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SEAT BELT USE-INDUCING SYSTEM EFFECTIVENESS

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16. Abstract

Seat belt use inducing system effectiveness was measured in fleet automobiles of a private business and in rental automobiles at a large airport. There were three parts to the activity:

1. Seat belt use inducing systems and seat belt use counting systems were installed in 30 fleet vehicles of the Automobile Club of Southern California (ACSC). The vehicles were driven on work related and personal business by ACSC employees whose seat belt use habits were known. Hardware was retrofitted to the vehicles and consisted of a 1974 seat belt system, a seat belt use counting system and electronic vehicle modifications which provided the following use inducement methods:

a. Ignition interlock system b. Sequencing system c. Speed limiting system

The test subjects were subjected to the use inducing systems in various sequences and for varying periods of time, during which bi-weekly counts of seat belt use were recorded.

The seat belt count data was compiled and analyzed for significane using "t" tests:

-- There was a significant increase in seat belt use for all three (3) methods of use inducement.

-- There was no significant difference in seat belt use between the three methods of use inducement

-- There was no significant change of seat belt use for any of the three (3) inducement systems according to time of exposure.

-- There was a significant difference between previous no system seat belt use and no system seat belt use, the latter being higher, after exposure to the use inducing system.

The test subjects were periodically administered a questionnaire, the results of which indicated higher self reported than actual seat belt use and specific confusion, inconvenience discomfort factors.

2. An observation study was performed to determine the shoulder belt usage of ACSC employees as they drove their assigned 1974 fleet vehicles into an ACSC parking lot equipped with interlock systems 540 of 750 (72%) observations showed correct shoulder belt use. One non seat belt user was induced to wear seat belts by modifying the seat belt system. Additional data on make of vehicle and sex of drivers was obtained.

3. An observation study was performed to determine the shoulder belt usage of occupants of 1974 rental automobiles at Los Angeles International Airport equipped with interlock system. 1,823 drivers were observed of which 1,281 (70.3%) were wearing shoulder belts. 472 front passengers were observed of which 287 (60.8%) were wearing shoulder belts. Additional data on make of vehicle and sex of occupant was obtained.

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SUMMARY

Automobile seat belt use inducing system effectiveness was measured in fleet automobiles of a private business and in rental automobiles at a large airport. The three parts of the activity were:

1. Modified Vehicle Phase

Seat belt use inducing systems and seat belt use counting systems were installed in 30 fleet vehicles of the Automobile Club of Southern California (ACSC). The vehicles were driven on work related and personal business by ACSC employees whose seat belt use habits were known.

Main elements of the hardware consisted of custom fitted integral lap and shoulder belts, an electro-mechanical seat belt use counting system and an electronic vehicle modification which provided the following use inducement methods:

a. Ignition interlock system b. Sequencing system c. Speed limiting system

The test subjects were subjected to the use inducing systems in various sequences and for varying periods of time, during which bi-weekly counts of seat belt use were recorded. When the test subjects had completed all required or possible exposure to the use inducing systems, the test subjects belt usage, when returned to "no system" was obtained. A questionnaire was administered to the test subjects at the completion of each of the above phases.

The seat belt count data was compiled and analyzed for significance using "t" tests. The following results also illustrated in Figure I were significant:

a. There was a significant increase in seat belt use for all three (3) methods of use inducement when compared to seat belt use for no inducement and reminder system inducement.

b. There was no significant difference between the three (3) methods of use inducement.

c. There was no significant change of seat belt use for any of the three (3) inducement systems according to time of exposure.

d. There was a significant difference between previous no system seat belt use and no system seat belt use, the latter being higher, after exposure to the use inducing system.

Figure I

USE INDUCING SYSTEM USAGE

USE INDUCING SYSTEM	SAMPLE SIZE	Group Mean Usage % 0 10 20 30 40 50 60 70 80 90 100	%
PRIOR NO SYSTEM	29		25
REMINDER	29		51
INTERLOCK	29		86
SEQUENCING	20		77
SPEED LIMITING	20		81
FINAL NO SYSTEM	21		49

Analysis of the driver questionnaire data showed:

a. In excess of 80% of the respondents reported they always used their seat belts irrespective of both short and long trips and regardless of the presence or type of use inducing system.

b. The majority of respondents indicated the same or decreased seat belt use in their family vehicles when compared to their seat belt use in their assigned vehicle equipped with a use inducing system.

c. There were never more than 23% of respondents who indicated they found the seat belt systems confusing, inconvenient, or uncomfortable. Specific confusion, inconvenience and discomfort aspects of the seat belt systems were compiled.

2. Parking Lot Observation Phase

An observation study was performed to determine the shoulder belt usage of Automobile Club of Southern California (ACSC) employees as they drove their assigned company vehicles into an ACSC parking facility.

Visual observations of the drivers of 34-1974 model vehicles assigned to a particular parking lot and was performed during the twenty-six week period of February 19 through August 23, 1974. A total of 750 observations occurred of which 540 (72%) indicated correct shoulder belt use.

Individual drivers shoulder belt use was:

1. 24 drivers (70%) were wearing shoulder belts between 81% and 100% of observations.

2. 5 drivers (15%) were wearing shoulder belts between 51% and 80% of observations.

3. 3 drivers (9%) were wearing shoulder belts between 21% and 50% of observations.

4. 2 drivers (6%) were wearing shoulder belts between 0 and 20% of observations.

(1 driver after being observed using the shoulder belt on three occurrences cut the shoulder belt from the buckle).

Seat belt use improvement was attempted for one driver who found a method to defeat the interlock system on his Ford (activated by the lap belt retractor switch) by looping the seat belt around the door handle. His visually observed shoulder belt usage was erroniously recorded to be 59%. Counters placed in the vehicle determine his actual seat belt use at 10%. This vehicle was modified to activate the ignition interlock from a buckle switch after which counters, used in the modified vehicle phase, showed that the drivers seat belt usage increased to 85%.

3. Airport Observation Phase

An observation study was performed to determine the shoulder belt usage of drivers and right front seat occupants in 1974 model year vehicles returning to the Hertz Rental Car facility at Los Angeles International Airport.

The study was performed during five week days in February, 1974 and resulted in 1,823 vehicle observations.

1. 1,823 drivers were observed, of which 1,281 (70.3%) were wearing shoulder belts.

2. 472 passengers were observed, of which 287 (60.8%) were wearing shoulder belts.

3. There appeared to be no significant difference in shoulder belt usage in vehicles manufactured by different domestic corporations.

4. There appeared to be significantly higher shoulder belt usage by male occupants compared to female occupants (70.2% to 56.2%).

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INTRODUCTION

The Automobile Club of Southern California (ACSC) contracted with the National Highway Traffic Safety Administration (NHTSA), Office of Driver Performance Research to perform research into the seat belt usage of subjects exposed to various use inducing systems. The specific devices were an ignition interlock system (as required by Federal Motor Vehicle Safety Standard 208 on 1974 vehicles), a logic or sequencing system, and a speed limiting interlock system.

