47	Tire Treads
17	Mileage	48	Tires All
18	Inspection Number	49	Total Control
19	Safety Glass	50	Exhaust Noise
20	Vision Obstructed	51	Exhaust Smoke
21	Total Glass	52	Exhaust All
22	Wipers	53	Operators License
23	Washers	54	Registration/Insurance
24	Wipers-Washers Combination	55	Total Operator
25	Mirror	56	Total Major Mechanical
26	Total Vision Items	57	Total Mechanical
27	Front Directional	58	Total Inspection
28	High Beam Headlight	59	Vehicle All
29	Low Beam Headlight	60	Summons
30	Headlight Aim	61	Seat Belt
31	Headlight Output		

TABLE III.2

Regression Analyses on Vehicle All: number of failures per 100 vehicles

County	Income	Constant	Cycle	Error*	F	Significance
Kent	All	50.44	-.15	25.02	.040	.84
Genesee	All	51.11	.25	24.90	.097	.75
Ingham	All	52.09	-.50	25.01	.446	.50
Kent	Low	53.38	.13	24.91	.013	.91
	High	47.55	-.29	24.93	.071	.79
Genesee	Low	55.76	.37	24.58	.103	.75
	High	47.25	.10	24.99	.009	.92
Ingham	Low	61.85	-1.71	24.53	2.55	.11
	High	42.11	.93	24.77	.764	.38

*Error terms presented in Section III tables are the Mean Squared Errors. These represent observation errors after removing the effects of Cycle.

TABLE III.3

Number of Total Operator Defects per 100 Vehicles Inspected

COUNTY	CYCLE 1	2	3	4	5
Kent	10.34	1.27	0	0	0
Genesee	10.19	2.30	.681	4.61	0
Ingham	17.68	6.89	0	0	0

As the reader will undoubtedly note in this section, the Sample Team data produced rather meager information on random vehicle inspection. However, it should be pointed out that evidence for significant changes may have been suppressed due to the inspection procedures. The Sample Team began ignoring previously inspected vehicles, as evidenced by cars bearing passing stickers, sometime around cycle three. This had the effect of omitting vehicles from the sample which were non-defective and altered the purely random selection scheme. Of course, the result was probably a bias toward stopping more defective vehicles than exist in the total population, since non-defective cases were systematically excluded. Since this bias may have been great, the potential exists that evidence for decrements in defects was thus camouflaged by the selection process.*

Therefore, decrements found despite this "noise" are substantial evidence for random vehicle inspection at the 20% coverage level, and other defect decreases may have been hidden by the selection bias. The remainder of the data presented herein should be studied with that warning in mind.

Data gathered in the lighting survey aspect of this project indicated that changes in vehicles' external lamp outages occurred differentially in high and low income areas of the test counties. Therefore, it seems reasonable to ask if there may have been an income area-related change in the percentage of vehicle failures.

Regression analyses of the Vehicle All data from the Sample Team were computed for low and high income areas in each of the three sample counties. Table III.2 shows that no significant changes occurred in any of the counties when the data were stratified by high and low income areas. It can be seen from the cycle coefficient that the low income area of Ingham County exhibited some decrement in failures which was greater than that in

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* For example, 23% of the fifth cycle sample in Ingham County were vehicles which were substituted for cars with current passing stickers. For a fuller discussion, see Chapter II.

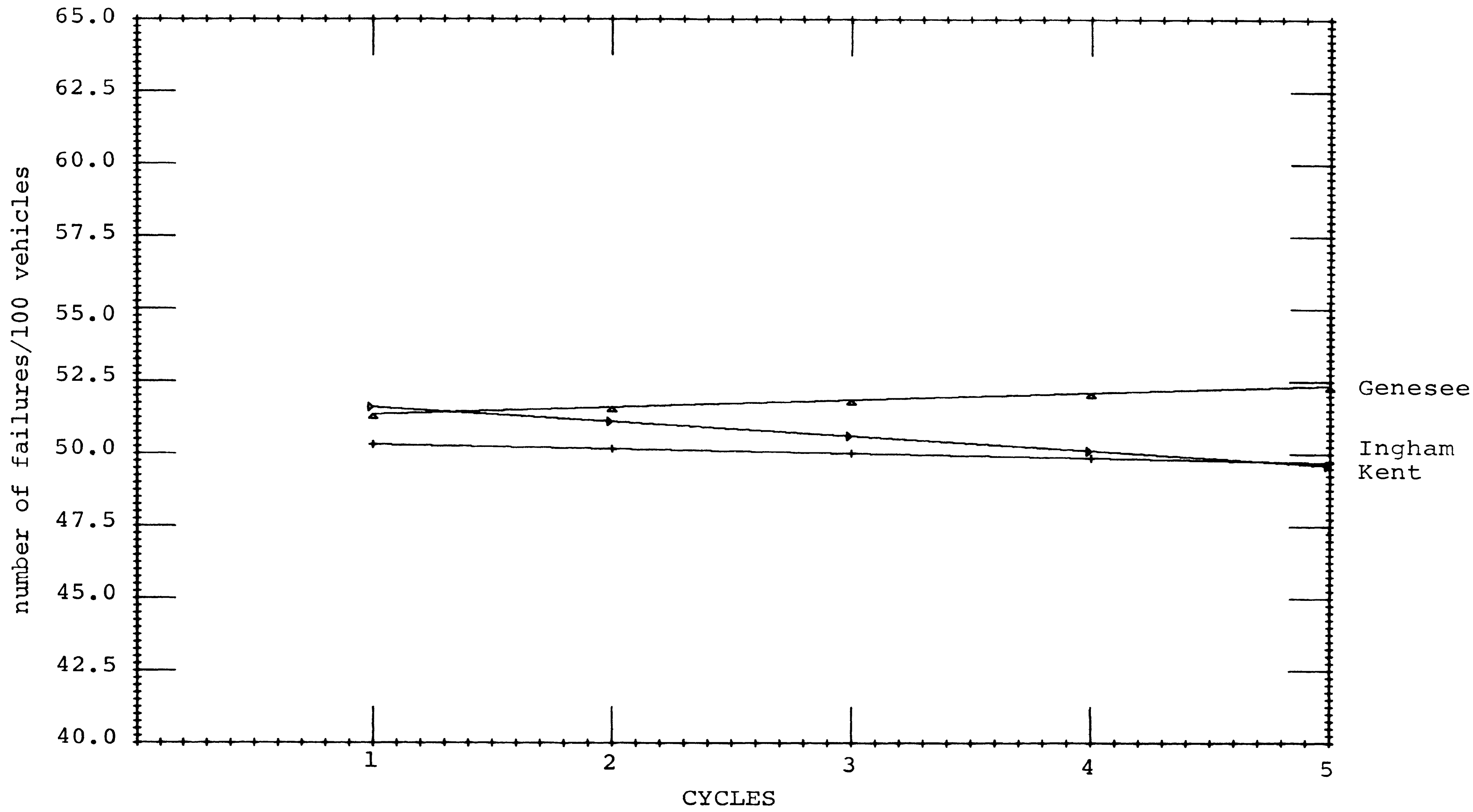

FIGURE III.1

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

the other areas, but even at the rather liberal .10 Type I error probability level this cannot be accepted as a significant downtrend.

For those readers who are unfamiliar with the regression results tables as presented in this report, it may be valuable to comment briefly on them. Regression analysis is a procedure used to fit a straight line through some number of data points so that the fitted line best represents all the points (i.e., minimizes the error or "miss" between the line and all data points). Figure III.1 shows regression lines fitted to the Vehicle All data. Figure III.2 contains the number of Vehicle All failures for each cycle. If one superimposes these two plots, it can be seen that the regression lines are the "best linear fit" to the data.

One can plot regression lines from the tables using the formula: $Y=a+bx$

where x = the cycle number

a = constant coefficient

b = cycle coefficient

Thus, from Table III.2 the regression line for Kent County, all income areas, begins at 50.29 in cycle one ($Y = 50.44 + (1)\ (-.15)$), and ends at 49.69 in cycle five ($Y = 50.44 + (5)\ (-.15)$). It can be seen that the constant coefficient represents the starting point of the regression line at hypothetical cycle zero and the cycle coefficient represents the slope of the line. Negative cycle coefficients indicate downtrends, while positive cycle coefficients indicate uptrends.

Those who wish to verify the significance levels obtained by checking appropriate F-tables are advised that the degrees of freedom for county statistics are always 1 and approximately 2000. The degrees of freedom for income stratified analyses are 1 and approximately 1000.

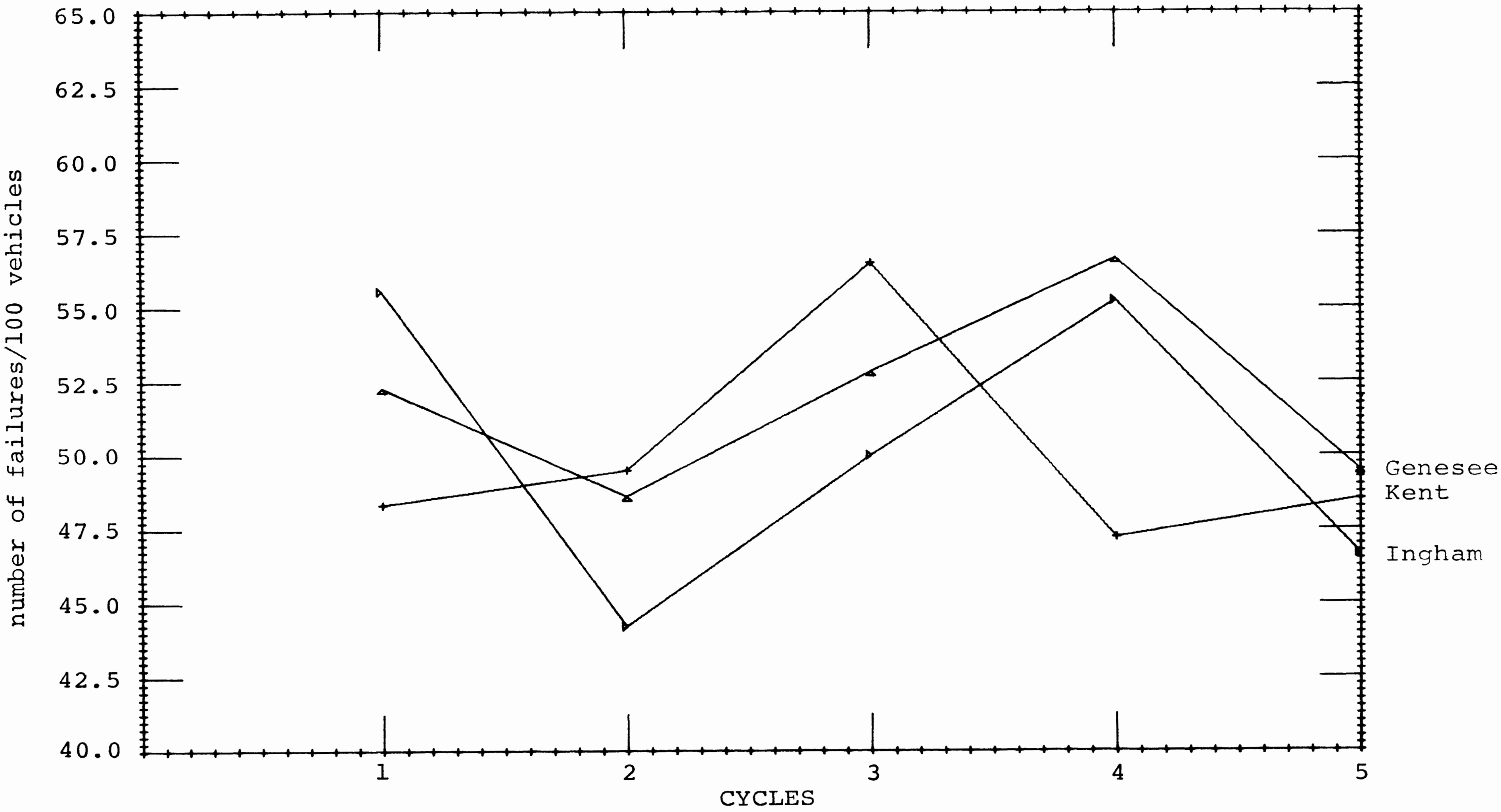

FIGURE III.2

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

While the pass-fail rate did not change in any of the three inspection counties, it may be hypothesized that the average number of defects per vehicle would decrease over the five inspection cycles. One can reasonably suppose that the presence of police inspection teams causes individuals to repair obvious vehicle defects such as burned-out lights or worn wiper blades. If this did occur, it is probable that it would not be apparent in the percentage of vehicles which pass inspection, since many minor and/or relatively expensive defect repairs may not be made by vehicle owners prior to inspection, but would be discovered in the inspection lane.

Variable 58 of our computer file, Total Inspection, contains codes for the total number of defects found for each component inspected. Thus, in addition to vehicle components, the operators' licenses and registration/insurance categories are included in this variable. Our observations of the inspection procedure and conversations with the checklane inspection team revealed that part-way through this project these non-vehicle components were rarely checked, since very few invalid operators' licenses and registration/insurance certificates were found in the first two cycles of project operation. A check of the Total Operator variable verified this (see Table III.3). Therefore, it was deemed desirable to exclude total inspection from analysis, due to this biasing effect.

The Total Mechanical variable (V57), however, does not include data for non-vehicle components. Rather, it includes only the results from inspection of all the vehicle components, and, thus, excludes the bias due to procedural changes in the inspection process. The results of regression analyses computed on the Total Mechanical variable are presented in Table III.4. It can be seen that no changes were found for Kent, Genesee, or Ingham Counties. In the present study, then, random vehicle inspection at the 5% (Kent), 10% (Genesee), and 20% (Ingham) levels resulted in no significant changes in terms of percent failure rate or average number of vehicle component defects per vehicle inspected.

The next logical step in analyzing these data is to determine the effects the experimental conditions may have had on the defect rate of individual components and sub-system component groups. Although no significant changes were found in the overall inspection, it is conceivable that the number of defects or the failure rate for individual components or component sub-systems may have changed as residents became aware of the presence and potential threat of the inspection teams. For example, vehicle owners may have replaced burned-out lights prior to being stopped for inspection. However, it seems unlikely they would make any significant repairs to something like control linkages or exhaust smoke problems. On that premise, then, it is desirable to analyze some of the specific components inspected in the checklane.

Total Major Mechanical is a sub-system category which includes most of the vehicle components, with the exception of a few minor items. The exceptions are headlight aim, headlight operation (since this variable contains high beam, low beam, and intensity, which are separate entries for total major mechanical), plate light, beam indicator, and horn. Regression analyses performed on total major mechanical for each of the three test counties did reveal a significant decrease in the average number of total major mechanical defects per inspected vehicle in Ingham County. It can be seen in Table III.5 that Ingham County experienced a decrease for this variable that was significant not only at the .10 acceptance level, but, in fact, reached the .05 level. This means, of course, that this decrease would be obtained by chance only 5 out of 100 times.

Figure III.3 contains the regression line plots of Total Major Mechanical. It can be seen that the decrease observed in Ingham County is strikingly different than the regression lines fitted to the data obtained in Kent and Genesee Counties. Based on the results of the lighting survey, which indicated some differences

TABLE III.4

Regression Analyses on Total Mechanical:
number of defects per 100 vehicles

County	Income	Constant	Cycle	Error	F	Significance
Kent	All	88.86	.61	158.1	.097	.75
Genesee	All	97.47	1.81	195.9	.649	.42
Ingham	All	108.50	-2.76	183.6	1.82	.18

TABLE III.5

Regression Analyses on Total Major Mechanical:
number of defects per 100 vehicles

County	Income	Constant	Cycle	Error	F	Significance
Kent	All	82.30	.71	179.4	.118	.73
Genesee	All	92.77	3.48	250.9	1.88	.17
Ingham	All	113.50	-4.61	238.0	3.91	.05
Ingham	Low	133.30	-6.46	258.8	3.48	.06
	High	93.13	-2.21	215.7	.501	.48

TABLE III.6

Regression Analyses on Exhaust All:
number of defects per 100 vehicles

County	Income	Constant	Cycle	Error	F	Significance
Kent	All	4.18	.58	5.56	2.56	.11
Genesee	All	7.05	3.09	7.34	.506	.48
Ingham	All	9.71	-.31	8.07	.523	.47

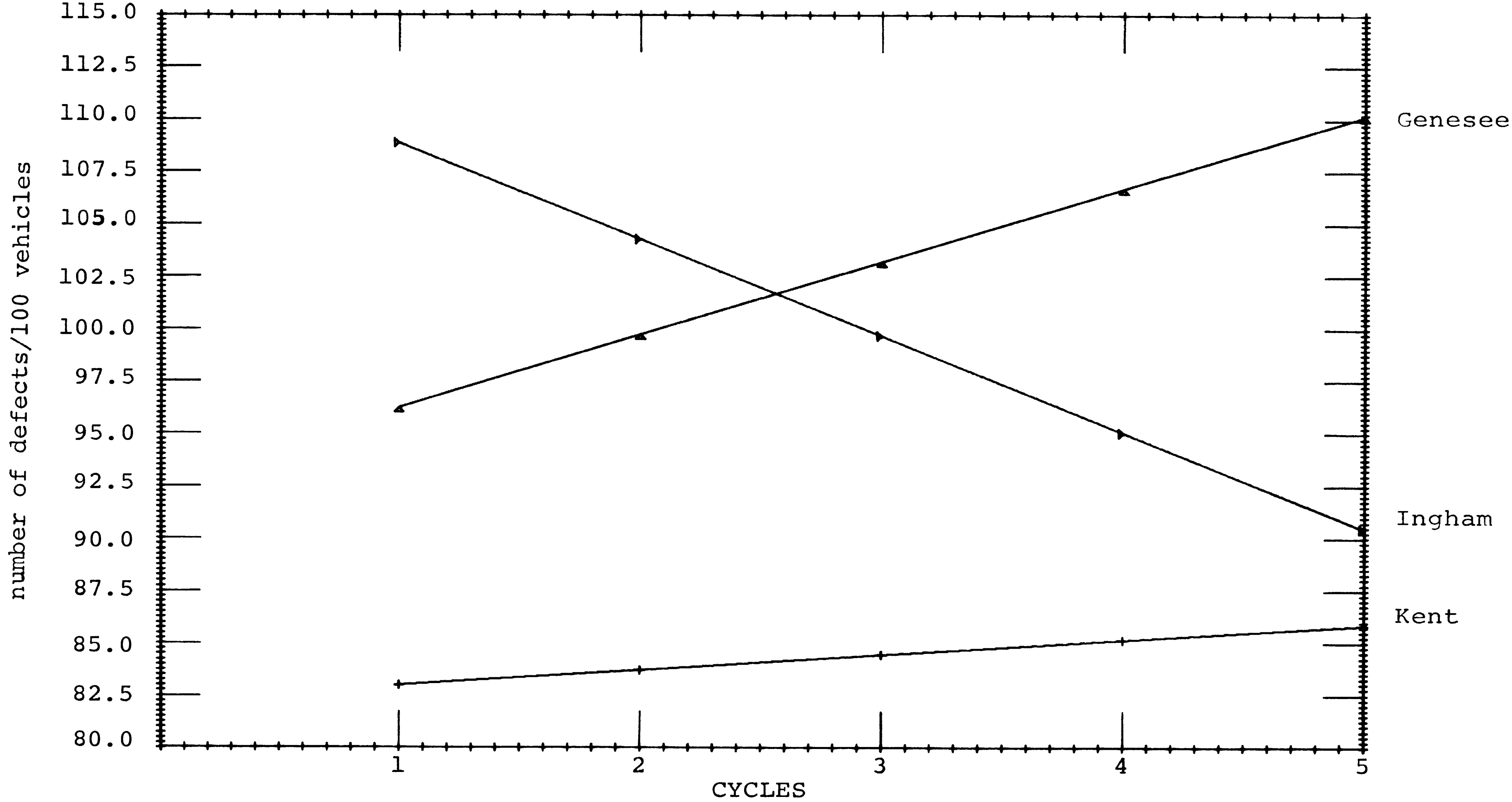

FIGURE III.3

Total Major Mechanical:
number of defects per 100 vehicles inspected

between high and low income areas, the Ingham County data were stratified by income and analyzed independently. The results of these analyses are shown in Table III.5. It is evident that total major mechanical defects decreased significantly in the low income areas, but not in the high income locations. Thus, it appears, that inspection of 20% of the vehicles in a given locale results in some decrease in defects, especially in low income areas.

Again, Total Major Mechanical contains nearly all of the vehicle components. These can be broken down into other smaller groups of components for analysis; namely, Exhaust All (noise and smoke), Total Vision (safety glass, obstructed vision, wipers, washers, and mirrors), Total Major Lights (front directional, high beam, low beam, headlight output, tail light, brake light, and rear directional), and Total Control (steering, foot brakes, emergency brakes, tire bulge, and tire treads). Since a significant change was found for Total Major Mechanical, regression analyses were computed for each of these sub-systems.

Results of the analyses of the exhaust category are presented in Table III.6. Based on the .10 significance level, no changes were found for the exhaust sub-system.

The results of the analyses of Total Major Lights were also somewhat discouraging. It is evident in Table III.7 that no changes were found for the number of defects of total major lights in the three test counties. Although the lighting survey found the average number of major light defects decreased in Ingham County, this occurred only in higher income areas. Therefore, there is some coincidence between the Sample Team and lighting survey results.*

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* However, the differences might be accounted for by the larger sample sizes and the absence of bias in the roadside observations.

TABLE III.7

Regression Analyses on Total Major Lights:
number of defects per 100 vehicles

County	Income	Constant	Cycle	Error	F	Significance
Kent	All	29.40	1.07	59.29	.820	.37
Genesee	All	36.53	1.08	76.11	.600	.44
Ingham	All	38.29	-1.08	69.72	.733	.39

TABLE III.8

Regression Analyses on Total Vision:
number of defects per 100 vehicles

County	Income	Constant	Cycle	Error	F	Significance
Kent	All	25.26	-.65	24.98	.705	.40
Genesee	All	28.43	-.03	32.32	.001	.97
Ingham	All	34.79	-2.17	32.18	6.42	.01
Ingham	Low	40.43	-2.53	34.60	3.99	.05
	High	28.98	-1.63	29.67	1.99	.16

TABLE III.9

Regression Analyses on Total Control:
number of defects per 100 vehicles

County	Income	Constant	Cycle	Error	F	Significance
Kent	All	23.41	-.20	23.73	.073	.79
Genesee	All	21.36	2.02	28.26	5.60	.02
Ingham	All	30.98	-1.05	28.53	1.69	.19
Genesee	Low	23.09	2.07	30.56	2.60	.11
	High	19.91	1.96	26.28	2.97	.09

A third sub-system contained within the total major mechanical category is Total Vision. This includes safety glass, obstructed vision, wipers, washers, and mirrors. Regression analyses on the Total Vision data revealed a significant decrease in these defects in Ingham County and no change in Kent and Genesee Counties (see Table III.8). Figure III.4 shows this decrement. Total Vision defects decreased approximately 2% per cycle or around 10% during the study period in Ingham County. Stratification of these data by income revealed decreasing slopes in both the Ingham-low and Ingham-high income areas with statistical significance attained for low income. Thus, both Total Major Mechanical and Total Vision showed a decrement in defects for the low income areas of Ingham County.

Total Control is the fourth and final sub-system that is included in Total Major Mechanical. It includes inspection of steering, brakes, and tires. The results of the regression analyses for this sub-system are presented in Table III.9. Total control defects can be seen to have increased in Genesee County, specifically in the high income areas. Figure III.5 shows this increase to be in sharp contrast to the total control defects data for Kent and Ingham Counties. (Further examination of positive trends is contained in Appendix A).

It is interesting to note in the tables and figures presented thus far that the trend for all sub-systems tested is down for Ingham while there are many instances where the trends seem to be up for the 5% and 10% coverage counties. Again, this can be seen by inspecting the coefficients for cycle in the tables. A negative coefficient indicates a down tendency while a positive number indicates an upward tendency. This lends some support to the notion that random vehicle inspection of 20% of the vehicle population has a beneficial effect on some defect categories. A caveat when inspecting these coefficients, however, is that unless the slope is great enough to reach statistical significance one is on extremely weak ground in concluding that a change occurred!

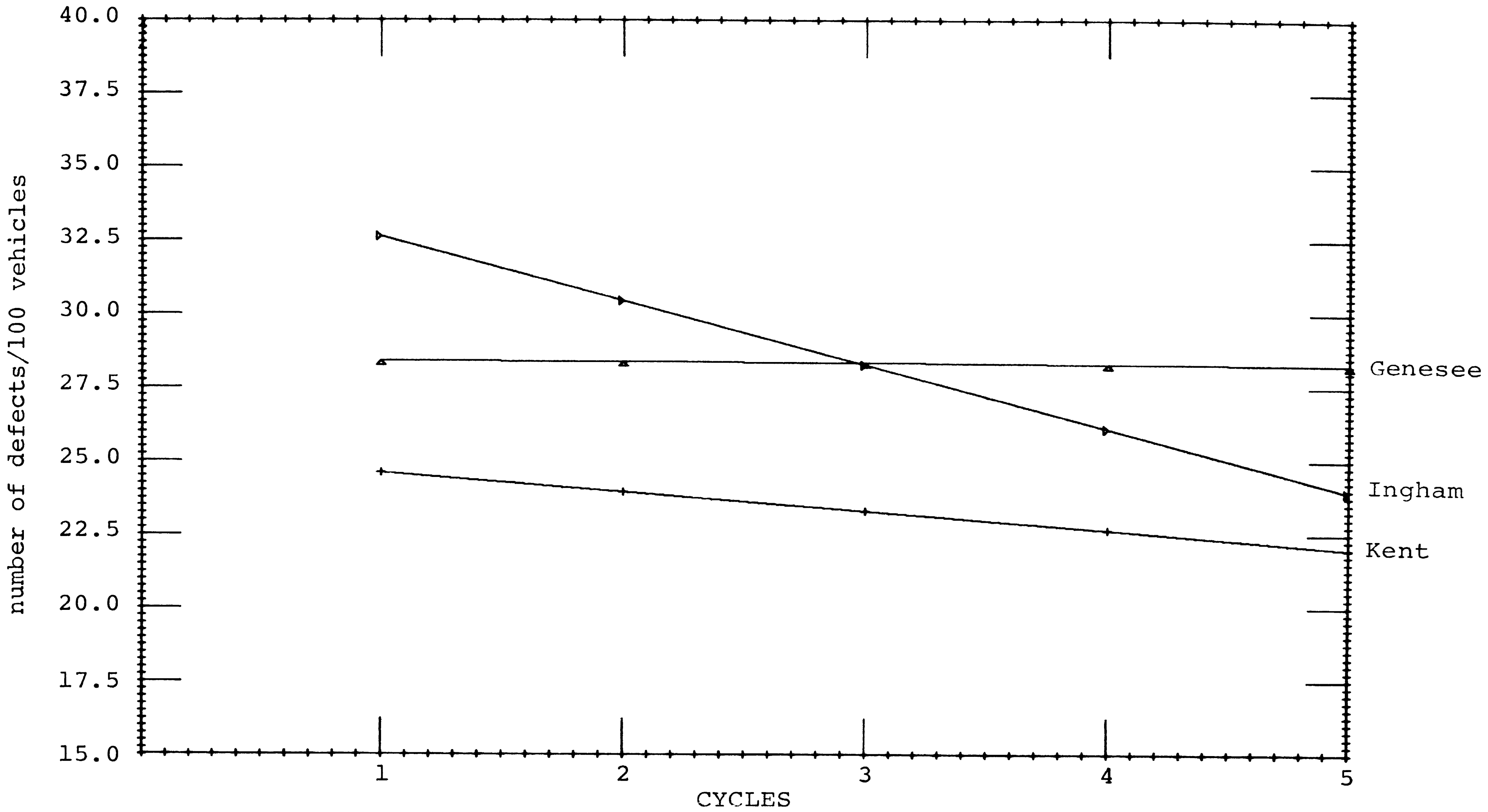

FIGURE III.4
Total Vision:
number of defects per 100 vehicles inspected

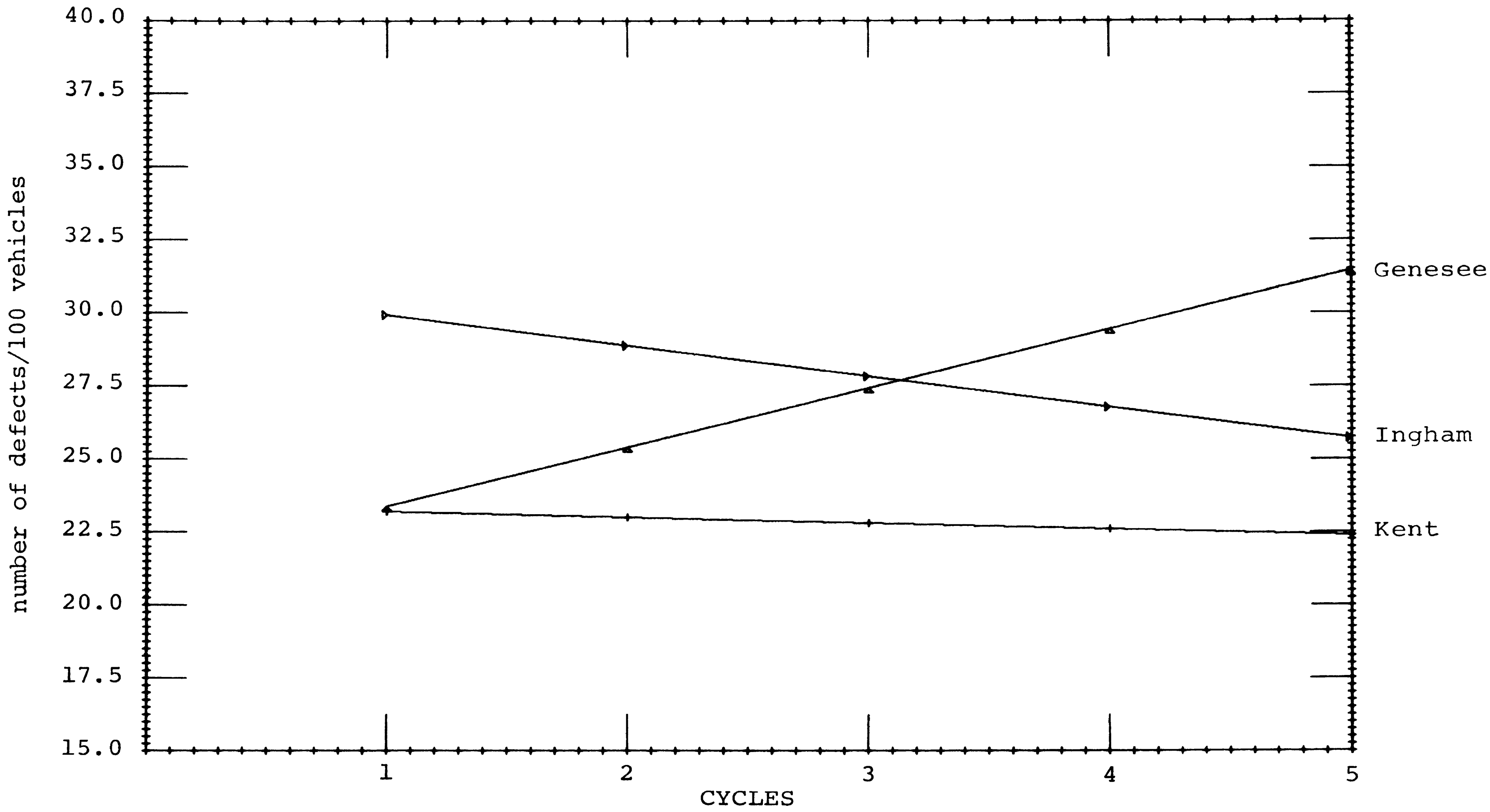

FIGURE III.5

Total Control:
number of defects per 100 vehicles inspected

Based on the significant downtrend found for Total Vision, the components included in that sub-system were subjected to analysis. Results of regression analyses on safety glass, vision obstructed,wipers, washers, and mirrors are presented in Table III.10. Briefly, it can be seen that the number of wiper defects per one hundred vehicles inspected increased in Genesee County, mirror defects decreased in Kent County, and defects for obstructed vision decreased dramatically in Ingham County. (Analyses of these data following income stratification are found in Appendix A). No changes were found for windshield washer defects or safety glass.

The results shown in Table III.10 indicate that very few defects were found for some of the Total Vision components (i.e., see the constant coefficient for these data). Indeed, there were no safety glass failures found in Genesee County. While a decrease in something like number of mirror defects may be found to be statistically significant, one may question the practical significance of such a change when the absolute number of defects is very small.

For example, consider Table III.11 which shows the number of defects per one hundred vehicles for each component of the Total Vision sub-system. Less than two mirror defects were found for each 100 vehicles inspected. Thus, although the decrease in these defects was found to be statistically significant in Kent County, one should hesitate to place much emphasis on this result. The same may be said about the decrements observed for wipers and vision obstructed.

Since the absolute numbers of defects for these components are so small, a breakdown by income area for those decrements which proved statistically significant will not be presented here. These analyses are presented in Appendix A.

In addition to the sub-system analyses and the individual component analyses computed for those sub-systems that had significant changes, regression analyses were computed for Total Number Defects - Lights. Although the failure rate for Total Major Lights showed no change, the argument may be made that the average number of defects for lights may be effected.

TABLE III.10

Regression Analyses on Total Vision Components: number of defects per 100 vehicles

Variable	County	Income	Constant	Cycle	Error	F	Sig.
Vision Obstructed	Kent	All	5.12	-.22	4.26	.500	.48
	Genesee	All	6.04	-.03	5.60	.007	.93
	Ingham	All	7.23	-1.00	4.03	10.8	.001
Wipers	Kent	All	2.93	-.11	2.55	.185	.67
	Genesee	All	1.42	.42	2.60	2.64	.10
	Ingham	All	4.23	-.02	4.01	.003	.95
Washers	Kent	All	15.84	-.07	13.21	.014	.91
	Genesee	All	18.84	-.22	14.89	.129	.72
	Ingham	All	21.19	-.94	14.98	2.60	.11
Mirror	Kent	All	1.19	-.21	.58	3.08	.08
	Genesee	All	2.13	-.20	1.51	1.03	.31
	Ingham	All	1.95	-.17	1.43	.841	.36
Safety Glass	Kent	All	.19	-.05	.05	1.91	.17
	Genesee	---	----	----	---	----	---
	Ingham	All	.18	-.05	.04	2.09	.15

TABLE III.11

Number of Defective Vehicles per 100 Vehicles Inspected:
Vision Components

VARIABLE	COUNTY	CYCLE 1	2	3	4	5
Vision Obstructed	Kent	4.72	5.08	4.18	4.36	3.94
	Genesee	5.63	3.90	9.30	6.78	4.00
	Ingham	7.03	4.22	3.65	4.10	1.97
Wipers	Kent	2.02	3.30	3.19	3.15	1.48
	Genesee	1.88	1.38	2.95	5.42	2.00
	Ingham	3.63	4.44	3.88	5.97	2.46
Washers	Kent	14.16	16.24	17.94	16.47	13.55
	Genesee	18.77	16.06	20.18	20.87	15.25
	Ingham	21.54	18.44	16.44	18.47	16.71
Mirror	Kent	1.12	.51	17.74	.24	.25
	Genesee	1.88	1.61	1.36	2.44	.50
	Ingham	1.59	2.00	.91	1.87	.74
Safety Glass	Kent	.22	0.00	0.00	0.00	0.00
	Genesee	0.00	0.00	0.00	0.00	0.00
	Ingham	.22	0.00	0.00	0.00	0.00

TABLE III.12

Regression Analyses on Total # Defects-Lights:
number of defects per 100 vehicles

County	Income	Constant	Cycle	Error	F	Significance
Kent	All	33.10	.86	33.5	.920	.34
Genesee	All	34.31	.04	33.5	.002	.97
Ingham	All	29.13	.56	29.1	.470	.49

Regression analyses on Total Number Defects - Lights are presented in Table III.12. No significant changes were found for any of the three counties. Indeed, the regression lines again are very nearly flat, indicating zero change.

Following the heuristic approach of breaking down sub-systems into their individual components only when significant changes are found would negate further analyses of lights. However, based on the lighting survey, which found some changes in lamp defects, it is reasonable to continue with analyses of the light components. Regression analyses for the light categories are presented in Table III.13.

Significant decreases in the number of front directional and rear directional defects and an increase in taillight defects occurred in Ingham County. These components showed no change in either Genesee or Kent Counties. Additionally, it can be seen that headlight operation, brake light, and plate light remained unchanged in all three counties.

Stratifying Ingham County by high and low income areas and computing regression analyses for front and rear directionals and taillights revealed a decrease in rear directional defects for low income locations (see Table III.14). No other changes were found.

Overall then, the Sample Team data provide some evidence that random vehicle inspection of 20% of the vehicle population is effective in reducing certain component defects. Total major mechanical defects decreased, particularly in low income areas. Of the components contained within this sub-system, the most clear cut decrements were found for directional lights.

One may also interpret defect increases in the 5% (Kent) and/or 10% (Genesee) Counties, with no defect increases in the 20% (Ingham) County, as support for the contention that random inspection of a greater proportion of vehicles is beneficial. However, such an interpretation is open to debate. Consequently, exploration of defect increases (particularly total control and exhause) was undertaken and the results are presented in Appendix A as supportive data.

TABLE III.13

Regression Analyses on Total Major Light Components: number of defects per 100 vehicles

Variable	County	Income	Constant	Cycle	Error	F	Sig.
Front Directional	Kent	All	4.72	.44	5.69	1.44	.23
	Genesee	All	6.12	.25	6.42	.392	.53
	Ingham	All	8.91	-.78	6.12	4.36	.04
Headlight Operation	Kent	All	8.75	.05	8.12	.015	.90
	Genesee	All	9.82	.11	9.13	.052	.82
	Ingham	All	9.31	-.29	7.74	.463	.50
Tail Light	Kent	All	4.92	-.03	4.61	.007	.93
	Genesee	All	6.08	.20	6.24	.255	.61
	Ingham	All	3.25	.53	4.61	2.65	.10
Brake Light	Kent	All	4.48	.56	5.77	2.30	.13
	Genesee	All	5.65	.51	6.67	1.53	.22
	Ingham	All	7.30	.06	6.93	.023	.88
Rear Directional	Kent	All	5.71	.03	5.48	.009	.93
	Genesee	All	7.74	-.10	6.88	.061	.81
	Ingham	All	8.77	-.69	6.24	3.34	.07
Plate Light	Kent	All	21.18	-.14	16.47	.048	.83
	Genesee	All	18.90	.33	14.73	.280	.60
	Ingham	All	18.15	.04	14.94	.005	.95

TABLE III.14

Regression Analyses on Total Major Light Components
Stratified by Income: number of defects per 100 vehicles

Variable	County	Income	Constant	Cycle	Error	F	Sig.
Front Directional	Ingham	Low	10.66	-.82	7.56	1.91	.17
		High	7.09	-.67	4.78	2.11	.15
Tail Light	Ingham	Low	2.94	.60	4.50	1.73	.19
		High	3.57	.45	4.71	.971	.32
Rear Directional	Ingham	Low	11.13	-1.10	7.23	3.63	.06
		High	6.36	-.24	5.32	.240	.62

These results are not highly encouraging. Precious little evidence of benefits gained by random vehicle inspection was found. The data do indicate probable improvement in some component defects if 20% of the vehicles are inspected. However, lower levels of inspection effort did appear to result in improvement of vehicle condition. Again, it must be noted that beneficial results may have been hidden by sample biases, as discussed in Chapter II.

IV. ROADSIDE OBSERVATION

A. Introduction

To complement data gathered in sample inspections, team members observed the vehicle lighting condition at sites throughout the three counties. During early evening hours, lighting and other obvious vehicle defects, such as exhaust noise, were tallied for vehicles forced to stop for a traffic control device. Some 43,000 vehicles were observed over the data collection period in a total of 163 observation sessions. The data collection form is shown in Figure IV.1 and the procedures are discussed in Appendix B-2.

The plan was to measure changes in observable vehicle condition over time with a sample that was representative of the general population. The technique was designed to gather a large unbiased sample. Observation sites were balanced completely in terms of income level and type of night (week night vs. Friday night) and partially controlled on urbanization and proximity to sample inspection locations. The experimental design is discussed in Section B of this chapter.

A multiple linear regression approach was used to determine if any time trends existed in the data.* This analysis produced several statistically significant downward trends over time.**

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* The multiple linear regression technique is a means of estimating a straight line which best fits the data for some dependent variable, such as percent of cars defective, against some explanatory variable, such as time, after allowing for the effects of other factors such as the characteristics of the area from which the data were taken. For a readable introduction to this subject the reader should consult: Freund, Modern Elementary Statistics, Prentice-Hall, 1967.

** By statistical significance, it is meant that the probability of an effect being caused by chance fluctuations in the data is less than 10%. In many tables the exact probability is presented, such as significance = .0025 which can be interpreted most simply as there being 25 chances in 10,000 that the effect indicated happened purely by chance.

AUTO LIGHTING SURVEY DATA SHEET

Study No. ____________

Location No. ______ Page ___ of ___

Date ____________

Checker ____________

(6)	Head ot										
(7)	Head brk										
(8)	Muffler										
(9)	Plate ot										
(10)	Brake 1 side ot										
(11)	Brake both sides ot										
(12)	Brake 1 side brk										
(13)	Brake both sides brk										
(14)	Tail 1 side ot										
(15)	Tail both sides ot										
(16)	Tail 1 side brk										
(17)	Tail both sides brk										
(18)	Wiring										
(19)	Glass										
(20)	Other										
(21)	Outstate										
(22)	No defect										

Figure IV.1 Sample Roadside Observation Data Sheet

Total Cars ____________

Number Defects ____________

In Ingham County, which received the most intensive inspection effort, the percent of defective vehicles declined at a rate of 2.0% per 100 days for a total change of approximately 4.0% over the project. This rate of decline was approximately 1.5% greater than in Kent County which received the least inspection. Ingham County was the only area to have a statistically significant down trend. These are illustrated in Figure IV-2. High income areas in all three counties performed better than low income areas with significant downtrends in Ingham and Genesee Counties. This analysis is discussed in Section C of this chapter.

Changes that occurred were broken down into specific component and vehicle classifications. License plate lights and taillights accounted for the bulk of the reduction in the percent of defective vehicles. The average number of defects per vehicle fell significantly in the higher income areas of each county. The frequency of vehicles with only one defect fell significantly in Genesee and Ingham Counties, and average number of defects per vehicle were reduced in the higher income areas of all three counties. These results are presented in Section D of this chapter.

Other factors included in the experimental design also influenced the defect rate, the average number of defects per vehicle, and the sample size per observation. Income had the strongest influence. High income areas had 21.3% failures, and low income areas had 31.4% outage. The type of night had a marked influence on the sample sizes with week nights having a much lower traffic volume than Friday nights. This accounts for Friday night data showing significant results more often. Suburban sites had lower failure frequencies, but this can be attributed to the higher income of these areas. Proximity to sample inspection sites presents the most confusing picture. Nearby sites had significantly better vehicles, but the difference may have come

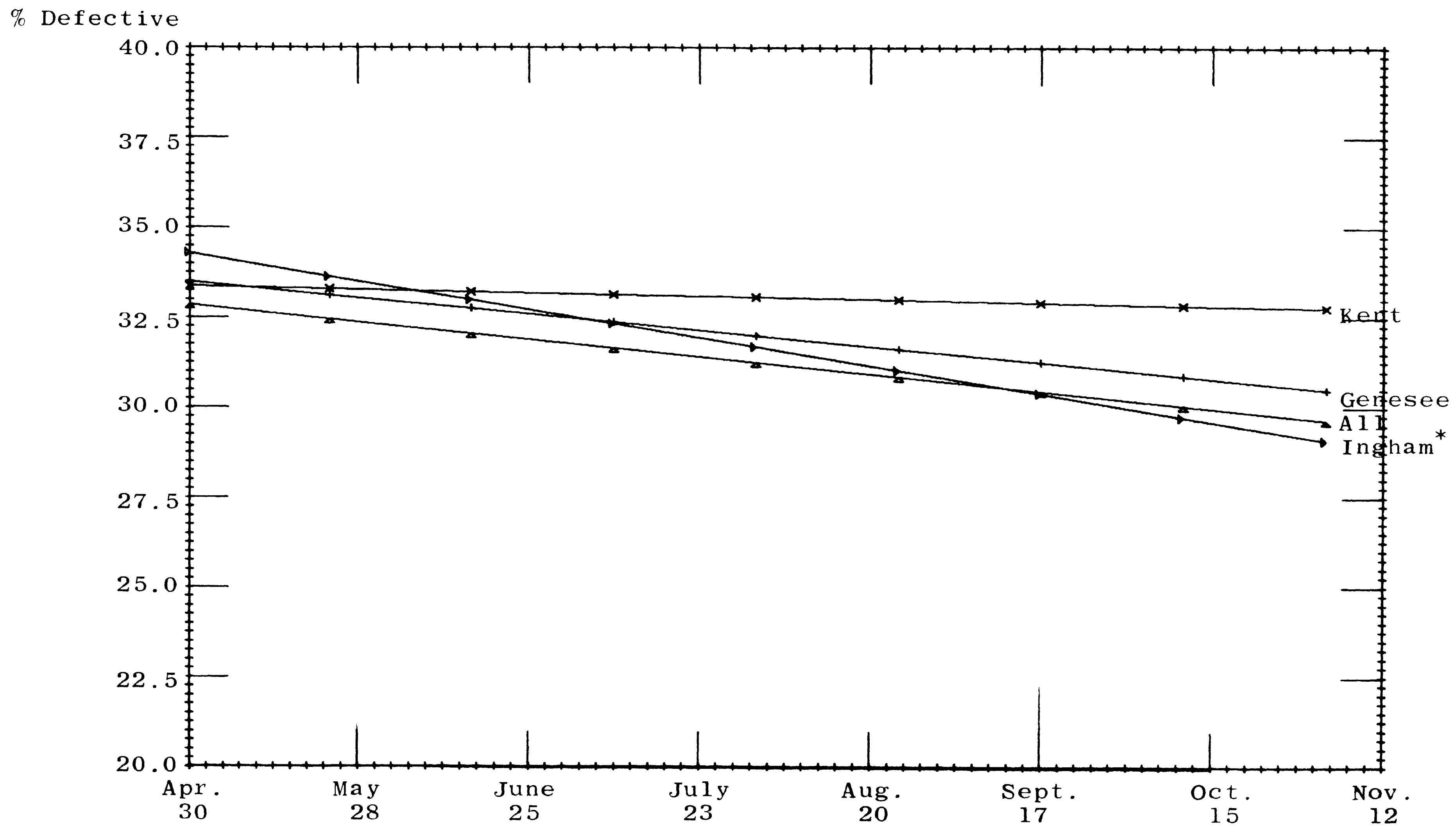

Figure IV.2 Regression Lines

% Defective Vehicles vs Time; by County

* Significant at the 90% confidance level or better

from the fact that the nearby sites were frequently in high income areas. If sites had been balanced on proximity, the failure percent would have increased by only 0.37%. Yet, there are some limited indications that the time trends in Genesee and Kent, but not in Ingham were influenced by the fact that the sample inspection saturated certain areas. Some observer biases may have occurred, but reports were consistent with the type of site. No significant differences in time trends were found among observers. Fluctuations in the hours of observations, which happened with early darkness in the fall, had no apparent effect. Several of these points are illustrated in Table IV.1, and all of the points are discussed in Section E.

