Report No. FHWA-RD-77-145

URBAN INTERSECTION IMPROVEMENTS FOR PEDESTRIAN SAFETY

Vol. IV. Pedestrian Signal Displays and Operation

December 1977
Final Report

Prepared for

FEDERAL HIGHWAY ADMINISTRATION
Offices of Research & Development
Washington, D.C. 20590

FOREWORD

This five-volume report describes pedestrian problems at urban intersections and timing and display improvements for pedestrian signals. This report will be of interest to traffic engineers and others responsible for pedestrian safety.

The five volumes are:

Vol. I - Executive Summary
Vol. II - Identification of Safety and Operational Problems at Intersections
Vol. III - Signal Timing for the Pedestrian
Vol. IV - Pedestrian Signal Displays and Operation
Vol. V - Evaluation of Alternatives to Full Signalization at Pedestrian Crossings

Sufficient copies of the five volumes are being distributed to provide a minimum of one copy to each FHWA Regional and Division office. Additional copies of the Executive Summary have also been provided to allow wider distribution of this report. Copies sent direct to the Division Offices should be distributed to the State highway agency, Governor's Representative for Highway Safety, and to major metropolitan areas.

Charles F. Scheffey
Director, Office of Research
Federal Highway Administration

TECHNICAL REPORT STANDARD TITLE PAGE

1. Report No.	2. Government Accession No.	3. Recipient's Catalog No.
FHWA-RD-77-145		

4. Title and Subtitle

URBAN INTERSECTION IMPROVEMENTS FOR PEDESTRIAN SAFETY
Volume IV. Pedestrian Signal Displays and Operation

5. Report Date: December 1977

6. Performing Organization Code:

7. Author(s)

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8. Performing Organization Report No.:

9. Performing Organization Name and Address

BioTechnology, Inc.
3027 Rosemary Lane
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10. Work Unit No.: FCP 31E2072

11. Contract or Grant No.: DOT-FH-11-8533

12. Sponsoring Agency Name and Address

U.S. Department of Transportation
Federal Highway Administration
Offices of Research and Development
Washington, D.C. 20590

13. Type of Report and Period Covered: Final Report
June 1974 - June 1977

14. Sponsoring Agency Code:

15. Supplementary Notes

FHWA Contract Manager: Julie A. Fee, HRS-41

16. Abstract

This report summarizes that portion of the research dealing with pedestrian signal displays and operation which was completed in Phase II of the three-phase project on urban intersection improvements for pedestrian safety. Three evaluation studies were conducted.

The first study was a controlled experiment to determine what differences existed between "lunar" and "clear" white WALK lenses in pedestrian signals. The findings indicated that "clear" white had better target value, but that "lunar" white was more readable for three of the four lighting conditions tested.

The second study consisted of three experiments, two of which dealt with the clearance interval display, while the third evaluated flashing versus steady WALK. Of the two clearance displays tested, i.e., steady DONT WALK and steady DONT START, *neither* showed a significant improvement over the standard flashing DONT WALK clearance indication. Flashing WALK was found *not* to be effective as a means of warning pedestrians of turning vehicles.

The third study evaluated the *concept* of using symbolic pedestrian displays in place of the current word message display. The hand-walking man symbol was found to show a significant improvement over the standard WALK-DONT WALK display. Orange and white were found to be better colors for pedestrian signal indications than red and green.

Other Volumes in this series include:

Volume I – Executive Summary
Volume II – Identification of Safety and Operational Problems at Intersections
Volume III – Signal Timing for the Pedestrian
Volume V – Evaluation of Alternatives to Full Signalization at Pedestrian Crossings

17. Key Words	18. Distribution Statement
Pedestrian Signals, Traffic Signals, Traffic Control Devices, Pedestrians, Safety, Intersections, Traffic Operations	No restrictions. This document is available to the public through the National Technical Information Service, Springfield, Virginia 22161.

19. Security Classif. (of this report)	20. Security Classif. (of this page)	21. No. of Pages	22. Price
UNCLASSIFIED	UNCLASSIFIED	172	

Form DOT F 1700.7 (8-69)

PREFACE

This research project was conducted in three phases. Phase I dealt with the investigation and identification of both operational and safety problems encountered by pedestrians and motorists at urban-type intersections. Phase II dealt with the development, evaluation, and design criteria formulation of countermeasures that address the problems identified in Phase I. Phase III evaluated some alternatives to full signalization at intersections requiring pedestrian protection.

Volume I of the Final Report is the Executive Summary of the project. Phase I is reported in Volume II and Phase II is reported in Volumes III and IV. Specifically, Volume III addresses the subject of signal .timing for the pedestrian; and Volume IV deals with pedestrian signal displays and signal operation. Phase III is reported in Volume V.

SUMMARY OF SIGNIFICANT FINDINGS

This report summarizes the research completed which pertains to the message, color and operation of pedestrian signals. Three evaluation studies were conducted.

The first study (described in Chapter II) was a controlled experiment to determine what differences, if any, existed between "lunar" and "clear" white WALK lenses in pedestrian signals. The use of "lunar" white had been criticized on the basis of its susceptibility to "sun phantom" or "wash out" when the sun was shining directly into it. The following conclusions were drawn from the analysis of data:

- "Clear" has a much better target value under all conditions tested.
- "Clear" is better in terms of readability for conditions where bright sunlight cannot be prevented from shining directly into the lens.
- "Lunar" is better for all other light conditions with respect to readability, and its effectiveness in this regard increases as the level of illumination decreases.
- Neither "lunar" nor "clear" is best for all conditions.

The second study (described in Chapter III) was made up of three experiments. The first two experiments dealt with the display of the clearance interval. Pedestrians had complained of not having sufficient time to complete their crossing before traffic was released. There were also indications that pedestrians were confused about the intended meaning of the flashing DONT WALK clearance display currently in use. Consequently, two alternatives to the flashing DONT WALK clearance display were tested in two cities. The first was a steady DONT WALK indication; the second was a steady DONT START indication.

The third experiment was to determine how effective was the practice of flashing the WALK indication to warn pedestrians that vehicles might be turning through their crosswalk during the WALK interval. Previous studies had shown that the practice was not particularly effective. Thus a comparison was made between the flashing WALK and the steady WALK indications at intersections where turns were permitted. This experiment was conducted in the same two cities and simultaneously with the clearance display experiments.

The following conclusions were drawn from the analysis of data:

- A steady DONT WALK clearance display appears to have the same effectiveness as a flashing DONT WALK clearance display.
- The DONT START message offers little or no improvement over the current DONT WALK message.
- Flashing WALK is *not* an effective means of warning pedestrians about turning vehicles.

- Based on pedestrians' stated expectancy in regard to turning vehicles, there is a need to make pedestrians more aware of turning vehicles.
- Pedestrians' observance of pedestrian signals varies somewhat from intersection to intersection and greatly from city to city.
- Further research is needed to determine (1) the optimal clearance indication and (2) the best means of alerting both drivers and pedestrians to turning vehicle conflicts.

The third study (described in Chapter IV) evaluated the *concept* of using symbolic pedestrian displays in place of the current word message display. Five preference surveys were conducted to determine: (1) which symbols and colors had the most intuitive meaning, and (2) would these symbols and colors be safe to field test. Traffic and safety experts, pedestrians and school-age children were surveyed. Three symbol displays and two color sets were selected for field testing. Each symbol was tested in two colors in each of two cities. The "best" symbol was then validated in two additional cities.

The following conclusions were drawn from an analysis of the data:

- The Hand-Walking Man symbol display shows a significant improvement over the standard WALK-DONT WALK display.
- The Standing Man-Walking Man symbol display appears to be as effective as the WALK-DONT WALK display.
- The Circle Slash-Walking Man symbol appears to be *not* as effective as the WALK-DONT WALK display.
- Even though pedestrians indicated a preference for red and green pedestrian signal indication colors, compliance with the orange and white colors was significantly higher.
- If symbolic pedestrian signals come into use, an educational program will be necessary for elementary school age pedestrians.

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CHAPTER I. INTRODUCTION

This report summarizes the research completed which pertains to the message, color and operation of pedestrian signals. The need to improve pedestrian signal displays was a major finding of the research in Phase I of the project.

Background

In Phase I, the problem identification portion of the project,(1)* several undesirable characteristics emerged which appeared to be related to pedestrian signal displays and signal operation. Specifically, the following characteristics were noted:

- Nonuniform and/or improper (nonstandard) signal colors, sizes and messages
- Inconsistent use of messages
- Failure of the signal to convey the intended message
- Failure of the signal to meet pedestrian and/or driver expectancies
- Signal not visible (sun phantom or wash-out)
- Pedestrian noncompliance with the signal
- Turning vehicle conflicts with pedestrians

At the Project Advisory Panel meeting in June 1975, the results of Phase I were thoroughly reviewed and areas for further study were identified. The following pertained to signal displays and operation:

- Investigation of the "white" color used in the WALK indication
- Evaluation of the pedestrian clearance interval display with regard to word message and operation (i.e., steady versus flashing)
- Evaluation of flashing and steady WALK in relation to pedestrian/turning vehicle conflicts
- Use of symbols in place of words
- Use of colors other than orange/white

With the above inputs, specific countermeasures were developed and experiments designed. The remainder of the report describes those studies.

Study Objectives

The objectives of this portion of Phase II were to empirically evaluate the following:

- A "clear" versus the "lunar" white WALK lens
- A steady DONT WALK versus the flashing DONT WALK clearance interval
- A steady DONT START versus the flashing DONT WALK clearance interval

*Numbers underlined in parentheses refer to the References on page 47.

- Steady versus flashing WALK
- Symbol versus word message displays
- Red/green versus orange/white pedestrian signal display colors

Scope

In order to conform to the budget and time constraints of the research contract, certain limitations were imposed on the evaluations in order to avoid piecemeal experimentation that might result in inconclusive findings. Even though specific devices and/or operations were tested, the basic idea was to test concepts and leave the final design or fine tuning for subsequent development and implementation activities.

For the field studies, the most common and "worst case" (for turning vehicles) type of intersection was selected as the test site, i.e., four approach legs with two-way two-way directional flow. The assumption was that if the experimental device or operation would work at this type of intersection, it would probably work at other configurations as well.

In order to minimize equipment costs, all experiments utilized incandescent, two-section pedestrian signals; therefore, only the lenses had to be changed for the experimental condition. In order to achieve some degree of geographical representation, each experiment was conducted in at least two different cities at a minimum of two intersections in each city.

This research does not answer all of the questions pertaining to pedestrian signal displays. In fact, some of the answers that were found generated additional questions. This report does present factual information based on accurate, reliable data which should guide the implementation of findings and the conduct of further research in the proper direction.

CHAPTER II. LUNAR VS. CLEAR WHITE WALK LENS STUDY

Introduction

In Phase I of the project, a number of traffic engineers responding to the survey of expert opinions stated that the "lunar" white WALK indication, which is the current Manual on Uniform Traffic Control Devices (MUTCD) standard, was not entirely satisfactory.(1, 2) Detailed comments from the Project Advisory Panel and members of the National Advisory Committee (NAC), Signal Subcommittee indicated that one problem was illegibility or "wash-out" of the message in bright sunlight (sometimes referred to as "sun phantom'). Another problem was that "lunar" white lacked sufficient target value in terms of brightness.(3)

On the basis of these comments, an experiment was designed to test and evaluate an alternate "white" color for the pedestrian WALK signal indication. "Clear" white was selected as the alternate to test since it was an available on-the-shelf item, had also been used on-the-street without noticeable adverse effects, and had the appropriate light transmission characteristics.

Methodology

A controlled experiment was conducted to determine what differences, if any, existed between "lunar" and "clear" white under different lighting conditions at different distances with respect to brightness and readability. Nine-inch lenses of the two colors were mounted in each of two 2-section pedestrian signal heads with 75-watt lamps providing the light source. The signal heads were placed side by side in a parking lot at the standard minimum mounting height of eight feet (2.4 m) (see Figure 1).

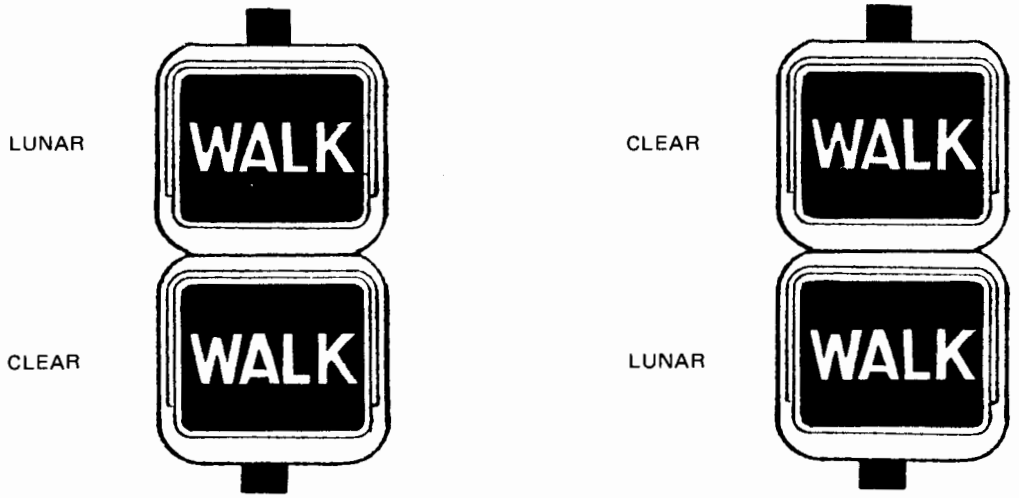


Figure 1. Signal Display for Lunar vs. Clear Experiment

Twenty-five subjects chosen at random participated in all aspects of the experiment. There were 18 males and seven females. They ranged in age from 22 to 49 with a mean age of 33. Each subject was tested at each of three distances from the signal: 40 ft. (12.2 m), 80 ft. (24.4 m) and 120 ft. (36.6 m) for each of four lighting conditions (bright sun shining into the signal lenses, bright sun behind the lenses, overcast, and night with street lighting). Each subject was shown the lighted "clear" and "lunar" lenses side by side twice at each distance for each condition. The subject was asked two questions about each display: "Which of the two lighted signals is brighter? Which of the two lighted signals is easier to read?" The subjects were not informed about the difference in the color of the lenses, nor about the reasons for conducting the tests until after the experiment was completed.

A randomized block design representing a two-way classification of data with replication was employed.(4) The linear model for this experiment was mixed with one qualitative variable, blocks, assumed to be randomly selected from a population and the other variable, treatments, assumed to be fixed. Two replications of each block-treatment combination were performed. The model, therefore, may be expressed as

$$Y_{ijk} = \mu + \beta_i + \tau_j + (\beta\tau)_{ij} + \xi_{ijk}$$

with i = 1, 2, 3 j =1, 2, 3, 4 k = 1, 2

where, a response, Y_{ijk}, corresponding to the kth replication of treatment j in block i is assumed to be the sum of a general mean, μ, a random component of β_i due to the ith block, a fixed effect τ_j due to treatment j, a random interaction term $(\beta\tau)_{ij}$, and a random component contributed by replication, ξ_{ijk}. The three distances (40, 80, and 120 feet) represented blocks (random effect) and the four lighting conditions (sun into the lens, sun behind the lens, overcast sky, and night with street lighting) represented treatments (fixed effect). The proportion of subjects selecting "lunar" in answer to the above questions represented the response, Y_{ijk}. Other assumptions included the following:

$$\beta_i \sim \text{NID}\ (0, \sigma_b^2)$$

$$\sum_{j=1}^{4} \tau_j = 0$$

$$(\beta\tau)_{ij} \sim \text{NID}\ (0, \sigma_{bt}^2)$$

$$\xi_{ijk} \sim \text{NID}\ (0, \sigma^2)$$

When the original data are samples from binomial populations (as was the case in this experiment), the proportion of success (subjects choosing "lunar") $\hat{P}_{ij} = a_{ij}/N$ has a variance of $\hat{P}_{ij}\ (1 - \hat{P}_{ij})/N$, where a_{ij} successes out of a sample of N are obtained in the kth replicate of the ith block and jth treatment.

In the binomial distribution, which is markedly non-normal, the variance is related to the mean. Hence, a transformation of the binomial data that makes the variance almost independent of the mean is needed so that the assumptions of a normal distribution may be applied to the data.

In the angular scale, proportions near 0 or 1 are spread out so as to increase their variance. If all of the error variance is binomial, the error variance in the angular scale is approximately 821/N. The transformation does not remove inequalities in variance arising from differing values of N, and if, the N's vary widely, a weighted analysis in the angular scale is required. In order to improve the equality of variance in the angles, a zero proportion was counted as 1/4N and a one proportion was counted as (N – 1/4)/N before transforming to angles.

The transformation used for this experiment was

$$\text{Angle} = \text{Arcsin}\sqrt{\text{Proportion}}$$

An analysis of variance (ANOVA) two-way classification with replication was first performed on each of the two data sets: brightness and readability. Then hypothesis testing of a binomial proportion was conducted on individual cells of all significant effects of the ANOVA. The null hypothesis was that the proportion of subjects choosing "lunar" was equal to the proportion of subjects choosing "clear" for the conditions in question. The z-test was employed and may be expressed as follows:

H_o: $\hat{p} = p$

$z = |r - np| - ½/npq$

where

$r = n\hat{p}$

n = sample size

$½$ = correction for continuity

$q = 1 - p$

assume

$p = q = ½$

Discussion of the Results

With respect to the ANOVA, the data for each block, treatment, and replication of each data set are shown in Tables 1 and 2. The ANOVA source tables for each data are presented in Tables 3 and 4.

Table 1

Brightness Data
(Numbers are percentage of subjects choosing "lunar")

		Light Condition			
		Sun Into Lens	Sun Behind Lens	Overcast	Night
Distance	40 ft. (12.2 m)	0.00 0.00	0.00 0.00	0.00 0.00	0.00 20.00
	80 ft. (24.4 m)	0.00 0.00	0.00 0.00	0.00 0.00	0.00 8.00
	120 ft. (36.6 m)	0.00 0.00	0.00 0.00	0.00 0.00	0.00 0.00

Table 2

Readability Data
(Numbers are percentage of subjects choosing "lunar")

		Light Condition			
		Sun Into Lens	Sun Behind Lens	Overcast	Night
Distance	40 ft. (12.2 m)	26.09 20.83	63.16 65.00	95.24 80.95	95.83 91.67
	80 ft. (24.4 m)	20.83 20.00	80.95 80.00	80.00 80.00	100.00 96.00
	120 ft. (36.6 m)	12.00 16.00	66.67 65.22	72.00 80.00	100.00 95.24

NOTE: The two numbers appearing in each cell of Tables 1 and 2 represent the two replications of the experiment.

Table 3

ANOVA Source Table for Brightness

Source	Sum of Squares	d.f.	Mean Squares	EMS	F-Ratio
Distance	42.90	2	21.46	$\sigma^2+8\sigma_b^2$	0.56
Light Condition	218.93	3	72.98	$\sigma^2+2\sigma_{bt}^2+2\Sigma\tau_j^2$	3.40
Interaction.	128.71	6	21.45	$\sigma^2+2\sigma_{bt}^2$	0.56
Error	463.51	12	38.63	σ^2	
Total	854.05	23			

Table 4

ANOVA Source Table for Readability

Source	Sum of Squares	d.f.	Mean Squares	EMS	F-Ratio
Distance	79.60	2	39.80	$\sigma^2+8\sigma_b^2$	3.07
Light Condition	9153.99	3	3051.33	$\sigma^2+2\sigma_{bt}^2+2\Sigma\tau_j^2$	72.32**
Interaction	253.13	6	42.19	$\sigma^2+2\sigma_{bt}^2$	3.25*
Error	155.66	12	12.97	σ^2	
Total	9642.38	23			

*Significant at 0.05 level.

**Significant at 0.01 level.

For the question of brightness, no significant differences were found in the responses with respect to either distance (0.05 level), light condition (0.05 level), or the interaction of distance and light condition (0.01 level). For the question of readability, no significant differences were found in the responses with respect to distance. However, differences were found to be significant (0.05 level) with respect to the interaction of distance and light condition and highly significant (0.01 level) with respect to light condition.

With regard to brightness, both distance and light condition were found not to reflect significant differences. Consequently, the data was collapsed over all distances and all light conditions. The z-test was applied to the proportion of subjects choosing 'lunar." The results were overwhelmingly (7 responses for "lunar," 592 responses for "clear") in favor of the "clear" lens. Thus, the null hypothesis was rejected.

Since distance was found not to be a significant factor for readability, the data were collapsed over all distances and the z-test was applied to the proportion of subjects choosing "lunar" for each light condition. The number of responses for each lens, as well as the z-values are shown for each light condition in Table 5.

Table 5

Readability Data for Type of Lens vs. Light Condition
(Numbers in first three categories are
actual number of responses)

Light Condition / Categories	Sun Into Lens	Sun Behind Lens	Overcast	Night	Total All Conditions
"Lunar"	28	89	115	135	367
"Clear"	118	38	27	5	188
Total (n)	146	127	142	140	555
z-values	-7.366*	4.437*	7.301*	10.916*	

*Significant at the 0.001 level.

In terms of readability, a highly significant difference (0.001 level) in favor of the "clear" lens was found for the "sun into lens" light condition; however, a highly significant difference (0.001 level) in favor of the "lunar" lens was found for the three remaining light conditions. Again, the null hypothesis was rejected in all cases.

When plotted, the readability data reflected an apparent trend (see Figure 2). As the level of illumination decreased, the percent of subjects choosing "lunar" as more readable increased. As expected from the results of the ANOVA, this trend held true at all three distances. The most dramatic change occurred between the "sun into lens" condition and the "sun behind lens" condition.

Several observations made during the conduct of the experiment are worthy of mention. The "lunar" lens appeared to diffuse the light from the lamp more uniformly than did the "clear" lens. With the "clear" lens, the letters appeared fuzzy, particularly the "A" and "L." All of the letters were very distinct and well-defined on the "lunar" lens.

When the sun was shining into the lenses, there was an almost complete "wash out" on the "lunar" lens. It was very difficult to tell whether or not the lens was illuminated. For the same light condition, one might mistakenly think that the "clear" lens was illuminated when it was not, due to the sunlight reflected off the "clear" lens. As long as other cues are present (e.g., the DONT WALK being illuminated whenever the WALK was not), this phenomena should cause no problems.

Conclusions

The following conclusions were drawn from the analysis of data:

- "Clear" has a much better target value under all conditions tested.
- "Clear" is better in terms of readability for conditions where bright sunlight cannot be prevented from shining directly into the lens.
- "Lunar" is better for all other light conditions with respect to readability, and its effectiveness in this regard increases as the level of illumination decreases.
- Neither "lunar" nor "clear" is best for all conditions.

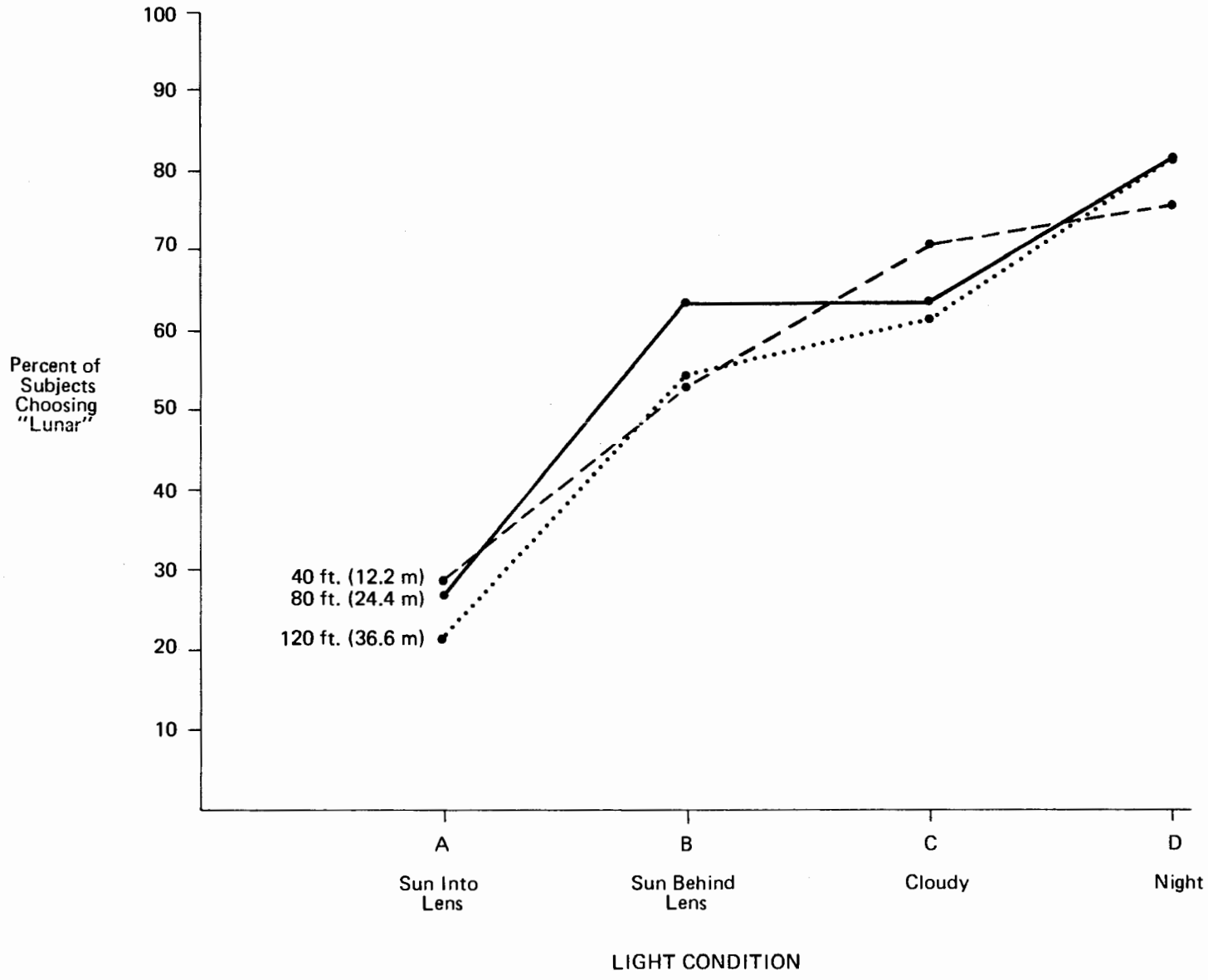


Figure 2. Percent Choosing "Lunar" as More Readable vs. Light Condition and Distance

CHAPTER III. WORD MESSAGE AND OPERATION STUDY

Introduction

Two problem areas were addressed in the research described here. One problem identified in Phase I of the project involved the display of the pedestrian clearance interval. Pedestrians complained that there was not enough WALK time for them to complete their crossing. They did not understand that a clearance interval was provided for them to complete their crossing before traffic was released. Additionally, some 15 percent of pedestrians hit by vehicles at signalized intersections were crossing against the signal. At 71 percent of 38 matched high and low pedestrian accident site pairs (intersections) in Washington, D.C., the percentage of pedestrians who started their crossing during the clearance display was greater at the high accident location. Finally 40 percent of the pedestrians observed crossing against the pedestrian signal started on the clearance indication (flashing DONT WALK).

The second problem area was centered on how effective was the practice of flashing the WALK indication to warn pedestrians that vehicles might be turning through their crosswalk. A study by D'Angelo in 1973 (5) showed that pedestrians did not understand the intended meaning of flashing WALK and that a educational campaign produced no change in pedestrian crossing behavior. Observations in Phase I of this project confirmed that there was no significant difference in compliance between locations with flashing WALK and locations with steady WALK. The accident data indicated that turning vehicles represented a serious safety hazard to pedestrians. Approximately 25 percent of pedestrian intersection accidents involved turning vehicles.

Study Methodology

Three experimental conditions were devised to address these two problem areas. In all cases, the experimental condition was compared to the current recommended MUTCD standard and the pedestrian signal timing remains unchanged throughout each experiment. Experiment 1 compared a steady DONT WALK (DW) clearance indication to the standard flashing DONT WALK (FDW) clearance indication. The hypotheses was that if pedestrians were not *shown* a distinct clearance interval indication, compliance would increase, undesirable behaviors would decrease and the need to understand the clearance interval would be eliminated, i.e., WALK means it is safe to cross, DONT WALK means it is not safe to cross. This hypotheses, however, contained a possible flaw. Would the pedestrian understand what to do if he started on the WALK and the signal changed to DONT WALK while he was still in the street?

Experiment 2 was designed to address this question and consisted of a DONT START message in place of the DONT WALK message. The operation was the same as the experimental condition in Experiment 1, i.e., a steady DONT START (DS) indication during the clearance and prohibited intervals. The hypothesis was that when the DONT START message was displayed, pedestrians

already in the street would continue their crossing while those still on the curb would not start their crossing.

Experiment 3 dealt with the second problem area and compared steady WALK (W) to flashing WALK (FW). The objective was to determine whether or not pedestrians understood the intended meaning of flashing and steady WALK and whether or not pedestrians behaved differently with the two displays. Figure 3 depicts the experimental design.

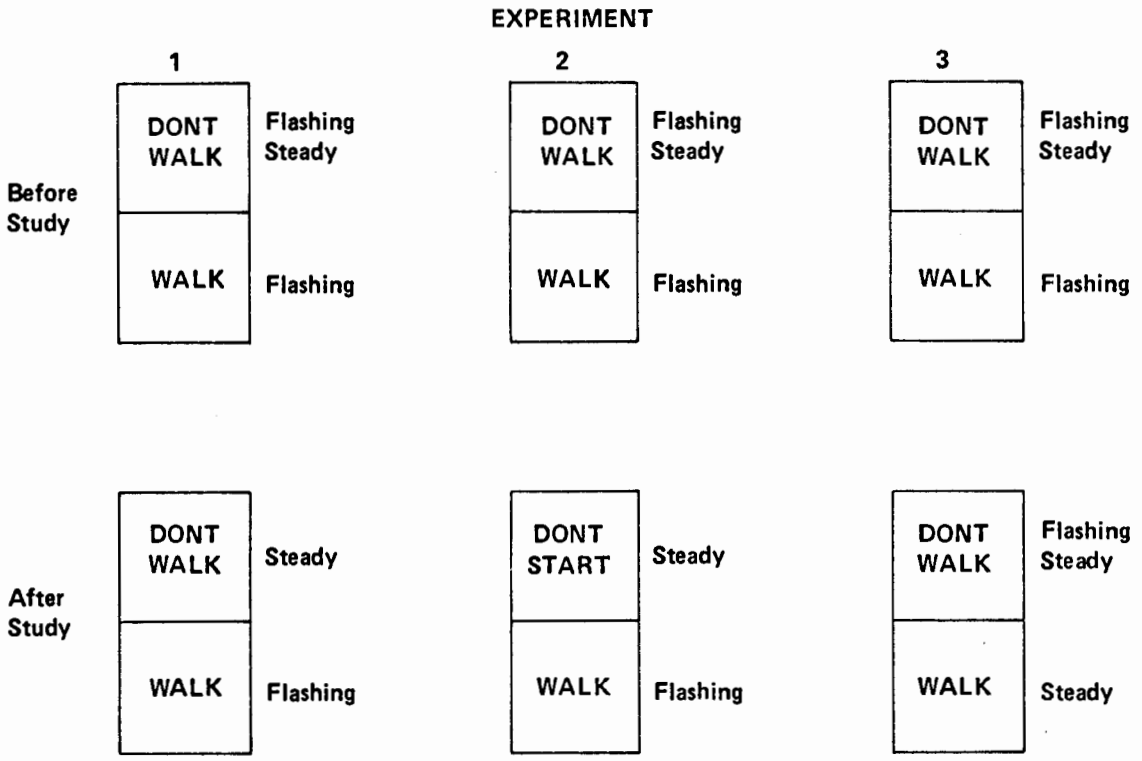


Figure 3. Experimental Displays for Word Message and Operation Study

All three experiments were conducted simultaneously in Buffalo, New York, and Phoenix, Arizona. A "before/after" type study design was employed. Each experiment was conducted at two different test intersections (one central urban and one suburban) in each of the two cities, i.e., four intersections per experiment. A two-month acclimation period was allowed after installation of the experimental condition. One exception was that Experiment 3 in Buffalo was reversed in the "before/after" sequence because the normal operation in Buffalo was steady WALK. All of the test sites operated on two-phase, fixed-time control with all turning movements permitted. See Appendix A for detailed descriptions of the test sites.

Three types of variables were measured: observed pedestrian behavior, pedestrian compliance, and user understanding. In Phase I of the project, a set of hazard-related pedestrian behaviors was developed. These behaviors occurred more frequently at high accident intersections than at similar low accident intersections. The behaviors included the following:

Backup Movement (B) – Momentary reversal in pedestrian direction of travel in the traffic lane or hesitation, in response to a vehicle in a traffic lane.

Moving Vehicle (MV) – Thru traffic moving through the crosswalk while a pedestrian is in a traffic lane.

Turning Vehicle (TV) – Pedestrian in the path and within 20 feet of a turning vehicle.

Vehicle Hazard (VH) – Pedestrian entering a traffic lane when a thru vehicle, unrestricted by a traffic control device, is approaching in that lane within one block.

Running Vehicle Hazard Conflict (RVH) – Running in a traffic lane in response to a VH.

Running Turning Vehicle Conflict (RTV) – Running in a traffic lane in response to a TV or TV potential.

The second type of variable measured was observed pedestrian compliance with the signal display. In addition to recording the number of pedestrians starting on the clearance interval, starting on the prohibited interval, and anticipating the signal, the distribution of these occurrences were recorded.

The third type of variable measured was user understanding of the signal display. A survey was made of pedestrians using the crossings where the above described observations were taken. See Appendix B, Signal Design Survey (message/operation study). Three days were spent at each site pair for each experimental condition during the "before" and "after" study in each of the two cities. See Appendix C for a more detailed description of the data collection procedures.

The evaluation of each experimental signal display, when compared to the base condition, was based on the following criteria:

- A significant change in the occurrence of one or more of the pedestrian behaviors observed.
- A significant difference in the types of pedestrian violations and the distributions of those violations by interval.
- Responses from the user survey with respect to meaning of the indications and perceived actions required by the indications.

The data analyses were designed to reflect the three evaluation areas: understanding, compliance, and behavior. Within each of these areas, a statistical comparison, contrasting the experimental and standard signal, were performed. These analyses were based on standard psychometric procedures with all statistical tests evaluated at the .01 level (two-tail).

The analysis of data on signal understanding consisted of a series of "Z" tests which were used to compare the percent of pedestrians correctly identifying the meaning of the various signal displays under investigation.

The analysis of the compliance data consisted of comparing "before and after" the proportion of pedestrians leaving the curb during each of the three timed intervals of a signal cycle, i.e., the permissive (cross), the clearance (don't start to cross) and the prohibited (don't cross). "Z" tests were conducted to isolate the particular time interval in the cycle that showed a significant difference between "before" and "after."

The behavioral data were analyzed by comparing the proportion of pedestrians involved in each of the target behaviors. The proportions of each behavior occurring under the different signal displays were tested using the "Z" test. Appendix D contains the understanding, behavioral and compliance data summaries for each intersection.

In order to assist in the explanation of significant differences, traffic volume was sampled during the collection of behavioral and compliance data for both the "before" and "after" conditions. Since this data represented correlated samples, Sandler's A-statistic(6) was used to check the traffic volume data for significant differences. See Appendix D for summaries of the data tested.

Discussion of the Results

Experiment 1 – Flashing DONT WALK vs. Steady DONT WALK

The results of Experiment 1 are shown in Table 6. Almost no behavioral differences were found. In Phoenix the three behaviors showing a slight significant difference occurred in less than 2 percent of the 3000 observed crossings.

The compliance data were summarized in two ways. First, the proportion of pedestrians leaving the curb during the WALK indication (in compliance with the signal) were noted. Highly significant differences were found at one intersection in each of the two cities. In Buffalo the "before" case (FDW) was favored (compliance was 10.5 percent higher), while in Phoenix the "after" case (DW) was favored (compliance was 8 percent higher). No significant differences were found at the other intersection in each city. Combining the two sites in each city resulted in the same trend but a lower level of significance. Thus the improvement shown by steady DONT WALK in Phoenix appears to be offset by the findings in Buffalo. In general, compliance ranged from 8 to 32 percent in Buffalo and 65 to 89 percent in Phoenix.