The program was performed by the Automobile Club of Southern California's Automotive Engineering Department at the Automotive Research Center and in-field locations in three parts. The first part involved the acquisition of seat belt use data from specially equipped vehicles in the ACSC fleet, designated the modified vehicle phase. The second part involved observation of shoulder belt use and countermeasures to circumvention of 1974 vehicle interlock systems, designated the parking lot observation phase. The third part, an observation study of seat belt usage in 1974 rental vehicles, was performed in February 1974 at Los Angeles International Airport, designated the airport observation phase.

This report describes the work performed and the results obtained in all three phases.

SAMPLE SELECTION

1. The subjects for the modified vehicle phase was choses from a known group of individuals whose previous seat belt use in response to no inducement system and reminder system (buzzer and light) inducement was known (Ref. 1). Driver seat belt use only was monitored, and precautions were taken to ensure that the

drivers were unaware that their seat belt usage was being continuously monitored.

The test vehicles were ACSC fleet vehicles based at or within close proximity of ACSC Headquarters in the downtown Los Angeles area. The initial Statement of Work required an equal mix of Chrysler, General Motors, and Ford manufactured automobiles to be monitored. Because of various difficulties beyond the control of the ACSC's Automotive Engineering Department, acquisition of the exact mix of vehicles was not possible, and with the agreement of the Contract Technical Manager, the actual number of vehicles monitored were 22 Chrysler, 6 General Motors and 2 Ford vehicles.

The vehiclesin the study were driven by ACSC employees on business in the Southern California area. In addition these employees also used these vehicles for personal purposes and some of the vehicles may have been driven by an employee's friend or relative for a small number of trips. The actual number of these trips is not known but is estimated to be less than 5%.

2. The 34 subjects for the parking lot observation phase were from a same general group of ACSC employees who used a particular parking lot at the ACSC Headquarters facility.

3. The subjects for the airport observation phase consisted of occupants returning rental vehicle to the Hertz Rental Company during the observation period.

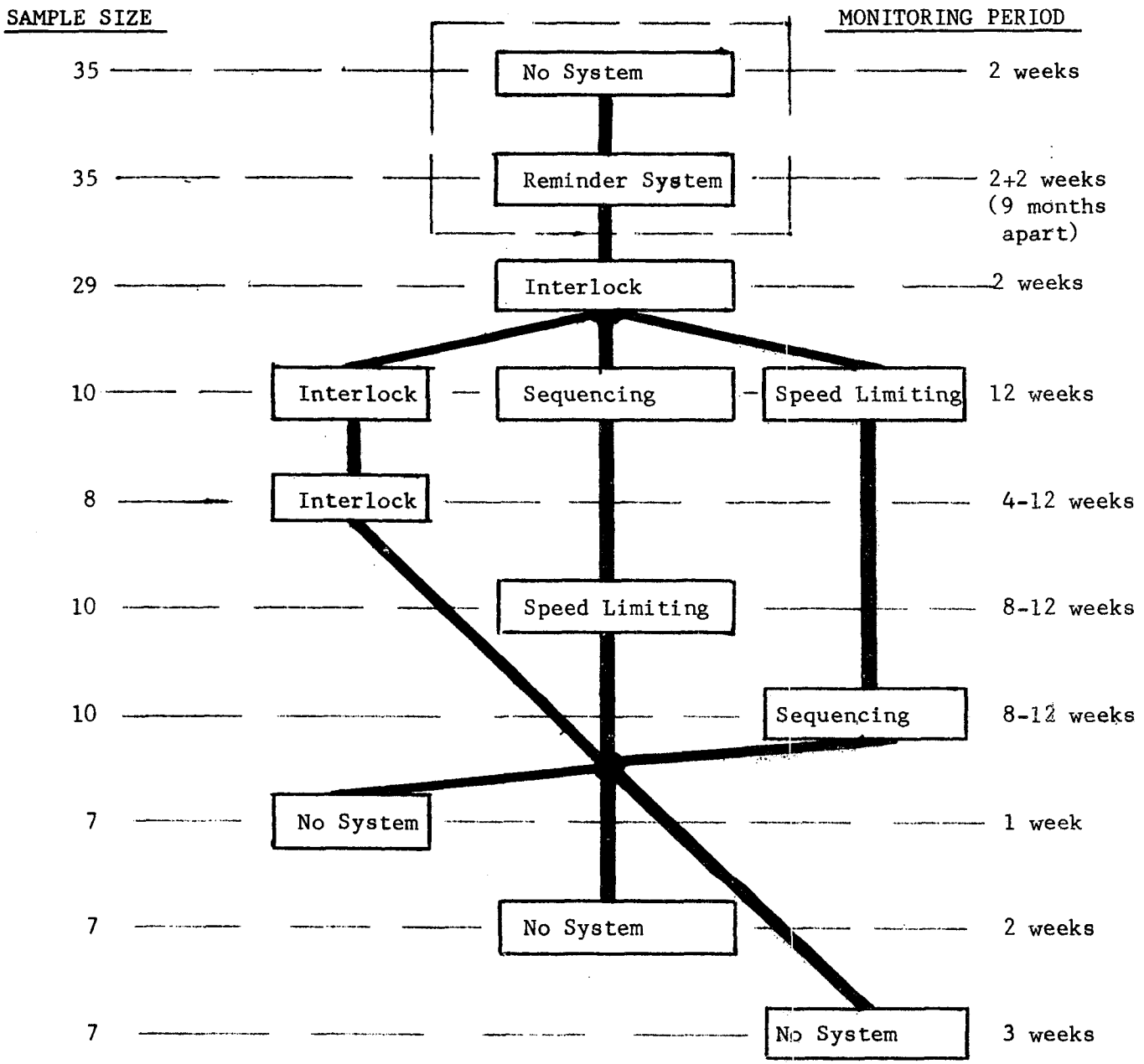
TEST METHODOLOGY

Modified Vehicle Phase

The test subjects were divided into three groups. Each group was exposed to the use inducement systems as briefly described below, illustrated in Figure 2, and described in detail on Page 12.

Figure 2

EXPERIMENTAL DESIGN



a. A seat belt ignition interlock system which met the 1974 requirements of Federal Motor Vehicle Safety Standard 208, hereafter designated as the interlock system.

b. A seat belt logic or sequencing system hereafter designated as the sequencing system.

c. A seat belt speed limiting interlock system, hereafter designated as the speed limiting system.

One group of subjects was exposed only to the interlock system. All vehicles in this phase of the study completed 12 weeks of monitoring, some vehicles completed more, and one vehicle completed 24 weeks of monitoring.

The second group of subjects was exposed to the interlock system for 12 weeks, the speed limiting system for a maximum of 12 weeks followed by the sequencing system for a maximum of 12 weeks. (The second and third groups eventually contained the same test subjects and therefore for the purposes of some of the statistical analyses they are treated as the same group.)

As a result of discussions with NHTSA personnel including the Contract Technical Manager, some of the test subjects were subjected to a further stage of monitoring. This stage was to be performed on 23 test subjects who had completed the previously mentioned stages. Two test subjects were eliminated from the initial group and the remaining 21 subjects were divided into three groups of seven subjects whose previous use inducing system exposure and seat belt use were similar. The seat belt use inducement systems on the vehicles of all subjects were switched to "no-system". Seat belt use was then obtained for periods of 1, 2, and 3 weeks exposure to no-system for groups 1, 2, and 3 respectively.