From the data, it can be concluded that there was a strong downtrend in Ingham County and in higher income areas of Genesee County. Changes that occurred in Ingham County were more substantial in the higher income areas. In other areas, where the results were not statistically significant, a negative time effect was commonly present. The overall pattern of results indicates a progressively stronger downtrend in moving from Kent County, which received the least inspection effort, to Ingham County, which had the most intense inspection. Taking Genesee and Ingham Counties in combination, their performance is stronger than the control area, Kent County. Components which changed significantly, plate and taillights, represent the most common failures and, therefore, these items might be expected to change most quickly under the enhanced program.

Taken strictly at face value, these results imply strongly that the checklane had a statistically significant and substantial effect on the condition of lighting components in Ingham County. Yet given the data collection period, the possibility of the effect being due to some other factor cannot be completely ruled out. As discussed in Section E, seasonal variations in driving patterns, i.e., more people of necessity driving at night in the fall, appar-

TABLE IV.1

Design Effects on Defect Percentage,
Average Number of Defects, and Sample Size

	Income		Urbanization		Day of Week		Distance	
	Low	High	Central	Suburban	Fridays	Weeknights	Near	Far
Defect %	31.4	21.3	27.7	24.9	27.7	25.1	23.8	30.6
Average Defects	0.411	0.262	0.350	0.321	0.356	0.318	0.297	0.403
Sample Size	249.8	279.9	208.6	339.1	325.8	199.6	259.8	272.2
Number of Samples	83	80	93	70	84	79	100	63

ently did not have an effect. People preparing for the cold-weather driving season in mid-fall might have reduced the outage independently of the checklane's effect. Heavy new car sales in late summer and early fall could also have played a role. That the strongest changes occurred in the high income areas even though the police concentrated in the lower income areas, somewhat supports the notion that seasonal maintenance changes and newer cars produced the downtrend.

On extremely conservative statistical grounds, the possibility that the Ingham County downtrend came from non-inspection factors cannot be eliminated. Kent County did not receive increased inspection activity. If on this basis Kent County is used as a control, then changes in other counties should be compared with the Kent trend value. Such a comparison might show the differential effect of enhanced inspection. A very conservative statistical test reveals, however, no significant difference between the time trends in Ingham and Kent Counties, either for the counties as a whole or for the high income areas.* Therefore, it might be concluded that the program had no effect.

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* An approximate T test of the difference between Ingham and Kent County time coefficients is given by:

Ingham coefficient:	-2.0295	S.E.=1.1173	D.F.=52
Kent coefficient:	-0.5667	S.E.=1.5056	D.F.=48
Difference:	-1.4628	S.E.=1.8567	D.F.=100
T=0.7878	$p > 0.10$		

An approximate T test of the difference between Ingham and Kent County high income area time coefficients is given by:

Ingham coefficient:	-3.4403	S.E.=1.6057	D.F.=25
Kent coefficient:	-2.3784	S.E.=0.8136	D.F.=23
Difference:	-1.0619	S.E.=1.8457	D.F.=48
T=0.5753	$p > 0.10$		

Note: Values shown here may differ slightly with those indicated elsewhere in text due to differences in regression model used or due to minor corrections in the data files.

footnote continued

However as stated, the tests are only approximate and comparing the standard errors suggests that the two counties are not strictly comparable. Taking the ratio of the squared standard errors yields:

All areas: $F_{(48,52)} = 1.8158 \quad .01\ p\ .05$

High income areas: $F_{(23,25)} = 0.2567 \quad p\ .05$

The observed time coefficient for Kent County, all areas, also lies outside the 90% confidence interval of the time coefficient for Ingham County, but not vice versa.

Neither the original optimistic assessment nor the later negative conclusion seems wholly warranted. Changes were most probably the result of inspection effects but with some seasonal factors. From a purely technical point, Kent County might not be a suitable control. As indicated in the last footnote and as discussed in Section E, Kent County differs somewhat from the other two counties in a number of ways. Furthermore, in Kent County, roadside observation sites and sample inspection locations slightly overlapped. The roadside observation might have been picking up immediate area effects of the sample inspections, which constituted a larger fraction of the total inspections in Kent County.* First, in the high income areas of all three counties, the condition of vehicles may have been improving independently of inspection activity. Second, the relative magnitude of the time effects consistently show the smallest change in Kent County and the greatest change in Ingham County. The statistically significant change in Ingham County is quite usual for an operational program of short duration. Therefore, while solid estimates of the relative seasonal and checklane effects cannot be made, it still seems reasonable to conclude that enhanced inspection activity did improve vehicle condition.** Consequently, the analysis will proceed on the assumption that time trends significantly different from zero represent cases in which the inspection activity served to improve vehicle condition.***

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* In addition, the tests used were highly conservative, since they were based on the site as a unit of observation. Using individual vehicles as the unit makes the differences between Kent and Ingham Counties highly significant.

** In a statistical sense, the "best" estimate of the difference in inspection intensity levels is the difference in values of the time trend coefficients. However, as indicated in the discussion, such comparison might not be very precise because of the underlying variability of the data.

*** The validity of this assumption is reinforced by the fact that Kent County data almost universally fail to indicate a time trend significantly different from zero, and in many cases the coefficients for Kent County are only a small fraction of those for the other two counties.

B. Experimental Design and General Procedures

The general design of the roadside observation was in keeping with the overall program plan. The purpose was to obtain a representative sample of the vehicle population and to measure as cleanly as possible changes occurring over time. The large number of vehicles observed and the inclusion of all vehicles passing a particular point well met this purpose. Sites were selected on the basis of income level of the area, day of the week of observation, degree of urbanization, and proximity to sample inspection locations. Sites were required to have, if possible, a minimum traffic volume of 50 cars per hour in order to assure statistical validity.* The original plan called for observations being conducted for a 12 month period, but this had to be reduced to seven months because of limited observer availability.

Eight sites were used in each county, four each in high and low income areas. For each income area, two sites were observed on week nights and two sites were observed on Friday nights. General areas for sites were selected in the same fashion as the sample inspection areas. Specific sites were chosen in consultation with local traffic and police officials to find streets in the general area which would carry the minimum traffic volume and which offered good observation points.

Besides income level of the area, night type, and general suitability, two other factors motivated site selection: degree of urbanization and proximity to sample inspection locations. These factors increased the sample's representativeness by having sites from both central city and suburban areas and from areas both near to and far from the daytime sample inspection locations. Due to a short implementation period, sites were not balanced exactly on these factors.** However, a clustering of sites was avoided in this fashion, except in Kent County where there was a high degree of overlap between evening and daytime sites.

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* For example, if the observed value of some dependent variable is 25%, 50 cases will yield 95% confidence that the true value is between 19% and 31%.

** The greatest single difficulty was in locating high income central city locations. This problem was also troublesome in selecting sample inspection sites.

With minor exceptions, the same sites with the same observers were used throughout the data gathering period.* This was done to avoid confounding effects of changes over time with effects of observer or site changes. Seven visits to each site were scheduled. This plan was followed exactly in Ingham County for a total of 56 observations. In Genesee County, one Friday evening set of observations was substituted for a week-night visit. In Kent County,one set of week-night observations was omitted entirely. One additional observation at a week-night site in Genesee County was missed,due to the unavoidable absence of the observer for that location.

Troopers conducting the observation received initial training in the procedures from HSRI personnel for a one evening period. In addition, they were given follow-up instruction during each of their initial observation periods. The actual task of observing vehicles, recording defects on the data sheet, and maintaining a traffic count with a hand counter were elementary and quickly mastered. Most questions concerned clerical details of completing summary forms and arranging data sheets for later keypunching. During the balance of the period, the observers were visited frequently, and often on an unannounced basis, by HSRI personnel. Besides serving the obvious, and totally unnecessary function of maintaining continued alertness, the visits helped to insure consistent and accurate data collection by answering questions as they arose,and by demonstrating personal interest while the people involved were performing a lonely and uninteresting task.

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* Four sites were moved from the first to the second observation. The moves were undertaken either for insufficient traffic volume at the site or for difficult observing conditions such as the lack of a good parking spot for the observer's vehicle. These changes were minor usually involving a move of a block or so, and in one instance the observer simply moved to a different leg of the same interesection. On seven occasions substitute observers, who had been trained in the procedure, were used.

C. Analysis of Overall Failure Frequency

The most general measure of the condition of the vehicle population is the percent of vehicles having any defect. If this figure drops, it indicates a general improvement, since failures of any kind have been reduced. Hence, analysis of changes in this variable has been the most extensive.

To analyze changes in the percent of defective vehicles, a three step procedure was used. First, the percent failing was computed for each month of observation for each county, and for each income level within the county. This was done to identify major patterns in the data. Next, a multiple linear regression analysis was performed using all variables which might have affected the passing rate. Finally, the data were grouped into the design categories of income level, night type, and county to identify areas where significant time trends had occurred. All analysis used the defective percent at a location for a night. This was done to minimize the effect of chance fluctuations in traffic volume on the reported figures.*

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* This procedure weights each site equally. Vehicles at different sites are given unequal weights. Mathematically, if there were two observations at a site with a total of N_1 and N_2 vehicles, and D_1 and D_2 were defective, the average reported for the site under the procedure used would be:

$$Avg = \frac{1}{2} \frac{(D_1 + D_2)}{N_1 \quad N_2}$$

It should be recognized that the more common way of computing this would be:

$$Avg = \frac{D_1 + D_2}{N_1 + N_2}$$

For statistical analysis purposes, though, the first procedure may yield cleaner results, and, over a large number of observations, the two figures will converge.

Table IV.2a shows the average percent of vehicles defective by month for all three counties, for each individual county, and for Genesee and Ingham Counties combined. This last category is included here and elsewhere in the analysis to indicate the general effect of enhanced inspection activity as opposed to the experience in Kent County which received rather minimal attention. The table indicates a lack of clear trends in the data, and shows a good amount of variability from month to month. The clearest pattern would appear to be in Ingham County. Here, some improvement in June and July is followed by a worsening in August and September, and then by renewed improvement in October and November. However, the F ratio tests suggest that there is about as much variability among observations conducted during a particular month as among the months. This implies a large variability among sites at any one time. Month-to-month differences in sites used might obscure all but the strongest time effects, since not every site was observed in every month. The best illustration of this effect is the Ingham County average for August, which represents only one set of site observations.

Turning to Table IV.2b, in which the Genesee and Ingham data are grouped into high and low income areas, a much clearer pattern emerges. In the high income areas of Ingham County, there is a strong decline in the percent of defective vehicles, and in the high income areas of Genesee county, there is a moderate decline. The low income areas remain relatively unchanged. Additionally, the table suggests that the strongest changes in the high income areas of Ingham County occurred in the last three months of the project. The changes may have been caused by the seasonal factors discussed in the introduction, or they may have resulted from the increasing activity of the operational teams in the higher income areas later on in the project in order to meet the 20% inspection goal.

TABLE IV.2a

Percent of Cars Defective by County by Month

Month	All Counties	Genesee County	Ingham County	Kent County	Genesee and Ingham Combined
May	27.3	25.4	29.4	29.1	26.7
June	27.0	27.6	27.7	24.1	27.7
July	27.9	28.8	25.9	29.0	27.1
Aug.	29.1	27.5	33.3	28.7	29.4
Sept.	25.6	24.0	27.3	----	25.6
Oct.	25.6	25.2	23.8	28.0	24.3
Nov.	25.3	24.0	24.0	27.4	24.0
Mean	26.8	26.0	26.4	28.0	26.2
F Ratio	0.752	0.581	1.86	0.154	1.459
Prob. Level*	0.609	0.744	.107	.978	0.200
Degrees of Freedom	(6,156)	(6,48)	(6,49)	(5,46)	(6,104)

* Probability that such variation among months would occur by chance.

TABLE IV.2b

Percent of Cars Defective by Income Level by Month
Genesee and Ingham Counties

	Genesee		Ingham		Combined	
Month	Low	High	Low	High	Low	High
May	29.2	21.6	28.8	29.8	29.1	24.4
June	31.5	22.4	20.9	24.5	21.1	23.9
July	29.5	28.1	27.9	24.1	28.6	25.7
Aug.	31.4	23.6	33.6	32.9	32.1	26.7
Sept.	29.9	18.1	33.2	22.3	31.0	20.2
Oct.	31.8	18.6	27.2	19.8	28.9	19.3
Nov.	29.7	18.3	28.3	19.6	29.1	18.9
Mean	30.4	21.5	29.2	23.6	29.8	22.6
F Ratio	.130	3.4329	0.563	3.55	0.440	4.06
Prob. Level*	0.991	0.0172	0.755	0.014	0.848	0.002
Degrees of Freedom	(6,21)	(6,20)	(6,21)	(6,21)	(6,49)	(6,48)

* Probability that such variation among months would occur by chance.

Having a general picture of the data,the next step was to examine the effect of all possible factors on the percent of defective vehicles. A multiple linear regression technique was used. In non-technical terms, the regression mathematically finds a straight line time trend which "best" fitted the data after adjusting for other factors like income. In the equations presented, a number of "dummy" or "shift" variables were used to control for the other factors. These variables commonly took on two values to represent the two possible levels of the factor, like low and high income. The estimated effect of the factor on the percent of defective vehicles is reflected in the coefficient calculated for it. For example, a coefficient of -5.0 for the income variable indicates that the percent of defective cars was on the average 5% lower in the high income areas. Time was measured in 100-day units from the start of the project. For example, an observation conducted on October 14 had a time value of 1.67. This provided a continuous time variation. The time values were then used to calculate the expected change in the outage rate.

The regression analysis is presented in Table IV.3. The strongest effect is income. For all three counties, high income areas had a 7.75% lower failure rate than low income areas. Night type had a consistent, although not as strong, effect. For all three counties, week nights had 2.34% fewer defects than Friday nights, and for Kent County, week nights had 6.27% fewer defects. The effects of urbanization and proximity tended to be insignificant and were inconsistent across counties. The high correlation between high income areas, suburban locations, and sites near to the sample inspection locations caused these variables to reflect more the chance variations among particular sites rather than consistent effects of these two factors. The observer effects were sizable and often significant, particularly for the first observer. These effects may be explainable, though, in terms of the pecularities of certain sites. For instance, observer number one, who drove the team's only unmarked car, was consistently assigned to low income, central city sites. The large, positive coefficients for his observations demonstrated the high defective vehicle percent in these areas. The intensity variable shows Genesee and Ingham Counties tending initially to have vehicles in better condition than Kent County. The time coefficients follow the basic hypothesis, with Kent County having the least time trend, which was not significant, and Ingham County having the greatest trend effect, although Ingham was only slightly stronger than Genesee. The overall comparisons show that Genesee was different from Ingham, with the largest differences being in the proximity and observer effects. Kent was also different than Genesee and Ingham with income and urbanization apparently having the most marked effect. The differences among counties on these factors are discussed further in Section E.

The next step focused on the time trends. Variables on urbanization, proximity, intensity, and observers were dropped from the analysis.* The regressions were reconstructed using only time, income, and night type. In addition, the data were grouped within counties to identify areas with the strongest time trends. The sub-categories examined were high vs. low income areas, Friday night vs. week night sites, the four groupings formed by crossing night type and income, e.g., high-income, Friday-night. This procedure reduced the number of observations available in any one group, but this disadvantage was offset by reducing the variation among sites. Complete regression analyses are found in Appendix B, Table B.1, and some more important results are shown in Table IV.4.

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* This was done because of the variables' high correlation with income which tends to produce inconsistent results. The problem is technically known as multicolinearity which can be treated either by dropping some variables, as in the present case, or collecting additional data.

TABLE IV. 3

% of Defective Regression Analysis
Including all Major Variables Measured

COUNTY		CONSTANT	TIME	INCOME	TYPE	URBANI-ZATION	PROXIMITY	INTEN-SITY	OBS. 1	OBS. 2	NUMB OBS.	R^2
ALL	Coefficient	38.960	-1.211	-7.751	-2.339	0.687	-0.252	-7.407	9.957	3.478	163	59.8
	Std. Error		0.663	0.941	0.893	0.994	1.202	7.508	1.483	1.120		
	Significance		0.0698	0.0000	0.0097	0.4682	0.834	0.325	0.0000	0.0023		
Genesee	Coefficient	53.234	-2.001	-8.045	-2.111	-3.111	-7.4403	-----	15.55	1.2997	56	79.2
	Std. Error		0.745	-1.915	1.648	2.124	2.322		2.037	1.772		
	Significance		0.0098	0.0001	0.2063	0.1495	0.0024		0.000	0.4669		
Ingham	Coefficient	36.955	-2.018	-7.987	-1.384	-1.484	2.165	------	4.258	5.615	56	54.4
	Std. Error		0.962	1.630	1.271	1.669	1.486		2.872	2.184		
	Significance		0.0412	0.0000	0.2818	0.3784	0.1518		0.1447	0.0133		
Kent	Coefficient	44.284	-0.442	-12.337	-6.746	5.319	------	------	13.715	2.181	51	82.5
	Std. Error		1.110	1.712	-1.3080	1.717			2.752	2.006		
	Significance		0.6928	0.0000	0.0000	0.0034			0.0000	0.2830		
Genesee	Coefficient	33.079	-2.051	-6.269	-0.207	0.436	0.262	0.204	8.135	3.652	112	55.9
& Ingham	Std. Error		0.694	1.040	0.965	1.042	1.286	9.440	1.591	1.207		
Combined	Significance		0.0039	0.0000	0.8305	0.6762	0.8389	0.9828	0.0000	0.0031		

OVERALL COMPARISONS:

GENESEE vs INGHAM:

SSE GENESEE = 0.068051
SSE INGHAM = 0.096804
SSE COMBINED = 0.208500

$F_{(6,100)} = 4.4121 \quad p<.001$

GENESEE & INGHAM vs KENT:

SSE GENESEE & INGHAM = 0.208500
SSE KENT = 0.094491
SSE ALL = 0.416270

$F_{(6,149)} = 9.2868 \quad p<0.001$

TABLE IV. 3
(Continued)

Explanation of terms:

Coefficient: This represents the amount that a unit change in one of the variables would change the percent of defective vehicles, e.g. in the equation presented for all counties the coefficient on time of -1.211 indicates that a 100 day period of operation would reduce the percent of defective vehicles 1.2 percentage points.

Standard error: This is a measure of the mean variability of the estimated value of the coefficient. Again, for the time variable for all counties, the standard error of 0.663 indicates that if the experiment were repeated many times about 2/3's of the time the estimated coefficient would fall between -1.874 and -0.548, which is -1.211 plus or minus 0.663.

Significance: This number indicates the probability that the true value of the coefficient is zero. In the case of the all county time coefficient, the value of 0.698 indicates that there was about a 7% chance given variations in the data that the true value of the coefficient was zero. It should be noted that when significance is indicated as 0.0000 it does not imply that there was a zero probability of the coefficient being equal to zero but that the probability was less than 5 chances in 100,000.

Constant: This is the base percent of vehicle defective if all the other variables were zero. It does not exactly correspond to the mean values reported in Tables IV. 2a and IV. 2b since several of the dummy variables were coded 1 or 2 due to a peculiarity of the computer program used to calculate the regression equations.

Time: This represents the effect of the passage of time on the percent defective and is referred to in the text as the time trend effect. It is measured in 100 day units.

Income: This is a dummy or categorical variable. It assumes the value of 1 if an observation were conducted in a low income area and the value of 2 if an observation were conducted in a high income area. It indicates the mean difference between the two kinds of area.

Type: This is a dummy variable which reflects the effect of the type of night on which an observation was conducted. It has a value of 1 for Friday night observations and a value of 2 for week night observations.

Urbanization: This is a dummy variable which reflects the effect of the type of area in which the observation was conducted. It takes on a value of 1 for central city and a value of 2 for suburban locations.

TABLE IV. 3

(Continued)

Proximity: This is a dummy variable which measures the effect of distance from the sample inspection site. A value of 1 was assigned to nearby sites and a value of 2 was assigned to more distant sites.

Intensity: This is a three-level variable designed to measure the effect of any sharp differences among the three counties, either due to differences prior to the start of the program or due to a sudden shift in the vehicle condition not represented by the time trend. It assumes values of .05 for Kent, .10 for Genesee, and .15 for Ingham County.

Obs 1 and Obs 2: These are two dummy variables which reflect the peculiarities of sites to which two of the four observers were regularly assigned. These effects are discussed in more detail in section E.

R^2: This statistic represents the percent of the total variation in the data accounted for by the variables included in the regression.

SSE: This is a measure of the remaining variability in the data it is computed for each observation by taking the square of the difference between the value predicted for that observation and the actual value of the observation. If this number is divided by the number of observations it provides a measure of the average amount by which the estimated value missed the true value. In the context of the overall comparisons presented at the foot of the table, these numbers are used to test how much the mean variation in the data is changed by combining groups of observations. If the mean variation is made much larger by combining groups, i.e. a large value of the F statistic, then this is taken as evidence that the groups are not alike.

Values of certain variables are omitted from certain equations, since their inclusion in these equations would present a problem similar to that in ordinary algebra when one has more unknowns than equations.

Examining Table IV.4, income effects continue to be quite strong. High income areas for the three counties combined, for Genesee County, for Ingham County, and for two combined showed significant downtrends. High income areas of Genesee County dropped more than those in Ingham County which again raises the possibility of independent seasonal effects. Or, the Genesee County result might indicate the influence of sample inspection team induced changes. The strongest trend occurred in high income week night sites, one of which was a very low traffic volume sample inspection site. In other words, the Genesee County result may be strongly influenced by the sample inspection saturating one neighborhood.* In Ingham County, high income areas contributed most substantially to the overall significant improvement in the county. Friday night sites produced statistically stronger results than week night sites, since the larger traffic volumes on Friday evenings yielded smaller variations among sites. High income areas had more consistent data than low income areas as indicated by the higher R^2 statistics. Figures IV.3 through IV.7 illustrate the trends for groups in Table IV.4.

Overall, the analysis suggests three possible effects working in parallel. First, in the high income areas there well might have been a seasonal improvement in vehicles which was independent of the checklane. Second, particularly in Genesee and less so in Kent County, outcomes may have been influenced by the sample inspection activity in the same area as the roadside observation. Third, in Ingham County with the 20% inspection level, the checklane activity in all likelihood produced some improvement in

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* There were two such sample inspection locations where traffic volume was so low that the sample team was required to select a very high proportion of the traffic passing the location. One was in a high income area of Genesee County, and the other, was in a low income area of Kent County. In retrospect, it seems quite likely that the sampling rate was sufficiently high and the neighborhoods sufficiently compact that the team's efforts may have saturated the area.

TABLE IV.4

Selected Regression Results,
Percent of All Cars Defective vs. Time and Income

County	Income Group	Type Group	Constant	Time	Income	R^2
All	All	All	38.78	-1.5 (0.102)	-6.87 (0.0000)	20.6
	High	All	27.01	-3.2 (0.007)	---	8.8
Genesee	High	All	25.57	-3.5 (0.019)	---	20.1
Ingham	All	All	30.59	-2.6 (0.02)	-5.72 (0.0002)	28.9
	Low	All	31.26	-1.2 (0.462)	---	2.1
	High	All	27.98	-4.0 (0.011)	---	22.2
	All	Fri	38.54	-2.1 (0.059)	-5.97 (0.0005)	45.3
	Low	Fri	31.26	-0.7 (0.687)	---	1.5
	High	Fri	27.90	-3.4 (0.007)	---	46.8
Ingham and Genesee Combined	All	All	28.64	-2.2 (0.026)	---	4.4
	All	Fri	38.93	-1.5 (0.110)	-7.16 (0.0000)	37.4
	High	Fri	25.69	-2.6 (0.020)	---	21.3
	High	Week	29.86	-6.2 (0.006)	---	28.1

Numbers in parentheses indicate significance level.

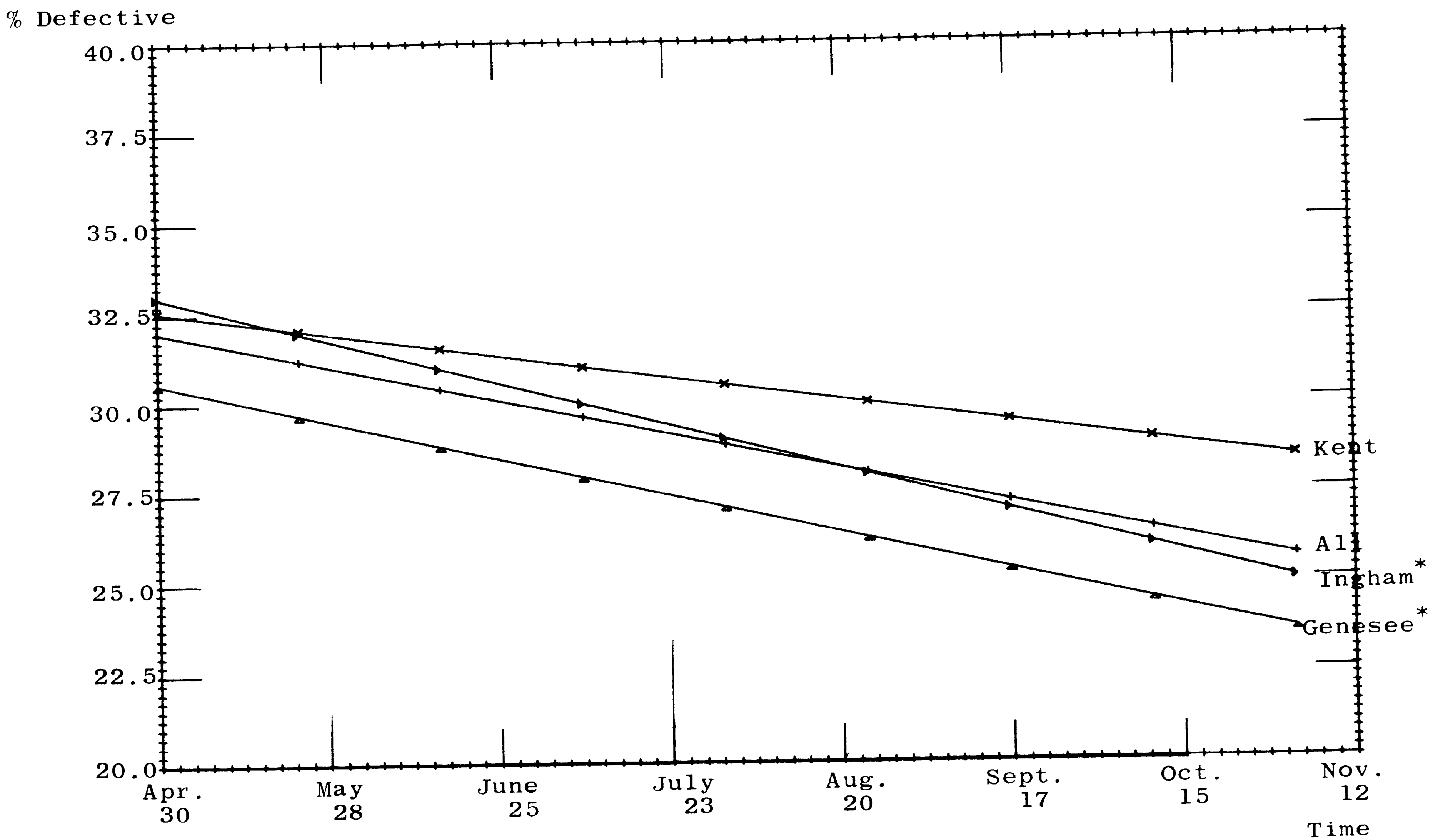

Figure IV.3 Regression Lines

% Defective vs Time; High Income Areas by County

* Significant at the 90% confidence level or better

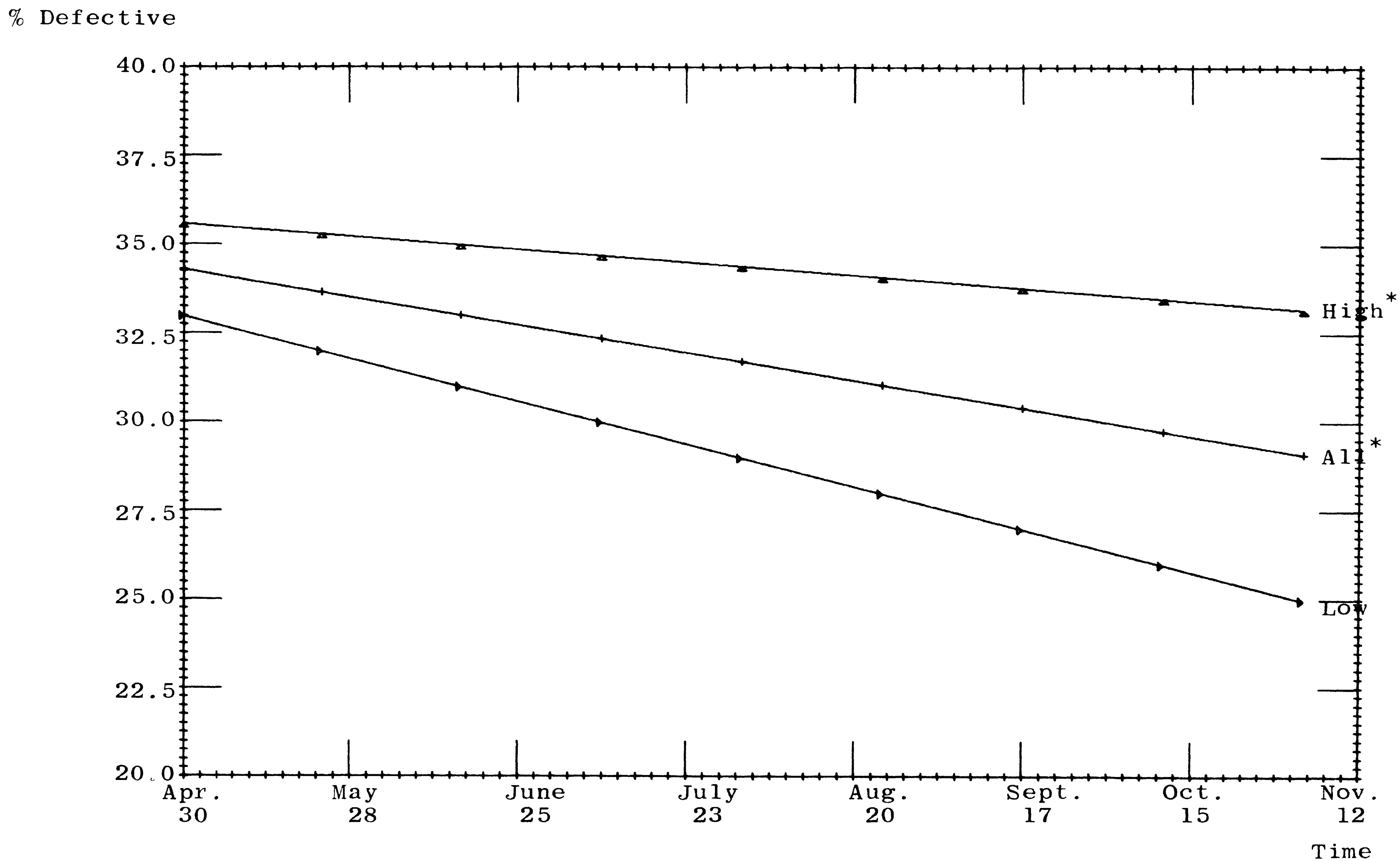

Figure IV.4 Regression Lines

% Defective vs Time; Ingham County by Income Level

* Significant at the 90% confidence level or better

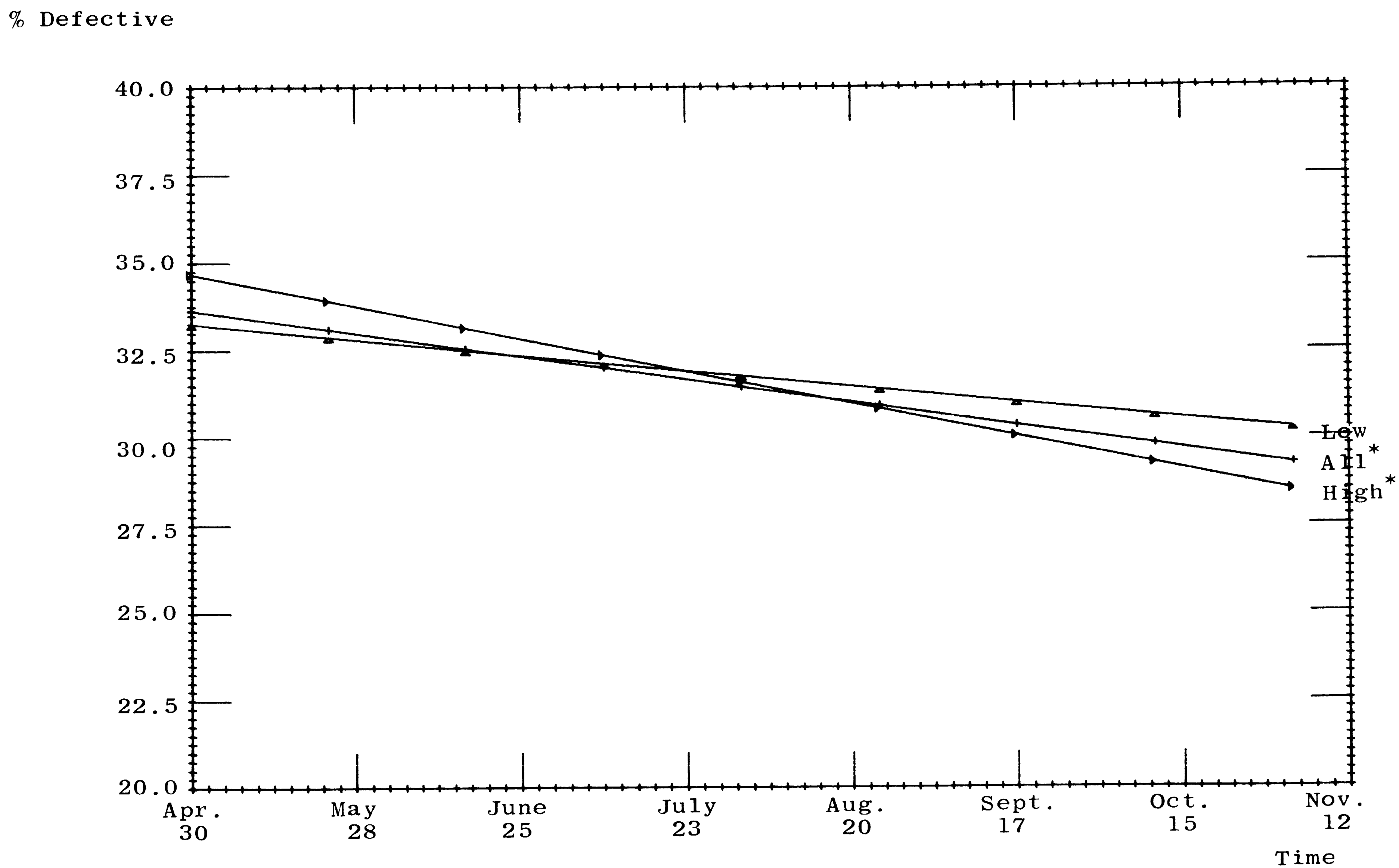

Figure IV.5 Regression Lines

% Defective vs Time; Genesee and Ingham Combined by Night Type

* Significant at the 90% confidence level or better

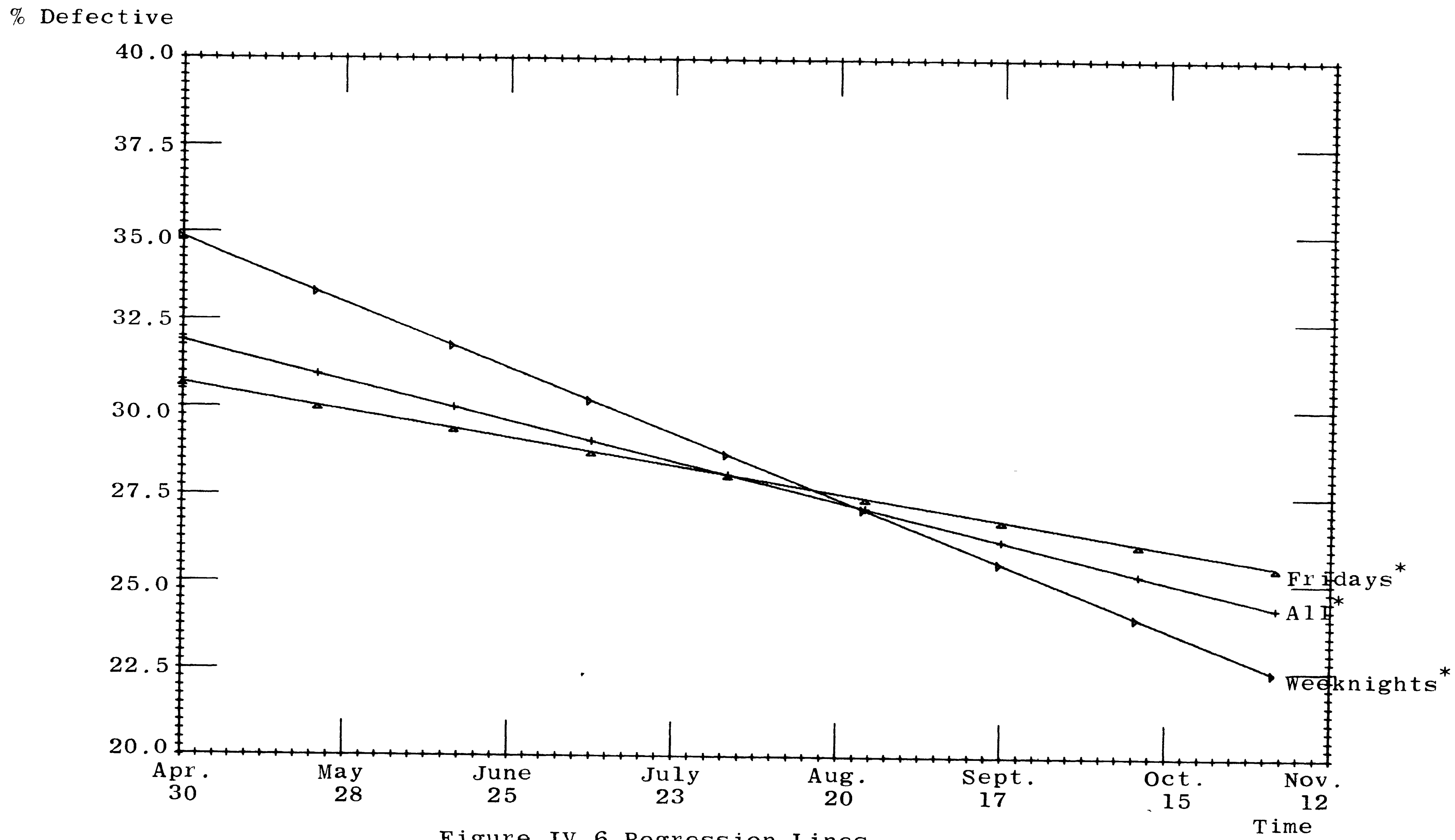

Figure IV.6 Regression Lines

% Defective vs Time; Genesee and Ingham
High Income Areas by Night Type

* Significant at the 90%
confidence level or better

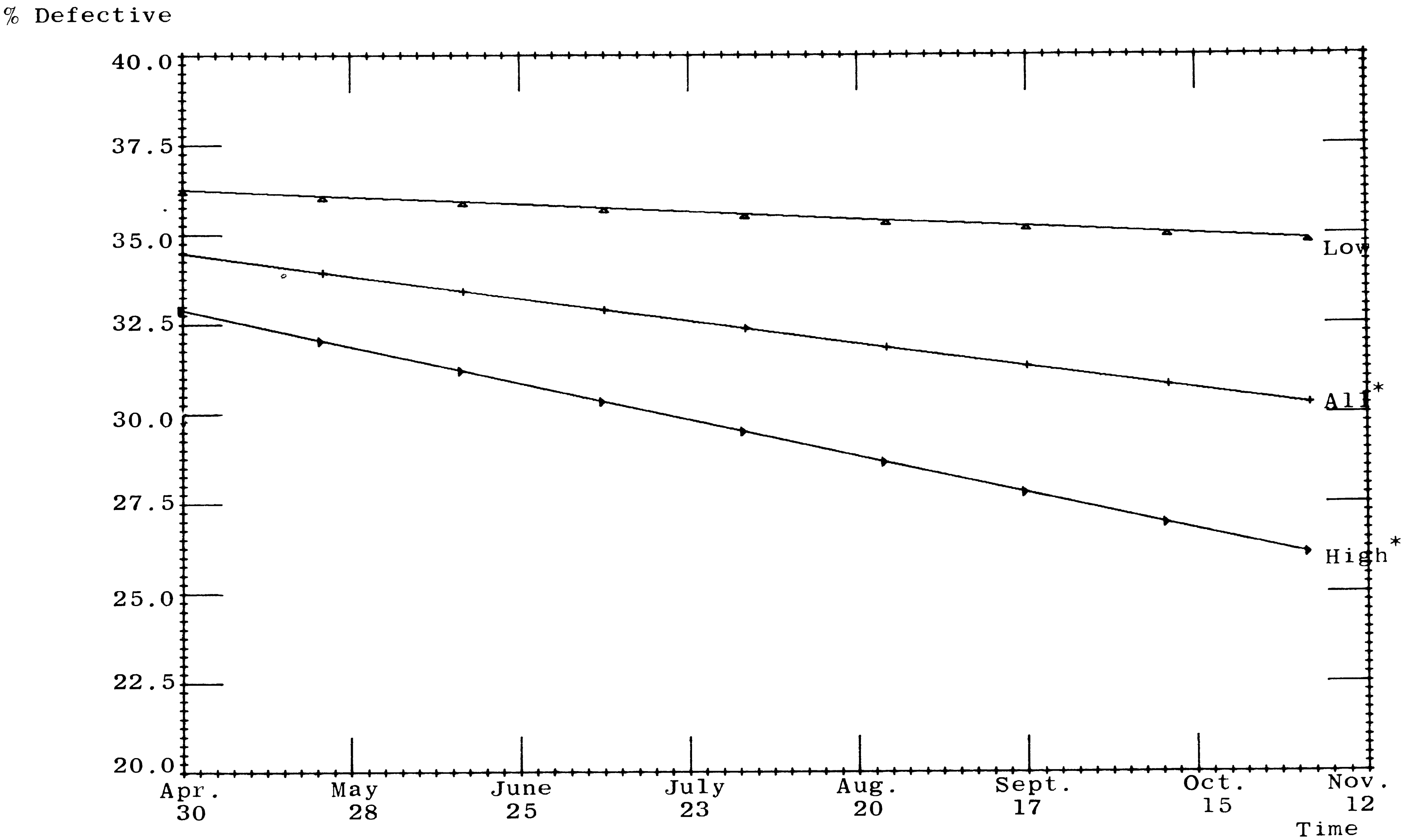

Figure IV.7 Regression Lines

% Defective vs Time: Ingham County
Friday Night Sites by Income Level

* Significant at the 90% confidence level or better

the vehicle population beyond seasonal and neighborhood saturation effects. In retrospect, the sample inspection and roadside observation locations were relatively better chosen in Ingham County so as to avoid a high degree of overlap. In addition, the low income areas in Ingham County, while not statistically significant, did show a larger time trend than the other counties. Only Ingham County, even with less biased data, yielded a significant downtrend. Hence, the conclusion is that the 20% inspection level in Ingham County did somewhat improve the vehicles in that county.*

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* It could also be argued that the saturation effect observed in certain areas constitutes evidence in favor of the check-lane program. Since it is not known what fraction of the area's vehicles were inspected in the saturation condition, it really cannot be inferred whether such effects resulted from the check altering repair practice or from a periodical effect of forcing repair of defective vehicles.

D. Analysis of Specific Components and Vehicle Groupings

After having identified changes in the overall failure rate, the subsequent question was how did the change come about? This was addressed in three related ways.* First, defective vehicles were classified into two two-level groups: one group concerned the number of defects on the vehicle, single vs. multipl; the second grouping was according to whether the vehicle had only a license plate defect or some other defect or combination of defects.** The percent of vehicles in each group for each observation was computed. The second approach was to compute for each observation the average number of total defects, of minor defects, and of major defects per 100 vehicles. Thirs, the percent of vehicles with particular component failures was calculated for each observation. Tables IV.5a and IV.5b show the measurements by county.

