FINAL REPORT

Developing Guidelines for Use of Pedestrian Countdown Traffic Signals

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Michigan Department of Transportation

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16. Abstract

Pedestrians' behavior and understanding of pedestrian signal displays of traditional and countdown pedestrian signals (CDPS) were studied at sixteen (16) intersections throughout the State of Michigan. A before-and-after evaluation was conducted. The objective of the study is to evaluate pedestrian behavior vis-à-vis CDPS with the ultimate goal of developing guidelines for use of these signals. The crossing behavior of over 33,000 pedestrians was observed.

The aggregated data from all 16 intersections revealed that: 1) pedestrians overwhelmingly (91%) liked the CDPS, 2) over 80% of the surveyed pedestrians correctly understood the meaning of the countdown signal, 3) younger adult pedestrians appear to be using the time displays of not only their own crosswalk but others as well to determine if they can cross safely, and in the process appear to have become less compliant after the CDPS were installed, 4) the solid Walk symbol is not correctly understood both in the before and after conditions, 5) the flashing Do Not Walk and solid Do Not Walk are correctly understood by majority of the surveyed pedestrians (70% and 80%, respectively), and 6) for a given number of lanes yet to be crossed before the solid Don't Walk appeared, there were fewer such pedestrians after the CDPS were installed. Guidelines for installation of CDPS are proposed based on information assembled from video recordings and observations of field crews.

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EXECUTIVE SUMMARY

Pedestrians' behavior and understanding of pedestrian signal displays of traditional and countdown pedestrian signals (CDPS) were studied at sixteen (16) intersections throughout the State of Michigan. A before-and-after evaluation was conducted. The objective of the study is to evaluate pedestrian behavior vis-à-vis CDPS with the ultimate goal of developing guidelines for use of these signals. The crossing behavior of over 33,000 pedestrians was observed.

The aggregated data from all 16 intersections revealed that: 1) pedestrian overwhelmingly (91%) liked the CDPS, 2) over 80% of the surveyed pedestrians correctly understood the meaning of the countdown signal, 3) younger adult pedestrians appear to be using the time displays of not only their own crosswalk but others as well to determine if they can cross safely, and in the process appear to have become less compliant after the CDPS were installed, 4) the solid Walk symbol is not correctly understood both in the before and after conditions, 5) the flashing Do Not Walk and solid Do Not Walk are correctly understood by majority of the surveyed pedestrians (70% and 80%, respectively), and 6) for a given number of lanes yet to be crossed before the solid Don't Walk appeared, there were fewer such pedestrians after the CDPS were installed. Guidelines for installation of CDPS are proposed based on information assembled from video recordings and observations of field crews.

BACKGROUND

Pedestrian countdown signals (CDPS) provide information to pedestrians regarding the amount of time remaining to safely cross a street. A countdown is used in conjunction with the conventional pedestrian signal indications. CDPS have been proposed for inclusion in the Manual on Uniform Traffic Control Devices (MUTCD) as part of Revision 2.

This research was initiated by the Michigan Department of Transportation (MDOT) to study the impact of CDPS on pedestrian crossing behavior and level of compliance. The study results would serve as necessary background for developing guidance for installation/use of CDPS.

Sixteen (16) locations were selected throughout the State. The locations represent areas with diverse land use, levels of urbanization, and volume of pedestrians. The locations are:

1. Saginaw/Capitol, Lansing
2. Michigan Ave/Larch, Lansing
3. Saginaw/Pennsylvania, Lansing
4. Dexter/Washington, Ionia
5. Michigan/Rose, Kalamazoo
6. Bridge/Jefferson, Grand Ledge
7. Genesee/Washington, Saginaw
8. VanDyke/10 Mile, Centerline
9. Wyoming/8 Mile, Detroit
10. Mission/ Bellows, Mt Pleasant
11. Beach/5th, Flint
12. Michigan/ Ann Arbor, Saline
13. Gratiot/Filbert, Detroit
14. Gratiot/Outer, Detroit
15. Gratiot/Hickory, Detroit
16. Gratiot/Linhurst, Detroit

For the purpose of analysis and evaluation of the results, the study locations were divided into three groups based on similarities of general surroundings and the socio-economic characteristics of likely pedestrians. Analysis and results for individual intersections were performed as well.