During all phases seat belt use data was collected at bi-weekly intervals. To accomplish this, drivers of the vehicles were asked to bring the cars to ACSC Headquarters or make the car available at an in-field location for an inspection and check out of various vehicle systems and components.

At the completion of a phase the test subjects were given a questionnaire relating to their seat belt use. This questionnaire is attached as Appendix B.

PARKING LOT OBSERVATION PHASE

The observation study was performed in parking lot #1 at the ACSC Los Angeles Headquarters from February 19 through August 23, 1974. The observer, a regular parking lot attendant/guard who was normally present at the entrance of the lot, checked each car for correct shoulder belt usage as the subjects entered the parking area. Observations were made five days a week, Monday through Friday, from 8:00 am to 4:00 pm. After each observation the following data was recorded for 1974 model year vehicles:

-- The vehicle license number.
-- Make of vehicle.
-- Sex of driver.
-- Shoulder belt usage of driver.

Thirty-four vehicles were observed during the course of the study. Twenty-one vehicles were General Motors products, ten vehicles were Ford Motor Company products, two were Chrysler Corporation products and one vehicle was an American Motors product.

AIRPORT OBSERVATION PHASE

Observations were performed at the Los Angeles International Airport during the week ending Saturday, March 2, 1974. The observation times were:

Monday, February 25	7:00 am through 7:00 pm
Tuesday, February 26	7:00 am through 7:00 pm
Wednesday, Feburary 27	7:00 am through 7:00 pm
Thursday, Feburary 28	7:00 am through 5:00 pm *
Friday, March 1	7:00 am through 7:00 pm

* Note: Observations were curtailed after ten hours due to extremely inclement weather.

Returning Hertz Rental Cars only were observed.

Two observers were continuously on duty during the periods previously stated, except for 15 minute coffee breaks, and brief periods when one observer verified vehicle information in the Hertz Rental Car facility.

The observers were stationed on the public sidewalk adjacent to the Hertz Rental Car return entrance at the beginning of the airport "loop". The observers took turn about to record the required data on the data sheets. While one observer recorded the data, the second observer, equipped with a tape recorder, served as a back-up in the event that more than one car was returned in a short period of time.

The following data was recorded:

-- Vehicle license
-- Make of vehicle
-- Sex of driver
-- Shoulder belt use of driver
-- Sex of passenger
-- Shoulder belt use of passenger

TEST HARDWARE FOR MODIFIED VEHICLE PHASE

The test hardware consisted of two basic systems:

1. The mechanical seat belt system consisted of an integral lap and shoulder belt. The shoulder belt was equipped with a webbing (velocity) sensitive inertia reel mechanism which was similar to the systems on 1974 production vehicles. Because the inertia reel needed to be secured in the vehicle in a crashworthy manner, a unique Plusnut fastener (Ref.2) was used to mount the shoulder belt to the vehicle (see Figures 6 and 7, page 34). Additionally, the installation of the upper shoulder harness was located to insure the maximum comfort for the vehicle occupant, i.e., a custom fit was performed. (See Figure 5, Page 33).
2. The use inducing system and counting hardware consisted of electronic circuitry combined with electromechanical counters which was obtained from Irvin Industries Inc. Also a time delay was included in the counter circuit to prevent spurious counts. The following use inducement methods were available.
   a. No system - no use inducement.
   b. Reminder system - use inducement with a buzzer-light according to the 1972 requirements of Federal Motor Vehicle Safety Standard 208.
   c. Sequencing system - a buzzer-light reminder system which was able to be de-activated only by buckling the seat belt or by cycling the seat belt into the retractor for every vehicle start.
   d. Interlock system which included b. above and which met the 1974 requirements of Federal Motor Vehicle Safety Standard 208.

3. An additional method of use inducement was developed. This method consisted of attaching an engine speed limiting device in conjunction with the sequencing system (c. above). The device was purchased from Mallory Electric Company and was a modified version of their production unit designed for limiting the engine speed at relatively high revolutions per minute (rpm). The device was modified to provide engine speed limitation between 500 and 1500 rpm by grounding the ignition pulse if the limit was exceeded. See Figures 3 and 4.

RESULTS

Modified Vehicle Phase

Data was collected on a bi-weekly basis from each vehicle. The data consisted of vehicle trip counts obtained from engine starts, seat belt retractor unit counts, and vehicle seat belt buckle counts. Both the retractor unit and seat belt buckle counts were divided by the vehicle trip counts and multiplied by one hundred to produce a percentage.

Any possible bias in the data for each group, as defined by previous seat belt use and data derived from buckle switch and retractor switch counters was evaluated:

a. The previously known seat belt use of the test subjects in the interlock group was compared to that of the test subjects in the sequencing and speed limiting groups by means of "t" tests. (See Table 1, Page 30).

   The "t" tests showed that there was no significant difference in no-system seat belt use between the subjects in the interlock group and the sequencing/speed limiting group prior to exposure to a use inducing system. Likewise there was no significant difference between the two groups' reminder system seat belt use during prior exposure to a reminder system.

   There was an average increase in seat belt usage for the interlock, sequencing and speed limiting groups when prior no-system usage was compared to prior reminder system usage. However, the increase was statistically significant only for the interlock group (See Table 1). (A previous paper (Ref. 1) compared two larger groups of test subjects from which the subjects for this research were chosen

and which demonstrated a significant increase in seat belt use in response to the reminder system.)

b. The seat belt usage of the test subjects as recorded by the buckle switch and retractor switch counters was compared for each use inducing system (See Table II, Page 30).

Since the "t" tests indicate that there was no significant difference between buckle switch data and retractor switch data for each of the three groups, the statistical analyses which follow only use buckle switch data.

Seat Belt Usage Change From No-System to Interlock, Sequencing or Speed Limiting Systems

The seat belt usage change from no-system to each of the use inducing systems was compared for the test subjects in each group.

Table III indicates that there was a statistically significant increase in seat belt usage for each group as a result of exposure to the use inducing system.

Table III

Type of Use Inducing System \ System In-Use	No-System (Previous Usage)			Use-Inducing System			"t" Test Results		Significant Difference
	$\bar{x}$	s	n	$\bar{x}$	s	n	t	df	(p=.05)
Interlock	24.48	29.25	29	86.21	15.02	29	10.10	56	Yes
Sequencing	26.15	32.08	20	77.35	19.32	20	6.12	38	Yes
Speed Limiting	26.15	32.08	20	81.10	18.67	20	6.62	38	Yes

See below for statistical abbreviations

Statistical Abbreviations

$\bar{x}$ - group mean seat belt use
s - standard deviation
n - number of subjects
t - "t" value
df - degrees of freedom

Seat Belt Usage Change From Reminder System to Interlock, Sequencing or Speed Limiting Systems

The seat belt usage change from reminder system to each of the current experiments use inducing systems was compared for test subjects in each group.

Table IV indicates that there was a statistically significant increase in seat belt usage for each group after exposure to the use inducing system.