For analysis, the multiple linear regression approach was again used. All vehicle classifications and the major component classifications were studied.*** Results closely followed the overall percent of defective vehicles. Significant downtrends were found for:

(1) the percent of vehicles with single defects
(2) the percent of vehicles with only plate light defects
(3) the average number of minor defects
(4) the percent of vehicles with plate light defects
(5) the percent of vehicles with taillight defects

Areas with significant declines on these items corresponded almost exactly to the areas where the overall percent of defective vehicles fell. Of other components, only mufflers showed signifi-

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* The first two approaches can be considered vehicle measures since they concern some characteristic of the vehicle such as the average number of defects on that vehicle. The last approach is strictly a component measurement.

** The categories are not mutually exclusive between groupings. For example, a vehicle with only a licenst plate light out would fall in both the single defect category and in the plate light only category, and a vehicle with a license plate light out and a noisy muffler would fall into the multiple defect and all other defect categories.

*** For example, analysis was performed on the total percent of taillight outages for whatever reason rather than on the specific subcategories such as one side out.

TABLE IV.5a

Descriptive Statistics of Roadside Observation Data
Vehicle Groupings by County

Average Number of Cars Observed per Sample	All	Genesee	Ingham	Kent	Genesee/Ingham Combined
	264.6	241.3	262.0	293.0	251.69
Vehicle Measures:					
Percent Defective	26.45	25.8	26.1	27.60	25.93
Percent Plate Light Only[1]	13.70	12.2	13.8	15.22	13.01
Percent All Others[1]	12.75	13.5	12.3	12.39	12.92
Percent Single Defects[2]	20.59	19.7	20.4	21.77	20.06
Percent Multiple Defects[2]	5.86	6.1	5.7	5.83	5.87
Average Defects per 100 Cars[3]	33.8	33.7	33.1	34.6	33.4
Average Defects per 100 Cars Excluding Plate Lights	15.9	17.4	15.3	15.0	16.3
Average Major Defects[4] per 100 Cars	11.1	12.2	11.1	9.9	11.6
Average Minor Defects[5] per 100 Cars	22.7	21.5	22.1	24.6	21.8
Defective Vehicle Measures:[6]					
Defects per Defective Vehicle		1.296	1.266	1.226	1.281
Major Defects per Defective Vehicle		0.457	0.427	0.330	0.442
Minor Defects per Defective Vehicle		0.839	0.839	0.896	0.839

TABLE IV.5b

Descriptive Statistics of Roadside Observation Data on Components, Component Groups by County

Average Number of Cars Observed per Sample	All 264.6	Genesee 241.3	Ingham 262.0	Kent 293.0	Genesee/Ingham Combined 251.69
Component Measures:					
Percent Head Light Out[7]	0.92	0.92	1.02	0.82	0.97
Percent Head Light Broken[8]	0.03	0.03	0.03	0.02	0.03
Percent Head Light Combined[9]	0.95	0.95	1.05	0.84	1.00
Percent Muffler	3.96	4.24	3.52	4.14	3.88
Percent Plate Light	17.88	16.37	17.83	19.60	17.10
Percent Brake Light 1 Side	2.79	3.17	2.23	2.97	2.70
Percent Brake Light Both Sides	1.51	1.81	1.50	1.18	1.65
Percent Brake Light Combined	4.29	4.99	3.72	4.16	4.36
Percent Tail Light Out 1 Side	3.42	3.82	3.60	2.78	3.71
Percent Tail Light Out 2 Sides	0.33	0.43	0.34	0.22	0.39
Percent Tail Light Broken 1 Side	1.93	1.81	2.18	1.78	2.00
Percent Tail Light Broken 2 Sides	1.72	0.24	0.12	0.15	0.18
Percent Tail Light Combined	5.85	6.30	6.25	4.92	6.27
Percent Wiring Problems	0.36	0.41	0.13	0.56	0.27
Percent Glass Defects	0.01	0.01	0.02	0.02	0.01
Percent Other	0.47	0.48	0.63	0.32	0.54

Notes for Table IV.5

1. The plate light only category represents the percent of cars in the sample with only a license plate light out. The all other category is the percent of cars with some other defect or combination of defects. For example, a car with both a plate light out and a taillight out will be in the second category.

2. The single defects category represents the percent of cars with only one defect of any type. The multiple defects category is the percent of cars with more than one defect of any category.

3. The average defects per 100 cars category was computed by taking the total number of defects on the vehicles and dividing that number by the total number of vehicles in the observation.

4. Average major defects was computed by taking the total number of headlight, taillight, brake light, and muffler defects on the vehicles and by dividing this sum by the total number of vehicles in the observation.

5. Average minor defects was computed in the same fashion as average major defects except the defect categories of plate light, wiring, and other were used.

6. The defective vehicle measures were formed by using the same numerators as the average defect categories but using only the total number of defective vehicles as the denominator.

7. The out categories for lights indicated that the light was simply not burning.

8. The broken category indicates that the unit was physically damaged. The most common occurrence was of taillight lenses which were broken but with the lamp still functioning.

9. The combined categories do not represent the sum of the individual categories but were scored as a failure if any of the individual categories were failures.

cant time changes. These changes followed no consistent pattern. In low income areas of Genesee County, mufflers worsened significantly, and in high income areas of Kent County they improved significantly. In addition, the average number of total defects per 100 vehicles fell significantly in the high income areas of all three counties.

The more detailed measures fail to show any dramatic effect of the checklane. Where the overall failure percent changed significantly, the most common repair apparently was of a single plate light or taillight outage. These are the most frequent defects, and, hence, these items would be expected to change most easily under the checklane. Yet, the absence of a more broadly based change suggests little overall improvement in repair practice. The uniformly significant decreases in the average number of defects per vehicle in the high income areas of all three counties points to a seasonal improvement.* It is interesting to note, however, that in low income areas the average number of defects per vehicle showed a decrease only in Ingham County. However, with the wide variation of results in low income areas, little weight can be given to this finding. Complete regression results are presented in Appendix B, and several of the measurements are discussed further in the following paragraphs.

Of the observed components, only license plate lights and taillights displayed a consistent pattern of significant results. Tables IV.6a and IV.6b give the outage rates for these components by month in Genesee and Ingham Counties. Like the overall failure rate, plate and taillights show much month-to-month variation. Plate light performance is rather flat for the first four months in both counties. During the last three months, September through November, the failure percent does fall off. In low income areas of both counties, little change is apparent. In high income areas of Ingham County, the plate light pattern is "V"-shaped for the

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* Unless, of course, individuals in the higher income areas responded much more strongly to a more limited checklane activity than do those in lower income areas.

first four months, May through August. This is followed by a decline in the last three months. The "V" pattern may come from the peculiarities of sites observed in both May and August. For taillights, the only noticeable pattern is an apparent downward drift in Genesee County. Turning to the regression analysis, plate light defects follow closely the pattern of the overall outage rate. Plate lights declined significantly in all of Ingham County and in the county's high income areas. The most significant changes again occurred on Friday nights. For taillights, a somewhat unusual result emerges. In Genesee County, the taillight outage decreased significantly in the county as a whole and in both the low and the high income areas with the stronger effect apparently in low income areas. Ingham County did not show any significant changes, although the downtrend approached significance at the 0.10 level, for low income sites. No clear-cut explanation can be offered for the taillights' unusual performance. The absence of improvement in high income areas can be explained by the low initial frequency which left little room to improve. For low income areas, the change is not consistent with the overall performance of these areas, nor with the sample inspection data. These inconsistencies raise the possibility that the changes came from chance effects, rather than from true checklane induced improvement.

Returning to the vehicle measurements, the data reflect both specific component performance and the overall failure rate pattern. The measurements indicate that the overall failure rate changed through the repair of single, isolated defects, primarily license plate lights. In one or more counties, usually Ingham, the percent of cars with single defects, the percent of cars with only plate light outage, and the average number of minor defects declined significantly. Conversely, the percent of cars with multiple defects, the percent of cars with defects other than a single plate light outage, the average number of major defects,

TABLE IV.6a

Percent of Cars with Plate Light Defects by Month: Genesee and Ingham Counties; All, Low and High Income Levels

Genesee County

	All Income		Low Income		High Income	
Month	Number	Percent	Number	Percent	Number	Percent
May	8	16.77	4	18.18	4	15.36
Jun	8	17.45	4	19.30	4	15.60
Jul	8	17.87	4	19.12	4	16.62
Aug	8	17.99	4	18.77	4	17.21
Sep	4	14.28	2	16.38	2	12.17
Oct	8	15.79	4	20.92	4	10.65
Nov	12	14.41	6	16.51	6	12.30
F Ratio		1.135		1.475		1.5375
Significance		(0.356)		(0.235)		(0.215)
Degrees of Freedom		(6,49)		(6,21)		(6,21)

Ingham County

	All Income		Low Income		High Income	
Month	Number	Percent	Number	Percent	Number	Percent
May	4	22.29	2	21.02	2	23.56
Jun	11	18.47	6	21.23	5	15.15
Jul	12	18.34	6	19.82	6	16.86
Aug	4	21.00	2	21.53	2	20.48
Sep	4	18.53	2	20.51	2	16.54
Oct	13	15.12	7	18.70	6	10.93
Nov	8	16.39	4	19.57	4	13.22
F Ratio		1.857		0.489		2.697
Significance		(0.107)		(0.809)		(0.044)
Degrees of Freedom		(6,49)		(6,22)		(6,20)

TABLE IV.6b

Percent of Cars with Tail Light Defects by Month:
Genesee and Ingham Counties; All, Low, and High Income Levels

Genesee County

	All Income		Low Income		High Income	
Month	Number	Percent	Number	Percent	Number	Percent
May	8	6.44	4	8.93	4	3.94
Jun	8	7.69	4	10.79	4	4.60
Jul	8	7.06	4	8.63	4	5.48
Aug	8	7.37	4	10.51	4	4.22
Sep	4	4.62	2	6.38	2	2.85
Oct	8	5.10	4	8.82	4	3.17
Nov	12	4.83	6	6.01	6	3.64
F Ratio		0.843		1.053		1.055
Significance		(0.543)		(0.421)		(0.420)
Degrees of Freedom		(6,49)		(6,21)		(6,21)

Ingham County

	All Income		Low Income		High Income	
Month	Number	Percent	Number	Percent	Number	Percent
May	4	5.13	2	6.57	2	3.68
Jun	11	6.40	6	7.89	5	4.61
Jul	12	7.34	6	7.21	6	7.46
Aug	4	9.24	2	8.00	2	10.48
Sep	4	4.89	2	7.09	2	2.69
Oct	13	5.30	7	5.64	6	4.89
Nov	8	5.71	4	6.20	4	5.22
F Ratio		1.649		0.767		1.620
Significance		(0.154)		(0.602)		(0.194)
Degrees of Freedom		(6,49)		(6,22)		(6,20)

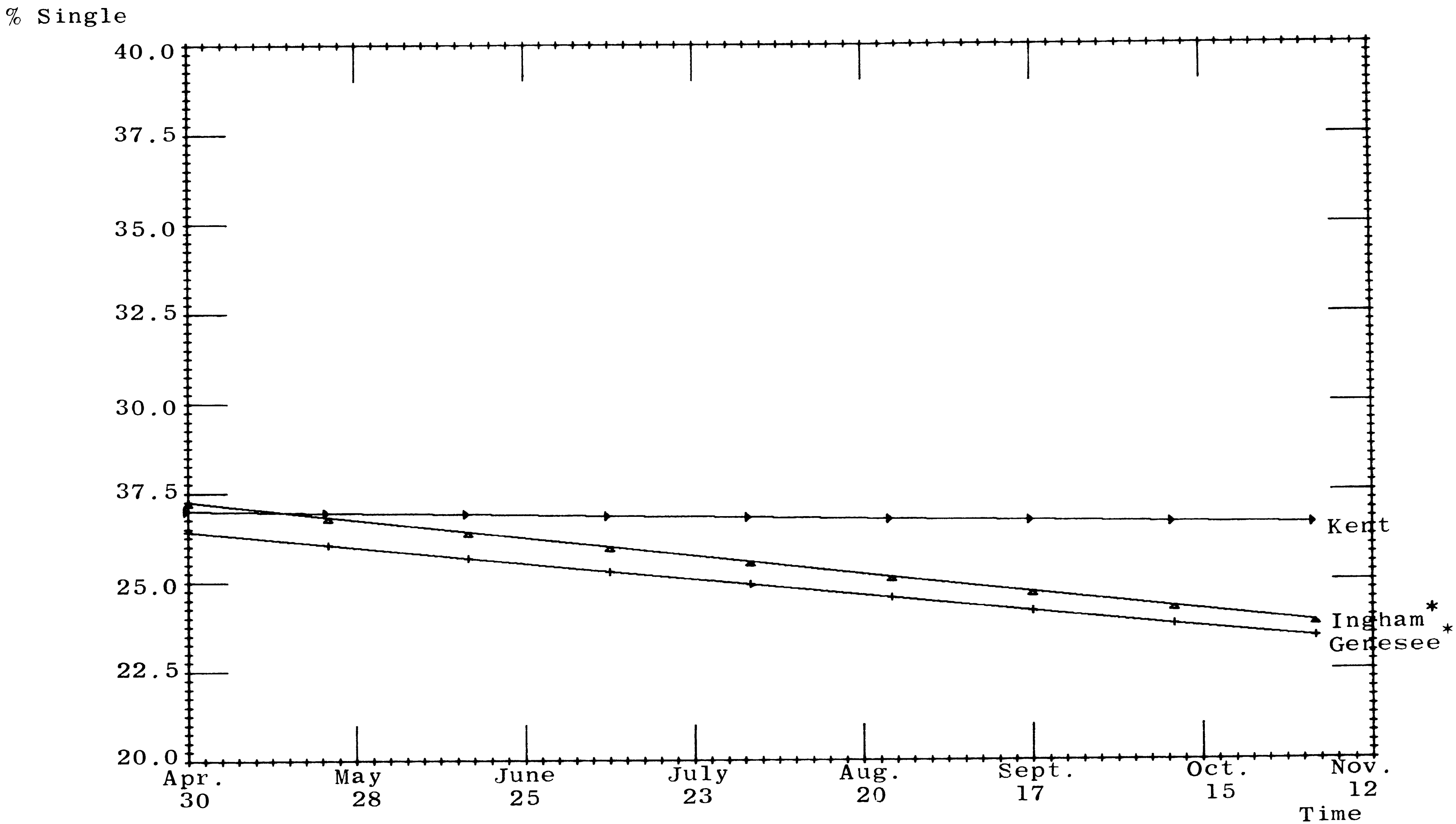

Figure IV.8 Regression Lines

% Single Defect Cars vs Time; by County

* Significant at the 90% confidence level or better

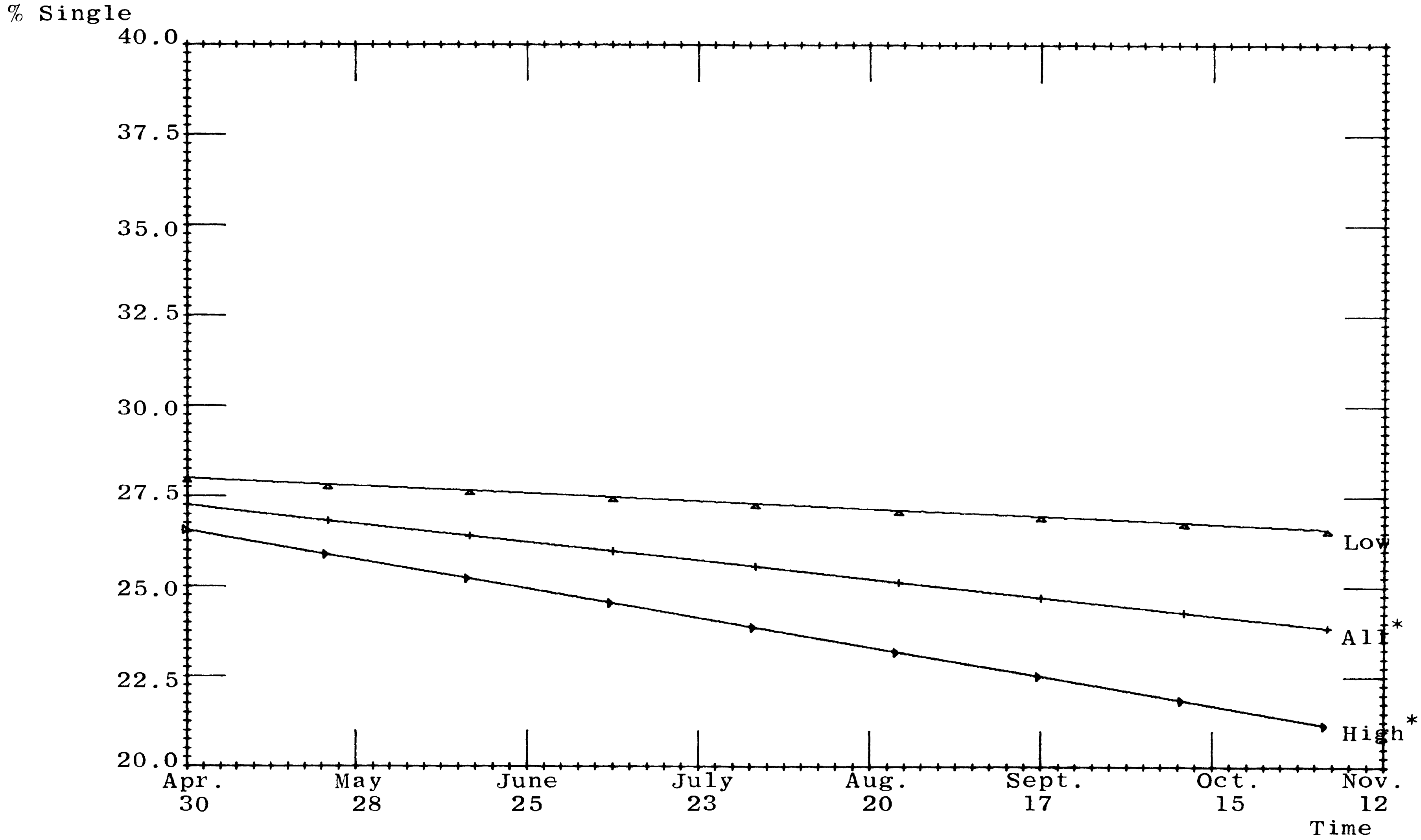

Figure IV.9 Regression Lines

% Single Defect Cars vs Time;
Ingham County by Income Area

* Significant at the 90% confidence level or better

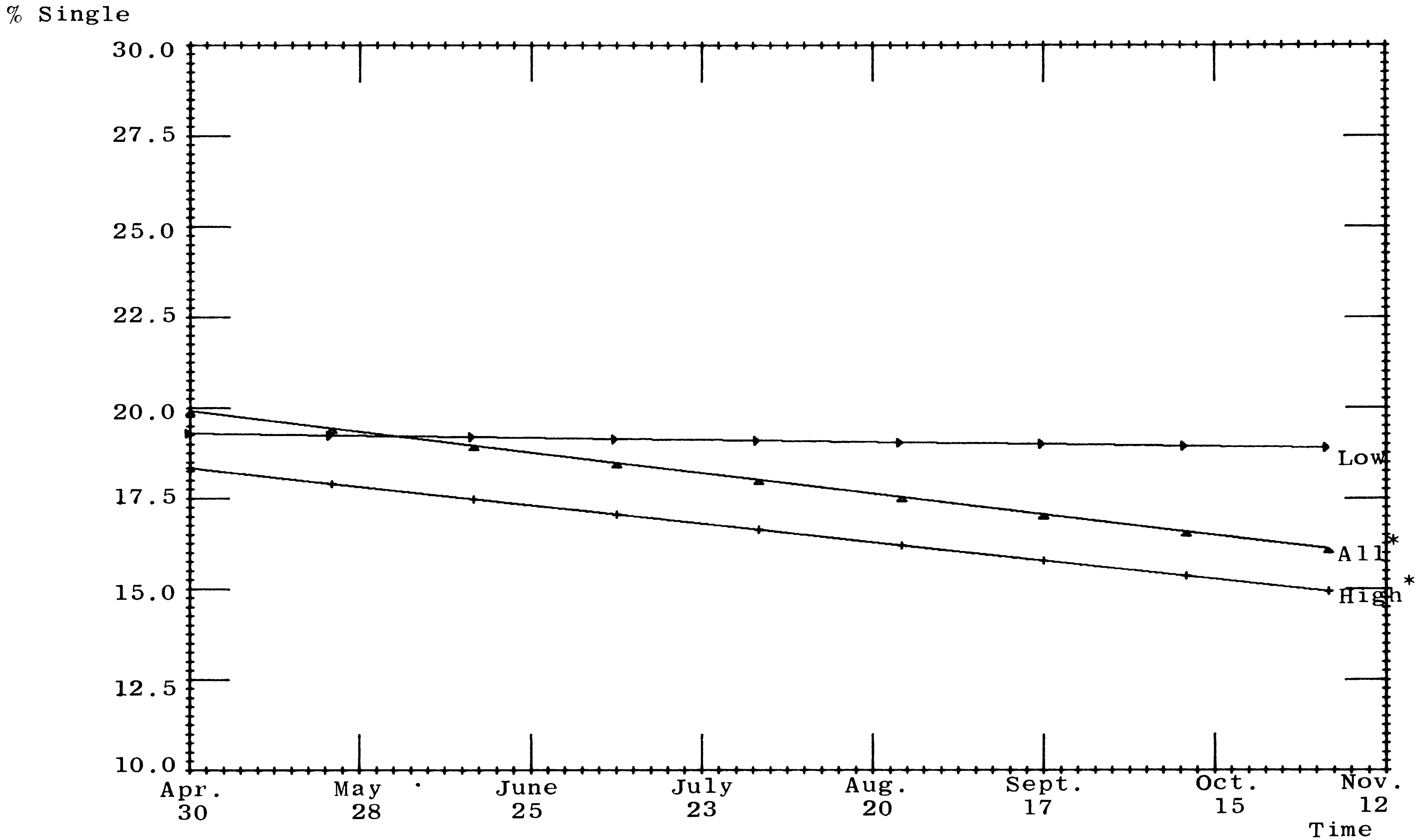

Figure IV.10 Regression Lines

% Single Defect Cars vs Time; Ingham County
by Income Area Friday Night Sites

* Significant at the 90% confidence level or better

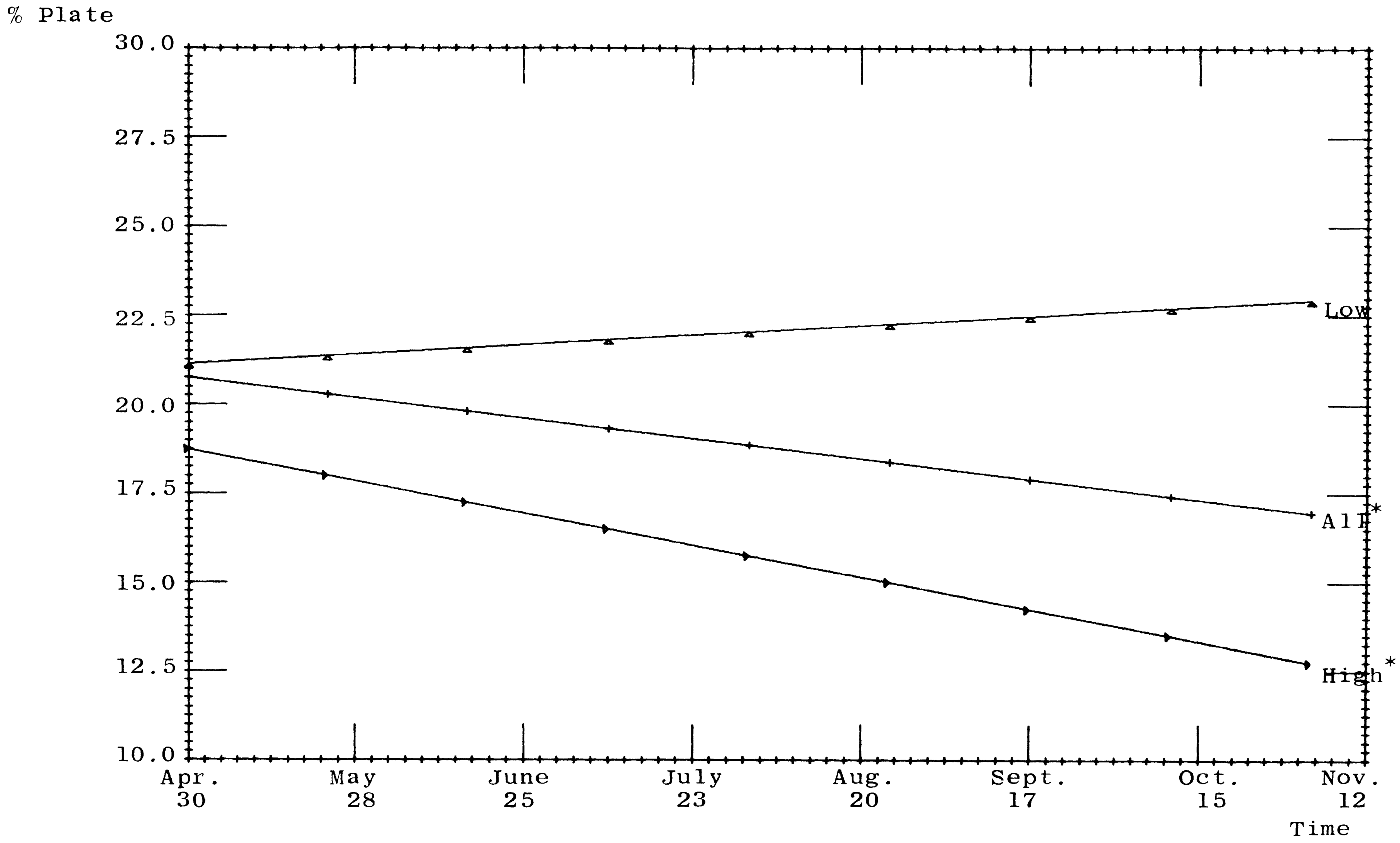

Figure IV.11 Regression Lines

% Plate Light Outage vs Time;
Ingham County by Income Area

* Significant at the 90% confidence level or better

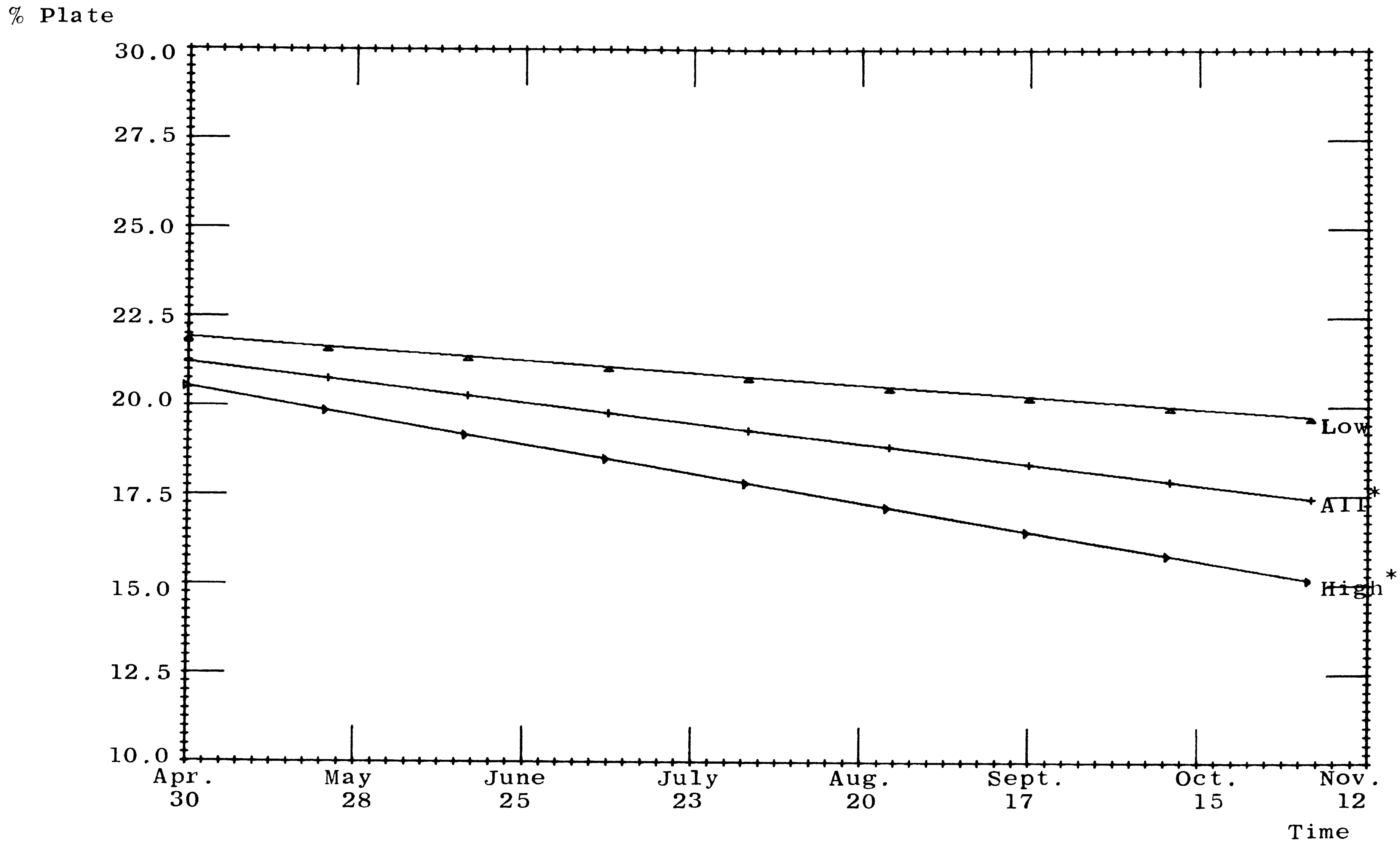

Figure IV.12 Regression Lines

% Plate Light Outage vs Time; Ingham County
Friday Night Sites by Income Area

* Significant at the 90% confidence level or better

and the average number of total defects remain unchanged. Regression results for all of these classifications are presented in Appendix B.

The single-defect car percent is typical of the vehicle measures which changed significantly. Selected regression results for this variable are in Table IV.7a. The percent of single-defect vehicles declined significantly in all of Ingham County, in all of Genesee and Ingham, and in the high income areas of the combined two counties. The time coefficients for single-defect vehicles were very similar to those for all vehicles with defects. Regression lines for the single defect category are plotted in Figures IV.13 through IV.15. Finally, from Table IV.7d, the average number of total defects per vehicle declined significantly in high income areas of all three counties. No significant differences exist in the time trends among the three counties, which again suggests the possibility that an independent seasonal change was affecting vehicle condition in higher income areas.

Briefly, the more detailed measures indicate that change came from the repair of single defects, mostly license plate light outage. No change occurred in the overall frequency of vehicles with multiple defects, which presumably represent a more hazardous part of the population. In addition, the average number of total defects per vehicle declined uniformly in the high income areas of all three counties, which strongly suggests an independent seasonal improvement. The more detailed analysis ,therefore,would indicate that if the checklane had any effect on the vehicle population this effect was of a small magnitude. Moreover, the effect probably occurred only in the county which had the 20% inspection level, or in specific areas of the other counties which received checklane activity at a far more substantial level than the county as a whole.

This concludes the substantive portions of this chapter. The next two sections deal with two technical issues, which do not alter the conclusions. Section E covers the effect of design

TABLE IV.7a

Selected Regression Results, Percent of Vehicles with Only One Defect vs. Time, Income, and Type

County	Income Level	Constant[1]	Time[2]	Income	Type[3]	R^2
Genesee	All	33.878	-0.857 (0.138)	-6.293 (0.000)	-1.956 (0.007)	30.6
Ingham	All	29.046	-1.483 (0.071)	-5.318 (0.000)	0.732 (0.473)	42.5
	Low	21.174	-0.690 (0.410)	----	1.541 (0.1502)	9.2
	High	19.465	-2.376 (0.112)	----	-0.077 (.965)	10.1
Genesee and Ingham Combined	All	30.888	-1.617 (0.011)	-4.819 (0.000)	-0.648 (0.409)	30.9
	Low	22.647	-0.678 (0.373)	----	0.363 (0.703)	1.6
	High	22.961	-2.578 (0.011)	----	-1.684 (0.1752)	17.2

[1]Average value if all other variables were zero.

[2]Measured in 100-day units past 4/30/72.

[3]Binary variable, 1 = Friday site, 2 = Week-night site

TABLE IV.7b

Selected Regression Results, Percent of Vehicles with Plate Light Defects vs. Time, Income, and Type

County	Income Level	Constant[1]	Time[1]	Income	Type[3]	R^2
Genesee	All	25.101	-1.693 (.0307)	-4.182 (.0000)	-.375 (.6980)	32.9
	Low	17.526	-.876 (.3092)	1.352 (.2156)	----	8.4
	High	20.131	-2.511 (.0483)	-2.102 (.1800)	----	3.0
Ingham	All	30.951	-1.943 (.0258)	-4.703 (.0000)	-2.657 (.0156)	39.9
	Low	23.021	-0.9 (.2801)	-1.244 (.2698)	----	10.7
	High	24.882	-2.956 (.0515)	-4.143 (.0312)	----	33.8
Ingham (Fridays)	All	25.715	-1.934 (.0053)	-2.990 (.0024)	----	45.3
	Low	21.922	-1.117 (.1852)	----	----	14.1
	High	20.538	-2.752 (.0145)	----	----	40.5

[1]Average value if all other variables were zero.

[2]Measured in 100-day units past 4/30/72.

[3]Binary variable, 1 = Friday site, 2 = Week-night site.

TABLE IV.7c

Selected Regression Results, Percent of Vehicles with Plate Light Outages vs. Time, Income, and Type

County	Income Level	Constant[1]	Time[2]	Income	Type[3]	R^2
All	All	10.792	-.879 (.0161)	-3.129 (.0000)	.5035 (.2612)	26.3
	Low	9.242	-1.045 (.0677)	----	-.424 (.5437)	4.9
	High	2.915	-.711 (.1065)	----	1.468 (.0080)	10.7
Genesee	All	12.773	-1.534 (.0110)	-4.513 (.0000)	1.424 (.0576)	48.6
	Low	8.929	-2.189 (.0538)	----	1.474 (.2899)	15.6
	High	3.079	-.880 (.0618)	----	1.373 (.0232)	24.8
Genesee and Ingham Combined	All	9.478	-1.230 (.0049)	-2.825 (.0000)	1.634 (.0030)	29.1
	Low	8.516	-1.568 (.0181)	----	.627 (.4404)	10.1
	High	1.927	-.893 (.1056)	----	2.680 (.0003)	23.8

[1]Average value if all other variables were zero.

[2]Measured in 100-day units past 4/30/72.

[3]Binary variable, 1 = Friday site, 2 = Week-night site

TABLE IV. 7d

Regression Results: Average Total Defects per 100 vehicles High Income Areas by County

COUNTY		CONSTANT	TIME	TYPE	NUMB OBS	R^2
All	Coefficient	32.277	-4.223	-0.862	80	17.8
	Std. Error		1.075	1.331		
	Significance		0.0002	0.5192		
Genesee	Coefficient	32.580	-4.888	-0.158	28	23.3
	Std. Error		1.812	2.284		
	Significance		0.0123	0.9453		
Ingham	Coefficient	32.330	-4.096	0.416	27	12.5
	Std. Error		2.243	2.815		
	Significance		0.0803	0.8837		
Kent	Coefficient	30.455	-3.171	-2.236	25	28.8
	Std. Error		1.184	1.407		
	Significance		0.0137	0.1262		
Genesee and Ingham combined	Coefficient	32.337	-4.517	0.224	55	17.0
	Std. Error		1.404	1.764		
	Significance		0.0022	0.8993		

Comparison of Time Coefficients

Ingham vs Genesee:	Difference	-0.127	T= 0.0442	df=49
	Std. Error	2.873	$p > 0.10$	
Ingham vs Kent:	Difference	0.925	T= 0.3462	df=46
	Std. Error	2.700	$p > 0.10$	
Genesee vs Kent:	Difference	1.052	T= 0.4727	df=47
	Std. Error	2.226	$p > 0.10$	

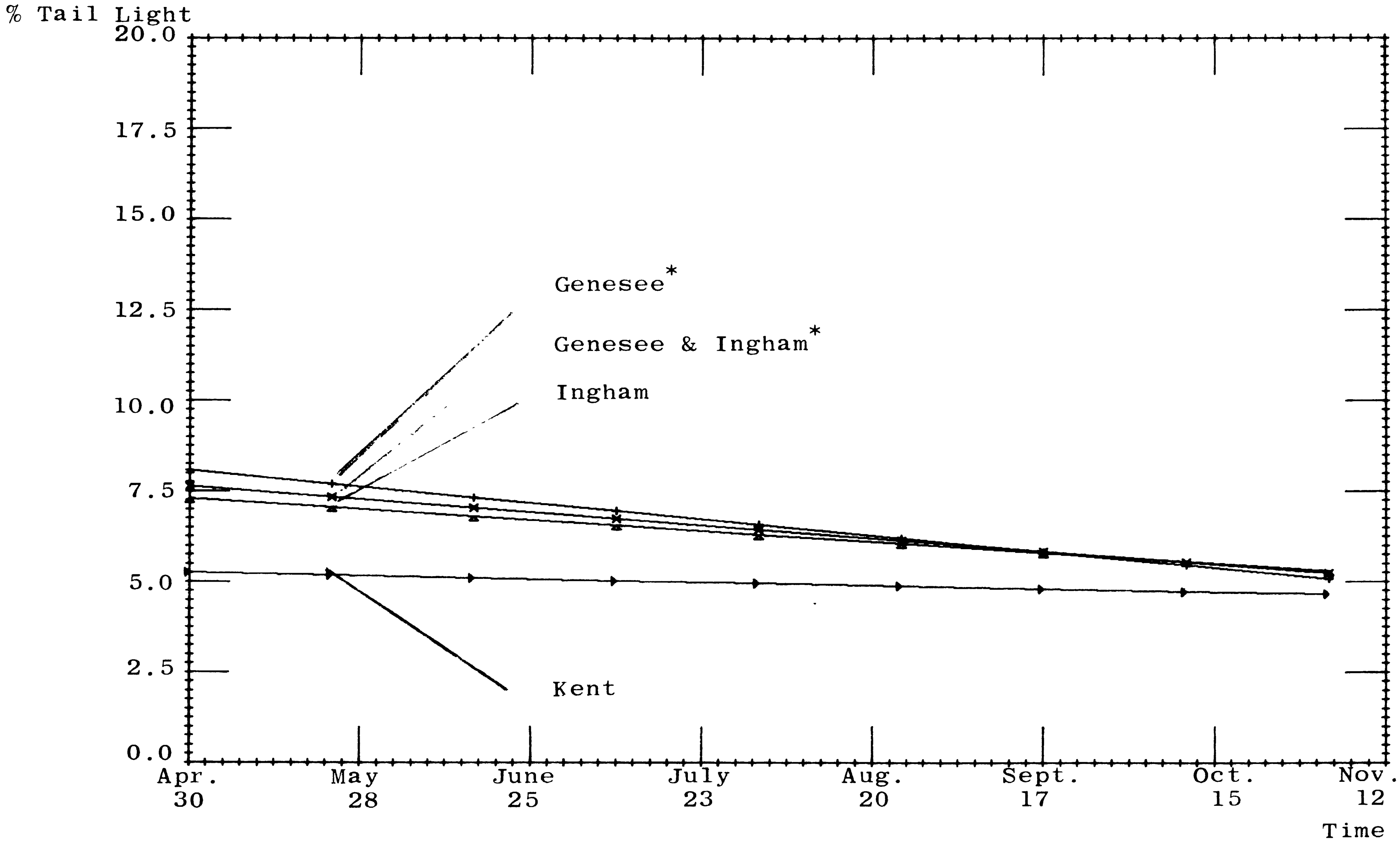

Figure IV.13 Regression Lines

% Tail Light Outage vs Time;
by County

* Significant at the 90% confidence level or better

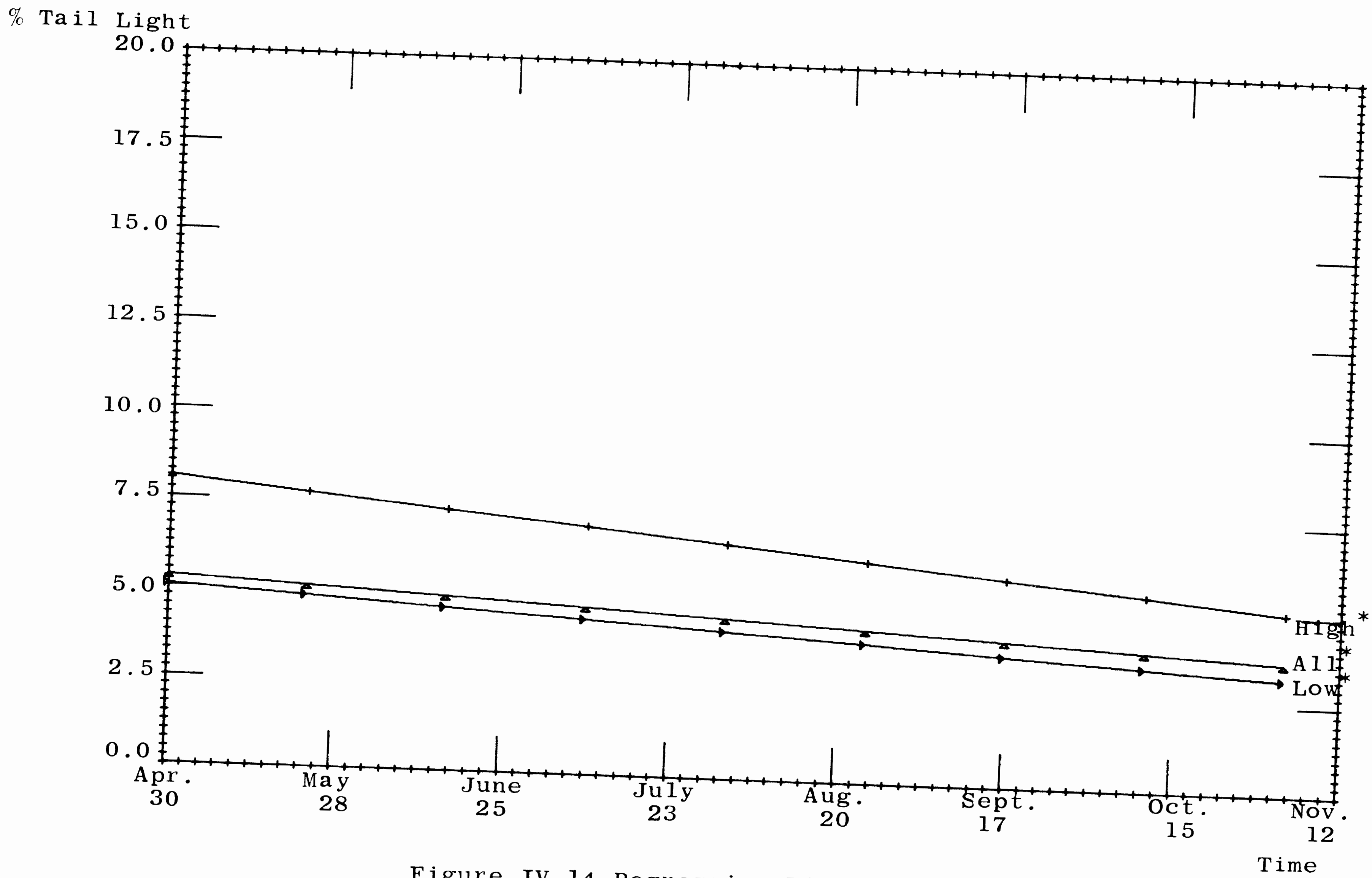

Figure IV.14 Regression Lines
% Tail Light Outage vs Time; Genesee County by Income Area

* Significant at the 90% confidence level or better

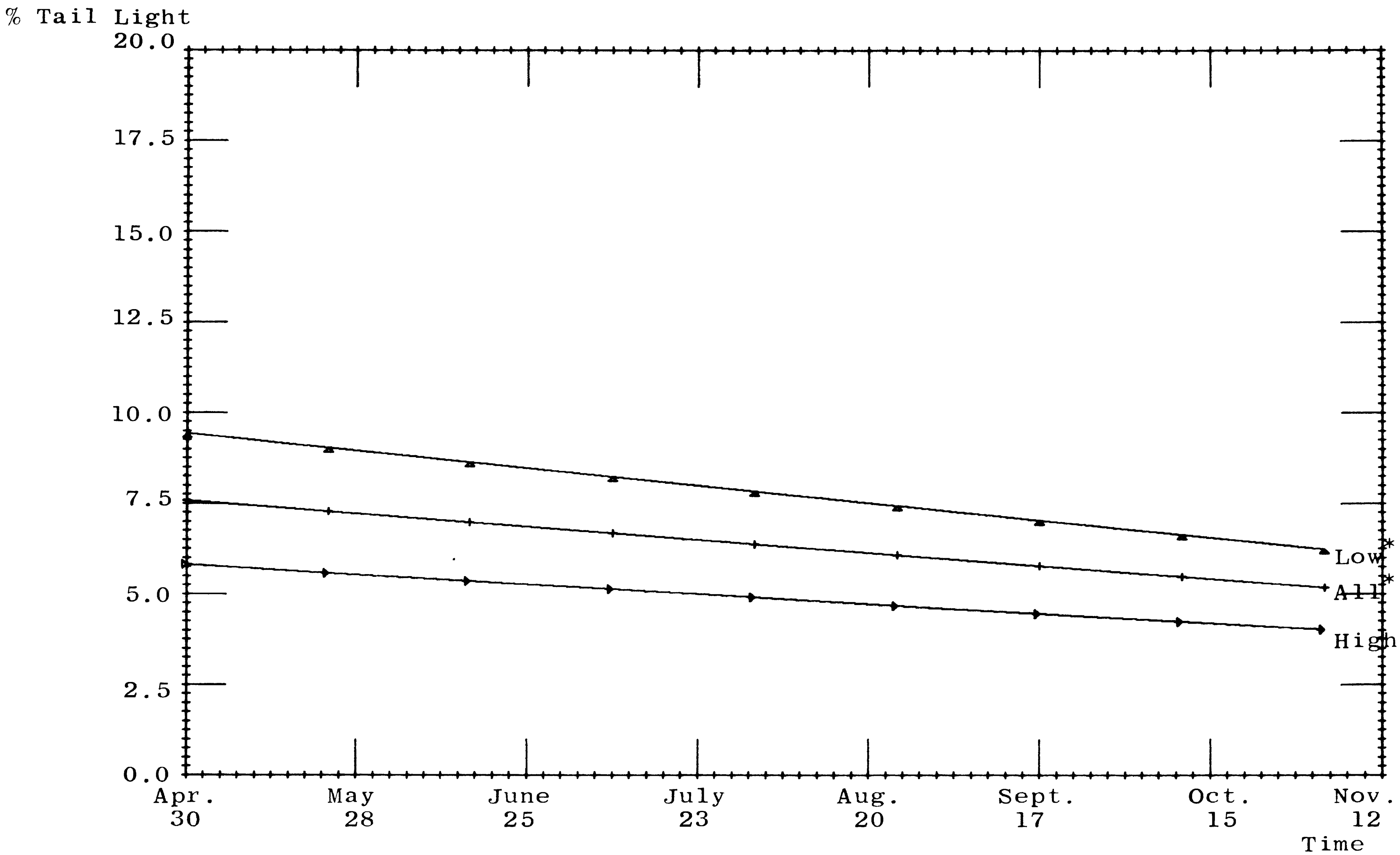

Figure IV.15 Regression Lines

% Tail Light Outage vs Time; Genesee and Ingham Combined by Income Area

* Significant at the 90% confidence level or better

factors and extraneous influences on the overall defect rate. Section F reports on a re-analysis of the time trends in the overall defect rate using a somewhat more sophisticated statistical approach than described earlier; the more sophisticated approach does not materially alter the results. The non-technical reader can omit these two sections without loss of understanding of the overall report.