Group A:

1. Saginaw/Capitol, Lansing
2. Michigan Ave/Larch, Lansing
3. Saginaw/Pennsylvania, Lansing
4. Michigan/Rose, Kalamazoo
5. Bridge/Jefferson, Grand Ledge
6. Beach/5th, Flint

These intersections are characterized by normal geometric layouts with pedestrians who exhibited average (expected normal) behavior.

Group B:

1. Gratiot/Filbert, Detroit
2. Gratiot/Outer, Detroit
3. Gratiot/Hickory, Detroit
4. Gratiot/Linhurst, Detroit
5. Dexter/Washington, Ionia
6. Genesee/Washington, Saginaw

These intersections are located in visibility distressed areas, with a significant number of pedestrians displaying less than normal behavior.

Group C:

1. Mission/ Bellows, Mt Pleasant
2. Michigan/ Ann Arbor, Saline
3. Wyoming/8 Mile, Detroit
4. VanDyke/10 Mile, Centerline

There is no consistency in the characteristics of these intersections. Geometry at some of these was significantly different than others (e.g., relatively too wide, presence of island, or large number of lanes). This group had wider that typical variation in pedestrian age distribution. Hence, each intersection was evaluated individually.

OBJECTIVES AND SCOPE

The objective of this study is to determine the effect of pedestrian countdown signals on the crossing behavior of pedestrians using a diverse group of intersections with a visible presence of pedestrian traffic and representative surroundings and geographic coverage in the State of Michigan. The objective was to be accomplished through a combination of a survey and an observational before-and-after study. The purpose of the project is to study pedestrian crossing behavior and pedestrian understanding of pedestrian signal displays. The overarching objective is to develop guidelines for use of CDPS in Michigan.

The scope of the project is pedestrian crossing behavior, potential vehicle and pedestrian conflicts, and pedestrian understanding.

Pedestrian Survey

Pedestrians were surveyed at sixteen (16) locations in different parts of Michigan. They were asked about their understanding and acceptance of the pedestrian signal displays. This was done both in conjunction with the traditional signal head displays (Before Condition) and with the countdown signal head displays (After Condition). The survey was administered in the field and pedestrians were randomly selected by trained researchers from Michigan State University. A sample of the survey and the data reduction forms is included in Appendix A.

Observation Study

An observational before-and-after study was used to determine the effect of the CDPS. A combination of video recording and manual field observations were used to determine and

quantify the impact. Specific measures of pedestrian compliance or "violation" were adopted to standardize the comparison and to ascertain the impact of the CDPS. Besides ease of understanding, the before-and-after study has the advantage of enabling comparisons without having to consider variations between locations and hence would require measurements at fewer locations, than other experiment designs *(1)*.

For the purpose of this study, the installation of the pedestrian countdown signal was the treatment, and the sixteen intersections equipped with the pedestrian countdown signals were the experimental units. Measurements were taken both before and after the pedestrian countdown signals were installed, and then compared.

Sample size and across locations
In total, the behavior of thirty-three thousand three hundred and ninety three (33,393) pedestrians was observed in the combined before and after conditions. Of those, 51.6% were in the before phase and 48.4% were in the after phase. Although the same number of hours was devoted to each intersection--and to the before and after conditions--the numbers of pedestrians actually observed were not the same for the same locations due to normal variation of pedestrian traffic. Comparing across sites, the number of pedestrians observed varied widely based on level of urbanization and surrounding land uses. For both before and after observations, similar time durations were used (20 hours "before" and 20 hours "after" for each approach of each of the study intersections) in order to ensure comparable sample sizes. Data was collected during daylight hours and good weather conditions; extreme weather conditions were avoided in both before and after conditions.

While numbers of pedestrian accidents would be the more direct mean to assess the effectiveness of CDPS, indirect measures of effectiveness were used instead: 1) pedestrian compliance with the signal displays and 2) pedestrian understanding of signal displays. These are easier to observe (as it is more frequent) compared to pedestrian accidents that are rare events.