Table IV

Type of Use Inducing System \ System In-Use	Reminder System (Previous Usage)			Use Inducing System			"t" Test Results		Significant Difference
	$\bar{x}$	s	n	$\bar{x}$	s	n	t	df	(p=.05)
Interlock	50.79	42.97	29	86.21	15.02	29	4.19	56	Yes
Sequencing	43.15	43.01	20	77.35	19.32	20	3.24	38	Yes
Speed Limiting	43.15	43.01	20	81.10	18.67	20	3.62	38	Yes

Comparison of Seat Belt Usage Between Interlock, Sequencing and Speed Limiting Systems

The seat belt usage of the test subjects exposed to the three use inducing systems was compared. (See Tables V, VI and VII). The "t" tests indicate that there was no significant difference in the seat belt usage of the test subjects exposed to the three systems.

However, interlock system usage approached being significantly higher than sequencing system usage. (Significant at the .10 level).

Table V

Interlock System			Sequencing System			"t" Test Results		Significant Difference (p=.05)
$\bar{x}$	s	n	$\bar{x}$	s	n	t	df	
86.21	15.02	29	77.35	19.32	20	1.71	47	No

Comparison between interlock and sequencing system

Table VI

Interlock System			Speed Limiting System			"t" Test Results		Significant Difference (p=.05)
$\bar{x}$	s	n	$\bar{x}$	s	n	t	df	
86.21	15.02	29	81.10	18.67	20	1.01	47	No

Comparison between interlock and speed limiting system

Table VII

Sequencing System			Speed Limiting System			"t" Test Results		Significant Difference (p=.05)
$\bar{x}$	s	n	$\bar{x}$	s	n	t	df	
81.10	18.67	20	77.35	19.32	20	0.62	38	No

Comparison between sequencing and speed limiting system

Seat Belt Usage Change According to Time

The seat belt usage of the test subjects exposed to the three use inducing systems was compared for changes which may have occurred during the time of exposure to each system.

The "t" tests indicate that there was no regular pattern of significant seat belt usage change related to time of exposure to each of the use inducing systems. The sole statistically significant change was an increase in usage which occurred for the sequencing system between weeks 6 and 10. (See Tables VIII, IX and X).

Table VIII

Use Inducing System	Week 2			Week 6			"t" Test Results		Significant Difference
	$\bar{x}$	s	n	$\bar{x}$	s	n	t	df	(p=.05)
Interlock	88.44	11.80	27	89.19	9.33	21	0.25	45	No
Sequencing	77.44	22.99	18	71.56	19.73	18	0.82	34	No
Speed Limiting	85.69	12.96	16	78.75	17.92	12	1.14	26	No

Table IX

Use Inducing System	Week 2			Week 10			"t" Test Results		Significant Difference
	$\bar{x}$	s	n	$\bar{x}$	s	n	t	df	(p=.05)
Interlock	88.44	11.80	27	86.41	19.64	27	0.46	52	No
Sequencing	77.44	22.99	18	86.20	9.73	15	1.47	31	No
Speed Limiting	85.69	12.96	16	80.20	29.59	10	0.67	24	No

Table X

Use Inducing System	Week 6			Week 10			"t" Test Results		Significant Difference
	$\bar{x}$	s	n	$\bar{x}$	s	n	t	df	(p=.05)
Interlock	89.19	9.33	21	86.41	19.64	27	0.65	46	No
Sequencing	71.56	19.73	18	86.20	9.73	15	5.53	31	Yes
Speed Limiting	78.75	17.92	12	80.20	29.59	10	0.14	20	No

Comparisons of seat belt use changes according to time of exposure to a use inducing system.

Seat Belt Use of Test Subjects After Removal of the Use Inducing Systems

The seat belt usage of the test subjects exposed to no-system after previous exposure to all three systems was compared in two ways:

-- Previous no-system seat belt usage of all subjects compared to no-system usage after exposure to the inducing systems.

-- The seat belt usage of each of three newly established groups exposed to no-system for 1, 2 and 3 weeks was compared.

Because the above new groups were established for this final part of the work the system usage derived from seat belt buckle and retractor switches was again compared. As the "t" tests indicate that there was no significant difference between buckle switch and retractor switch data for the new groups, the statistical analyses follows only use buckle switch data. (See Table XI, Page 31).

When previous no-system seat belt usage of the subjects was compared to no-system usage after exposure to the use inducing systems, "t" tests showed that there was significantly higher seat belt use after exposure to the use inducement systems. (See Table XII).

The seat belt use of the three groups (exposed one, two and three weeks respectively to no use inducing systems) were compared. The "t" tests showed that there was no significant difference in the no-system seat belt use between the groups. (See Table XIII).

Table XII

Prior No-System Seat Belt Use			No-System Seat Belt Use After Exposure to the Use Inducing Systems			"t" Test Results		Significant Difference
$\bar{x}$	s	n	$\bar{x}$	s	n	t	df	(p=.05)
23.81	30.29	21	48.81	33.38	21	2.54	40	Yes

Comparison of no-system seat belt use before and after exposure to use inducing systems.

Table XIII

Comparison	Group A			Group B			"T" Test Results		Significant Difference
	$\bar{x}$	s	n	$\bar{x}$	s	n	t	df	
Groups 1^A and 2^B	27.14	28.98	7	59.43	27.94	7	2.12	12	No
Groups 2^A and 3^B	59.43	27.94	7	59.86	35.66	7	0.03	12	No
Groups 1^A and 3^B	27.14	28.98	7	59.86	35.66	7	1.88	12	No

Comparison of no-system seat belt use according to time of exposure (after previous exposure to use inducing systems)

Driver Questionnaire

The following results were obtained from questionnaires administered to the driver after exposure to each use inducing system. The questions dealt with self reported seat belt use on trips under 25 miles, over 25 miles and in family vehicles. In addition respondents were asked to identify specified seat belt confusion, inconvenience and discomfort factors. Seventy-two questionnaires were completed, 28 after interlock exposure, 15 after sequencing system exposure, 6 after speed limiting system exposure and 23 after final no-system exposure.

A. SELF REPORTED BELT USE

An analysis was performed of the questionnaires from the respondents who stated they drove their vehicles on trips under 25 miles (70 of 72 questionnaires), and on trips over 25 miles (coincidently 70 of 72 questionnaires):

Table XIV

SELF REPORTED BELT USE IN EXCESS OF 50%

SELF REPORTED BELT USE IN EXCESS OF 50%	INTERLOCK	SEQUENCING	SPEED LIMITING	NO SYSTEM
Trips Under 25 Miles	26 (96%)	15(100%)	6 (100%)	22(100%)
Trips Over 25 Miles	27 (100%)	15(100%)	6 (100%)	22(100%)

Table XIV indicates there was no difference in self reported seat belt use for different trip distances.

2. Seat Belt Use in Family Vehicles

In 49 of the 72 questionnaires the respondents stated they had other family vehicles and 40 (82%) of their vehicles had lap belts and 31 (63%) of them had shoulder belts.

Table XV displays the data obtained from the respondents.

Table XV
SELF REPORTED SEAT BELT USE IN FAMILY VEHICLES

SELF REPORTED SEAT BELT USE IN FAMILY VEHICLES	INTERLOCK	SEQUENCING	SPEED LIMITING	NO SYSTEM
Increase in seat belt use	3 (16%)	0 (0%)	0 (0%)	4 (25%)
Same in seat belt use	9 (47%)	6 (67%)	2 (40%)	9 (56%)
Decrease in seat belt use	7 (37%)	3 (33%)	3 (66%)	3 (19%)

NOTE: Direct comparison between use of the integral lap and shoulder belts used in the research and the seat belts in the test subjects family automobiles is not possible because their family vehicles may not have been fitted with lap and/or shoulder belts.