E. Analysis of Design Factors and Extraneous Influences on Roadside Observation Results

The goal of any sample is to produce an accurate representation of the general population within acceptable error tolerances. The scientific art, or artful science, of experimental design aims to create a sampling procedure that adequately accounts for known or suspected differences in the population and to plan sufficient observations so that the effects of chance variation are within tolerable limits. After collecting the sample, the adequacy of the design must be examined and the influence of any extraneous factors or biases which might alter the results much be checked. This section considers these problems.

In the roadside observation, there were three major design factors: the county, the income level of the site, and the type of night. Two secondary design factors were included in selecting sites, urbanization and proximity to sample inspection sites. Within this framework, 150 vehicles per observation per site was established as the target for a minimum sample, to measure between-site or between-observation differences.*

The county as a design variable was established by the evaluation plan. The income level, night type, and urbanization criteria were based on a previous use of the roadside observation technique. The earlier study clearly established the effect of area income on the outage rate, and observer's subjective evaluation indicated Friday evening traffic represented a broader cross-section. Urbanization apparently was associated with vehicle condition. Suburban areas had the lowest defect rate, and central city and extreme rural areas had higher defect rates. In retrospect though, urbanization differences seem to be explained by income effects.** The

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* For example, if the observed value of some dependent variable is 25%, 150 cases will yield 95% confidence that the true value is between 19% and 31%.

** The previous study was an informal evaluation of the checklane conducted in 1968 by HSRI. The study produced inconclusive results because the completely randomized sampling design yielded so much among-site variation that any time effects could not be measured. The more structured design of the present study was based on learning from that experience. Significant design factors were established from a very thorough analysis of the original data by a former graduate assistant, Mr. Calvin Kirchick.

proximity factor arose from concern in preparing the present plan that experience of areas which were near sample inspection sites might be biased by the presence of sample inspection activity.

After data were collected, two possible extraneous factors were identified and reviewed; the factors were observer bias and shifts in observation times across months. Possibilities for observer bias are present in any data collection which does not use purely mechanical recording techniques. Individuals differ in alertness, in visual acuity, in subjective evaluation of brightness and of loudness, and in motivation. All may affect recorded data. The change of starting times came from the nature of the roadside observation. Data collection could not begin until dark. Since observations were conducted from late Spring through mid Fall, darkness came earlier in later months. Although observers were encouraged to use a constant starting time, they gradually began collecting data at an earlier hour. Traffic operating from 7:00 p.m. to 10:00 p.m. might be different than traffic from 9:00 p.m. to midnight, so the change in starting time may have introduced a bias.

Reviewing these matters indicates, though, that the samples well represented the counties. Sample size generally exceeded the 150 vehicle target. Genesee and Ingham counties had almost identical outage rates and Kent County displayed a failure rate that was approximately 3% higher. The primary design factors of income and of night type affected the defective vehicle fraction significantly. Urbanization apparently did not greatly affect the outage rate. Proximity had a statistically significant effect, making desirable a balanced design on this factor. Yet, balancing on proximity would have increased the failure percent by only 0.37%. No statistically significant difference in time trends arose between sites close to and distant from sample inspection locations. Large differences existed among observers, but the differences can be plausibly accounted for by the peculiarities of the sites to which certain observers were regularly assigned. No significant dif-

Table IV. 8 Number of Vehicles Observed and Number of Observations by County, Income Level, and Type of Evening

County	Site Type / Income Level	All: Numb Obs	All: Avg # Cars	Friday: Numb Obs	Friday: Avg # Cars	Weeknight: Numb Obs	Weeknight: Avg # Cars
All	All	163	262.7	85	325.4	78	194.4
	Low	82	266.8	41	313.9	41	219.7
	High	81	258.9	44	336.1	37	166.4
Genesee	All	55	245.4	32	311.7	23	153.0
	Low	28	264.7	16	295.8	12	223.3
	High	27	225.3	16	327.7	11	76.4
Ingham	All	56	255.6	27	361.1	29	156.9
	Low	28	296.8	13	337.9	15	261.2
	High	28	213.9	14	382.6	14	45.2
Kent	All	52	289.1	26	305.2	26	272.9
	Low	26	236.8	12	312.1	14	172.3
	High	26	341.3	14	299.3	12	390.3

ference exists in the time trends reported by different observers. Changes in the starting time of observations did not significantly affect the failure frequency. Based on the analysis, the experimental design and its execution apparently produced a representative sample of the counties. Specific conclusions are reviewed in more detail in the following paragraphs.

Table IV.8 presents the average number of vehicles in each observation type. Overall, the target of 150 vehicles per observation was amply met. The principal exceptions were high income, and week night sites, in Genesee and Ingham Counties. The same observation type in Kent County shows an atypically high vehicle count. Friday evenings, as expected, have more traffic than do week nights. This accounts for the frequent occurrence of significant results for Friday evening observations but not for comparable week night data. High income locations had slightly lower traffic counts. Based on the average sample size, the measurements had an accuracy of plus or minus 4.5% about 25% with a 0.05 error probability.

Analysis of covariance was used to compare the three counties after controlling for the four design factors.* The analysis is presented in Table IV.9a. The defective vehicle percentages for

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* The analysis of covariance technique is quite similar to the multiple regression technique. For each factor, (covariate) i.e., income, the procedure computes a least squares regression coefficient which estimates the effect of the factor on the observed data. The procedure then adjusts the observed values for the effects of the factors and performs a standard analysis of variance using the adjusted observations. The adjustment formula is:

$$Y^* = Y + c(X - XAVG)$$

where Y* is the adjusted value, Y is the original observation, X is factor value associated with the data point, XAVG is the average value of the factor, and c is the least squares coefficient. In addition, if the factor is a binary variable, the effects of an unbalanced design can be determined by the formula:

$$YCOR = c(\tfrac{1}{2}(X1+X2) - (X1*N1+X2*N2)/(N1+N2)),$$

where X1 and X2 are the two values of the factor, N1 and N2 are the number of observations for each factor, and YCOR is the resulting correction. For more information see: B.E. Cooper, Statistics for Experimentalists. London: Pergamon Press, 1969.

Genesee and Ingham are virtually identical, and the two counties are quite similar on other measures except for major defects per 100 vehicles. Kent County has more defective vehicles except again for the major defects category. Moreover, the county's overall failure rate would be 1.36% higher if observations were balanced on proximity. Kent County produces most of the significance in the differences among counties. Caution therefore should be exercised in comparing Kent County experience with the other two counties.

Of the design factors, income most strongly determines differences among sites. High income areas have substantially better vehicles across all categories. The other primary design factor, night type, has a significant but much smaller effect than income. The secondary design factor of urbanization had a small and generally insignificant effect on the measurements. Failure to balance observations on this criteria seemingly does not substantially alter results.

Proximity, however, apparently has a rather strong effect on the results. Sites located some distance from sample inspection locations display a 3.2% higher failure rate than did nearby sites. This suggests that there is contamination of an area's results by a more intense sample inspection there than in the whole county. Yet, turning to Table IV.9b, proximity correlates highly with income and somewhat less so with night type.* Near sites were more frequently high-income,week-night sites; conversely, far sites were more often of the low-income,Friday-night variety. Two possibilities exist. First, part of the proximity effect may come from the differing night type and income characteristics of near and far sites. Alternatively, some of the income and night type effects might arise from proximity. On statistical grounds alone, a choice cannot be made between the two hypotheses. Careful examination of sample inspection sites indicates a limited number may have experi-

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* The negative signs on the correlations of income and of night type with proximity result from arbitrary coding conventions and,hence,do not have any intrinsic meaning.

TABLE IV. 9a

Analysis of Covariance of Vehicle Measures by County Adjusted For Income, Urbanization, Night Type, and Proximity to Day-Time Sample Sites

		% Defective	Defects/100 cars	Major Defects/ 100 cars	Minor Defects/ 100 cars
Genesee County	Adj Mean	25.47	33.56	12.41	21.16
	Raw Mean	25.78	33.73	12.23	21.50
Ingham County	Adj Mean	25.48	31.89	9.66	22.23
	Raw Mean	26.08	33.15	11.03	22.12
Kent	Adj Mean	28.61	36.12	11.22	24.90
	Raw Mean	27.60	34.57	9.92	24.65
F Ratio	Adj Means	4.265 (2,156)	2.355 (2,156)	2.977 (2,156)	5.642 (2,156)
Significance		0.0157	0.0982	0.0539	0.0043
F Ratio	Raw Means	0.735 (2,160)	0.186 (2,160)	1.626 (2,160)	2.699 (2,160)
Significance		0.4535	0.8303	0.2000	0.0703
Effect of	Income	-8.47 (0.0000)	-12.58 (0.0000)	-3.74 (0.0003)	-8.84 (0.0000)
	Urbanization	-1.65 (0.0938)	-0.63 (0.6758)	0.79 (0.4008)	-1.43 (0.1277)
	Night Type	-2.32 (0.0217)	-2.65 (0.0895)	1.14 (0.2374)	-3.79 (0.0001)
	Proximity	3.22 (0.0102)	5.63 (0.0039)	5.12 (0.0000)	.004 (0.9997)

Numbers under F-Ratio give degrees of freedom. Numbers under covariates give significance levels.

TABLE IV. 9b

Correlations of Income, Urbanization Night Type, and Proximity

	Income	Night Type	Urbanization	Proximity
Income	1.000			
Night Type	-0.019	1.000		
Urbanization	0.1647	-0.147	1.000	
Proximity	-0.426	-0.298	- .103	1.000

Note: Codes for Income 1=low, 2=High; Urbanization 1=Central, 2=Suburban; Night Type 1=Friday, 2=Week; Proximity 1=Near, 2=Far. N=163

TABLE IV. 9c

Effects of Proximity to Sample Inspection Sites on Time Trends in Road Side Observation Results

Regression Results (% of Vehicles Defective):

COUNTY	PROXIMITY		CONSTANT	TIME	INCOME	NIGHT TYPE	R^2	Numb Obs
Genesee and Ingham Combined	Near	Coefficient	34.977	-2.489	-4.940	-0.541	23.7	56
		Std. Error		1.014	1.596	1.422		
		Significance		0.0157	0.0032	0.7052		
	Far	Coefficient	37.830	-1.356	-7.478	1.590	28.5	56
		Std. Error		1.138	1.716	1.556		
		Significance		0.2390	0.0001	0.3120		
Ingham	Near	Coefficient	30.130	-1.683	-1.837	-1.435	7.5	22
		Std. Error		1.827	2.592	2.708		
		Significance		0.3692	0.4877	0.6026		
	Far	Coefficient	39.894	-2.231	-7.287	0.603	44.3	34
		Std. Error		1.259	1.646	1.612		
		Significance		0.0865	0.0001	0.7726		

Comparison of Time Coefficients (Near vs Far)

Genesee and Ingham Combined	Difference = -1.1306	T= 0.7421	d.f. = 106
	Std. Error = 1.5236	$p > 0.10$	
Ingham County	Difference = 0.5478	T= 0.2567	d.f.= 50
	Std. Error = 2.3140	$p > 0.10$	

enced sample inspection saturation.* Also,review of the proximity classification shows some borderline cases, approximately three sites or 14 observations. To be conservative on the possibility of saturation effects, these borderline cases were placed in the near category. These two considerations recommend the first hypothesis. A portion of the proximity effect is accounted for by income and night characteristics of the sites rather than vice-versa. In Genesee and Ingham County data where proximities are reasonably dispersed, analysis of time trends shows no significant differences between near and far sites, Table IV.9c. In Ingham County far sites had a greater downtrend than near sites. It would have been desirable to have balanced the design on proximity. More importantly, while some possibility still remains that high income data represent saturation effects, it is more likely that the quality of results was affected adversely by the absence of balance on proximity.

In data collection with human observers, individual differences very probably will influence reported outcomes. The roadside observation design allowed for these influences by having the same person at a site for each observation. An individual presumably would be consistent in his reporting accuracy over time so that observed changes would mirror underlying trends in the population. Observer assignment to sites was more or less arbitrary. No attempt was made to balance assignments across income and night type. Observer 1 was normally sent to low income inner city sites since he drove the team's only unmarked vehicle. Observer 2, having seniority, chose sites which permitted him an expeditious departure for home; his sites were more frequently in high income suburban areas. Observers 3 and 4 were given the remaining sites in numerical order. Since high income sites had been assigned lower identification numbers for data coding, Observer 3 usually was sent to a high income site, and Observer 4 usually received a low income site. The distribution of observers over night type and income

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* Only two locations are highly suspect. One is a high income location in Genesee County, and the other is a low income area of Kent County.

levels is shown in Table IV.10a. An analysis of covariance was performed on several measures across observers. Looking at the results shown in Table IV.10b, the most striking effect is the substantially higher failure incidnece across all measures for Observer 1. This probably represents the nature of the sites to which this person was assigned. When he covered high income locations his reports were similar to the other observers. Of the remaining observers Observer 2 indicated somewhat fewer defects and Observer 3 reported somewhat more defects than might be expected from the general nature of their sites. Apart from Observer 1, differences while significant do not appear substantial. On specific components, observers were quite consistent, except that Observer 3 apparently was quite sensitive to muffler noise. This bias may account for the rather variable performance of mufflers. Most variation among observers occurred in low income areas. This suggests that much of the differences among observers can be attributed to differences in sites.

Since measuring time trends was a major concern, two checks were made on the possibility of observer bias over time. Time trend regressions were re-estimated using two dummy variables to indicate observer effect. The first variable measured differences between Observer 1 and the others. The other dummy variable measured the difference between Observers 3 and 4 and Observer 2. Observers 3 and 4 were paired since their results were similar. Examining Table IV.10c, shows that both observer variables were in general significantly positive. In Genesee County, the time coefficient remains constant with or without the observer variables. The significance level is increased, suggesting that observer or site differences account for a good portion of the variance. In Ingham County, the downtrend's size is reduced. Possibly, some of the time effect in Ingham can be accounted for by differences in sites or observers. Conversely in Kent County, the size of the downtrend increased, suggesting that possible time effects might have been masked by observer differences.* The lack of significance indicates that the effect was not important. Overall, the freedom from strong observer biases is indicated by the absence of a clear pattern among counties. The second approach to check observer bias on time trends was to group the data by pairs of observers. Observers 1 and 2 and Observers 3 and 4 were paired under the assumption that the first pair had the best and worst sites and that the second pair had more typical sites. The usual time trend regressions were performed on the two pairs. Results are presented in Table IV.10d, for all three counties combined and for Genesee County.** The first pair had smaller time trends than the second pair, but in neither case shown were the differences significant. The absence of significant differences indicates again consistent observer accuracy over time. Based on both the previous analysis of levels and this analysis of time trends, it can be safely concluded that observer biases did not materially alter the results.

A second possible bias was a change in the time period of observations. The plan called for observations from 8:30 p.m. to 11:30 p.m. throughout the project. The starting time was determined by the latest occurrence of dusk from May to November.*** The constant interval served to avoid any biases induced by traffic changes through the evening. However in the field, the plan was

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* Since the regression estimates the line that best fits the data, a difference in time trends in two subsets of the data can either exaggerate or mask the overall time trend unless the differences in subsets is accounted for. For example in Ingham County, if Observer X's area was substantially better than the other areas and if no trend existed in Observer X's area but a trend existed for the other areas, then the regression would show a steeper slope in order to accomodate the lower reports from Observer X's area.

** Results for the other counties are quite similar but with differences of smaller magnitude.

*** In the summer of 1972 Michigan was not on daylight savings time.

Table IV.10a

Number of Observations by
Income and Type for Each of
Four Regular Observers

	Income	All	Night Type Fri.	Week
Observer 1	All	38(100%)	21(100%)	17(100%)
	Low	32(84%)	20(95%)	12(71%)
	High	6(16%)	1(5%)	5(29%)
Observer 2	All	38(100%)	19(100%)	19(100%)
	Low	13(34%)	6(32%)	7(37%)
	High	25(64%)	13(68%)	12(63%)
Observer 3	All	40(100%)	20(100%)	20(100%)
	Low	5(12%)	5(25%)	0
	High	35(88%)	15(75%)	20(100%)
Observer 4	All	40(100%)	20(100%)	20(100%)
	Low	27(68%)	7(35%)	20(100%)
	High	13(32%)	13(65%)	0

Note: Due to unavoidable absences of regular team members two other observers, both trained in the technique, one a state police officer, the other HSRI's team liason person, conducted 4 and 3 observations respectively. While not analyzed in detail their performance was essentially the same as regular observers. %'s in parentheses indicate fractions performed in income categories.

TABLE IV. 10b

Analysis of Covariance of Selected Variables by Observer Adjusted for Income and Type

Variable	Mean	Observer 1	Observer 2	Observer 3	Observer 4	F Ratio Among All 4	Significance Among all 4	F - Ratio Among 2-4	Significance Among 2-4
% Cars Defective	Adjusted	31.34	22.68	27.61	24.07	21.55 (3,150)	<0.00005	9.23 (2,113)	0.0002
	Raw	34.66	21.25	24.18	25.73	30.77 (3,152)	<0.00005	5.91 (2,115)	0.0036
Defects/100 Cars	Adjusted	42.38	29.45	35.23	28.20	29.07 (3,150)	<0.00005	8.46 (2,113)	0.0004
	Raw	47.34	27.31	30.09	30.65	35.65 (3,152)	<0.0005	1.76 (2,115)	0.1774
% Plate Light	Adjusted	18.63	17.03	18.30	17.31	1.23 (3,150)	0.3015	0.88 (2,113)	0.4170
	Raw	20.80	16.10	16.09	18.35	7.56 (3,152)	0.0001	3.22 (2,115)	0.0435
% Muffler	Adjusted	3.25	3.24	6.03	3.26	8.81 (3,150)	<0.00005	------	------
	Raw	4.58	2.66	4.65	3.93	3.43 (3,152)	0.0186	------	------
% Tail Light	Adjusted	8.29	4.79	5.12	4.90	15.95 (3,150)	<0.00005	0.23 (2,113)	0.7938
	Raw	9.06	4.45	4.30	5.31	28.56 (3,152)	<0.00005	2.12 (2,115)	0.1244
% Defective by Income level*	Low Income	37.00	24.82	38.73	27.41	28.03 (3,73)	<0.00005	--------	-------
	High Income	22.15	19.40	22.10	22.16	2.12 (3,75)	0.1054	--------	-------

Note: Covariates were income level and night type. Numbers below F statistics indicate degrees of freedom. Adjusted means shown are for analysis of all four observers. Adjusted means for analysis of observers 2 through 4 differ slightly due to minor differences in covariate weights.

*This is a simple analysis of variance across observer for each income level.

TABLE IV.10c

Regression Results. % Defective by Time, Income, Night Type, and Observer for Each County.

County	Constant	Time***	Income	Type	Observer 1*	Observer 3 or 4*	R^2
Genesee	27.71	-1.93 (0.0228)	-3.83 (0.0105)	1.15 (0.2783)	12.30 (0.0000)	3.08 (0.0339)	75.2
Ingham	40.86	-1.79 (0.0672)	-1.06 (0.0000)	-2.24 (0.0677)	7.87 (0.0001)	8.59 (0.0000)	57.6
Kent	54.77	-1.01 (0.4245)	-11.58 (0.0000)	-7.14 (0.0000)	9.46 (0.0012)	-0.49 (0.9810)	79.4
Genesee and Ingham	35.44	-1.94 (0.0064)	-6.91 (0.0000)	-4.69 (0.5953)	7.91 (0.0000)	3.76 (0.0005)	57.8

* Binary variable=1, if observer 1, =0 otherwise. ** Binary variable=1, if observers 3 or 4, =0 otherwise.

*** 100-day units past. 4/30/73

Numbers in parentheses indicate significance levels.

TABLE IV. 10d

Effects of Observer on Time Trends
in Road Side Observation Results

Regression Results (% Defective):

COUNTY	GROUP		CONSTANT	TIME	INCOME	TYPE	R^2	N
All	Observers 1 & 2	Coefficient	50.959	-0.730	-13.210	-2.400	54.5	76
		Std. Error		1.202	1.500	1.481		
		Significance		0.5456	0.0000	0.1095		
	Observers 3 & 4	Coefficient	40.725	-1.252	-7.013	-2.133	31.9	87
		Std. Error		0.929	1.170	1.170		
		Significance		0.1817	0.0000	0.0719		
Genesee	Observers 1 & 2	Coefficient	52.121	-1.423	-1.610	0.845	27	88.
		Std. Error		0.979	1.214	1.261		
		Significance		0.1597	0.0000	0.5092		
	Observers 3 & 4	Coefficient	30.339	-2.362	-3.449	1.281	29	25.
		Std. Error		1.291	1.575	1.601		
		Significance		0.0793	0.0381	0.4312		

Comparison of Time Coefficients (Obs. 1 & 2 vs Obs 3 & 4)

All Counties: Difference= 0.5220 T= 0.3840 d.f.= 155
S.E. Diff.= 1.5002 $p > 0.10$

Genesee: Difference= 0.9388 T= 0.5722 d.f.= 48
S.E. Diff.= 1.6406 $p > 0.10$

modified. Observations started at dusk when most vehicles began using lights. The starting time shift is shown in Table IV.11a. If vehicles traveling early in the evening are in better condition than later on, then observing more early evening traffic in the final months would create an apparent downtrend when one did not exist. Testing this possibility presents a statistical dilemma. Correlation between starting time and calendar time prevents separating the two effects using the entire data set.* Instead, a simple strategy was used to solve the problem. Over a short calendar interval, it was assumed that variation in starting time would be relatively uncorrelated with calendar time. Also, it was assumed that the calendar time trend would be relatively small in a short period. In May through August, starting times are relatively flat, and in September to November, they have an inverted "V" pattern. Therefore, under the two assumptions, regressions were calculated for the two time periods to indicate the effect of starting time on failure frequency. Two sets of these regressions are given in Table IV.11b; other counties follow similar patterns. The coefficients on starting time were uniformly insignificant, and the R^2 statistics indicate that starting time accounts for a very small part of the variation in failure frequency. Curiously, earlier starting times yield lower failure percents in high income areas and higher failure percents in low income areas. This might be taken as an indication that the shift in observation interval amplified high income area time trends and masked low income area time trends. Yet, a differential effect does not seem a priori reasonable.** This, along with the high probability that the true value of the coefficients is zero, leads to the conclusion that starting time changes did not bias the results.

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* The problem is technically known simultaneous equations bias with undertermined coefficients, i.e., more unknowns than equations.

** If any change would be expected, it would be that cars out in early evening hours would be in better condition independent of neighborhood. Early evening traffic probably includes more family and commutation travel which might involve better maintained vehicles than those driven by later travelers, e.g., teenagers involved in social activities.

TABLE IV. 11a

Mean Starting Time of Observations by Months

Month	Numb Obs	Mean Starting Time*	
May	16	203.50	(8:24 p.m.)
June	23	202.61	(8:23 p.m.)
July	32	186.84	(8:07 p.m.)
Aug	20	162.25	(7:42 p.m.)
Sept	8	116.00	(6:56 p.m.)
Oct	32	171.03	(7:51 p.m.)
Nov	32	133.13	(6:13 p.m.)

F Ratio

Significance

* Measured in minutes past 5:00 p.m.

TABLE IV. 11b

Regression Results. % Defective vs Starting Time for May-Aug and Sept-Nov; All, Low, and High Income Levels

Period	Income	Constant	Starting Time *	Income	R^2
May-Aug	All	35.86	-0.28 (0.9148)	-4.98 (0.0012)	11.27
	Low	34.79	-2.35 (0.5545)	-------	8.19
	High	21.74	1.94 (0.5612)	-------	7.73
Sept-Nov	All	39.79	-0.26 (0.8798)	-9.32 (0.0000)	33.13
	Low	33.36	-2.31 (0.3444)	-------	2.56
	High	16.03	3.06 (0.2283)	-------	4.37

* Measured in 100 minute periods past 5:00 p.m.

The overall conclusion of this section is that the roadside observation technique succeeded quite well in measuring the condition of vehicles in the three counties. While there were some flaws, as will always be the case in any field data collection activity, the sample seems quite representative. The major design factors of income and night type accounted for a substantial proportion of the variation in the data. The secondary design element of urbanization, which was largely neglected, had little influence on the outcome. The secondary factor of proximity did yield significant variation in the data which might have influenced the performance in certain areas, but this was sufficiently controlled so that the overall effect was not substantial. Observer biases are obviously present, but on examination, they seem to be closely associated with peculiarities of sites rather than wide divergences in individual accuracy. Most importantly, there were no significant differences in time trends among observers. Finally, the unplanned shifts in observation interval produced insignificant changes in the failure frequency, thus eliminating one potential source of bias on time trends.

F. Analysis of Transformed Data

Previous data analyses of the failure rate or of other measures have been computed for each observation at each site. The approach presents several problems, which fortunately can be treated with advanced statistical techniques. The more sophisticated analysis in this section yields results which are quite comparable to the original approach. The analysis hints at some possible biases in time trends produced by particular sites in Genesee and Kent Counties. Except for this, problems of the original approach are minor, and the non-technical reader may omit this section without loss of understanding of the overall evaluation.

Three statistical problems come with the use of failure rate per observation as the basic measurement. First, applying a linear relationship to the data implies a logical impossibility that, if the time trend were extended long enough, less than 0% or more than 100% of the vehicles would be defective. Hence, the linear relationship is only approximate and shows only short-run effects. Second the approach neglects differences in sample sizes among observations. An observation with a small number of vehicles carries the same weight as one with a large number of vehicles. Since small samples have greater variability, the unweighted approach increases the likelihood that the results are unduly affected by chance fluctuations at low volume sites. Third since the underlying probability distribution of the data is binomial, the variance of observations will change as the failure probability changes. This will reduce the power of the statistical tests to detect significant changes. The reduced power will increase the likelihood of finding or of stating that no change occurred when, in fact a change did happen.

The technique used was a variation of probit analysis. Cox suggests the logistic transform as having several desirable statistical properties which are based on the transformation's close approximation of the normal distribution. The basic transformation is:

$y = \log(p/q)$, where:

p is the proportion of the sample that are successes, or in the present context the fraction of cars with defects, and

$q = 1-p$, is the proportion of the sample that are failures, or in the present context the fraction of cars free of defects.

The ratio p/q ranges from zero if there are no "successes" to positive infinity if there are no "failures." The ratio expresses the odds for success. A 0.25 probability of success is also a 1 to 3 chance of success. Recalling that the logarithm of 1 is 0 and that the logarithm of a fraction less than one is negative, y ranges between minus and plus infinity and is zero for a 0.5 probability of success. The transformation is continuous over all real numbers. A plot of the function closely approximates the cumulative normal distribution. These properties solve the first problem. A time trend calculated from transformed data will produce a failure frequency that asymptotically approaches 0 or 1 when the inverse of the transform is computed.*

Problems associated with uneven sample size and with altered variance as the proportion of successes changes can be treated by a further transformation to normalize the observations. The normalization is performed by multiplying the original transform by the estimated sample variance of each observation, so:

$$Y^{W}_{i} = y_{i} * \frac{D_i(N_i - D_i)}{(N_i - 1)}$$, where:

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* D.R. Cox, Analysis of Binary Data. London: Methuen, 1970.

y^w_i is the weighted transform of the data for the ith sample,

D^w_i is the number of defective vehicles in the ith sample, and

N^i is the total number of vehicles in the ith sample.

The second transformation yields data with an approximate normal distribution of unit variance. Furthermore, the weight assigned to larger samples is greater. Differences in proportions will be magnified by a nonlinear factor. The net effect of these two properties is that large changes in larger samples affect the conclusions much more strongly than small changes in small samples. Statistical tests performed using the transformed data are more powerful in the sense that they will less often indicate no change when, in fact, a change has occurred.

To perform least squares regression analysis using the weighted transformation, each observation and the associated independent variables are multiplied by the square root of $(N_i-D_i)D_i/(N_i-1)$. In matrix notation the relation estimated is:

$$W^{\frac{1}{2}}Y = W^{\frac{1}{2}}(XC+E) \quad \text{, and}$$

the resulting normal equations are:

$$C = (X'WX)^{-1}X'WY \quad \text{, where:}$$

C is the vector of m regression coefficients to be estimates,

Y is the vector of n sample observations,

X is an n by m matrix of independent variables,

E is a vector of n error terms, and

W is an n by n matrix of weights such that

$w_{ii} = (N_i-D_i)D_i/(N_i-1)$, and

$w_{ij} = 0 \ (i \neq j)$

The model yields unbiased estimates of the regression coefficients. Using the weights, however, causes cases with larger sample sizes to influence the outcome more strongly than cases with smaller numbers of observations.

Failure data for all sites and observations were transformed, and a complete set of regressions paralleling the analysis in Section C was computed. Full results are given in Appendix B. The transformations did not substantially alter the previous results, but they did suggest that patterns in Kent and Genesee Counties arose from the peculiarities of certain sites. Ingham County results were made uniformly more significant. Changes between the original untransformed regressions and the transformed results are summarized in Table IV.12a.

Friday nights, which had higher traffic volumes, generally increased in significance. A significant downtrend for all three counties combined was indicated, and a previously significant up trend in the low income areas of the combined three counties was eliminated. In Genesee County, the apparent downtrends in the whole county and in the high income areas became nonsignificant, as did the week night results for Genesee and Ingham combined. All three changes can probably be attributed to the lessening of the effect of one low volume, high income site in Genesee. This site probably experienced saturation from the presence of sample inspections. The influence of the one site is still shown, though, in the regression for week night, high income sites in Genesee County. This regression and other examples are presented in Table IV.12b. The significance of Ingham County results was increased. In Kent County, results remained totally insignificant.

Unfortunately, the insignificant time coefficient for the high income areas of Kent County is of greater magnitude than the significant time coefficient for the equivalent area of Ingham County, thus leaving the seasonal variation vs. inspection effect problem unresolved. The lack of significance in the Kent County outcome despite a sizeable coefficient suggests the possibility

TABLE IV. 12a

Comparison of Untransformed and Transformed Regression Results

I. Cases in which Transformed Regression Did Indicate Significant Time Effect and Untransformed Did Not.

All Counties, All Incomes, All Nights

All Counties, All Incomes, Friday Nights

Genesee/Ingham Combined, All Income, Friday Night

II. Cases in which Transformed Regression Did Not Indicate Significant Time Effect and Untransformed Regression Did.

All Counties, Low Income, All Nights*

Genesee County, High Income, All Nights

Genesee County, All Income, All Nights

Genesee/Ingham Combined, All Income, Week Nights

* In this case a significantly positive time effect became insignificantly negative after transformation.

TABLE IV. 12b

Selected Regression Results Transformed Failure Rate - vs - Time and Income

County	Income	Type	Constant	Time	Income	R^2
All	All	All	-.43205	-.00099 (.0177)	-.33034 (.0000)	58.1
	All	Friday	-.56483	-.00099 (.0906)	-.23353 (.0034)	46.8
	High	Friday	-.99382	-.00131 (.0999)	-------	10.2
Genesee	High	Week	-.74259	-.00461 (.0042)	-------	81.4
Genesee/Ingham Combined	All	Friday	-.40360	-.00098 (.0357)	-.36126 (.0000)	47.3
	High	Friday	-1.0796	-.00140 (.0173)	-------	68.9

that the large coefficient was produced by unusual behavior of a single, high volume site.* Conversely, the relative strengthening of the statistical significance of the Ingham County results points toward a more uniform and pervasive effect. The dilemma is clear. The tests indicate that quite probably Genesee and Kent did not change and that Ingham did. Qualitative examination of the sites also suggests that Genesee and Kent possibly were influenced by unusual locations.** Yet, equally valid statistical tests indicate that the observed magnitude of the change in Ingham County is very similar to the changes, if they exist, in the other counties. Consequently, the same conclusion as before must be made. In all likelihood,there was a differential improvement in Ingham County which did not occur in the other counties, but because of possible seasonal variation in the vehicle condition,and because of the influence of unusual behavior in certain sites in Kent and Genesee, it is not possible to establish with precision the degree of relative improvement in Ingham County.

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* One high income site in Kent County had unusually high traffic volumes due to a high school football game being held in the area on the last two observations at that site. This could have affected the results in two ways. First, in the weighted analysis, the two occasions would have influenced the estimates quite strongly by the sheer numbers. Second, with the high traffic volume, the observer may have missed defective vehicles while still including them in the total count.

** It is very tempting to remove the offending sites from Genesee and Kent Counties. This would however be very unscientific since no matter how cogent the reasons nor how pure the intention, the procedure would amount to <u>ex post</u> doctoring of the data to produce the desired results.

V. DRIVER INTERVIEWS

A. Introduction

A third major portion of the evaluation was interviews of drivers while they were stopped in the checklane. The sample inspections were used to conduct the interviews. Five major areas were to be explored. These were:

1. Demographic characteristics of the sample inspection.
2. Operator characteristics affecting the condition of vehicles.
3. The extent of public knowledge about the Michigan vehicle inspection program.
4. Driver's reactions to being stopped in the checklane.
5. Changes in knowledge, attitude, or repair practice over time which could have affected vehicle condition.

The first item, demographic characteristics, was covered in chapter two in discussing the overall sample properties. The remaining four items are discussed here.

Briefly reviewing the sample procedure discussed earlier, interviews were conducted by a questionnaire which was given to drivers as they awaited inspection. Completion of the questionnaire was voluntary, with 99% of the drivers offering some information and about 95% completing most items. The interview form was pre-tested during the training period and the initial two weeks of sample inspections. A final version was used for the balance of the project. Questions were posed in simple, multiple choice format which probably produced reasonably accurate answers and the relatively high completion rate. Analysis was confined to the final questionnaire version.

Analysis of the interviews indicated many differences in the population. Generalizations are risky, but the data indicate two rather broad groups of drivers.* One was older, wealthier, and better informed. These persons tended to drive newer vehicles, to pass inspection more frequently, and to have a more positive attitude toward the checklane. The second group was younger, poorer, and less well informed. These individuals tended to have older cars, to fail inspection more frequently, and to dislike encountering the checklane. A person's identity, in a demographic sense, determined his response much more strongly than did the direct impact of the program.

Few systematic differences were found among inspection intensity levels, and relatively small changes were found over time. Knowledge of the checklane and recency of vehicle repair increased from earlier to later periods. Such changes were more or less independent of inspection activity among the counties. Attitude toward the lane deteriorated somewhat over time. Interestingly enough though, the smallest increase in unhappiness came in the county which received the most intensive lane effort. However, all differences among counties and over time were relatively small compared with the differences among population groupings in terms of age, sex, and income.

Specific responses revealed several interesting results. A large majority (78%) of drivers reported servicing their vehicles within a three month period. Brakes, mufflers, and tires constitute the most frequent items reported to have been serviced. While a large number of persons (79%) claimed to have heard of the program prior to being stopped, relatively few persons could give fully (18%) or partially (40%) correct answers to questions on the pro-

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* The terms driver, owner, and operator are used interchangeably here. Since ownership was not explicitly determined, the most typical case of the driver being in a family owned and operated vehicle was assumed. Borrowed, leased, and commercial passenger cars and light trucks were also included in the sample, but these non-family cars were a small minority.

gram's details. Attitudes toward the lane were relatively uniformly distributed among those unhappy (28%), neutral (40%), and pleased (25%).*

Relating the interview results to the overall evaluation requires some care. Apart from the basic demographic data, little information is available on expected response patterns. No good yardsticks exist to compare the checklane's performance as a public persuasion tool with other inspection programs, or with other highway safety countermeasures. Owner maintenance practice, extent of knowledge of program details, and level of public acceptability are largely uncharted. Prior studies are not very comparable due to differences in scope, sampling, method, and questions posed. Many items cannot be rated, then, as representing outstanding, average, or abysmal results on some absolute scale.

Still a judgement must be made. Relative to other programs, the results do not look unreasonable. Most carefully conducted studies of public persuasion campaigns in highway safety have not shown dramatic effects. Against this standard, the checklane probably falls somewhere in the no effect to moderately successful range. Levels of information about the lane increased over time, and a slight, but statistically insignificant, increase in owner repair frequency was noted. No marked deterioration of public acceptance occurred despite very intensive levels of effort.

More importantly, the results suggest both the limits and the potential of any inspection system. Most individuals claim to maintain their vehicles regularly, and there is a positive correlation between the claims and the inspection outcomes. The sample inspection results further suggest that only a relatively small fraction of the vehicles constitute serious hazards. Inspection may be rather superfluous for many vehicles as a consequence. The checklane has the potential of efficiently focusing on problem

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* 7% did not respond to this question so the sum of the percentages does not equal 100.

vehicles, and the available evidence indicates that the operation has been successful in identifying areas with heavy concentrations of defective vehicles. Yet without a large effort devoted to follow-up procedures, the checklane may not be effective. Younger, poorer, less well informed, and possibly more alienated persons constitute a disproportionate share of the defective vehicle operators. Since economics and maturity, for lack of a better term, strongly influence vehicle condition, operators of defective vehicles may not respond to the simple presence of intense checklane activity. This could explain the lack of effect in the low income areas discussed previously. Consequently, the checklane will not only have to contact a large number of defective vehicles but will also have to insure that repairs are made. The follow-up procedures instituted in the present program are a positive, and in many respects successful, step in this direction, but efforts will have to continue.*

Finally, in interpreting results, one cautionary note needs to be given. Many social scientists believe that people tend to slant interview answers in directions thought pleasing to the interviewer or conforming to social values. There is no sure cure. Constructing the questions and giving the interview in a neutral manner helps, and independent checks on facts is highly desirable. The present interview has some distinct limitations on these points. Independent verification was not possible. The interview setting was anything but neutral; a good number of people will try actively to impress the police with their honesty, sincerity, and respectability. Realizing these problems, care was exercised in forming questions that would be as neutral and factual as possible. Further, in analysing the data, internal consistency was constantly checked.

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* This is not to say that a goodly number of young, poor, etc., persons are not quite responsible motorists, or that all older, wealthier, etc. drivers are paragons of maintenance virtue. Rather, the statistical association between the factors and faulth vehicles is strong. The authors recognize and have discussed elsewhere in this report the problem of potential discrimination in focusing on areas with heavy concentrations of defective vehicles.

Still, a healthy degree of skepticism should be maintained. People most likely were not as conscientious, knowledgable, and favorably disposed as their replies indicated. Frequent use of qualifying words like "assumed" and "claimed" serve as reminders. Yet, since most people are reasonably open and honest, the results still have a general validity in revealing broad patterns of relationships.

The remainder of this chapter will cover several of the points discussed above in detail. Section B examines the content of individual questions. Sections C, D, and E report on factors affecting vehicle condition, knowledge, and attitude respectively. Section F covers changes over time, and in the final section, G, a limited number of previous studies are reviewed briefly.

B. Individual Questions

This section gives an overview of the questionnaire. Since response patterns among several items generally are more interesting, little comment will be made about answers to particular questions here. Instead, the intent of each question will be explained, and any problems will be discussed.

A completed questionnaire is illustrated in Figure V.1, and the response frequencies for major items are shown in Table V.1. The demographic data discussed earlier are omitted. The questionnaire used a simple multiple choice format. Basic demographic information was written by the driver in the blanks provided. Other responses were made by circling the chosen answer. After the driver completed the form, several items were added. In the field, the vehicle registration number was recorded, as illustrated by the "AEI-530" in the figure.* The number matched the interview with the inspection report. Inspection status was coded in the blank marked "IS" at the form's bottom; codes assigned were: (1) pass, (2) fail-no-summons-issued, and (3) fail-summons-issued. Problems in completing the form were noted by the interviewer in the blank marked "CC"; values assigned were: (1) no-problem, (2) assistance-required, (3) incapable-of-completion, and (4) refused.** At HSRI, two additional items were added. Vehicle make was numerically coded, "03" in the figure,and an identification number was added. The question designators "Q1," etc., were added to the illustration for easy identification.

Turning to specific questions, the first two in discussion were intended to measure the frequency and nature of maintenance

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* The license number has been altered to protect the respondent's confidentiality and does not correspond to a valid Michigan registration number.

** Inability to respond was primarily due to functional illiteracy or to non-English speaking respondents. Rare cases of senility or of other apparent mental problems were encountered.

TABLE V. 1

Summary of Responses to Final Version
of Questionaire, Non-Demographic Items
(54449 Total Respondents)

Question 1: When was this vehicle last given regular service or maintenance?

Past Month	48.6%	Never	1.8%
Past 3 Months	29.6%	Don't Know	4.7%
Past 6 Months	8.1%	No Response	4.8%
Past Year	2.3%		

Question 2: The last time a major repair was made on this car, what was repaired:

Item	% of Possible Responses*	% of Interviews	Item	% of Possible Responses*	% of Interviews
Body Work	1.4	7.0	Steering	0.7	3.6
Brakes	3.3	16.3	Tires	3.4	16.8
Engine	2.2	11.1	Transmission	0.8	4.0
Lights	1.0	5.0	Other or none	6.1	30.6
Muffler	3.3	16.7	More than 5	0.9	0.7
Shocks	1.6	7.8	No Response	76.0	N.A.

* Only five possible responses per interview coded. Total possible responses are 27245.

Table V. 1 con't:

Question 3: When you were stopped, why were you traveling?

To or from work	24.7%	Personal Business	16.9%
Job assignment	11.5%	Other	10.8%
Shopping	17.2%	No response	12.6%
Pleasure trip	6.3%		

Question 4: To have your car inspected in Michigan you must?

Self	5.1%	Don't know	15.6%
Inspection Station	28.7%	No response	10.8%
Police	39.8%		

Question 5: How often must you have your car inspected in Michigan?

Never	5.4%	On request	27.6%
Every 6 Months	12.0%	Don't Know	26.9%
Every year	20.9%	No response	7.2%

Table V. 1 con't:

Question 6: Where did you firs hear of the Michigan Vehicle Inspection Program?

Friends	18.4%	Don't remember	12.5%
News Media	34.2%	Hadn't heard	9.6%
Service Station	2.1%	No Response	8.6%
Police	14.6%		

Question 7: When did you first learn of the Michigan Vehicle Inspection Program?

Today	12.9%
Before	78.9%
No response	8.1%

Question 8: About how far are you from home now?

Under mile	31.0%	5 to 10 miles	12.9%
1 to 2 miles	16.2%	over 10 miles	12.5%
2 to 5 miles	22.4%	No response	5.0%

Question 9: About how much is your family's total annual income?

Under $5000	8.6%	$12500 to $20,000	21.2%
$5000 to $7500	11.8%	Over $20,000	11.4%
$7500 to $12500	28.8%	No response	18.1%

Table V. 1 cont't:

Question 10: By being stopped today do you feel?

Greatly inconvenienced	5.9%	Somewhat pleased	14.5%
Somewhat inconvenienced	23.4%	Greatly pleased	10.0%
Not inconvenienced	39.5%	No response	3.0%

Inspection Status:

Pass	49.2%
Fail	49.3%
Not recorded	1.5%

Completion Problems:

None	85.9%	Incapable*	2.8%
Assisted	10.8%	Not recorded	0.2%
Refused	0.3%		

* Primarily illiterate, no reading glasses, or senile.

THIS QUESTIONNAIRE IS BEING USED TO FIND OUT WHAT PEOPLE THINK ABOUT THE MICHIGAN MOTOR VEHICLE INSPECTION PROGRAM. YOUR ANSWERS WILL NOT AFFECT THE CHECK OF YOUR CAR. THANK YOU!

AEI-53(

03

Age: ________ Sex: ________ Car Make: ____________ Car Year: ________

FOR THE NEXT QUESTIONS, PLEASE CIRCLE THE NUMBER OF YOUR ANSWER. GIVE THE ANSWER WHICH IS MOST RIGHT OR BEST SHOWS YOUR IDEAS.

Q1. When was this vehicle last given regular service or maintenance?

1. Past month
2. Past 3 months
3. Past 6 months
4. Past year
5. Never
6. Don't know

Q2. The last time a major repair was made on this car, what was repaired? (If more than one, give most important)

1. Body work
2. Brakes
3. Engine
4. Lights
5. Muffler
6. Shocks
7. Steering
8. Tires
9. Transmission
10. Other or none

Q3. When you were stopped, why were you travelling?

1. To or from work
2. Job assignment
3. Shopping
4. Pleasure trip
5. Personal business (doctor, etc.)
6. Other (school, church, etc.)