Table 6

Summary of Results

Experiment 1 – Steady DONT WALK (After) Vs. Flashing DONT WALK (Before)

City		Buffalo				Phoenix		
Site #		1	2	1 & 2		5	6	5 & 6
BEHAVIOR	Backup Movement	nc	nc	nc		A*	nc	nc
	Running Turning Vehicle Conflict	nc	nc	nc		nc	nc	B*
	Moving Vehicle	nc	nc	nc		nc	nc	nc
	Turning Vehicle Conflict	nc	nc	nc		nc	nc	nc
	Running Vehicle Hazard	nc	nc	nc		nc	nc	nc
	Vehicle Hazard	nc	nc	nc		nc	A*	nc
COMPLIANCE	Leaving Curb on Walk	B**	nc	B*		A**	nc	A*
	Leaving Curb on Clearance	nc	A*	nc		nc	nc	nc
UNDERSTANDING	Question 1	nc	nc	nc		nc	nc	nc
	Question 2	nc	nc	B*		nc	A*	A*

NOTE:

A = Significant difference in favor of "after" (experimental) condition.

B = Significant difference in favor of "before" (MUTCD standard) condition.

nc = No significant difference between "before" and "after" conditions.

* = Significant at the 0.05 level.

** = Significant at the 0.01 level.

Question 1 – If you are at the curb, what should you do if you see the (FDW/DW) indication?

Question 2 – If you had just started to cross the street and you saw the (FDW/DW) indication, what should you do?

See Appendix D for the data summaries that support this table.

The compliance data were next summarized and tested by comparing the proportion of pedestrians leaving the curb during the clearance interval. The hypothesis was that fewer pedestrians would leave the curb during the DW clearance than during the FDW clearance. At one site in Buffalo the hypothesis proved correct at the 0.05 level of significance (a reduction of 9.1 percent). At the remaining sites there were no significant differences. In general, pedestrians leaving the curb during the clearance interval ranged from 10.0 to 20.4 percent in Buffalo and from 3.7 to 20.7 percent in Phoenix. In Volume III of this report, *Signal Timing for the Pedestrian*, it was determined that the allocation of excess pedestrian time to the "WALK" interval decreased the number of pedestrians leaving the curb on the clearance interval and had little effect on the number of pedestrians leaving the curb on the "DONT WALK" interval(7).

Some 400 pedestrians were surveyed to obtain user understanding data (50 pedestrians per site per condition, i.e., "before/after"). The questions asked pertaining to the clearance interval are shown in Table 6. No significant differences were found in the responses to Question 1 in either city. On the average across both cities, 91 percent of the responses to this question were correct. In other words, most pedestrians understood that they should not leave the curb on either FDW or DW. Question 2, which asked the pedestrian what he should do if he had just left the curb and saw the clearance indication (FDW or DW), produced mixed results. In Buffalo, the combined correct responses (i.e., to continue across) for both sites were significant at the 0.05 level in favor of the FDW clearance indication (59.1 percent 'before" compared to 42.6 percent "after"). In Phoenix, the correct response at one site and at both sites combined were significant at the 0.05 level in favor of the steady DW clearance indication. At the one site correct responses ranged from 74 percent "before" to 90 percent "after." With both sites combined the correct responses ranged from 74 percent "before" to 91 percent "after."

The differences between cities were considerable. In Phoenix, pedestrians exhibited both a higher compliance with and a better understanding of pedestrian signal indications. In Buffalo, the number of significant differences were fewer than in Phoenix; pedestrians did not react differently to the change in clearance indications; and the responses to a question about when it would be safe to leave the curb (the correct answer being "on the WALK indication") implied that some 21 percent either do not understand pedestrian signals or do not bother to use them as an aid in crossing the street. No significant differences were found in traffic volumes during the "before" and "after" data collection periods in either city.

Experiment 2 – Flashing DONT WALK vs Steady DONT START

The results of Experiment 2 are shown in Table 7. No significant differences in behaviors occurred in either city with the exception of one site in Phoenix. At that site, turning vehicle conflicts (TV's) were reduced from 23.5 to 14.5 percent thus favoring the DONT START display. This difference was significant at the 0.01 level and contributed largely to the difference for both Phoenix sites combined to be significant at the 0.05 level. Turning vehicle conflicts were approximately 8 percent higher in Phoenix than in Buffalo even though the proportion of turning vehicles was about 2 percent lower than Buffalo.

Table 7
Summary of Results
Experiment 2 – Steady DONT START (After) Vs. Flashing DONT WALK (Before)

City		Buffalo				Phoenix		
Site =		3	4	3 & 4		1	2	1 & 2
BEHAVIOR	Backup Movement	nc	nc	nc		nc	nc	nc
	Running Turning Vehicle Conflict	nc	nc	nc		nc	nc	nc
	Moving Vehicle	nc	nc	nc		nc	nc	nc
	Turning Vehicle Conflict	nc	nc	nc		nc	A**	A*
	Running Vehicle Hazard	nc	nc	nc		nc	nc	nc
	Vehicle Hazard	nc	nc	nc		nc	nc	nc
COMPLIANCE	Leaving Curb on Walk	nc	nc	nc		nc	A*	nc
	Leaving Curb on Clearance	nc	nc	nc		nc	nc	nc
UNDERSTANDING	Question 1	nc	A**	nc		nc	nc	A*
	Question 2	nc	nc	nc		nc	nc	nc

NOTE:

A = Significant difference in favor of "after" (experimental) condition.
B = Significant difference in favor of "before" (MUTCD standard) condition.
nc = No significant difference between "before" and "after" conditions.
* = Significant at the 0.05 level.
** = Significant at the 0.01 level.

Question 1 – If you are at the curb, what should you do if you see the (FDW/DS) indication?
Question 2 – If you had just started to cross the street and you saw the (FDW/DS) indication, what should you do?
See Appendix D for the data summaries that support this table.

Only one significant difference was found in the compliance data. In Phoenix at one site, compliance increased from 80.9 percent to 87.8 percent (significant at the 0.05 level) thus favoring the DONT START message. This difference was not sufficient to cause the combined data from both sites to be significantly different. No significant difference was found in the proportion of pedestrians (approximately 11 percent in Phoenix and 8 percent in Buffalo) leaving the curb during the clearance interval. In general, compliance ranged from 39 to 49 percent in Buffalo and from 81 to 88 percent in Phoenix. Thus compliance was greater at the Experiment 2 sites than at the Experiment 1 sites in both cities.

The survey questions in Experiment 2 were the same as those asked in Experiment 1 and again 400 pedestrians were surveyed. A highly significant (at the 0.01 level) increase in correct responses to Question 1 (82 to 98 percent) was found at one site in Buffalo, thus favoring the "after" case. In Phoenix, the difference was not significant at either site but was significant at the 0.05 level for the two sites combined also favoring the "after" case (an increase in correct responses from 84 to 91 percent). No significant differences were found in the responses to Question 2 in either city, thus the hypothesis that DONT START would be better understood as a clearance display was not sustained.

As in Experiment 1, the differences between cities were great at the Experiment 2 sites. Compliance in Phoenix was nearly twice as high as in Buffalo. Understanding of pedestrian signal indications also remained higher in Phoenix than in Buffalo. However, traffic volumes were not significantly different "before" and "after' in either city except for one intersection in Buffalo where the traffic volume was significantly lower at the 0.10 level of significance.

Experiment 3 – Flashing vs. Steady WALK

The results of Experiment 3 are shown in Table 8. As can be seen in the table, a number of differences were found in the Buffalo behavioral data, whereas no significant differences were found in the Phoenix behavioral data. All of the differences in Buffalo favored the flashing WALK case. The most significant results were that hesitations were reduced by 13 percent, vehicle hazards by 6 percent, and turning vehicle conflicts by 4 percent.

Significant differences were also apparent in the compliance data. As was the case in Experiment 1, the differences in pedestrians leaving the curb on the WALK indication were offsetting. In Buffalo, the flashing WALK case was favored (compliance decreased 19 percent) and in Phoenix the steady WALK case was favored (compliance increased 8 percent). The same trends held when data from both sites in each city were combined. Compliance at these sites ranged from 21 to 40 percent in Buffalo and 78 to 93 percent in Phoenix.

Table 8
Summary of Results
Experiment 3 – Steady WALK (After) Vs. Flashing WALK (Before)

City		Buffalo				Phoenix		
Site =		5	6	5 & 6		3	4	3 & 4
BEHAVIOR	Backup Movement	B**	B**	B**		nc	nc	nc
	Running Turning Vehicle Conflict	B*	nc	B**		nc	nc	nc
	Moving Vehicle	nc	nc	nc		nc	nc	nc
	Turning Vehicle Conflict	nc	B*	B**		nc	nc	nc
	Running Vehicle Hazard	nc	nc	nc		nc	nc	nc
	Vehicle Hazard	nc	B**	B**		nc	nc	nc
COMPLIANCE	Leaving Curb on Walk	B**	nc	B**		A**	nc	A**
	Leaving Curb on Clearance	nc	nc	nc		A*	nc	A*
UNDERSTANDING	Question 3	nc	nc	nc		nc	nc	nc
	Turn Expectancy	49.5%	41.4%	45.5%		35.0%	44.0%	39.5%

NOTE:

A = Significant difference in favor of "after" (experimental) condition.
B = Significant difference in favor of "before" (MUTCD standard) condition.
nc = No significant difference between "before" and "after" conditions.
* = Significant at the 0.05 level.
** = Significant at the 0.01 level.

Question 3 – At some intersections, the WALK signal flashes, at some, it does not. What does the flashing (non-flashing) WALK signal mean here at this intersection?

Turn Expectancy – The percent of peds that would expect vehicles to be turning into their crosswalk if they started their crossing on the WALK indication.

See Appendix D for the data summaries that support this table.

The proportion of pedestrians leaving the curb during the clearance indication (FDW) was not expected to change because the indication was the same in both the "before" and "after" cases. This expectation held true except at one site in Phoenix where a difference at the 0.05 level was found.

The most significant finding in this experiment was from the understanding data. Of the 400 pedestrians surveyed, only 2.5 percent understood the intended meanings of flashing WALK and steady WALK. Less than half of the pedestrians in both cities said that they would *expect* vehicles to be turning into the crosswalk during the WALK interval even though turning vehicles in both cities made up one-fourth of the total traffic passing through the intersections and all turns were permitted. As mentioned earlier, turning vehicle conflicts dropped in Buffalo (4.0 to 0.4 percent) and remained the same "before and after" in Phoenix (approximately 16 percent).

The trends in compliance differences between cities remained consistent with the trends in Experiments 1 and 2. The behavioral differences found in Buffalo are not easily explained. The "before-after" sequence was reversed in Buffalo for this experiment, but there was a two-month acclimation period to reduce or eliminate the novelty effect. Besides, there was no novelty effect apparent in the behavioral data for the two other experiments and they were conducted simultaneously with this experiment. Again traffic volumes "before" and "after" were not found to be significantly different in either city.

Conclusions

The following conclusions were drawn from the findings summarized in the previous section:

- A steady DONT WALK clearance display appears to have the same effectiveness as a flashing DONT WALK clearance display. There is not sufficient evidence to say that a steady clearance is better than a flashing clearance. This conclusion is the same as that reached in a study conducted in 1968 by ITE Committee 36(65), Traffic Control Measures (8).
- The DONT START message offers little or no improvement over the current DONT WALK message.
- Flashing WALK is *not* an effective means of warning pedestrians about turning vehicles.
- Based on pedestrians' stated expectancy in regard to turning vehicles, there is a need to make pedestrians more aware of turning vehicles.
- Pedestrians' observance of pedestrian signals varies somewhat from intersection to intersection and greatly from city to city.
- Further research is needed to determine (1) the optimal clearance indication and (2) the best means of alerting both drivers and pedestrians to turning vehicle conflicts.

CHAPTER IV. SYMBOL MESSAGE STUDY

Introduction

Symbolic pedestrian signals may be found throughout the world. In Europe, the most common symbols are the "standing man" and the "walking man" figures, usually displayed in red and green respectively (9). The same symbols are also used in Mexico. In Canada, a study was completed in 1967 (10) that compared word messages with two sets of symbol displays, "standing man – walking man" and "outline of hand-walking man." Red-green was also compared to orange-white. As a result of these studies, the Council on Uniform Traffic Control Devices For Canada adopted the "outline of hand-walking man" symbols in orange and white, respectively, as standard pedestrian signal displays.

Since the Phase I findings indicated a need to improve pedestrian signal displays, a portion of the research was directed at developing and evaluating symbolic pedestrian signal indications for use in the United States. The development of symbols was accomplished through the use of several preference surveys as well as drawing on the experiences of other countries currently using symbols. Field evaluations were conducted of the top three symbol displays resulting from the surveys.

Preference Surveys

Five preference surveys were conducted. Two were directed at traffic engineers and safety experts, two were directed at pedestrians on the street in twelve different cities, and one was directed at young pedestrians ages 5-12 years. A total of 89 engineers and experts, 1,290 pedestrians on the street, and 231 children were surveyed. Sample survey forms may be found in Appendix B.

First Engineer's Survey

This survey was designed to obtain comments on ten suggested pedestrian displays and to afford an opportunity for respondents to suggest additional ideas. The ten displays are shown in Figure 4. Note that #1 was the Canadian standard and #5 was the European standard. For each display, the respondent was asked to state how the display should be operated (i.e., steady or flashing) for the prohibited, clearance and permissive intervals; to list any problems the display might cause; and to rate the potential of the display in terms of it providing a symbolic replacement for the standard WALK-DONT WALK display. Next a sheet was provided for the respondent to suggest a display of his own. The last page of the survey asked for a rating of each display in terms of accident reduction potential, cost of implementation, and anticipated compliance. Finally, the respondent was asked to indicate the three best displays based on his overall judgement. The survey form is on pp. B-7 to B-18 in Appendix B.

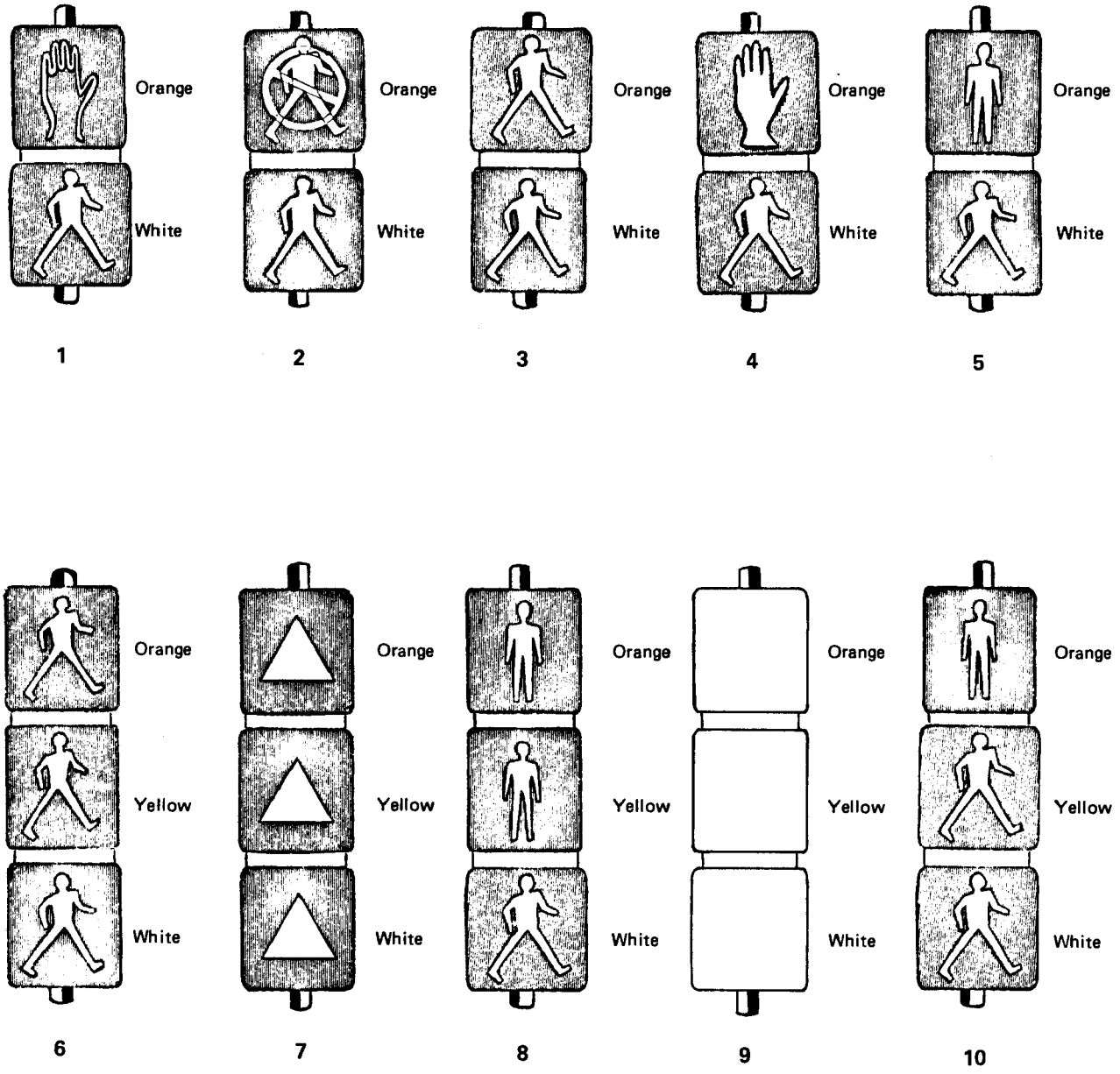


Figure 4. First Engineer's Survey Displays

Forty-four engineers and safety experts responded to the survey. Twenty-four were from city government, ten from state government and six from the federal government. The other four were consultants, manufacturers, or university affiliated. Twenty-five of the 44 respondents were members of the National Advisory Committee on Uniform Traffic Control Devices, Subcommittee on Signals. The significant results were as follows.

Each of the ten displays was first assigned a weighted score on the basis of being selected as an overall first, (3 points) second, (2 points) or third (1 point) choice of the respondent. Table 9 shows the weighted scores as well as a breakdown of first, second and third choices. The top four displays were #10, #4, #5 and #2, respectively. Next, the responses for rating the potential of each display to replace the standard WALK-DONT WALK display were compiled. The percentage of responses in each category for each display is shown in Table 10. Note that 19, 21, 19 and 29 percent of the respondents respectively found the top four displays unacceptable replacements for WALK-DONT WALK.

Table 9

Overall Choice for Displays – First Engineer's Survey

Display *	Choices **			Weighted Score
	1st (3 Points)	2nd (2 Points)	3rd (1 Point)	
# 1	2	6	6	24
# 2	7	2	8	33
# 3	2	2	1	11
# 4	8	7	6	44
# 5	5	9	5	38
# 6	3	3	6	21
# 7	0	2	1	5
# 8	1	9	5	26
# 9	2	2	0	10
# 10	14	2	3	49

* See Figure 4

** Numbers are number of responses

Overall the hand and standing man symbols seemed the most appealing to the respondents. The three section signal head appeared to be favored over the two section signal, which was a bit surprising because all of the three section head displays were consistently rated too costly and too difficult to implement. The preferred operation was almost unanimous for a steady display of the prohibited and permissive intervals. For the clearance interval, 70 percent indicated flashing the prohibited display on the two section heads, but only 50 percent wanted a flashing clearance on the three section head. Finally, all of the additional 19 suggested displays made by the respondents to the First Engineers Survey were basically modifications to either the hand or standing man symbols.

Table 10

Rating of Symbolic Display for Replacing WALK – DONT WALK Display

(Numbers Are Percent of Responses)

Display *	Excellent Candidate	Very Satisfactory	Satisfactory	Somewhat Satisfactory	Unacceptable
# 1	11	8	21	31	29
# 2	13	6	19	33	29
# 3	0	6	19	19	56
# 4	12	15	29	23	21
# 5	6	21	19	35	19
# 6	4	15	23	31	27
# 7	0	6	2	19	73
# 8	8	13	24	38	17
# 9	6	2	4	15	73
#10	16	23	19	23	19

* See Figure 4

Second Engineer's Survey

Based on the results of the first survey, a second survey was designed to identify one or two displays for field evaluation. Three variations of the hand and standing man displays each representing a different operational concept were presented (see Figure 5). Concept I was a two section, two color display; Concept II was a three section, three color display; and Concept III was a two section, three color display.

The respondent's were first asked to select their preferred display for each concept, and for that choice to indicate whether the clearance interval should be a flashing or a steady indication. Next they were asked to select the one *BEST* display from the six shown based on overall judgment and briefly explain why they chose it. For the display they chose as best, they were asked to indicate their preference of color for each interval. The last question was "would you consider your above choice of *BEST* symbolic display to be a satisfactory replacement for the present WALK-DONT WALK display?" The survey form is on pp. B-19 to B-20 in Appendix B.

Forty-five engineers and experts responded: 23 from city, 10 from state and 7 from the federal government. Five were consultants, manufacturers or university affiliated. The significant results were as follows.

Table 11 shows the respondent's choices of displays by concept (column 1), by preferred operation of clearance interval (columns 2 and 3), and by overall choice of best and least liked display (columns 4 and 5). For all three concepts the majority of respondents (60 percent) favored the hand symbol display over the standing man display. For the clearance operation, flashing was

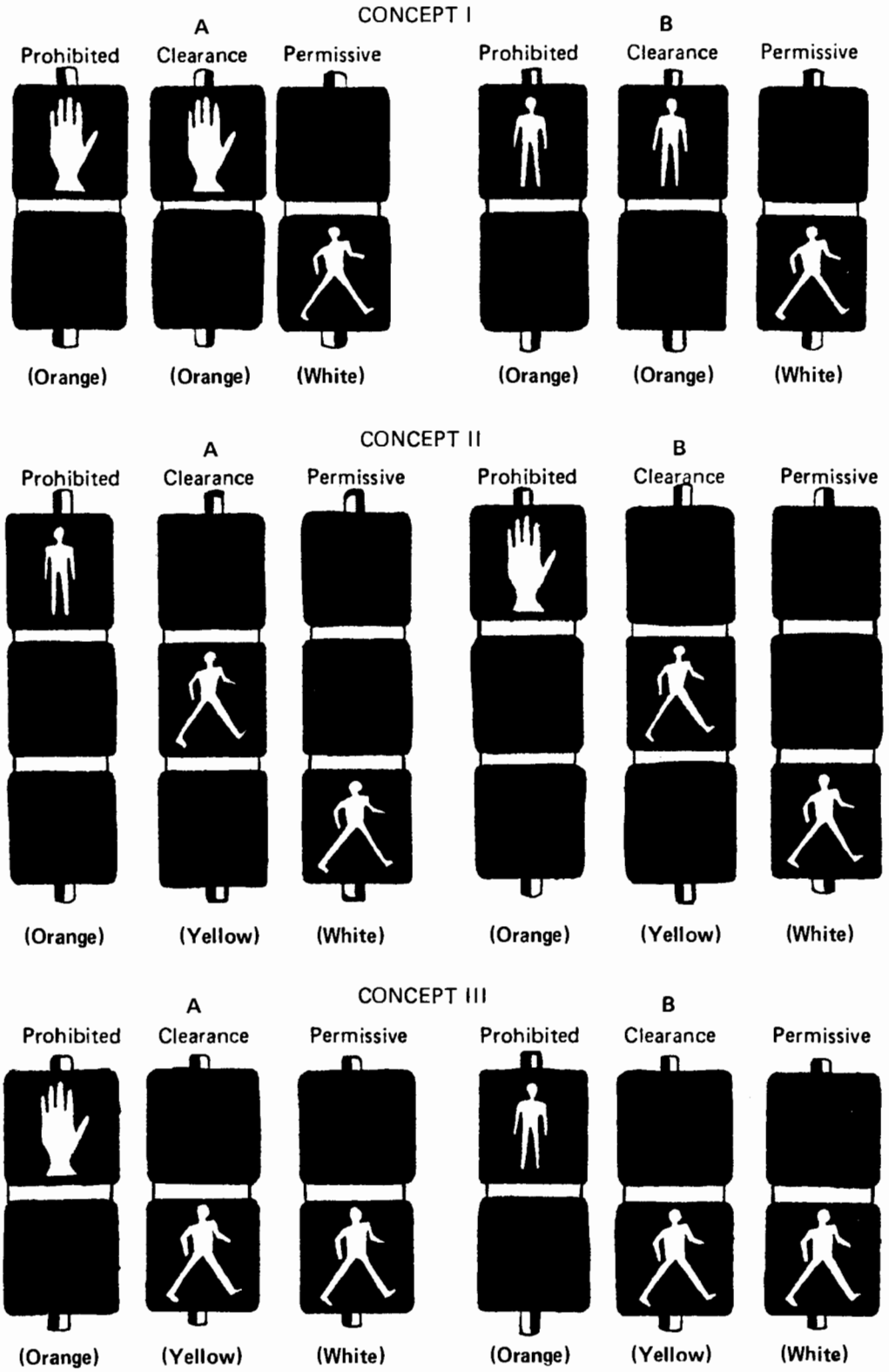


Figure 5. Second Engineer's Survey Displays

preferred for Concepts I and III with steady being preferred for Concept II. Overall choice for best display was a tie between Display IA and Display IIIA (see Figure 5). However, note that Display IA had the highest number of responses for the least liked display, even more than the number of responses for best display. Only three respondents indicated that Display IIIA was least liked. Therefore, Display IIIA was the overall best choice. Taking into account the least liked choices, Concept III appeared to be preferred to the other two concepts.

Table 11
Choice of Displays and Operation – Second Engineer's Survey
(Numbers are Number of Responses)

Display *	Choice by Concept (1)	Clearance Operation		Overall Choice	
		Flashing (2)	Steady (3)	Best (4)	Least (5)
IA	25	23	2	10	14
IB	20	18	2	4	9
IIA	18	8	12	9	8
IIB	27	13	14	7	5
IIIA	27	20	7	10	3
IIIB	18	10	8	5	6

* See Figure 5

Table 12 shows the results with regard to the preferred color for the displays. Surprisingly, 44 percent preferred red over the standard orange for the prohibited indication, and 36 percent preferred green to the standard white permissive indication. Yellow was the most preferred color for the clearance indication where three colors were used, and orange or red was preferred for the clearance where two colors were used.

Table 12
Choice of Color – Second Engineer's Survey
(Numbers are number of responses)

Color	Interval		
	Prohibited	Permissive	Clearance
Orange	24	–	9
Red	20	–	6
White	–	28	1
Green	–	16	–
Yellow	–	–	28
Other	1	1	1

In order to determine if any regional significance existed regarding the choice of the hand or standing man symbol, a breakout by region was constructed and is shown in Table 13. Seventy to seventy-five percent of the respondents from the South, Midwest and West preferred the hand symbol compared to 38 percent in the Northeast. On a breakout by type of employment, city and state people chose the hand symbol 2 to 1 over the standing man. The reverse was true of the federal people with the others being evenly split between the two symbols. Finally 82 percent of the respondents indicated that symbols would be a satisfactory replacement for word message displays on pedestrian signals.

Table 13

Choice of Symbol by Region – Second Engineer's Survey

(Numbers are Number of Responses)

Symbol	Region			
	Northeast	South	Midwest	West
Hand	6	7	9	5
Standing Man	10	3	3	2
Total	16	10	12	7

First User Survey

This survey of users was designed to determine which symbols and colors (based on the results from the engineer survey) had the most intuitive meaning to pedestrians. Thirty pedestrians in each of ten cities were first shown a card with five symbols (see Figure 6) and asked "which *one* of these symbols *most clearly* means DONT WALK to you?" In half of the cities the symbols were red while in the other half the symbols were orange. Next, they were shown a card with the same symbols in both red and orange and were asked "For the symbol you just picked which *color* most clearly means DONT WALK to you?" Finally, they were shown a card with the symbol of a walking man in two colors, green and white, and were asked "which *one* of these symbols most clearly means WALK to you?" The survey forms are on pp. B-21 to B-24 of Appendix B. Pedestrians were interviewed on street corners where pedestrian signals were located. Of the 330 respondents, 52 percent were male and 48 percent were female. The results are shown in Table 14.

The circle slash symbol most clearly meant DONT WALK to 70 percent of the 330 pedestrians surveyed. Twenty-three percent preferred the hand symbol. In response to the most meaningful color for DONT WALK, 85 percent chose red, while 86 percent selected green as most clearly meaning WALK. In light of the results from the two engineer surveys, these results were surprising. It appeared that engineers' and pedestrians' preferences were quite different, at least with respect to choice of symbol and color of pedestrian signal displays.

Figure 6. Symbols for First User Survey

Table 14

Results of First User Survey

(Numbers are Number of Responses)

City	Question 1					Question 2		Question 3		Sex	
						Orange	Red	White	Green	M	F
Alexandria, VA	2	1	11	0	16	2	28	5	25	18	12
Baltimore, MD	0	1	6	0	23	4	26	6	24	15	15
Daytona Beach, FL	1	1	12	0	16	17	13	8	22	15	15
Denver, CO	0	4	6	0	20	6	24	1	29	15	15
Tempe, AZ	1	2	3	0	24	4	26	3	27	15	15
Buffalo, NY	0	1	11	0	18	3	27	6	24	15	15
Greensboro, NC	0	2	8	0	50	6	54	6	54	30	30
San Diego, CA	0	2	7	0	21	2	28	0	30	15	15
Sioux City, IO	0	3	10	1	16	7	23	8	22	14	16
Washington, DC	0	1	2	0	27	0	30	3	27	20	10
Total	4	18	76	1	231	51	279	46	284	172	158
% of 330 responses	1.2	5.5	23.0	0.3	70.0	15.5	84.5	13.9	86.1	52.1	47.9

Question 1 Which one of these symbols most clearly means DONT WALK to you?

Question 2 For the symbol you just picked which color most clearly means DONT WALK to you?

Question 3 Which one of these symbols most clearly means WALK to you?

Second User Survey

Although the original plan had been to field test the one "best" symbol display, the surveys described above indicated a need to evaluate at least two symbol displays, i.e., the hand and circle slash. Consequently, a second user survey was designed to insure that pedestrians at the field test sites would not be confused in a manner that could produce adverse safety effects. Prior to the beginning of the field tests, the second user survey was conducted at six intersections in each of the four test cities, i.e., Baltimore, MD, Buffalo, NY, San Francisco, CA, and Phoenix/Tempe, AZ.*

A card with each symbol display (see Figure 7) was shown to the pedestrian; and he was asked the following three questions about each display: (1) When is it safe to start your crossing? (2) What should you do if you see the (prohibited indication)? (3) If you had just started to cross the street and you saw the (prohibited indication), what should you do? Finally, the pedestrian was asked which of the two symbols was easiest to understand. For half of the pedestrians interviewed at each intersection the symbols were red and green and for the other half they were orange and white. The survey form is shown on pp. B-25 and B-26 in Appendix B, Signal Design Survey (Symbol Study).

Forty pedestrians were surveyed at each of the six intersections in each of the four cities. A summary of the survey results are shown in Tables 15 and 16. No significant differences were found in responses between the red/green cards and the orange/white cards. Both symbols appeared to be understood equally well in all four cities. Some people had trouble with the permissive indication in Buffalo, but better than 90 percent in all four cities understood the prohibited indication. Again some people in Buffalo had trouble with the prohibited indication in the situation presented in the survey. If they had started to cross and saw the prohibited indication, their response was to stop and wait in the street. Overall the results indicated that the symbols were safe to use. With respect to preference (see Table 16), the hand was favored in Baltimore and Buffalo, and the circle slash was favored in San Francisco and Phoenix/Tempe. In the field studies described in a later section, each symbol was placed in one city where it was preferred and one city where it was not.

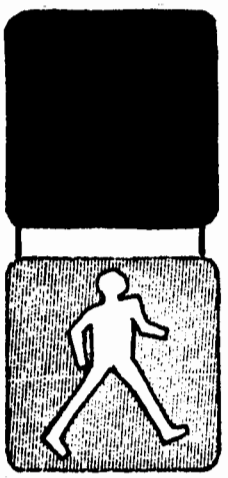
School Age Survey

It has long been recognized that children experience difficulties in crossing streets safely. Reiss(11) found that in urban areas only 25 percent of school age pedestrians wait for the traffic signal in deciding when to cross, and 36 percent interpret the signal incorrectly. He also found that the younger children experience even greater difficulty, a finding similar to Sandels(12) in Sweden where 700 children were tested on their understanding of road signs. The Phase I accident analyses indicated that 38 percent of the pedestrians involved in some 400,000 accidents in 1973 were between the ages of five and fourteen. In order to understand the impact that symbolic pedestrian signals might have on the school age pedestrian, a survey of 231 children between the ages of 5 and 12 years was conducted.

*The survey was conducted at four intersections in Phoenix and two intersections in Tempe even though the field test was conducted in Tempe. Since most of Tempe's pedestrians were college age, it was necessary to sample in Phoenix to broaden the range of ages.

SIGNAL # 1

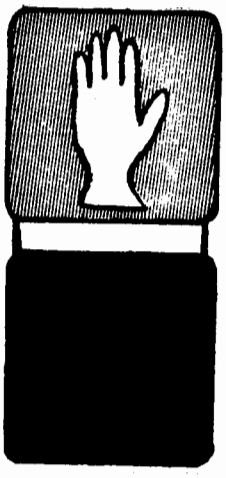
A



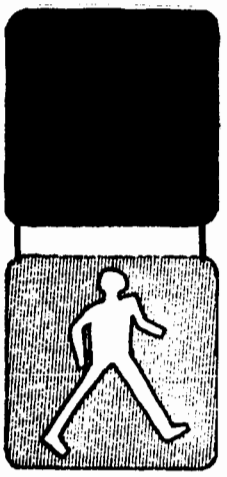
B

(FRONT)

SIGNAL # 2



C



D

(BACK)

Figure 7. Card Showing Displays for Second User Survey

Table 15

Summary of Results, Questions 1-3 – Second User Survey

(Numbers are Percentage of Correct Responses)

Questions	Baltimore		Buffalo		San Francisco		Phoenix/Tempe	
	Circle Slash	Hand	Circle Slash	Hand	Circle Slash	Hand	Circle Slash	Hand
1	93	92	85	80	99	99	97	98
2	91	95	91	92	97	99	98	97
3	98	98	85	82	88	87	99	99

Question 1 When is it safe to start your crossing? Answer: Walking man symbol.
Question 2 What should you do if you see (prohibited indication)? Answer: Don't start to cross.
Question 3 If you had just started to cross the street and you saw (prohibited indication), what should you do? Answer: Either continue or return to the curb.

Table 16

Summary of Results, Question 4 – Second User Survey

(Numbers are percentage of responses to the question "Which of the two signals do you think is the easiest to understand?")

Response	Baltimore	Buffalo	San Francisco	Phoenix/Tempe
Circle Slash	41	40	50	59
Hand	56	53	44	37
Neither	2	2	2	4
Same	1	5	4	0

The subjects were elementary school children from three schools in Fairfax County, Virginia. The number surveyed were kindergarten class (N=33), 1st grade (N=39), 2nd grade (N=48), 3rd grade (N=55), and 5th grade (N=56). Students in kindergarten and lst grade were interviewed individually; the remaining classes were interviewed in class size groups. The subjects were first shown a picture of a boy crossing the street at a signalized intersection and given the following instructions: "Here is a picture of a boy walking down the sidewalk on his way to school who has come up to a corner. Across the street you can see his school and also a signal that tells him something about crossing the street. I am going to show you some signs and I want you to pretend that each sign I show you is in that signal. You tell me what each sign means."

The subjects were then shown drawings one at a time in random order of each of eight symbols (see Figure 8) and were asked to indicate what each symbol meant to them.