B. CONFUSION, CONVENIENCE AND COMFORT FACTORS

The compilation of responses for the 72 questionnaires which were completed have varying totals. This is because of the following variables:

a. Number of questions for each factor.

b. Number of test subjects exposed to each use inducing system.

The following tables XVI, XVII and XVIII show the expected consistancy in the ratings which were more dependant upon seat belt hardware and geomentry than changes in use inducing systems.

Table XVI
QUESTIONNAIRE DATA
CONFUSION FACTORS

RATING	Use Inducing Systems			
	INTERLOCK	SEQUENCING	SPEED LIMITING	NO SYSTEM
Not Confusing	126 (90%)	73 (97%)	27 (90%)	110 (88%)
Slightly Confusing	10 (7%)	2 (3%)	3 (10%)	10 (9%)
Fairly Confusing	3 (2%)	0	0	4 (3%)
Very Confusing	1 (1%)	0	0	0

The significant confusion factor was "Extending belts so that they can be connected" 19 (27%)

Table XVII
QUESTIONNAIRE DATA
INCONVENIENCE FACTORS

RATING	Use Inducing Systems			
	INTERLOCK	SEQUENCING	SPEED LIMITING	NO SYSTEM
Not Inconvenient	256 (83%)	151 (91%)	58 (88%)	230 (80%)
Slightly Inconvenient	37 (12%)	10 (6%)	8 (12%)	34 (13%)
Fairly Inconvenient	9 (3%)	3 (2%)	0	7 (3%)
Very Inconvenient	6 (2%)	1 (1%)	0	10 (4%)

Significant inconvenience factors were:

-- Extending belts so they can be connected 30 (24%)

-- Lock of mobility and freedom to 26 (21%)

-- Belts become twisted 21 (17%)

Table XVIII
QUESTIONNAIRE DATA
DISCOMFORT FACTORS

RATING	Use Inducing Systems			
	INTERLOCK	SEQUENCING	SPEED LIMITING	NO SYSTEM
Not Uncomfortable	181 (81%)	102 (85%)	37 (77%)	148 (81%)
Slightly Uncomfortable	26 (11%)	15 (12%)	6 (13%)	25 (14%)
Fairly Uncomfortable	11 (5%)	1 (1%)	4 (8%)	2 (1%)
Very Uncomfortable	7 (3%)	2 (2%)	1 (2%)	8 (4%)

Significant discomfort factors were:

-- Belt rubbing across neck, face, etc. 35 (32%)

-- Belt distorting or pulling clothing 26 (24%)

-- Belt becomes tighter during journey 18 (27%)

PARKING LOT OBSERVATION PHASE

A. Total Observations of Drivers

The 34 vehicles in the project were observed 750 times. Shoulder belts were being worn properly on 540 (72%) occasions.

B. Observation of Individual Drivers

Twenty-four of the 34 drivers (70%) were wearing their shoulder belts between 81% and 100% of trips.

Five of the 34 drivers (15%) were wearing their shoulder belts between 51% and 80% of trips.

Three of the 34 drivers (9%) were wearing their shoulder belts between 21% and 50% of trips.

Two of the 34 drivers (6%) were using their shoulder belts between 0% and 20% of trips.

(One driver, after being observed three times (5%) using the seat/shoulder belts, cut the shoulder belt and was a non-user for the remaining 55 (95%) observations).

C. Observations of Driver Shoulder Belt Use by Sex of Driver and Make of Vehicle

The male drivers were wearing their shoulder belts in 510 of 719 observations (71%).

The female drivers were wearing their shoulder belts in 30 of 31 observations (97%).

By Vehicle Make

The drivers of the 10 Ford Motor Company vehicles were wearing shoulder belts in 193 of 209 observations (92%).

The drivers of the 21 General Motors Corporation vehicles were wearing shoulder belts in 281 of 468 observations (60%).

The driver of the sole American Motors vehicle was wearing a shoulder belt 23 of 29 observations (79%).

The drivers of the two Chrysler Corporation vehicles were wearing shoulder belts 43 of 44 observations (98%).

Seat Belt Use Improvement Project

The driver of the vehicle selected for this project was observed using a shoulder belt apparently in 59% of observations. However, closer observations of the driver revealed that when the shoulder and lap belts were not worn and the interlock has been defeated by hooking the belts over the arm rest which

could only occur with Ford vehicles.) This was possible in this vehicle as the interlock was activated by the lap belt retractor switch. (Shoulder belts were not worn correctly by other drivers but these drivers did wear the lap belt correctly and routed the shoulder belt into an incorrect position).

Monitoring of retractor switch activations indicated 90% seat belt usage. Then both retractor and buckle switch were monitored and indicated 85% and 10% usage respectively.

Finally interlock activation was changed from the retractor switch to the buckle switch. As a result retractor switch monitoring indicated 88% seat belt use and buckle switch monitoring indicated 85% seat belt use.

AIRPORT OBSERVATION PHASE

a. Total Observations of Drivers and Passengers

1,823 vehicle observations were performed. The data collected included the seat belt use of the 1,823 drivers, 249 front seat passengers.

The following tables XIX to XXI show the results of the observations:

TABLE XIX
AIRPORT OBSERVATIONS - DRIVER AND PASSENGER DATA

Total Observations		
Total number of complete vehicle observations	1823	
Total number of incomplete vehicle observations	11	
1. There were 5 license numbers missed.		
2. There were 6 models and vehicles missed.		
All Drivers		
Shoulder belts used	1281	(70.3%)
Shoulder belts not used	542	(29.7%)
TOTAL	1823	(100.0%)
All Passengers		
Shoulder belts used	287	(60.8%)
Shoulder belts not used	185	(39.2%)
TOTAL	472	(100.0%)

TABLE XX
AIRPORT OBSERVATIONS - DRIVER DATA

Sex of Drivers

	Male		Female	
Shoulder belts used	1234	(70.9%)	47	(56.6%)
Shoulder belts not used	506	(29.1%)	36	(43.4%)
TOTAL	1740	(100.0%)	83	(100.0%)

Make of Vehicle and Total Drivers

Ford		
Shoulder belts used	956	(69.5%)
Shoulder belts not used	420	(30.5%)
TOTAL	1376	(100.0%)
General Motors Corporation		
Shoulder belts used	80	(72.1%)
Shoulder belts not used	31	(27.9%)
TOTAL	111	(100.0%)
American Motors Corporation		
Shoulder belts used	238	(73.0%)
Shoulder belts not used	88	(27.0%)
TOTAL	326	(100.0%)
Chrysler Corporation		
Shoulder belt used	7	(70.0%)
Shoulder belts not used	3	(30.0%)
TOTAL	10	(100.0%)