Q4. To have your car inspected in Michigan you must

1. Do it yourself
2. Take it to an authorized inspection station
3. Allow the police to check it at any time
4. Don't know

Q5. How often must you have your car inspected in Michigan:

1. Never
2. Every 6 months
3. Every year
4. When requested by police
5. Don't know

Q6. Where did you first hear of the Michigan Vehicle Inspection Program?

1. Friends
2. Newspapers, radio, T.V.
3. Service station or garage
4. Police
5. Don't remember
6. Didn't hear of it

Q7. When did you first learn of the Michigan Vehicle Inspection system?

1. Today
2. Sometime in the past

Q8. About how far are you from your home now?

1. Less than 1 mile
2. One to 2 miles
3. Two to 5 miles
4. Five to 10 miles
5. More than 10 miles

Q9. About how much is your family's total annual income?

1. Less than $5,000 per year
2. $5,000 to $7,500 per year
3. $7,500 to $12,500 per year
4. $12,500 to $20,000 per year
5. More than $20,000 per year

Q10. By being stopped today, do you feel?

1. Greatly inconvenienced
2. Somewhat inconvenienced
3. Not inconvenienced
4. Somewhat pleased
5. Greatly pleased

02595

IS ____________ CC ____________ IN ____________

Figure V.1. Example of completed driver questionaire activities. A positive relationship between these and vehicle condition was sought. Both questions were clear but were probably subject to the respondent giving what he thought was the proper response. This is particularly well illustrated by the relatively large and uniform responses to question two for mufflers, brakes, and tires. Yet, since these are major items, they could have been more easily recalled. Although the response instructions called for the single most important repair, drivers frequently checked several items. Up to five different items were coded for each form. This covered most cases, since under one percent of the interviews indicated five or more items. A slight difficulty in interpretation was thereby created since analysis could be expressed either in terms of the percent of interviews on which an item was mentioned or of the percent of total possible items. Both figures are presented in Table V.1. An average of 1.2 items per interview were given.

Question three served two purposes. It measured the relative inconvenience under the assumption that those traveling for more critical reasons, e.g., going to work, would be less pleased. The question also checked sample representativeness. If answers had been skewed heavily toward a particular trip type, then the sample probably would have covered only one portion of the driving population.

Questions four through seven were aimed at finding out the level of knowledge about the lane. Questions four and five examined specific program details. The correct answers were "3. Allow the police to check it at any time, "for question four, and "4. When requested by police, "for question five. Questions six and seven were aimed at finding out how and when persons learned of the check-lane program. News media were the most common source of information, and most people (79%) claimed to have heard about the program prior to being stopped. The program was not unknown to most motorists, although they may have been hazy on details. The close agreement between occurrences of those who had not heard of the program (in question six) and of persons who learned of the program the day of being stopped (in question seven) tends to support the 80% figure for those that had some prior knowledge. In all four questions, the "no response" category probably is equivalent to the "did not know" response, since some persons omit answering a question rather than admit ignorance.

Questions eight and nine were for designed to validate the sample. Question eight checked how much of the sample represented local traffic. Question nine, on family income, validated the sample as a match for the neighborhood income characteristics. It also measured directly the relationship between economic circumstances and vehicle condition. As shown by the high non-response rate, the question also posed the greatest difficulty. Many expressed the opinion that their income was "none of your ....business." The person was then informed that the question need not be answered. Besides outright refusal to answer, persons near category borders may on occasion have given somewhat less than candid answers.* The direction of the bias, if any, is not obvious. The desire of some to impress with affluence might be balanced by those who considered it shrewd not to reveal their full resources. A few apparently obvious misstatements were noted; income in excess of $20,000 was listed by some, while their vehicle, dress, demeanor, and neighborhood did not seem to correspond with such affluence. Still, most persons were probably candid, and, on the whole, the distribution of income was in fair agreement with census information.

Question ten measured the inconvenience of being stopped. Answers were unambiguous. Candor is difficult to assess. Unhappy individuals might overstate negative feelings, but others might

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* Responses 2, 3 and 4 to question 9 do contain one technical ambiguity in that the end points of the categories overlap. A person with precisely $7,500 or $12,500 income might be confused as to which category to circle. Yet, in practical terms, few problems probably resulted. The categories were sufficiently broad that the relative error would be small.

have feared showing hostility to the police. Some apparently sarcastic responses of "greatly pleased" were provided by persons whose facial expressions and verbal comments indicated quite the opposite. Those who failed to answer may have been the most unhappy. Field personnel indicated that visibly annoyed persons tended to skip the last few items. In all, persons might have been somewhat more inconvenienced than stated on the questionnaire, but since the exact degree is unknown, responses are taken at face value for the remainder of the analysis.*

In general, the interview probably presents a fair picture of the public response to the checklane. While certain problems and ambiguities were present in some items, the overall results do not show any marked biases, and where comparisons were possible with other measurements agreement was relatively good. Every effort was made to avoid giving an obvious indication of what the person might perceive as the desired answer, and, as a result, most responses were generally quite honest.

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* If understatement of negative attitudes was consistent, then comparisons between groups and over time are still valid.

C. Vehicle Condition

A basic hypothesis of the evaluation was that owner maintenance practice and inherent vehicle quality strongly affected vehicle condition. Based on previous work and on intuition, these two factors were assumed to be closely related to operator characteristics like family income and age. Several questions tested these relations. Strong associations were found among vehicle age, driver age, driver income, and inspection outcome. Older vehicles driven by younger, poorer persons failed inspection more frequently. Reported maintenance practice less strongly influenced vehicle condition. Still, there was a significant relation between how recently the vehicle had been serviced and how well it performed on inspection.

The association between maintenance practice and vehicle condition is shown in Tables V.2a and V.2b. Passing rates fall steadily from cars serviced in the month before the interview to those serviced seven or more months before. For service performed in the zero to three month period, the passing rate was substantially higher than for more remote service (52% vs. 38%). Persons who claimed never to have serviced their cars passed most often. The inclusion of very new cars explains this seemingly anomolous result. Little systematic relationship was found between reported major repairs and inspection success. The below average passing rate for those marking anything perhaps suggests that drivers named the repairs that they felt should have been made, rather than those items that were actually repaired. The low correspondence between items checked on the interview and causes for inspection failure makes the supposition tenuous. More likely, motorists either did not understand the question, and/or they did not recall correctly what work was done. Based on the less ambiguous relationship between time of service and inspection outcome, the interviews do provide some evidence for the maintenance/condition hypothesis.

Table V.2a

Vehicle Condition *vs* Time Last Repair

Repaired	Total	Pass	%Pass
Past month	2650	1439	54.3
1 to 3 months	1615	769	47.6
4 to 6 months	442	180	40.7
7 to 12 months	125	34	27.2
Never*	96	74	77.1
No response	521	187	35.9
0 to 3 months	2650	1439	51.8
4 to 12 months	567	214	37.7
Overall	5449	2863	49.2

0 to 3 *vs* 3 to 12

$X^2 = 39.39$ df. = 1, $p < .001$

*Quite possibly new cars

Table V.2b

Components Repaired *vs* Vehicle Condition

Component	Number Marked	% Cars Showing	Pass	% Pass
Body	381	7.0	152	39.9
Brakes	886	16.2	297	33.5
Engine	607	11.1	213	35.1
Lights	273	5.0	84	30.8
Muffler	909	16.7	285	31.4
Shocks	425	7.8	179	42.1
Steering	199	3.6	68	34.2
Tires	918	16.8	388	42.3
Transmission	216	4.0	70	32.4

Note: Categories not independent. See text for discussion.

Table V.2c

Vehicle Model Year *vs* Vehicle Condition

Year	Number	Pass	% Pass	Year	Number	Pass	% Pass
1973	45	44	97.8	1967	459	141	30.7
1972	933	791	84.8	1966	358	77	21.5
1971	804	534	66.4	1965	325	48	14.8
1970	649	381	58.7	1964	220	32	14.6
1969	656	316	48.2	Pre 64	286	39	13.6
1968	592	228	38.5	Unknown	122	52	43.0

1970-1973	2431	1750	72.0
1967-1969	1707	685	40.1
Pre 1967	1189	196	16.5

Among all three: $X^2 = 1070.16$, df = 2, $p < .001$

70-73 *vs* 67-69: $X^2 = 420.27$, df = 1, $p < .001$

67-69 *vs* pre 67: $X^2 = 185.11$, df = 1, $p < .001$

Table V.2d

Vehicle Condition By Reported Family Income

Income	Total	Pass	% Pass
Under 5,000	468	169	36.1
5,000-7,499	642	265	41.3
7,500-12,499	1572	753	47.9
12,500-19,999	1157	657	56.8
20,000 up	622	379	60.9
No response	988	460	46.6
Under 12,500	2682	1187	46.3
12,500 up	1779	1036	58.2
Overall	5449	2683	49.2

Under 12,500 *vs* 12,500 vp
$X^2 = 83.57$, df = 1, $p < .001$

Table V.2e

Vehicle Condition *vs* Age of Driver

Driver Age	Number	% Passing
15-24	1327	37.5
25-34	1202	45.9
35-44	1002	50.7
45-54	892	57.7
55-64	573	59.2
65 and up	399	61.9
Overall	5395	49.2

Younger *vs* older drivers comparison:

15-44 % Passing 44.0 45 and older % Passing 59.1

Difference 15.1 T value 10.50 $p \simeq .001$

Vehicle model year, driver age, and driver income strongly affected inspection outcomes. These three factors are shown in Tables V.2c, V.2d, and V.2e. Passing rates systematically declined from a high of 98% for 1973 vehicles to a low of 13.6% for 1963 and earlier model years. Highly significant differences were found for three groupings of vehicles: pre-1967, 1967-1969, and 1970-1973. Analytically, the relation between vehicle age and inspection outcome probably represents both vehicle quality and owner maintenance practice. As the vehicle ages, the cumulative effects of wear and possible interactions with other degraded items increase the likelihood that a component will fail at any particular time. Even if all is in working order at a particular moment, the older vehicle can be considered of poorer quality since failure is more likely to occur than for a newer vehicle.* At the same time, older vehicles tend to be owned by less affluent individuals who may not be able to afford frequent, high quality maintenance. As a consequence, failures, when they occur, remain uncorrected for longer periods of time. Vehicle age thereby reflects both owner maintenance and inherent quality. The direct effect of owner income is shown in Table V.2d. Passing rates systematically increased from the lowest to the highest income levels. A highly significant difference was observed between the under $12,500 and over $12,500 groups. Owner age also was quite strongly related to vehicle condition as shown in Table V.2e. Younger drivers failed inspection relatively frequently, while middle-aged and older drivers did so much less often.

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* These facts are intuitively obvious to anyone who has driven an older vehicle for an extended period of time. Unfortunately, no well controlled reliability data are available which would permit disentangling the separate effects of maintenance practice, environment, and aging on failure rates.

Several of the factors correlate quite highly with each other and with vehicle condition. Taking each relationship on a one by one basis may lead to a partially misleading picture. For example, income often rises with a person's age, and wealthier persons tend to drive newer cars. Is the car in better condition because it is newer, or because a more mature, driver takes a more responsible approach to maintenance, or because a wealthier operator spends more on maintenance regardless of his or the vehicle's age, or because of combinations of these effects? Fortunately, statistical procedures have been developed to deal with such questions.

One such procedure is the Automatic Interaction Detector (AID). The AID program divides the population into a number of mutually exclusive groups. The divisions are made by finding which set of predictor variables accounts for the most substantial differences in the population. The process determines the relations in decreasing order of strength until a predetermined significance level is reached. At this point, the population is clustered into groups which represent the combined effects of various characteristics. For example, an analysis of salaries of major league pitchers might need to disentangle several effects: (1) right- vs. left-handed, (2) starting vs. relief, (3) won-lost record, (4) earned run average (ERA), (5) height, and (6) weight. An AID analysis might show that of the factors starting vs. relief had the greatest single effect on salary. Then among starting pitchers won-lost record might have the next greatest effect, and among relief pitchers, earned run average might mostly influence salary. After several more steps when all substantial differences had been exhausted, the program would indicate that left-handed starting pitchers, with a good won-lost record, commanded the highest pay and that fat, high ERA, relief ptichers received the least money. While other statistically significant associations could exist in the data, the program successfully identifies the most substantial.*

An AID analysis was performed on the driver interview data. Inspection result was used as the dependent variable; all other items, except question two on items repaired and the completion difficulty code, were used as potential predictor variables. The results are presented in Figure V.2. The figure is in the form of a "tree" showing the divisions of the data made by the AID program. The boxes indicate: (1) the category forming each subgroup, (2) the passing percent and number of vehicles in that category, (3) the difference in passing percent between the two subgroups formed from the group, and the T statistic for the difference.** In the diagram, the most substantial difference was between pre-1969 vehicles and 1969-1973 vehicles. The program next subdivided the population into four groups again based on vehicle model year. Pre-1967 vehicles had the lowest passing rate and 1972 vehicles had the highest passing rate.*** All groups except 1967-1968 cars

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* For the technically inclined, AID essentially runs a two by n analysis of variance "backwards." The term substantial is used instead of significant at a number of points. While all differences reported by the program are highly significant, not all highly significant differences in the data are shown by the most commonly available version of the program. For computational efficiency, the program supplies or permits the user to supply a predetermined F-ratio below which a split will not occur. The ratio must be conservatively defined to allow for groups with small numbers of cases. This however often results in procedure not exhausting all significant possibilities in some large groups. On rare occasions, if the population is heavily skewed, the most significant split could be missed. The program was developed by the University of Michigan Institute for Social Research and is used with their permission.

** The T statistic is a normalized form of the difference which allows both for the relative size of the difference with respect to the base percentage in the parent group and for the number of cases involved in the computation.

*** The small number of 1973 model year vehicles prevented 1973 cars from being combined with 1972 cars even though the 1973 passing rate was the highest for all years. This resulted from a minor program quirk.

then divided on driver age with older drivers having more success on inspection. Finally certain categories split either on family income or attitude about being stopped.* Further examination of the detailed output (not presented here) indicated that income was frequently the closest contender to model year or driver age as the basis for splitting groups. In all, the analysis shows that 35 to 74-year-old drivers of 1972 vehicles passed inspection most frequently and 15 to 34-year-old drivers of pre-1967 vehicles had the lowest passing rate.

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* Whether attitude determines inspection outcome or vice-versa is open to question. Someone who is aware that his vehicle is not up to par is less likely to enjoy encountering the checklane. At the same time, someone with strong negative views on highway safety programs could well be less concerned about maintaining his vehicle.

D. Knowledge

If people are to respond to a program, they must first of it. Four interview questions measured knowledge about the checklane. Most drivers (70% to 80%) knew something about the lane prior to being stopped. Fewer (about 50%) could supply accurate information on program details. Level of information did not markedly affect inspection passing rates or, did inspection activity levels influence the amount of correct knowledge. Personal characteristics, like age and income, and information sources did influence the number of correct responses. In brief, exact information about the lane was not widely communicated, and those who had better information frequently came from groups which were likely to pass inspection in any event.*

General awareness of the lane can be inferred from questions covering how and when a person learned of the checklane (Q6 and Q7 in Figure V.1). At a minimum, those giving specific responses, other than police, for the source of their information could have known previously. This yields 52.7% with prior knowledge. Assuming that all those who replied "police" knew beforehand, the fraction with prior knowledge than rises to 69.3%. Alternately, it could be assumed that only those who "hadn't heard," or who failed to respond were uninformed. This yields 81.8% with some awareness. A less ambiguous measure of foreknowledge is provided by question seven on when the person learned of the program. Here 73.9% claimed to have heard of the program before the day of the interview.

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* It could be argued on the basis of the data that persons who were well-informed about the lane took effective action to maintain their vehicles. The more plausible explanation, though, is the one given. Older, wealthier (and therefore more likely well-educated) persons, who receive their information from news media, are likely to be better informed about a wide range of subjects, including the inspection program, and also to be in the position of having a better vehicle.

While some may have claimed to have heard when, in fact, the program was unfamiliar to them, the number doing so may have been quite small. Qualitatively, field personnel reported few persons expressing genuine surprise at encountering a checklane. Consequently, it seems reasonable that somewhere in the range of 70% to 80% of the sample were familiar with the program.

Depth of knowledge provides another, possibly better indicator of influence on the public. Ability to supply correct details can indicate a desire to comply. Factual replies are less subject to the respondent's giving "pleasing" answers. Somewhat balancing this, multiple-choice formats normally allow mentally agile respondents to guess successfully without prior knowledge. Detailed knowledge may not be needed to encourage desired behavior. Many shun bank robbery (or overtime parking, for that matter) without knowing details of the criminal code; a hazy notion about likely unpleasant consequences is a sufficient deterrent. Consequently, persons with detailed knowledge probably represent the lower limit on numbers affected, and the population fraction having heard of a program marks the upper limit.

The interview contained two questions to test information on how and when cars were to be inspected in Michigan. Question four, "To have your car inspected in Michigan you must ________?" covered how; and question five, "How often must you have your car inspected in Michigan?" covered when. Correct answers to both involved some variation on police activity on the checklane.

In evaluating responses to these two questions, two possibilities for error must be considered. The first possibility is that the patterns of response were produced by purely wild, random guesses. This can be ruled out; the frequency of correct response was too great to be explained by chance.* The second possibility of fortunate or perceptive guesses by alert drivers cannot be entirely

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* Based on four possible answers for one question and five possible for the other, purely random guesses would yield 40% with at least one correct answer. The actual frequency (48.9%) was significantly greater than this: $X^2 = 179.83$, d.f.=1, $p < .001$.

precluded. Since the person was stopped in the checklane when interviewed, the situation provided a rather strong hint at the correct answer. This is particularly true of the question on how inspection is conducted. Consequently, some drivers may have answered these questions correctly without prior knowledge of the checklane. Two aspects of the interview, however, would have minimized the number of fortunate guesses. When the person was stopped, he was told it was for a special survey. Thus, he may not have associated the proceedings with the normal inspection program. In addition, alternative answers were partially correct in terms of messages conveyed about the program from time to time. On the "how" question, the ongoing public information effort about the checklane stresses the continual maintenance of one's vehicle in order to be ready for the lane. Consequently, "self" could be a logical reply to the question of how the vehicle is to be checked. On the "when" question, the practice of issuing passing stickers valid for the balance of the calendar year clearly implies an annual nature of the program.* So, if people were inclined to guess, the questionnaire offered some plausible alternatives. Therefore, correct answers to the two questions are interpreted as being the minimum level of public knowledge.

Correct answers to the two questions were rather infrequent, as can be seen from Table V.3a. Only 18.5% correctly answered both questions. An additional 21.3% correctly answered on "how" without knowing "when", and another 9.1% knew "when" but not "how". In all, slightly less than one-half (48.9%) were able to supply at

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* The pedantically inclined might even argue that the "never" response to the "when" question was logically correct, since the wording of the question might imply a periodic phenomena. Logical niceties aside, there was a high correlation between those who answered "self" on "how", and "never" on "when". This 5% of the population probably represents the minimum figure for the truly uninformed, since their replies indicate that they had no idea that Michigan even had such a program.

Table V.3a

Comparison of How Inspected with When Inspected

How	Police Request	When Annual	Other	Total	%	
Police	1010	433	728	2171	39.8	
Self	60	28	188	276	5.1	60.2
Other	433	676	1893	3002	55.1	
Total	1503	2809	2809	5449		
%	27.6	20.9	51.5			
		72.4				

% of All Interviews

How	Police Request (When)	Wrong (When)
Police	18.5	21.3
Wrong	9.1	51.1

% of Those Answering Both (N=3048)

How	Police Request (When)	Other (When)
Police	33.1	23.0
Wrong	10.0	33.8

least one correct detail. These numbers do indicate room for improvement in public information, but as is reviewed in Section G, they do not compare unfavorably with other studies.

Several interesting patterns emerge both for the source of information and for the types of persons with more correct information. Formal sources like the news media and prior awareness lead to more correct responses, whereas county where interviewed did not. Table V.3b gives the correct response by frequency information source. Persons who learned from formal sources, the police and news media, had the highest frequencies of correct response; those who relied on friends or service stations, informal means, had somewhat poorer information; and drivers who did not know of the program or did not state a source were predictably the least well-informed. Those not recalling the source were about average, perhaps suggesting that their sources were distributed similarly to named sources.

Drivers whose knowledge predated the sample inspection had substantially higher frequencies of correct response, Table V.3c. The frequency of correct response for drivers who said that they learned today was very close to purely random guesses both on the "how" (29% vs. 25%) and on the "when" (21% vs. 20%) questions.*

No systematic pattern was found in correct answers among couties. Ingham County and Kent County, which received the most and the least attention respectively, were quite close, while Genesee County with intermediate inspection intensity had marginally fewer correct responses. This lack of association with the lane intensity, and the higher correct response rate for formal sources indicate that the normal public information channels, rather than informal sources and personal observation, were more effective in disseminating

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* Since there were four possible answers to "how" and five to "when," purely random guesses would yield a "correct" answer to these questions 25% and 20% of the time respectively.

Table V.3b

Knowledge vs Source of Information

Source	% Correct Response on How	When
Friends	38.2	24.4
News Media	44.9	32.7
Service Station	27.8	16.5
Police	48.5	34.8
Don't Recall	40.2	28.2
Didn't Know	30.8	21.2
No Response	21.3	10.7
Friends and Service Station	37.1	23.6
News and Police	46.0	33.4
Comparison: X^2	25.01	34.52
df = 1	$p < .001$	$p < .001$

Table V.3c

Knowledge vs When Learned of Program

Time Learned	% Correct Response on How	When
Today	28.9	21.4
Past	44.2	30.7
No Response	14.4	7.4

facts about the checklane system.*

Personal characteristics also influenced knowledge, but to a less marked extent than they affected vehicle condition. Persons with higher incomes had somewhat better knowledge, and older individuals had distinctly better information. These two points are shown in Tables V.3e and V.3f. Little difference among income groups was observed on the "how" question, but the possibly more challenging "when" question indicated a clear difference among income groups.

In summary, while many claimed to have heard of the lane, detailed knowledge of the program's features was by far not universal. This lack of accurate detail is consistent with other programs. Using detailed knowledge as a criteria, exposure to the lane did not affect information, and, conversely, better knowledge did not strongly influence inspection outcomes. Rather, the two processes operated somewhat in parallel. More conventional public information sources reached an older and possibly wealthier audience who tended to be the same individuals who maintained their cars in good condition. Unfortunately, the younger, and possibly poorer group which operated more defective vehicles was not informed, and, therefore, would be less likely to alter their maintenance practice.** This again suggests that exposure to the lane per se

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* The police being given by 15% of the motorists as their source, and this source having a relatively high correct response rate may or may not contradict this last statement. If the drivers gained their information from the police by being stopped, then the checklane does serve as an effective communications device about itself. On the other hand, if people remembered the originating agency rather than the communication media, then the statement holds. That is to say, if someone read in the newspaper about a police program, he might later recall the message coming from the police even though he received it through news media.

** Again, subject to the qualification stated earlier that detailed knowledge may not be necessary to affect behavior.

Table V.3d

Knowledge *vs* County

County	% Correct Response on: How	% Correct Response on: When
Genesee	38.1	23.5
Ingham	39.1	30.2
Kent	42.0	28.3
Comparison of Ingham vs Kent	$T = 1.816$ $p > 0.10$ $df = 3721$	$T = 0.736$ $p > 0.10$ $df = 3721$

Table V.3e

Knowledge *vs* Reported Family Income

Income Level	% Correct Response on: How		% Correct Response on: When	
Under $5,000	44.0		22.9	
$5,000-7,499	40.0	42.4	24.9	26.8
$7,500-$.2,500	42.9		28.8	
$12,500-$19,999	44.3	42.7	34.6	34.5
$20,000 up	39.7		34.2	
No response	27.8		16.3	
X^2 under $12,500 *vs* over	0.032		29.88	
df = 1	$p > 0.10$		$p < 0.001$	

Table V.3f

Comparison of Driver Age with Knowledge

Age	Number	% Correct on How	% Correct on When
15-24	1327	37.0	23.3
25-34	1202	37.3	30.5
35-44	1002	41.6	29.3
45-54	892	42.6	29.7
55-64	573	44.0	29.0
65 and up	399	41.4	22.3
Overall	5395	39.9	27.6

Younger *vs* Older Drivers:

Age	% Correct on How	% Correct on When
15-35	37.1	26.7
35-64	42.5	29.4
Difference	5.4	2.7
T value	3.89	2.66
Significance	0.001	0.05

did not heighten awareness, since the lane typically concentrated activities in lower income areas. Correct response to both questions systematically increased with age except for the oldest group. This is in reasonable accord with other studies of the level of general information among the public.

Finally, correct knowledge was only weakly associated with repair frequency and with inspection success, Tables V.3g and V.3h. Persons who claimed to have repaired their cars within three months were significantly more correct on the "how" question than those repairing in the four to 12 month period. This did not hold true for the "when" question. Interestingly, persons who replied "never" had rather low correct response rates, which possibly suggests that new car buyers were relatively unconcerned with the program. On the outcome of inspection, persons correct on the "how" question performed insignificantly better than did those answering wrong. Differences in passing between those correct and incorrect on the "when" query were significant, but relatively small compared with other factors associated with inspection success. These small and inconsistent results on the two measures indicate that there was only a weak, if any, relationship between detailed knowledge of the program and owner maintenance.

Table V.3g

Comparison of Knowledge with Time of Last Repair

When Repaired	Number	% Correct on How Inspect	% Correct on When Inspect
Past month	2650	43.1	29.4
2-3 months	1615	41.4	29.5
4-6 months	442	36.9	26.5
7-.2 months	125	36.8	27.2
Never	96	31.3	24.0
No response or don't know	521	23.4	13.8
Overall	5449	39.8	27.6

Recent *vs* Prior Repair Extent of Knowledge

	% of Those Correct Repairing in 1-3 months	% of Those Correct Repairing in 4-12 months	Difference
How Inspect	42.4	36.9	5.6*
When Inspect	29.5	26.6	2.9

* Difference significant at .99 confidence level

Table V.3h

Vehicle Condition vs. Knowledge of Checklane

	Number	% Pass
Correct on How Inspected	2169	50.9
Wrong on How Inspected	3262	48.4

Difference: 2.5%

T Value: 1.80 $p \geq .05$

	Number	% Pass
Correct on When Inspected	1498	54.1
Wrong on When Inspected	3932	47.6

Difference: 6.5%

T Value: 4.31 $p \geq .001$

E. Attitude

One purpose of the questionnaire was to measure public attitude. Question ten, "By being stopped today, do you feel?" was directed toward attitude. Overall, attitudes could be characterized as being neutral. The most frequent response was "not inconvenienced" (39.5%). If the responses were rated on a one, "greatly inconvenienced," to five, "greatly pleased," scale, the average response was almost exactly neutral (2.99).

Attitude, however, was related to a number of driver characteristics. Younger persons, women, and those with higher incomes, all expressed greater than average inconvenience. Direct program impact was also a factor. Persons stopped while on business, as opposed to casual trips were substantially more unhappy. Those who were subsequently to pass inspection were more pleased than those who were to fail. This indicates that the later group were somewhat aware of their car's defective condition. Yet, there were no systematic differences among counties, which suggests that the activity level does not adversely influence attitude.

Earlier comments about respondents giving "pleasing" answers are highly relevant here. Two instances apparently arise in the data. Field personnel reported men to seem more irritated at being stopped, but the questionnaire replies show quite the opposite. Kent County posed the greatest difficulties with public acceptance. The problem was sufficiently bothersome to require the HSRI field representative to be at every sample inspection in the county, a step not necessary in other areas. Yet Kent County respondents claimed to be the most pleased of the three counties.

Direct effects on attitude of the program were measured by comparing answers with trip purpose, with inspection outcome, and with county, Tables V.4a, V.4b, and V.4c. Of all trip purposes, "other" had the lowest level of acceptance. Persons in this category may have felt intruded upon by being asked where they were going,

Table V.4a

Comparison of Attitude with Trip Purpose

Purpose	Number	Average Response	% Very Displeased	% Displeased	% Neutral	% Pleased	% Very Pleased	% No Response
To/From Work	1348	2.92	6.5	29.0	37.6	15.0	9.5	2.4
Job Assignment	626	2.94	6.7	25.7	41.1	15.5	8.8	2.2
Shopping	936	3.14	3.2	19.3	46.4	17.7	10.6	2.8
Pleasure	341	3.14	5.0	19.9	42.8	15.2	14.4	2.6
Personal Business	923	2.93	6.6	25.8	42.0	13.5	9.5	2.5
Other	588	2.84	7.7	26.5	44.0	11.9	7.1	2.7
Not Stated	687	3.20	5.7	11.4	23.4	11.4	12.2	35.9
Overall	5449	2.99	5.9	23.4	39.5	14.5	10.0	6.7

Comparison of Business Associated with Casual Activities (To/From Work, Job Assignment, Personal Business - Shopping, Pleasure)

	Number	Avg. Resp.	% Happy
Business	2827	2.93	24.6
Casual	1242	3.14	29.5
Difference		0.21	4.9
T-value		6.02	3.27
Prob.		0.001	<0.01

Table V.4b

Comparison of Inspection Outcome with Attitude

Outcome	Number	Average Response	% Very Displeased	% Displeased	% Neutral	% Pleased	% Very Pleased	% No Response
Pass	2683	3.07	5.3	20.8	41.4	15.1	11.2	6.2
Fail no summons	2685	2.93	6.3	26.0	37.9	14.0	8.8	7.1
Fail summons	63	2.65	17.5	19.4	31.75	11.1	6.3	14.3
Fail All	2748	2.92	6.5	25.8	37.7	13.9	8.8	7.2
Overall	5431	2.99	5.9	23.4	39.5	14.5	10.0	6.7

Comparison of Average Responses:

Pass *vs* Fail All: Difference = 0.15, $t = 4.98$, $p < .001$

Fail No Summons *vs* Fail Summons: Difference = 0.27, $t = 1.94$, $0.05 < p < 0.10$

Table V.4c

Comparison of County with Attitude

County	Number	Average Response	% Very Displeased	% Displeased	% Neutral	% Pleased	% Very Pleased	% No Response
Genesee	1726	2.68	26.4	15.4	25.6	14.7	11.7	6.4
Ingham	1708	2.94	5.8	25.8	39.9	13.6	9.1	2.6
Kent	2015	2.97	6.6	24.2	38.5	14.5	9.9	6.4

Comparison of Average Response Genesee vs Ingham and Kent (Avg. = 2.96)

Difference = 0.28 T = 7.99 $p < .001$

and other items and hence they were the most unhappy. Of specifically named missions, "to or from work" yielded the most inconvenience, and "pleasure" generated the most happiness. Grouping the "to/from work," "job assignment," and "personal business," categories as business trips and calling the "shopping" and "pleasure" answers casual trips, persons on business missions were substantially less happy than those on casual journeys. (2.93 vs. 3.14 average response).

Drivers passing inspection had a more positive attitude than those who failed (3.07 vs. 2.92). Of those failing, operators who received summons were markedly less happy than those who did not (2.65 vs. 2.93).* Since the interview was completed before the vehicle was inspected, the results indicate that people were aware of their car's defective condition and somewhat feared the consequences.**

No pattern was found among the counties in degree of acceptance. Genesee County which received an intermediate amount of attention showed the lowest acceptance. Kent County with least activity reported the highest response. Yet, Kent County was not different from Ingham County which had the most inspection. In addition, Kent County, as noted above, probably overstated in the degree of pleasure.*** The absence of a pattern suggests that an increase

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* The number receiving summons was so small, 63, that the difference is only marginally significant in a statistical sense.

** The causation on summons issuance conceivably could have been in the other direction. Under some circumstances, an extremely hostile driver could receive a summons when a co-operative one would not. This would be highly unlikely in the sample since enforcement was de-emphasized and a civilian observer was frequently present.

*** The perceptive reader will note that the average for each of the three counties is below the overall average which is a mathematical impossibility. An unfortunate data processing "bug" prevented correctly identifying the county for all interviews.

in inspection activity will not adversely affect public attitude. Rather, the direct effect comes how people perceive the lane at the moment. Those who have something to lose, in terms of delay on an important trip and/or of failing inspection, are quite predictably less positive.

Personal factors also affected attitude. Men claimed to be more happy about being stopped than women (3.08 vs. 2.88), Table V.4d. This difference may be more apparent than real. Almost twice as many men reported being "greatly pleased" (12.2% vs. 6.0%). "Greatly pleased" may often have been a sarcastic reply. Team personnel reported men to be generally more annoyed at being stopped.*

The attitude about being stopped declined more or less systematically with reported family income. Those with incomes under $7,500 were significantly more happy about encountering the lanes than those with over $7,500 income (32.4% vs. 23.9%). The lowest degree of acceptance came (2.81 average response) from those that did not state their income, which again represents persons who felt that the lane and the interview were an intrusion. The overall pattern still is somewhat surprising. Conventional wisdom in academic circles and the news media frequently suggest that lower income individuals are more alienated toward authority than upper income, establishment types. These results are contrary to that perception. Qualitatively, however, the field personnel agreed with the general result. They frequently commented

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* While not wishing to speculate on the psycho-dynamics of police/citizen interaction, men, through more frequent contacts with police, may have learned the advisability of a certain degree of restraint in expressing negative attitudes. The same might be speculated about the responses of lower income individuals. In mentioning this point, it should be stressed that team members maintained very high standards of deportment treating even the most abrasive citizens with courtesy. Any feelings of intimidation were probably inherent in the situation.

Table V.4d

Comparison of Attitude for Men and Women

	Men	Women
Very Displeased	6.0	5.6
Displeased	22.0	25.3
Neutral	36.3	44.2
Pleased	16.6	11.9
Very pleased	12.2	6.9
No response	6.8	6.0
Avg. Response	3.08	2.88
Number	2873	2164

Difference in Avg. Response = 0.19 $t = 6.4772$ $p < .001$

that doctors, lawyers, and school teachers often acted as if persons of their standing were "too busy to be bothered."*

Attitude improved with age. The youngest age group (15-24) displayed the least positive attitude (2.86) and the oldest age group (65 and older) showed the most positive attitude (3.53). Overall 15 to 44-year-olds were more negative than those 45 and older (2.89 vs. 3.21). The pleasure expressed by the over 65 group was quite likely genuine. Field personnel commented that retired persons were delighted to have the different experience of being included in a sample. The remainder of the pattern evokes trite expressions about the rebelliousness of youth, etc., but it does show surprising agreement with the conventional wisdom on such matters.

To close, what one was doing when stopped and who one was in a demographic sense affected one's attitude toward the lane. Beyond this almost truism, little can be said since when most results fail to meet a priori reasonable expectations, they are readily explainable in terms of purposeful respondent distortion. Lacking good comprable studies, it is difficult to put these results on some absolute scale. Perhaps the most important result is what the data do not say. They do not indicate wide spread dissatisfaction with the lane and of particular importance they do not show an increase in negative public reaction accompanying an increase in inspection activity. Considering the nature of the operation, it is a good achievement to be accepted if not beloved.

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* No documentary evidence can be offered for this but a frequent refrain in asking to be excused was, "I'm a ... and I've got to get to the ...," where the profession and appropriate local were named.

Table V.4e

Comparison of Attitude with Reported Family Income

Income	Average Response	% of Persons with Attitude: Very Displeased	Displeased	Neutral	Pleased	Very Pleased	Not Stated	Number
Under $5,000	3.09	8.8	20.9	33.8	17.5	14.7	4.3	468
$5,000-$7,499	3.14	3.9	23.4	39.6	17.0	13.7	2.5	642
$7,500-$12,499	3.02	4.2	23.9	45.0	15.4	9.5	1.9	1572
$12,500-$19,999	3.00	5.0	23.6	45.0	15.8	9.0	1.6	1157
$20,000 up	2.90	5.0	28.9	43.6	13.5	7.7	1.3	622
Not stated	2.81	10.1	19.8	24.3	9.1	8.7	7.3	988
Overall	2.99	5.9	23.4	39.5	14.5	10.0	6.8	5449

Comparisons:

Income given N = 4369 avg. = 3.02 dif. = 0.21

Not given N = 712 avg. = 2.81 t = 4.99 p .001

Income	Number	% Pleased or Very Pleased	
Under $7,500	1074	32.4	dif. = 8.5%
$12,500 up	1753	23.9	t = 4.94 p .001

Note: Column hfeadings condensed from questionaire answers

Table V.4f

Comparison of Attitude with Driver Age

Age	Number	Avg. Response	% Unhappy	% Happy
15-24	1284	2.86	36.8	23.1
25-34	1152	2.92	33.6	22.6
35-44	948	2.90	33.3	32.1
45-54	812	3.04	28.7	27.0
55-64	528	3.27	21.6	36.7
65 and up	315	3.53	15.9	48.3
Overall	5039	2.99	31.2	28.2

Younger *vs* older drivers comparison:

Age	Avg. Response	%Happy
15-44	2.89	25.4
45 and up	3.21	34.1
Difference	0.32	8.7
T value	10.41	6.46
Significance	0.001	0.001

F. Time Trends

Attitude, knowledge, and repair practice were examined over the five inspection cycles.* This was done to determine if the presence of the lane had cumulative effects which were not apparent for examining inspection activity levels among counties. In other words, how long an area was exposed to continuous activity might affect the impact as much as the amount of activity at a particular point in time. Attitude and knowledge did change over time, but repair practice did not.

On attitude, the percent unhappy at being stopped increased significantly from the first three cycles to the last two cycles, Table V.5a. This was true for all counties, both individually and taken in combination. The average attitude, declined significantly in Kent and Genesee Counties, but not in Ingham County. This result, combined with the fact that the relative increase in unhappiness was smallest in Ingham County, suggests a seasonal pattern in public acceptance of the lane. When the lane reappears in Spring, public acceptance is high. With increased exposure, acceptance declines somewhat until it reaches some minimum determined, probably, by local characteristics. Once acceptance has "bottomed-out," it will remain fairly constant. Since Ingham County received the most intense activity, it probably approached its minimum point most quickly, and, consequently, it had the smallest changes over time.

Knowledge showed a slight increase over time, but the pattern was not as regular as for attitude, Table V.5b. In Ingham County, the percent of correct response on the "how" question showed a better than average increase (36.8% to 41.4% vs. 38.3% to 41.8%), from

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* It should be recalled that the pre-test version of the questionnaire was used for the first cycle in Ingham and Genesee Counties. Final version results thereby are only available for the last four cycles, in these two counties.

TABLE V. 5a

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.

TABLE V. 5b

Change in Knowledge over Time
by County

	Genesee County			Ingham County			Kent County			All Counties		
		% Correct on			% Correct on			% Correct on			% Correct on	
Cycle	N	How	When	N	How	When	N	How	When	N	How	When
1	---	-----	----	---	---	------	449	40.8	28.3	449	40.8	28.3
2	438	40.4	21.5	437	36.8	29.5	402	39.8	25.6	1277	39.0	25.6
3	435	32.4	25.3	438	36.8	28.1	405	41.2	30.9	1278	36.7	28.0
4	454	38.5	24.7	433	42.0	29.8	361	43.5	28.3	1248	41.2	27.5
5	399	41.4	22.6	400	40.8	33.7	398	45.0	31.2	1197	42.4	29.2
ALL	1726	38.1	23.5	1708	39.1	30.2	2015	42.0	28.8	5449	39.8	27.6

Comparison of % Correct on How Inspected Cycles 1-3 vs Cycles 4-5:

Cycle	Ingham County	All Counties
1-3	36.8	38.3
4-5	41.4	41.8
Difference	4.6	3.5
T Value	1.956	2.607
	$p \simeq .05$	$p \leq .02$

the first three to the last two cycles. Correct answers on the "when" question increased more in Ingham County (28.8% to 31.7%) than in the other two counties (25.0% to 26.7%), but these changes are so small that they could have occurred by chance.* Cumulative exposure to the lane brought some improvement in knowledge with Ingham County which had the greatest exposure having the largest change.

No discernible pattern occurred in reported repair practice over time, Table V.5c. The apparent increase between the first three and the last two cycles very probably resulted from chance. Since most people have something done to their car fairly frequently, and since the questionnaire was not particularly effective in probing what was done, the data do not indicate whether the lane did or did not have an effect on maintenance practice.**

In summary, the time trend analysis suggested an influence on attitude and knowledge which was not indicated by the previous analysis. Exposure to the lane over time will produce some decrease in public acceptance, and at the same time will increase public knowledge of the lane. The effects on knowledge were stronger for the highest intensity area. Still, duration of exposure seems to play as important a role as intensity. However, the identity of the respondent and the time at which he was contacted, in terms of daily routine, determined a person's response much more strongly than did direct exposure to the lane's operations over time.

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* For the Ingham County difference: T=1.29, d.f.=1707, p. 0.20.

** On strict statistical grounds, the hypothesis that there was no change cannot be rejected. The intent was to remind the reader of the possibility of a Type II error, that is accepting a false hypothesis of no effect when, in fact, an effect was present. Qualitatively, the two questions on repairs probably did not address the problem well. In retrospect, a more satisfactory approach probably would have been to require the person to state when he had last repaired particular items, rather than to separate the item repaired from the time of repair.

TABLE V. 5c

Repair Practices Over Time

All Counties

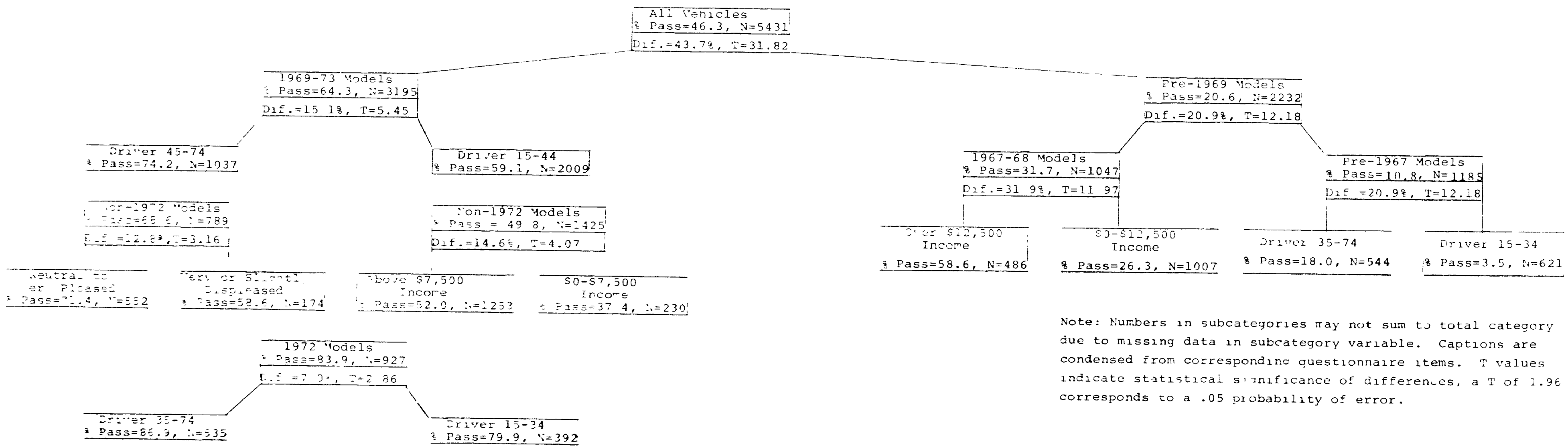
Cycle	Number	% Past Month	% 2-3 Months	% 1-3 Months
1	449	48.3	28.5	76.8
2	1277	48.8	28.5	77.3
3	1278	49.0	29.7	78.7
4	1248	45.9	32.0	77.9
5	1197	51.0	28.7	79.8
Overall	5449	48.6	29.6	78.3

Individual Counties

	Cycle 1-3		Cycle 4-5	
County	N	% 1-3 Months	N	% 1-3 Months
Genesee	873	77.0	853	77.7
Ingham	875	78.3	833	79.4
Kent	1256	78.1	759	79.5
All	3004	77.8	2445	78.8

Figure V.2

AID Analysis of Vehicle Condition



Note: Numbers in subcategories may not sum to total category due to missing data in subcategory variable. Captions are condensed from corresponding questionnaire items. T values indicate statistical significance of differences, a T of 1.96 corresponds to a .05 probability of error.

G. Other Studies

As indicated earlier, the driver interview data are difficult to judge on an absolute scale. Few **comparable studies** are available. A brief, non-exhaustive review of public opinion sources was conducted. The review centered on highway safety matters in Michigan and on motor vehicle inspection. Compared with other studies, the interview results on attitude, knowledge, and repair practice do not look unreasonable. More precise analyses are not valid due to differences in scope, method, and questions posed.

In many ways, attitude was the easiest to assess. Several studies have sought people's feelings about vehicle inspection programs. Most of these studies have focused on opinions of the merit of periodic inspection. Sherman (1) interviewed several hundred motorists in three inspection programs. He found that between 84% and 90% of the drivers favored periodic inspection. Two Michigan studies (2,3), one of which was conducted in another county at the same time as the driver interviews,indicated most person's favoring periodic inspection. In the first study, 93% favored inspection, and the 1972 poll yielded a similar figure. In an interview of some 200 drivers passing through the Memphis, Tennessee city inspection station, Goodwin (4) discovered 75% believed vehicle inspection reduced the number of unsafe vehicles and 64% through inspection prevented accidents.

Yet,when the studies probed somewhat deeper, a different picture emerged. Given a choice among alternative highway safety programs or asked about the direct impact of the inspection program on themselves, the interview subjects rated inspection less highly. In the earlier Michigan study (2) the fraction of persons favoring inspection dropped to 44% if a $4.00 fee were to be imposed. In both of the Michigan surveys (2,3) required annual inspection ranked only modestly high among alternative programs

(5th of 9 and 5th of 11), and in the 1972 Michigan survey (3), only 12% rated vehicle inspection as their first choice. In a national survey, Harris (5) discovered that unsafe vehicles rated only fifth out of seven in a list of highway safety problems. Moreover, 24% considered unsafe vehicles to be a major cause of accidents. Goodwin's (4) Memphis study indicated a host of problems. Among them were the fact that 52% felt inspection was an inconvenience, 44% thought the inspection fee a disguised tax, 40% believed the fee too high, 79% needed more than an hour to meet the inspection requirements, and 44% suggested reducing the time required and/or increasing the number of stations. These studies suggest that people find inspection very appealing in the abstract, but when confronted with more concrete situations, opinions become less favorable.