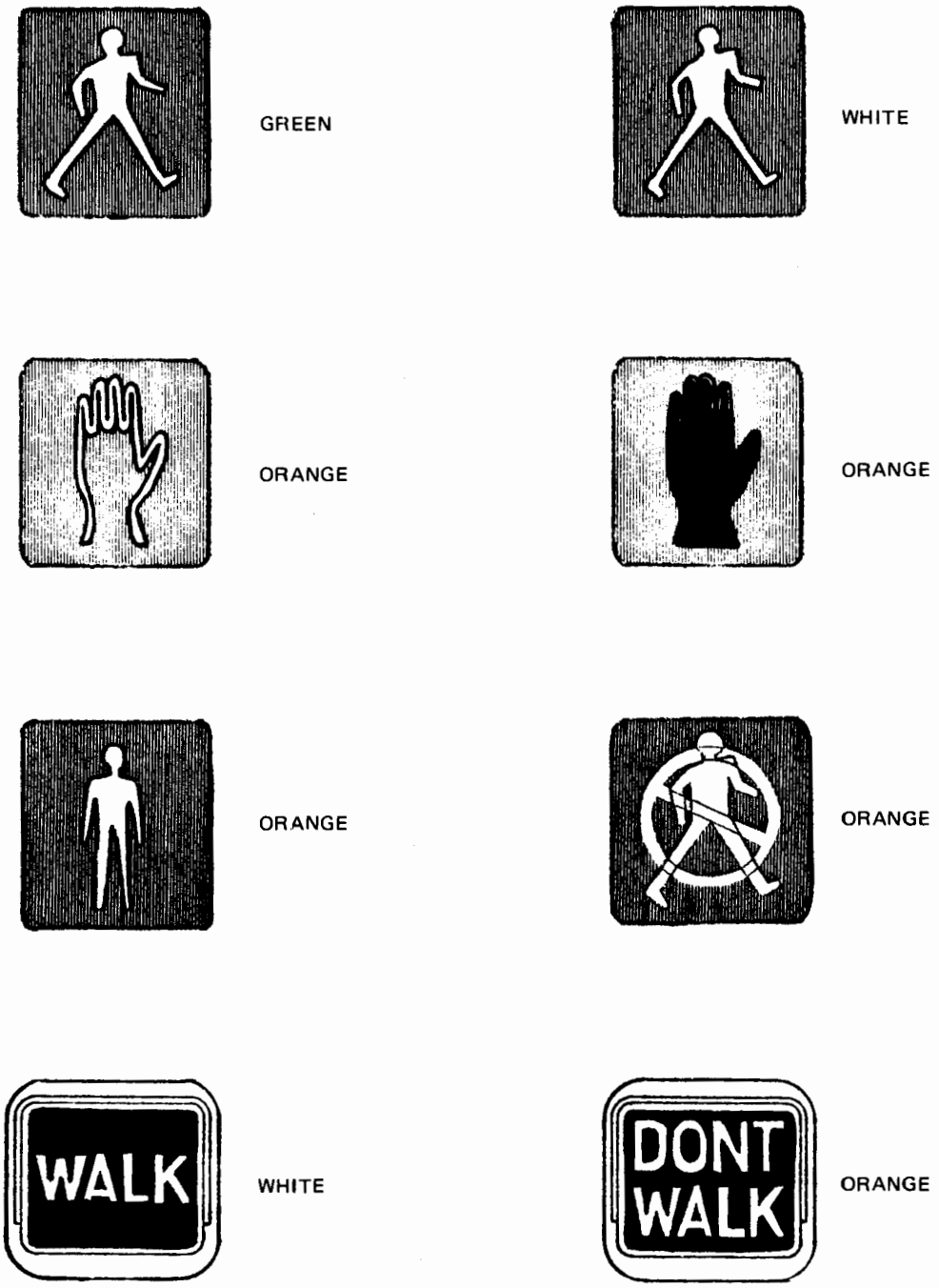


Figure 8. Pedestrian Signal Indications for School Age Survey

Table 17 shows the percentage of correct responses by grade and symbol. Approximately 70 percent of the children responded correctly across all grades and symbols. As expected, the kindergarten (ages 5-6) did not do as well as the other grades. Grades 1-5, however, did not show the expected upward trend in correct responses, but remained relatively constant with respect to each other.

With respect to the symbols, the verbal WALK-DONT WALK were the most meaningful by far, a result which could probably be attributed to education and exposure to those messages. Even the kindergarten children did best on them. The green and white walking man symbols had equal responses, thus indicating that color did not make an overall difference, This was particularly true of the 5-6 year olds. The solid hand received the most correct responses of the non-verbal symbols with the standing man coming a close second. This corresponded to the preferences of the engineers. Somewhat surprisingly, the circle slash received the least number of correct responses. Only the fifth graders appeared to understand its meaning. Should the circle slash ever become standard, retraining programs would certainly have to be directed to younger children. One might assume that the present level of education on traffic signals might suffice if non-verbal symbols, particularly the hand or standing man and walking man, came into use, since over 70 percent of the children already seem to attach an inherent meaning to them.

Summary of Survey Findings

The first engineer's survey indicated a preference for the hand and standing man displays and a three section three color signal head. The second engineer's survey favored the hand over the standing man with a preference for a two section; three color signal. Orange and white were the preferred colors, even though red and green came in a respectable second. Yellow was the favored clearance indication color. Symbols were thought to be a suitable replacement for words in pedestrian signal displays.

The first user's survey overwhelmingly attached the most intuitive meanings to the circle slash symbol and to red and green for pedestrian signal display colors. The second user survey indicated that symbols could be field tested without adverse safety effects. Preference for the hand and circle slash displays was evenly split between the four cities participating in the surveys. The school age survey indicated that the symbols did have some degree of intuitive meaning, but that unless retraining was provided, the field test sites should not be located on elementary school walking routes.

Table 17

Percentage of Correct Responses by Grade and Symbol

(Numbers are Percentages)

Grade \ Symbols	Green	White					WALK	DONT WALK	Average Percentage Correct
K N = 33	60	60	36	49	55	24	82	79	56
1 N = 39	72	67	77	77	85	44	75	69	71
2 N = 48	75	79	56	90	77	60	100	77	77
3 N = 55	62	46	60	89	69	33	89	95	68
5 N = 56	55	71	63	68	79	71	96	98	75
All Grades Combined N = 231	65	65	59	76	74	48	90	85	70

Field Study Methodology

Based on the survey results, three symbol displays were designated for field evaluation. The hand-walking man was selected for its strong showing in the engineer's and school-age pedestrian surveys and the fact that Canada selected a similar display for its standard. The circle slash-walking man was selected for its widespread use throughout most of the world. Both the orange/white and red/green colors were designated for testing.

The remaining available resources of the project were directed toward evaluating the concept of symbolic versus word message pedestrian signal displays. The questions raised in the word message studies (Chapter III) regarding turning vehicle conflicts and clearance interval displays were not pursued any further. Standard two section incandesant pedestrian signal heads were used so that signal displays could be changed from words to symbols by simply changing lenses. In all cases the symbolic displays were compared to the MUTCD standard lunar white WALK (W)-Portland orange Flashing DONT WALK (FDW)-Portland orange Steady DONT WALK (DW) display.

A "before/after" type experimental design was employed. Each of the three symbol displays was tested in two different cities at two intersections in each city. Data were collected for all crosswalks at each test site. A one-month acclimation period was allowed after the installation of the experimental displays. Signal timing and phasing remained the same "before" and "after." All of the test sites were four leg, two way-two way intersections operated on two-phase, fixed-time control with turning movements permitted. (See Appendix A for detailed descriptions of the test sites.) At one intersection in each city the symbol displays were Portland orange and lunar white; at the other intersection they were red and green. Figure 9 shows the "before" and "after" displays and the respective cities in which they were evaluated.

As in the word message studies (Chapter III) three types of variables were measured: observed pedestrian behavior, pedestrian compliance, and user understanding. (See Appendix B, Signal Design Survey [Message Study] for a sample of the survey forms.) Three days were spent at each site pair for each experimental condition during the "before" and "after" study in each of the six cities. Data collection procedures *are detailed in Appendix C.*

The evaluation of each experimental signal display, when compared to the base condition, was based on the following criteria:

- A significant change in the occurrence of one or more of the pedestrian behaviors observed.
- A significant difference in the types of pedestrian violations and the distributions of those violations by observation interval.
- Responses from the user survey with respect to meaning of the indications and perceived actions required by the indications.

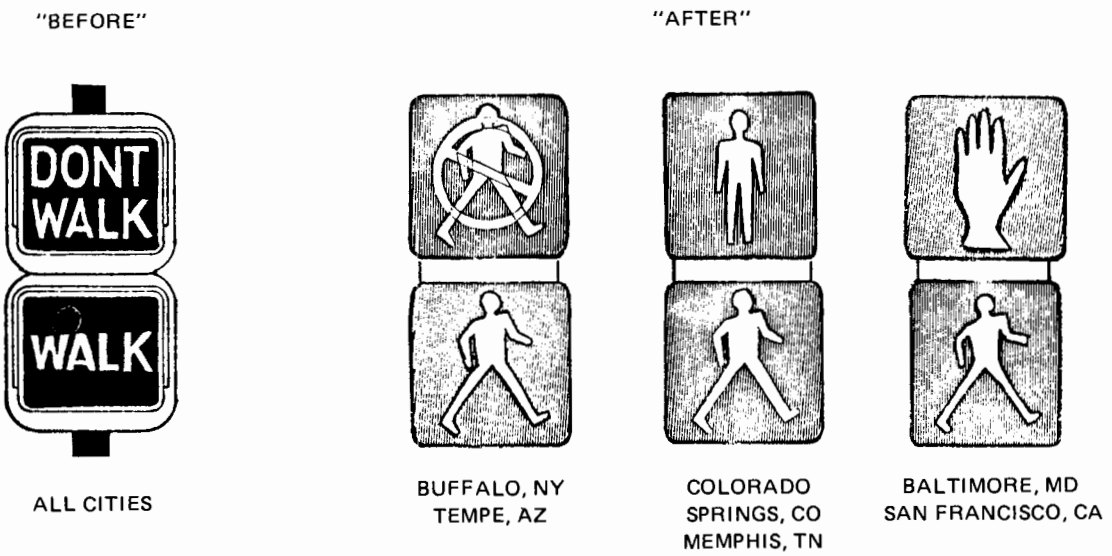


Figure 9. "Before/After" Displays for Symbol Study

Within the three areas of evaluation, understanding, compliance, and behavior, a statistical comparison, contrasting the experimental and standard signal, was performed. These analyses were based on standard psychometric procedures with all statistical tests evaluated at the .01 and .05 levels (two-tail).

The analysis of data on signal understanding consisted of a series of "Z" tests which were used to compare the percent of pedestrians correctly identifying the meaning of the various signal displays under investigation.

The analysis of the compliance data consisted of comparing "before and after" the proportion of pedestrians leaving the curb during each of the three timed intervals of a signal cycle, i.e., the permissive (cross), the clearance (don't start to cross) and the prohibited (don't cross). "Z" tests were conducted to isolate the particular time interval in the cycle that showed a significant difference between "before" and "after."

The behavioral data were analyzed by comparing the proportion of pedestrians involved in each of the target behaviors. The proportions of each behavior occurring under the different signal displays were tested using the "Z" test. Appendix E contains the understanding, behavioral and compliance data summaries for each intersection.

In order to assist in the explanation of significant differences, traffic volumes were sampled during the collection of behavioral and compliance data for both the "before" and "after"

conditions. Since this data represented correlated samples, Sandler's A-statistic(6) was used to check the traffic volume data for significant differences. See Appendix E for summaries of the data tested.

Discussion of the Results

The results of each symbol comparison to the standard MUTCD display is first discussed followed by a validation study of the symbol which showed the most improvement. Finally the results of the color comparisons are presented.

Circle Slash-Walking Man

Table 18 summarizes the results of the behavioral, compliance and understanding data collected in Buffalo and Tempe. The data summaries that support the table may be found in Appendix E. Only two behaviors changed significantly. In Buffalo, hesitations decreased from 6 percent to 1 percent (significant at the .05 level) at one intersection favoring the symbol display Also favoring the symbol, turning vehicle conflicts decreased from 26 to 18 percent (significant at the .05 level) at one intersection in Tempe.

No significant differences in compliance were found in Tempe. Although the same held true in Buffalo for pedestrians leaving the curb on the clearance indication, both intersections experienced significant changes in the proportion of pedestrians leaving the curb on the WALK indication. At one intersection compliance increased with the symbol display by 11 percent (significant at the .05 level), but at the other, compliance decreased by 16.5 percent (significant at the .01 level). Combining both intersections compliance dropped from 56 to 44 percent, a decrease of 12 percent (also significant at the .01 level), thereby heavily favoring the WALK-DONT WALK display. Checking Tempe more closely revealed the same trend even though the differences were not statistically significant. Compliance increased from 82 to 85 percent at one site, but decreased from 82 to 75 percent at the other site. This decrease was very close to being significant at the .05 level.

Traffic volumes differed significantly before and after in Buffalo. Volume was lower at the site with the increase in compliance and higher at the site with the decrease, which does not help to explain the differences. Traffic volumes in Tempe were not significantly different.

The understanding data reflected mixed results. In Buffalo, at both intersections combined, correct responses to "On which indication was it safe to start to cross?" decreased from 87 percent for the word display to 71 percent for the symbol display (significant at the .01 level). No significant differences were found with the two questions on the clearance indication. In Tempe, no significant difference was found in understanding when it was safe to cross (98 percent responded correctly for both words and symbols). However, significant increases were found in understanding

Table 18

Summary of Results

WALK – DONT WALK (Before) Vs. Circle Slash Symbol (After)

	City	Buffalo				Tempe		
	Site #	2A	3A	2A & 3A		7	9	7 & 9
	Colors	O/W	R/G			R/G	O/W	
BEHAVIORAL	Hesitation or Reversal	A*	nc	nc		nc	nc	nc
	Running Turning Vehicle Conflict	nc	nc	nc		nc	nc	nc
	Moving Vehicle	nc	nc	nc		nc	nc	nc
	Turning Vehicle Conflict	nc	nc	nc		A*	nc	nc
	Running Vehicle Hazard	nc	nc	nc		nc	nc	nc
	Vehicle Hazard	nc	nc	nc		nc	nc	nc
COMPLIANCE	Leaving Curb on WALK	A*	B**	B**		nc	nc	nc
	Leaving Curb on Clearance	nc	nc	nc		nc	nc	nc
UNDERSTANDING	Question 1	B**	nc	B**		nc	nc	nc
	Question 2	nc	nc	nc		A*	A**	A**
	Question 3	nc	nc	nc		nc	B*	nc

NOTE: A = Significant difference in favor of "after" (experimental) condition.
B = Significant difference in favor of "before" (MUTCD standard) condition.
nc = No significant difference between "before" and "after" conditions.
* = Significant at the 0.05 level.
** = Significant at the 0.01 level.

Question 1 On which indication is it safe to start your crossing?
Question 2 If you are at the curb, what should you do if you see the (FDW/Flashing Symbol) indication?
Question 3 If you had just started to cross the street and you saw the (FDW/Flashing Symbol) indication, what should you do?

Appendix E contains the data summaries that support this table.

the clearance indication when the symbol was used if the indication was on before the pedestrian started to cross. The increase was significant at the .05 level at one site and at the .01 level at the other site resulting in an increase of 19 percent (77 to 96) at both sites combined (also significant at the .01 level). Question three concerning the clearance indication after starting to cross in Tempe showed a significant difference (.05 level) in favor of the word display at one site. No significant differences were found at the other site nor at both sites combined.

As with the word message study (Chapter III), differences between cities were great, particularly with respect to compliance and understanding. Pedestrians in Tempe exhibited higher compliance and better understanding than the pedestrians in Buffalo. Tempe appeared to accept the symbol display more favorably than Buffalo. Overall, however, the decrease in compliance at two of the four sites and the problem in Buffalo with understanding the permissive display indicate that the standard WALK-DONT WALK display is better than the circle slash-walking man symbol display.

Standing Man – Walking Man

Table 19 summarizes the results of the behavioral, compliance and understanding data collected in Memphis and Colorado Springs. The data summaries that support this table may be found in Appendix E.

Several significant differences in behavior were found in both cities, all of which favored the WALK-DONT WALK display. In Memphis vehicle hazard conflicts increased significantly at one site and at both sites combined (.05 level). Hesitations increased significantly at both sites combined (.05 level). The same was true of hesitations in Colorado Springs at one site and at both sites combined (.01 level). Also in Colorado Springs the moving vehicle behavior increased at one site and at both sites combined (.05 level); turning vehicle conflicts increased by 10 percent at one site (.05 level) and at both sites combined (.01 level).

The compliance data also showed significant differences all of which strongly favored the symbol display. For pedestrians leaving the curb on the permissive interval in Memphis, compliance increased 5 percent (85 to 90 percent) which was significant at the .05 level. In Colorado Springs, compliance increased 8 percent at one site, 14 percent at the other site, and 10 percent (67 to 77 percent) at both sites combined. All three increases were significant at the .01 level. For pedestrians leaving the curb on the clearance indication, the following occurred in both cities: compliance increased at one site (.05 level) and at both sites combined (.01 level). Traffic volumes decreased significantly (.05 level) at both sites in Memphis which does not help to explain the compliance increases experienced there. However, traffic volumes increased significantly (.10 and .01 levels) at both sites in Colorado Springs where the increase in compliance was highly significant. This result seems to support the hypothesis that increases in traffic volumes are accompanied by increases in compliance with pedestrian signals.

Table 19

Summary of Results

WALK – DONT WALK (Before) Vs. Standing Man Symbol (After)

	City	Memphis				Colorado Springs		
	Site #	1	2	1 & 2		1	2	1 & 2
	Colors	R/G	O/W			R/G	O/W	
BEHAVIORAL	Hesitation or Reversal	nc	nc	B*		nc	B**	B**
	Running Turning Vehicle Conflict	nc	nc	nc		nc	nc	nc
	Moving Vehicle	nc	nc	nc		B*	nc	B*
	Turning Vehicle Conflict	nc	nc	nc		B*	nc	B**
	Running Vehicle Hazard	nc	nc	nc		nc	nc	nc
	Vehicle Hazard	nc	B*	B*		nc	nc	nc
COMPLIANCE	Leaving Curb on WALK	nc	A*	nc		A**	A**	A**
	Leaving Curb on Clearance	nc	A*	A**		nc	A*	A**
UNDERSTANDING	Question 1	nc	B**	B*		A*	nc	A*
	Question 2	nc	nc	nc		nc	nc	nc
	Question 3	nc	nc	nc		nc	nc	nc

NOTE: A = Significant difference in favor of "after" (experimental) condition.
B = Significant difference in favor of "before" (MUTCD standard) condition.
nc = No significant difference between "before" and "after" conditions.
* = Significant at the 0.05 level.
** = Significant at the 0.01 level.

Question 1 On which indication is it safe to start your crossing?
Question 2 If you are at the curb, what should you do if you see the (FDW/Flashing Symbol) indication?
Question 3 If you had just started to cross the street and you saw the (FDW/Flashing Symbol) indication, what should you do?

Appendix E contains the data summaries that support this table.

The understanding data produced mixed results between the cities. For the question about the permissive indication, the WALK-DONT WALK display was favored in Memphis (.01 level at one site; .05 level at both sites combined). In Colorado Springs, this question response favored the symbol display (.05 at one site and at both sites combined). No significant differences were found in either city for the two clearance indication questions.

There were differences between the two cities, but not as marked as the differences between Buffalo and Tempe. Average compliance was higher in Memphis (86 percent) than in Colorado Springs (72 percent), but understanding was better in Colorado Springs than in Memphis. Even though the behavior data favored the word display and the understanding data was conflicting, the strong increases in compliance in both cities made the standing man-walking man symbol display slightly better than the word display.

Hand-Walking Man

Table 20 summarizes the results of the behavioral, compliance and understanding data collected in Baltimore and San Francisco. The data summaries that support this table may be found in Appendix E.

Two-thirds of the behaviors were significantly different in Baltimore and *all* were different in San Francisco. As shown in Table 20 all of the significant differences in Baltimore were in favor of the word display at one site or both sites or at both sites combined except for the running vehicle hazard conflict, which was highly significant (.01 level) in favor of the symbol display. In San Francisco all of the significant differences (15 out of 18 possible) were at the .01 level and *all* favored the symbol display. Even though the behavioral differences were mixed, the overall behavioral difference heavily favored the symbol display.

The compliance data completely favored the symbol display. In Baltimore compliance on the permissive interval increased significantly (.05 level) at one site (38 to 44 percent) and at both sites combined (48 to 52 percent). Compliance on the clearance interval was not significantly different in Baltimore; however, traffic volumes were significantly greater (.05 level) at the site with the significant increase in compliance. In San Francisco, traffic volumes were *not* significantly different; nevertheless, the increase in compliance was highly significant (.01 level) at both sites and for both sites combined for the permissive interval and at one site and for both sites combined for the clearance interval. At one site in San Francisco compliance increased 9.5 percent while at the other the increase was 5 percent. Compliance for both sites combined increased from 70 to 77 percent.

Table 20

Summary of Results

WALK – DONT WALK (Before) Vs. Hand Symbol (After)

City		Baltimore			San Francisco		
Site #		1	2	1 & 2	1	2	1 & 2
Colors		R/G	O/W		R/G	O/W	
BEHAVIORAL	Hesitation or Reversal	B**	nc	B**	A**	A**	A**
	Running Turning Vehicle Conflict	B**	nc	B**	A**	A**	A**
	Moving Vehicle	nc	nc	nc	A**	A**	A**
	Turning Vehicle Conflict	B*	B*	B**	nc	A**	A**
	Running Vehicle Hazard	A**	nc	nc	A*	nc	nc
	Vehicle Hazard	nc	nc	nc	A**	A**	A**
COMPLIANCE	Leaving Curb on WALK	A*	nc	A*	A**	A**	A**
	Leaving Curb on Clearance	nc	nc	nc	A**	nc	A**
UNDERSTANDING	Question 1	nc	nc	nc	nc	nc	nc
	Question 2	nc	nc	A**	nc	nc	nc
	Question 3	nc	A**	A**	nc	nc	nc

NOTE: A = Significant difference in favor of "after" (experimental) condition.
B = Significant difference in favor of "before" (MUTCD standard) condition.
nc = No significant difference between "before" and "after" conditions.
* = Significant at the 0.05 level.
** = Significant at the 0.01 level.

Question 1 On which indication is it safe to start your crossing?
Question 2 If you are at the curb, what should you do if you see the (FDW/Flashing Symbol) indication?
Question 3 If you had just started to cross the street and you saw the (FDW/Flashing Symbol) indication, what should you do?
Appendix E contains the data summaries that support this table.

Understanding of the permissive interval was not significantly different in either city. In Baltimore the symbol display was favored with regard to understanding the clearance display questions. No significant differences were found in San Francisco for the clearance display questions. San Francisco illustrated dramatically that even though words and symbols were equally understood, behavior and compliance greatly improved with the symbol display.

Both compliance and understanding were greater in San Francisco than in Baltimore. Both cities appeared to accept the symbol display, particularly San Francisco. Thus, due to the overall improvement in all three of the variables measured, the hand-walking man symbol display was deemed significantly better than the current standard WALK-DONT WALK display.

Validation of Best Symbol

At the beginning of the symbol display evaluation studies, provisions were made to validate the results of the best symbol display, unless, of course, none of the symbols proved better than the word displays. At the completion of the last symbol field evaluation the data were reviewed to determine which, if any, was the best symbol. Since all three symbols were compared to the same "before" condition, the choice was made on the basis of the relative improvement (or unimprovement) measured. Tables 21 and 22 show one method of weighting the significant differences for each evaluation to arrive at a quantitative value for each of the three measures of effectiveness which, in turn, permits a comparison between symbols. It is readily evident that the hand-walking man symbol display was the best of the three symbols for all three measures.*

Table 21

Comparisons Between Symbol Displays

(Numbers are Weighted Scores*)

Measure of Effectiveness	Circle Slash	Standing Man	Hand	Validation of Hand	Max. Score
Behavior	+2	−5	+15	+5	48
Compliance	−1	+7	+ 7	0	16
Understanding	0	−1	+ 2	−1	24

*Weights are assigned as follows to the results shown in Tables 18-20 and are applied only to the individual sites and not to the sites combined:

B** = −2
B* = −1
nc = 0
A* = +1
A** = +2

*Of the three measures: behavior, compliance and understanding; compliance appeared to be the most sensitive to change (significant differences were found at eight of the twelve sites tested). Of the six behaviors, hesitation (B's) and turning vehicle conflicts (TV s) appeared to be the most sensitive to change.

Table 22

Comparisons Between Symbol Colors

(Numbers are Weighted Scores*)

Measure of Effectiveness	Orange/ White	Red/ Green	Max. Score
Behavior	+10	+7	96
Compliance	+ 8	+5	32
Understanding	−2	+2	48

*Weights are assigned as follows to the results shown in Tables 18-20 and are applied only to the individual sites and not to the sites combined:

B** = −2
B* = −1
nc = 0
A* = +1
A** = +2

Since the hand symbol was initially tested in an East coast and a West coast city, two cities, Greensboro, NC, and Milwaukee, WI, were selected thus representing the South and Midwest, respectively. These cities were also smaller in size than Baltimore and San Francisco.

The validation evaluation was conducted in exactly the same manner as all the other evaluations. The significant results are summarized in Table 23 for the behavioral, compliance and understanding data collected. The data summaries that support this table may be found in Appendix E.

Several significant behavioral differences were found in each city. As can be seen in the table, only one significant difference favored the word display; the other eight favored the symbol. Applying the weighting scheme used in Table 21 results in a behavioral value of "+5."

No significant differences were found in either city with regard to compliance with either the permissive or the clearance intervals. One site in Greensboro had an increase in compliance of 9 percent (52 to 61 percent). All other differences were less than 5 percent. Average compliance was considerably higher in Milwaukee (78 percent) than in Greensboro (48 percent). Traffic volumes were not significantly different in either city.

The understanding data contained few significant differences with some conflicting results. The responses to the permissive indication question favored the symbol display at one site in Milwaukee (.05 level), but favored the word display at one site in Greensboro (.05 level). The only other significant difference in the understanding data was at one site in Greensboro and favored the word display (.05 level). Despite the difference between cities in average compliance, understanding was only slightly better in Milwaukee.

Table 23

Summary of Results

Validation of WALK – DONT WALK (Before) Vs. Hand Symbol (After)

City		Milwaukee				Greensboro		
Site #		1	2	1 & 2		1	2	1 & 2
Colors		O/W	R/G			O/W	R/G	
BEHAVIORAL	Hesitation or Reversal	nc	nc	nc		nc	A**	nc
	Running Turning Vehicle Conflict	nc	nc	nc		nc	nc	A*
	Moving Vehicle	A**	nc	A**		nc	nc	nc
	Turning Vehicle Conflict	A*	nc	A*		B*	nc	nc
	Running Vehicle Hazard	nc	nc	A*		A*	nc	nc
	Vehicle Hazard	nc	nc	nc		nc	nc	nc
COMPLIANCE	Leaving Curb on WALK	nc	nc	nc		nc	nc	nc
	Leaving Curb on Clearance	nc	nc	nc		nc	nc	nc
UNDERSTANDING	Question 1	nc	A*	nc		B*	nc	nc
	Question 2	nc	nc	nc		nc	B*	nc
	Question 3	nc	nc	nc		nc	nc	nc

NOTE: A = Significant difference in favor of "after" (experimental) condition.
B = Significant difference in favor of "before" (MUTCD standard) condition.
nc = No significant difference between "before" and "after" conditions.
* = Significant at the 0.05 level.
** = Significant at the 0.01 level.

Question 1 On which indication is it safe to start your crossing?
Question 2 If you are at the curb, what should you do if you see the (FDW/Flashing Symbol) indication?
Question 3 If you had just started to cross the street and you saw the (FDW/Flashing Symbol) indication, what should you do?
Appendix E contains the data summaries that support this table.

Overall, the validation study indicated some improvement with the symbol display, but not nearly to the extent experienced in Baltimore and San Francisco. On the other hand, the symbol display was not worse than the word display. Thus the hand-walking man symbol display was as good or better than the standard word display in all four of the cities where it was tested.

Red/Green versus Orange/White

As mentioned earlier, each symbol display was installed in both red/green and orange/white in each city. An analysis of the evaluation results by color was performed and the significant findings were as follows.

No significant differences were found between colors in the behavioral data. The understanding data appeared to slightly favor the red/green, which corresponded to the preference surveys. The compliance data produced highly significant findings. Across all eight cities, 70 percent compliance (based on 5,163 observed crossings) was exhibited at orange/white sites compared to 61 percent (based on 3,447 crossings) at red/green sites (significant at the .001 level). The same trend held for each of the symbols individually.

In addition to the above described evaluation, a survey of drivers was conducted at each of the red/green sites to determine whether or not drivers were being confused by red/green pedestrian signals operating near red, yellow, green traffic signals. See Appendix B – Signal Design Survey (Color Study) for a sample of the survey form. Drivers were stopped after passing through the intersection with the red/green pedestrian signals and asked first if there *were* pedestrian signals at the intersection they just passed. Only 35 percent of the 325 drivers interviewed indicated that they saw the pedestrian signals. When asked about the pedestrian signals causing confusion, 9 percent of those that saw the signal (3 percent of the total interviewed) indicated some degree of confusion. Of those indicating confusion, their reaction was one of increased caution and awareness. Overall, red/green pedestrian signal indications did not appear to have a significant adverse effect on drivers.

Conclusions

The following conclusions were drawn from the results discussed in the preceeding section:

- The Hand-Walking Man symbol display shows a significant improvement over the standard WALK-DONT WALK display.
- The Standing Man-Walking Man symbol display appears to be as effective as the WALK-DONT WALK display.
- The Circle Slash-Walking Man symbol appears to be *not* as effective as the WALK-DONT WALK display.
- Even though pedestrians indicated a preference for red and green pedestrian signal indication colors, compliance with the orange and white colors was significantly higher.
- If symbolic pedestrian signals come into use, a retraining program will be necessary for elementary school age pedestrians.

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APPENDIX A

SITE DESCRIPTIONS

The word message and operation study sites are described on pages A-2 through A-7. The symbol message study sites are described on pages A-8 through A-15.

SITE DESCRIPTION

Experiment Flashing DONT WALK vs. Steady DONT WALK Clearance

City Buffalo **Site** 1 Bailey & Broadway

	Major Street	Minor Street
Street Width	90 ft. (27.4 m)	65 ft. (19.8 m)
Cross Walk Width	10 ft. (3.0 m)	10 ft. (3.0 m)
Pedestrian Signal Size	9 in. (22.9 cm)	9 in. (22.9 cm)
Cycle Length	100 sec.	100 sec.
WALK Interval	7 sec.	7 sec.
Clearance Interval	13 sec.	13 sec.
DONT WALK Interval	(Semi-Actuated Controller	(Semi-Actuated Controller)

*Peak Hour Traffic Volume 3420

Percent Turning Vehicles 36%

Experiment Flashing DONT WALK vs. Steady DONT WALK Clearance

City Buffalo **Site** 2 Broadway & Michigan

	Major Street	Minor Street
Street Width	61 ft. (18.6 m)	46 ft. (14.0 m)
Cross Walk Width	10 ft. (3.0 m)	10 ft. (3.0 m)
Pedestrian Signal Size	9 in. (22.9 cm)	9 in. (22.9 cm)
Cycle Length	80 sec.	80 sec.
WALK Interval	16 sec.	25 sec.
Clearance Interval	16 sec.	12 sec.
DONT WALK Interval	48 sec.	43 sec.

*Peak Hour Traffic Volume 1800

Percent Turning Vehicles 16%

*Peak hour volumes are estimated from counts made during "before" data collection.

SITE DESCRIPTION

Experiment Flashing DONT WALK vs. Steady DONT START Clearance

City Buffalo **Site** 3 Broadway & Fillmore

	Major Street	Minor Street
Street Width	61 ft. (18.6 m)	60 ft. (18.3 m)
Cross Walk Width	10 ft. (3.0 m)	10 ft. (3.0 m)
Pedestrian Signal Size	9 in. (22.9 cm)	9 in. (22.9 cm)
Cycle Length	80 sec.	80 sec.
WALK Interval	14 sec.	27 sec.
Clearance Interval	15 sec.	14 sec.
DONT WALK Interval	51 sec.	39 sec.

*Peak Hour Traffic Volume 1980

Percent Turning Vehicles 36%

Experiment Flashing DONT WALK vs. Steady DONT START Clearance

City Buffalo **Site** 4 Broadway & Miller / Krupp

	Major Street	Minor Street
Street Width	60 ft. (18.3 m)	29 ft. (8.8 m)
Cross Walk Width	10 ft. (3.0 m)	10 ft. (3.0 m)
Pedestrian Signal Size	9 in. (22.9 cm)	9 in. (22.9 cm)
Cycle Length	80 sec.	80 sec.
WALK Interval	8 sec.	28 sec.
Clearance Interval	16 sec.	8 sec.
DONT WALK Interval	56 sec.	44 sec.

*Peak Hour Traffic Volume 1440

Percent Turning Vehicles 27%

*Peak hour volumes are estimated from counts made during "before" data collection.

SITE DESCRIPTION

Experiment Steady vs. Flashing WALK

City Buffalo **Site** 5 Michigan & Eagle

	Major Street	Minor Street
Street Width	42 ft. (12.8 m)	41 ft. (12.5 m)
Cross Walk Width	None	None
Pedestrian Signal Size	9 in. (22.9 cm)	9 in. (22.9 cm)
Cycle Length	60 sec.	60 sec.
WALK Interval	10 sec.	25 sec.
Clearance Interval	11 sec.	10 sec.
DONT WALK Interval	39 sec.	25 sec.

*Peak Hour Traffic Volume 1400

Percent Turning Vehicles 16%

Experiment Steady vs. Flashing WALK

City Buffalo **Site** 6 Clinton & Jefferson

	Major Street	Minor Street
Street Width	48 ft. (14.6 m)	40 ft. (12.2 m)
Cross Walk Width	None	None
Pedestrian Signal Size	9 in. (22.9 cm)	9 in. (22.9 cm)
Cycle Length	60 sec.	60 sec.
WALK Interval	16 sec.	19 sec.
Clearance Interval	11 sec.	9 sec.
DONT WALK Interval	33 sec.	32 sec.

*Peak Hour Traffic Volume 1200

Percent Turning Vehicles 31%

*Peak hour volumes are estimated from counts made during "before" data collection.

SITE DESCRIPTION

Experiment Flashing DONT WALK vs. Steady DONT START Clearance

City Phoenix **Site** 1 1st Ave. & Van Buren

	Major Street	Minor Street
Street Width	60 ft. (18.3 m)	70 ft. (21.3 m)
Cross Walk Width	14 ft. (4.3 m)	14 ft. (4.3 m)
Pedestrian Signal Size	12 in. (30.5 cm)	12 in. (30.5 cm)
Cycle Length	50 sec.	50 sec.
WALK Interval	6 sec.	12 sec
Clearance Interval	10 sec.	14 sec.
DONT WALK Interval	34 sec.	24 sec.

*Peak Hour Traffic Volume 2160

Percent Turning Vehicles 26%

Experiment Flashing DONT WALK vs. Steady DONT START Clearance

City Phoenix **Site** 2 Central & Osborn

	Major Street	Minor Street
Street Width	88 ft (26.8 m)	70 ft. (21.3 m)
Cross Walk Width	14 ft. (4.3 m)	14 ft. (4.3 m)
Pedestrian Signal Size	12 in. (30.5 cm)	12 in. (30.5 cm)
Cycle Length	55 sec.	55 sec.
WALK Interval	7 sec.	8 sec.
Clearance Interval	14 sec.	17 sec.
DONT WALK Interval	34 sec.	30 sec.

*Peak Hour Traffic Volume 4929

Percent Turning Vehicles 21%

*Peak hour volumes are estimated from counts made during "before" data collection.

SITE DESCRIPTION

Experiment Flashing vs. Steady WALK

City Phoenix Site 3 1st St. & Van Buren

	Major Street	Minor Street
Street Width	55 ft. (16.8 m)	65 ft. (19.8 m)
Cross Walk Width	14 ft. (4.3 m)	14 ft. (4.3 m)
Pedestrian Signal Size	12 in. (30.5 cm)	12 in. (30.5 cm)
Cycle Length	50 sec.	50 sec.
WALK Interval	6 sec.	15 sec.
Clearance Interval	–	–
DONT WALK Interval	44 sec.	45 sec.