Pedestrian Compliance of Signals

Pedestrian compliance with the pedestrian signals was measured by comparing specific crossing behaviors in the before and after conditions. Pedestrians were observed using taping with portable video cameras. All crosswalks at an intersection were video taped concurrently (a camera per crosswalk). Taped observations were then reviewed and data recorded on specially prepared forms. Data reduction and recording of observation took place in the laboratory where tapes could be stopped and re-reviewed as necessary. Each pedestrian's crossing behavior or location in the crosswalk vis-à-vis the display of the signal head was recorded. The following measures of compliance were used:

- Cleared before solid Don't Walk indication,
- Didn't clear before solid Don't Walk,
- Started during flashing Don't Walk, or
- Crossing on solid Don't Walk.

Other studies used similar, and in some cases different, measures of effectiveness (2,3,4,5); therefore comparison a cross different studies may not be valid or meaningful.

A sample of the form used by observers to reduce (summarize) the data is shown in Appendix A.

Data Collection

The before and after observations and measurements were such that there is at least a two (2) week cooling period in between. For purposes of data collection, sites were divided into three (3) groups. Data was collected between Augusts 2005 and September 2006. In all cases data collection was avoided in extreme rain and cold conditions since studies have shown that pedestrians may be less likely to wait for the WALK indication before crossing a street. Knoblauch et al. *(6)* found that the environment influences some pedestrian behaviors.

RESULTS

Pedestrians' Acceptance and Understanding

A survey was done to gauge the understanding of pedestrians of both the new countdown signal as well as the traditional pedestrian signals displays. The survey also sought to determine how pedestrians perceived the countdown signals. The questions asked of the pedestrians are noted at the top of each of the graphs presented below. It is noted that the countdown clock on the CDPS start at the beginning of the flashing Don't Walk and goes through to the **end** of the yellow interval[1] of the appropriate parallel traffic approach.

Pedestrians' Understanding of Countdown Signals

Understanding of pedestrian signal displays are presented in figure 1. It is clear that majority of the pedestrians correctly understood the meaning of the time display of the CDPS.

[1] In most other states, the countdown clock reaches zero at the **beginning** of the yellow interval.