Finally a 1968 HSRI study (6) probed attitudes about the checklane. The research included 900 drivers stopped in operational checklanes. The 1968 and 1972 studies used the identical question on attitude. Results of the earlier study are presented in Table V.6a. Attitudes in 1968 were substantially worse than in 1972. This suggests that attitudes may have improved over the four year period. Differences in approach could possibly explain the change. The earlier interview was given after inspection was completed, rather than before as in the 1972 survey. People in 1968 had been detained several minutes longer and may have received unpleasant news about their vehicle's condition. Second, since operational lanes were used, relatively more negatively inclined drivers could have been included in the 1968 study. These two factors could have heightened the amount of unhappiness expressed. Therefore, while attitude could well have improved between 1968 and 1972, it definitely did not deteriorate. Based on this finding of possible improvement and on the attitudes about concrete inspection problems, the present operation of the checklane does not compare unfavorably with other programs.

Table V.6a

Summary of Results of 1968 HSRI
Checklane Interviews

1. General Attitude:

Average response	2.88
% Unhappy	43.0%
% Pleased	30.2%

2. Distribution of % Unhappy by Trip Purpose:

To/From Work	53.5%	Other	39.5%
School	50.0%	Pleasure	33.9%
Personal business	45.9%	Shopping	32.2%
Job Assignment	42.0%		

3. General Knowledge:

Learned on day stopped	17.8%
Learned by being stopped	38.9%

4. Implied Consent question:

No knowledge	55.2%	Fair knowledge	6.8%
General awareness*	2.8%	Good knowledge	3.2%
Rudimentary knowledge	16.3%	No response	15.6%

* Those who claimed to have heard the term but could not offer details.

Direct assessment of knowledge was difficult. Only two studies, including the 1968 HSRI investigation, tested knowledgability about inspection. The 1968 HSRI effort (6) only checked the general information level. As in 1972, between 65% and 80% of the drivers claimed to have known about the program before being stopped. In a national survey by Henderson (7), motorists in random inspection states were found to be generally more knowledgable about vehicle condition matters than those in periodic inspection states. However, while the study inquired about specifics of the inspection program, reporting on the degree of accuracy among various jurisdictions was not reported.

Lacking much data on inspection knowledge, other studies about knowledgability were sought. The first Michigan poll (2) indicated 73% of the sample could spontaneously name at least one highway safety program and that 34% could name three programs. Vehicle safety however was mentioned by only 13% of the respondents.* The 1968, HSRI study (6) also examined knowledge about the state's newly passed implied consent legislation. Of the motorists interviewed, 55% had no knowledge of the law. Only 26% could supply details, and a minimal 3% were rated as having "good" information.** In a related study, Little (8) interviewed

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* This survey was conducted shortly before passage of the checklane legislation, and consequently the figure does not represent information about an ongoing program.

** Respondents were asked to describe the Implied Consent Law. They were scored as having no knowledge if they stated that they had not heard or incorrectly identified the law. Knowledge was scored on a three point scale of rudimentary, fair, or good depending on whether the reply included one, two, or three and four principal points of the law. The principal points were: (1) law applied to persons arrested for drunk driving, (2) law required taking a breath test for blood alcohol, (3) penalty for refusal to take test was suspension of license, and (4) presumptive limit for driving while intoxicated was .15% blood alcohol level (since reduced to .10%).

200 young male drivers in Ann Arbor, Michigan. With a series of true/false questions on possible penalties for drunken driving, Little determined that, with one exception, between 75% and 90% could correctly discriminate between valid and invalid penalties.* Yet using the more general multiple choice format, Little found that 35% knew the number of annual U.S. traffic fatalities and that about 45% indicated the correct proportion of drinking related traffic deaths. Both numbers had been widely publicized. In a similar vein Waller and his associates (9) found in Vermont that about one-third of drivers could correctly state the presumptive blood alcohol level for conviction of drunken driving and that less than one-fifth could state the number of drinks within an hour period required to reach that level. In general these studies suggest that the level of specific factual knowledge about highway safety programs among the general public is not high. Consequently, the 25% to 40% range of correct factual knowledge indicated by the interview results can be considered a fairly typical showing, but still room for improvement exists.

General comparative statistics on owner repair practice were obtained from two studies. The Sherman (1) investigation asked drivers how long they waited between the time they discovered a defect and the time they repaired it. Thirty-two percent stated that they repaired within one day, and an additional 53% stated that repairs were made within a week. The Henderson (7) survey covered repair practice in detail. Table V.6b indicates the service frequency within a year. The four most common components on the Henderson list coincide with the most frequently mentioned items from the checklane interviews. Henderson's frequency for

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* Only 43% correctly stated that impoundment of one's vehicle was not a penalty for driving while intoxicated. The author states however that persons may have confused imposition of post conviction impoundment with the necessity of removing the vehicle from the street, normally by towing to the police pound, at the time the driver was taken into custody.

Table V.6b

Distribution of Repair Frequencies
from National Maintenance Practice Survey*

Items	% Answers stating Number times repaired past year: Once	Two or More
Brakes	47.5%	19.3%
Muffler	44.8%	6.1%
Shock absorber	32.9%	2.8%
Tires	54.6%	20.6%

* Source: Henderson (7)

specific items is much higher than in the checklane interviews, but the period encompassed, one year, is much longer than the typical period reported for the checklane. While Henderson does not give any breakdown on the time period since the last repair, it can be reasonably inferred from his data that at least 75% of the vehicles had some service within a one year period. As indicated in the previous section, the driver interview questions on repair practice were not wholly satisfactory as questions, but the responses are generally consistent with the other two sources.

REFERENCES

1. Sherman, Harold W. "Sampling Driver Opinions Toward Periodic Motor Vehicle Inspection," Highway Research Board. 420:1972, 36-43.

2. Troldahl, Verling C. and Farace, Vincent R. Public Opinion in Michigan on Traffic Accident Prevention. East Lansing: Michigan State University, Highway Traffic Safety Center, January 1966.

3. "A Safety Demonstration Program for Oakland County Michigan: Final Report." Bloomfield Hills, Michigan: Oakland County Traffic Improvement Association and Oakland County Board of Commissioners, May, 1973. ("Prepared for U.S. Department of Transportation, National Highway Traffic Safety Administration, Contract Number FH-11-7542. DOT-HS-800-856.")

4. Goodwin, William A., "Development of a Periodic Motor Vehicle Inspection System: Interim Report." Knoxville, Tenessee: The University of Tennessee, Department of Civil Engineering, October, 1970.

5. Harris, Louis and associates. "Public Attitudes Toward Automobiles and Their Future." New York(?):Newsweek Publishing, December, 1967 (?). (Pamphlet with "A Newsweek Study," inscribed on cover).

6. Kirchick, Calvin B. "Preliminary Findings Driver Interviews," Unpublished research memorandum, HSRI, December, 1968.

7. Henderson, H.L., et.al. "Motor Vehicle Owner Maintenance Practice: Final Report." Scranton, Pennsylvania: Intext Transportation Research Division, April, 1970. ("Prepared under contract FH-11-6939 with U.S. Department of Transportation National Highway Safety Bureau.)

8. Little, Joseph W. "A Theory and Empirical Study of What Deters Drinking Drivers, If, When, and Why," Administrative Law Review. 23(1): December, 1970, 23-57.

9. Waller, Julian A., Worden, John K., and Maranville,Irvin M., "Baseline Data for Public Education about Alcohol and Highway Safety in Vermont." Waterbury, Vermont: Project CRASH, February 1972. ("This survey was carried out as a program planning study...Vermong Department of Mental Health under Contract FH-11-7543 with the National Highway Traffic Safety Administration, U.S. Department of Transportation.")

VI. ANALYSIS OF FOLLOW-UP PROCEDURES

A. Introduction

The follow-up system constituted the most successful aspect of the program. Some 15,000 postcard repair certifications were received which represented more than 60% of the vehicles failing initial inspection. Over 5,000 reinspections were conducted with an 89.4% passing rate. About 12.5% initially inspected were reinspected.* Defective vehicle drivers received about 2,000 summons, of which 850 were exclusively for vehicle defects. While the measures are not independent, probably in excess of 70% of those who failed the initial inspection took some action to comply with the inspection requirements.**

Three elements made up the follow-up system. Operators of vehicles which had less serious defects received postcards. They were instructed to repair their vehicles within 21 days and to return the postcard certifying repair (Figure VI.1). For vehicles with more hazardous defects, drivers received summons and were required to have their vehicle repaired and reinspected prior to settling the case. The license plate numbers of all defective vehicles were entered into the State Police's Law Enforcement Information Netowrk computer, and a "reinspect" decal was placed on their windshields. When the vehicle again encountered a check lane, the compliance status was determined, and if the vehicle had

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* This represents 26.3% of the vehicles failing initial inspections.

** The structure of the files prevents tracing individual responses. For example, some returned postcards might have come from persons who submitted their cars voluntarily for reinspection. The only precise information on this is that 1.75% of the reinspections constituted second or subsequent reinspections.

Figure VI.1
Sample Self-Certification Return Post Card

Date | MICHIGAN VEHICLE INSPECTION | Dept

Veh Make | Model Year | Reg No

DEFECTS

☐ Safety glass
☐ Vision impaired
☐ Wipers
☐ Washers
☐ F direct lights
☐ High beams
☐ Low beams
☐ Aim

☐ Output
☐ Tail
☐ Stop
☐ R direct lights
☐ Plate light
☐ Horn
☐ Beam indicator
☐ Steering

☐ Tire bulge/break/tread ☐ OTHER
☐ Exhaust noise/smoke
☐ Mirrors
☐ Foot brake
☐ Parking brake

Officer

Correct the above listed defect(s) within 21 days and mail this card as indicated on the reverse side. The results of your vehicle inspection have been entered into the Law Enforcement Information Network Computers and if you fail to make the needed repairs you are subject to detection and prosecution anytime this vehicle is stopped by a police-officer.

I hereby certify that the above listed defect(s) have been corrected

Signature of Driver or Owner

First Class
Permit No. 160
East Lansing,
Michigan
48823

PREPAID BUSINESS REPLY CARD
No Postage Stamp Necessary If Mailed in the United States

Postage Will Be Paid By:

DEPARTMENT OF STATE POLICE
VEHICLE INSPECTION UNIT
714 S HARRISON ROAD
EAST LANSING, MICHIGAN 48823

not been repaired within the grace period, appropriate action--usually a summons, was taken. Details of the system were discussed in Chapter II.

Direct monitoring of the follow-up system was not undertaken. Rather its effect must be inferred mostly from normal operational data. HSRI received copies of the State Police's monthly data tapes on inspection activity for the entire state. Reports for the three experimental counties were subsetted from the tapes. Data included all the inspection variables described in Chapter III, but of most use to the present analysis was the information on summons and on initial vs. subsequent inspection. In addition, information from all returned postcards was keypunched and placed in a computer data file. This chapter analyzes these two sources of information. Returned postcards are covered in Section B, and reinspection and summons information are discussed in Section C.

B. Postcard Return

Voluntary repair certification via return postcard worked quite well. Over 15,000 cards were received, which represented approximately 60% of vehicles failing initial inspection. In addition,participating agencies reported frequent inquiries from the public concerning the compliance requirements. The extent of response was both surprising and gratifying to project personnel since initially some reservations had been expressed about the likely responsiveness of the public. It would appear that both the medium, delivery by a police officer, and the message, a threat of possible criminal prosecution if action were not taken, were effective in persuading a large number of persons to certify that they had repaired their vehicles.

The number of returned cards, with some exceptions, quite closely followed the overall pattern of inspection activity. The breakdown of the cards returned by month for both county and for inspecting agency is presented in Tables VI.la and VI.lb. The level of response appears to have remained steady over the project period. The decline in the later months parallels a dimunition of inspection activity in the fall. The principal exceptions to the response pattern came from inspection conducted by the Flint and Grand Rapids Police Departments. Grand Rapids chose to maintain a repair and reinspection system operated under municipal ordinances rather than participating in the postcard system. As will be illustrated below, Flint apparently used the cards more sparingly than did other participating agencies.

The distributions of reportedly repaired defects is quite similar to the incidence in the inspected population. Windshield washers, license plate lights, parking brakes, and tires were the most frequently repaired items. The average vehicle age on the returned cards generally reflects the somewhat older population which is more commonly checked by the inspecting teams. Some

Table VI.1a

Number of Postcards Returned by Issuing Agency by Month

Month	State Police	Flint Police	Lansing Police	All*
May	709	0	561	1271
June	1872	135	1147	3160
July	1336	148	1315	2800
August	1855	36	962	2853
September	1526	0	829	2356
October	1345	0	720	2066
November	526	0	166	712
All*	9217	319	5707	15252

Table VI.1b

Estimated Number of Postcards Returned by County by Month

Month	Genesee County	Ingham County	Kent County	All*
May	159	845	266	1271
June	838	1659	657	3160
July	562	1800	437	2800
August	890	1234	729	2853
September	557	1233	565	2356
October	770	1207	88	2066
November	254	448	292	712
All*	4064	7938	3250	15252

* Rows and columns may not sum due to inclusion of missing data cases in "All", e.g. team identification given but date missing, or due to estimation of returns by county.

variability among teams in particular components is present. Cars checked by the Flint Police Department show a lower incidence of most types of defects. The Lansing Police team's cards indicate few tire problems. The State Police apparently found the most defects when issuing cards. The differences probably came from subjective judgement on certain items, like parking brakes, and from varying policies on requiring reinspection. The distribution of the most common defect items by county and by issuing agency is present in Tables IV.2a and IV.2b.

More precise comparison of the postcards with the inspection reports presented some analytical problems The principal difficulty arose in using the State Police inspection data tapes. To expedite processing, HSRI received copies of the working tapes each month as they were generated. In some months, reports for certain teams were not received until after the monthly close-out date. This resulted in the incompleteness of the file. Rather than reprocess some 350,000 records for the entire state, the problem was treated in two fashions. First, when general comparisons were sufficient, the data file was viewed as a representative sample of inspection activity. Second, when precision was required, analysis was confined to subsets of the data where both complete postcard and inspection information was available.

Comparing the specific incidence of component outage between postcards and inspection results shows several interesting effects. The ordering of the most common defects coincides exactly. Washers and wipers were the most frequently defective group on both measures, and brake lights the least frequently defective. In all of the most common categories, the postcards had fewer defects than cars failing inspection. Differences between particular components show an interesting pattern. Headlights, license plate lights, and brake lights had relatively small differences, while tires and washers/wipers had intermediate differences, and exhaust and brake problems had relatively large differences. A reasonable hypothesis

Table VI.2a

Distribution of Common Components
Outage on Returned Postcard by County

Item	Genesee County	Ingham County	Kent County	Overall
Washers	34.3%	38.5%	34.2%	36.5%
Plate Lights	35.6%	38.8%	39.2%	38.0%
Brake Lights	11.7%	9.3%	12.9%	11.0%
Tires	25.6%	12.2%	28.2%	19.2%
Parking Brake	21.2%	18.0%	20.1%	19.3%
Defects/Car	2.531	2.044	2.538	2.299
Model Year	66.904	66.915	66.642	66.848
Number of Cards	4064	7937	3251	15252

Table VI.2b

Distribution of Common Components
Outage on Returned Postcards by Inspecting Agency

Item	State Police	Lansing Police	Flint Police	Overall
Washers	34.3%	41.0%	20.1%	36.5%
Plate Lights	37.6%	38.7%	38.2%	38.0%
Brake Lights	12.8%	9.0%	2.2%	11.0%
Tires	26.2%	8.3%	11.6%	19.2%
Parking Brake	20.9%	18.5%	12.9%	19.3%
Defects/Car	2.481	2.029	1.859	2.299
Model Year	66.854	66.904	65.687	66.848
Number of Cards	9217	5707	319	15243

to explain these effects includes two factors. First, program policy was to require reinspection and repair of vehicles with hazardous single defects or multiple minor defects. This would explain the lower overall incidence of outages on the postcards and to some extent the performance of specific components. For example problems with service brakes almost automatically invoked mandatory repair and reinspection requirement.* Second, the pattern probably reflects the operator's willingness to repair particular components. Items which were relatively inexpensive to replace or which had a clearly understood safety effect, like tires, had a higher response frequency. Conversely, expensive to repair or apparently non-critical problems, like parking brakes aroused less concern. These results are presented in Table VI.3a.

One anomolous result appears. The average number of defects per vehicle on the returned postcards is greater than in the inspection results. While the difference was small enough that it could easily have occurred by chance, the effect was explored further. As shown in Table VI.3b, the percent of cards with two or fewer defects was greater than the percent of inspected vehicles with two or fewer defects (66.3% vs. 65.4%), and the number of cards with three to five defects was smaller than for failing vehicles (28.7% vs. 31.1%). However, when cards or cars with six or more defects are considered, the relationship is again reversed with the postcards having relatively more defects. (5.05% vs. 4.56%). The last effect accounts for the average number of defects per vehicle being higher on the returned cards than in the inspection results. While one could speculate on a number of reasons for the last

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* Service brake problems alone occurred on only 0.2% of all cards. Service brake problems probably were the most frequent cause of vehicles being condemned and towed from the lanes.

Table VI.3a

Distribution of Outage Frequencies for Postcard Return and Failed Vehicles***

Component	% of Postcards	% of Failed Vehicles	Difference*
Washers/Wipers	40.8	47.0	6.2
Plate Lights	38.0	41.3	3.3
Head Lights	23.8	24.9	1.1
Brakes**	19.5	24.6	5.1
Tires	19.2	21.9	2.7
Exhaust	13.9	19.1	5.2
Brake Light	11.0	12.1	1.1
Defects/Vehicle	2.299	2.235	-0.64

* All differences significant at .99 confidence level or higher except for defects/vehicle

** Mostly parking brakes

*** Data sets not exactly matched. See text for discussion.

Table VI.3b

Distribution of Total Defects on Returned Postcards and on Failed Vehicles*

Number of Defects	Number of Cards	%	Number Failing**	%
1	5805	31.99	7870	38.59
2	4063	21.29	5462	26.79
3	2298	15.43	3453	16.93
4	1300	8.73	1935	9.49
5	672	4.51	944	4.63
6	390	2.82	447	2.19
7+	362	2.43	280	1.37
	14890		20391	

* Data sets not exactly matched. See text for discussion.

** Initial inspections.

result, it is probably an artifact of the data.* Consequently it would appear that the police issued and owners returned relatively more cards for the less seriously defective vehicles, which was the expected effect.

About 60% of defective vehicle operators returned their post cards. Several steps were required to derive the estimate. Since the inspection data file did not indicate that a card was issued but only the pass/fail status of the vehicle, it was necessary to estimate the response rate on the basis of the number of vehicles failing. Still, the appropriate choice of denominator for the response estimate was open to question. To be very conservative, one set of estimates used all vehicles failing inspection for the denominator. Yet since only vehicles failing initial inspection were likely to have received postcards a second set of estimates were prepared using this group as the denominator. Both estimates would still tend to underestimate the response rate, since some vehicles were subject to mandatory repair and reinspection. In addition, since the data files did not contain information for certain teams for certain periods, it was necessary to restrict the analysis to returns for certain areas. To insure accuracy on this point, the coverage for each team for each month was classified as questionable and certain. Separate estimates were prepared for all data and for the certain data to indicate the likely range of response. In determining rates for particular counties, another problem was encountered. The special sample team used the same identification code on their postcards in all three counties. It was, therefore, necessary to distribute this team's results over

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* Precise statistical tests of these differences are not possible since the two data sets are neither strictly independent or dependent. However, the numbers of cases are sufficiently large that, if such tests were legitimate, even quite small differences would be highly significant. For example, the .999 confidence interval about 20% for 20,000 cases is 0.87%, and about 5% is 0.15%.

the counties in proportion to the number of vehicles they failed in each county. In all, four sets of estimates were prepared for each inspecting agency and for each county. These are given in Tables VI.4a and VI.4b. In Table VI.4a, the more inclusive estimates are given in the "a" category, and the more conservative estimates are shown in the "b" category. In Table VI.4b, the more inclusive estimates are presented, and the more conservative estimates are shown in the footnotes.

As can be seen in the tables, there is a rather wide variation in response rates among the counties with a low of 43.47% in the Genesee "a" category and with a high of 81.37% in the Kent "a" category. However, the Kent County figure is suspect, since the estimate of the returns for the special sample team may have overstated actual returns for the county. Using the more conservative estimates and the more reasonable initial inspection denominators, the county estimates fall in the 50% to 60% area. The agency estimates in Table VI.4b give an even clearer picture. The Lansing Police and the State Police had quite similar return rates. The Flint Police experienced a very low, 15%, return rate which leads to the suspicion that this department issued postcards only in special circumstances. Excluding Flint, results in estimates ranged from 55.7% to 63.1%. Allowing, then, for the fact that not all failed vehicle drivers received postcards the conclusion seems to be that about 60% of the drivers returned their cards.

Table VI.4a

Number of Cards Returned vs.
Inspection Outcome by County

County		Cards Returned	All Inspections Cars Failed	% Return	Initial Inspections Cars Failed	% Return
Genesee	(a)	4064	9348	43.47	9118	44.57
	(b)	3745	7266	51.54	7049	53.16
Ingham	(a)	7937	11760	67.49	11,444	69.39
	(b)	6333	10991	57.82	10667	59.37
Kent	(a)	1188	1534	77.45	1460	81.37
	(b)	3251	6247	52.06	----	-----
Overall	(a)	13,225	22,642	58.41	22,022	60.05
	(b)	13,329	24,504	54.40	----	56.89*

Notes: Genesee(a) includes State Police Regular and Special Team Inspections and Flint Police.
Genesee(b) excludes Flint Police.
Ingham(a) includes State Police Regular and Speical Team Inspections and Lansing Police.
Ingham(b) reflects adjustments for possible underreporting of Lansing Police and State Police Regular Team results.
Kent (a) includes State Police Special Team.
Kent (b) includes State Police Special Team and Regular Team for both vehicles and drivers.
Overall (a) and (b) represents sum of counties.

* Genesee and Ingham only.

Table VI.4b

Number of Cards Returned vs.
Inspection Outcome by Agency

Agency	Returned	All Inspections Cars Failed	All Inspections % Return	Initial Inspections Cars Failed	Initial Inspections % Return
State Police[1]	7164	10741	66.70*	10325	69.38*
Lansing Police[2]	5707	10257	55.64	10065	57.70
Lansing Police[3]	4987	9488	52.56	9298	53.64
Flint Police	319	2082	15.32	2072	15.40
Combined[4]	13190	23080	57.15	22462	58.73
All Except Flint	12871	20998	61.30**	20390	63.12**

1 Includes special team and Ingham and Genesee County regular teams

2 Based on all reports in file

3 Based on reports with known inspection date

4 Lansing category 1 used in summations

* Allowance for possible underreporting of Ingham State Police regular teams would reduce these to 58.47% and 60.82% respectively

** Use of Lansing Category 1 and allowance for possible underreporting of Ingham State Police Regular Team would reduce these to 55.70% and 57.4% respectively

C. Summons and Reinspection Activity

The second portion of the follow-up system involved mandatory repair and reinspection of vehicles with hazardous defects or with multiple minor defects. The driver of such a vehicle was issued a summons for defective equipment. Through arrangements with local courts, the person was required to have the vehicle repaired and reinspected prior to disposition of the case. Some 2000 summons were issued to drivers of defective vehicles, and 5700 vehicles were reinspected. Since not all summons were for defective equipment, a minimum of 4% of the defective vehicles were subject to mandatory reinspection, and in all some 30% of the vehicles which failed initial inspection were reinspected with a 90% success rate.

Estimation of total reinspections was quite straightforward. The State Police data tapes contain a variable indicating a reinspection. With this variable, the percent of initial inspections leading to reinspection was computed for each county and for each inspecting agency. The results are shown in Tables VI.5a and VI.5b. Overall, 13% of the initial inspections led to reinspections. Since about half of the vehicles passed initial inspection, about twice the fraction of vehicles which failed initial inspection were reinspected. The highest frequency occurred in Ingham County which had the most intense program. Some sharp divergence occurred in agency performance. The Lansing Police and the State Police, which formally participated in the program, had reinspection rates in the 14% to 18% range*. The Flint and Grand Rapids Police Departments, which operated somewhat independently, had much lower reinspection rates. If the Lansing and State Police experience is typical of what the full system can achieve, then about 30% of the vehicles which failed initial inspections were reinspected.

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* The higher figures for the State Police were derived by excluding special sample team operations from the estimates. This was done since the sample team concentrated on data collection rather than on inspection *qua* inspection activities.

Table VI.5a

Number of Reinspections and Ratio to Initial Inspections by County

County	Number of Reinspections	Reinspection/ 100 Initial
Genesee	1941	12.47
Ingham	3489	15.60
Kent	272	4.60
Overall	5702	13.00

Table VI.5b

Number of Reinspections and Ratio to Initial Inspections by Agency

Agency	Number of Reinspections	Reinspections/ 100 Initial
State Police(a)	2369	14.18
(b)	1956	18.31
Lansing Police	3052	15.55
Flint Police	163	3.77
Grand Rapids Police	115	3.60
Overall	5699	13.00
State and Lansing (a)	5421	14.90
(b)	5008	16.52

Notes: (a) Based on all reports in file.

(b) Excluding Special sample reports.

with about 90% passing. The program would appear to have been successful in bringing about the repair of a large number of defective vehicles.

The 5700 reinspected vehicles fell into three categories: 1. voluntary reinspections, 2. apprehensions of those failing to comply with the voluntary repair procedures, and 3. mandatory reinspections. Since the data do not indicate why a particular vehicle was reinspected, precise estimates cannot be given for each group. In fact a vehicle failing an initial inspection might subsequently appear in both the second and third groups. The first reinspection might occur when a checklane was encountered after having failed to comply with the voluntary repair provisions. Under this circumstance a summons might well have been issued. This in turn would lead to a second reinspection. Neglecting the overlap, minimum frequencies can be established for the latter two categories. About 6% of the reinspections may have come from apprehension of those not complying with the return postcard option. At least 15% of the reinspections resulted from the issuance of a summons requiring mandatory repair and reinspection.

The 6% minimum estimate of reinspections coming from apprehension of non-complying individuals was inferred from data on reinspection outcome. It is difficult to imagine someone's willingly or knowingly bringing a car with defects to be reinspected. About 350 reinspected vehicles had two or more defects which represented about 6% of the reinspections. Many more reinspections could have resulted from cars with reinspection stickers encountering checklanes. So it is reasonable to suppose that the multiple failure group represents the minimum frequency of apprehensions.

Exact estimates of mandatory reinspections from summons are not possible. Inspection data simply indicate whether or not a summons was issued. Since the operator could be cited for an equipment violation, or for driver's license, registration, or insurance violations, the number of summons does not necessarily indicate the amount of mandatory repair and reinspection activity.

However, it is possible to compare the number of defects on a vehicle with whether or not a summons was issued. This comparison is presented in Table VI.6. Summons systematically increased from vehicles with no defects to vehicles with four defects. For five and six or more defects, the citations issued dropped somewhat. The result for vehicles with many defects is rather unexpected. Yet, a minor electrical problem, like a blown fuse, might result in many inoperative components; under such circumstances, the inspectors might have felt that a summons was not warranted. Allowing for such exceptions, the more defective the vehicle, the more likely the operator to receive a summons and to be required to have the vehicle repaired and reinspected.

The numbers in Table VI.6 roughly indicate the proportion of vehicles subject to mandatory compliance. The true fraction for a fully implemented program could be higher. The data include the not-fully participating Flint and Grand Rapids teams, which might have diluted the result. The high frequency of reinspections for the State and Lansing Police teams points in this direction. Lower bounds can be established from two data points. Some 850 summons were issued when there were no driver violations. This represents some 3.8% of all vehicles failing inspection. Alternatively, about 9% of the defective vehicle operators received summons and only 4.0% of other operators received summons. The difference of 4.1% represents the "excess" summons for defective vehicles. This "excess" provides another estimate of the minimum frequency of mandatory reinspection. The minimum represents 15% of reinspection activity. Therefore, at least 4% of all vehicles failing inspection were required to be reinspected, and the number could have been much higher.

Overall, the total reinspection figures provide the best guide to the program's effect. They indicate that some 30% of the drivers presented their cars for reinspection, most after having successfully repaired the vehicles. The mandatory reinspections

Table VI.6

Summon's Issued by Inspection
Outcome of Vehicle

Number of Defects Found	Summons Issued	All Inspections % Vehicles	%	Initial Inspections # Vehicles	%
0	1244	25266	4.92	20151	6.17
1	735	8741	8.41	8551	8.60
2	579	8052	9.57	5924	9.77
3	358	3684	9.72	3818	9.89
4	199	2024	9.83	1968	10.11
5	83	958	8.66	942	8.81
6+	52	752	6.91	726	7.16
All	3250	47470	6.85	41880	7.76

Note: Difference between 6+ and other failures is significant $x^2 = 4.2548$ $p < .05$ d.f=1.
Difference between 0 and failures is significant $x^2 = 136.4420$. $p < .00005$ d.f=1.

were an indeterminate fraction of total reinspections, but at a minimum were on the order of 15% of the reinspections. More likely the mandatory reinspections were a higher fraction. Combining the reinspection figures with the postcard return figures and allowing for overlap, yields the conservative estimate that at least 70% of the persons with failed vehicles responded to the follow-up program. While some doubt remains that all persons who returned postcards did in fact repair their vehicles, the high response rate, including a number of voluntary reinspections, does indicate that the program was successful in securing the repair of defective vehicles.

VII. OTHER INSPECTION ACTIVITY IN THE STATE

The final step of the evaluation was to compare the performance of the three experimental counties with that of the remainder of the state. Outside the experimental counties, some 234,000 inspections were performed by various agencies. Comparison of the operational results for the test counties showed a substantially higher passing rate than the rest of the state (53.1% vs. 41.4%), and Ingham County which received the most intense inspection had an even higher passing rate (58.1%). For almost every component, the passing rate was higher in the test counties with the greatest difference being washer/wipers (78.0% vs. 69.9%). No apparent time trends existed in the state data. Significantly more reinspections were performed in the experimental counties (11.7% vs. 9.3%). The comparisons are presented in Tables VII.1, VII.2, and VII.3.

Interpretation of the differences between the test counties and the rest of the state must be guarded. Neither the test counties operational data nor the information from the remainder of the state represent true random samples of the vehicle population. Still, the large difference in passing rates suggests two things. First, the population in the experimental counties may have been somewhat better than that in the remainder of the state. Second, the increase in inspection volume in the experimental counties might have lead to diminishing returns. Stated simply, as the teams increased their activities, they moved from areas with relatively worse vehicles to areas with relatively better vehicles. The passing rate correspondingly rose. The marked difference between Ingham and the other test counties, suggests that at about the 15% inspection level the teams began to exhaust the supply of derelict vehicles and began to inspect vehicles with progressively more inconsequential defects.

The increased level of reinspection activity points again to the successful operation of the follow-up system. The lack of time trends found in the test counties were the consequence of the enhanced inspection activity, and not the result of some other phenomena.

Data presented for the state as a whole were derived from the State Police inspection report tapes furnished to HSRI. Information contained in these data files was the same as for other inspection data collected. Estimates were prepared using a subset of the entire data tape. The subset was generated by taking 5% of the cases on the tape at random and converting them to the HSRI data format.

Table VII.1

Percent of Vehicles Passing Inspection by Month; Ingham County, Three Test Counties, and State Sample

Month	Ingham*	Test*	State
May	54.4	53.2	39.9
June	56.1	54.1	42.6
July	59.2	55.2	43.7
August	58.4	51.9	43.6
September	60.1	55.1	41.9
October	---**	45.0	37.8
November	62.4	50.9	37.3
All	58.1	53.1	41.4
Number	23569	43104	14942

* Operational Teams in all three counties.

** Data not available

Table VII.2

Percent of Component Groups Passing Inspection; Test Counties and State Sample

Component	Test	State
Glass	93.7	91.3
Wipers/Washers	78.0	69.9
Mirror	97.8	97.7
Headlights	88.4	88.8
Tail Lights	95.8	94.2
Brake Lights	94.4	92.0
Plate Lights	80.9	73.5
Steering	99.1	99.2
Brakes	88.4	86.1
Tires	89.7	83.0
Exhaust	91.4	88.5
Total Vehicle	53.1	41.4
Number	49986	14942

Table VII.3

Percent of All Inspections in Reinspection Activity; Test Counties and State Sample by Month

Month	Test Counties	State Sample
May	12.3	10.6
June	11.0	9.7
July	10.4	8.5
August	11.2	10.5
September	14.6	10.8
October	9.2	9.0
November	13.7	9.0
All	11.7	9.3

VIII. PROGRAM ALTERNATIVES

A. Introduction

In Chapter I, it was stated "the best or most effective means of maintaining vehicles in safe condition has yet to be determined." Here, this statement is examined in more detail. The discussion will be more of a qualitative essay than of a rigorous quantitative analysis. The purpose is to examine the issues which must be considered in selecting any system. The goals of a vehicle safety quality program are first discussed. Then four alternative approaches are considered: 1. the recommended check lane program, 2. a limited conventional inspection system, 3. a full conventional inspection system, and 4. a future diagnostic system.

This review of alternatives serves two not entirely compatible goals. The primary purpose, hopefully, is objectively to appraise each alternative. The secondary purpose is to support the recommendations. At this stage, these recommendations must be highly judgemental since the evidence favoring any particular system is far from conclusive. From a purely academic viewpoint, the cry for more research would seem most warranted. Yet, practical decisions must be made, and hence the recommendations were given. Since judgements are arguable, the reasons for them are expressed as fully as possible.

B. Goals

The goal of any vehicle safety quality program should be to minimize the cost to society of accidents and of vehicle operation. Costs are normally measured in economic terms, but due allowance can be given for intangibles such as reduction of pain and grief. In concrete terms, the objective is to pick or to design a program which maximizes the benefit/cost ratio. Benefits are primarily reduced accident loss and improved operating economy. Costs are mainly initial design expenses and increased inspection and replacement activity. Failure to achieve the highest net benefits results in some waste. A too low quality vehicle population results in an avoidable toll of property damage, injuries, and deaths. An over-maintained vehicle population diverts resources from areas where they might be better employed like other accident reduction techniques, environemtal improvement, better schools. Ideally, all possible complex trade-offs among various alternative approaches would be considered, and an optimum solution would be produced.

Far short of the ideal, limited efforts have been made to determine what should be done. This has been approached both by advocacy and by research. Most advocacy has favored more and better inspection procedures. Proponents have appealed to the wide-spread public belief that defective vehicles constitute a safety menace. They have stressed security feelings that come from knowing one's own car is in safe condition. Periodic inspection has been the most widely acclaimed solution. Calls for improved vehicle reliability have been fewer. Quite naturally, proponents have minimized the costs and have indicated ever increasing net benefits from more activity. Proponents have been highly successful as evidenced by the strong emphasis on inspection in the National Highway Safety Act of 1966 and the Motor Vehicle Cost Savings and Information act of 1972.

A much smaller group of either skeptics or outright opponents have questioned the value of inspection programs. The skeptics have pointed to the high costs of inspection procedures and the relatively small fraction of accidents demonstrably caused by vehicle defects. Outright opponents have focused on the potentials for graft in certain forms of inspection and on the burdens imposed on disadvantaged citizens. Such negative attitudes have blocked implementation of inspection programs in several states and have probably resulted in the same narrowing of federal standards to critical components and to problem vehicle populations.*

Attempts at resolving the problems through research have had some limited success. Investigators have sought answers to questions in seven related areas:

1. How long will a component last without failure or degradation?
2. How long will this failure persist before someone, either the vehicle operator or some enforcement procedure, intervenes to remedy the problem?
3. Given that a component has failed or its performance has degraded to a particular point, how have the vehicles operating characteristics been altered?
4. How will the altered vehicle performance affect the likelihood of an accident under a number of driving conditions and driver behaviors?
5. How do the factors suggested in the four initial question combine to influence overall failure frequencies and accident rates?
6. How can the government and industry influence the process?

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* No specific references are provided for the characterizations of particular positions. Since for brevity it was necessary to paint with a rather broad brush, names have been omitted to avoid unfairly attributing a view to someone without completely summarizing his ideas. The author would prefer to avoid the advocacy role altogether, but the necessity of making recommendations somewhat thrusts it upon him. His position would best be described as a skeptic who feels that a much more carefully thought out and refined program would be desirable.

7. How much will such interventions cost, and what will be the savings resulting from them?

Given the complexities of the accident causation process, quite understandably no one has successfully answered all seven questions. The research approaches have tended to go in two general directions: determining the influences on the incidence of failures (questions 1 and 2) and examining the effects of failures on crashes, (questions 3 and 4). Both of these approaches have offered partial answers to the fifth question. Almost all investigations have considered some form of inspection as the answer to question 6. Answers to the last question have varied widely, depending on the answers to the first six, and have probably contained as much opinion, informed and otherwise, as fact.

Only one study has approached systematically the addressing of all of the questions. The work by Beraru at TRW (1) touched on all of the elements indicated, but since the main effort was directed toward specific inspection techniques, certain other areas received uneven attention.* The major overall conclusion of the study was that conventional periodic inspection was not or only marginally cost effective, but that more automated systems would yield substantially positive returns. The gains from the untested automation techniques would come mainly from an increase in the likelihood of detecting defects and in reductions in the costs of inspection.

Analysis of the determinants of vehicle condition has been much more successful. Mathematical models by Creswell and O'Day at HSRI (2,3) and by Beraru at TRW (1) have been developed to

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* A somewhat earlier study at HSRI structured the entire problem along lines similar to the questions posed in the previous paragraph and in a manner similar to that used by Beraru. Yet since the authors of that study then limited themselves to a restricted part of the problem, no claim for comprehensiveness is made.

predict population failure frequencies. These models emphasize the key roles of component quality in determining the mean time to failure and of owner maintenance practice in determining the mean time to repair. Inspection is introduced as a means of reducing the repair time once a component has failed. Jointly these factors determine the average outage time, and hence the fraction of cars with defects. The implication of the models is that inspection will make a great difference for components which fail frequently and are rarely repaired, like head light aim, but will have a small effect on components which fail rarely and are quickly fixed. Neither study dealt with subtle degradations of components, like steering and suspension, which affect performance.

Empirical work has demonstrated extensively the relationship between vehicle age, vehicle mileage, and owner characteristics, like age and income, with component outage rates. (4,5,6). Such findings were also present in this study. Two of the studies also compared condition across inspection jurisdictions, and they showed a clear advantage for periodic systems in terms of overall vehicle condition. Yet, differences were substantially smaller and in a few cases negative for more safety critical components.(4,5) No empirical study has fully solved the problem of obtaining a truly representative, random sample of the vehicle population. Little work has been done to examine perating conditions and driver actions in affecting condition. So while relative rankings of particular component outages have been established, precise predictions under differing circumstances are not so easily made.

Attempts to relate degraded mechanical condition to accident causation have yielded a less clear picture. This is quite understandable in light of the complexities of the accident causation process. Three approaches have been used: statistical analysis of accident data, engineering fault analysis of critical systems, and direct accident investigations.

The most common studies are statistical analysis of accident data. Two groups of authors reported strong associations between motor vehicle inspection and fatal accident rates. These are the widely cited work of Bauxbaum and Colton (7,8) and of Meyer and Houltman (9). Others, Fuchs and Levison (10) and Recht (11), using different techniques, failed to find statistically significant relationships. Yet these authors did find a nominally positive association, and thereby concluded that inspection must do some good. More negatively, Bintz (13) discovered that the accident experience of the non-inspection jurisdictions since 1950 had improved faster than inspection jurisdictions. Since the non-inspection jurisdictions started from a possibly higher base, the relative effect of many safety programs might be expected to be stronger in them. Taking a somewhat different tract, Little and Hall (14) and Josch (15), attempted to determine if older vehicles were overinvolved in crashes. The hypothesis was that such overinvolvements might indicate the role of mechanical problems. The two studies differed sharply in both methodology and conclusions, but both pointed away from the vehicle and toward differences in drivers and usage as explaining any differences in crash experience. Finally, in an as yet unpublished investigation, Campbell (16) followed accident experience of vehicles as they were introduced into the North Carolina and Florida inspection systems. He was unable to discern any difference in accident involvement between inspected and uninspected vehicles, and for inspected cars as a function of time since inspection.

Analytical approaches attempt to resolve the problem indirectly. Two such studies have been conducted under federal sponsorship. (17,18) Both studies relied on expert judgement to determine how particular faults altered the probability of an accident. These studies then combined the accident probability estimates with component failure data to generate overall component criticality indices. The second study by Booze-Allen (18) further assessed the relative desirability of vehicle inspection, design changes, or improved quality. In general, the report favored vehicle inspection, but in several areas design changes were preferred. While the conditional probability techniques are useful, the outcomes of such analyses are only as good as the underlying judgements. Since the expert opinion of safety effects tends to have a smaller dispersion than known failure rates, the failure frequency dominates the index. Consequently, what some might view as critical components receive a relatively low criticality index. In short, the approach may obscure the fact that items which are important to safety tend to be quite reliable to begin with.

In the area of components, limited work has been done to determine how changes in condition affect the performance of the vehicle. The studies have explored brakes, steering, suspension, and tires. For brakes, total failure has quite naturally been shown to increase stopping distance greatly, and extreme imbalances are known to cause controllability problems (33). Steering and suspension degradations, short of complete failure, seem to leave performance relatively unchanged. (31,32). Tire tread depth critically alters the onset of hydroplaning. (34) Such studies represent a useful beginning at understanding how altered performance causes accidents in a testable, engineering sense. Still, more work needs to be done, and far more needs to be known about critical performance limits in the driving task before such studies can be used to directly predict changes in accident experience arising out of particular component failures.

Finally, attempts have been made to define the role of degraded components in accidents. Work at Indiana University has been directed toward determining the frequency of component failures in accident causation. Despite the many difficulties in *ex post* assessment of accident causation, the investigators have established relatively firm figures. Some 6% of the crashes investigated were directly caused by vehicle defects and another 8% were associated with vehicle defects (19,20) A companion study indicated a modest correlation between the incidence of defects found in the general population and faults found in the accident involved vehicles. Crash investigations so far have usefully indicated the upper bounds on the amount of accident reduction that can be expected from a vehicle quality improvement program. Still, the amount of information is sufficiently modest that it does not offer the complete answer, since such factors as differences in mileage exposure and driver characteristics have not been fully assessed.

To draw together what has been said so far, component quality and owner maintenance practice determine how frequently a part will be failed or in some state of reduced performance. This has been mathematically expressed in terms of the mean time to failure and the mean time to repair and is closely related to owner characteristics. Given that a part has failed, the risk of a crash will increase steadily with the amount of time that the failure persists. How much the crash risk is increased has not been determined. Expert opinion views such increases in accident risk as rather uniform across differing components. On the other hand, engineering studies have shown wide variations in how performance is altered by component degradation. Accident investigations have pointed to a definite role of degraded components in crash causation. The most carefully conducted study to date indicates that somewhere between 6% to 14% of accidents re related to vehicle defects. Inspection has been the most frequently discussed solution. The primary function of inspection is seen as reducing the repair time once a component has failed. Inspection will have its greatest effects for components which fail frequently and are repaired slowly and will have only marginal influence on long-lived, quickly repaired parts. Changes in vehicle design have only received passing mention in the literature.

How much inspection would reduce accidents in not apparent from the data. The Indiana study indicates that a modest fraction but still substantial numbers of crashes were influenced by mechanical problems. With any inspection system, some defects would still occur. For an annual or semi-annual check, more catastrophic failures might evolve so rapidly that inspection would be very unlikely to intercept them before disaster struck. Further complicating the issue is the rather high correlation between groups with a large fraction of problem drivers and with a high proportion of problem vehicles. This makes it unlikely that even with perfect vehicles all of the crashes associated with defective cars would be avoided. Thus the 14% figure indicated by the Indiana study represents a modestly liberal upper limit. Comparisons of inspection and non-inspection jurisdictions reveal wide variations in component outage rates. The advantage usually is for the inspection jurisdictions. However with rare exceptions, usually headlight aim, inspection jurisdictions seldom have an outage rate that is half of non-inspection areas. Consequently it seems reasonable to suppose that at most half of the defect related accidents would be prevented by an inspection system. Applying this to the 14% figure of the Indiana study, then yields 7% as the greatest reduction in crashes that could realistically be expected to come from any inspection system.