*Peak Hour Traffic Volume 2160

Percent Turning Vehicles 22%

Experiment Flashing vs. Steady WALK

City Phoenix Site 4 16th St. & Thomas

	Major Street	Minor Street
Street Width	60 ft. (18.3 m)	60 ft. (18.3 m)
Cross Walk Width	14 ft. (4.3 m)	14 ft. (4.3 m)
Pedestrian Signal Size	12 in. (30.5 cm)	12 in. (30.5 cm)
Cycle Length	55 sec.	55 sec.
WALK Interval	11 sec.	15 sec.
Clearance Interval	–	–
DONT WALK Interval	44 sec.	40 sec.

*Peak Hour Traffic Volume 4975

Percent Turning Vehicles 20%

*Peak hour volumes are estimated from counts made during "before" data collection.

SITE DESCRIPTION

Experiment Flashing DONT WALK vs. Steady DONT WALK Clearance

City Phoenix **Site** 5 2nd Ave. & Van Buren

	Major Street	Minor Street
Street Width	60 ft. (18.3 m)	65 ft. (19.8 m)
Cross Walk Width	14 ft. (4.3 m)	14 ft. (4.3 m)
Pedestrian Signal Size	12 in. (30.5 cm)	12 in. (30.5 cm)
Cycle Length	50 sec.	50 sec.
WALK Interval	4 sec.	10 sec.
Clearance Interval	12 sec.	16 sec.
DONT WALK Interval	34 sec.	24 sec.

*Peak Hour Traffic Volume 2538

Percent Turning Vehicles 19%

Experiment Flashing DONT WALK vs. Steady DONT WALK Clearance

City Phoenix **Site** 6 17th Ave. & Madison

	Major Street	Minor Street
Street Width	60 ft. (18.3 m)	42 ft. (12.8 m)
Cross Walk Width	14 ft. (4.3 m)	14 ft. (4.3 m)
Pedestrian Signal Size	12 in (30.5 cm)	12 in. (30.5 cm)
Cycle Length	50 sec.	50 sec.
WALK Interval	8 sec.	14 sec.
Clearance Interval	10 sec.	9 sec.
DONT WALK Interval	32 sec.	27 sec.

*Peak Hour Traffic Volume 1098

Percent Turning Vehicles 36%

*Peak hour volumes are estimated from counts made during "before" data collection.

SITE DESCRIPTION

Experiment WALK – DONT WALK vs. Circle Slash Symbol (Red/Green)

City Buffalo **Site** 3A Broadway & Fillmore

	Major Street	Minor Street
Street Width	61 ft. (18.6 m)	60 ft. (18.3 m)
Cross Walk Width	10 ft. (3.0 m)	10 ft. (3.0 m)
Pedestrian Signal Size	9 in. (22.9 cm)	9 in. (22.9 cm)
Cycle Length	80 sec.	80 sec.
WALK Interval	14 sec.	27 sec.
Clearance Interval	15 sec.	14 sec.
DONT WALK Interval	51 sec.	39 sec.

*Peak Hour Traffic Volume 1980

Percent Turning Vehicles 36%

Experiment WALK – DONT WALK vs. Circle Slash Symbol (Orange/White)

City Buffalo **Site** 2A Broadway & Michigan

	Major Street	Minor Street
Street Width	61 ft. (18.6 m)	46 ft. (14.0 m)
Cross Walk Width	10 ft. (3.0 m)	10 ft. (3.0 m)
Pedestrian Signal Size	9 in. (22.9 cm)	9 in. (22.9 cm)
Cycle Length	80 sec.	80 sec.
WALK Interval	16 sec.	25 sec.
Clearance Interval	16 sec.	12 sec.
DONT WALK Interval	48 sec.	43 sec.

*Peak Hour Traffic Volume 1800

Percent Turning Vehicles 16%

*Peak hour volumes are estimated from counts made during "before" data collection.

SITE DESCRIPTION

Experiment WALK – DONT WALK vs. Circle Slash Symbol (Red/Green)

City Tempe **Site** 7 5th & Mill

	Major Street	Minor Street
Street Width	86 ft. (26.2 m)	68 ft. (20.7 m)
Cross Walk Width	9 ft. (2.7 m)	9 ft. (2.7 m)
Pedestrian Signal Size	12 in. (30.5 cm)	12 in. (30.5 cm)
Cycle Length	70 sec.	70 sec.
WALK Interval	11 sec.	18 sec.
Clearance Interval	11 sec.	15 sec.
DONT WALK Interval	48 sec.	37 sec.

*Peak Hour Traffic Volume 3720

Percent Turning Vehicles 31%

Experiment WALK – DONT WALK vs. Circle Slash Symbol (Orange/White)

City Tempe **Site** 9 University & Forest

	Major Street	Minor Street
Street Width	66 ft. (20.1 m)	43 ft. (13.1 m)
Cross Walk Width	9 ft. (2.7 m)	9 ft. (2.7 m)
Pedestrian Signal Size	12 in. (30.5 cm)	12 in. (30.5 cm)
Cycle Length	70 sec.	70 sec.
WALK Interval	7 sec.	38 sec.
Clearance Interval	12 sec.	5 sec.
DONT WALK Interval	51 sec.	27 sec.

*Peak Hour Traffic Volume 2430

Percent Turning Vehicles 15%

*Peak hour volumes are estimated from counts made during "before" data collection.

SITE DESCRIPTION

Experiment WALK – DONT WALK vs. Hand Symbol (Red/Green)

City Baltimore Site 1 Eastern & Broadway

	Major Street	Minor Street
Street Width	112 ft. (34.1 m)	40 ft. (12.2 m)
Cross Walk Width	10 ft. (3.0 m)	10 ft. (3.0 m)
Pedestrian Signal Size	9 in. (22.9 cm)	9 in. (22.9 cm)
Cycle Length	80 sec.	80 sec.
WALK Interval	10 sec.	30 sec.
Clearance Interval	25 sec.	10 sec.
DONT WALK Interval	45 sec.	40 sec.

*Peak Hour Traffic Volume 1710

Percent Turning Vehicles 40%

Experiment WALK – DONT WALK vs. Hand Symbol (Orange/White)

City Baltimore Site 2 Eastern & Conkling

	Major Street	Minor Street
Street Width	70 ft. (21.3 m)	40 ft. (12.2 m)
Cross Walk Width	10 ft. (3.0 m)	10 ft. (3.0 m)
Pedestrian Signal Size	9 in. (22.9 cm)	9 in. (22.9 cm)
Cycle Length	80 sec.	80 sec.
WALK Interval	20 sec.	30 sec.
Clearance Interval	10 sec.	11 sec.
DONT WALK Interval	50 sec.	39 sec.

*Peak Hour Traffic Volume 1725

Percent Turning Vehicles 28%

*Peak hour volumes are estimated from counts made during "before" data collection.

SITE DESCRIPTION

Experiment WALK – DONT WALK vs. Hand Symbol (Red/Green)

City San Francisco **Site** 1 24th & Bryant

	Major Street	Minor Street
Street Width	55 ft. (16.8 m)	40 ft. (12.2 m)
Cross Walk Width	10 ft. (3.0 m)	10 ft. (3.0 m)
Pedestrian Signal Size	9 in. (22.9 cm)	9 in. (22.9 cm)
Cycle Length	60 sec.	60 sec.
WALK Interval	10 sec.	26 sec.
Clearance Interval	8 sec.	7 sec.
DONT WALK Interval	42 sec.	27 sec.

*Peak Hour Traffic Volume 1040

Percent Turning Vehicles 28%

Experiment WALK – DONT WALK vs. Hand Symbol (Orange/White)

City San Francisco **Site** 2 Stockton & Vallejo

	Major Street	Minor Street
Street Width	36 ft. (11.0 m)	36 ft. (11.0 m)
Cross Walk Width	10 ft. (3.0 m)	10 ft. (3.0 m)
Pedestrian Signal Size	9 in. (22.9 cm)	9 in. (22.9 cm)
Cycle Length	60 sec.	60 sec.
WALK Interval	18 sec.	30 sec.
Clearance Interval	7 sec.	7 sec.
DONT WALK Interval	35 sec.	23 sec.

*Peak Hour Traffic Volume 880

Percent Turning Vehicles 36%

*Peak hour volumes are estimated from counts made during "before" data collection.

SITE DESCRIPTION

Experiment WALK – DONT WALK vs. Standing Man Symbol (Red/Green)

City Colorado Springs **Site** 1 Colorado & Nevada

	Major Street	Minor Street
Street Width	90 ft. (27.4 m)	65 ft. (19.8 m)
Cross Walk Width	10 ft. (3.0 m)	10 ft. (3.0 m)
Pedestrian Signal Size	9 x 12 in. (22.9 x 30.5 cm)	9 x 12 in. (22.9 x 30.5 cm)
Cycle Length	70 sec.	70 sec.
WALK Interval	9 sec.	10 sec.
Clearance Interval	21 sec.	22 sec.
DONT WALK Interval	40 sec.	38 sec.

*Peak Hour Traffic Volume 2897

Percent Turning Vehicles 25%

Experiment WALK – DONT WALK vs. Standing Man Symbol (Orange/White)

City Colorado Springs **Site** 2 Pikes Peak & Nevada

	Major Street	Minor Street
Street Width	90 ft. (27.4 m)	90 ft. (27.4 m)
Cross Walk Width	10 ft. (3.0 m)	10 ft. (3.0 m)
Pedestrian Signal Size	9 x 12 in. (22.9 x 30.5 cm)	9 x 12 in. (22.9 x 30.5 cm)
Cycle Length	70 sec.	70 sec.
WALK Interval	8 sec.	8 sec.
Clearance Interval	24 sec.	24 sec.
DONT WALK Interval	38 sec.	38 sec.

*Peak Hour Traffic Volume 3463

Percent Turning Vehicles 33%

*Peak hour volumes are estimated from counts made during "before" data collection.

SITE DESCRIPTION

Experiment WALK – DONT WALK vs. Standing Man Symbol (Orange/White)

City Memphis **Site** 2 Poplar & Cleveland

	Major Street	Minor Street
Street Width	65 ft. (19.8 m)	48 ft. (14.6 m)
Cross Walk Width	10 ft. (3.0 m)	10 ft. (3.0 m)
Pedestrian Signal Size	9 in. (22.9 cm)	9 in. (22.9 cm)
Cycle Length	80 sec.	80 sec.
WALK Interval	17 sec.	33 sec.
Clearance Interval	9 sec.	12 sec.
DONT WALK Interval	54 sec.	35 sec.

*Peak Hour Traffic Volume 3465

Percent Turning Vehicles 13%

Experiment WALK – DONT WALK vs. Standing Man Symbol (Red/Green)

City Memphis **Site** 1 Madison & Cleveland

	Major Street	Minor Street
Street Width	60 ft. (18.3 m)	48 ft. (14.6 m)
Cross Walk Width	10 ft. (3.0 m)	10 ft. (3.0 m)
Pedestrian Signal Size	9 in. (22.9 cm)	9 in. (22.9 cm)
Cycle Length	80 sec.	80 sec.
WALK Interval	17 sec.	36 sec.
Clearance Interval	11 sec.	8 sec.
DONT WALK Interval	52 sec.	36 sec.

*Peak Hour Traffic Volume 2925

Percent Turning Vehicles 12%

*Peak hour volumes are estimated from counts made during "before" data collection.

SITE DESCRIPTION

Experiment Validation of WALK – DONT WALK vs. Hand Symbol (Red/Green)

City Greensboro **Site** 2 Elm & Lindsay

	Major Street	Minor Street
Street Width	65 ft. (19.8 m)	40 ft. (12.2 m)
Cross Walk Width	10 ft. (3.0 m)	10 ft. (3.0 m)
Pedestrian Signal Size	9 in. (22.9 cm)	9 in. (22.9 cm)
Cycle Length	70 sec.	70 sec.
WALK Interval	14 sec.	32 sec.
Clearance Interval	10 sec.	6 sec.
DONT WALK Interval	46 sec.	32 sec.

*Peak Hour Traffic Volume 1080

Percent Turning Vehicles 29%

Experiment Validation of WALK – DONT WALK vs. Hand Symbol (Orange/White)

City Greensboro **Site** 1 Elm & Washington

	Major Street	Minor Street
Street Width	50 ft. (15.2 m)	24 ft. (7.3 m)
Cross Walk Width	10 ft. (3.0 m)	10 ft. (3.0 m)
Pedestrian Signal Size	9 in. (22.9 cm)	9 in. (22.9 cm)
Cycle Length	70 sec.	70 sec.
WALK Interval	16 sec.	32 sec.
Clearance Interval	9 sec.	6 sec.
DONT WALK Interval	45 sec.	32 sec.

*Peak Hour Traffic Volume 1029

Percent Turning Vehicles 26%

*Peak hour volumes are estimated from counts made during "before" data collection.

SITE DESCRIPTION

Experiment Validation of WALK – DONT WALK vs. Hand Symbol (Red/Green)

City Milwaukee **Site** 2 55th & North

	Major Street	Minor Street
Street Width	60 ft. (18.3 m)	30 ft. (9.1 m)
Cross Walk Width	10 ft. (3.0 m)	10 ft. (3.0 m)
Pedestrian Signal Size	9 in. (22.9 cm)	9 in. (22.9 cm)
Cycle Length	60 sec.	60 sec.
WALK Interval	17 sec.	20 sec.
Clearance Interval	11 sec.	8 sec.
DONT WALK Interval	32 sec.	32 sec.

*Peak Hour Traffic Volume 1860

Percent Turning Vehicles 23%

Experiment Validation of WALK – DONT WALK vs. Hand Symbol (Orange/White)

City Milwaukee **Site** 1 16th & Mitchell

	Major Street	Minor Street
Street Width	48 ft. (14.6 m)	48 ft. (14.6 m)
Cross Walk Width	10 ft. (3.0 m)	10 ft. (3.0 m)
Pedestrian Signal Size	9 in. (22.9 cm)	9 in. (22.9 cm)
Cycle Length	80 sec.	80 sec.
WALK Interval	19 sec.	36 sec.
Clearance Interval	11 sec.	10 sec.
DONT WALK Interval	50 sec.	34 sec.

*Peak Hour Traffic Volume 1598

Percent Turning Vehicles 22%

*Peak hour volumes are estimated from counts made during "before" data collection.

APPENDIX B
SURVEY FORMS

U.S. Office of Management and Budget
Approval No. 004R2453
Approval Expires 12/31/76

SIGNAL DESIGN SURVEY

(Message/Operation Study)

Good morning/afternoon. I am conducting a study to determine how to improve the traffic signals at intersections. In particular, I am interested in your opinion about the signal at this intersection (point to the signal). (Hand the subject card _____.) At different times this signal can look like A, or B, or C.

1. When is it safe to start your crossing?
   - ☐ A
   - ☐ B
   - ☐ C

2. What should you do if you see A?
   - ☐ Start to cross
   - ☐ Don't start to cross
   - ☐ Vehicle will soon be coming
   - ☐ Signal will change soon
   - ☐ Other _____

3. If you had just started to cross the street and you saw A, what should you do?
   - ☐ Continue across
   - ☐ Stop and wait in the street
   - ☐ Return to the curb

4. At some intersections, the WALK signal flashes, at some, it does not. What does the flashing (non-flashing) WALK signal mean here at this intersection?
   - ☐ Don't start to cross
   - ☐ Start to cross now
   - ☐ Vehicles may be turning in your path
   - ☐ Vehicles will not be turning in your path
   - ☐ Signal will change soon
   - ☐ No difference between flashing and non-flashing walk
   - ☐ Don't know
   - ☐ Other _____

5. Would you expect vehicles to be turning into your crosswalk if you crossed during the WALK signal?
   - ☐ Yes
   - ☐ No
   - ☐ Don't know

Age _____ Sex _____

Date _____ Location _____

Interviewer _____

CARD 1

SIGNAL AT THIS
INTERSECTION

A
(FLASHING)

B

C
(FLASHING)

CARD 2

SIGNAL AT THIS
INTERSECTION

A

B
(FLASHING)

CARD 3

SIGNAL AT THIS
INTERSECTING

A

B
(FLASHING)

CARD 4

SIGNAL AT THIS
INTERSECTION

A
(FLASHING)

B

C

SIGNAL DISPLAY # 1

A
Prohibited

B
Permissive

1. Check preferred operation of each display interval shown at left.

Interval	Flashing	Steady
A	☐	☐
B	☐	☐

2. During the clearance interval, the signal display should be: (select one)

A (flashing) B (flashing)

A (steady) B (steady)

3. List any common situations in which this signal display might be misinterpreted. _____

_____

_____

_____

_____

4. List any groups of people that might misinterpret this signal display.

_____ _____

_____ _____

_____ _____

5. How would you improve this signal display? _____

_____

_____

_____

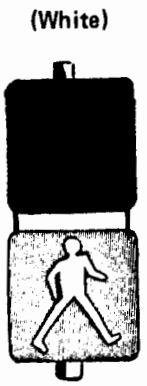
_____

6. How would you rate the potential of this signal display in terms of providing a symbolic replacement for the standard (WALK - DONT WALK) pedestrian signal? (Circle one)

A. Excellent Candidate
B. Very Satisfactory
C. Satisfactory
D. Somewhat Satisfactory
E. Unacceptable

SIGNAL DISPLAY # 2

A
Prohibited



B
Permissive

1. Check preferred operation of each display interval shown at left.

Interval	Flashing	Steady
A	☐	☐
B	☐	☐

2. During the clearance interval, the signal display should be: (select one)

A (flashing) B (flashing)

A (steady) B (steady)

3. List any common situations in which this signal display might be misinterpreted. _____

_____

_____

_____

_____

4. List any groups of people that might misinterpret this signal display.

_____ _____

_____ _____

_____ _____

5. How would you improve this signal display? _____

_____

_____

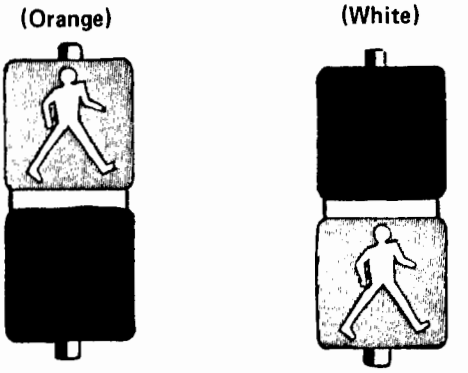
_____

_____

6. How would you rate the potential of this signal display in terms of providing a symbolic replacement for the standard (WALK - DONT WALK) pedestrian signal? (Circle one)

A. Excellent Candidate
B. Very Satisfactory
C. Satisfactory
D. Somewhat Satisfactory
E. Unacceptable

SIGNAL DISPLAY # 3



A
Prohibited

B
Permissive

1. Check preferred operation of each display interval shown at left.

Interval	Flashing	Steady
A	☐	☐
B	☐	☐

2. During the clearance interval, the signal display should be: (select one)

A (flashing) B (flashing)

A (steady) B (steady)

3. List any common situations in which this signal display might be misinterpreted. _____

_____

_____

_____

_____

4. List any groups of people that might misinterpret this signal display.

_____ _____

_____ _____

_____ _____

5. How would you improve this signal display? _____

_____

_____

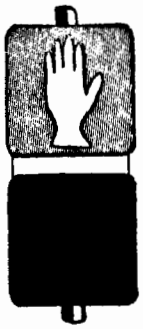
_____

_____

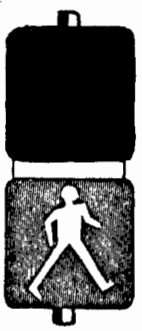
6. How would you rate the potential of this signal display in terms of providing a symbolic replacement for the standard (WALK - DONT WALK) pedestrian signal? (Circle one)

A. Excellent Candidate
B. Very Satisfactory
C. Satisfactory
D. Somewhat Satisfactory
E. Unacceptable

SIGNAL DISPLAY # 4



A
Prohibited



B
Permissive

1. Check preferred operation of each display interval shown at left.

Interval	Flashing	Steady
A	☐	☐
B	☐	☐

2. During the clearance interval, the signal display should be: (select one)

A (flashing) B (flashing)

A (steady) B (steady)

3. List any common situations in which this signal display might be misinterpreted. _____

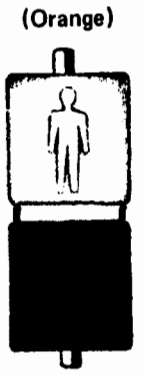
4. List any groups of people that might misinterpret this signal display.

5. How would you improve this signal display? _____

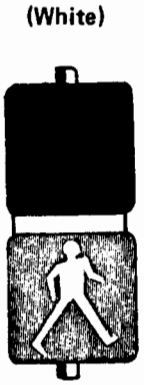
6. How would you rate the potential of this signal display in terms of providing a symbolic replacement for the standard (WALK - DONT WALK) pedestrian signal? (Circle one)

A. Excellent Candidate
B. Very Satisfactory
C. Satisfactory
D. Somewhat Satisfactory
E. Unacceptable

SIGNAL DISPLAY # 5



A
Prohibited



B
Permissive

1. Check preferred operation of each display interval shown at left.

Interval	Flashing	Steady
A	☐	☐
B	☐	☐

2. During the clearance interval, the signal display should be: (select one)

A (flashing) B (flashing)

A (steady) B (steady)

3. List any common situations in which this signal display might be misinterpreted. _____

_____

_____

_____

_____

4. List any groups of people that might misinterpret this signal display.

_____ _____

_____ _____

_____ _____

5. How would you improve this signal display? _____

_____

_____

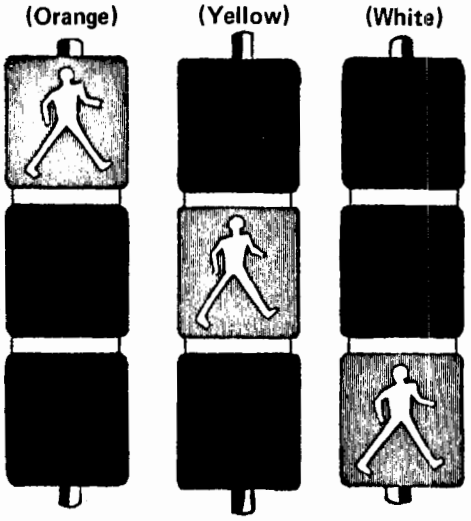
_____

_____

6. How would you rate the potential of this signal display in terms of providing a symbolic replacement for the standard (WALK - DONT WALK) pedestrian signal? (Circle one)

A. Excellent Candidate
B. Very Satisfactory
C. Satisfactory
D. Somewhat Satisfactory
E. Unacceptable

SIGNAL DISPLAY # 6



1. Check preferred operation of each display interval shown at left.

Interval	Flashing	Steady
A	☐	☐
B	☐	☐
C	☐	☐

2. List any common situation in which this signal display might be misinterpreted. _____

_____

_____

_____

_____

_____

_____

3. List any groups of people that might misinterpret this signal display

_____ _____

_____ _____

_____ _____

_____ _____

4. How would you improve this signal display? _____

_____

_____

_____

_____

5. How would you rate the potential of <u>this</u> signal display in terms of providing a symbolic replacement for the standard (WALK-DONT WALK) pedestrian signal? (Circle one)

A Excellent Candidate

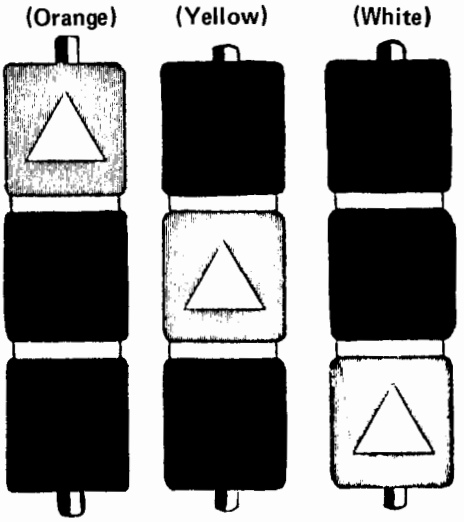
B Very Satisfactory

C Satisfactory

D Somewhat Satisfactory

E Unacceptable

SIGNAL DISPLAY # 7



1. Check preferred operation of each display interval shown at left.

Interval	Flashing	Steady
A	☐	☐
B	☐	☐
C	☐	☐

2. List any common situation in which this signal display might be misinterpreted. _____

_____

_____

_____

_____

_____

_____

3. List any groups of people that might misinterpret this signal display

_____ _____

_____ _____

_____ _____

_____ _____

4. How would you improve this signal display? _____

_____

_____

_____

_____

5. How would you rate the potential of this signal display in terms of providing a symbolic replacement for the standard (WALK-DONT WALK) pedestrian signal? (Circle one)

A Excellent Candidate

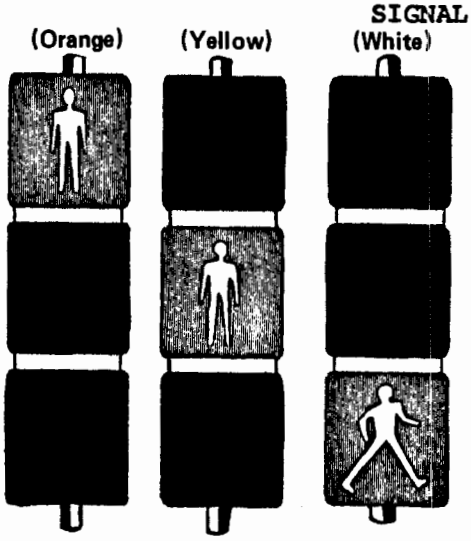
B Very Satisfactory

C Satisfactory

D Somewhat Satisfactory

E Unacceptable

SIGNAL DISPLAY # 8



A Prohibited B Clearance C Permissive

1. Check preferred operation of each display interval shown at left.

Interval	Flashing	Steady
A	☐	☐
B	☐	☐
C	☐	☐

2. List any common situation in which this signal display might be misinterpreted. _____

_____

_____

_____

_____

_____

_____

3. List any groups of people that might misinterpret this signal display

_____ _____

_____ _____

_____ _____

_____ _____

4. How would you improve this signal display? _____

_____

_____

_____

_____

5. How would you rate the potential of <u>this</u> signal display in terms of providing a symbolic replacement for the standard (WALK-DONT WALK) pedestrian signal? (Circle one)

A Excellent Candidate

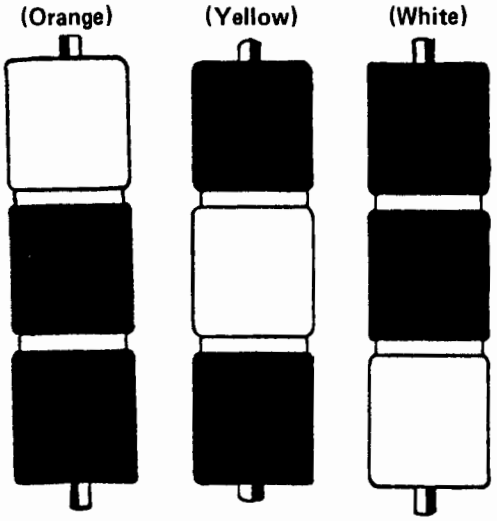
B Very Satisfactory

C Satisfactory

D Somewhat Satisfactory

E Unacceptable

SIGNAL DISPLAY # 9



1. Check preferred operation of each display interval shown at left.

Interval	Flashing	Steady
A	☐	☐
B	☐	☐
C	☐	☐

2. List any common situation in which this signal display might be misinterpreted. _____

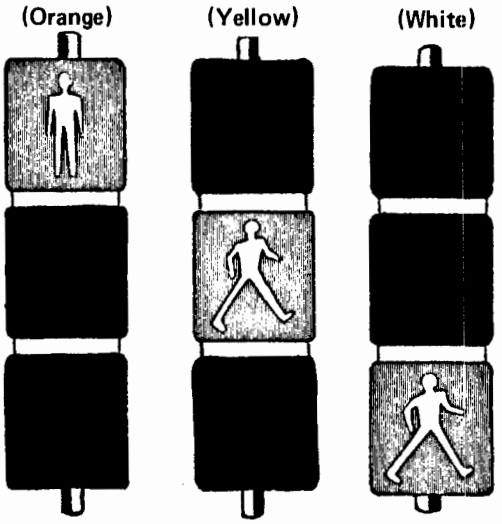
3. List any groups of people that might misinterpret this signal display

4. How would you improve this signal display? _____

5. How would you rate the potential of this signal display in terms of providing a symbolic replacement for the standard (WALK-DONT WALK) pedestrian signal? (Circle one)

   A Excellent Candidate
   B Very Satisfactory
   C Satisfactory
   D Somewhat Satisfactory
   E Unacceptable

SIGNAL DISPLAY # 10



1. Check preferred operation of each display interval shown at left.

Interval	Flashing	Steady
A	☐	☐
B	☐	☐
C	☐	☐

2. List any common situation in which this signal display might be misinterpreted. _____

3. List any groups of people that might misinterpret this signal display

4. How would you improve this signal display? _____

5. How would you rate the potential of this signal display in terms of providing a symbolic replacement for the standard (WALK-DONT WALK) pedestrian signal? (Circle one)

   A Excellent Candidate
   B Very Satisfactory
   C Satisfactory
   D Somewhat Satisfactory
   E Unacceptable

Suggested Signal Display

This page is provided so that you may suggest a signal display design of your own. Please sketch your idea, describe its operation, and briefly discuss its advantages and disadvantages in the spaces provided. Suggested displays will be sent out for comment in a second mailing.

Sketch

Description of Operation

Advantages and Disadvantages

How would you rate the potential of this signal display in terms of providing a symbolic replacement for the standard WALK - DONT WALK pedestrian signal? (Circle one)

A. Excellent Candidate
B. Very Satisfactory
C. Satisfactory
D. Somewhat Satisfactory
E. Unacceptable

RATING FORM

Your opinion on the applicability of each of the preceding signal displays in your area is of vital interest. Please rate each signal display on a scale from 1 to 4 relative to the following criteria:

1. Accident Reduction. If used as recommended, how effective would the signal display be in preventing pedestrian accidents?
2. Cost of Implementation. Rate the signal display on acceptability of cost to install and maintain it in your area.
3. Ease of Implementation. Rate how difficult it would be to install, operate and maintain each signal display in your area.
4. Anticipated Compliance. Rate each signal display on the degree of user compliance in your area.

RATING CRITERIA

ACCIDENT REDUCTION	COST OF IMPLEMENTATION	EASE OF IMPLEMENTATION	ANTICIPATED COMPLIANCE
1. Very effective, eliminates most of the pedestrian accidents.	1. Acceptable cost and low.	1. Very easy to implement.	1. Good compliance, no problems.
2. Effective, eliminates a large proportion of pedestrian accidents.	2. Acceptable cost and moderate.	2. Can be implemented with some problems.	2. Fair compliance, some problems.
3. Somewhat effective, eliminates a small proportion of pedestrian accidents.	3. Acceptable cost but high.	3. Presents considerable implementation problems, but can be done.	3. Poor compliance, considerable problems.
4. Not effective, would not reduce the number of pedestrian accidents.	4. Unacceptable cost, too high	4. Not feasible.	4. No substantial compliance.

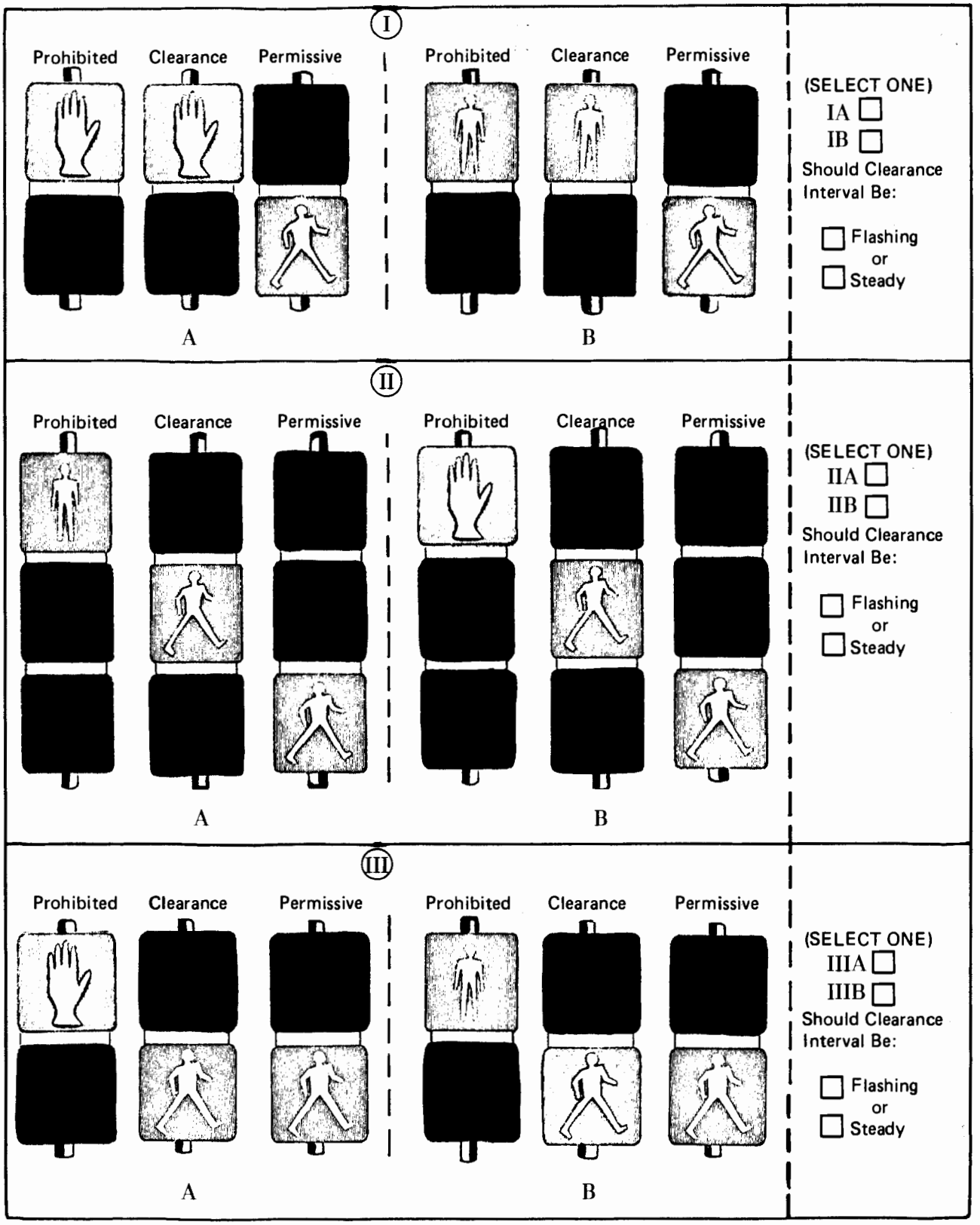
SIGNAL DISPLAY	Accident Reduction	Cost of Implementation	Ease of Implementation	Anticipated Compliance
#1	____	____	____	____
#2	____	____	____	____
#3	____	____	____	____
#4	____	____	____	____
#5	____	____	____	____
#6	____	____	____	____
#7	____	____	____	____
#8	____	____	____	____
#9	____	____	____	____
#10	____	____	____	____

Based on your overall judgment, indicate the three best signal displays:

1st Choice: #_____

2nd Choice: #_____

3rd Choice: #_____


I
Prohibited
Clearance
Permissive
Prohibited
Clearance
Permissive
A
B
(SELECT ONE)
IA
IB
Should Clearance Interval Be:
Flashing
or
Steady
II
Prohibited
Clearance
Permissive
Prohibited
Clearance
Permissive
A
B
(SELECT ONE)
IIA
IIB
Should Clearance Interval Be:
Flashing
or
Steady
III
Prohibited
Clearance
Permissive
Prohibited
Clearance
Permissive
A
B
(SELECT ONE)
IIIA
IIIB
Should Clearance Interval Be:
Flashing
or
Steady

1. From the three displays you chose on the preceding page, select the one BEST display based on your overall judgment and briefly explain why you chose it.