Make of Vehicle and Driver Sex

	Male		Female	
Ford Motor Company				
Shoulder belts used	914	(70.0%)	42	(60.0%)
Shoulder belts not used	392	(30.0%)	28	(40.0%)
TOTAL	1306	(100.0%)	70	(100.0%)
General Motors Corporation				
Shoulder belts used	79	(73.8%)	1	(25.0%)
Shoulder belts not used	28	(26.2%)	3	(75.0%
TOTAL	107	(100.0%)	4	(100.0%)
American Motors Corporation				
Shoulder belts used	235	(73.9%)	3	(37.5%)
Shoulder belts not used	83	(26.1%)	5	(62.5%)
TOTAL	318	(100.0%)	8	(100.0%)
Chrysler Corporation				
Shoulder belts used	6	(66.7%)	1	(100.0%)
Shoulder belts not used	3	(33.3%)	0	(0.0%)
TOTAL	9	(100.0%)	1	(100.0%)

TABLE XXI
AIRPORT OBSERVATIONS - PASSENGER DATA

Sex of Passengers	Male		Female	
Shoulder belts used	162	(65.1%)	125	(56.1%)
Shoulder belts not used	87	(34.9%)	98	(43.9%)
TOTAL	249	(100.0%)	223	(100.0%)

Make of Vehicles and Total Passengers		
Ford Motor Company		
Shoulder belts used	217	(61.1%)
Shoulder belts not used	138	(38.9%)
TOTAL	355	(100.0%)
General Motors Corporation		
Shoulder belts used	23	(82.1%)
Shoulder belts not used	5	(17.9%)
TOTAL	28	(100.0%)
American Motors Corporation		
Shoulder belts used	46	(53.5%)
Shoulder belts not used	40	(46.5%)
TOTAL	86	(100.0%)
Chrysler Corporation		
Shoulder belts used	1	(33.3%)
Shoulder belts not used	2	(66.7%)
TOTAL	3	(100.0%)

Make of Vehicles and Passenger Sex	Male		Female	
Ford Motor Company				
Shoulder belts used	116	(65.2%)	101	(57.1%)
Shoulder belts not used	62	(34.8%)	76	(42.9%)
TOTAL	178	(100.0%)	177	(100.0%)
General Motors Corporation				
Shoulder belts used	12	(80.0%)	11	(84.6%)
Shoulder belts not used	3	(20.0%)	2	(15.4%)
TOTAL	15	(100.0%)	13	(100.0%)
American Motors Corporation				
Shoulder belts used	33	(60.0%)	13	(41.9%)
Shoulder belts not used	22	(40.0%)	18	(58.1%)
TOTAL	55	(100.0%)	31	(100.0%)
Chrysler Corporation				
Shoulder belts used	1	(100.0%)	0	(0.0%)
Shoulder belts not used	0	(0.0%)	2	(100.0%)
TOTAL	1	(100.0%)	2	(100.0%)

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1. Appleby, Michael R. and Bintz, Louis J. "Increased Seat Belt Use as a Result of Improved Seat Belt Systems". Automobile Club of Southern California, SAE Paper No. 740048, February 1974.

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Table I

Possible Bias of Groups Due to Prior Seat Belt Use

Prior Exposure \ Group	Interlock Group			Sequencing/Speed Limiting Group			"t" Test Results		Significant Difference
	$\bar{x}$	s	n	$\bar{x}$	s	n	t	df	(P=.05)
Non-System	24.48	29.25	29	26.15	32.08	20	0.19	47	no
Reminder System	50.79	42.97	29	43.15	43.01	20	0.61	47	no
"t" test result t	8.20			1.42					
"t" test result df	46			38					
Significant Difference (p=.05)	Yes			No					

Table II

Possible Differences Due to Data Derived from Buckle Switch Counters and Retractor Switch Counters

Use Inducing Group \ Origin of data	Buckle Switch			Retractor Switch			"t" Test Results		Significant Difference
	$\bar{x}$	s	n	$\bar{x}$	s	n	t	df	(P=.05)
Interlock	86.21	15.02	29	88.83	8.23	29	0.82	56	no
Sequencing	77.35	19.32	20	75.84	19.69	19	0.24	37	no
Speed Limiting	81.10	18.67	20	75.65	19.84	20	0.89	38	no

Statistical Abbreviations

$\bar{x}$ = group mean seat belt use

s = standard deviation

n = number of subjects

t = "t" value

df = degrees of freedom

Table XI

Comparison of buckle switch and retractor switch data for final no-system exposure

Buckle Switch Data			Retractor Switch Data			"t" Test Results		Significant Difference
$\bar{x}$	s	n	$\bar{x}$	s	n	t	df	(p=.05)
48.81	33.38	21	53.00	31.52	21	0.42	40	No