Finally one must ask how much will all this cost? The expense will vary with the number of vehicles checked, the thoroughness of the inspections, and the inspection techniques used. Appropriate calculations of costs must include direct operational expense of inspection facilities, administrative overhead, an allowance for the owners time and travel, and the expense of unnecessary repairs. Owners time costs are frequently overlooked in assessing inspection expenses. It is a particularly difficult item to measure and to value, but its inclusion is necessary, since loss of time from other desirable activities does represent one of the largest burdens of inspection procedures to the motorist. Unnecessary repair expenses are also commonly neglected from estimates since no one has any idea how much is involved. This is one element which will lead to some underestimation in any cost statement. Direct inspection expenses are easily measurable since they involve well defined activities using inputs with easily determinable prices. For conventional state inspection systems estimates have ranged from a naive use of the typical state inspection fee of $1.25 per vehicle (22) to more recent and comprehensive estimates in the $10 to $15 range (23,24). For more automated inspection systems, a cost of $5 per vehicle was estimated for 1969 prices, but this estimate failed to include owner's time costs. (17) The $10 to $15 range seems probably most realistic. This is consistent with HSRI's 1968 estimate of $7.50 to $10.00 per vehicle after allowing for intervening inflation (2,3) For a checklane type system costs per vehicle would lie in the $4.00 to $7.25 range, and total costs would be much lower since only a fraction of the vehicles would be checked.*

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* The checklane costs were derived in the manner shown in the following table:

Cost Element:	Cost per hour	Low: Time Needed	Low: Amount	High: Time Needed	High: Amount
1. Initial Inspection					
a. Police time	$10.00	0.250	$2.50	0.325	$3.25
b. Citizen time	$ 3.00	0.167	$ .50	0.250	$ .75
c. Total initial inspection			$3.00		$4.00
2. Reinspections					
a. Police time	$10.00	0.100	$1.00	0.200	$2.00
b. Citizen time	$ 3.00	1.000	$3.00	1.500	$4.50
c. Total inspection			$4.00		$6.50
d. Fraction of population reinspected			.25		.50
e. Average per initial check			$1.00		$3.25
Total cost per initial inspection (1c+2e)			$4.00		$7.25

It should be noted that these estimates are not highly refined, but were based on general familiarity with checklane operations. The police cost per man hour may be somewhat high particularly on an incremental cost basis. Conversely the citizen time valuation per hour may be somewhat low, considering current Michigan wage

The goal of a vehicle quality improvement program, then is, to reduce the net cost to society of automobile operation. In more immediate terms, the problem is to devise a cost/effective inspection program. This presents a rather challenging problem. The maximum inspection effect of a 7% crash reduction places rather tight restrictions on the investment per vehicle in eliminating defects. Using a possibly conservative estimate of $1,000 cost per accident (25), and allowing 7% crash reduction yields an average reduction of $70 per accident attributable to inspection programs. Now, approximately 8% of the vehicles are involved in crashes in a year, so on an actuarial basis the maximum allowable "inspection premium" per vehicle would be $5.60 per year. On the other hand, allowing a quite generous cost of $3.750 per crash (derived by applying typical fatality/injury/property damage ratios to figures contained in reference 26) and assuming 10% of the vehicles are involved in crashes, yields a maximum allowable inspection expenditure of $26.25 per vehicle. It should be carefully noted that these estimates were not based on a rigorous economic analysis. Rather, they were formulated to illustrate the limits on investment in inspection based on commonly available published data. What they suggest, though, is that any inspection program should combine the advantages of low cost per vehicle inspected and the ability to intercept a high number of defects relatively soon after defects occur. With these constraints in mind, the discussion will turn to specific alternative approaches.

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* footnote continued from previous page

rates. Times spent on initial inspections are generally consistent with current operating experience. Reinspection times were judgemental. These numbers may be slightly high since the 1972 MSP average direct cost was $1.50 per inspection.

C. Checklane Approaches

The most pronounced advantage of a checklane system is economy. The savings are three-fold. First, by contacting motorists on the road, the checklane avoids travel and time costs associated with the person's going to an inspection facility. Second, few costs are incurred in building extensive inspection facilities. The third major savings is the program's focus on the core of seriously defective vehicles. This avoids the expense of examining many vehicles without hazardous defects. The concentration on hazardous vehicle populations may also shorten the time between when a defect occurs and when it is detected and repaired. Under the checklane system, some obviously poorly maintained vehicles may be checked several times a year. The checklane has also been postulated to yield an overall bettering of owner maintenance practice. Concern with keeping the vehicle in good repair may be increased in order to avoid a possible traffic citation if stopped in the lane. Unfortunately, the present study produced scant evidence of such an effect. A final advantage of the checklane, which was not considered in this report, is that it does provide an opportunity to enforce driver's license regulations thus possibly reducing the number of unlicensed, suspended, and revoked drivers on the road.

The checklane approach is not without disadvantages. First the inspections conducted are likely to be gross functional checks of certain system's operation. Such inspection may not reveal more subtle defects which could be equally as important to safety as the more obvious failures. Second, drivers may become adept at avoiding the lanes and those with the most seriously defective vehicles would have the greatest incentive to do so. Once the vehicle had been inspected and found defective, extensive steps are necessary to secure repair of the defect. Absence of such re-inspection has been the major shortcoming of current systems. Finally,by concentrating on areas with high proportions of defective vehicles, the lane as a natural consequence will weigh disproportionately on economically disadvantaged persons, many of whom are members of racial minority groups. Thus, the lane can raise a rather delicate civil rights issue which will require careful consideration of the relative merits of efficiency and equity. In this same vein, constant alertness must be maintained to prevent the lane from becoming merely a pretext for other law enforcement goals rather than a vehicle inspection tool. However, in expressing these concerns it should be stated that they may be academic. The Michigan program has been in effect for six years, including operations through some very "hot" summers when police community relations were severely strained. Yet, while not entirely free of occasional individual citizen unhappiness, the lane did not generate any major incidents or widespread protest.

The major unresolved question about the checklane is whether it is as good as a periodic inspection system, in the sense of attaining as low an incidence of vehicle defects as attained under the periodic system. This report does not answer the question in any specific, quantitative sense. The issue has been largely avoided for two reasons. The first is somewhat philosophical, but also contains some real technical problems. As suggested in the discussion of goals, the equally important question of what is the optimal incidence of vehicle defects has not been resolved. Thus testing two systems against the same standard, when the standard may not be appropriate, does not necessarily lead to a sound course of action. Even given that the performance of a periodic system is somewhere near the optimum, the issue of what is the appropriate test criteria remains open. Should it be the overall incidence of defective vehicles in the population, some weighted index of outage rates of particular components, or the frequency of truly derelict vehicles? This suggests the second reason why the "as good as" question was not answered. Review of the other investigations of vehicle condition indicated that they differed sufficiently in scope, inspection techniques and criteria, and sampling methodology so that direct comparison of the present results with them would be invalid. Consequently, in the earlier chapters, the issue of whether the checklane had an effect was considered, and here, given that some effect was indicated, the concern has been whether the lane is sufficiently attractive compared with other alternatives to merit continuation.

D. Limited Conventional Inspection

A second alternative is inspecting a portion of the vehicle population each year through conventional inspection procedures. A reasonable approach might be to inspect all vehicles five years of age and older and all vehicles sold as used cars. This system would be less costly than universal inspections and would concentrate on the vehicles most likely to be defective. Annual inspection of vehicles five-years old and older, and of used cars at time of sale would involve nearly 60% of the state's vehicles. Approximately 40% of the vehicles fall in the five-years and older category. The remainder would depend on used car sales. Some administrative burden would be involved in keeping track of which vehicles ought to be inspected. In all, though, limited conventional inspection would possess all the advantages and disadvantages of a full conventional system. The main virtue would be that its overall cost would be lower. The main specific disadvantage would again be the equity issue. Wealthier new vehicle owners would be exempt while the less affluent owners of older vehicles would be subject to inspection requirements.

E. Full Conventional Inspection

This would be an annual inspection of every registered vehicle in the state as envisioned by the Federal Highway Safety Standards. Such a system could be conducted by private garages under state supervision, by state operated facilities, or, as in Florida, by some mixed system at county option. The main appeal of such a system is its universality so that no opportunity to repair a defective vehicle would be missed. Additionally conventional inspections might be more thorough than the checklane. Repair of defective vehicles would be more likely since rejected or uninspected vehicles would be quite easily detectable from the mass of passed vehicles.

On the negative side, conventional approaches lack the opportunity to maintain pressure on the vehicle owners for good maintenance practice between inspection intervals. The major drawback is their high cost. As discussed in section B, such systems are likely to cost from $10 to $15 per vehicle examined. For the full system, inspecting the state's 5.5 million vehicles would cost in the $55 to $82.5 million range. Using the state police's estimate of economic loss from accidents of $752 million per year and the 7% accident reduction figure discussed in Section B, the benefit of the full conventional program would be $52.6 million per year. Hence, unless more generous estimates of accident costs or higher estimates of effectiveness are used, a full conventional program would not appear to be cost beneficial.* The major cost burden of the full conventional system comes from inspecting a large number of vehicles which are quite unlikely to have hazardous defects.

With either a full or a limited conventional system, the appropriate structure will have to be selected. The ramifications

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* It should be again noted that these numbers are not based on a rigorous economic analysis and thus may not be imprecise. Nevertheless, they are not patently unreasonable.

either of a private garage system or of a state operated one require more investigation, but state operation initially seems more attractive. Private garages offer great motorist convenience and low initial cost. Yet, they are more costly per inspection due to use of low-volume, labor-intensive methods, they are less amenable to technological improvement, and they carry a high risk of widespread abuses. A state operated system would entail more inconvenience for the motorist, particularly in thinly populated areas, and would impose all the difficulties of establishing a major new state program. These disadvantages seem offset by the lower cost of high-volume operations and the assurance of uniform, fair procedures. The county option approach, as used in Florida, avoids the issue at the state level, but only at the cost of creating 83 different inspection programs, each with differing standards and reliability. A uniform state-wide system therefore seems more advantageous.

Overall the full conventional system would not appear to be cost beneficial. The possibility that a full conventional system will be more effective in reducing the incidence of certain types of defects undeniably exists. Nevertheless, the additional safety benefit from such possible improvements lack proof. Such factors then mitigate against recommendation of a full conventional system.

F. Diagnostic Systems

The diagnostic systems approach to vehicle safety quality encompasses two related concepts: (1) automation and instrumentation of the inspection process and (2) installation of in-vehicle condition monitoring systems. Diagnostic systems represent the bold new future in vehicle maintenance. In some way this future has already come with the introduction of electronic condition monitoring devices on Volkswagens. Further development of such systems is envisioned by the Motor Vehicle Cost Savings and Information Act of 1972 which provides substantial Federal funding for both research and development and for implementation of state demonstration programs.

Diagnostic systems promise several marked improvements in the state of the art. For inspection, automation techniques have been predicted to increase greatly the ability to detect failures and are assumed to lower costs by speeding the process. (1) Additionally, these techniques may lower repair cost by providing more accurate information on the precise nature of the problem. (28) Such benefits can accrue even with current vehicle designs. Briefly, adoption of autmoation techniques to inspection can reduce costs and increase effectiveness, perhaps then making periodic inspections clearly cost effective.

More importantly, building condition monitoring systems into the vehicle has a high potential for improving safety quality and increasing maintainability. Such systems could provide immediate warnings of hazardous conditions. Or,if continuous onboard monitoring were not feasible, sensors might be regularly checked by test equipment as part of the service operations, as in the present Volkswagen system. (29) It is easy to envision every service station with a mini-computer which scans critical component systems with plug-in read-out circuits in just as routine a fashion as checking oil with each fill-up. On-vehicle systems can bridge two important gaps of any inspection system. First, they can radically shorten the time between a failure's occurrance and its detection, thus minimizing the duration of the hazard. Second, such systems may lower costs sufficiently to make frequent, wide-spread testing viable. However, careful though would have to be given to appropriate enforcement mechanisms for those who would be unwilling to meet the standards.

Since diagnostic systems exist more in concept than in reality, it is difficult to appraise fully their merits. An easy criticism is that such systems have not yet had a full, independent economic appraisal. Yet, some attempts have been made, and they have indicated a good potential payoff (1,28). Condition monitoring approaches do look particularly promising, provided that people heed the warnings. A host of technical problems remain to be solved. These include what systems to monitor, how to monitor them, reliability, and standardization. Progress on these problems has been made, and at least one system is in mass production. Yet until more is known, a solid assessment cannot be made.

Experience in other areas can provide a guide. In aviation, diagnostic systems have greatly altered maintenance practice and lead to substantial increases in efficiency. (30) These developments have provided impetus to the diagnostic approach in motor vehicles. Yet even in aviation, there have been limits to the payoffs from such systems. Further, aviation applications have been to more complex and critical systems than found in motor vehicles. Since automotive systems are less complex, monitoring systems may be correspondingly simple and inexpensive, thus making them economically attractive. To generalize, the success of a technological approach in one area indicates that it merits serious consideration in other fields, but such a transfer requires precise understanding of the differences among areas.* The history

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* The well publicized troubles of the F-111 point to the difficulty of applying certain automotive design concepts to aviation. Similarly the problems of aerospace contractors in working on ground transportation systems indicates that technology might not flow too easily in the other direction. The lesson is that while such exchanges of ideas are often valuable there are rarely easy solutions.

of complex systems has often shown that original estimates of merit were optimistic. Implementation often has taken longer, been more difficult, and incurred higher costs than originally anticipated. Realized gains have often turned out to be lower. Yet in computers, communications, aviation, and medicine, among many areas, technological change has brought dramatic reductions in cost, increases in performance, and improvements in reliability and safety, all within relatively short time periods. In short, progress is a tricky, unpredictable beast. One's dreams are often unrealized, but one's reality is usually substantially improved.

Philosophy aside, the present federal program under the Motor Vehicle Cost Savings Act offers the state administration some attractive opportunities. Availability of substantial Federal funding would ease the financial burdens of establishing an inspection system. Michigan's unique position with the automobile industry provides good opportunities for technical exchanges in developing an outstanding system. Applying the most modern approach is in keeping with Michigan's progressive image. Politically state officials would be in a much stronger position with Federal officials by helping shape the future rather than continuing a ruggedly independent stance. Still, the cost of pioneering are likely to be high, even with Federal support, and risks of substantial disappointments cannot be ignored. The difficulty of finding well-established, continuing success stories in highway safety programs adds plausibility to such risks of failure. Still, the potentials of diagnostic systems merit serious consideration. At a minimum a technically qualified individual should be made responsible for keeping abreast of developments and periodically reporting on them to other responsible officials.

G. Conclusions

In Chapter I, the recommendation was for Michigan to continue the checklane program as its inspection system. Hopefully, in this chapter, the reasons behind the recommendation were more clearly spelled out. After reviewing the alternatives, the checklane appears to be the most satisfactory. The evaluation research indicated that the program did have an effect on vehicle safety quality and that the follow-up procedures did remarkably well. Admittedly, the evidence might have been stronger, but the magnitude of the investigation does increase its believability. Given that the research does point to an effect, then the low cost, ability to focus on the core of the problem and the non-vehicle safety benefits of the checklane all point to its continuation.

If state officials chose to act otherwise, then the limited conventional or the experimental diagnostic systems would be rated equally. Both will be more costly than the checklane program, by a substantial margin, and the additional immediate benefits are problematical. The choice is between a pioneering and a conventional approach. Universal conventional inspection is by far the most costly alternative, and the costs may well exceed the benefits. Additionally, the conventional approach faces the possibility of becoming obsolete, and a full system would be harder to change than a limited one. For an alternative state operation seems more desirable. The administrative burdens of establishing a new state operated system will be great, but these are small compared with those of maintaining a fair, equitable, effective, and progressive system with several thousand independent operators.

To restate the conclusions once more, the checklane appears to merit continuation for the intermediate future. The present evaluation has shown some positive, though qualified, effects on improving vehicle condition. The good success of the experimental follow-up procedures indicates a fairly strong potential for even greater improvements with the enactment of mandatory repair provisions. At the same time, the state should keep abreast of changing technology, so that in five to ten years when the potentials of diagnostic systems have been more fully realized, the state can move to what is then the best system.

References

1. Beraru, Jonas. "Automated Diagnostic Systems and Vehicle Inspection, Final Report: Phase I." Redondo Beach, California: TRW Systems Group, March 1968.

2. O'Day, James and Creswell, Jay S., Jr., "A Modeling Approach to Motor Vehicle Inspection," American Society of Mechanical Engineers Proceedings, Winter, 1967.

3. ____________. "An Analytical Model of Periodic Motor Vehicle Inspection," Ann Arbor: The University of Michigan Highway Safety Research Institute (HSRI), December, 1969. ("Paper presented to the 36th Winter Annual Meeting, Operations Research Society of America, Miami Beach, Florida, November 27, 1969.")

4. McCutchen, Robert W. and Sherman, Harold W. "The Influence of Periodic Motor Vehicle Inspection on Mechanical Condition." Ann Arbor: HSRI, July, 1968.

5. Fisher, F.G., Jr., Eidmiller, R., Biche, P., Vehicle-in-Use Safety Standards Study (4 Vols). Newport Beach, California: Ultrasystems, Inc., August, 1971.

6. Barrett, Rolin F. and Whitfield, John K., "Cost Effectiveness Guidelines for Motor Vehicle Safety Inspection Programs." Raliegh, North Carolina: North Carolina State University at Raleigh, School of Engineering, June 30, 1972.

7. Buxbaum, Robert C. and Colton, Theodore. "Relationship of Motor Vehicle Inspection to Accident Mortality," Journal of the American Medical Association. 197:31-36, 1966.

8. Colton, Theodore and Buxbaum, Robert C. "Motor Vehicle Inspection and Motor Vehicle Accident Mortality," American Journal of Public Health. 58(6):657-661, 1967.

9. Mayer, Albert J. and Hoult, Thomas F., "Motor Vehicle Inspection: A Report on Current Information, Measurement, and Research." Detroit, Michigan: Wayne State University, Institute for Regional and Urban Studies, 1963.

10. Fuchs, Victor R. and Leveson, Isaac. "Motor Accident Mortality and Compulsory Inspection of Vehicles," Journal of the American Medical Association. 201:657-661, 1967.

11. Recht, J.L. Multiple Regression Study of the Effects of Safety Activities on the Traffic Accident Problem. Chicago: National Safety Council, 1965.

12. Brenner, Robert; Bradford, Lynn; and Parker, George. "Motor Vehicle Inspection," 1970 International Automobile Safety Compendium. New York: Society of Automotive Engineers, 1970.

13. Bintz, Louis J., Dauchy, Craig E., and Appelby, Michael R. "Motor Vehicle Inspection." Los Angeles(?):Automobile Club of Southern California, 1970.

14. Little, Joseph W. and Hall, William K. "A Study to Investigate the Association of Accident Severity and Frequency with Vehicle Age," Ann Arbor, HSRI, 1968.

15. Joksch, Hans C. "The Relationship Between Injury Frequency and Severity and Vehicle Age in Pre-1967 Automobiles," Accident Analysis and Prevention. 3:281-289, 1971.

16. Campbell, B.J. and Reinfurt, Donald W. Personal communications of research in progress, 1971-1972. (A study being undertaken at Highway Safety Research Center, University of North Carolina, Chapel Hill.)

17. Wells, E.N., et al., "An Investigation of Used Car Safety Standards" Silver Spring, Maryland: Operations Research, Inc., 1969.

18. "Vehicle-in-Use-System Safety Analysis." Bethesda, Maryland: Booze-Allen Applied Research, Inc., 1970.

19. Treat, John R. and Joscelyn, Kent B. "Study to Determine the Relationship between Vehicle Defects and Crashes, Interim Report." Bloomington, Indiana: Indiana University, Institute for Research in Public Safety, November, 1971.

20. ___________. "Study...Crashes, Final Report." Bloomington, Indiana: Indiana University, Institute for Research In Public Safety, May, 1973.

21. Fisher, F.G., Jr., Eidmiller, R., Biche, P. "Inspection of Motor Vehicles in Bloomington, Indiana and Monroe County." Newport Beach, California; Ultrasystems, Inc., 1972.

22. "Motor Vehicle Inspection--Evaluation and Recommendations." New York:Coverdale and Colpitts, 1967.

23. "Cost Effectiveness Study of Selected Motor Vehicle Inspection Systems for Michigan." East Lansing: Michigan Department of State Police, Operations Research Unit, 1972.

24. "Vehicle-in-Use-Inspection Standards." Federal Register. 38(171): 23949-23952, September, 1973.

25. Accident Facts, 1972. Chicago: National Safety Council, 1973.

26. "Benefits and Costs of Motor Vehicle Safety Standards Planned for Passenger Cars, Staff Report (Preliminary)." Washington, D.C.: U.S. Department of Transportation, National Highway Traffic Safety Administration, 1972.

27. Peszek, R.J. "Why the Difference in Accident Price Tags?" Traffic Safety. 73(4):22, April, 1973.

28. Weiss, David W. and Mateyka, James. "Periodic Motor Vehicle Inspection Requirements for Improved Diagnosis." New York: Society of Automotive Engineers, 1973. (Publication number 730207).

29. "Standardization of Automotive Diagnostic Systems," Proceedings First International Congress on Automotive Safety. Washington, D.C.(?):National Motor Vehicle Safety Advisory Council(?), 1972. (Publisher and sponsor of this document not clearly specified in standard fashion. Title page contains logotype of U.S. Department of Transportation and Foreward contains footnote "For additional information contact: Executive Secretariat, Department of Transportation Headquarters, Washington, D.C.")

30. Michael L. Yaffee. "New Maintenance Systems Aid Efficiency," Aviation Week. 99(17):57, October 22, 1973.

31. Bird, K.D., Belsdorf, M.R., and Rice, R.S. "Effects of Steering and Suspension Component Degradation on Automobile Stability and Control." Buffalo, New York: Cornell Aeronautical Laboratory, January, 1971.

32. Fancher, Paul S., et.al. "Limit Handling Performance as Influenced by Degradation of Steering and Suspension Systems." Ann Arbor, HSRI, 1972.

33. Murphy, Ray W., Limpert, Rudolf, and Segel, Leonard. "Bus, Truck, Tractor/Trailer Braking Performance," Ann Arbor: HSRI, 1971.

34. DeVinney, W.E. "Factors Affecting Tire Traction." New York: Society of Automotive Engineers, 1967. (Publication number 670461).

APPENDIX A

SECONDARY ANALYSES OF SAMPLE INSPECTION DATA

As noted in Chapter III, increases of defects in Kent or Genesee counties with no change in Ingham county may be viewed as supportive evidence for random inspection of 20% of the vehicle population. However, since that interpretation is questionable at best, those data are presented here rather than in the main text.

Since total control defects were found to increase in Genesee county (see Table III.9), regression analyses were computed for each component of the total control sub-system. Results for these analyses on steering, foot brake, emergency brake, tire bulge, and tire treads are presented in Table A.1.

Steering defects decreased significantly in Ingham and Kent counties. Again, note the very small number of defects per 100 vehicles (i.e., constant coefficient). Since the absolute figures are so small, a decrement is practically meaningless. Tire tread defects can be seen to have increased significantly in Genesee county, but were unchanged in Kent and Ingham.

In order to determine if these effects were specific to either low or high income areas, the data were stratified by income. The results are presented in Table A.2. Steering defects were found to have decreased only in Kent's high income areas. Tire tread defects showed no change in Genesee following income stratification.

As noted in Chapter III, defects for the total vision components were so few that drawing conclusions about observed changes is tenuous. Therefore, computation of regression analyses after stratifying by income is included here to try to circumvent questionable conclusions while still presenting the relevant results. Table A.3 shows that wiper defects increased in the high income areas of Genesee county and obstructed vision decreased in both the high and low income areas of Ingham.

TABLE A.1

Regression Analyses of Total Control Defects:
number of defects per 100 vehicles

Variable	County	Income	Constant	Cycle	Error	F	Sig.
Steering	Kent	All	.66	-.14	.24	3.38	.07
	Genesee	All	.19	.05	.35	.310	.58
	Ingham	All	.57	-.12	.22	2.64	.10
Foot Brake	Kent	All	.28	-.05	.15	.600	.44
	Genesee	All	.09	.05	.25	.429	.51
	Ingham	All	.09	-.00	.09	.000	.99
Emergency Brake	Kent	All	8.03	.22	7.92	.249	.62
	Genesee	All	8.03	.68	9.04	1.96	.16
	Ingham	All	11.22	-.16	9.59	.114	.74
Tires Bulge	Kent	All	---	---	---	----	---
	Genesee	All	---	---	---	----	---
	Ingham	All	.04	-.00	.04	.000	.99
Tire Treads	Kent	All	14.45	-.23	11.87	.196	.66
	Genesee	All	13.04	1.24	13.92	4.28	.04
	Ingham	All	19.06	-.78	13.93	1.90	.17

TABLE A.2

Regression Analyses of Steering and Tire Treads
Stratified by Income:
number of defects per 100 vehicles

Variable	County	Income	Constant	Cycle	Error	F	Sig.
Steering	Ingham	Low	.36	-.01	.09	1.93	.16
		High	.78	-.14	.33	1.38	.24
Steering	Kent	Low	.47	-.09	.21	.817	.37
		High	.83	-.18	.27	2.75	.10
Tire Treads	Genesee	Low	13.83	1.32	14.63	2.23	.14
		High	12.40	1.15	13.32	2.01	.16

TABLE A.3

Regression Analyses of Wipers, Mirrors, and Obstructed Vision Stratified by Income: number of defects per 100 vehicles

Variable	County	Income	Constant	Cycle	Error	F	Sig.
Wipers	Genesee	Low	2.05	.21	2.62	.320	.57
		High	.85	.61	2.59	2.91	.09
Mirror	Kent	Low	1.23	-.17	.72	.835	.36
		High	1.15	-.23	.45	2.60	.11
Vision Obstructed	Ingham	Low	9.41	-1.34	5.13	7.48	.01
		High	5.01	-.62	3.01	2.87	.09

TABLE A.4

Regression Analyses of Exhaust Noise: number of defects per 100 vehicles

Variable	County	Income	Constant	Cycle	Error	F	Sig.
Exhaust Noise	Kent	All	3.53	.62	5.08	3.20	.07
	Genesee	All	6.84	.23	6.97	.297	.59
	Ingham	All	8.63	-.15	7.52	.127	.72
	Kent	Low	3.70	1.12	6.47	3.93	.05
		High	3.35	.21	3.84	.259	.61

Finally, regression analyses were computed for exhaust noise because the lighting survey results indicated this component showed improvement in some cases and worsening in others. Table A.4 reveals that exhaust noise increased in Kent county, specifically in low income areas.

Sample Inspection Procedures

1. <u>General</u>. The inspection procedure for the sample inspection will be the same as for regular vehicle inspections as outlined in the <u>Michigan Motor Vehicle Manual</u>. The inspection criteria, lane set-up, and general operations will follow standard practice. The sample inspection will differ, however, in scheduling, general site location, vehicle selection, and interview administration.

2. <u>Site Selection</u>. (a) General. Areas for sites will be selected according to the experimental plan. Eight sites will be selected in each county. Four of these sites will be in higher income areas, and four will be in lower income areas. Moreover, sites will be chosen to include both central city and urban fringe locations.

(b) Specifics. Within the selected areas, specific sites will be chosen to have two characteristics. First, should be sites on streets with moderate traffic volume, 100 to 300 vehicles per hour, of predominantly local traffic. Through routes and neighborhood streets are to be avoided. Secondly, a site must be suitable for safe and efficient operation and must be set up according to the inspection manual.

3. <u>Scheduling</u>. Sample inspections will be conducted for a three hour period at each site. Starting times will be varied over the day in order to have a representative mix of traffic. Four starting times will be used, 7:30 a.m., 10:30 a.m., 12:30 p.m., and 2:30 p.m. Each site will be visited on the same day of the week and at the same starting time for each visit. All the sites in a county will be visited during a one week period. Starting times will be balanced across site types. This means that each starting time will be used twice during the week, once for a high income location and once for a low income location. Each county, and thereby each site, will be visited five times over the data collection period.

4. <u>Vehicle selection</u>. Since the purpose of the sample is to obtain a representative picture of the population of the vehicles, selection procedures must be adhered to with great care. The procedure outlined here has been designed to insure that the sample will be free of bias. In effect, the procedure is to make the selection of a vehicle for inspection completely arbitrary so that the person making the selection will not affect the sample with his own preconceptions of what the representative population looks like. The

procedure used is simple. Starting with the first vehicle to arrive at the site after the scheduled starting time, the person responsible for stopping vehicles, the point man, will start counting cars which pass the sample site. He will count only those cars traveling in the direction for which the lane is set up to accept vehicles. Depending on traffic volume he will stop every 5th, 10th, 15th or 25th vehicle that arrives. The interval will vary from one in five for light traffic to one in twenty-five for very heavy traffic. When the vehicle that arrives in "on the count" it will be waved into the inspection lane regardless of its age or condition. Only three types of vehicles are to be omitted: large trucks, emergency vehicles, and out-of-state vehicles. If one of these "exempt" vehicles arrives on the count, the vehicle immediately following it will be chosen. If traffic volume changes over the sampling period, the observer may change the selection interval. This change should be make immediately after selecting a vehicle and without observing the nature of vehicles approaching.

5. Post-selection. After the vehicle has been waved into the lane, the person assigned to greet the motorist will state that the motorist has been stopped for a regular vehicle inspection. The motorist will be also informed that as part of a special study of the inspection program, he is being asked to complete a brief questionnaire while awaiting inspection. Completion of the questionnaire will be voluntary. If the motorist needs assistance in completing the questionnaire, it should be given. Requests to be excused from inspection should be denied in keeping with regular operating procedure. In instances where detaining the individual will obviously and materially affect his welfare, e.g. when the driver is transporting a visibly ill or injured passenger for medical treatment, the vehicle may be excused. After the person has completed the questionnaire, the form will be collected from him, and the vehicle registration number will be noted on the form. Then the vehicle will be inspected according to standard inspection procedures, and the condition will be recorded on the usual record keeping form.

6. Special clerical procedures. Inspection results will be recorded on the regular report form. Special identification numbers are assigned to each sample site, and these should be recorded on the form so that sample inspections can be identified for later data

processing purposes. Besides the regular processing of inspection forms, two other clerical tasks must be performed. First a summary activity sheet for the site must be completed. This sheet will indicate site number, date, total vehicles sampled, and number of vehicles failed. Second, questionnaires and inspection reports will be matched, and the inspection status of the vehicle will be recorded on the appropriate place on the questionnaire.

APPENDIX B

Table B.1a

Regression Analysis of
Failure Rates by County
Income, and Location Types
for Road-Side Observation Data

County	Income	Type	Constant	Time*	Income	R^2
All 3	All	All	.38786	-.00015 (.1019)	-.06866 (.0000)	.206
		Friday	.37784	-.00008 (.5419)	-.05970 (.0009)	.130
		Weekday	.39984	-.00020 (.0985)	-.08036 (.0000)	.357
	Low	All	.30003	.00002 (.8993)		.000
		Friday	.30547	-.00004 (.8561)		.009
		Weekday	.29213	.00002 (.9142)		.000
	High	All	.27012	-.00032 (.0071)		.088
		Friday	.27087	-.00019 (.2321)		.034
		Weekday	.26979	-.00045 (.0055)		.200

Numbers in parentheses indicate Type I error probabilities.
*Time in days past 4/30.

Table B.1b

Regression Analysis of
Failure Rates by County
Income, and Location Types
for Road-Side Observation Data

County	Income	Type	Constant	Time*	Income	R^2
Genesee	All	All	.40990	-.00016 (.1635)	-.08811 (.0000)	.451
		Friday	.39124	-.00009 (.5618)	-.08222 (.0003)	.370
		Weekday	.44554	-.00033 (.0725)	-.09458 (.0001)	.609
	Low	All	.30154	-.00002 (.9028)		.001
		Friday	.30127	-.00002 (.9528)		.000
		Weekday	.30341	-.00005 (.8030)		.007
	High	All	.25571	-.00035 (.0190)		.201
		Friday	.23455	-.00017 (.3427)		.064
		Weekday	.32272	-.00082 (.0058)		.590

Numbers in parentheses indicate Type I error probabilities.
*Time in days past 4/30.

Table B.1c

Regression Analysis of
Failure Rates by County
Income, and Location Types
for Road-Side Observation Data

County	Income	Type	Constant	Time*	Income	R^2
Ingham	All	All	.37872	-.00026 (.0223)	-.05724 (.0002)	.289
		Friday	.38538	-.00021 (.0592)	-.05968 (.0005)	.453
		Weekday	.37265	-.00029 (.2120)	-.05612 (.0271)	.212
	Low	All	.30587	-.00012 (.4621)		.021
		Friday	.31261	-.00007 (.6868)		.015
		Weekday	.29493	-.00011 (.7189)		.010
	High	All	.27975	-.00040 (.0113)		.222
		Friday	.27900	-.00034 (.0070)		.468
		Weekday	.28225	-.00047 (.1845)		.142

Numbers in parentheses indicate Type I error probabilities.
*Time in days past 4/30.

Table B.1d

Regression Analysis of
Failure Rates by County
Income, and Location Types
for Road-Side Observation Data

County	Income	Type	Constant	Time*	Income	R^2
Kent	All	All	.37477	-.00003 (.9088)	-.06069 (.0315)	.091
		Friday	.37524	-.00009 (.8224)	-.03654 (.4507)	.026
		Weekday	.39127	-.00000 (.9878)	-.09450 (.0006)	.409
	Low	All	.29115	.00015 (.6778)		.007
		Friday	.30852	.00014 (.8297)		.005
		Weekday	.28169	.00012 (.7683)		.008
	High	All	.27583	-.00021 (.4811)		.021
		Friday	.32919	-.00030 (.5045)		.038
		Weekday	.21835	-.00014 (.3496)		.088

Numbers in parentheses indicate Type I error probabilities.
*Time in days past 4/30.

Table B.1e

Regression Analysis of
Failure Rates by County
Income, and Location Types
for Road-Side Observation Data

County	Income	Type	Constant	Time*	Income	R^2
Genesee & Ingham	All	All	.28646	-.00022 (.0265)		.044
		Friday	.38932	-.00015 (.1098)	-.07159 (.0000)	.374
		Weekday	.40525	-.00031 (.0394)	-.07327 (.0000)	.356
	Low	All	.30381	-.00005 (.6614)		.004
		Friday	.30687	-.00005 (.7688)		.003
		Weekday	.29731	-.00003 (.8774)		.010
	High	All	.26896	.00038 (.0004)		.213
		Friday	.25694	-.00026 (.0197)		.179
		Weekday	.29860	-.00062 (.0064)		.281

Numbers in parentheses indicate Type I error probabilities.
*Time in days past 4/30.

Table B.2a Selected Component and Vehicle Measures by Month; All Counties by Income Level

All Income Levels

Month	Number of Observations	Avg Defs/ 100 Cars	Avg Minor Defs/100 Cars	Percent Plate Light Only	Percent Single Defects	Percent Plate Light	Percent Tail Light
May	16	34.31	23.78	14.58	21.28	18.91	5.76
Jun	23	33.58	21.49	13.45	20.59	17.51	6.47
Jul	32	35.35	24.26	14.33	21.13	19.13	6.48
Aug	20	36.38	24.21	14.67	22.80	19.13	6.91
Sep	8	32.82	22.54	12.73	19.76	16.40	4.75
Oct	32	32.30	22.25	13.00	19.63	16.92	5.30
Nov	32	32.25	21.00	13.16	19.51	16.94	4.99
F Ratio		0.419	0.819	0.79634	1.001	1.0298	1.389
Significance Level		(0.865)	(0.556)	(0.574)	(0.466)	(0.4081)	(0.224)

All Columns have (6,156) degrees of freedom.

Low Income Levels

Month	Number of Observations	Avg Defs/ 100 Cars	Avg Minor Defs/100 Cars	Percent Plate Light Only	Percent Single Defects	Percent Plate Light	Percent Tail Light
May	8	38.10	24.62	14.94	23.34	19.68	7.56
Jun	12	40.01	24.09	14.60	23.35	19.85	8.45
Jul	16	41.63	48.10	15.77	23.31	21.89	7.75
Aug	10	43.20	28.24	15.53	25.13	21.42	8.63
Sep	4	41.74	27.40	13.22	23.21	18.45	6.73
Oct	17	40.68	28.62	15.61	23.53	21.13	6.68
Nov	16	42.04	27.34	15.18	23.75	20.60	6.30
F Ratio		0.179	0.846	0.349	0.164	0.499	0.992
Significance Level		(0.982)	(0.539)	(0.908)	(0.986)	(0.807)	(0.437)

All Columns have (6,76) degrees of freedom

High Income Levels

Month	Number of Observations	Avg Defs/ 100 Cars	Avg Minor Defs/100 Cars	Percent Plate Light Only	Percent Single Defects	Percent Plate Light	Percent Tail Light
May	8	30.52	22.94	14.22	19.22	18.15	3.96
Jun	11	26.57	18.65	12.18	17.59	14.96	4.31
Jul	16	29.06	20.42	12.90	18.95	16.37	5.20
Aug	10	29.55	20.19	13.80	20.47	15.83	5.19
Sep	4	23.90	17.68	12.24	16.32	14.36	2.77
Oct	15	22.80	15.03	10.05	15.20	12.16	3.74
Nov	16	22.47	14.67	11.14	15.27	13.28	3.68
F Ratio		4.016	5.621	1.904	3.653	3.387	1.138
Significance Level		(0.002)	(0.0001)	(0.092)	(0.003)	(0.005)	(0.349)

All Columns have (6,73) degrees of freedom.

Table B.2b Selected Component and Vehicle Measures by Month; Genesee County by Income Level

All Income Levels

Month	Number of Observations	Avg Defs/ 100 Cars	Avg Minor Defs/100 Cars	Percent Plate Light Only	Percent Single Defects	Percent Plate Light	Percent Tail Light
May	8	32.97	21.13	12.51	19.49	16.77	6.44
Jun	8	36.18	21.59	12.61	20.23	17.45	7.69
Jul	8	36.90	24.35	13.11	21.56	17.87	7.06
Aug	8	35.19	22.79	13.78	21.49	17.99	7.37
Sep	4	20.54	20.48	11.24	18.34	14.28	4.62
Oct	8	32.13	20.76	12.25	19.13	15.79	6.00
Nov	12	31.64	19.73	10.53	17.82	14.41	4.83
F Ratio		0.319	0.943	1.042	0.787	1.135	0.843
Significance Level		(0.924)	(0.486)	(0.410)	(0.585)	(0.356)	(0.543)

All Columns have (6,49) degrees of freedom.

Low Income Levels

Month	Number of Observations	Avg Defs/ 100 Cars	Avg Minor Defs/100 Cars	Percent Plate Light Only	Percent Single Defects	Percent Plate Light	Percent Tail Light
May	4	37.86	21.73	13.47	22.37	18.18	8.93
Jun	4	43.64	23.63	13.75	23.74	19.30	10.79
Jul	4	38.54	25.25	13.58	22.21	19.12	8.63
Aug	4	41.78	24.48	12.93	22.86	18.77	10.51
Sep	2	38.85	24.07	12.25	23.03	16.38	6.38
Oct	4	43.33	27.44	14.09	23.01	20.92	8.82
Nov	6	39.93	25.50	11.47	21.63	16.51	6.01
F Ratio		0.146	0.775	0.943	0.246	1.475	1.053
Significance Level		(0.988)	(0.598)	(0.486)	(0.955)	(0.235)	(0.421)

All Columns have (6,21) degrees of freedom.

High Income Levels

Month	Number of Observations	Avg Defs/ 100 Cars	Avg Minor Defs/100 Cars	Percent Plate Light Only	Percent Single Defects	Percent Plate Light	Percent Tail Light
May	4	28.07	20.54	11.56	16.61	15.36	3.94
Jun	4	28.72	19.55	11.48	16.71	15.60	4.60
Jul	4	35.26	23.46	12.63	20.91	16.62	5.48
Aug	4	28.59	21.11	14.64	20.12	17.21	4.22
Sep	2	22.22	15.89	10.24	13.64	12.17	2.85
Oct	4	20.93	14.08	9.42	15.26	10.65	3.17
Nov	6	23.36	13.96	9.58	14.01	12.30	3.64
F Ratio		3.578	2.619	1.086	1.769	1.5375	1.055
Significance Level		(0.134)	(0.047)	(0.403)	(0.155)	(0.215)	(0.420)

All Columns have (6,21) degrees of freedom.

Table B.2c Selected Component and Vehicle Measures by Month; Ingham County by Income Level

All Income Levels

Month	Number of Observations	Avg Defs/ 100 Cars	Avg Minor Defs/100 Cars	Percent Plate Light Only	Percent Single Defects	Percent Plate Light	Percent Tail Light
May	4	36.71	27.32	17.50	22.96	22.29	5.13
Jun	11	33.34	22.06	14.63	21.48	18.47	6.40
Jul	12	33.15	22.21	13.81	20.38	18.34	7.34
Aug	4	41.66	25.60	16.23	25.31	21.00	9.24
Sep	4	35.10	24.60	14.22	21.19	18.53	4.89
Oct	13	30.47	20.25	11.42	18.11	15.12	5.30
Nov	8	30.22	19.54	13.17	18.73	16.39	5.71
F Ratio		1.122	1.1305	1.692	1.732	1.857	1.649
Significance Level		(0.364)	(0.359)	(0.143)	(0.136)	(0.107)	(0.154)

All Columns have (6,49) degrees of freedom.

Low Income Levels

Month	Number of Observations	Avg Defs/ 100 Cars	Avg Minor Defs/100 Cars	Percent Plate Light Only	Percent Single Defects	Percent Plate Light	Percent Tail Light
May	2	37.63	25.14	16.29	21.50	21.02	6.57
Jun	6	39.08	24.84	15.67	23.13	21.23	7.89
Jul	6	25.92	24.05	15.67	22.33	19.82	7.21
Aug	2	40.46	27.87	17.22	24.42	21.53	8.00
Sep	2	44.62	29.72	14.20	23.38	20.51	7.09
Oct	7	35.23	24.99	14.37	21.07	18.70	5.64
Nov	4	37.13	24.59	15.35	21.61	19.57	6.20
F Ratio		0.447	0.400	0.418	0.240	0.489	0.767
Significance Level		(0.839)	(0.871)	(0.859)	(0.958)	(0.809)	(0.602)

All Columns have (6,22) degrees of freedom.

High Income Levels

Month	Number of Observations	Avg Defs/ 100 Cars	Avg Minor Defs/100 Cars	Percent Plate Light Only	Percent Single Defects	Percent Plate Light	Percent Tail Light
May	2	35.78	29.51	18.70	24.41	23.56	3.68
Jun	5	26.45	18.71	13.37	19.49	15.15	4.61
Jul	6	30.37	20.37	11.94	18.43	16.86	7.46
Aug	2	42.86	23.33	15.24	26.19	20.48	10.48
Sep	2	25.57	19.47	14.25	19.00	16.54	2.69
Oct	6	24.91	14.73	7.97	14.66	10.93	4.89
Nov	4	23.30	14.49	10.98	15.85	13.22	5.22
F Ratio		4.071	2.589	2.0137	3.199	2.697	1.620
Significance Level		(0.008)	(0.050)	(0.111)	(0.023)	(0.044)	(0.194)

All Columns have (6,20) degrees of freedom.

Table B.2d Selected Component and Vehicle Measures by Month; Kent County by Income Level

All Income Levels

Month	Number of Observations	Avg Defs/ 100 Cars	Avg Minor Defs/100 Cars	Percent Plate Light Only	Percent Single Defect	Percent Plate Light	Percent Tail Light
May	4	34.59	25.54	15.81	23.18	19.82	5.04
Jun	4	29.05	19.71	11.85	18.91	14.99	4.21
Jul	12	36.51	26.25	15.68	21.59	20.77	5.23
Aug	8	34.93	24.93	14.78	22.86	19.33	5.29
Sep		---	---	---	---	---	---
Oct	11	34.58	25.70	15.42	21.78	19.88	4.79
Nov	12	34.22	23.25	15.79	21.72	19.83	4.67
F Ratio		0.129	0.343	0.622	0.196	0.467	0.100
Significance Level		(0.985)	(0.884)	(0.684)	(0.963)	(0.798)	(0.992)

All Columns have (5,45) degrees of freedom.

Low Income Levels

Month	Number of Observations	Avg Defs/ 100 Cars	Avg Minor Defs/100 Cars	Percent Plate Light Only	Percent Single Defect	Percent Plate Light	Percent Tail Light
May	2	39.05	29.88	16.54	27.13	21.31	5.79
Jun	2	35.53	22.73	13.10	23.21	16.78	5.44
Jul	6	49.40	34.04	17.32	25.01	25.82	7.71
Aug	4	46.00	32.17	17.29	27.75	24.03	7.06
Sep		---	---	---	---	---	---
Oct	6	45.26	33.65	17.40	26.76	24.10	6.46
Nov	6	47.41	31.01	18.77	27.30	25.37	6.65
F Ratio		0.329	0.604	0.431	0.167	0.774	0.712
Significance Level		(0.889)	(0.698)	(0.821)	(0.972)	(0.579)	(0.967)

All Columns have (5,20) degrees of freedom.

High Income Levels

Month	Number of Observations	Avg Defs/ 100 Cars	Avg Minor Defs/100 Cars	Percent Plate Light Only	Percent Single Defect	Percent Plate Light	Percent Tail Light
May	2	30.14	21.19	15.08	19.24	18.32	4.29
Jun	2	22.56	16.70	10.61	14.60	13.20	2.98
Jul	6	23.62	18.46	14.03	18.17	15.72	2.76
Aug	4	23.85	17.70	12.26	17.96	14.64	3.53
Sep		---	---	---	---	---	---
Oct	5	21.76	15.15	13.04	15.80	14.83	2.80
Nov	6	21.02	15.49	12.80	16.14	14.30	2.68
F Ratio		2.209	3.367	1.269	3.069	1.077	1.274
Significance Level		(0.096)	(0.024)	(0.319)	(0.034)	(0.4042)	(0.316)

All Columns have (5,19) degrees of freedom.

Table B.2e Selected Component and Vehicle Measures by Month: Genesee and Ingham Combined by Income Level

All Income Levels

Month	Number of Observations	Avg Defs/ 100 Cars	Avg Minor Defs/100 Cars	Percent Plate Light Only	Percent Single Defect	Percent Plate Light	Percent Tail Light
May	12	34.21	23.20	14.18	20.65	18.61	6.00
Jun	19	34.54	21.86	13.79	20.95	18.04	6.94
Jul	20	34.65	23.07	13.53	20.85	18.15	7.22
Aug	12	37.34	23.73	14.60	22.76	18.99	7.99
Sep	8	32.82	22.54	12.73	19.76	16.40	4.75
Oct	21	31.10	20.45	11.73	18.50	15.37	5.56
Nov	20	31.07	19.65	11.58	18.18	15.20	5.18
F Ratio		0.762	1.048	1.656	1.826	2.100	1.908
Significance Level		(0.601)	(0.399)	(0.139)	(0.101)	(0.059)	(0.086)

All Columns have (6,105) degrees of freedom.

Low Income Levels

Month	Number of Observations	Avg Defs/ 100 Cars	Avg Minor Defs/100 Cars	Percent Plate Light Only	Percent Single Defect	Percent Plate Light	Percent Tail Light
May	6	37.78	22.87	14.41	22.08	19.13	8.15
Jun	10	40.91	24.36	14.90	23.38	20.46	9.05
Jul	10	36.97	24.53	14.83	22.28	19.54	7.78
Aug	6	41.34	25.61	14.36	23.38	19.69	9.68
Sep	4	41.74	27.40	13.22	23.21	18.45	6.73
Oct	11	38.18	25.88	14.63	21.78	19.51	6.79
Nov	10	38.81	25.13	13.02	21.62	17.73	6.09
F Ratio		0.267	0.554	0.597	0.374	0.804	1.500
Significance Level		(0.950)	(0.769)	(0.731)	(0.892)	(0.572)	(0.197)

All Columns have (6,50) degrees of freedom.