   Best Overall Display _____

   Reason for Selection: _____

   _____

   _____

   _____

2. For the display you have just chosen as BEST, indicate your preference of color for each interval.

   Prohibited ☐ Orange ☐ Red ☐ Other _____

   Clearance ☐ Yellow ☐ Other _____ ☐ Same as Prohibited

   Permissive ☐ White ☐ Green ☐ Other _____

3. From the six displays on the preceding page, indicate the one display you liked least.

   Least Liked Display _____

4. Would you consider your above choice of BEST symbolic display to be a satisfactory replacement for the present WALK-DONT WALK ped signal? ☐ Yes ☐ No

   If not, why? _____

   _____

   _____

   _____

Good morning/afternoon. Would you take just a minute of your time to answer three questions about traffic signals which will help the city improve pedestrian safety? We are asking people who walk on our streets about symbolic pedestrian signals. I'll show you three different pictures and ask you a question about each.

1. (Show Card__ __) Which *one* of these symbols *most clearly* means DONT WALK to you?
2. (Show Card__ __) For the symbol you just picked which *color* most clearly means DONT WALK to you?
3. (Show Card__ __) Which *one* of these symbols most clearly means WALK to you?

THANK YOU FOR YOUR TIME AND HELP.

	Question 1					Question 2		Question 3			
Subject	A	B	C	D	E	Orange	Red	A	B	M	F
1	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐
2	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐
3	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐
4	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐
5	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐
6	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐
7	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐
8	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐
9	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐
10	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐
11	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐
12	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐
13	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐
14	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐
15	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐
16	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐
17	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐
18	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐
19	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐
20	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐
21	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐
22	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐
23	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐
24	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐
25	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐
26	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐
27	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐
28	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐
29	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐
30	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐

CARD_____

(RED)

A B C D E

CARD_____

(ORANGE)

A B C D E

CARD_____

(RED)

(ORANGE)

CARD_____

(ORANGE)

(RED)

CARD_____

(GREEN)

A

(WHITE)

B

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Approval No. 004R2453
Approval Expires 12/31/76

SIGNAL DESIGN SURVEY

(Symbol Study)

Good morning/afternoon. I am conducting a study to determine how to improve the traffic signals at intersections. In particular, I am interested in your opinion about two pedestrian signals that we are considering. (Hand the subject the picture card with signal #1 facing up.) At different times, this signal can look like A or B.

1. When is it safe to start your crossing?

#1	#2
☐ A	☐ C
☐ B	☐ D

2. What should you do if you see A/C? (If answer to Q.1 above is wrong, ask this question about the correct response).

#1	#2
☐	☐ Start to cross
☐	☐ Don't start to cross
☐	☐ Vehicle will soon be coming
☐	☐ Signal will change soon
☐	☐ Other _____

3. If you had just started to cross the street and you saw A/C, what should you do?

#1	#2
☐	☐ Continue across
☐	☐ Stop and wait in the street
☐	☐ Return to the curb

4. Which of the two signals #1 or #2 do you think is the easiest to understand?

☐ Signal #1
☐ Signal #2
☐ Neither
☐ Same

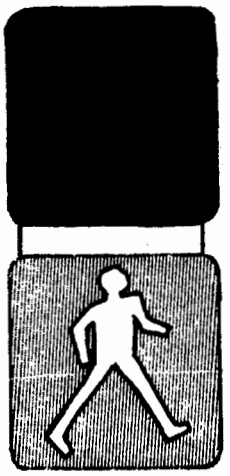
Age _____ Sex _____

Date _____ Location _____

Interviewer _____

SIGNAL # 1

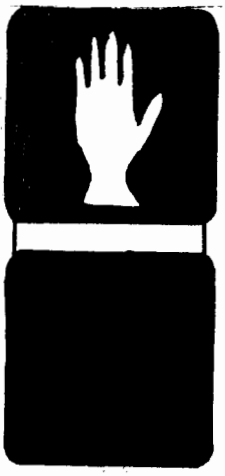
A



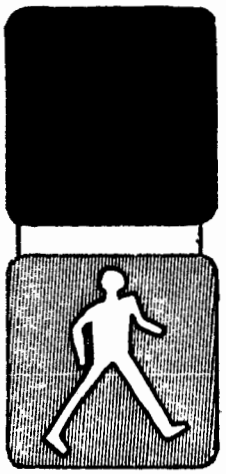
B

(FRONT)

SIGNAL # 2



C



D

(BACK)

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Approval No. 004R2453
Approval Expires 12/31/76

SIGNAL DESIGN SURVEY

(Message Study)

Good morning/afternoon. I am conducting a study to determine how to improve the traffic signals at intersections. In particular, I am interested in your opinion about the signal at this intersection (point to the signal). (Hand the subject card _____.) At different times this signal can look like A, or B, or C.

1. When is it safe to start your crossing?
   - ☐ A
   - ☐ B
   - ☐ C

2. What should you do if you see A?
   - ☐ Start to cross
   - ☐ Don't start to cross
   - ☐ Vehicle will soon be coming
   - ☐ Signal will change soon
   - ☐ Other _____

3. If you had just started to cross the street and you saw A, what should you do?
   - ☐ Continue across
   - ☐ Stop and wait in the street
   - ☐ Return to the curb

Age _____ Sex _____

Date _____ Location _____

Interviewer _____

CARD 4

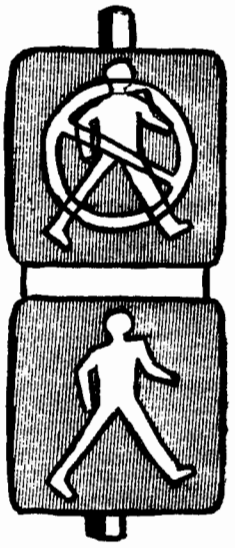
SIGNAL AT THIS
INTERSECTION

A
(FLASHING)

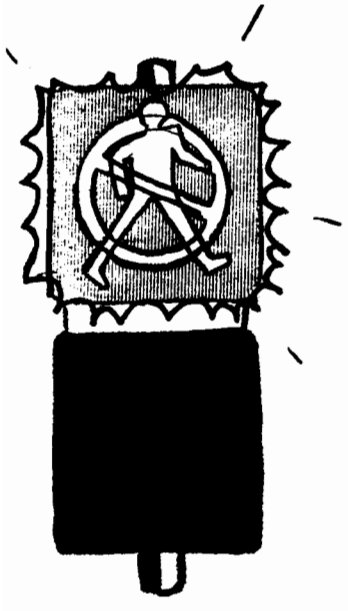
B

C

CARD 5

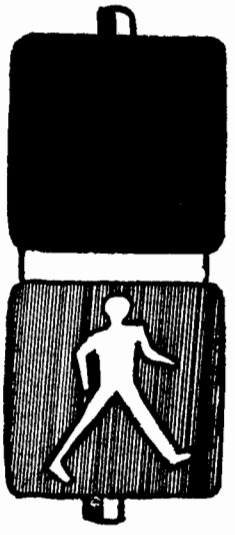


SIGNAL AT THIS INTERSECTION



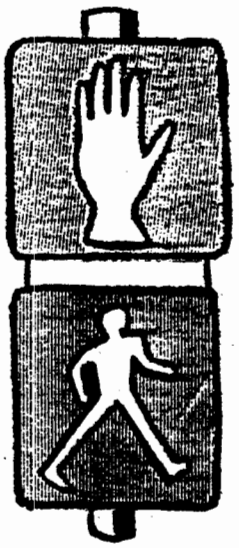
A
(FLASHING)

B

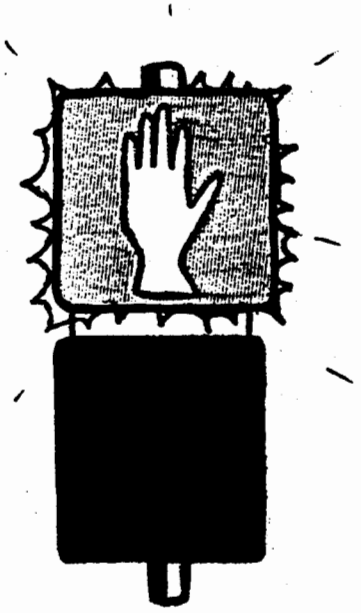


C

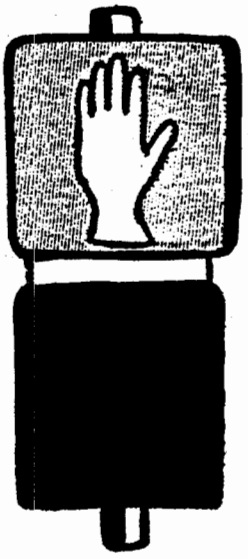
CARD 6



SIGNAL AT THIS INTERSECTION



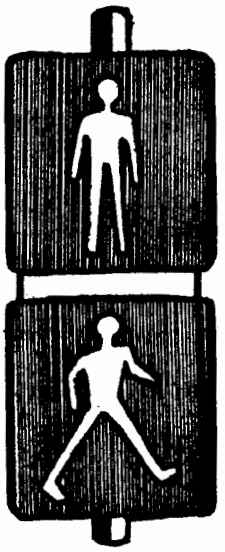
A
(FLASHING)



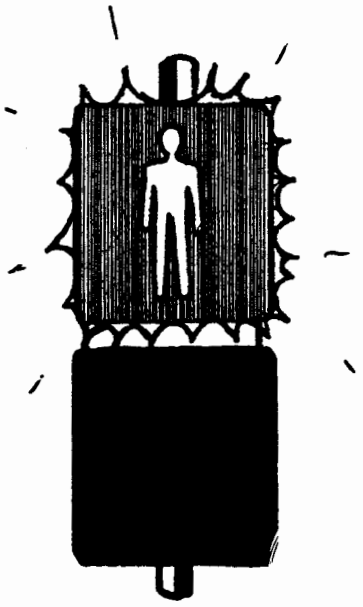
B

C

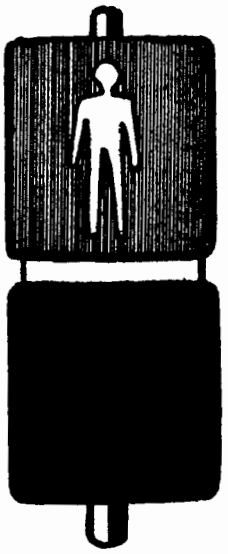
CARD 7



SIGNAL AT THIS INTERSECTION



A
(FLASHING)



B

C

U.S. Office of Management
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Approval No. 004R2453
Approval Expires 12/31/76

SIGNAL DESIGN SURVEY
(Color Study)

Good afternoon. We are conducting a traffic study and will take only two minutes of your time.

1. Were there any pedestrian signals at the intersection you just passed?
   - ☐ No Thank you, that is all.
   - ☐ Yes Go to 2

2. What colors were displayed by the pedestrian signal?
   - ☐ Red
   - ☐ Green
   - ☐ Orange
   - ☐ White
   - ☐ Other_____

3. What did you do or think when you saw the pedestrian signals?_____

_____

_____

_____

_____

4. Were you in any way confused by the pedestrian signal?
   - ☐ No Thank you, that is all.
   - ☐ Yes How?_____

_____

_____

_____

Thank you

Age_____ Sex_____

Date_____ Location_____

Interviewer_____

APPENDIX C
DATA COLLECTION PROCEDURES

Introduction

A series of controlled signal display experiments were designed to determine the most effective message and operational characteristics for pedestrian signal displays.

Variables to be Measured

Three types of variables were measured: observed pedestrian behaviors, pedestrian compliance, and user understanding. In Phase I of the project, a set of hazard-related pedestrian behaviors was developed. These behaviors occurred more frequently at high accident intersections than at similar low accident interscctions. These behaviors included the following:

(B) – Backup Movement or Hesitation – Momentary reversal in pedestrian direction of travel in the traffic lane or hesitation, in response to a vehicle in a traffic lane.

(MV) – Moving Vehicle – Thru traffic moving through the crosswalk while a pedestrian is in a traffic lane.

(TV) – Turning Vehicle – Pedestrian in the path and within 20 feet of a turning vehicle.

(VH) – Vehicle Hazard – Pedestrian entering a traffic lane when a thru vehicle, unrestricted by a traffic control device, is approaching in that lane within one block.

(RVH) – Running Vehicle Hazard Conflict – Running in a traffic lane in response to a VH.

(RTV) – Running Turning Vehicle Conflict – Running in a traffic lane in response to a TV or TV potential.

The second type of variable measured was observed pedestrian compliance with the signal display. In addition to recording the number of pedestrians starting on the clearance interval, starting on the prohibited interval, and anticipating the signal, the distribution of these occurrences were recorded.

The third type of variable measured was user understanding of the signal display. A survey was made of pedestrians using the crossings where the above described observations were made. Appendix B contains samples of the survey instruments used (see the Signal Design Surveys).

Type of Study

Before and after studies at locations where standard pedestrian indications were in use were employed.

Criteria for Evaluation

The evaluation of each experimental signal display, when compared to the base condition, was based on the following criteria:

- A significant change in the occurrence of one or more of the pedestrian behaviors observed.
- A significant difference in the types of pedestrian violations and the distributions of those violations over time.
- Responses from the user survey with respect to meaning of the indications and perceived actions required by the indications.

Method of Data Collection

A four-man data collection team was utilized to collect the behavioral, compliance and survey data. The following is a description of the duties of each team member:

- Chief Behavior Observer – team leader; responsible for the conduct of all the data collection to include adherence to the schedule and the quality, accuracy, and completeness of the data; collects behavior data.
- Assistant Behavior Observer – assists the team leader in collection of behavior data.
- Compliance Observer – collects and is responsible for the compliance data; works along with the behavior observers.
- Interviewer – conducts and is responsible for all surveys; works independently of the rest of the team; reduces and codes data when not interviewing; replaces other team members in cases of absence or illness.

Three days were spent at each site pair for each experimental condition during the "before" and "after" study in each of the two cities. The data collection schedule for one study (before or after) of one experiment in one city is shown in Table C-1.

Table C-1

Sample Data Collection Schedule

Time of Day	Day		
	1	2	3
AM	Training	Site #1 Observations	Site #2 Observations
PM	Site #1 Observations	Site #2 Observations	Sites #1 & 2 Survey

Definitions

1. Pedestrian – an individual whose feet are in contact with the roadway during his entire crossing *and* who leaves the curb within 20 feet of the crosswalk being observed. The person must show an intent to cross the street to be considered a pedestrian, e.g., not waiting for a bus or cab.

2. Cycle – the time from the display of a given signal indication on a given signal head until that same indication is displayed again on the same signal head, e.g., from the beginning of green on the SW corner traffic signal until the green is displayed again on that same signal.

3. Parking lane – an extended space provided by a parked vehicle in which a pedestrian may safety stand for a period of time without constituting a hazard to himself or being a hindrance to vehicular traffic.

4. Roadway – the portion of a street, including parking lanes (and in this study, islands), for vehicular use, i.e., curb to curb.

5. Traffic lanes (traveled way) – the portion of the roadway for movement of vehicles, exclusive of parking lanes.

Conventions

1. Pedestrians in the roadway at the beginning of the pedestrian activity sampling cycle were coded for any behaviors they exhibited. Pedestrians in the roadway at the end of the pedestrian activity sampling cycle were coded for any behaviors exhibited up to the end of the cycle.

2. *All* unusual circumstances or occurrences and the time they began and ended, as well as doubts as to how to code a particular behavior were noted on the margin of the data form and the word "Notes" was written at the top of the first data form completed for that shift.

3. The first data form completed for a shift had labeled clearly at the top of the page the city, date, time period (AM or PM), observer's name or initials, and the intersection number and corresponding street names, e.g., 2/25/75 AM #1, 12th & N.Y., Ave., N.W.

4. It is important to remember that the intent of this data collection effort was to code pedestrian and driver behaviors which constitute a hazard to the pedestrian.

5. If pedestrian volumes were very low, two parallel crosswalks were observed simultaneously, e.g., A and C or B and D.

The following are instructions for the use of the observation data forms attached.

Data Form #20

1. Record the intersection name, date, initials of person coding, sequence number and time that sampling begins for the sweep.

2. Note the current signal timing in the "sweep and leg" box at the top of the form.

3. Periodically check the signal timing with a stopwatch to insure that the timing has not changed.

4. Set the prescribed time on the interval timer,* and note this time at the top of the form.

5. Note in the first box the number of pedestrians in the roadway when the WALK indication comes on.

6. Start the timer when the WALK indication comes on and tally the pedestrians leaving the curb on the leg you are observing.

7. When the timer beeps, move to the next box and continue to tally. Repeat this procedure until the WALK indication comes on again.

Data Form #21

1. Record the intersection name, date, sequence number and initials of person coding.

2. For Codes B and RTV – the upper half of the cell should be used to indicate the number of pedestrians exhibiting the behavior. When a pedestrian exhibits this behavior more than one time in a single crossing, the number of times he or she exhibits the behavior should be recorded in the lower half of the cell.

3. Codes MV and TV are vehicular behaviors. Any one vehicle and/or any one pedestrian may be counted only once.

4. Data is to be collected in the following order. Leg "A", leg "C", leg "B", leg "D". When data has been collected on all 4 legs, one sweep is finished. Proceed to the next sweep until the form is completed.

Data Form #22

1. Record the Intersection name, date, sequence number and initials of person coding.

---

*The interval timer is an audio clock that may be set at various time intervals. When started the timer emits an audible tone or "beep" each time the prescribed interval times out.

2. For codes RVH and VH, the upper half of the cell should be used to record the number of pedestrains exhibiting the behavior. Each pedestrian should be coded only one time in this section. When a pedestrian exhibits this behavior more than one time in a single crossing, the number of times he or she exhibits the behavior should be recorded in the lower half of the cell.

3. Data is to be collected in the following order, Leg "A", leg "C", leg "B", and leg "D". When data is collected on all 4 legs then you have completed one sweep. Proceed to the next sweep and so on until the form is completed.

Data Form #23

1. At the end of every four sweeps, count traffic on all legs for one cycle.

2. The directional arrow on the bottom of the form should always be pointing up for north (making Leg "A" the northmost leg).

3. Data must be collected in the following order: Leg "A" and leg "C", leg "B" and leg "D".

4. The complete cycle starts as the vehicle traffic light turns green. When the light again turns green, discontinue count.

5. ALL MOTORIZED VEHICLES WILL BE COUNTED AS VEHICLES.

6. The box letters refer to the legs of the intersection. The box numbers refer to vehicle direction. (1 refers to right turning vehicles, 2 refers to through vehicular traffic, and 3 refers to left turning vehicles, e.g., all right turning vehicles are to be counted in boxes A1, B1, C1, D1.)

7. Leg "A" will always be the northern leg of the intersection. Leg "C" will be the southern leg, leg "B" the eastern leg and leg "D" the western leg.

Form Number 20 (9/11/75)

Compliance Data

INTERSECTION _____ OBSERVER _____

DATE _____ TIME _____

SWEEP AND LEG																			
1 A																			
1 C																			
1 B																			
1 D																			
2 A																			
2 C																			
2 B																			
2 D																			

Form Number 20A (9/11/75)

Compliance Data

INTERSECTION _____ OBSERVER _____

DATE _____ TIME _____

SWEEP AND LEG																			
3 A																			
3 C																			
3 B																			
3 D																			
4 A																			
4 C																			
4 B																			
4 D																			

HOP–PEDESTRIAN ACTIVITY SAMPLING SHEET

Form Number 21 (9/18/75)

INTERSECTION _____ DATE _____ CODER _____

SWEEP AND LEG	COUNTS			
	B	RTV	MV	TV
1 A	#P =			
	#T =			
1 C				
1 B				
1 D				
2 A				
2 C				
2 B				
2 D				
3 A				
3 C				
3 B				
3 D				
4 A				
4 C				
4 B				
4 D				

B= Momentary reversal in pedestrian direction of travel in the traffic lane or hesitation, in response to a vehicle in a traffic lane.

RTV= Running in a traffic lane in response to TV.

TV= Number of turning vehicles involved coming within 20 feet of a pedestrian (in path of vehicle).

MV= Thru vehicle moving thru the crosswalk while pedestrian is in a traffic lane (anyone vehicle and/or anyone pedestrain maybe counted only once).

KEY: #P= Number of pedestrians.
#T= Number of times per pedestrian (multiples).

HOP–PEDESTRIAN ACTIVITY SAMPLING SHEET

Form Number 22(9/18/75)

INTERSECTION _____ DATE _____ CODER _____

SWEEP AND LEG	RVH	VH	PEDESTRIAN COUNTS
1 A	#P =		
	#T =		
1 C			
1 B			
1 D			
2 A			
2 C			
2 B			
2 D			
3 A			
3 C			
3 B			
3 D			
4 A			
4 C			
4 B			
4 D			

RVH= Running in a traffic lane in response to VH

VH= Thru vehicle in a traffic lane, unrestricted by a signal, at the time the pedestrian enters that lane.

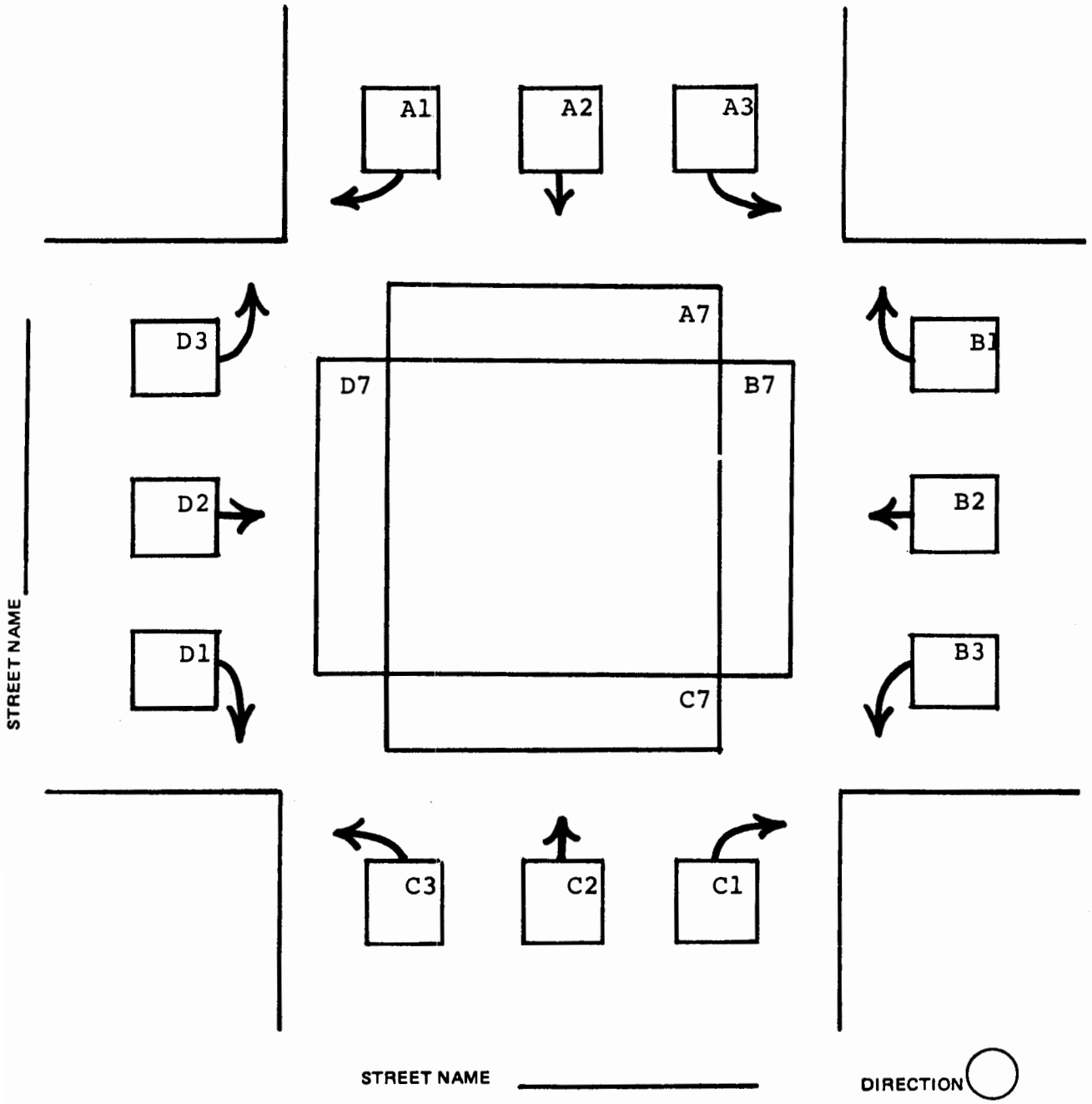
KEY: #P= Number of pedestrians.
#T= Number of times per pedestrian (multiples).

DATA FORM#23

VEHICLE AND PEDESTRIAN FLOW CHARACTERISTICS SUMMARY FORM

SITE#_____ DATE_____ DAY_____ OBSERVER_____

Summarized by_____ Checked by_____ Analyzed by_____



APPENDIX D

WORD MESSAGE AND OPERATION DATA SUMMARIES

The data summaries for the behavioral, compliance and understanding data are on pages D-2 through D-19. Traffic volume data summaries are on pages D-20 through D-25.

EXPERIMENT Flashing DONT WALK vs. Steady DONT WALK Clearance

CITY Buffalo **SITE** 1 & 2 Combined

SIGNAL UNDERSTANDING DATA SUMMARY

Question[1]		Correct		N[2]	Z-Value[3]
		Freq.	Percent		
Q1	Before	76	69.1	110	-3.753**
	After	91	90.1	101	
Q2	Before	92	83.6	110	-1.383
	After	91	90.1	101	
Q3	Before	65	59.1	110	2.398*
	After	43	42.6	101	
Q4	Before	3	2.7	110	-3.151**
	After	15	14.9	101	
Q5	Before	59	53.6	110	-2.333*
	After	70	69.3	101	

PEDESTRIAN BEHAVIOR DATA SUMMARY

Behavior	Frequency		Percent		Z-Value
	Before	After	Before	After	
B	50	38	13.9	14.2	-0.118
RTV	13	11	3.6	4.1	-0.332
MV	45	25	12.5	9.3	-1.240
TV	23	27	6.4	10.1	-1.709
RVH	4	5	1.1	1.8	-0.798
VH	15	6	4.2	2.2	1.356
N	361	268			

CHARACTERISTICS OF PEDESTRIANS SURVEYED

Condition	Sex		Age				
	M	F	0-15	16-30	31-45	46-60	60+
Before	74	36	9	27	23	32	19
After	69	33	4	27	26	28	12

COMPLIANCE DATA SUMMARY BY INTERVAL

Interval	Permissive			Clearance			Prohibited			N
	Freq.	Percent	Z	Freq.	Percent	Z	Freq.	Percent	Z	
Before	80	24.8	2.035*	48	14.9	1.186	194	60.2	-2.604**	322
After	48	17.9		31	11.6		189	70.5		268

LEGEND:

1. See Appendix B. Signal Design Survey (Message/Operation Study)
   - Q1. When is it safe to start your crossing?
   - Q2. What should you do if you see A? (Where A is the clearance interval indication)
   - Q3. If you had just started to cross the street and you saw A, what should you do?
   - Q4. At some intersections, the WALK signal flashes, at some, it does not. What does the flashing (non-flashing) WALK signal mean here at this intersection?
   - Q5. Would you expect vehicles to be turning into your crosswalk if you crossed during the WALK signal?
2. N = Total number of responses or pedestrians observed.
3. Z = The Z-statistic for a two-tail test of proportions where $Z_{.05} = 1.960$ and $Z_{.01} = 2.576$.

*Significant at .05 level.

**Significant at .01 level.

EXPERIMENT Flashing DONT WALK vs. Steady DONT WALK Clearance

CITY Buffalo **SITE** 1 Bailey & Broadway

SIGNAL UNDERSTANDING DATA SUMMARY

Question[1]		Correct		N[2]	Z-Value[3]
		Freq.	Percent		
Q1	Before	40	80.0	50	-0.521
	After	42	84.0	50	
Q2	Before	38	76.0	50	-1.274
	After	43	86.0	50	
Q3	Before	28	56.0	50	1.803
	After	19	38.0	50	
Q4	Before	2	4.0	50	-2.676**
	After	11	22.0	50	
Q5	Before	22	44.0	50	-2.626
	After	35	70.0	50	

PEDESTRIAN BEHAVIOR DATA SUMMARY

Behavior	Frequency		Percent		Z-Value
	Before	After	Before	After	
B	18	14	10.6	9.7	.253
RTV	12	11	7.1	7.6	.197
MV	8	6	4.7	4.2	.232
TV	16	20	9.4	13.9	-1.242
RVH	0	2	0.0	1.4	-1.553
VH	2	2	1.2	1.4	- .168
N	170	144			

CHARACTERISTICS OF PEDESTRIANS SURVEYED

Condition	Sex		Age				
	M	F	0-15	16-30	31-45	46-60	60+
Before	27	23	6	18	5	16	5
After	30	20	2	12	10	15	11

COMPLIANCE DATA SUMMARY BY INTERVAL

Interval	Permissive			Clearance			Prohibited			N
	Freq.	Percent	Z	Freq.	Percent	Z	Freq.	Percent	Z	
Before	32	18.8	2.668**	17	10.0	-0.513	121	71.2	-1.775	170
After	12	8.3		17	11.8		115	79.9		144

LEGEND:

1. See Appendix B. Signal Design Survey (Message/Operation Study)
   - Q1. When is it safe to start your crossing?
   - Q2. What should you do if you see A? (Where A is the clearance interval indication)
   - Q3. If you had just started to cross the street and you saw A, what should you do?
   - Q4. At some intersections, the WALK signal flashes, at some, it does not. What does the flashing (non-flashing) WALK signal mean here at this intersection?
   - Q5. Would you expect vehicles to be turning into your crosswalk if you crossed during the WALK signal?
2. N = Total number of responses or pedestrians observed.
3. Z = The Z-statistic for a two-tail test of proportions where $Z_{.05} = 1.960$ and $Z_{.01} = 2.576$.

*Significant at .05 level.

**Significant at .01 level.

EXPERIMENT Flashing DONT WALK vs. Steady DONT WALK Clearance

CITY Buffalo **SITE** 2 Broadway & Michigan

SIGNAL UNDERSTANDING DATA SUMMARY

Question[1]		Correct		N[2]	Z-Value[3]
		Freq.	Percent		
Q1	Before	36	60.0	60	-4.473**
	After	49	96.1	51	
Q2	Before	54	90.0	60	-0.792
	After	48	94.1	51	
Q3	Before	37	61.7	60	1.542
	After	24	47.1	51	
Q4	Before	1	1.7	60	-1.564
	After	4	7.8	51	
Q5	Before	37	61.7	60	-0.766
	After	35	68.6	51	

PEDESTRIAN BEHAVIOR DATA SUMMARY

Behavior	Frequency		Percent		Z-Value
	Before	After	Before	After	
B	32	24	16.8	19.4	- .591
RTV	1	0	0.5	0	.828
MV	37	19	19.4	15.3	.919
TV	7	7	3.7	5.6	- .837
RVH	4	3	2.1	2.4	- .194
VH	13	4	6.8	3.2	1.384
N	191	124			

CHARACTERISTICS OF PEDESTRIANS SURVEYED

Condition	Sex		Age				
	M	F	0-15	16-30	31-45	46-60	60+
Before	47	13	3	9	18	16	14
After	39	13	2	15	16	13	1

COMPLIANCE DATA SUMMARY BY INTERVAL

Interval	Permissive			Clearance			Prohibited			N
	Freq.	Percent	Z	Freq.	Percent	Z	Freq.	Percent	Z	
Before	48	31.6	0.457	31	20.4	2.037**	73	48.0	-1.930	152
After	36	29.0		14	11.3		74	59.7		124

LEGEND:

1. See Appendix B. Signal Design Survey (Message/Operation Study)
   - Q1. When is it safe to start your crossing?
   - Q2. What should you do if you see A? (Where A is the clearance interval indication)
   - Q3. If you had just started to cross the street and you saw A, what should you do?
   - Q4. At some intersections, the WALK signal flashes, at some, it does not. What does the flashing (non-flashing) WALK signal mean here at this intersection?
   - Q5. Would you expect vehicles to be turning into your crosswalk if you crossed during the WALK signal?
2. N = Total number of responses or pedestrians observed.
3. Z = The Z-statistic for a two-tail test of proportions where $Z_{.05} = 1.960$ and $Z_{.01} = 2.576$.

*Significant at .05 level.

**Significant at .01 level.

EXPERIMENT Flashing DONT WALK vs. Steady DONT START Clearance

CITY Buffalo **SITE** 3 & 4 Combined

SIGNAL UNDERSTANDING DATA SUMMARY

Question[1]		Correct		N[2]	Z-Value[3]
		Freq.	Percent		
Q1	Before	78	78.0	100	-0.707
	After	82	82.0	100	
Q2	Before	84	84.0	100	-1.497
	After	91	91.0	100	
Q3	Before	67	67.0	100	0.446
	After	65	64.0	100	
Q4	Before	1	1.0	100	-1.010
	After	3	3.0	100	
Q5	Before	67	67.0	100	0.884
	After	61	61.0	100	

PEDESTRIAN BEHAVIOR DATA SUMMARY

Behavior	Frequency		Percent		Z-Value
	Before	After	Before	After	
B	97	55	8.0	6.9	.882
RTV	15	13	1.2	1.6	- .906
MV	81	60	6.7	7.6	- .790
TV	123	64	10.1	8.1	1.570
RVH	25	18	2.1	2.3	- .337
VH	37	23	3.0	2.9	.204
N	1217	794			

CHARACTERISTICS OF PEDESTRIANS SURVEYED

Condition	Sex		Age				
	M	F	0-15	16-30	31-45	46-60	60+
Before	34	66	12	32	17	21	18
After	51	49	11	39	18	19	13

COMPLIANCE DATA SUMMARY BY INTERVAL

Interval	Permissive			Clearance			Prohibited			N
	Freq.	Percent	Z	Freq.	Percent	Z	Freq.	Percent	Z	
Before	577	47.4	0.633	104	8.5	-0.502	536	44.0	-0.350	1217
After	365	46.0		73	9.2		356	44.8		794

LEGEND:

1. See Appendix B. Signal Design Survey (Message/Operation Study)
   - Q1. When is it safe to start your crossing?
   - Q2. What should you do if you see A? (Where A is the clearance interval indication)
   - Q3. If you had just started to cross the street and you saw A, what should you do?
   - Q4. At some intersections, the WALK signal flashes, at some, it does not. What does the flashing (non-flashing) WALK signal mean here at this intersection?
   - Q5. Would you expect vehicles to be turning into your crosswalk if you crossed during the WALK signal?
2. N = Total number of responses or pedestrians observed.
3. Z = The Z-statistic for a two-tail test of proportions where $Z_{.05} = 1.960$ and $Z_{.01} = 2.576$.

* Significant at .05 level.

** Significant at .01 level.

EXPERIMENT Flashing DONT WALK vs. Steady DONT START Clearance

CITY Buffalo **SITE** 3 Fillmore & Broadway

SIGNAL UNDERSTANDING DATA SUMMARY

Question[1]		Correct		N[2]	Z-Value[3]
		Freq.	Percent		
Q1	Before	41	82.0	50	-0.266
	After	42	84.0	50	
Q2	Before	43	86.0	50	-0.280
	After	42	84.0	50	
Q3	Before	36	72.0	50	-1.448
	After	42	84.0	50	
Q4	Before	1	2.0	50	-0.587
	After	2	4.0	50	
Q5	Before	39	78.0	50	-0.912
	After	35	70.0	50	

PEDESTRIAN BEHAVIOR DATA SUMMARY

Behavior	Frequency		Percent		Z-Value
	Before	After	Before	After	
B	83	48	8.1	8.1	- .006
RTV	15	12	1.5	2.0	- .886
MV	70	44	6.8	7.4	- .459
TV	115	53	11.2	8.9	1.458
RVH	22	12	2.1	2.0	.168
VH	33	16	3.2	2.7	.615
N	1030	595			

CHARACTERISTICS OF PEDESTRIANS SURVEYED

Condition	Sex		Age				
	M	F	0-15	16-30	31-45	46-60	60+
Before	26	24	10	20	9	4	7
After	29	21	1	28	8	9	4

COMPLIANCE DATA SUMMARY BY INTERVAL

Interval	Permissive			Clearance			Prohibited			N
	Freq.	Percent	Z	Freq.	Percent	Z	Freq.	Percent	Z	
Before	502	48.7	0.195	92	8.9	-0.324	436	42.3	-0.009	1030
After	287	48.2		56	9.4		252	42.4		595

LEGEND:

1. See Appendix B. Signal Design Survey (Message/Operation Study)
   - Q1. When is it safe to start your crossing?
   - Q2. What should you do if you see A? (Where A is the clearance interval indication)
   - Q3. If you had just started to cross the street and you saw A, what should you do?
   - Q4. At some intersections, the WALK signal flashes, at some, it does not. What does the flashing (non-flashing) WALK signal mean here at this intersection?
   - Q5. Would you expect vehicles to be turning into your crosswalk if you crossed during the WALK signal?
2. N = Total number of responses or pedestrians observed.
3. Z = The Z-statistic for a two-tail test of proportions where $Z_{.05} = 1.960$ and $Z_{.01} = 2.576$.