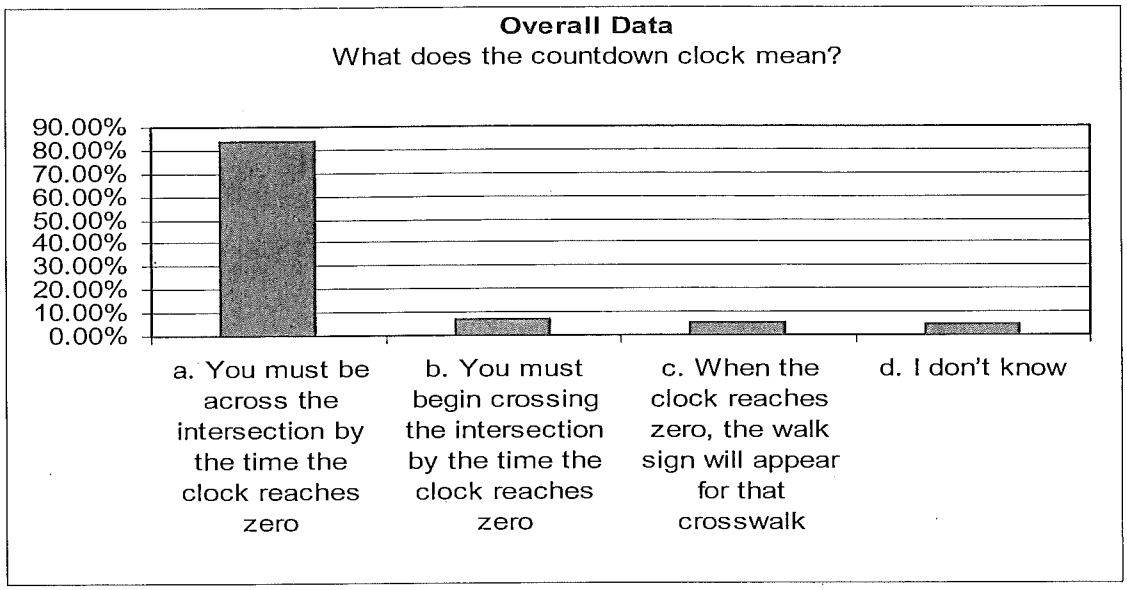

Figure 1 Understanding of countdown signal, all locations combined

The same results for each of the three groups are shown in figures 2 through 4. Although there is variation between the groups, and among the individual intersections within each groups, the results are consistent in that majority of the surveyed pedestrians correctly understood the meaning of the countdown clock display. Given the diversity of the sites and the pedestrian population, there is little reason to believe these results would not hold for other locations.