High Income Levels

Month	Number of Observations	Avg Defs/ 100 Cars	Avg Minor Defs/100 Cars	Percent Plate Light Only	Percent Single Defect	Percent Plate Light	Percent Tail Light
May	6	30.64	23.53	13.94	19.21	18.10	3.85
Jun	9	27.46	19.08	12.53	18.25	15.35	4.60
Jul	10	32.33	21.60	12.22	19.42	16.77	6.67
Aug	6	33.35	21.85	14.84	22.14	18.30	6.30
Sep	4	23.90	17.68	12.24	16.32	14.36	2.77
Oct	10	23.32	14.47	8.55	14.90	10.82	4.21
Nov	10	23.33	14.17	10.14	14.75	12.67	4.28
F Ratio		4.347	4.386	2.330	3.014	3.443	1.825
Significance Level		(0.0014)	(0.001)	(0.047)	(0.014)	(0.007)	(0.114)

All Columns have (6,48) degrees of freedom.

Table B.3a

Regression Results: Percent Cars with Only Plate Light Out by County and Income Level

County	Income Level	No. Obs.	Constant	Time	Night Type	Income	R^2
All 3	All	163	22.047	-0.538	-2.049**	-3.137**	22.555
	Low	83	16.549	0.320	0.808		2.678
	High	80	18.150	-1.421**	-1.719**		17.247
Genesee	All	56	16.830	-1.134*	-0.377	-1.845**	13.772
	Low	28	12.874	-0.845	0.871		6.276
	High	28	15.251	-1.423	-1.626		12.988
Ingham	All	56	24.361	-1.392*	-2.705**	-3.348**	33.808
	Low	29	16.456	-0.628	-0.261		2.953
	High	27	22.381	-2.147*	-5.316**		46.172
Kent	All	51	26.189	0.414	-3.344**	-4.281**	44.238
	Low	26	22.748	1.398	-4.697**		33.102
	High	25	16.742	-0.554	-1.967**		21.829
Genesee and Ingham Combined	All	112	20.449	-1.321**	-1.414**	-2.601**	21.456
	Low	57	14.443	-0.799	0.498		3.527
	High	55	18.718	-1.834**	-3.403**		27.723

*Significant at .90 confidance level or higher.
**Significant at .95 confidance level or higher.

Table B.3b

Regression Results: Percent Cars with Single Defects by County and Income Level

County	Income Level	No. Obs.	Constant	Time	Night Type	Income	R^2
All 3	All	163	33.878	-0.857	-1.956**	-6.293**	35.997
	Low	83	26.380	0.463	-2.180*		4.732
	High	80	22.531	-2.220**	-1.719**		17.247
Genesee	All	56	29.046	-1.483*	0.732	-5.818**	42.450
	Low	28	21.174	-0.690	1.541		9.241
	High	28	19.465	-2.276	-0.077		10.191
Ingham	All	56	31.117	-1.690*	-2.071*	-3.845**	26.723
	Low	29	24.035	-0.669	-0.685		2.140
	High	27	26.776	-2.755**	-3.524**		31.920
Kent	All	51	43.436	-0.250	-4.698**	-9.505**	59.108
	Low	26	37.457	0.830	-7.875**		36.079
	High	25	20.738	-1.276*	-1.429*		23.978
Genesee and Ingham Combined	All	112	30.008	-1.617**	-0.648	-4.819**	30.897
	Low	57	22.647	-0.678	0.363		1.560
	High	55	22.961	-2.578**	-1.684		17.186

*Significant at .90 confidance level or higher.
**Significant at .95 confidance level or higher.

Table B.3c

Regression Results: Average Number of Defects per 100 Vehicles by County and Income Level

County	Income Level	No. Obs.	Constant	Time	Night Type	Income	R^2
All 3	All	163	63.386	-1.149	-3.933**	-15.036**	42.236
	Low	83	49.273	1.829	-6.876**		9.229
	High	80	32.377	-4.233**	-0.862		17.845
Genesee	All	56	56.511	-2.258	0.365	-13.823**	39.750
	Low	28	38.973	0.352	0.888		0.241
	High	28	32.580	-4.888**	-0.158		23.281
Ingham	All	56	53.101	-1.971	-2.620	- 9.328**	33.062
	Low	29	45.805	-0.080	-5.344*		12.235
	High	27	32.330	-4.096*	0.416		12.452
Kent	All	51	83.956	-0.759	-9.563**	-22.588**	63.117
	Low	26	69.031	1.774	-16.686**		35.759
	High	25	30.455	-3.455	-3.171**		28.756
Genesee and Ingham Combined	All	112	54.823	-2.111*	-1.234	-11.538**	35.320
	Low	57	42.694	0.182	-2.579		1.831
	High	55	32.337	-4.517**	0.224		16.985

*Significant at .90 confidance level or higher.
**Significant at .95 confidance level or higher.

Table B.3d

Regression Results: Percent Cars with Muffler Defects by County and Income Level

County	Income Level	No. Obs.	Constant	Time	Night Type	Income	R^2
All 3	All	163	8.488	-0.034	-0.455	-2.556**	17.603
	Low	83	5.652	1.038*	-1.103		5.720
	High	80	3.667	-1.143**	0.224		10.881
Genesee	All	56	6.635	0.377	-0.319	-1.575**	10.009
	Low	28	3.593	2.112**	-0.668		26.514
	High	28	4.951	-1.357*	0.030		11.664
Ingham	All	56	6.819	0.247	-0.451	-1.957**	14.263
	Low	29	4.159	1.126	-0.632		6.014
	High	27	3.629	-0.710	-0.216		6.707
Kent	All	51	13.251	-1.063	-0.850	-4.343**	34.827
	Low	26	11.884	-1.100	-2.755*		12.358
	High	25	1.457	-0.985*	1.130*		27.051
Genesee and Ingham Combined	All	112	6.771	0.326	-0.439	-1.753**	11.771
	Low	57	3.952	1.622**	-0.703		13.563
	High	55	4.346	-1.027**	-0.134		8.632

*Significant at .90 confidance level or higher.
**Significant at .95 confidance level or higher.

Table B.3e

Regression Results: Percent Cars with Plate Light Defects by County and Income Level

County	Income Level	No. Obs.	Constant	Time	Night Type	Income	R^2
All 3	All	163	31.514	-0.880*	-2.566**	-5.900**	37.382
	Low	83	23.457	0.494	-2.194**		5.604
	High	80	21.928	-2.297**	-2.947**		25.910
Genesee	All	56	25.101	-1.693**	-0.375	-4.182**	32.917
	Low	28	17.526	-0.876	1.353		8.417
	High	28	20.131	-2.511**	-2.102		22.978
Ingham	All	56	30.951	-1.943**	-2.657**	-4.703**	39.878
	Low	29	23.021	-0.970	-1.244		10.666
	High	27	24.882	-2.956*	-4.143**		33.801
Kent	All	51	40.456	0.170	-4.949**	-9.057**	63.485
	Low	26	33.375	1.583	-7.392**		42.255
	High	25	20.267	-1.209	-2.451**		28.487
Genesee and Ingham Combined	All	112	27.896	-1.870**	-1.410*	-4.446**	34.277
	Low	57	20.121	-0.979	0.170		4.238
	High	55	22.397	-2.773**	-3.043**		27.420

*Significant at .90 confidance level or higher.
**Significant at .95 confidance level or higher.

Table B.3f

Regression Results: Percent Cars with Tail Light Defects by County and Income Level

County	Income Level	No. Obs.	Constant	Time	Night Type	Income	R^2
All 3	All	163	10.792	-0.879**	0.504	-3.129**	26.289
	Low	83	9.243	-1.045*	-0.424		4.877
	High	80	2.915	-0.711*	1.468**		10.678
Genesee	All	56	12.773	-1.534**	1.424*	-4.513	48.577
	Low	28	8.929	-2.189*	1.474		15.648
	High	28	3.079	-0.880*	1.373**		24.830
Ingham	All	56	6.116	-0.965*	1.930**	-1.135	17.328
	Low	29	7.795	-1.060*	0.144		9.735
	High	27	0.930	-0.915	3.859**		30.903
Kent	All	51	13.184	-0.285	-1.490**	-3.777**	42.738
	Low	26	10.429	-0.045	-2.234*		11.326
	High	25	4.750	-0.513*	-0.742*		22.395
Genesee and Ingham Combined	All	112	9.478	-1.230**	1.634**	-2.825**	29.065
	Low	57	8.516	-1.568**	0.627		10.072
	High	55	1.927	-0.893*	2.680**		23.770

*Significant at .90 confidance level or higher.
**Significant at .95 confidance level or higher.

Table B.3g

Regression Results: Average Number of Minor Defects per 100 Cars by County and Income Level

County	Income Level	No. Obs.	Constant	Time	Night Type	Income	R^2
All 3	All	163	42.046	-0.853	-3.240**	-9.086**	42.403
	Low	83	29.893	2.043*	-3.446		9.323
	High	80	27.028	-3.844**	-3.015**		33.865
Genesee	All	56	33.608	-1.235	-0.645	-6.529**	34.583
	Low	28	21.536	1.987*	0.681		12.134
	High	28	26.094	-4.456**	-1.971		32.114
Ingham	All	56	38.854	-1.618	-3.441**	-6.588	36.991
	Low	29	27.323	0.565	-1.784		3.456
	High	27	30.786	-3.933**	-5.137**		40.092
Kent	All	51	57.148	-0.948	-6.190**	-14.656	69.661
	Low	26	47.615	0.579	-10.773**		44.014
	High	25	22.477	-2.397**	-1.474*		41.847
Genesee and Ingham Combined	All	112	36.150	-1.462*	-2.008**	-6.545**	34.395
	Low	57	24.415	1.235	-0.539		3.113
	High	55	28.346	-4.246**	-3.483**		34.627

*Significant at .90 confidance level or higher.
**Significant at .95 confidance level or higher.

Table B.4

Supplemental Significant Regression Results, Component and Vehicle Variables vs Time by County Income and Night Type

Variable	County	Income Level	Night Type	Constant	Time	Income	Type	R^2
% PLONLY	Ingham	All	Fri.	17.765	-1.591 (.0221)	-0.623 (.5006)		20.4
	Genese & Ingham	All	Fri.	15.978	-1.157 (.0235)	-0.674 (.3193)		10.1
	All	High	Fri.	15.017	-1.269 (.0265)			11.4
	Ingham	High	Fri.	17.297	-2.383 (.0370)			31.4
	Kent	High	Fri.	16.363	-1.824 (.0151)			42.9
	Genese & Ingham	High	Fri.	13.431	-3.034 (.0954)			11.6
% AODC	All	High	All	8.605	-1.637 (.0171)		1.709 (.0434)	10.6
	Kent	High	All	8.993	-1.824 (.0122)		.047 (.9532)	25.7
	Genese & Ingham	High	All	8.036	-1.448 (.0845)		2.700 (.0119)	13.9
	All	High	Fri.	10.31	-1.678 (.0137)			13.9
	Kent	High	Fri.	8.596	-1.511 (.0829)			24.9
	Kent	High	Week	9.663	-2.257 (.0792)			27.6

Table B.4 (Continued)

Variable	County	Income Level	Night Type	Constant	Time	Income	Type	R^2
% SINGLE	Genese	All	Week	34.077	-2.973 (.0751)	-6.944 (.0008)		47.3
	Ingham	All	Fri.	26.530	-1.719 (.0290)	-2.148 (.0488)		27.9
	Genese & Ingham	All	Fri.	27.248	-1.255 (.0409)	-3.654 (.0000)		30.2
	All	High	Fri.	20.642	-2.0996 (.0038)			18.6
	All	High	Week	19.321	-2.410 (.0956)			7.7
	Genese	High	Week	22.996	-5.201 (.0941)			25.5
	Ingham	High	Fri.	23.513	-3.050 (.0078)			45.8
	Kent	High	Fri.	20.496	-2.247 (.0136)			43.9
	Genese & Ingham	High	Week	21.151	-3.808 (.0750)			13.1
	Genese & Ingham	High	Fri.	20.644	-1.952 (.0468)			13.3
	Genese & Ingham	All	Week	31.490	-2.259 (.0789)	-6.150 (.0000)		33.3
% MULTIPLE	All	High	All	4.224	-0.838 (.0387)		.466 (.3477)	6.0
	Kent	High	All	4.997	-1.102 (.0278)		-.491 (.3871)	21.3
	All	High	Fri.	4.685	-0.849 (.0515)			8.9

Table B.4 (Continued)

Variable	County	Income Level	Night Type	Constant	Time	Income	Type	R^2
ADEF	All	High	Fri.	31.33	-4.129 (.0009)			23.8
	All	High	Week	30.97	-4.439 (.0409)			11.4
	Genese	High	Week	36.097	-7.930 (.0144)			46.6
	Ingham	High	Fri.	32.548	-3.893 (.0482)			28.7
	Kent	High	Fri.	29.523	-4.228 (.0349)			34.5
	Genese & Ingham	High	Week	35.085	-6.333 (.0343)			18.0
	Genese & Ingham	High	Fri.	31.628	-3.594 (.0200)			17.9
ADEFEXPL	All	High	All	10.449	-1.936 (.0201)		2.085 (.0424)	10.4
	Genese	High	All	12.449	-2.377 (.0876)		1.944 (.2598)	13.5
	Kent	High	All	10.188	-1.963 (.0242)		.215 (.8255)	21.7
	Genese & Ingham	High	All	9.940	-1.744 (.0794)		3.27 (.0102)	14.4
	All	High	Fri.	12.7	-2.133 (.0209)			12.3
	Kent	High	Week	11.103	-2.331 (.0647)			30.1
% MUF	All	High	Fri.	36.303	-0.898 (.0425)			9.7

Table B.4 (Continued)

Variable	County	Income Level	Night Type	Constant	Time	Income	Type	R^2
% MUF (continued)	All	High	Week	4.676	-1.595 (.0254)			13.4
	Genese	Low	Fri.	2.231	2.781 (.0067)			42.0
	Kent	High	Week	5.153	-2.195 (.0315)			38.5
	Genese & Ingham	Low	Fri.	2.325	2.536 (.0026)			28.1
% PL	Ingham	All	Fri.	25.715	-1.934 (.0053)	-2.990 (.0024)		45.3
	Ingham	All	Week	28.101	-1.896 (.3069)	-6.427 (.0020)		34.6
	Genese & Ingham	All	Fri.	23.688	-1.614 (.0018)	-2.753 (.0001)		32.8
	All	High	Fri.	18.63	-1.996 (.0010)			23.3
	All	High	Week	16.556	-2.76 (.0684)			9.2
	Genese	High	Week	19.927	-5.687 (.0493)			33.3
	Ingham	High	Fri.	20.538	-2.752 (.0145)			40.5
	Genese & Ingham	All	Week	28.506	-2.3051 (.0605)	-6.393 (.0000)		37.2
% BL	Ingham	Low	Week	.538	1.613 (.0596)			24.7
	Genese & Ingham	All	Week	1.875	1.612 (.0885)	.078 (.9378)		5.8

Table B.4 (Continued)

Variable	County	Income Level	Night Type	Constant	Time	Income	Type	R^2
% TL	All	All	Fri.	10.297	- .862 (.1893)	-4.068 (.0000)		42.5
	Genese	All	Week	16.092	-2.037 (.0036)	-4.405 (.0000)		70.8
	Ingham	All	Fri.	10.736	- .846 (.0807)	-3.007 (.0001)		49.7
	Genese & Ingham	All	Fri.	12.460	-1.038 (.0439)	-3.854 (.0000)		38.9
	All	High	Fri.	4.246	- .606 (.0160)			13.3
	Genese	High	Week	7.029	-1.836 (.0910)			25.9
	Genese & Ingham	Low	Week	9.873	-1.651 (.0522)			14.3
	Genese & Ingham	High	Fri.	4.264	- .5547 (.0829)			10.4
AMAJOR	Ingham	All	Fri.	22.390	- .767 (.5100)	-7.350 (.0001)		46.2
AMINOR	All	High	Fri.	23.427	-3.327 (.0002)			28.7
	All	High	Week	22.007	-4.698 (.0031)			22.5
	Ingham	High	Fri.	25.345	-3.623 (.0274)			34.4
	Kent	High	Fri.	7.496	-1.081 (.4089)			6.28
	Genese & Ingham	High	Fri.	23.698	-3.095 (.0092)			21,8

Table B.4 (Continued)

Variable	County	Income Level	Night Type	Constant	Time	Income	Type	R^2
AMINOR (continued)	Genese & Ingham	High	Week	24.245	-6.510 (.0053)			29.2
	Genese & Ingham	All	Fri.	30.383	- .689 (.4147)	-4.559 (.0002)		22.8
	Genese & Ingham	All	Week	37.226	-2.847 (.0505)	-8.809 (.0000)		43.8

Table B.5

Regression Analysis % Defective vs Observation Starting Time by Month

Month	Constant	Starting Time*	Income	Night Type	R^2
May	14.988	0.069 (0.4095)	1.171 (0.8954)	---	7.5
June	46.980	-0.032 (0.4047)	-7.828 (0.0067)	-1.204 (0.669)	35.3
July	28.980	0.111 (0.1266)	-4.378 (0.1112)	-2.237 (0.3535)	20.9
Aug.	44.024	-0.009 (0.9396)	-6.242 (0.1311)	-2.529 (0.5490)	15.9
Sept.	41.239	0.005 (0.9815)	-10.800 (0.0652)	---	53.7
Oct.	44.821	0.002 (0.9649)	-9.492 (0.0003)	-3.214 (0.2250)	40.4
Nov.	43.62	0.004 (0.8722)	-8.987 (0.0028)	-3.925 (0.1864)	31.1

* Measured in minutes past 5:00 p.m.

Table B.6a

Regression Analysis of
Transformed Failure Rate
by County, Income, and Location Types
for Road-Side Observation Data

County	Income	Type	Constant	Time*	Income	R^2
All 3	All	All	-.43205	-.00099 (.0177)	-.33034 (.0000)	.581
		Friday	-.56483	-.00099 (.0906)	-.23353 (.0034)	.468
		Weekday	-.21609	-.00061 (.2731)	-.54659 (.0000)	.772
	Low	All	-.82657	-.00047 (.4299)		.377
		Friday	-.83712	-.00066 (.4444)		.558
		Weekday	-.81636	-.00019 (.8121)		.102
	High	All	-1.0162	-.00161 (.0059)		.704
		Friday	-.99382	-.00131 (.0999)		.357
		Weekday	-1.1717	-.00159 (.0217)		.945

Numbers in parentheses indicate Type I error probabilities.
*Time in days past 4/30.

Table B.6b

Regression Analysis of
Transformed Failure Rate
by County, Income, and Location Types
for Road-Side Observation Data
(continued)

County	Income	Type	Constant	Time*	Income	R^2
Genesee	All	All	-.28675	-.00049 (.3708)	-.50037 (.0000)	.634
		Friday	-.34099	-.00053 (.4810)	-.46954 (.0001)	.520
		Weekday	-.16295	-.00060 (.4618)	-.56253 (.0001)	.384
	Low	All	-.83887	-.00004 (.9599)		.064
		Friday	-.83727	-.00028 (.8211)		.022
		Weekday	-.83341	-.00023 (.8087)		.001
	High	All	-1.2103	-.00115 (.1056)		.834
		Friday	-1.2482	-.00081 (.3633)		.709
		Weekday	-.74259	-.00461 (.0042)		.814

Numbers in parentheses indicate Type I error probabilities.
*Time in days past 4/30.

Table B.6c

Regression Analysis of
Transformed Failure Rate
by County, Income, and Location Types
for Road-Side Observation Data
(continued)

County	Income	Type	Constant	Time*	Income	R^2
Ingham	All	All	-.49215	-.00127 (.0082)	-.26326 (.0001)	.757
		Friday	-.45202	-.00134 (.0120)	-.27255 (.0006)	.787
		Weekday	-.47703	-.00083 (.4586)	-.36080 (.0480)	.542
	Low	All	-.81467	-.00079 (.3098)		.450
		Friday	-.78496	-.00084 (.3517)		.728
		Weekday	-.86615	-.00061 (.6941)		.079
	High	All	-.95066	-.00188 (.0004)		.925
		Friday	-.94644	-.00180 (.0044)		.842
		Weekday	-.98965	-.00248 (.2076)		.451

Numbers in parentheses indicate Type I error probabilities.
*Time in days past 4/30.

Table B.6d

Regression Analysis of
Transformed Failure Rate
by County, Income, and Location Types
for Road-Side Observation Data
(continued)

County	Income	Type	Constant	Time*	Income	R^2
Kent	All	All	-.45003	-.00134 (.2372)	-.26828 (.0391)	.511
		Friday	-.91984	-.00132 (.4462)	.07419 (.7272)	.490
		Weekday	.00048	-.00040 (.6488)	-.67767 (.0000)	.898
	Low	All	-.83631	-.00046 (.7841)		.417
		Friday	-.97715	-.00036 (.8979)		.857
		Weekday	-.70879	-.00016 (.9192)		.032
	High	All	-.87671	-.00000 (.1764)		.514
		Friday	-.65572	-.00220 (.3329)		.164
		Weekday	-1.3229	-.00063 (.4926)		.955

Numbers in parentheses indicate Type I error probabilities.
*Time in days past 4/30.

Table B.6e

Regression Analysis of
Transformed Failure Rate
by County, Income, and Location Types
for Road-Side Observation Data
(continued)

County	Income	Type	Constant	Time*	Income	R^2
Genesee & Ingham	All	All	-.39283	-.00094 (.0107)	-.37404 (.0000)	.677
		Friday	-.40360	-.00098 (.0357)	-.36126 (.0000)	.608
		Weekday	-.33856	-.00071 (.3144)	-.45388 (.0001)	.473
	Low	All	-.82430	-.00046 (.4054)		.299
		Friday	-.81129	-.00058 (.4381)		.412
		Weekday	-.85799	-.00021 (.8276)		.061
	High	All	-1.0661	-.00160 (.0006)		.858
		Friday	-1.0796	-.00140 (.0173)		.645
		Weekday	-.84991	-.00372 (.0021)		.689

Numbers in parentheses indicate Type I error probabilities.
*Time in days past 4/30.

Technical Note on Seasonal Factors

At several points in the main body of the text, some concern was expressed that the roadside observation came about because of factors other than checklane activity. Specifically, observed improvement in Ingham County might have arisen from people repairing their lights on account of longer periods of darkness in the fall. The statistical test procedures which were originally used in the body of the report indicated that the downtrend in Ingham County was only marginally different from that in Kent County. In simple terms, Kent County showed a slight downtrend, and Ingham had a much larger one, yet there was some possibility that the two trends were identical. Thus, the differences between the counties might have arisen by chance. If this were the case, then the effect of the checklane could not be inferred from the data. If Kent, which received the least treatment, and Ingham, which received the most, were in fact no different, then one would not be able to conclude that the lane had an effect.

After the main text was written, a further statistical analysis was conducted on the point. This analysis differed from the original in that the unit of observation used was the individual vehicle rather than that of the observation site.

The original use of the site was a highly conservative procedure. It confined the number data points to 163, representing each individual site visit. In effect, a single number represented several hundred vehicles which passed the site during an evening. The procedure reduced what was a very large sample to a very small one, and so increased the liklihood of not finding a change when in fact one was present. The original procedure was selected since indications of change produced by it would represent quite strong evidence. However, the conservatism was purchased at a price, and the price was that the outcome for a particular site might be overly influenced by chance fluctuations in the traffic flow by that site. The effect of these chance fluctuations, however, can be greatly reduced by using the individual vehicles as the unit of measurement. Thus chance fluctuations at a particular site tend to be averaged out over the several thousand vehicles observed for each visit to a county.

To perform an analysis of individual vehicles, the original data tape containing the observation reports for each vehicle was accessed. From this tape, 20% of the random sample vehicles were read into the statistical analysis program. Least squares regressions were then run using time, income, county, and night-type on the observation results for the 8,000 vehicle sub-sample. The overall pattern was the same as that found in the original analysis. There was a strong downtrend in Ingham County, some indication (but not statistically significant) of a trend in Genesee County, and virtually no change in Kent County. Again, the strongest effect was found in the higher income areas of Ingham County. The new analysis was then consistent with the original analysis. However, the new comparisons of the trends in Ingham County with those in Kent County indicated that indeed those in Ingham County were significantly, and highly so, different from those in Kent County. Hence, it can be concluded that the lane did have a positive effect in Ingham County which was independent of any seasonal effects. These results are shown in Tables B.7a and B.7b.

Table B.7a
Regression Results, % of Vehicles Defective, Roadside Observation
Sample Vehicle File, All Income Areas

County	Item	Constant	Time[1]	Income	Night Type	Summary
All	Coeff.	46.26	-2.0497	-10.399	-1.8111	N=8399
	Std. Err.		0.7581	0.9854	1.013	R^2=1.53
	Sig		0.0069	0.0000	0.0739	Sig.=0.000
Genesee	Coeff.	45.22	-1.9891	-10.402	-1.8775	N=2609
	Std. Err.		1.3211	1.7457	2.0546	R^2=1.48
	Sig.		0.1323	0.0000	0.3609	Sig.=0.0000
Ingham	Coeff.	36.08	-3.2434	-4.1664	0.3839	N=2867
	Std. Err.		1.2865	1.7969	1.9259	R^2=0.42
	Sig.		0.0118	0.0205	0.8420	Sig.=0.0065
Kent	Coeff.	59.84	-0.7281	-17.762	3.1578	N=2923
	Std. Err.		1.3642	1.6879	1.5656	R^2=3.76
	Sig.		0.5936	0.0000	0.0438	Sig.=0.0000

Comparison of Time Coefficients: Ingham vs. Genesee
Difference = 2.5153 — T = 72.15 — d.f. = 5787
S.E. Difference = 0.0349 — $p \leq 0.0001$

1 Measured in 100 day units.

Table B.7b

Regression Results, % of Vehicles Defective, Roadside Observation, Sample Vehicle File, High Income Areas

County	Item	Constant	Time[1]	Night Type	Summary
Genesee	Coeff.	32.75	-1.4001	-0.8296	N=1381
	Std. Err.		1.9286	2.6436	R^2=0.05
	Sig.		0.4680	0.7537	Sig.=0.702
Ingham	Coeff.	27.77	-3.7913	-1.1443	N=1148
	Std. Err.		1.8387	4.1041	R^2=0.391
	Sig.		0.0394	0.7804	Sig.=0.1059
Kent	Coeff.	24.30	-1.8361	-2.0824	N=2010
	Std. Err.		1.5225	1.7568	R^2=0.16
	Sig.		0.2279	0.2360	Sig.=0.2011

Comparison of Time Coefficients: Ingham vs. Kent

Difference 1.9552 — $T = 32.47$ — d.f. = 3256

S.E. Difference = 0.0602 — $p < 0.0001$

1 Measured in 100 day units.

Summary of Roadside
Observation Procedures

1. Sites. (a) General. Sites will be located in neighborhoods selected according to the experimental plan. These neighborhoods will be classified on the basis of income and urbanization. Also, it will be desirable to have sites located both near-to and far-from sample inspection locations.

(b). Intersection type. Sites will be located at intersections that are controlled by either stop signs or traffic signals. The street on which the observation will be taken should carry a moderate volume of evening traffic, 100 to 300 vehicles per hour. Traffic should come from the local area. Streets serving facilities like regional shopping centers, plants, theaters, etc. should be avoided.

(c). Site specifics. The site should provide a clear view of the intersection for at least 100 feet. The site should have a location where the observer may park his car safely.

2. Equipment. The observer should have an ample supply of data forms, several sharpened pencils, a clip board, a flash light, and a hand counter.

3. Procedure. (a) Set-up. Before beginning observation, observer should notify local authorities of when the observation will be conducted, and he should have obtained permission to park if his parking location is on private property. Before leaving for the site, the observer should check to see that he has adequate equipment and supplies. The observer should plan to arrive a few minutes before the scheduled starting time and position his vehicle so that he has a clear view of the intersection for the entire observation period. Prior to beginning observations, the observer should complete the necessary identification information on his forms.

(b). Observations. Observations should begin with the first vehicle to arrive at the intersection after the scheduled starting time. For this and every subsequent vehicle which stops for the traffic control device, a count should be made on the counter. For those vehicles that do not come to a full halt, some judgement must be exercised. Vehicles which make a substantial reduction in velocity, e.g. those that slow to a "walking pace" will be included, but those that make only a slight or momentary reduction in speed will not be included, e.g. someone who hesitates slightly before going through on a caution light. As the vehicle approaches the observer, he should note the condition of the headlights. listen for the condition of the muffler, and observe any other peculiarities of its condition, e.g. obviously shattered windshield. After the vehicle has passed him and stops, he should note the operation of the brake lights and observe the condition of the taillights and of the license plate light. If nothing is wrong with the vehicle, the observer should record nothing on the data sheet. If there are defects present, the observer should record these by entering a mark on the data sheet in the row for that defect category. One column on the data sheet should be used for each defective vehicle. Several specific rules should be followed. For multiple lamp units, such as a taillight with three bulbs, a defect will be counted if any lamp is not working. If neither the brake light nor the taillight is working, a separate entry should be made for both. The broken category for taillights should be recorded only when the light is operating but the lense is broken. For the "other" category on the bottom of the data sheet, the observer should note the nature of the defect on the bottom of the data form, e.g. body damage causing severely misaimed headlamp. For out-of-state vehicles, the observer should check the out-of-state box even if there are not any defects on the vehicle.

(c) Post-observation. After the end of the observation period, the observer should record the total car count on the first page of the data sheet. Additionally he should note the number of pages of data sheets used and page number the data sheets. Finally he should record the total traffic count, the number of defective vehicles, and the number of out-of-state vehicles on his summary sheet. All the materials should then be placed in an envelope and returned to the field supervisor.

APPENDIX C

Appendix C

General Notes

Itmes Included in Summary Categories

All: Sum of all items checked on post card. See Figure VI.1

All except plate light: Same as "all" excluding plate light category

Lights: Front and Rear Turn Signals; Headlight high and low beams, aim and intensity; tail lamps; stop lamps; plate lamp; and beam indicator

Lights except plate light: All of above light except plate lamp

Mechanical: Wipers and Washers; Safety Glass and Vision Impared; Service and Parking Brakes; Steering; Tires; Exhaust; Mirrors; and Other

TABLF C.1

Post Card Return Information
by Inspecting Team

Team	No. of Cars Re-turned	Model Year	All Types	Average Number of Defects per Vehicle for: All Types Except Plate Light	Lights	Lights Except Plate Light	Mechan-ical	Washers	Front Turn Signals	Percent of Vehicles Failed for: High Beams	Stop Light	Plate Light	Tires	Parking Brake
District 1 S.P.[1]	884	66.626	2.320	1.928	1.165	.774	1.115	33.1	15.2	21.8	12.2	39.1	11.8	21.0
Sample Team[2]	3785	67.096	2.364	1.976	1.137	1.064	1.102	31.7	13.3	17.0	13.3	38.8	29.5	20.2
Lansing P.D.	5707	66.904	2.029	1.842	1.017	.934	.949	41.0	12.5	19.0	9.0	38.7	8.3	17.0
District 3 S.P.[3]	2494	66.963	2.701	2.364	1.174	1.134	1.261	37.4	14.1	19.4	12.1	33.7	25.3	22.7
Flint P.D.	319	65.687	1.859	1.476	1.107	.875	.857	20.1	14.7	28.2	2.2	42.7	11.6	12.9
District 5 S.P.[4]	855	66.207	2.821	2.392	1.232	802	1.589	40.8	12.8	21.9	13.3	42.9	29.9	18.8
District 6 S.P.[5]	1208	66.489	2.272	1.901	1.133	.975	.942	32.1	14.9	22.6	12.3	37.0	25.0	21.0
Total	15252	66.848	2.299	1.919	1.104	1.016	1.077	36.5	13.4	19.4	11.1	38.0	25.7	19.3
F-Ratio		27.200	78.581	89.796	10.484	15.170	100.230	24.625	1.781	7.572	13.531	5.227	159.238	8.842

F(= .9) = 2.72 F(= .95) = 3.67 F(= .99) = 6.88 F(= .999) = 15.75

[1]State Police Teams in Ingham County except Sample Team.

[2]All Counties.

[3]State Police Teams in Genesee County except Sample Team.

[4]State Police Teams in Northern Kent County.

[5]State Police Teams in Southern Kent County.

[6]For column definitions see notes at end of this series of tables.

TABLE C.2

Post Card Return Information
by Type of Inspecting Team

Team Type	No. of Cars Re- turned	Model Year	Average Number of Defects per Vehicle for: All Types	All Types Except Plate Light	Lights	Lights Except Plate Light	Mechan- ical	Washers	Percent of Vehicles Failed for: Front Turn Signals	High Beams	Stop Light	Plate Light	Tires	Parking Brake
State Police	9226	66.854	2.481	2.105	1.158	.782	1.323	34.3	13.9	19.3	12.8	37.6	26.2	20.9
City Police	6026	66.840	2.020	1.633	1.022	.635	.998	39.9	12.6	19.5	8.6	38.7	8.4	16.8
Total	15252	66.848	2.299	1.919	1.104	.724	1.195	36.5	13.4	19.4	11.1	38.0	19.2	19.3
F-Ratio		1.00	320.091	361.348	54.697	76.480	339.549	49.270	4.843	0.145	63.916	1.847	782.653	41.015

F(= .90) = 63.33 F(= .95) = 254.3 F(= .99) = 6366 F(= .999) = 636600

TABLE C.3

Post Card Return Information
by County

County	No. of Cars Re-turned	Model Year	All Types	All Types Except Plate Light	Lights	Lights Except Plate Light	Mechan-ical	Washers	Front Turn Signals	High Beams	Stop Light	Plate Light	Tires	Parking Brake
			Average Number of Defects per Vehicle for						Percent of Vehicles Failed for					
Genesee	2813	66.815	2.605	2.263	1.166	.824	1.439	35.4	14.2	20.4	11.0	34.2	23.8	21.6
Ingham	10376	66.952	2.176	1.788	1.074	.686	1.102	36.9	13.0	18.5	10.8	38.8	16.3	18.5
Kent	2063	66.372	2.499	2.105	1.174	.779	1.325	35.7	14.0	22.3	12.7	39.5	27.4	20.1
Total	15252	66.848	2.299	1.919	1.104	.724	1.195	36.5	13.4	19.4	11.1	38.0	19.2	19.3
F-Ratio		44.633	103.255	128.388	12.375	23.943	127.843	1.324	1.747	9.010	3.023	10.685	93.055	7.246

F(= .9) = 9.49 F(= .95) = 19.50 F(= .99) = 99.50 F(= .999) = 999.50

TABLE C.4

Post Card Return Information
by Month

Month	No. of Cars Re-turned	Model Year	Average Number of Defects per Vehicle for: All Types	All Types Except Plate Light	Lights	Lights Except Plate Light	Mechan-ical	Percent of Vehicles Failed for: Washers	Stop Light	Plate Light	Tires	Parking Brake
May	1271	66.763	2.268	1.856	1.103	0.982	1.165	34.9	11.0	41.2	17.5	40.0
June	3160	66.678	2.339	1.949	1.119	1.017	1.220	35.0	10.5	39.0	17.8	39.6
July	2800	66.580	21258	1.851	1.130	1.038	1.128	38.4	10.2	39.6	15.4	38.9
August	2853	66.890	2.311	1.941	1.114	1.020	1.198	37.3	11.9	37.0	19.8	39.3
September	2356	66.954	2.297	1.931	1.093	1.031	1.203	37.4	12.1	36.6	21.5	39.3
October	2066	67.249	2.281	1.922	1.069	0.996	1.212	35.9	11.1	35.9	21.8	40.6
November	712	67.097	2.381	2.008	1.069	0.993	1.312	34.0	11.8	37.2	26.0	38.4
December	28	66.536	2.250	1.929	1.750	0.742	1.500	53.6	7.1	32.1	14.3	41.8
Total	15246	66.847	2.300	1.920	1.105	1.016	1.195	36.5	11.1	38.0	19.2	39.5
	F-Ratio	12.551	.976	1.523	1.168	.856	3.539	2.2330	1.249	2.543	10.372	.803

F(= .90) = 2.47 F(.95) = 3.23 F(.99) = 5.65 F(= .999) = 11.70

APPENDIX D

Appendix D*

Brief Descriptive Summary of Checklane Activities
by
Jimmie L. Wright

I. The Team Members

The team was composed of four regular full-time members and one relief member. The team members were all of trooper rank and had varying terms of longevity with MSP. The field supervisor had approximately 17 years of service in with MSP, 4 of those years were spent in checklane activities in the 4th District, working out of the Jackson Post. The trooper second in seniority had approximately six years of service with MSP, with the total of this time spent in Road Patrol activities. The trooper with the third greatest service time, also approximately 6 years was assigned to the checkland from the "Capitol Detail", similar to the second ranking trooper this individual had no previous experience in motor vehicle inspection. The team members lowest in years of service, about three, had two years experience in checklane activities in Flint.

II. Routine Day

The use of three widely separated communities in the sample activity necessitated some travel for each of the team members. Pre-designated locations (usually a restaurant) in each sample community was agreed upon as a daily meeting place. After a brief cup of coffee the team members would depart the meeting place and head for the sample location in police vehicles which were assigned to them.

Upon arriving at the sample site the team members had designated tasks to perform before actual lane operation commenced. Two

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* These remarks were prepared by the HSRI staff member responsible for coordination of the field activities. They are included to give a better idea of actual data collection operations.

of the members would build the lane, i.e., erect the appropriate signs, and create a special inspection lane by the use of orange pylons or "cones". The other two members would fill in the "mark sense" inspection forms with "constant" data such as date and location.

In every case except one, the sample site was conducted on an active roadway lane, or in the instance of a two-lane road, on the shoulder, as opposed to using parking lot space or other off-traffic-way space.

A supply of sample questionnaires were placed on three separate clipboards and were issued and picked up from driver-respondents by the senior trooper (or if I was there the task would be shared). One trooper acted as "point man" with the responsibility of selecting the vehicles to be inspected according to the sampling plan. The "count" or sampling ratio for each location was derived by making a crude estimate of the traffic flow versus the number of vehicles easily handled by the inspectors. The count or ratio for each site was determined and followed throughout the entire sample time, except when contingencies arose, e.g., a factory shift change or other unusual increase or decrease in traffic flow. The careful use of the sample ratio was noted on all visits and was presumed to be used at times when monitoring was not in effect. It is believed that the sample is more than moderately representative of the total vehicle population based on observations of the type of vehicle, physical condition and driver characteristics in the sample. The more common "random" method of selection utilized by other regular teams was not in effect during this experiment. It was observed and commented upon that in the usual "random" selection methodology the random element is set aside when prospects for an enforcement "hit" are presumed. Overt discrimination was also observed and commented upon in regular checklane operations, examples include:

1. Often an elderly driver is allowed to pass by an inspection because of the assumptions that the driver's advanced age and concomitant "slowness" may hinder the volume of inspections performed.
2. Attractive females are sometimes summoned into the checklane non-randomly.
3. To a much lesser degree skin color or length of hair may have been a determining factor in selection or non-selection for inspection.
4. The condition of the vehicle often biased the "point man" in his choice of vehicles to be inspected.

In the regular checklane operation the emphasis on enforcement and summons writing is particularly strong and acts as (to some district or post commanders) as a justification for the activity. Originally the sample team was to draw an enforcement officer from the state police post or local police department to accompany them at every sample site. The role of this officer was to be strictly enforcement, i.e., summons writing, pursuit of "turn-arounds", thereby freeing the sample team members to perform inspection related tasks only. There were on occasion in the first and second cycles officers drawn and performing this function. Soon after the second cycle was completed this activity was terminated due to the lack of cost-effectiveness in assigning an officer for a full shift with a very substantial return in terms of summons written and implicit enforcement activity. Thereafter a summons was written or enforcement taken very infrequently and only when blatant defects occurred or when criminal activity was apparent. The usual sample day ended after approximately 3 hours or fifty vehicles were inspected at each of the two sites. In most cases there was a very close match between the three hour time limit and the required fifty vehicles. On some occasions more than fifty vehicles were inspected.

III. Site Comments

(Ingham)
Lansing Locations

1601 - Delta River Drive (Northeast Bound) (High income) This site was on a two-lane road in a moderate to high income residential area. By visual inspection many of the sample respondents appeared to be of higher income strata.

1602 - Haag Road - South Lansing (southeast bound) (low income) the sample was taken from Haag Road and filtered onto a gravel side street for inspection. Haag Road connects a low to moderate, high density housing area with a north-south artery (Logan/M-99). The housing area is comprised of relatively inexpensive frame one-family dwellings and co-op type townhouses.

1603 - Aurelius Road at Holt Road - Holt (northbound) (low income) The sample traffic at this site was routed into a shopping center parking lot for inspection. There appeared to be a variation in income at this site.

1604 - Harrison Road at Wildwood - East Lansing (northbound) (high income) Many of the respondents at this site were either students or staff members at MSU. Two-lane road.

1605 - Hamilton Road - Okemos (eastbound) (high income) Two lane road heavily travelled route into Okemos off from Grand River Avenue (US-16).

1606 - Pleasant Grove Road (northbound) (low income) Four-lane collector running through a moderate to low income transitional area.

1607 - Turner Street - urban fringe (southbound) (low income) This is a two-lane collector running north/south. This site is in an area which has a fairly heavy concentration of Chicano families. There appeared to be a number of respondents who could not answer the questionnaire because of a language barrier or illiteracy.

1608 - Mt. Hope Road - E. Lansing (eastbound) (high income) This is a major 4-lane artery connecting south central Lansing with the Okemos area and adjacent shopping mall. The traffic was extremely heavy.

(Genesee)
Flint Locations

3901 - Perry Road, Grand Blanc (westbound) (high income) Two-lane road, moderate traffic flow, no extreme income characteristics.

3902 - Genesee Street - Mount Morris (eastbound) (low income)

3903 - Franklin at Court - (southbound) (high income) two-lane residential

3904 - Lewis at Belle (northbound) (low income) two-lane street, through an old commercial area of town.

3905 - Stanley Road - near Saginaw (eastbound) (low income)

3906 - Calkins Road (eastbound) (high income)

3907 - Detroit at Pierson Road (northbound) (low income) Inner city fringe area, four-lane road with a boulevard moderate to heavy flow.

3908 - Circle Drive - (westbound) (high income) One of the highest income areas in Flint, this was a residential enclave with very low traffic volume - a sample of every vehicle was used.

(Kent)
Grand Rapids and East Grand Rapids Locations

6901 - Robinson Road - East Grand Rapids (high income)

6902 - Buchanan at 44th - Wyoming (southbound) (low income) two-lane road in a moderate-to-low income area - due to short blocks and long visibility there were a number of "turn offs" before reaching the lane.

6903 - Indiana and Fulton (southbound) (low income) low income residential street, low flow of traffic.

6904 - Kalamazoo at 44th (northbound) (high income) aptly nicknamed "The Racetrack" due to the heavy traffic flow - it appeared to resemble an "artery" more than a "collector", 4-lane, undivided.

6905 - Hall near Breton - E. Grand Rapids (westbound) (high income) four-lane (Boulevard) residential street - appeared to be a good representative sample of the area.

6906 - Lee - Wyoming (eastbound) (low income) 4-lane (Boulevard) collector, moderate flow, this was used as an afternoon site - the only problem here was that "shop traffic" let out at 3:00 and much of it traveled Lee, causing a problem with the count.

6907 - Layfayette & Carrier - (northbound) (low income) this location was situated between an orphanage and an elementary parochial school - it was difficult working around the children, moderate traffic flow.

6908 - Okemos at Breton (eastbound) (high income) A collector running from a high income residential area - moderate flow, two-lane problem - some of sample could have been from two moderate incomes apartment complexes located back on Okemos.

IV. Unusual Conditions Roadside Observation*

June 1 - 1610 - heavy railroad traffic causing traffic platooning.

June 7 - 6915 - trooper moved from Breton and Beechwood to Hall and Breton at 10:05 after traffic light changed to blinking caution.

May 31 - 3909 - traffic picked up considerable after 10:00 p.m. suspected rise due to country club function.

July 25- 3909 - two new stores opened at location - increase in traffic.

Sept 8 - 1611 - increase in traffic - perhaps explained by a detour on nearby road.

Sept 8 - 1612 - increase in traffic - unexplained.

Oct 5 - 1616 - recorded as location on data sheet - should read 6916.

Oct 6 - 6911 - increase in traffic caused by a football game.

Oct 27 - 1611 - increase in count caused by poor road causing many to put brakes on.

Oct 27 - 1610 - warm weather may have accounted for increase in traffic - ten train crossings again.

* Note sites beginning with 39 are in Genesee, 16 in Ingham, and 69 in Kent.

Oct 27 - 1612 - increase in traffic possibly due to football game in area.

Nov 3 - 3909 - football game traffic increased traffic flow.

Nov 20 - 1611 - road construction completed count lower than last time.

Nov 20 - all sites - regularly Friday night sites done on Monday.

Nov 21 - all sites - regularly Friday night sites done on Tuesday.

Nov 27 - all sites - regularly Friday night sites done on Monday night.

V. Unusual Conditions, Sample Inspection

May 10 - (1605) incomplete sample due to demonstrations in E. Lansing. Sample completed May 12 pm.

May 18 - incomplete sample due to two revoked ops. and need for trooper to go to court. This site was changed on second cycle reassigned number 3927 from 3907.

May 23 - the site was moved mid-stream due to poor set-up conditions. Half of sample at original site and half at Stocking and Third. This site was changed on second cycle, reassigned number 6923 from 6903.

June 16 - this site was changed for the second time. Reassigned number 1636 - this was High Street - New permanent site is Pleasant Grove - 1606. For remainder of field survey.

Aug 4 - (1601) rained out on August 2. Was done on this date.

Aug 3 - (1608) rained out at 47 vehicles.

Sept 29 - (6901) rained out on September 25. Made up on this date.

Nov 7 - (6903) rained out. Completed on November 11.