Statistical Abbreviations

$\bar{x}$ = group mean seat belt use

s = standard deviation

n = number of subjects

t = "t" value

df = degrees of freedom

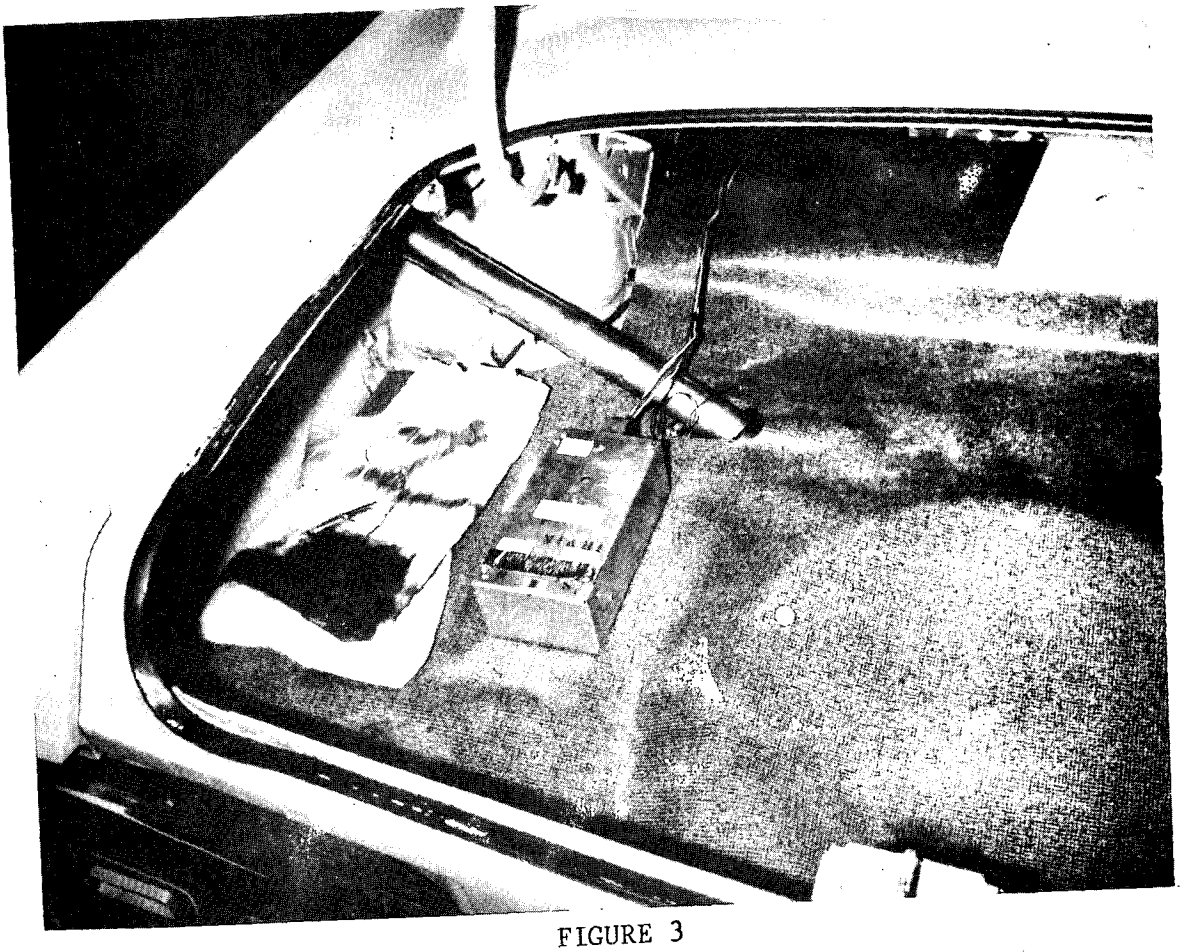

FIGURE 3

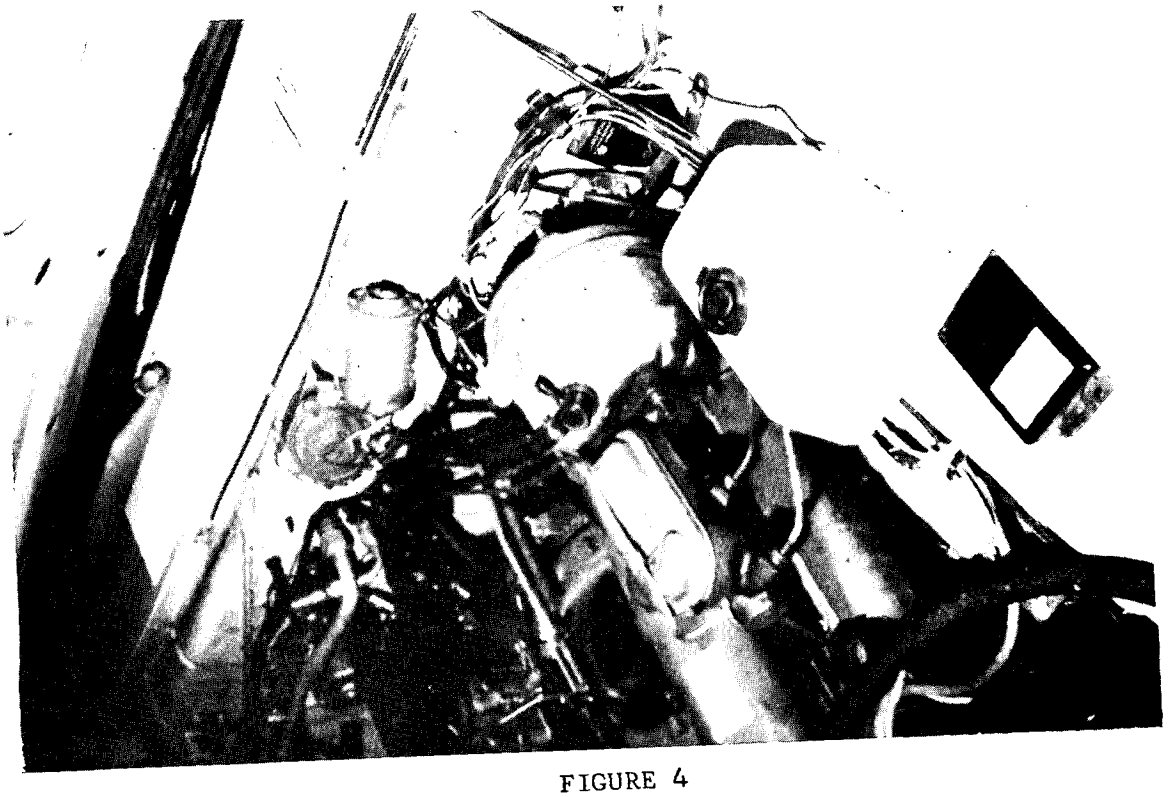

FIGURE 4

FIGURE 5

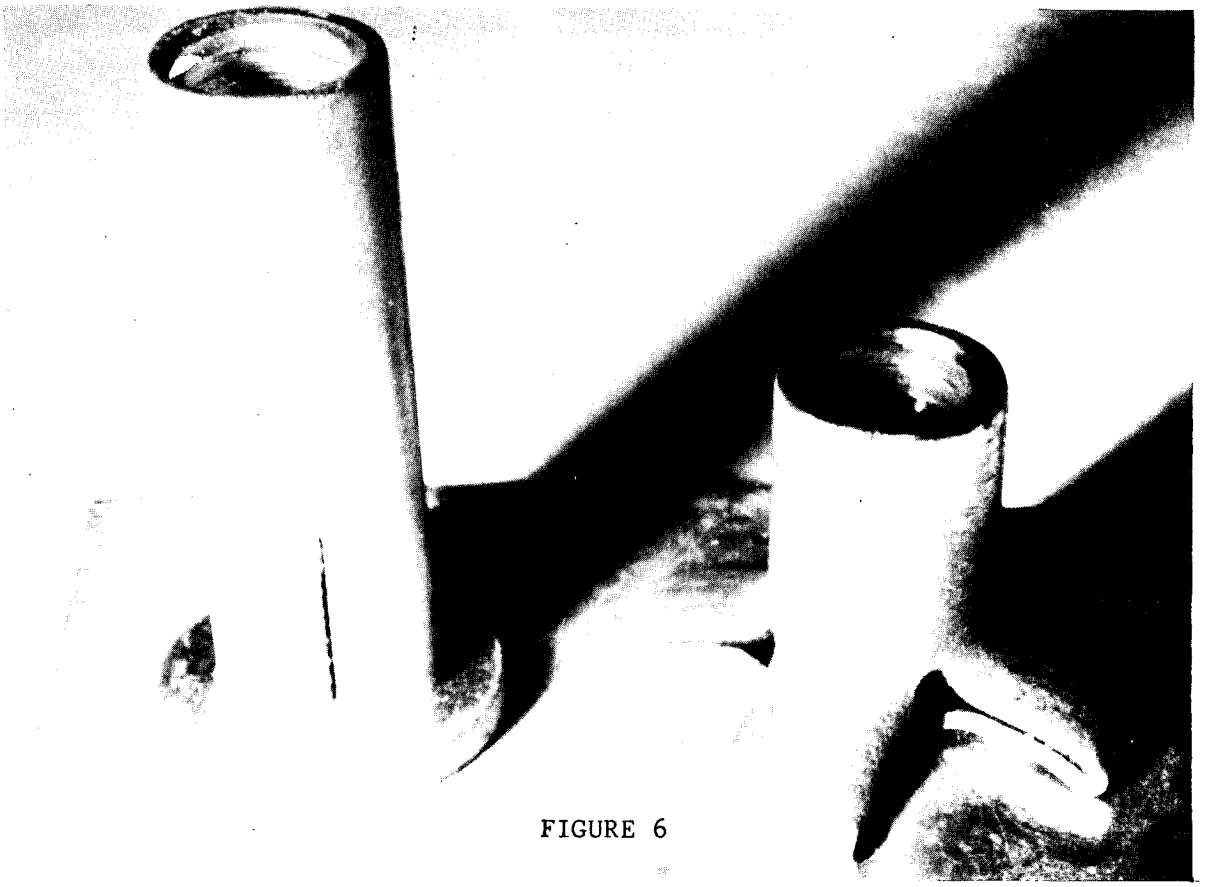

FIGURE 6

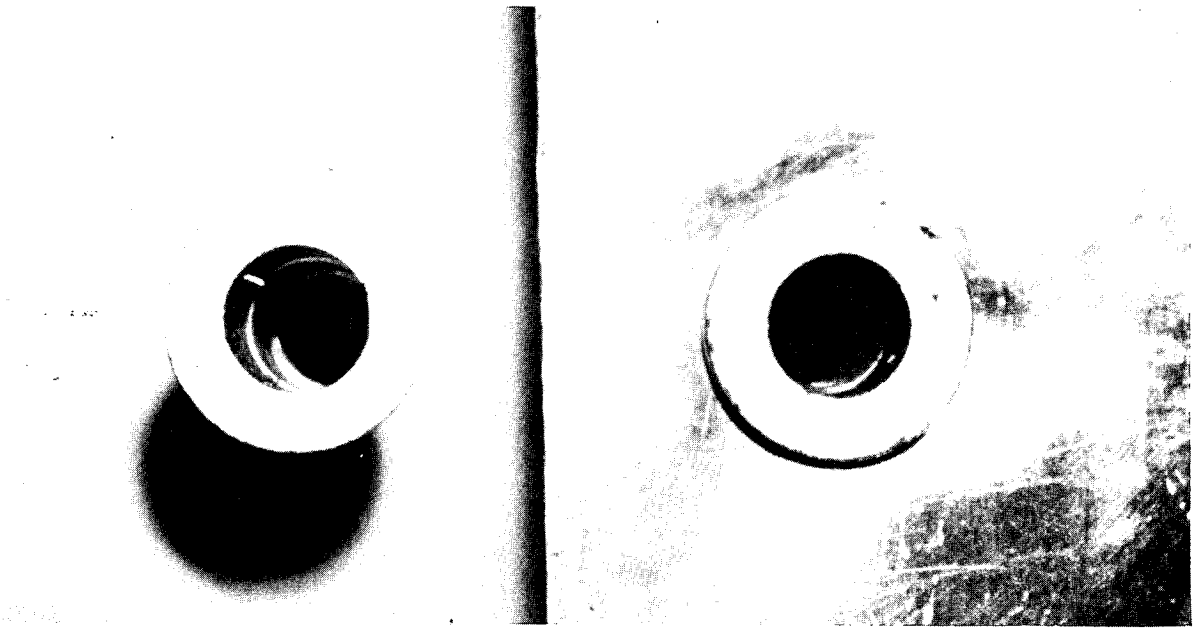

FIGURE 7

APPENDIX A

VEHICLE _____ _____ _____ RESPONDENT _____
Year Make Model

CONTROL # _____ LICENSE # _____ PHASE _____

TIME

DATE								
WEEK#	0	2	4	6	8	10	12	14
ELAPSED DAYS								

MILEAGE

ODOMETER								
CUMULATIVE MILES								

TRIPS

IGNITION COUNTER								
CUMULATIVE COUNTS								

BUCKLE

BUCKLE COUNTER								
CUMULATIVE COUNTS								

RETRACTOR

RETRACTOR COUNTS								
CUMULATIVE COUNTS								

SEAT BELT CONDITION								

BUCKLE TRIPS %								
RETRACTOR TRIPS %								

COMMENTS

_____

_____

APPENDIX B

RESPONDENT _____ PHASE _____ Page 1 of 6
(Name) (Control)

The Automobile Club of Southern California, in cooperation with the Department of Transportation, is conducting a research project among people who use company cars. We would like to ask you a few questions about the seat belt system in the car you drive.

1. a. While you were driving this car, were any of the trips less than 25 miles in length?

Yes No

b. While you were driving on trips of less than 25 miles, did you wear the lap belt?

Never Infrequently Frequently Always

c. While you were driving on trips of less than 25 miles, did you wear the shoulder belt?

Never Infrequently Frequently Always

d. While you were driving on trips of less than 25 miles, did you wear the lap and shoulder belt?

Never Infrequently Frequently Always

2. a. Now, while you were driving this car, were any of the trips 25 miles or longer?

Yes No

b. While you were driving on trips of 25 miles or more, did you wear the lap belt?

Never Infrequently Frequently Always

c. While you were driving on trips of 25 miles or more, did you wear the shoulder belt?

Never Infrequently Frequently Always

d. While you were driving on trips of 25 miles or more, how often did you wear the lap and shoulder belt?

Never Infrequently Frequently Always

The next several questions concern your use of safety belts in cars other than your assigned car.