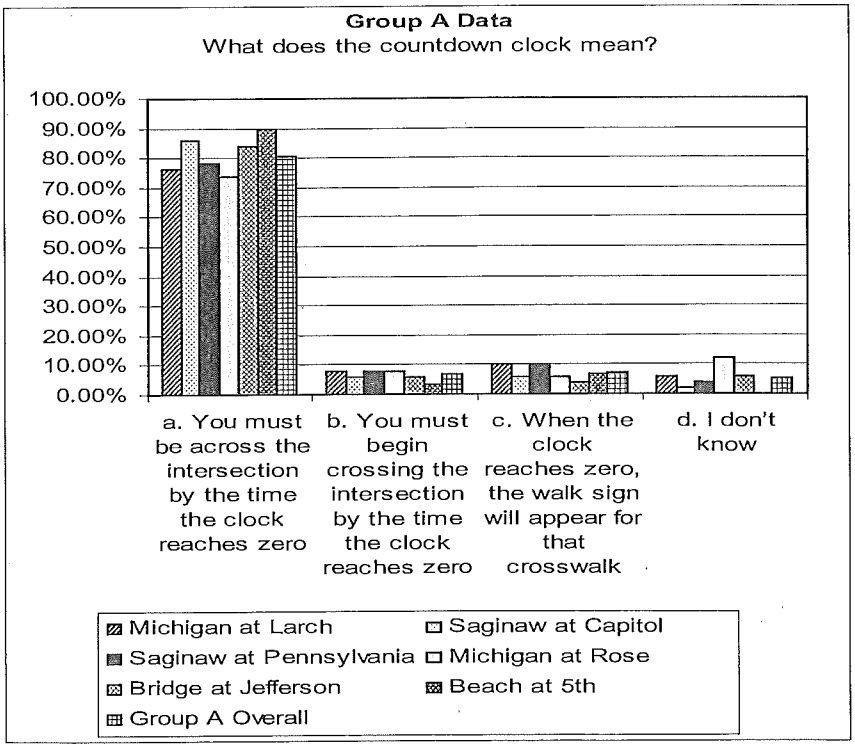

Figure 2 Understanding of countdown signal, group A

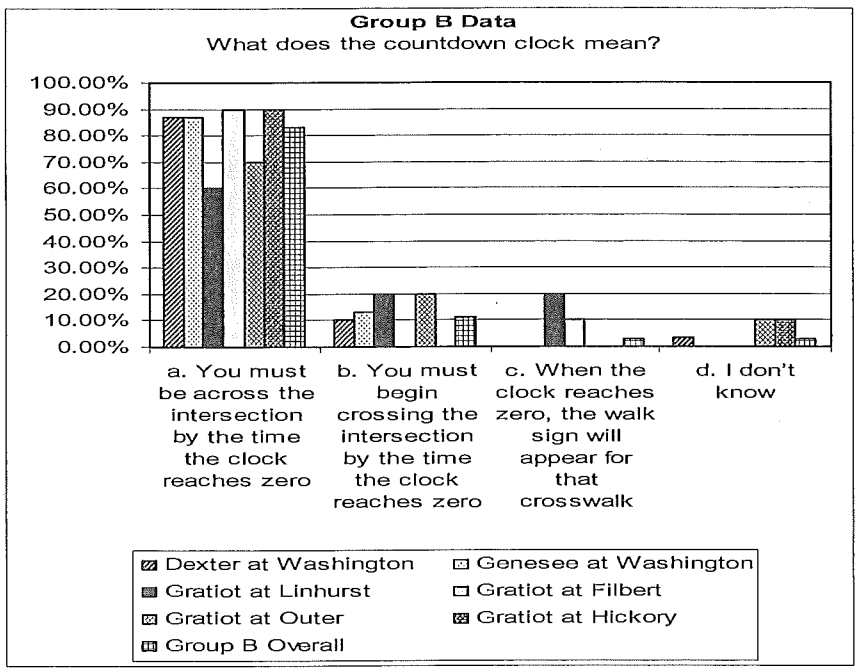

Figure 3 Understanding of countdown signal, group B

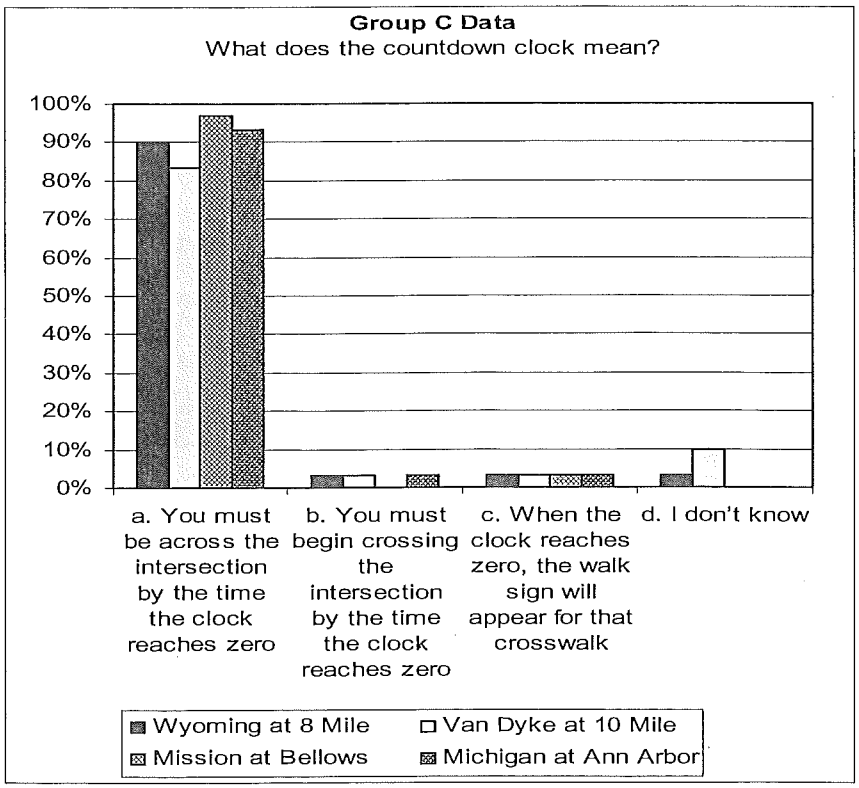

Figure 4 Figure 2 Understanding of countdown signal, group C

Pedestrians' Perception of Countdown Signals

Pedestrians' perception of countdown signals was overwhelming positive. This is evident from figure 5 which reflects data from all locations combined. Results for each of the three groups, and the individual intersections with them, are shown in figures 6 through 8. Other studies found similar results (2).