* Significant at .05 level.

** Significant at .01 level.

EXPERIMENT Flashing DONT WALK vs. Steady DONT START Clearance

CITY Buffalo **SITE** 4 Broadway & Miller/Krupp

SIGNAL UNDERSTANDING DATA SUMMARY

Question[1]		Correct		N[2]	Z-Value[3]
		Freq.	Percent		
Q1	Before	37	74.0	50	-0.713
	After	40	70.0	50	
Q2	Before	41	82.0	50	-2.667**
	After	49	98.0	50	
Q3	Before	31	62.0	50	1.803
	After	22	44.0	50	
Q4	Before	0	0	50	-1.005
	After	1	2.0	50	
Q5	Before	28	56.0	50	0.401
	After	26	52.0	50	

PEDESTRIAN BEHAVIOR DATA SUMMARY

Behavior	Frequency		Percent		Z-Value
	Before	After	Before	After	
B	14	7	7.5	3.5	1.724
RTV	0	1	0	.5	1.123
MV	11	16	5.9	8.0	- .834
TV	8	11	4.3	5.5	- .570
RVH	3	6	1.6	3.0	- .931
VH	4	7	2.1	3.5	- .824
N	187	199			

CHARACTERISTICS OF PEDESTRIANS SURVEYED

Condition	Sex		Age				
	M	F	0-15	16-30	31-45	46-60	60+
Before	8	42	2	8	12	17	11
After	22	28	10	11	10	10	9

COMPLIANCE DATA SUMMARY BY INTERVAL

Interval	Permissive			Clearance			Prohibited			N
	Freq.	Percent	Z	Freq.	Percent	Z	Freq.	Percent	Z	
Before	75	40.1	0.183	12	6.4	-0.792	100	53.5	0.239	187
After	78	39.2		17	8.5		104	52.3		199

LEGEND:

1. See Appendix B. Signal Design Survey (Message/Operation Study)
   - Q1. When is it safe to start your crossing?
   - Q2. What should you do if you see A? (Where A is the clearance interval indication)
   - Q3. If you had just started to cross the street and you saw A, what should you do?
   - Q4. At some intersections, the WALK signal flashes, at some, it does not. What does the flashing (non-flashing) WALK signal mean here at this intersection?
   - Q5. Would you expect vehicles to be turning into your crosswalk if you crossed during the WALK signal?
2. N = Total number of responses or pedestrians observed.
3. Z = The Z-statistic for a two-tail test of proportions where $Z_{.05} = 1.960$ and $Z_{.01} = 2.576$.

*Significant at .05 level.

**Significant at .01 level.

EXPERIMENT Steady vs. Flashing WALK

CITY Buffalo **SITE** 5 & 6 Combined

SIGNAL UNDERSTANDING DATA SUMMARY

Question[1]		Correct		N[2]	Z-Value[3]
		Freq.	Percent		
Q1	Before	75	74.3	101	-1.291
	After	81	81.8	99	
Q2	Before	76	75.2	101	-1.131
	After	81	81.8	99	
Q3	Before	78	77.2	101	3.107 **
	After	56	56.6	99	
Q4	Before	3	3.0	101	-1.054
	After	6	6.1	99	
Q5	Before	37	36.6	101	-2.543*
	After	54	54.5	99	

PEDESTRIAN BEHAVIOR DATA SUMMARY

Behavior	Frequency		Percent		Z-Value
	Before	After	Before	After	
B	106	26	22.5	9.3	4.601**
RTV	12	0	2.5	0.0	2.843**
MV	56	29	11.9	10.4	.637
TV	19	1	4.0	.4	3.101**
RVH	9	8	1.9	2.9	- .868
VH	41	8	8.9	2.9	3.163**
N	472	280			

CHARACTERISTICS OF PEDESTRIANS SURVEYED

Condition	Sex		Age				
	M	F	0-15	16-30	31-45	46-60	60+
Before	55	46	9	48	24	13	7
After	67	32	26	41	13	, 10	9

COMPLIANCE DATA SUMMARY BY INTERVAL

Interval	Permissive			Clearance			Prohibited			N
	Freq.	Percent	Z	Freq.	Percent	Z	Freq.	Percent	Z	
Before	117	24.8	-2.996**	71	15.0	0.829	284	60.2	2.150*	472
After	98	35.0		36	12.9		146	52.1		280

LEGEND:

1. See Appendix B. Signal Design Survey (Message/Operation Study)
   - Q1. When is it safe to start your crossing?
   - Q2. What should you do if you see A? (Where A is the clearance interval indication)
   - Q3. If you had just started to cross the street and you saw A, what should you do?
   - Q4. At some intersections, the WALK signal flashes, at some, it does not. What does the flashing (non-flashing) WALK signal mean here at this intersection?
   - Q5. Would you expect vehicles to be turning into your crosswalk if you crossed during the WALK signal?
2. N = Total number of responses or pedestrians observed.
3. Z = The Z-statistic for a two-tail test of proportions where $Z_{.05} = 1.960$ and $Z_{.01} = 2.576$.

*Significant at .05 level.

**Significant at .01 level.

EXPERIMENT Steady vs. Flashing WALK

CITY Buffalo **SITE** 5 Michigan & Eagle

SIGNAL UNDERSTANDING DATA SUMMARY

Question[1]		Correct		N[2]	Z-Value[3]
		Freq.	Percent		
Q1	Before	44	86.3	51	1.768
	After	36	72.0	50	
Q2	Before	37	72.5	51	-0.635
	After	39	78.0	50	
Q3	Before	40	78.4	51	2.009*
	After	30	60.0	50	
Q4	Before	2	3.9	51	0.569
	After	1	2.0	50	
Q5	Before	24	47.1	51	-0.497
	After	26	52.0	50	

PEDESTRIAN BEHAVIOR DATA SUMMARY

Behavior	Frequency		Percent		Z-Value
	Before	After	Before	After	
B	55	15	26.2	9.7	3.944**
RTV	5	0	2.4	0.0	1.928*
MV	34	17	16.2	11.0	1.402
TV	4	0	1.9	0.0	1.739
RVH	6	6	2.9	3.9	- .556
VH	17	6	8.1	3.9	1.634
N	210	154			

CHARACTERISTICS OF PEDESTRIANS SURVEYED

Condition	Sex		Age				
	M	F	0-15	16-30	31-45	46-60	60+
Before	26	25	4	29	10	6	2
After	38	12	5	22	8	9	6

COMPLIANCE DATA SUMMARY BY INTERVAL

Interval	Permissive			Clearance			Prohibited			N
	Freq.	Percent	Z	Freq.	Percent	Z	Freq.	Percent	Z	
Before	44	21.0	-3.882**	28	13.3	0.467	138	65.7	3.255	210
After	61	39.6		18	11.7		75	48.7		154

LEGEND:

1. See Appendix B. Signal Design Survey (Message/Operation Study)
   - Q1. When is it safe to start your crossing?
   - Q2. What should you do if you see A? (Where A is the clearance interval indication)
   - Q3. If you had just started to cross the street and you saw A, what should you do?
   - Q4. At some intersections, the WALK signal flashes, at some, it does not. What does the flashing (non-flashing) WALK signal mean here at this intersection?
   - Q5. Would you expect vehicles to be turning into your crosswalk if you crossed during the WALK signal?
2. N = Total number of responses or pedestrians observed.
3. Z = The Z-statistic for a two-tail test of proportions where $Z_{.05} = 1.960$ and $Z_{.01} = 2.576$.

*Significant at .05 level.

**Significant at .01 level.

EXPERIMENT Steady vs. Flashing WALK

CITY Buffalo **SITE** 6 Clinton & Jefferson

SIGNAL UNDERSTANDING DATA SUMMARY

Question[1]		Correct		N[2]	Z-Value[3]
		Freq.	Percent		
Q1	Before	31	62.0	50	-3.516**
	After	45	91.8	49	
Q2	Before	39	78.0	50	- .995
	After	42	85.7	49	
Q3	Before	38	76.0	50	2.387*
	After	26	53.1	49	
Q4	Before	1	2.0	50	-1.711
	After	5	10.2	49	
Q5	Before	13	26.0	50	-3.145**
	After	28	57.1	49	

PEDESTRIAN BEHAVIOR DATA SUMMARY

Behavior	Frequency		Percent		Z-Value
	Before	After	Before	After	
B	51	11	19.5	8.7	2.710**
RTV	7	0	2.7	0.0	1.889
MV	22	12	8.4	9.5	- .370
TV	15	1	5.7	0.8	2.300*
RVH	3	2	1.1	1.6	- .374
VH	24	2	9.2	1.6	2.804**
N	262	126			

CHARACTERISTICS OF PEDESTRIANS SURVEYED

Condition	Sex		Age				
	M	F	0-15	16-30	31-45	46-60	60+
Before	28	22	5	19	14	18	8
After	29	20	21	19	5	17	5

COMPLIANCE DATA SUMMARY BY INTERVAL

Interval	Permissive			Clearance			Prohibited			N
	Freq.	Percent	Z	Freq.	Percent	Z	Freq.	Percent	Z	
Before	73	27.9	-0.308	43	16.4	0.439	146	45.7	-0.116	262
After	37	29.4		18	14.3		71	56.3		126

LEGEND:

1. See Appendix B. Signal Design Survey (Message/Operation Study)
   - Q1. When is it safe to start your crossing?
   - Q2. What should you do if you see A? (Where A is the clearance interval indication)
   - Q3. If you had just started to cross the street and you saw A, what should you do?
   - Q4. At some intersections, the WALK signal flashes, at some, it does not. What does the flashing (non-flashing) WALK signal mean here at this intersection?
   - Q5. Would you expect vehicles to be turning into your crosswalk if you crossed during the WALK signal?
2. N = Total number of responses or pedestrians observed.
3. Z = The Z-statistic for a two-tail test of proportions where $Z_{.05} = 1.960$ and $Z_{.01} = 2.576$.

* Significant at .05 level.

** Significant at .01 level.

EXPERIMENT Flashing DONT WALK vs. Steady DONT START Clearance

CITY Phoenix **SITE** 1 & 2 Combined

SIGNAL UNDERSTANDING DATA SUMMARY

Question[1]		Correct		N[2]	Z-Value[3]
		Freq.	Percent		
Q1	Before	100	100.0	100	1.451
	After	98	98.0	100	
Q2	Before	96	96.0	100	-2.020*
	After	100	100.0	100	
Q3	Before	79	79.0	100	- .722
	After	83	83.0	100	
Q4	Before	0	0.0	100	–
	After	0	0.0	100	
Q5	Before	63	63.0	100	2.416*
	After	46	46.0	100	

PEDESTRIAN BEHAVIOR DATA SUMMARY

Behavior	Frequency		Percent		Z-Value
	Before	After	Before	After	
B	9	13	1.2	1.1	0.040
RTV	14	21	1.8	1.9	-0.075
MV	19	20	2.5	1.8	1.101
TV	138	162	17.9	14.3	2.100*
RVH	3	2	0.4	0.2	0.888
VH	25	24	3.2	2.1	1.584
N	771	1131			

CHARACTERISTICS OF PEDESTRIANS SURVEYED

Condition	Sex		Age				
	M	F	0-15	16-30	31-45	46-60	60+
Before	53	47	0	32	32	20	16
After	52	48	0	28	40	22	10

COMPLIANCE DATA SUMMARY BY INTERVAL

Interval	Permissive			Clearance			Prohibited			N
	Freq.	Percent	Z	Freq.	Percent	Z	Freq.	Percent	Z	
Before	636	82.5	-1.164	97	12.6	1.517	38	4.9	-0.225	771
After	917	84.5		112	10.3		56	5.2		1085

LEGEND:

1. See Appendix B. Signal Design Survey (Message/Operation Study)
   - Q1. When is it safe to start your crossing?
   - Q2. What should you do if you see A? (Where A is the clearance interval indication)
   - Q3. If you had just started to cross the street and you saw A, what should you do?
   - Q4. At some intersections, the WALK signal flashes, at some, it does not. What does the flashing (non-flashing) WALK signal mean here at this intersection?
   - Q5. Would you expect vehicles to be turning into your crosswalk if you crossed during the WALK signal?
2. N = Total number of responses or pedestrians observed.
3. Z = The Z-statistic for a two-tail test of proportions where $Z_{.05} = 1.960$ and $Z_{.01} = 2.576$.

*Significant at .05 level.

**Significant at .01 level.

EXPERIMENT Flashing DONT WALK vs. Steady DONT START Clearance

CITY Phoenix **SITE** 1 1st Ave. & Van Buren

SIGNAL UNDERSTANDING DATA SUMMARY

Question[1]		Correct		N[2]	Z-Value[3]
		Freq.	Percent		
Q1	Before	50	100.0	50	1.433
	After	48	96.0	50	
Q2	Before	48	96.0	50	-1.433
	After	50	100.0	50	
Q3	Before	40	80.0	50	0.246
	After	39	78.0	50	
Q4	Before	0	0	50	–
	After	0	0	50	
Q5	Before	28	56.0	50	0
	After	28	56.0	50	

PEDESTRIAN BEHAVIOR DATA SUMMARY

Behavior	Frequency		Percent		Z-Value
	Before	After	Before	After	
B	5	9	0.9	1.2	-0.616
RTV	9	13	1.5	1.7	-0.293
MV	13	11	2.2	1.5	1.074
TV	95	108	16.2	14.2	0.979
RVH	2	0	0.3	0.0	1.607
VH	18	15	3.1	2.0	1.296
N	588	758			

CHARACTERISTICS OF PEDESTRIANS SURVEYED

Condition	Sex		Age				
	M	F	0-15	16-30	31-45	46-60	60+
Before	25	25	0	14	17	9	10
After	28	22	0	17	19	9	5

COMPLIANCE DATA SUMMARY BY INTERVAL

Interval	Permissive			Clearance			Prohibited			N
	Freq.	Percent	Z	Freq.	Percent	Z	Freq.	Percent	Z	
Before	488	83.0	-0.058	76	12.9	0.960	24	4.1	-1.331	588
After	630	83.1		85	11.2		43	5.7		758

LEGEND:

1. See Appendix B. Signal Design Survey (Message/Operation Study)
   - Q1. When is it safe to start your crossing?
   - Q2. What should you do if you see A? (Where A is the clearance interval indication)
   - Q3. If you had just started to cross the street and you saw A, what should you do?
   - Q4. At some intersections, the WALK signal flashes, at some, it does not. What does the flashing (non-flashing) WALK signal mean here at this intersection?
   - Q5. Would you expect vehicles to be turning into your crosswalk if you crossed during the WALK signal?
2. N = Total number of responses or pedestrians observed.
3. Z = The Z-statistic for a two-tail test of proportions where $Z_{.05} = 1.960$ and $Z_{.01} = 2.576$.

*Significant at .05 level.

**Significant at .01 level.

EXPERIMENT Flashing DONT WALK vs. Steady DONT START Clearance

CITY Phoenix **SITE** 2 Central & Osborn

SIGNAL UNDERSTANDING DATA SUMMARY

Question[1]		Correct		N[2]	Z-Value[3]
		Freq.	Percent		
Q1	Before	50	100.0	50	–
	After	50	100.0	50	
Q2	Before	48	96.0	50	-1.433
	After	50	100.0	50	
Q3	Before	39	78.0	50	-1.332
	After	44	88.0	50	
Q4	Before	0	0	50	–
	After	0	0	50	
Q5	Before	35	70.0	50	3.407**
	After	18	36.0	50	

PEDESTRIAN BEHAVIOR DATA SUMMARY

Behavior	Frequency		Percent		Z-Value
	Before	After	Before	After	
B	4	4	2.2	1.1	1.062
RTV	5	8	2.7	2.1	0.438
MV	6	9	3.3	2.4	0.598
TV	43	54	23.5	14.5	2.634**
RVH	1	2	0.5	0.5	0.016
VH	7	9	3.8	2.4	0.953
N	183	373			

CHARACTERISTICS OF PEDESTRIANS SURVEYED

Condition	Sex		Age				
	M	F	0-15	16-30	31-45	46-60	60+
Before	28	22	0	18	15	11	6
After	24	26	0	11	21	13	5

COMPLIANCE DATA SUMMARY BY INTERVAL

Interval	Permissive			Clearance			Prohibited			N
	Freq.	Percent	Z	Freq.	Percent	Z	Freq.	Percent	Z	
Before	148	80.9	-2.108*	21	11.5	1.194	14	7.7	1.778	183
After	287	87.8		27	8.3		13	4.0		327

LEGEND:

1. See Appendix B. Signal Design Survey (Message/Operation Study)
   - Q1. When is it safe to start your crossing?
   - Q2. What should you do if you see A? (Where A is the clearance interval indication)
   - Q3. If you had just started to cross the street and you saw A, what should you do?
   - Q4. At some intersections, the WALK signal flashes, at some, it does not. What does the flashing (non-flashing) WALK signal mean here at this intersection?
   - Q5. Would you expect vehicles to be turning into your crosswalk if you crossed during the WALK signal?
2. N = Total number of responses or pedestrians observed.
3. Z = The Z-statistic for a two-tail test of proportions where $Z_{.05} = 1.960$ and $Z_{.01} = 2.576$.

*Significant at .05 level.

**Significant at .01 level.

EXPERIMENT Flashing vs. Steady WALK

CITY Phoenix **SITE** 3 &4 Combined

SIGNAL UNDERSTANDING DATA SUMMARY

Question[1]		Correct		N[2]	Z-Value[3]
		Freq.	Percent		
Q1	Before	100	100.0	100	1.451
	After	98	98.2	100	
Q2	Before	92	92.0	100	1.554
	After	85	85.0	100	
Q3	Before	83	83.0	100	.368
	After	81	81.0	100	
Q4	Before	1	1.0	100	1.055
	After	0	0.0	100	
Q5	Before	44	44.0	100	1.303
	After	35	35.0	100	

PEDESTRIAN BEHAVIOR DATA SUMMARY

Behavior	Frequency		Percent		Z-Value
	Before	After	Before	After	
B	19	17	2.9	2.5	.499
RTV	12	11	1.8	1.6	.318
MV	14	11	2.1	1.6	.751
TV	103	115	15.8	16.9	- .544
RVH	3	1	0.5	0.1	–
VH	15	7	2.3	1.0	1.823
N	653	682			

CHARACTERISTICS OF PEDESTRIANS SURVEYED

Condition	Sex		Age				
	M	F	0-15	16-30	31-45	46-60	60+
Before	63	37	1	35	30	22	12
After	67	33	3	37	19	27	14

COMPLIANCE DATA SUMMARY BY INTERVAL

Interval	Permissive			Clearance			Prohibited			N
	Freq.	Percent	Z	Freq.	Percent	Z	Freq.	Percent	Z	
Before	525	80.4	-3.481**	79	12.1	2.452*	49	7.5	2.277*	653
After	596	87.4		55	8.1		31	4.5		682

LEGEND:

1. See Appendix B. Signal Design Survey (Message/Operation Study)
   - Q1. When is it safe to start your crossing?
   - Q2. What should you do if you see A? (Where A is the clearance interval indication)
   - Q3. If you had just started to cross the street and you saw A, what should you do?
   - Q4. At some intersections, the WALK signal flashes, at some, it does not. What does the flashing (non-flashing) WALK signal mean here at this intersection?
   - Q5. Would you expect vehicles to be turning into your crosswalk if you crossed during the WALK signal?
2. N = Total number of responses or pedestrians observed.
3. Z = The Z-statistic for a two-tail test of proportions where $Z_{.05} = 1.960$ and $Z_{.01} = 2.576$.

*Significant at .05 level.

**Significant at .01 level.

EXPERIMENT Flashing vs. Steady WALK

CITY Phoenix **SITE** 3 1st St. & Van Buren

SIGNAL UNDERSTANDING DATA SUMMARY

Question[1]		Correct		N[2]	Z-Value[3]
		Freq.	Percent		
Q1	Before	50	100.0	50	1.433
	After	48	96.0	50	
Q2	Before	46	92.0	50	1.487
	After	41	82.0	50	
Q3	Before	41	82.0	50	0.737
	After	38	76.0	50	
Q4	Before	0	0	50	0
	After	0	0	50	
Q5	Before	19	38.0	50	0.629
	After	16	32.0	50	

PEDESTRIAN BEHAVIOR DATA SUMMARY

Behavior	Frequency		Percent		Z-Value
	Before	After	Before	After	
B	14	14	2.9	2.7	.265
RTV	4	8	0.8	1.5	-1.090
MV	10	8	2.1	1.5	.683
TV	76	78	16.0	14.9	.462
RVH	2	1	.4	.2	.725
VH	12	5	2.5	1.0	1.910
N	476	523			

CHARACTERISTICS OF PEDESTRIANS SURVEYED

Condition	Sex		Age				
	M	F	0-15	16-30	31-45	46-60	60+
Before	36	14	0	13	20	14	3
After	39	11	0	15	8	19	8

COMPLIANCE DATA SUMMARY BY INTERVAL

Interval	Permissive			Clearance			Prohibited			N
	Freq.	Percent	Z	Freq.	Percent	Z	Freq.	Percent	Z	
Before	373	78.4	-3.096**	66	13.9	2.328*	37	7.8	1.820	476
After	449	85.9		48	9.2		26	5.0		523

LEGEND:

1. See Appendix B. Signal Design Survey (Message/Operation Study)
   - Q1. When is it safe to start your crossing?
   - Q2. What should you do if you see A? (Where A is the clearance interval indication)
   - Q3. If you had just started to cross the street and you saw A, what should you do?
   - Q4. At some intersections, the WALK signal flashes, at some, it does not. What does the flashing (non-flashing) WALK signal mean here at this intersection?
   - Q5. Would you expect vehicles to be turning into your crosswalk if you crossed during the WALK signal?
2. N = Total number of responses or pedestrians observed.
3. Z = The Z-statistic for a two-tail test of proportions where $Z_{.05} = 1.960$ and $Z_{.01} = 2.576$.

*Significant at .05 level.

**Significant at .01 level.

EXPERIMENT Flashing vs. Steady WALK

CITY Phoenix **SITE** 4 16th St. & Thomas

SIGNAL UNDERSTANDING DATA SUMMARY

Question[1]		Correct		N[2]	Z-Value[3]
		Freq.	Percent		
Q1	Before	50	100.0	50	0
	After	50	100.0	50	
Q2	Before	46	92.0	50	0.667
	After	44	88.0	50	
Q3	Before	42	84.0	50	-0.280
	After	43	86.0	50	
Q4	Before	1	2.0	50	1.013
	After	0	0	50	
Q5	Before	25	50.0	50	1.209
	After	19*	38.0	50	

PEDESTRIAN BEHAVIOR DATA SUMMARY

Behavior	Frequency		Percent		Z-Value
	Before	After	Before	After	
B	5	3	2.8	1.9	0.571
RTV	8	3	4.5	1.9	1.369
MV	4	3	2.3	1.9	0.241
TV	27	37	15.3	23.3	-1.868
RVH	1	0	0.6	0	1.031
VH	3	2	1.7	1.3	0.335
N	177	159			

CHARACTERISTICS OF PEDESTRIANS SURVEYED

Condition	Sex		Age				
	M	F	0-15	16-30	31-45	46-60	60+
Before	27	23	1	22	10	8	9
After	28	22	3	22	11	8	6

COMPLIANCE DATA SUMMARY BY INTERVAL

Interval	Permissive			Clearance			Prohibited			N
	Freq.	Percent	Z	Freq.	Percent	Z	Freq.	Percent	Z	
Before	152	85.9	-1.923	13	7.3	1.138	12	6.8	1.518	177
After	147	92.5		7	4.4		5	3.1		159

LEGEND:

1. See Appendix B. Signal Design Survey (Message/Operation Study)
   - Q1. When is it safe to start your crossing?
   - Q2. What should you do if you see A? (Where A is the clearance interval indication)
   - Q3. If you had just started to cross the street and you saw A, what should you do?
   - Q4. At some intersections, the WALK signal flashes, at some, it does not. What does the flashing (non-flashing) WALK signal mean here at this intersection?
   - Q5. Would you expect vehicles to be turning into your crosswalk if you crossed during the WALK signal?
2. N = Total number of responses or pedestrians observed.
3. Z = The Z-statistic for a two-tail test of proportions where $Z_{.05} = 1.960$ and $Z_{.01} = 2.576$.

*Significant at .05 level.

**Significant at .01 level.

EXPERIMENT Flashing DONT WALK vs. Steady DONT WALK Clearance

CITY Phoenix **SITE** 5 & 6 Combined

SIGNAL UNDERSTANDING DATA SUMMARY

Question[1]		Correct		N[2]	Z-Value[3]
		Freq.	Percent		
Q1	Before	100	100.0	100	-1.715
	After	100	100.0	100	
Q2	Before	93	93.0	100	-2.377*
	After	98	98.0	100	
Q3	Before	79	79.0	100	-1.451
	After	91	91.0	100	
Q4	Before	0	0.0	100	-1.842
	After	2	2.0	100	
Q5	Before	46	46.0	100	
	After	59	59.0	100	

PEDESTRIAN BEHAVIOR DATA SUMMARY

Behavior	Frequency		Percent		Z-Value
	Before	After	Before	After	
B	14	9	2.1	1.0	1.697
RTV	3	13	0.5	1.5	- 2.005*
MV	10	13	1.5	1.5	0.002
TV	85	111	12.8	12.8	- 0.030
RVH	1	1	0.2	0.1	0.187
VH	11	8	1.7	0.9	1.335
N	665	865			

CHARACTERISTICS OF PEDESTRIANS SURVEYED

Condition	Sex		Age				
	M	F	0-15	16-30	31-45	46-60	60+
Before	63	37	0	26	38	23	32
After	63	37	0	28	32	31	9

COMPLIANCE DATA SUMMARY BY INTERVAL

Interval	Permissive			Clearance			Prohibited			N
	Freq.	Percent	Z	Freq.	Percent	Z	Freq.	Percent	Z	
Before	488	73.4	-2.441*	96	14.4	0.379	81	12.2	3.079**	665
After	681	78.7		119	13.8		65	7.5		865

LEGEND:

1. See Appendix B. Signal Design Survey (Message/Operation Study)
   - Q1. When is it safe to start your crossing?
   - Q2. What should you do if you see A? (Where A is the clearance interval indication)
   - Q3. If you had just started to cross the street and you saw A, what should you do?
   - Q4. At some intersections, the WALK signal flashes, at some, it does not. What does the flashing (non-flashing) WALK signal mean here at this intersection?
   - Q5. Would you expect vehicles to be turning into your crosswalk if you crossed during the WALK signal?
2. N = Total number of responses or pedestrians observed.
3. Z = The Z-statistic for a two-tail test of proportions where $Z_{.05} = 1.960$ and $Z_{.01} = 2.576$.

*Significant at .05 level.

**Significant at .01 level.

EXPERIMENT Flashing DONT WALK vs. Steady DONT WALK Clearance

CITY Phoenix **SITE** 5 2nd Ave. & Van Buren

SIGNAL UNDERSTANDING DATA SUMMARY

Question[1]		Correct		N[2]	Z-Value[3]
		Freq.	Percent		
Q1	Before	50	100.0	50	–
	After	50	100.0	50	
Q2	Before	50	100.0	50	–
	After	50	100.0	50	
Q3	Before	42	84.0	50	-1.232
	After	46	92.0	50	
Q4	Before	0	0	50	-1.013
	After	1	2.0	50	
Q5	Before	17	34.0	50	-2.803**
	After	31	62.0	50	

PEDESTRIAN BEHAVIOR DATA SUMMARY

Behavior	Frequency		Percent		Z-Value
	Before	After	Before	After	
B	11	5	2.6	0.9	2.105*
RTV	2	6	0.5	1.1	- 1.090
MV	8	10	1.9	1.8	0.138
TV	44	62	10.5	11.1	- 0.314
RVH	1	0	0.2	0	1.155
VH	6	8	1.4	1.4	- 0.004
N	421	560			

CHARACTERISTICS OF PEDESTRIANS SURVEYED

Condition	Sex		Age				
	M	F	0-15	16-30	31-45	46-60	60+
Before	25	25	0	17	24	5	4
After	31	19	0	17	15	14	4

COMPLIANCE DATA SUMMARY BY INTERVAL

Interval	Permissive			Clearance			Prohibited			N
	Freq.	Percent	Z	Freq.	Percent	Z	Freq.	Percent	Z	
Before	275	65.3	-2.603**	87	20.7	0.606	59	14.0	3.114**	421
After	409	73.0		107	19.1		44	7.9		560

LEGEND:

1. See Appendix B. Signal Design Survey (Message/Operation Study)
   - Q1. When is it safe to start your crossing?
   - Q2. What should you do if you see A? (Where A is the clearance interval indication)
   - Q3. If you had just started to cross the street and you saw A, what should you do?
   - Q4. At some intersections, the WALK signal flashes, at some, it does not. What does the flashing (non-flashing) WALK signal mean here at this intersection?
   - Q5. Would you expect vehicles to be turning into your crosswalk if you crossed during the WALK signal?
2. N = Total number of responses or pedestrians observed.
3. Z = The Z-statistic for a two-tail test of proportions where $Z_{.05} = 1.960$ and $Z_{.01} = 2.576$.

*Significant at .05 level.

**Significant at .01 level.

EXPERIMENT Flashing DONT WALK vs. Steady DONT WALK Clearance

CITY Phoenix **SITE** 6 17th Ave. & Madison

SIGNAL UNDERSTANDING DATA SUMMARY

Question[1]		Correct		N[2]	Z-Value[3]
		Freq.	Percent		
Q1	Before	50	100.0	50	–
	After	50	100.0	50	
Q2	Before	43	86.0	50	-1.749
	After	48	96.0	50	
Q3	Before	37	74.0	50	-2.082*
	After	45	90.0	50	
Q4	Before	0	0	50	-1.013
	After	1	2.0	50	
Q5	Before	29	58.0	50	0.202
	After	28	56.0	50	

PEDESTRIAN BEHAVIOR DATA SUMMARY

Behavior	Frequency		Percent		Z-Value
	Before	After	Before	After	
B	3	4	1.2	1.3	-0.086
RTV	1	7	0.4	2.3	-1.886
MV	2	3	0.8	1.0	-0.212
TV	41	49	16.8	16.1	0.233
RVH	0	0	0	0.3	-1.035
VH	5	0	2.0	0	2.512*
N	244	305			

CHARACTERISTICS OF PEDESTRIANS SURVEYED

Condition	Sex		Age				
	M	F	0-15	16-30	31-45	46-60	60+
Before	38	12	0	9	14	18	8
After	32	18	0	11	17	17	5

COMPLIANCE DATA SUMMARY BY INTERVAL

Interval	Permissive			Clearance			Prohibited			N
	Freq.	Percent	Z	Freq.	Percent	Z	Freq.	Percent	Z	
Before	213	87.2	0.684	9	3.7	-0.149	22	9.0	0.924	244
After	272	89.2		12	3.9		21	6.9		305

LEGEND:

1. See Appendix B. Signal Design Survey (Message/Operation Study)
   - Q1. When is it safe to start your crossing?
   - Q2. What should you do if you see A? (Where A is the clearance interval indication)
   - Q3. If you had just started to cross the street and you saw A, what should you do?
   - Q4. At some intersections, the WALK signal flashes, at some, it does not. What does the flashing (non-flashing) WALK signal mean here at this intersection?
   - Q5. Would you expect vehicles to be turning into your crosswalk if you crossed during the WALK signal?
2. N = Total number of responses or pedestrians observed.
3. Z = The Z-statistic for a two-tail test of proportions where $Z_{.05} = 1.960$ and $Z_{.01} = 2.576$.

*Significant at .05 level.

**Significant at .01 level.

TRAFFIC VOLUME DATA ANALYSIS SUMMARY

Experiment Flashing DONT WALK vs. Steady DONT WALK Clearance

City Buffalo

Site 1 Bailey & Broadway

Time	Before	After
7:50 AM	48	36
8:50	70	45
9:40	47	56
11:00	62	56
2:35 PM	84	86
3:20	106	95

A = 0.547
d.f. = 5
Not significant

Site 2 Broadway & Michigan

Time	Before	After
8:35 AM	36	26
8:55	19	23
9:10	20	21
9:30	20	26
9:50	27	27
10:30	17	29
10:50	27	17
11:05	30	25
11:25	21	21
2:05 PM	28	31
2:25	47	27
2:45	34	37
3:00	40	28
3:20	19	32
3:40	35	33

A = 4.003
d.f. = 14
Not significant

NOTE: Volumes shown are total counts of traffic on all approaches for one signal cycle.

TRAFFIC VOLUME DATA ANALYSIS SUMMARY

Experiment Flashing DONT WALK vs. Steady DONT START Clearance

City Buffalo

Site 3 Broadway & Fillmore

Time	Before	After
8:00 AM	44	37
9:20	34	24
9:40	32	34
10:35	35	24
11:25	29	31
2:05 PM	44	33

A = 0.326

d.f. = 5

Significant at the 0.10 level

Site 4 Broadway & Miller/Krupp

Time	Before	After
9:25 AM	34	17
9:45	18	22
10:05	37	22
10:20	20	27
10:45	24	25
4:30 PM	31	37
4:50	32	42

A = 44.750

d.f. = 6

Not significant

NOTE: Volumes shown are total counts of traffic on all approaches for one signal cycle.

TRAFFIC VOLUME DATA ANALYSIS SUMMARY

Experiment Steady vs. Flashing WALK

City Buffalo

Site 5 Michigan & Eagle

Time	Before	After
7:55 AM	16	16
8:35	13	10
9:15	5	11
9:30	10	8
10:00	4	9
10:45	9	13
11:00	9	8
11:30	18	14
1:55 PM	21	12
2:10	12	13
2:25	19	21
2:40	14	19
2:55	20	12
3:08	16	14
3:25	22	24
3:35	17	19
4:05	13	17
4:23	21	13
4:40	22	14

A = 2.235

d.f. = 18

Not significant

Site 6 Clinton & Jefferson

Time	Before	After
8:10 AM	10	13
8:55	7	9
9:10	8	4
9:35	7	10
10:35	10	10
10:55	5	10
11:00	6	10
1:45 PM	11	8
2:15	13	9
2:30	18	10
2:45	19	11
3:00	10	13
3:15	26	18
3:35	19	7
4:00	26	8
4:45	2	21

A = 1.678

d.f. = 15

Not significant

NOTE: Volumes shown are total counts of traffic on all approaches for one signal cycle.

TRAFFIC VOLUME DATA ANALYSIS SUMMARY

Experiment Flashing DONT WALK vs. Steady DONT START Clearance

City Phoenix

Site 1 1st Ave. & Van Buren

Time	Before	After
8:45 AM	31	19
10:30	27	40
10:45	31	44
11:05	30	24
11:30	20	40
1:20 PM	30	21
1:50	33	22
2:10	26	34
2:25	30	46
3:25	30	27
3:45	30	37
4:10	28	39
4:20	26	27
4:35	34	38
4:55	30	29

A = 0.629

d.f. = 14

Not significant

Site 2 Central & Osborn

Time	Before	After
8:15 AM	60	54
8:30	44	60
8:50	81	56
9:00	49	49
9:50	35	57
10:20	56	54
10:35	45	46
10:45	53	55
11:05	54	45
11:20	59	54
11:30	61	69
1:10 PM	67	69
1:20	74	77
1:50	63	73
2:45	66	56
3:00	64	65
3:15	55	60
4:15	95	62
4:30	86	78
4:45	86	82

A = 10.130

d.f. = 24

Not significant

NOTE: Volumes shown are total counts of traffic on all approaches for one signal cycle.