3. a. Do you have a family car? _____ Yes _____ No

_____ Year _____ Make _____ Model

b. Does that car have lap belts? _____ Yes _____ No

c. Does that car have shoulder belts? _____ Yes _____ No

d. When driving your family car, do you think your use of seat belts increased, decreased or remained about the same as your normal usage of seat belts when driving your assigned car?

_____ Increased _____ Decreased _____ Same

CONFUSION related to the seat belts in your assigned car

1. Which of the following is very confusing (3), fairly confusing (2), only slightly confusing (1), not confusing (0), (circle one)

a. Determining which belts and/or hardware belong to your position	3	2	1	0
b. Orienting parts so they will mate properly	3	2	1	0
c. Extending belts so they can be connected	3	2	1	0
d. Finding the parts of your particular belt set	3	2	1	0
e. Other (explain)	3	2	1	0

INCONVENIENCE related to the seat belts in your assigned car

2. Which of the following is very inconvenient (3), fairly inconvenient (2), slightly inconvenient (1), not inconvenient (0), (circle one)

a.	Getting belt out of the way to sit down	3	2	1	0
b.	Reaching belt ends	3	2	1	0
c.	Extending belt ends so they can be connected	3	2	1	0
d.	Connecting belt ends	3	2	1	0
e.	Adjusting assembly to fit	3	2	1	0
f.	Lack of mobility & freedom to accomplish driving/other tasks	3	2	1	0
g.	Ease/speed of unfastening	3	2	1	0
h.	Getting belt out of the way for egress	3	2	1	0
i.	Belts become twisted	3	2	1	0
j.	Belts become tangled (explain)	3	2	1	0
k.	Other (explain)	3	2	1	0

DISCOMFORT related to the seat belts in your assigned car

3. Which of the following is very uncomfortable (3), fairly uncomfortable (2), only slightly uncomfortable (1), not uncomfortable (0), (circle one)

a.	The belt rubbing across your neck or face (or other tender area - explain)	3	2	1	0
b.	The hardware fittings (buckle, adjustment slide) pressing against you	3	2	1	0
c.	The hardware fittings feel too hot or too cold against your bare skin or through thin clothing	3	2	1	0
d.	Fittings have sharp edges or corners that hurt	3	2	1	0
e.	Belt riding up on stomach	3	2	1	0
f.	Belt distorting or pulling clothing	3	2	1	0
g.	Belt becomes tighter during journey	3	2	1	0
h.	Other (explain)	3	2	1	0