TRAFFIC VOLUME DATA ANALYSIS SUMMARY

Experiment Flashing vs. Steady WALK

City Phoenix

Site 3 1st St. & Van Buren

Time	Before	After
8:30 AM	22	24
8:45	19	23
8:55	26	25
9:10	31	21
10:20	23	24
10:30	27	25
10:45	26	28
11:00	25	25
11:15	25	32
11:30	26	29
1:40 PM	28	26
1:50	38	33
2:00	24	23
3:10	35	28
3:25	27	34
3:40	30	49
4:00	31	31
4:25	31	42

A = 1.018
d.f. = 17
Not significant

Site 4 16th St. & Thomas

Time	Before	After
9:15 AM	43	52
9:25	45	47
10:00	38	47
10:20	56	42
10:30	48	49
10:45	41	52
11:15	39	43
11:35	52	62
11:40	58	66
11:50	53	62
11:55	55	42
1:18 PM	48	68
1:26	50	54
1:35	67	55
1:45	60	60
2:04	63	64
2:12	68	66
3:03	62	60
3:15	54	64
3:31	52	86
3:40	69	58
3:48	64	66
4:00	65	62
4:40	87	67
4:55	75	72

A = 10.130
d.f. = 24
Not significant

NOTE: Volumes shown are total counts of traffic on all approaches for one signal cycle.

TRAFFIC VOLUME DATA ANALYSIS SUMMARY

Experiment Flashing DONT WALK vs. Steady DONT WALK Clearance

City Phoenix

Site 5 2nd Ave. & Van Buren

Time	Before	After
8:30 AM	26	24
8:40	18	19
9:00	12	21
10:40	22	15
10:55	29	19
1:30 PM	24	27
1:45	22	24
2:00	25	20
2:10	20	23
2:50	32	31
3:00	19	20
3:10	22	30
3:25	21	25
3:35	35	24
3:45	36	18
4:00	39	28
4:10	31	23
4:30	27	34
4:40	45	30
4:55	31	21

A = 0.380
d.f. = 19
Not significant

Site 6 17th Ave. & Madison

Time	Before	After
8:25 AM	13	14
8:35	5	7
8:45	6	4
9:00	10	12
10:00	12	14
10:10	6	9
10:20	14	6
10:30	17	4
10:40	7	6
10:50	10	8
11:00	6	9
11:20	15	7
11:30	18	8
1:40 PM	13	8
1:50	10	12
3:20	12	10
3:30	14	10
4:00	13	13
4:10	12	15
4:25	15	16
4:40	21	22

A = 0.584
d.f. = 20
Not significant

NOTE: Volumes shown are total counts of traffic on all approaches for one signal cycle.

APPENDIX E

SYMBOL MESSAGE DATA SUMMARIES

The data summaries for the behavioral, compliance and understanding data are on pages E-2 through E-25. Traffic volume data summaries are on pages E-26 through E-33.

EXPERIMENT WALK – DONT WALK vs. Circle Slash Symbol

CITY Buffalo **SITE** 2A & 3A Combined

SIGNAL UNDERSTANDING DATA SUMMARY

Question[1]		Correct		N[2]	Z-Value[3]
		Freq.	Percent		
Q1	Before	89	87.3	102	2.919**
	After	72	70.6	102	
Q2	Before	90	88.2	102	1.880
	After	80	78.4	102	
Q3	Before	54	52.9	102	0.701
	After	49	48.0	102	
Q4	Before	na	na	na	na
	After	na	na	na	
Q5	Before	63	61.8	102	1.415
	After	53	52.0	102	

PEDESTRIAN BEHAVIOR DATA SUMMARY

Behavior	Frequency		Percent		Z-Value
	Before	After	Before	After	
B	70	51	6.6	5.4	1.106
RTV	3	3	0.3	0.3	0.000
MV	46	27	4.3	2.9	1.879
TV	71	71	6.7	7.5	-0.766
RVH	8	7	0.8	0.7	0.253
VH	49	45	4.6	4.8	0.198
N	1064	941			

CHARACTERISTICS OF PEDESTRIANS SURVEYED

Condition	Sex		Age				
	M	F	0-15	16-30	31-45	46-60	60+
Before	66	36	9	29	26	22	16
After	64	38	4	39	23	22	14

COMPLIANCE DATA SUMMARY BY INTERVAL

Interval	Permissive			Clearance			Prohibited			N
	Freq.	Percent	Z	Freq.	Percent	Z	Freq.	Percent	Z	
Before	601	56.5	5.451**	130	12.2	-1.674	333	31.3	-4.434**	1064
After	418	44.4		139	14.8		384	40.8		941

LEGEND:

1. See Appendix B. Signal Design Survey (Message/Operation Study)
   - Q1. When is it safe to start your crossing?
   - Q2. What should you do if you see A? (Where A is the clearance interval indication)
   - Q3. If you had just started to cross the street and you saw A, what should you do?
   - Q4. At some intersections, the WALK signal flashes, at some, it does not. What does the flashing (non-flashing) WALK signal mean here at this intersection?
   - Q5. Would you expect vehicles to be turning into your crosswalk if you crossed during the WALK signal?
2. N = Total number of responses or pedestrians observed.
3. Z = The Z-statistic for a two-tail test of proportions where $Z_{.05} = 1.960$ and $Z_{.01} = 2.576$.

*Significant at .05 level.

**Significant at .01 level.

EXPERIMENT WALK – DONT WALK vs. Circle Slash Symbol (Orange / White)

CITY Buffalo **SITE** 2A Broadway & Michigan

SIGNAL UNDERSTANDING DATA SUMMARY

Question[1]		Correct		N[2]	Z-Value[3]
		Freq.	Percent		
Q1	Before	43	86.0	50	2.801**
	After	33	63.5	52	
Q2	Before	43	86.0	50	0.948
	After	41	78.8	52	
Q3	Before	26	52.0	50	0.785
	After	23	44.2	52	
Q4	Before	na	na	na	na
	After	na	na	na	
Q5	Before	31	62.0	50	1.027
	After	27	51.9	52	

PEDESTRIAN BEHAVIOR DATA SUMMARY

Behavior	Frequency		Percent		Z-Value
	Before	After	Before	After	
B	9	2	6.1	1.2	2.369*
RTV	0	0	0.0	0.0	na
MV	9	7	6.1	4.2	.755
TV	2	1	1.4	0.6	.689
RVH	3	4	2.0	2.4	-.230
VH	11	5	7.5	3.0	1.789
N	147	165			

CHARACTERISTICS OF PEDESTRIANS SURVEYED

Condition	Sex		Age				
	M	F	0-15	16-30	31-45	46-60	60+
Before	39	11	2	12	14	14	8
After	40	12	4	20	10	11	7

COMPLIANCE DATA SUMMARY BY INTERVAL

Interval	Permissive			Clearance			Prohibited			N
	Freq.	Percent	Z	Freq.	Percent	Z	Freq.	Percent	Z	
Before	70	47.6	-1.977*	17	11.6	-.471	60	40.8	2.409*	147
After	97	58.8		22	13.3		46	29.2		165

LEGEND:

1. See Appendix B. Signal Design Survey (Message/Operation Study)
   - Q1. When is it safe to start your crossing?
   - Q2. What should you do if you see A? (Where A is the clearance interval indication)
   - Q3. If you had just started to cross the street and you saw A, what should you do?
   - Q4. At some intersections, the WALK signal flashes, at some, it does not. What does the flashing (non-flashing) WALK signal mean here at this intersection?
   - Q5. Would you expect vehicles to be turning into your crosswalk if you crossed during the WALK signal?
2. N = Total number of responses or pedestrians observed.
3. Z = The Z-statistic for a two-tail test of proportions where $Z_{.05} = 1.960$ and $Z_{.01} = 2.576$.

*Significant at .05 level.

**Significant at .01 level.

EXPERIMENT WALK – DONT WALK vs. Circle Slash Symbol (Red / Green)

CITY Buffalo **SITE** 3A Fillmore & Broadway

SIGNAL UNDERSTANDING DATA SUMMARY

Question[1]		Correct		N[2]	Z-Value[3]
		Freq.	Percent		
Q1	Before	46	88.5	52	1.176
	After	40	80.0	50	
Q2	Before	47	90.4	52	1.721
	After	39	78.0	50	
Q3	Before	28	53.8	52	0.187
	After	26	52.0	50	
Q4	Before	na	na	na	na
	After	na	na	na	
Q5	Before	32	61.5	52	0.972
	After	26	52.0	50	

PEDESTRIAN BEHAVIOR DATA SUMMARY

Behavior	Frequency		Percent		Z-Value
	Before	After	Before	After	
B	61	49	6.7	6.3	0.286
RTV	3	3	0.3	0.4	0.000
MV	37	20	4.0	2.6	1.743
TV	69	70	7.5	9.0	-1.148
RVH	5	3	0.5	0.4	0.503
VH	38	40	4.1	5.2	1.011
N	917	776			

CHARACTERISTICS OF PEDESTRIANS SURVEYED

Condition	Sex		Age				
	M	F	0-15	16-30	31-45	46-60	60+
Before	27	25	7	17	12	8	8
After	24	26	0	19	13	11	7

COMPLIANCE DATA SUMMARY BY INTERVAL

Interval	Permissive			Clearance			Prohibited			N
	Freq.	Percent	Z	Freq.	Percent	Z	Freq.	Percent	Z	
Before	531	57.9	6.813**	113	12.3	-1.648	273	29.8	-5.885**	917
After	321	41.4		117	15.1		338	43.6		776

LEGEND:

1. See Appendix B. Signal Design Survey (Message/Operation Study)
   - Q1. When is it safe to start your crossing?
   - Q2. What should you do if you see A? (Where A is the clearance interval indication)
   - Q3. If you had just started to cross the street and you saw A, what should you do?
   - Q4. At some intersections, the WALK signal flashes, at some, it does not. What does the flashing (non-flashing) WALK signal mean here at this intersection?
   - Q5. Would you expect vehicles to be turning into your crosswalk if you crossed during the WALK signal?
2. N = Total number of responses or pedestrians observed.
3. Z = The Z-statistic for a two-tail test of proportions where $Z_{.05} = 1.960$ and $Z_{.01} = 2.576$.

*Significant at .05 level.

**Significant at .01 level.

EXPERIMENT WALK – DONT WALK vs. Circle Slash Symbol

CITY Tempe **SITE** 7 & 9 Combined

SIGNAL UNDERSTANDING DATA SUMMARY

Question[1]		Correct		N[2]	Z-Value[3]
		Freq.	Percent		
Q1	Before	97	97.0	100	-1.013
	After	99	99.0	100	
Q2	Before	77	77.0	100	-3.936**
	After	96	96.0	100	
Q3	Before	86	86.0	100	.953
	After	81	81.0	100	
Q4	Before	na	na	na	na
	After	na	na	na	
Q5	Before	67	67.0	100	-1.248
	After	75	75.0	100	

PEDESTRIAN BEHAVIOR DATA SUMMARY

Behavior	Frequency		Percent		Z-Value
	Before	After	Before	After	
B	14	17	20.6	28.1	-.898
RTV	10	13	14.7	21.5	-.959
MV	7	6	1.0	1.0	.069
TV	129	95	19.0	15.7	1.558
RVH	0	3	0.0	0.5	na
VH	13	5	1.9	0.8	1.717
N	680	605			

CHARACTERISTICS OF PEDESTRIANS SURVEYED

Condition	Sex		Age				
	M	F	0-15	16-30	31-45	46-60	60+
Before	63	37	0	74	12	10	4
After	60	40	0	72	18	8	2

COMPLIANCE DATA SUMMARY BY INTERVAL

Interval	Permissive			Clearance			Prohibited			N
	Freq.	Percent	Z	Freq.	Percent	Z	Freq.	Percent	Z	
Before	560	82.4	0.635	42	6.2	1.360	78	11.5	-1.640	680
After	490	81.0		27	4.5		88	14.5		605

LEGEND:

1. See Appendix B. Signal Design Survey (Message/Operation Study)
   - Q1. When is it safe to start your crossing?
   - Q2. What should you do if you see A? (Where A is the clearance interval indication)
   - Q3. If you had just started to cross the street and you saw A, what should you do?
   - Q4. At some intersections, the WALK signal flashes, at some, it does not. What does the flashing (non-flashing) WALK signal mean here at this intersection?
   - Q5. Would you expect vehicles to be turning into your crosswalk if you crossed during the WALK signal?
2. N = Total number of responses or pedestrians observed.
3. Z = The Z-statistic for a two-tail test of proportions where $Z_{.05} = 1.960$ and $Z_{.01} = 2.576$.

* Significant at .05 level.

** Significant at .01 level.

EXPERIMENT WALK – DONT WALK vs. Circle Slash Symbol (Red / Green)

CITY Tempe **SITE** 7 5th & Mill

SIGNAL UNDERSTANDING DATA SUMMARY

Question[1]		Correct		N[2]	Z-Value[3]
		Freq.	Percent		
Q1	Before	48	96.0	50	-1.433
	After	50	100.0	50	
Q2	Before	44	88.0	50	-1.961*
	After	49	98.0	50	
Q3	Before	38	76.0	50	-0.238
	After	39	78.0	50	
Q4	Before	na	na	na	na
	After	na	na	na	
Q5	Before	32	64.0	50	-2.028
	After	41	82.0	50	

PEDESTRIAN BEHAVIOR DATA SUMMARY

Behavior	Frequency		Percent		Z-Value
	Before	After	Before	After	
B	8	10	3.7	4.1	-0.268
RTV	7	10	3.2	4.1	-0.540
MV	1	3	0.5	1.2	-0.937
TV	58	44	26.5	18.2	2.151*
RVH	0	1	0.0	na	0.000
VH	4	2	1.8	0.8	0.954
N	219	242			

CHARACTERISTICS OF PEDESTRIANS SURVEYED

Condition	Sex		Age				
	M	F	0-15	16-30	31-45	46-60	60+
Before	30	20	0	31	8	7	4
After	32	18	0	29	11	8	2

COMPLIANCE DATA SUMMARY BY INTERVAL

Interval	Permissive			Clearance			Prohibited			N
	Freq.	Percent	Z	Freq.	Percent	Z	Freq.	Percent	Z	
Before	180	82.2	1.930	13	5.9	0.888	26	11.9	-2.645**	219
After	181	74.8		10	4.1		51	21.1		242

LEGEND:

1. See Appendix B. Signal Design Survey (Message/Operation Study)
   - Q1. When is it safe to start your crossing?
   - Q2. What should you do if you see A? (Where A is the clearance interval indication)
   - Q3. If you had just started to cross the street and you saw A, what should you do?
   - Q4. At some intersections, the WALK signal flashes, at some, it does not. What does the flashing (non-flashing) WALK signal mean here at this intersection?
   - Q5. Would you expect vehicles to be turning into your crosswalk if you crossed during the WALK signal?
2. N = Total number of responses or pedestrians observed.
3. Z = The Z-statistic for a two-tail test of proportions where $Z_{.05} = 1.960$ and $Z_{.01} = 2.576$.

*Significant at .05 level.

**Significant at .01 level.

EXPERIMENT WALK – DONT WALK vs. Circle Slash Symbol (Orange / White)

CITY Tempe **SITE** 9 University & Forest

SIGNAL UNDERSTANDING DATA SUMMARY

Question[1]		Correct		N[2]	Z-Value[3]
		Freq.	Percent		
Q1	Before	49	98.0	50	0.000
	After	49	98.0	50	
Q2	Before	33	66.0	50	-3.500**
	After	47	94.0	50	
Q3	Before	48	96.0	50	2.000*
	After	42	84.0	50	
Q4	Before	na	na	na	na
	After	na	na	na	
Q5	Before	35	15.0	50	0.216
	After	34	16.0	50	

PEDESTRIAN BEHAVIOR DATA SUMMARY

Behavior	Frequency		Percent		Z-Value
	Before	After	Before	After	
B	6	7	1.3	1.9	-0.750
RTV	3	3	0.7	0.8	-0.322
MV	6	3	1.3	0.8	0.672
TV	71	51	15.4	14.0	0.548
RVH	0	2	0	na	0.000
VH	9	3	2.0	0.8	1.347
N	461	363			

CHARACTERISTICS OF PEDESTRIANS SURVEYED

Condition	Sex		Age				
	M	F	0-15	16-30	31-45	46-60	60+
Before	33	17	0	43	4	3	0
After	28	22	0	43	7	0	0

COMPLIANCE DATA SUMMARY BY INTERVAL

Interval	Permissive			Clearance			Prohibited			N
	Freq.	Percent	Z	Freq.	Percent	Z	Freq.	Percent	Z	
Before	380	82.4	-1.041	29	6.3	.9978	52	11.3	.499	461
After	309	85.1		17	4.7		37	10.2		363

LEGEND:

1. See Appendix B. Signal Design Survey (Message/Operation Study)
   - Q1. When is it safe to start your crossing?
   - Q2. What should you do if you see A? (Where A is the clearance interval indication)
   - Q3. If you had just started to cross the street and you saw A, what should you do?
   - Q4. At some intersections, the WALK signal flashes, at some, it does not. What does the flashing (non-flashing) WALK signal mean here at this intersection?
   - Q5. Would you expect vehicles to be turning into your crosswalk if you crossed during the WALK signal?
2. N = Total number of responses or pedestrians observed.
3. Z = The Z-statistic for a two-tail test of proportions where $Z_{.05} = 1.960$ and $Z_{.01} = 2.576$.

*Significant at .05 level.

**Significant at .01 level.

EXPERIMENT WALK – DONT WALK vs. Hand Symbol

CITY Baltimore **SITE** 1 & 2 Combined

SIGNAL UNDERSTANDING DATA SUMMARY

Question[1]		Correct		N[2]	Z-Value[3]
		Freq.	Percent		
Q1	Before	86	86.0	100	1.375
	After	85	78.7	108	
Q2	Before	70	70.0	100	-2.636**
	After	92	85.2	108	
Q3	Before	32	32.0	100	-4.466**
	After	68	63.0	108	
Q4	Before	na	na	na	na
	After	na	na	na	
Q5	Before	59	59.0	100	-0.863
	After	70	64.8	108	

PEDESTRIAN BEHAVIOR DATA SUMMARY

Behavior	Frequency		Percent		Z-Value
	Before	After	Before	After	
B	109	246	7.4	10.8	-3.461**
RTV	5	37	0.3	1.6	-3.662**
MV	115	198	7.8	8.7	-0.945
TV	70	169	4.8	7.4	-3.257**
RVH	43	51	2.9	2.2	1.310
VH	69	123	4.7	5.3	-0.962
N	1471	2278			

CHARACTERISTICS OF PEDESTRIANS SURVEYED

Condition	Sex		Age				
	M	F	0-15	16-30	31-45	46-60	60+
Before	55	45	2	34	20	24	20
After	51	57	2	38	22	30	16

COMPLIANCE DATA SUMMARY BY INTERVAL

Interval	Permissive			Clearance			Prohibited			N
	Freq.	Percent	Z	Freq.	Percent	Z	Freq.	Percent	Z	
Before	712	48.4	-2.242**	158	10.7	0.1994	601	40.9	2.175*	1471
After	1188	52.2		240	10.5		850	37.3		2278

LEGEND:

1. See Appendix B. Signal Design Survey (Message/Operation Study)
   - Q1. When is it safe to start your crossing?
   - Q2. What should you do if you see A? (Where A is the clearance interval indication)
   - Q3. If you had just started to cross the street and you saw A, what should you do?
   - Q4. At some intersections, the WALK signal flashes, at some, it does not. What does the flashing (non-flashing) WALK signal mean here at this intersection?
   - Q5. Would you expect vehicles to be turning into your crosswalk if you crossed during the WALK signal?
2. N = Total number of responses or pedestrians observed.
3. Z = The Z-statistic for a two-tail test of proportions where $Z_{.05} = 1.960$ and $Z_{.01} = 2.576$.

*Significant at .05 level.

**Significant at .01 level.

EXPERIMENT WALK – DONT WALK vs. Hand Symbol (Red / Green)

CITY Baltimore **SITE** 1 Eastern & Broadway

SIGNAL UNDERSTANDING DATA SUMMARY

Question[1]		Correct		N[2]	Z-Value[3]
		Freq.	Percent		
Q1	Before	41	80.4	51	0.771
	After	40	74.1	54	
Q2	Before	32	62.7	51	-1.914
	After	43	79.6	54	
Q3	Before	18	35.3	51	-1.896
	After	29	53.7	54	
Q4	Before	na	na	na	na
	After	na	na	na	
Q5	Before	34	66.7	51	0.000
	After	36	66.7	54	

PEDESTRIAN BEHAVIOR DATA SUMMARY

Behavior	Frequency		Percent		Z-Value
	Before	After	Before	After	
B	48	145	8.8	15.5	-3.692**
RTV	2	24	0.4	2.6	-3.108**
MV	70	110	12.8	11.8	0.613
TV	26	74	4.8	7.9	-2.325**
RVH	28	22	5.1	2.4	2.860**
VH	27	65	5.0	7.0	-1.535
N	545	935			

CHARACTERISTICS OF PEDESTRIANS SURVEYED

Condition	Sex		Age				
	M	F	0-15	16-30	31-45	46-60	60+
Before	29	22	1	15	11	12	12
After	27	27	1	16	13	15	9

COMPLIANCE DATA SUMMARY BY INTERVAL

Interval	Permissive			Clearance			Prohibited			N
	Freq.	Percent	Z	Freq.	Percent	Z	Freq.	Percent	Z	
Before	209	38.3	-2.030*	64	11.7	0.174	272	49.9	1.895	545
After	409	43.7		107	11.4		419	44.8		935

LEGEND:

1. See Appendix B. Signal Design Survey (Message/Operation Study)
   - Q1. When is it safe to start your crossing?
   - Q2. What should you do if you see A? (Where A is the clearance interval indication)
   - Q3. If you had just started to cross the street and you saw A, what should you do?
   - Q4. At some intersections, the WALK signal flashes, at some, it does not. What does the flashing (non-flashing) WALK signal mean here at this intersection?
   - Q5. Would you expect vehicles to be turning into your crosswalk if you crossed during the WALK signal?
2. N = Total number of responses or pedestrians observed.
3. Z = The Z-statistic for a two-tail test of proportions where $Z_{.05} = 1.960$ and $Z_{.01} = 2.576$.

* Significant at .05 level.

** Significant at .01 level.

EXPERIMENT WALK – DONT WALK vs. Hand Symbol (Orange / White)

CITY Baltimore **SITE** 2 Eastern & Conkling

SIGNAL UNDERSTANDING DATA SUMMARY

Question[1]		Correct		N[2]	Z-Value[3]
		Freq.	Percent		
Q1	Before	45	91.8	49	1.298
	After	45	83.3	54	
Q2	Before	38	77.6	49	-1.846
	After	49	90.7	54	
Q3	Before	14	28.6	49	-4.427**
	After	39	72.2	54	
Q4	Before	na	na	na	na
	After	na	na	na	
Q5	Before	25	51.0	49	-1.224
	After	34	63.0	54	

PEDESTRIAN BEHAVIOR DATA SUMMARY

Behavior	Frequency		Percent		Z-Value
	Before	After	Before	After	
B	61	101	6.6	7.5	-0.848
RTV	3	13	0.3	1.0	-1.807
MV	45	88	4.9	6.6	-1.688
TV	44	95	4.8	7.1	-2.267*
RVH	15	29	1.6	2.1	-0.917
VH	42	58	4.5	4.3	0.248
N	926	1343			

CHARACTERISTICS OF PEDESTRIANS SURVEYED

Condition	Sex		Age				
	M	F	0-15	16-30	31-45	46-60	60+
Before	26	23	1	19	9	12	8
After	24	30	1	22	9	15	7

COMPLIANCE DATA SUMMARY BY INTERVAL

Interval	Permissive			Clearance			Prohibited			N
	Freq.	Percent	Z	Freq.	Percent	Z	Freq.	Percent	Z	
Before	512	55.3	-1.283	94	10.2	0.193	320	34.6	1.226	926
After	779	58.0		133	9.9		431	32.1		1343

LEGEND:

1. See Appendix B. Signal Design Survey (Message/Operation Study)
   - Q1. When is it safe to start your crossing?
   - Q2. What should you do if you see A? (Where A is the clearance interval indication)
   - Q3. If you had just started to cross the street and you saw A, what should you do?
   - Q4. At some intersections, the WALK signal flashes, at some, it does not. What does the flashing (non-flashing) WALK signal mean here at this intersection?
   - Q5. Would you expect vehicles to be turning into your crosswalk if you crossed during the WALK signal?
2. N = Total number of responses or pedestrians observed.
3. Z = The Z-statistic for a two-tail test of proportions where $Z_{.05} = 1.960$ and $Z_{.01} = 2.576$.

*Significant at .05 level.

**Significant at .01 level.

EXPERIMENT WALK – DONT WALK vs. Hand Symbol

CITY San Francisco **SITE** 1 & 2 Combined

SIGNAL UNDERSTANDING DATA SUMMARY

Question[1]		Correct		N[2]	Z-Value[3]
		Freq.	Percent		
Q1	Before	96	91.4	105	-0.785
	After	98	94.2	104	
Q2	Before	74	70.5	105	-0.734
	After	78	75.0	104	
Q3	Before	75	71.4	105	1.656
	After	63	60.6	104	
Q4	Before	na	na	na	na
	After	na	na	na	
Q5	Before	61	58.1	105	-1.974*
	After	74	71.2	104	

PEDESTRIAN BEHAVIOR DATA SUMMARY

Behavior	Frequency		Percent		Z-Value
	Before	After	Before	After	
B	83	39	3.8	1.5	4.957**
RTV	15	1	0.7	0.0	3.909**
MV	99	3	4.5	0.1	10.465**
TV	161	127	7.3	4.9	3.487**
RVH	23	15	1.0	0.6	1.808
VH	189	112	8.6	4.3	6.049**
N	2203	2588			

CHARACTERISTICS OF PEDESTRIANS SURVEYED

Condition	Sex		Age				
	M	F	0-15	16-30	31-45	46-60	60+
Before	64	41	3	46	23	16	17
After	61	43	12	48	22	8	14

COMPLIANCE DATA SUMMARY BY INTERVAL

Interval	Permissive			Clearance			Prohibited			N
	Freq.	Percent	Z	Freq.	Percent	Z	Freq.	Percent	Z	
Before	1543	70.0	-5.278**	176	8.0	2.947**	484	22.0	3.990**	2203
After	1987	76.8		151	5.8		450	17.4		2588

LEGEND:

1. See Appendix B. Signal Design Survey (Message/Operation Study)
   - Q1. When is it safe to start your crossing?
   - Q2. What should you do if you see A? (Where A is the clearance interval indication)
   - Q3. If you had just started to cross the street and you saw A, what should you do?
   - Q4. At some intersections, the WALK signal flashes, at some, it does not. What does the flashing (non-flashing) WALK signal mean here at this intersection?
   - Q5. Would you expect vehicles to be turning into your crosswalk if you crossed during the WALK signal?
2. N = Total number of responses or pedestrians observed.
3. Z = The Z-statistic for a two-tail test of proportions where $Z_{.05} = 1.960$ and $Z_{.01} = 2.576$.

*Significant at .05 level.

**Significant at .01 level.

EXPERIMENT WALK – DONT WALK vs. Hand Symbol (Red / Green)

CITY San Francisco **SITE** 1 24th & Bryant

SIGNAL UNDERSTANDING DATA SUMMARY

Question[1]		Correct		N[2]	Z-Value[3]
		Freq.	Percent		
Q1	Before	49	90.7	54	-1.610
	After	50	98.0	51	
Q2	Before	37	68.5	54	-1.391
	After	41	80.4	51	
Q3	Before	39	72.2	54	1.446
	After	30	58.8	51	
Q4	Before	na	na	na	na
	After	na	na	na	
Q5	Before	33	61.1	54	1.466
	After	38	74.5	51	

PEDESTRIAN BEHAVIOR DATA SUMMARY

Behavior	Frequency		Percent		Z-Value
	Before	After	Before	After	
B	17	9	3.1	1.2	2.515**
RTV	5	0	0.9	0.0	2.674**
MV	35	0	6.5	0.0	7.144**
TV	38	36	7.0	4.7	1.800
RVH	14	8	2.6	1.0	2.144*
VH	67	26	12.4	3.4	6.239**
N	542	769			

CHARACTERISTICS OF PEDESTRIANS SURVEYED

Condition	Sex		Age				
	M	F	0-15	16-30	31-45	46-60	60+
Before	28	26	1	31	10	7	5
After	30	21	7	27	9	5	3

COMPLIANCE DATA SUMMARY BY INTERVAL

Interval	Permissive			Clearance			Prohibited			N
	Freq.	Percent	Z	Freq.	Percent	Z	Freq.	Percent	Z	
Before	401	74.0	-4.200**	33	6.1	2.595**	108	19.9	3.170**	542
After	642	83.5		24	3.1		103	13.4		769

LEGEND:

1. See Appendix B. Signal Design Survey (Message/Operation Study)
   - Q1. When is it safe to start your crossing?
   - Q2. What should you do if you see A? (Where A is the clearance interval indication)
   - Q3. If you had just started to cross the street and you saw A, what should you do?
   - Q4. At some intersections, the WALK signal flashes, at some, it does not. What does the flashing (non-flashing) WALK signal mean here at this intersection?
   - Q5. Would you expect vehicles to be turning into your crosswalk if you crossed during the WALK signal?
2. N = Total number of responses or pedestrians observed.
3. Z = The Z-statistic for a two-tail test of proportions where $Z_{.05} = 1.960$ and $Z_{.01} = 2.576$.

*Significant at .05 level.

**Significant at .01 level.

EXPERIMENT WALK – DONT WALK vs. Hand Symbol (Orange / White)

CITY San Francisco **SITE** 2 Stockton & Vallejo

SIGNAL UNDERSTANDING DATA SUMMARY

Question[1]		Correct		N[2]	Z-Value[3]
		Freq.	Percent		
Q1	Before	47	92.2	51	.288
	After	48	90.6	53	
Q2	Before	37	72.5	51	.308
	After	37	69.8	53	
Q3	Before	36	70.6	51	.898
	After	33	62.3	53	
Q4	Before	na	na	na	na
	After	na	na	na	
Q5	Before	28	54.9	51	-1.365
	After	36	67.9	53	

PEDESTRIAN BEHAVIOR DATA SUMMARY

Behavior	Frequency		Percent		Z-Value
	Before	After	Before	After	
B	66	30	4.0	1.6	4.188**
RTV	10	1	.6	.05	2.883**
MV	64	3	3.9	.16	7.917**
TV	123	91	7.4	5.0	2.948**
RVH	9	7	.5	.4	.689
VH	122	86	7.3	4.7	3.254**
N	1661	1819			

CHARACTERISTICS OF PEDESTRIANS SURVEYED

Condition	Sex		Age				
	M	F	0-15	16-30	31-45	46-60	60+
Before	36	15	2	15	13	9	12
After	31	22	5	21	13	3	11

COMPLIANCE DATA SUMMARY BY INTERVAL

Interval	Permissive			Clearance			Prohibited			N
	Freq.	Percent	Z	Freq.	Percent	Z	Freq.	Percent	Z	
Before	1142	68.8	-3.386**	143	8.6	1.793	376	22.6	2.586**	1661
After	1345	73.9		127	7.0		347	19.1		1819

LEGEND:

1. See Appendix B. Signal Design Survey (Message/Operation Study)
   - Q1. When is it safe to start your crossing?
   - Q2. What should you do if you see A? (Where A is the clearance interval indication)
   - Q3. If you had just started to cross the street and you saw A, what should you do?
   - Q4. At some intersections, the WALK signal flashes, at some, it does not. What does the flashing (non-flashing) WALK signal mean here at this intersection?
   - Q5. Would you expect vehicles to be turning into your crosswalk if you crossed during the WALK signal?
2. N = Total number of responses or pedestrians observed.
3. Z = The Z-statistic for a two-tail test of proportions where $Z_{.05} = 1.960$ and $Z_{.01} = 2.576$.

*Significant at .05 level.

**Significant at .01 level.

EXPERIMENT WALK – DONT WALK vs. Standing Man Symbol

CITY Memphis **SITE** 1 & 2 Combined

SIGNAL UNDERSTANDING DATA SUMMARY

Question[1]		Correct		N[2]	Z-Value[3]
		Freq.	Percent		
Q1	Before	93	90.3	103	2.066*
	After	80	80.0	100	
Q2	Before	87	84.5	103	-.308
	After	86	86.0	100	
Q3	Before	46	44.7	103	.963
	After	38	38.0	100	
Q4	Before	na	na	na	na
	After	na	na	na	
Q5	Before	67	65.0	103	-.445
	After	68	68.0	100	

PEDESTRIAN BEHAVIOR DATA SUMMARY

Behavior	Frequency		Percent		Z-Value
	Before	After	Before	After	
B	7	25	1.4	4.0	-2.529*
RTV	3	2	.6	.3	.736
MV	1	6	.2	.9	-1.576
TV	41	54	8.2	8.4	-.118
RVH	2	4	.4	.6	-.515
VH	5	19	1.0	3.0	-2.286*
N	499	642			

CHARACTERISTICS OF PEDESTRIANS SURVEYED

Condition	Sex		Age				
	M	F	0-15	16-30	31-45	46-60	60+
Before	53	50	2	60	9	16	16
After	46	54	3	42	16	22	17

COMPLIANCE DATA SUMMARY BY INTERVAL

Interval	Permissive			Clearance			Prohibited			N
	Freq.	Percent	Z	Freq.	Percent	Z	Freq.	Percent	Z	
Before	419	84.0	-1.884	34	6.8	2.918**	46	9.2	0.107	499
After	564	87.9		20	3.1		58	9.0		642

LEGEND:

1. See Appendix B. Signal Design Survey (Message/Operation Study)
   - Q1. When is it safe to start your crossing?
   - Q2. What should you do if you see A? (Where A is the clearance interval indication)
   - Q3. If you had just started to cross the street and you saw A, what should you do?
   - Q4. At some intersections, the WALK signal flashes, at some, it does not. What does the flashing (non-flashing) WALK signal mean here at this intersection?
   - Q5. Would you expect vehicles to be turning into your crosswalk if you crossed during the WALK signal?
2. N = Total number of responses or pedestrians observed.
3. Z = The Z-statistic for a two-tail test of proportions where $Z_{.05} = 1.960$ and $Z_{.01} = 2.576$.

*Significant at .05 level.

**Significant at .01 level.

EXPERIMENT WALK – DONT WALK vs. Standing Man Symbol (Red / Green)

CITY Memphis **SITE** 1 Madison & Cleveland

SIGNAL UNDERSTANDING DATA SUMMARY

Question[1]		Correct		N[2]	Z-Value[3]
		Freq.	Percent		
Q1	Before	46	90.2	51	-0.737
	After	48	94.1	51	
Q2	Before	45	88.2	51	-0.666
	After	47	92.2	51	
Q3	Before	17	33.3	51	-0.209
	After	18	35.3	51	
Q4	Before	na	na	na	na
	After	na	na	na	
Q5	Before	33	64.7	51	-0.420
	After	35	68.6	51	

PEDESTRIAN BEHAVIOR DATA SUMMARY

Behavior	Frequency		Percent		Z-Value
	Before	After	Before	After	
B	2	10	1.0	3.7	-1.867
RTV	2	1	1.0	0.4	0.831
MV	0	3	0.0	1.1	-1.511
TV	13	24	6.4	8.9	-1.008
RVH	0	2	0.0	0.7	-1.232
VH	2	5	1.0	1.9	-0.778
N	203	269			

CHARACTERISTICS OF PEDESTRIANS SURVEYED

Condition	Sex		Age				
	M	F	0-15	16-30	31-45	46-60	60+
Before	20	31	2	32	5	7	5
After	24	27	0	22	7	14	8

COMPLIANCE DATA SUMMARY BY INTERVAL

Interval	Permissive			Clearance			Prohibited			N
	Freq.	Percent	Z	Freq.	Percent	Z	Freq.	Percent	Z	
Before	169	83.3	-0.669	12	5.9	1.811	22	10.8	-0.358	203
After	230	85.5		7	2.6		32	11.9		269

LEGEND:

1. See Appendix B. Signal Design Survey (Message/Operation Study)
   - Q1. When is it safe to start your crossing?
   - Q2. What should you do if you see A? (Where A is the clearance interval indication)
   - Q3. If you had just started to cross the street and you saw A, what should you do?
   - Q4. At some intersections, the WALK signal flashes, at some, it does not. What does the flashing (non-flashing) WALK signal mean here at this intersection?
   - Q5. Would you expect vehicles to be turning into your crosswalk if you crossed during the WALK signal?
2. N = Total number of responses or pedestrians observed.
3. Z = The Z-statistic for a two-tail test of proportions where $Z_{.05} = 1.960$ and $Z_{.01} = 2.576$.

* Significant at .05 level.

** Significant at .01 level.

EXPERIMENT WALK – DONT WALK vs. Standing Man Symbol (Orange / White)

CITY Memphis **SITE** 2 Poplar & Cleveland

SIGNAL UNDERSTANDING DATA SUMMARY

Question[1]		Correct		N[2]	Z-Value[3]
		Freq.	Percent		
Q1	Before	47	90.4	52	3.052**
	After	32	65.3	49	
Q2	Before	42	80.8	52	0.148
	After	39	79.6	49	
Q3	Before	29	55.8	52	1.298
	After	21	42.9	49	
Q4	Before	na	na	na	na
	After	na	na	na	
Q5	Before	34	65.4	52	-0.209
	After	33	67.3	49	

PEDESTRIAN BEHAVIOR DATA SUMMARY

Behavior	Frequency		Percent		Z-Value
	Before	After	Before	After	
B	5	15	1.7	4.0	-1.759
RTV	1	1	0.3	0.3	0.164
MV	1	3	0.3	0.8	-0.777
TV	28	30	9.6	8.0	0.688
RVH	2	2	0.7	0.5	0.232
VH	3	14	1.0	3.8	-2.237*
N	296	373			

CHARACTERISTICS OF PEDESTRIANS SURVEYED

Condition	Sex		Age				
	M	F	0-15	16-30	31-45	46-60	60+
Before	33	19	0	28	4	9	11
After	22	27	3	20	9	8	9

COMPLIANCE DATA SUMMARY BY INTERVAL

Interval	Permissive			Clearance			Prohibited			N
	Freq.	Percent	Z	Freq.	Percent	Z	Freq.	Percent	Z	
Before	250	84.5	-1.961*	22	7.4	2.277*	24	8.1	0.556	296
After	334	89.5		13	3.5		26	7.0		373

LEGEND:

1. See Appendix B. Signal Design Survey (Message/Operation Study)
   - Q1. When is it safe to start your crossing?
   - Q2. What should you do if you see A? (Where A is the clearance interval indication)
   - Q3. If you had just started to cross the street and you saw A, what should you do?
   - Q4. At some intersections, the WALK signal flashes, at some, it does not. What does the flashing (non-flashing) WALK signal mean here at this intersection?
   - Q5. Would you expect vehicles to be turning into your crosswalk if you crossed during the WALK signal?
2. N = Total number of responses or pedestrians observed.
3. Z = The Z-statistic for a two-tail test of proportions where $Z_{.05} = 1.960$ and $Z_{.01} = 2.576$.

*Significant at .05 level.

**Significant at .01 level.

EXPERIMENT WALK – DONT WALK vs. Standing Man Symbol

CITY Colorado Springs **SITE** 1 & 2 Combined

SIGNAL UNDERSTANDING DATA SUMMARY

Question[1]		Correct		N[2]	Z-Value[3]
		Freq.	Percent		
Q1	Before	99	95.2	104	-2.253*
	After	103	100.0	103	
Q2	Before	90	86.5	104	-0.843
	After	93	90.3	103	
Q3	Before	87	83.7	104	1.418
	After	78	75.7	103	
Q4	Before	na	na	na	na
	After	na	na	na	
Q5	Before	53	51.0	104	-0.777
	After	58	56.3	103	

PEDESTRIAN BEHAVIOR DATA SUMMARY

Behavior	Frequency		Percent		Z-Value
	Before	After	Before	After	
B	18	42	2.0	5.7	-3.950**
RTV	28	24	3.1	3.3	-0.154
MV	25	34	2.8	4.6	-1.969*
TV	185	222	20.7	30.3	-4.420**
RVH	16	16	17.9	21.8	-0.562
VH	14	22	1.6	3.0	-1.952
N	892	733			

CHARACTERISTICS OF PEDESTRIANS SURVEYED

Condition	Sex		Age				
	M	F	0-15	16-30	31-45	46-60	60+
Before	58	46	2	41	23	22	16
After	67	36	1	41	26	26	9

COMPLIANCE DATA SUMMARY BY INTERVAL

Interval	Permissive			Clearance			Prohibited			N
	Freq.	Percent	Z	Freq.	Percent	Z	Freq.	Percent	Z	
Before	601	67.4	-4.324**	167	18.7	2.985**	124	13.9	2.602**	892
After	565	77.1		97	13.2		71	9.7		733

LEGEND:

1. See Appendix B. Signal Design Survey (Message/Operation Study)
   - Q1. When is it safe to start your crossing?
   - Q2. What should you do if you see A? (Where A is the clearance interval indication)
   - Q3. If you had just started to cross the street and you saw A, what should you do?
   - Q4. At some intersections, the WALK signal flashes, at some, it does not. What does the flashing (non-flashing) WALK signal mean here at this intersection?
   - Q5. Would you expect vehicles to be turning into your crosswalk if you crossed during the WALK signal?
2. N = Total number of responses or pedestrians observed.
3. Z = The Z-statistic for a two-tail test of proportions where $Z_{.05} = 1.960$ and $Z_{.01} = 2.576$.

*Significant at .05 level.

**Significant at .01 level.

EXPERIMENT WALK – DONT WALK vs. Standing Man Symbol (Red / Green)

CITY Colorado Springs **SITE** 1 Colorado & Nevada

SIGNAL UNDERSTANDING DATA SUMMARY

Question[1]		Correct		N[2]	Z-Value[3]
		Freq.	Percent		
Q1	Before	48	92.3	52	-2.040
	After	52	100.0	52	
Q2	Before	44	84.6	52	-0.889
	After	47	90.4	52	
Q3	Before	48	92.3	52	1.954
	After	41	78.8	52	
Q4	Before	na	na	na	na
	After	na	na	na	
Q5	Before	27	51.9	52	-0.990
	After	32	61.5	52	

PEDESTRIAN BEHAVIOR DATA SUMMARY

Behavior	Frequency		Percent		Z-Value
	Before	After	Before	After	
B	3	7	1.3	3.7	-1.672
RTV	6	6	2.5	3.2	-0.421
MV	3	10	1.3	5.3	-2.424*
TV	35	44	14.6	23.3	-2.307*
RVH	3	7	1.3	3.7	-1.672
VH	7	8	2.9	4.2	-0.737
N	240	189			

CHARACTERISTICS OF PEDESTRIANS SURVEYED

Condition	Sex		Age				
	M	F	0-15	16-30	31-45	46-60	60+
Before	30	22	1	20	16	7	8
After	31	21	0	20	16	10	6

COMPLIANCE DATA SUMMARY BY INTERVAL

Interval	Permissive			Clearance			Prohibited			N
	Freq.	Percent	Z	Freq.	Percent	Z	Freq.	Percent	Z	
Before	138	57.5	-2.977**	53	22.1	1.762	49	20.4	1.957	240
After	135	71.4		29	15.3		25	13.2		189

LEGEND:

1. See Appendix B. Signal Design Survey (Message/Operation Study)
   - Q1. When is it safe to start your crossing?
   - Q2. What should you do if you see A? (Where A is the clearance interval indication)
   - Q3. If you had just started to cross the street and you saw A, what should you do?
   - Q4. At some intersections, the WALK signal flashes, at some, it does not. What does the flashing (non-flashing) WALK signal mean here at this intersection?
   - Q5. Would you expect vehicles to be turning into your crosswalk if you crossed during the WALK signal?
2. N = Total number of responses or pedestrians observed.
3. Z = The Z-statistic for a two-tail test of proportions where $Z_{.05} = 1.960$ and $Z_{.01} = 2.576$.

*Significant at .05 level.

**Significant at .01 level.

EXPERIMENT WALK – DONT WALK vs. Standing Man Symbol (Orange / White)

CITY Colorado Springs **SITE** 2 Pikes Peak & Nevada

SIGNAL UNDERSTANDING DATA SUMMARY

Question[1]		Correct		N[2]	Z-Value[3]
		Freq.	Percent		
Q1	Before	51	98.1	52	-0.995
	After	51	100.0	51	
Q2	Before	46	88.5	52	-0.285
	After	46	90.2	51	
Q3	Before	39	75.0	52	0.283
	After	37	72.5	51	
Q4	Before	na	na	na	na
	After	na	na	na	
Q5	Before	26	50.0	52	-0.099
	After	26	51.0	51	

PEDESTRIAN BEHAVIOR DATA SUMMARY

Behavior	Frequency		Percent		Z-Value
	Before	After	Before	After	
B	15	35	2.3	6.4	-3.557**
RTV	22	18	3.4	3.3	0.063
MV	22	24	3.4	4.4	-0.929
TV	150	136	23.0	25.0	-0.805
RVH	13	9	2.0	1.7	0.435
VH	7	13	1.1	2.4	-1.768
N	652	544			

CHARACTERISTICS OF PEDESTRIANS SURVEYED

Condition	Sex		Age				
	M	F	0-15	16-30	31-45	46-60	60+
Before	28	24	1	21	7	15	8
After	36	15	1	21	10	16	3

COMPLIANCE DATA SUMMARY BY INTERVAL

Interval	Permissive			Clearance			Prohibited			N
	Freq.	Percent	Z	Freq.	Percent	Z	Freq.	Percent	Z	
Before	463	71.0	-3.180**	114	17.5	2.390*	75	11.5	1.740	652
After	430	79.0		68	12.5		46	8.4		544

LEGEND:

1. See Appendix B. Signal Design Survey (Message/Operation Study)
   - Q1. When is it safe to start your crossing?
   - Q2. What should you do if you see A? (Where A is the clearance interval indication)
   - Q3. If you had just started to cross the street and you saw A, what should you do?
   - Q4. At some intersections, the WALK signal flashes, at some, it does not. What does the flashing (non-flashing) WALK signal mean here at this intersection?
   - Q5. Would you expect vehicles to be turning into your crosswalk if you crossed during the WALK signal?
2. N = Total number of responses or pedestrians observed.
3. Z = The Z-statistic for a two-tail test of proportions where $Z_{.05} = 1.960$ and $Z_{.01} = 2.576$.

* Significant at .05 level.

** Significant at .01 level.

EXPERIMENT Validation of WALK – DONT WALK vs. Hand Symbol

CITY Milwaukee **SITE** 1 & 2 Combined

SIGNAL UNDERSTANDING DATA SUMMARY

Question[1]		Correct		N[2]	Z-Value[3]
		Freq.	Percent		
Q1	Before	97	95.1	102	-1.146
	After	99	98.0	101	
Q2	Before	86	84.3	102	0.408
	After	83	82.2	101	
Q3	Before	86	84.3	102	-0.573
	After	88	87.1	101	
Q4	Before	na	na	na	na
	After	na	na	na	
Q5	Before	61	59.8	102	-1.876
	After	73	72.3	101	

PEDESTRIAN BEHAVIOR DATA SUMMARY

Behavior	Frequency		Percent		Z-Value
	Before	After	Before	After	
B	11	15	3.1	4.0	-0.658
RTV	2	1	0.6	0.3	0.669
MV	17	4	4.8	1.1	3.055**
TV	49	31	13.8	8.2	2.431*
RVH	8	2	2.3	0.5	2.067*
VH	5	12	1.4	3.2	-1.625
N	354	376			

CHARACTERISTICS OF PEDESTRIANS SURVEYED

Condition	Sex		Age				
	M	F	0-15	16-30	31-45	46-60	60+
Before	49	53	25	26	10	17	24
After	43	58	19	34	13	18	17

COMPLIANCE DATA SUMMARY BY INTERVAL

Interval	Permissive			Clearance			Prohibited			N
	Freq.	Percent	Z	Freq.	Percent	Z	Freq.	Percent	Z	
Before	280	79.1	0.124	22	6.2	0.694	52	14.7	-0.576	354
After	296	78.7		19	5.1		61	16.2		376

LEGEND:

1. See Appendix B Signal Design Survey (Message/Operation Study)
   - Q1. When is it safe to start your crossing?
   - Q2. What should you do if you see A? (Where A is the clearance interval indication)
   - Q3. If you had just started to cross the street and you saw A, what should you do?
   - Q4. At some intersections, the WALK signal flashes, at some, it does not. What does the flashing (non-flashing) WALK signal mean here at this intersection?
   - Q5. Would you expect vehicles to be turning into your crosswalk if you crossed during the WALK signal?
2. N = Total number of responses or pedestrians observed.
3. Z = The Z-statistic for a two-tail test of proportions where $Z_{.05} = 1.960$ and $Z_{.01} = 2.576$.

*Significant at .05 level.

**Significant at .01 level.

EXPERIMENT Validation of WALK – DONT WALK vs. Hand Symbol (Orange / White)

CITY Milwaukee **SITE** 1 16th & Mitchell

SIGNAL UNDERSTANDING DATA SUMMARY

Question[1]		Correct		N[2]	Z-Value[3]
		Freq.	Percent		
Q1	Before	51	98.1	52	0.620
	After	48	96.0	50	
Q2	Before	45	86.5	52	0.362
	After	42	84.0	50	
Q3	Before	45	86.5	52	0.079
	After	43	86.0	50	
Q4	Before	na	na	na	na
	After	na	na	na	
Q5	Before	35	67.3	52	1.576
	After	26	52.0	50	

PEDESTRIAN BEHAVIOR DATA SUMMARY

Behavior	Frequency		Percent		Z-Value
	Before	After	Before	After	
B	10	10	4.7	4.2	0.246
RTV	1	1	0.5	0.4	0.088
MV	14	4	6.6	1.7	2.664**
TV	33	21	15.6	8.9	2.176*
RVH	5	2	2.4	0.8	1.325
VH	4	7	1.9	3.0	-0.745
N	212	236			

CHARACTERISTICS OF PEDESTRIANS SURVEYED

Condition	Sex		Age				
	M	F	0-15	16-30	31-45	46-60	60+
Before	26	26	9	16	6	8	13
After	22	28	5	23	4	10	8

COMPLIANCE DATA SUMMARY BY INTERVAL

Interval	Permissive			Clearance			Prohibited			N
	Freq.	Percent	Z	Freq.	Percent	Z	Freq.	Percent	Z	
Before	159	75.0	0.308	10	4.7	-0.182	43	20.3	-0.236	212
After	174	73.7		12	5.1		50	21.2		236

LEGEND:

1. See Appendix B. Signal Design Survey (Message/Operation Study)
   - Q1. When is it safe to start your crossing?
   - Q2. What should you do if you see A? (Where A is the clearance interval indication)
   - Q3. If you had just started to cross the street and you saw A, what should you do?
   - Q4. At some intersections, the WALK signal flashes, at some, it does not. What does the flashing (non-flashing) WALK signal mean here at this intersection?
   - Q5. Would you expect vehicles to be turning into your crosswalk if you crossed during the WALK signal?
2. N = Total number of responses or pedestrians observed.
3. Z = The Z-statistic for a two-tail test of proportions where $Z_{.05} = 1.960$ and $Z_{.01} = 2.576$.

*Significant at .05 level.

**Significant at .01 level.

EXPERIMENT Validation of WALK – DONT WALK vs. Hand Symbol (Red / Green)

CITY Milwaukee **SITE** 2 55th & North

SIGNAL UNDERSTANDING DATA SUMMARY

Question[1]		Correct		N[2]	Z-Value[3]
		Freq.	Percent		
Q1	Before	46	92.0	50	-2.066**
	After	51	100.0	51	
Q2	Before	41	82.0	50	0.207
	After	41	80.4	51	
Q3	Before	41	82.0	50	-0.882
	After	45	88.2	51	
Q4	Before	na	na	na	na
	After	na	na	na	
Q5	Before	26	52.0	50	-4.509**
	After	47	92.2	51	

PEDESTRIAN BEHAVIOR DATA SUMMARY

Behavior	Frequency		Percent		Z-Value
	Before	After	Before	After	
B	1	5	0.7	3.6	-1.684
RTV	1	0	0.7	0.0	1.114
MV	3	0	2.1	0.0	1.785
TV	16	10	11.3	7.1	1.201
RVH	3	0	2.1	0.0	1.785
VH	1	5	0.7	3.6	-1.684
N	142	140			

CHARACTERISTICS OF PEDESTRIANS SURVEYED

Condition	Sex		Age				
	M	F	0-15	16-30	31-45	46-60	60+
Before	23	27	16	10	4	9	11
After	21	30	14	11	9	8	21

COMPLIANCE DATA SUMMARY BY INTERVAL

Interval	Permissive			Clearance			Prohibited			N
	Freq.	Percent	Z	Freq.	Percent	Z	Freq.	Percent	Z	
Before	121	85.2	-0.471	12	8.4	1.157	9	6.3	-0.498	142
After	122	87.1		7	5.0		11	7.9		140

LEGEND:

1. See Appendix B. Signal Design Survey (Message/Operation Study)
   - Q1. When is it safe to start your crossing?
   - Q2. What should you do if you see A? (Where A is the clearance interval indication)
   - Q3. If you had just started to cross the street and you saw A, what should you do?
   - Q4. At some intersections, the WALK signal flashes, at some, it does not. What does the flashing (non-flashing) WALK signal mean here at this intersection?
   - Q5. Would you expect vehicles to be turning into your crosswalk if you crossed during the WALK signal?
2. N = Total number of responses or pedestrians observed.
3. Z = The Z-statistic for a two-tail test of proportions where $Z_{.05} = 1.960$ and $Z_{.01} = 2.576$.

*Significant at .05 level.

**Significant at .01 level.

EXPERIMENT Validation of WALK – DONT WALK vs. Hand Symbol

CITY Greensboro **SITE** 1 & 2 Combined

SIGNAL UNDERSTANDING DATA SUMMARY

Question[1]		Correct		N[2]	Z-Value[3]
		Freq.	Percent		
Q1	Before	95	94.1	101	1.066
	After	90	90.0	100	
Q2	Before	89	88.1	101	1.399
	After	81	81.0	100	
Q3	Before	39	38.6	101	0.383
	After	36	36.0	100	
Q4	Before	na	na	na	na
	After	na	na	na	
Q5	Before	56	55.4	101	1.533
	After	66	66.0	100	

PEDESTRIAN BEHAVIOR DATA SUMMARY

Behavior	Frequency		Percent		Z-Value
	Before	After	Before	After	
B	28	16	6.3	3.6	1.909
RTV	3	0	0.7	0.0	2.127*
MV	36	30	8.1	6.7	0.785
TV	11	19	2.5	4.2	-1.508
RVH	5	5	1.1	1.1	0.005
VH	10	14	2.2	3.1	-0.848
N	446	447			

CHARACTERISTICS OF PEDESTRIANS SURVEYED

Condition	Sex		Age				
	M	F	0-15	16-30	31-45	46-60	60+
Before	61	40	6	35	23	27	10
After	54	46	4	43	28	17	8

COMPLIANCE DATA SUMMARY BY INTERVAL

Interval	Permissive			Clearance			Prohibited			N
	Freq.	Percent	Z	Freq.	Percent	Z	Freq.	Percent	Z	
Before	208	46.6	0.708	37	8.3	1.044	201	45.1	0.165	446
After	219	49.0		29	6.5		199	44.5		447

LEGEND:

1. See Appendix B. Signal Design Survey (Message/Operation Study)
   - Q1. When is it safe to start your crossing?
   - Q2. What should you do if you see A? (Where A is the clearance interval indication)
   - Q3. If you had just started to cross the street and you saw A, what should you do?
   - Q4. At some intersections, the WALK signal flashes, at some, it does not. What does the flashing (non-flashing) WALK signal mean here at this intersection?
   - Q5. Would you expect vehicles to be turning into your crosswalk if you crossed during the WALK signal?
2. N = Total number of responses or pedestrians observed.
3. Z = The Z-statistic for a two-tail test of proportions where $Z_{.05} = 1.960$ and $Z_{.01} = 2.576$.

*Significant at .05 level.

**Significant at .01 level.

EXPERIMENT Validation of WALK – DONT WALK vs. Hand Symbol (Orange / White)

CITY Greensboro **SITE** 1 Washington & Elm

SIGNAL UNDERSTANDING DATA SUMMARY

Question[1]		Correct		N[2]	Z-Value[3]
		Freq.	Percent		
Q1	Before	48	94.1	51	2.119*
	After	40	80.0	50	
Q2	Before	45	88.2	51	-1.018
	After	47	94.0	50	
Q3	Before	22	43.1	51	1.156
	After	16	42.0	50	
Q4	Before	na	na	na	na
	After	na	na	na	
Q5	Before	30	58.8	51	1.291
	After	23	46.0	50	

PEDESTRIAN BEHAVIOR DATA SUMMARY

Behavior	Frequency		Percent		Z-Value
	Before	After	Before	After	
B	18	15	5.3	4.7	0.372
RTV	1	0	0.3	0.0	0.000
MV	32	18	9.4	5.6	1.861
TV	6	15	1.8	4.7	-2.176*
RVH	3	0	0.9	0.0	1.978*
VH	8	12	2.4	3.8	-1.068
N	339	320			

CHARACTERISTICS OF PEDESTRIANS SURVEYED

Condition	Sex		Age				
	M	F	0-15	16-30	31-45	46-60	60+
Before	29	22	4	18	11	10	8
After	27	23	4	28	9	5	4

COMPLIANCE DATA SUMMARY BY INTERVAL

Interval	Permissive			Clearance			Prohibited			N
	Freq.	Percent	Z	Freq.	Percent	Z	Freq.	Percent	Z	
Before	153	45.1	0.196	29	8.6	0.350	157	46.3	-0.387	339
After	142	44.4		25	7.8		153	47.8		320

LEGEND:

1. See Appendix B. Signal Design Survey (Message/Operation Study)
   - Q1. When is it safe to start your crossing?
   - Q2. What should you do if you see A? (Where A is the clearance interval indication)
   - Q3. If you had just started to cross the street and you saw A, what should you do?
   - Q4. At some intersections, the WALK signal flashes, at some, it does not. What does the flashing (non-flashing) WALK signal mean here at this intersection?
   - Q5. Would you expect vehicles to be turning into your crosswalk if you crossed during the WALK signal?
2. N = Total number of responses or pedestrians observed.
3. Z = The Z-statistic for a two-tail test of proportions where $Z_{.05} = 1.960$ and $Z_{.01} = 2.576$.

*Significant at .05 level.

**Significant at .01 level.

EXPERIMENT Validation of WALK – DONT WALK vs. Hand Symbol (Red / Green)

CITY Greensboro **SITE** 2 Elm & Lindsey

SIGNAL UNDERSTANDING DATA SUMMARY

Question[1]		Correct		N[2]	Z-Value[3]
		Freq.	Percent		
Q1	Before	47	94.0	50	-1.762
	After	50	100.0	50	
Q2	Before	44	88.0	50	2.415*
	After	34	68.0	50	
Q3	Before	17	34.0	50	-0.622
	After	20	40.0	50	
Q4	Before	na	na	na	na
	After	na	na	na	
Q5	Before	26	52.0	50	-3.677**
	After	43	86.0	50	

PEDESTRIAN BEHAVIOR DATA SUMMARY

Behavior	Frequency		Percent		Z-Value
	Before	After	Before	After	
B	10	1	9.3	0.8	3.085**
RTV	2	0	1.9	0.0	0.717
MV	4	12	3.7	9.4	-1.730
TV	5	4	4.7	3.1	0.607
RVH	2	5	1.9	1.6	-0.934
VH	2	2	1.9	1.6	0.176
N	107	127			

CHARACTERISTICS OF PEDESTRIANS SURVEYED

Condition	Sex		Age				
	M	F	0-15	16-30	31-45	46-60	60+
Before	32	18	2	17	12	17	2
After	27	23	0	15	19	12	4

COMPLIANCE DATA SUMMARY BY INTERVAL

Interval	Permissive			Clearance			Prohibited			N
	Freq.	Percent	Z	Freq.	Percent	Z	Freq.	Percent	Z	
Before	55	51.4	1.419	8	7.5	1.502	44	41.1	0.768	107
After	77	60.6		4	3.1		46	36.2		127

LEGEND:

1. See Appendix B. Signal Design Survey (Message/Operation Study)
   - Q1. When is it safe to start your crossing?
   - Q2. What should you do if you see A? (Where A is the clearance interval indication)
   - Q3. If you had just started to cross the street and you saw A, what should you do?
   - Q4. At some intersections, the WALK signal flashes, at some, it does not. What does the flashing (non-flashing) WALK signal mean here at this intersection?
   - Q5. Would you expect vehicles to be turning into your crosswalk if you crossed during the WALK signal?
2. N = Total number of responses or pedestrians observed.
3. Z = The Z-statistic for a two-tail test of proportions where $Z_{.05} = 1.960$ and $Z_{.01} = 2.576$.

*Significant at .05 laval.

**Significant at .01 level.

TRAFFIC VOLUME DATA ANALYSIS SUMMARY

Experiment WALK – DONT WALK vs. Circle Slash Symbol

City Buffalo

Site 2A Broadway & Michigan

Time	After	Before
8:00 AM	39	30
10:00	44	25
10:20	33	16
10:40	33	16
10:55	24	19
11:15	21	13
11:35	28	28
11:50	32	21
1:20 PM	35	22
1:40	24	26
1:55	23	27
2:35	26	24
2:50	31	28
3:10	44	37
3:30	27	29

A = 0.140
d.f. = 14
Significant at 0.01 level

Site 3A Fillmore & Broadway

Time	Before	After
8:15 AM	30	37
10:00	26	35
1:40 PM	35	32
2:00	30	33
2:45	36	44
3:10	41	41
3:55	31	43

A = 0.275
d.f. = 6
Signigicant at 0.05 level

NOTE: Volumes shown are total counts of traffic on all approaches for one signal cycle.

TRAFFIC VOLUME DATA ANALYSIS SUMMARY

Experiment WALK – DONT WALK vs. Circle Slash Symbol

City Tempe

Site 7 Fifth & Mill

Time	Before	After
7:59 AM	18	62
8:15	24	59
8:30	30	20
9:00	25	34
9:18	35	43
10:05	34	32
10:20	33	45
10:38	36	32
2:00 PM	48	54
3:30	58	63
3:50	54	36

A = 0.547
d.f. = 10
Not Significant

Site 9 Forest & University

Time	Before	After
8:10 AM	31	24
8:25	29	27
8:50	35	25
10:00	27	15
10:15	29	29
10:30	33	39
10:40	38	41
11:00	25	31
1:20 PM	40	50
1:40	28	29
1:55	29	30
2:40	39	34
3:00	30	36
3:25	25	59
3:40	47	28
3:53	44	49
4:15	46	46
4:35	32	47

A = 2.254
d.f. = 17
Not Significant

NOTE: Volumes shown are total counts of traffic on all approaches for one signal cycle.

TRAFFIC VOLUME DATA ANALYSIS SUMMARY

Experiment WALK – DONT WALK vs. Hand Symbol

City Baltimore

Site 1 Broadway & Eastern

Time	Before	After
7:50 AM	23	33
8:30	27	34
9:35	29	27
10:05	36	41
10:30	28	22
10:50	31	25
11:10	29	28
1:35 PM	31	37
2:20	22	29
2:40	27	34
3:00	45	49
3:20	43	61
3:40	37	45

A = 0.243
d.f. = 12
Significant at 0.05 level

Site 2 Eastern & Conkling

Time	Before	After
7:55 AM	49	27
8:20	48	28
10:25	22	34
10:40	26	23
11:05	26	34
11:30	25	27
1:15 PM	38	25
2:00	29	28
2:44	36	32
3:10	40	28
3:30	39	40

A = 0.531
d.f. = 10
Not Siginificant

NOTE: Volumes shown are total counts of traffic on all approaches for one signal cycle.

TRAFFIC VOLUME DATA ANALYSIS SUMMARY

Experiment WALK – DONT WALK vs. Hand Symbol

City San Francisco

Site 1 24th & Bryant

Time	Before	After
8:10 AM	15	12
8:30	20	16
9:50	10	9
10:10	6	14
10:30	11	8
10:55	10	16
11:15	17	14
1:20 PM	17	10
1:45	5	10
2:30	16	20
2:50	12	9
3:15	15	9
4:00	18	14
4:20	23	19
4:40	11	18

A = 2.204
d.f. = 14
Not significant

Site 2 Vallejo & Stockton

Time	Before	After
9:35 AM	14	13
9:50	16	7
10:20	16	14
10:40	8	10
11:00	11	10
11:30	24	12
1:15 PM	18	13
1:40	15	21
3:40	13	11
4:05	21	12
4:30	10	26

A = 5.625
d.f. = 10
Not significant

NOTE: Volumes shown are total counts of traffic on all approaches for one signal cycle.

TRAFFIC VOLUME DATA ANALYSIS SUMMARY

Experiment WALK – DONT WALK vs. Standing Man Symbol

City Colorado Springs

Site 1 Colorado & Nevada

Time	Before	After
8:00 AM	28	61
8:35	42	42
10:00	50	44
10:20	45	55
10:45	34	61
11:10	45	56
1:40 PM	55	50
3:45	69	75

A = 0.370
d.f. = 7
Significant at 0.10 level

Site 2 Peak & Nevada

Time	Before	After
8:05 AM	27	54
8:30	37	52
10:00	41	47
10:30	45	43
11:00	48	56
1:50 PM	62	74
2:20	55	64
3:00	45	71
3:40	74	85
4:10	83	76

A = 0.193
d.f. = 9
Significant at 0.01 level

NOTE: Volumes shown are total counts of traffic on all approaches for one signal cycle.

TRAFFIC VOLUME DATA ANALYSIS SUMMARY

Experiment WALK – DONT WALK vs. Standing Man

City Memphis

Site 1 Madison & Cleveland

Time	Before	After
10:10 AM	33	36
10:35	42	30
8:10	69	33
11:10	56	36
11:30	60	46
11:50	70	50
1:50 PM	65	75

A = 0.321
d.f. = 6
Significant at 0.05 level

Site 2 Poplar & Cleveland

Time	Before	After
8:00 AM	92	68
8:25	64	44
9:50	47	48
10:10	50	50
10:30	67	47
10:55	69	68
11:20	79	49
1:20 PM	76	58
1:40	61	62
1:50	86	57
2:30	68	55
2:50	86	83
3:12	75	72
3:35	78	88
4:00	69	82

A = 0.211
d.f. = 14
Significant at 0.05 level

NOTE: Volumes shown are total counts of traffic on all approaches for one signal cycle.

TRAFFIC VOLUME DATA ANALYSIS SUMMARY

Experiment Validation of WALK – DONT WALK vs. Hand Symbol

City Greensboro

Site 1 Elm & Washington

Time	Before	After
8:00 AM	12	17
8:20	18	18
8:40	17	5
9:35	11	8
9:55	20	10
10:15	8	14
10:45	11	15
11:03	14	19
11:20	21	18
1:25 PM	14	25
1:45	19	15
2:00	15	19
2:35	20	16
3:15	21	22
3:30	18	17

A = 535.00
d.f. = 14
Not significant

Site 2 Elm & Lindsey

Time	Before	After
8:20 AM	13	23
8:35	12	14
8:50	7	17
9:50	10	16
10:25	11	8
10:40	13	13
11:00	19	16
11:25	20	15
11:45	25	21
12:20 PM	19	21
1:20	13	23
1:35	16	17
1:55	24	18
2:10	19	17
2:30	21	9
4:00	20	21
4:15	18	25
4:30	12	15
5:05	19	19

A = 2.239
d.f. = 18
Not significant

NOTE: Volumes shown are total counts of traffic on all approaches for one signal cycle.

TRAFFIC VOLUME DATA ANALYSIS SUMMARY

Experiment Validation of WALK – DONT WALK vs. Hand Symbol

City Milwaukee

Site 1 16th & Mitchell

Time	Before	After
9:20 AM	19	7
9:40	30	19
10:00	19	21
10:20	17	20
10:40	15	21
11:00	23	21
11:20	21	20
11:40	22	23
2:15 PM	33	32
2:35	33	29
3:00	26	39
3:20	26	29
3:40	46	46
4:00	36	31
4:20	34	32

A = 5.440
d.f. = 14
Not Significant

Site 2 55th & North

Time	Before	After
7:55 AM	26	20
8:10	17	25
8:20	18	14
8:35	25	23
9:45	23	22
10:00	25	18
10:15	17	23
10:30	23	18
10:45	20	14
11:00	20	22
11:15	29	20
11:30	23	31
1:00 PM	26	27
1:15	31	29
1:30	19	20
1:45	23	28
2:00	21	29
3:00	30	27
3:10	28	25
3:30	31	30
3:45	31	38
4:00	32	38
4:10	31	32

A = 3.85
d.f. = 22
Not Significant

NOTE: Volumes shown are total counts of traffic on all approaches for one signal cycle.

U.S. GOVERNMENT PRINTING OFFICE: 1978— 724-867/1279

FEDERALLY COORDINATED PROGRAM OF HIGHWAY RESEARCH AND DEVELOPMENT (FCP)

The Offices of Research and Development of the Federal Highway Administration are responsible for a broad program of research with resources including its own staff, contract programs, and a Federal-Aid program which is conducted by or through the State highway departments and which also finances the National Cooperative Highway Research Program managed by the Transportation Research Board. The Federally Coordinated Program of Highway Research and Development (FCP) is a carefully selected group of projects aimed at urgent, national problems, which concentrates these resources on these problems to obtain timely solutions. Virtually all of the available funds and staff resources are a part of the FCP, together with as much of the Federal-aid research funds of the States and the NCHRP resources as the States agree to devote to these projects.*

FCP Category Descriptions

1. Improved Highway Design and Operation for Safety

Safety R&D addresses problems connected with the responsibilities of the Federal Highway Administration under the Highway Safety Act and includes investigation of appropriate design standards, roadside hardware, signing, and physical and scientific data for the formulation of improved safety regulations.

2. Reduction of Traffic Congestion and Improved Operational Efficiency

Traffic R&D is concerned with increasing the operational efficiency of existing highways by advancing technology, by improving designs for existing as well as new facilities, and by keeping the demand-capacity relationship in better balance through traffic management techniques such as bus and carpool preferential treatment, motorist information, and rerouting of traffic.

3. Environmental Considerations in Highway Design, Location, Construction, and Operation

Environmental R&D is directed toward identifying and evaluating highway elements which affect the quality of the human environment. The ultimate goals are reduction of adverse highway and traffic impacts, and protection and enhancement of the environment.

4. Improved Materials Utilization and Durability

Materials R&D is concerned with expanding the knowledge of materials properties and technology to fully utilize available naturally occurring materials, to develop extender or substitute materials for materials in short supply, and to devise procedures for converting industrial and other wastes into useful highway products. These activities are all directed toward the common goals of lowering the cost of highway construction and extending the period of maintenance-free operation.

5. Improved Design to Reduce Costs, Extend Life Expectancy, and Insure Structural Safety

Structural R&D is concerned with furthering the latest technological advances in structural designs, fabrication processes, and construction techniques, to provide safe, efficient highways at reasonable cost.

6. Prototype Development and Implementation of Research

This category is concerned with developing and transferring research and technology into practice, or, as it has been commonly identified, "technology transfer."

7. Improved Technology for Highway Maintenance

Maintenance R&D objectives include the development and application of new technology to improve management, to augment the utilization of resources, and to increase operational efficiency and safety in the maintenance of highway facilities.

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* The complete 7-volume official statement of the FCP is available from the National Technical Information Service (NTIS), Springfield, Virginia 22161 (Order No. PB 242057, price $45 postpaid). Single copies of the introductory volume are obtainable without charge from Program Analysis (HRD-2), Offices of Research and Development, Federal Highway Administration, Washington, D.C. 20590.


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R&D