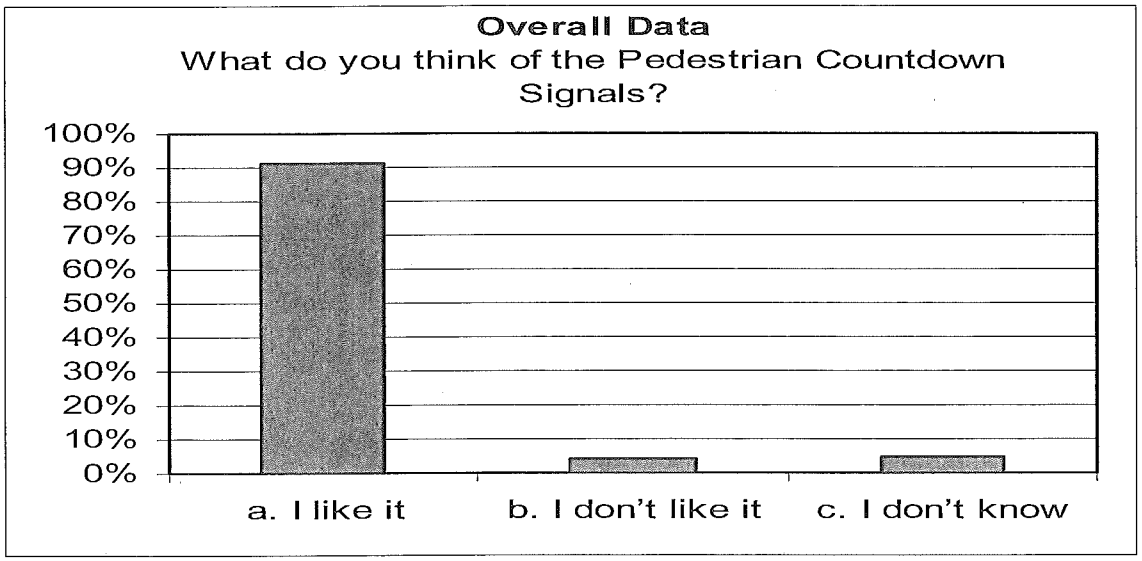

Figure 5 Perception of countdown pedestrian signals, all three locations

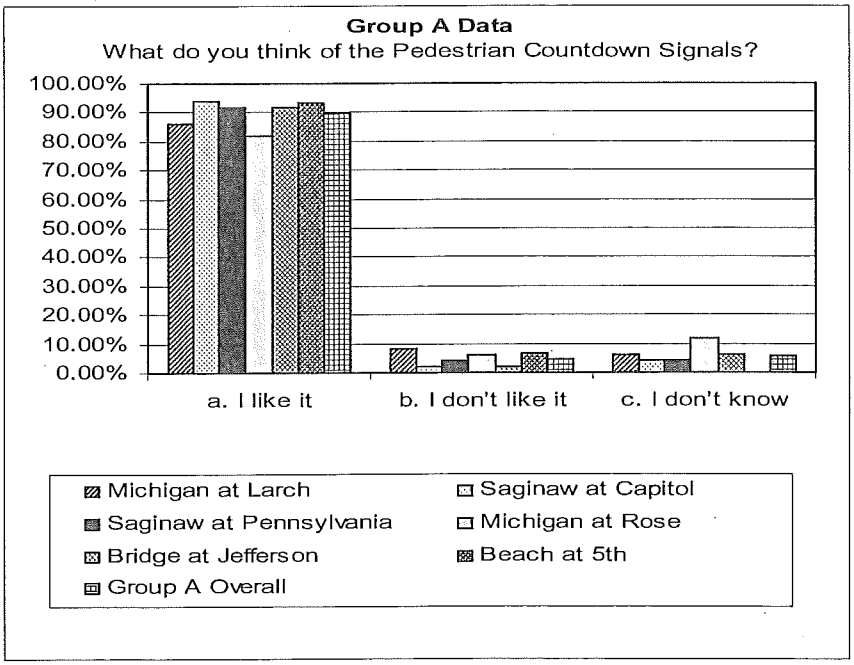

Figure 6 Perception of countdown pedestrian signals, group A

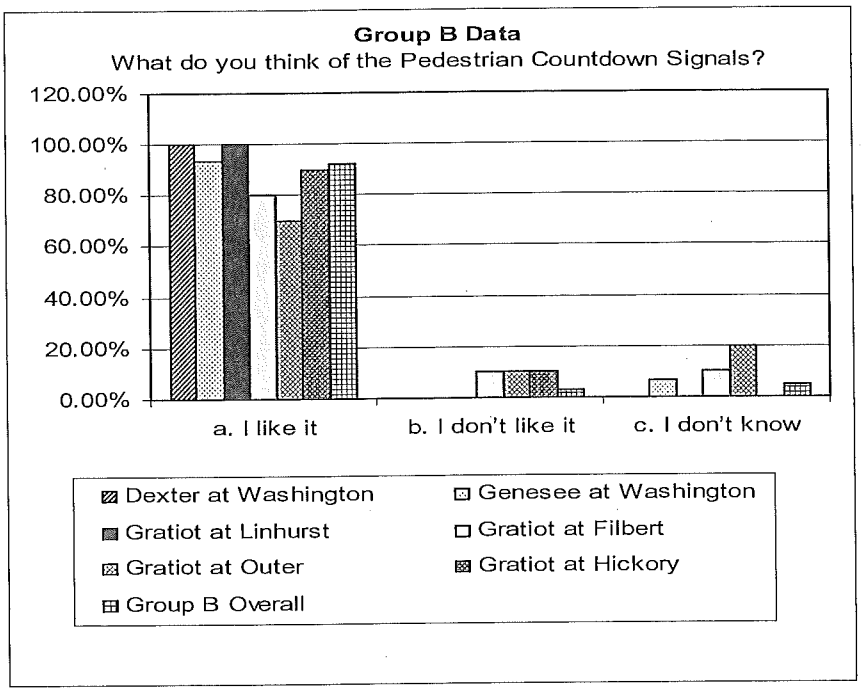

Figure 7 Perception of countdown pedestrian signals, group B

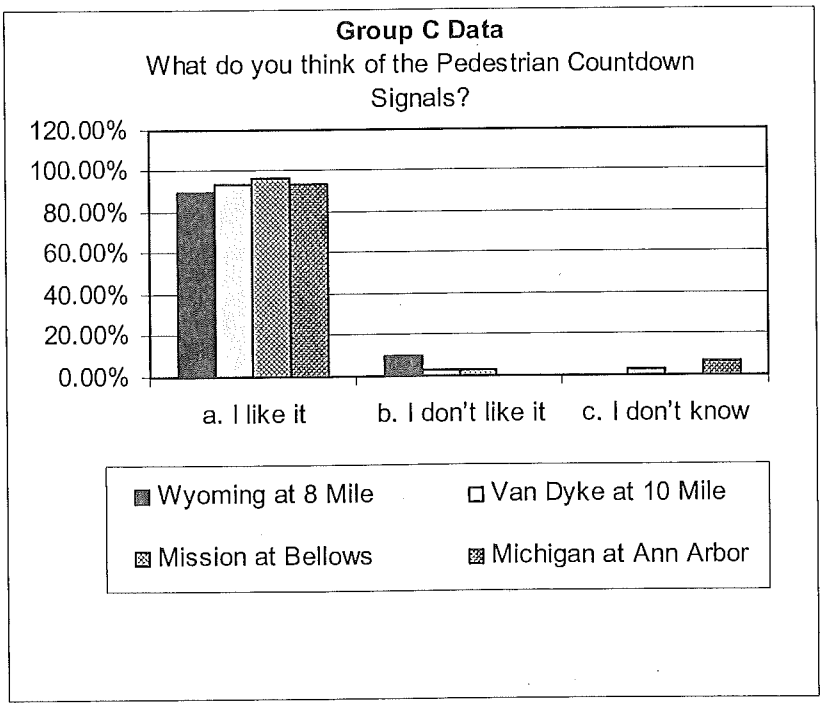

Figure 8 Perception of countdown pedestrian signals, group C

Evaluation of the Understanding of the Traditional Pedestrian Displays

Except for the solid Walk, the other displays of the traditional pedestrian signal heads seem to be understood by majority of the pedestrians who were surveyed, but there appears to be

some variation between the understandings of the same signal displays between the before and after cases. In some cases this variance is not negligible. One would not expect any significant difference; there is no reason to believe that the mere installation of the countdown heads will improve or worsen the understanding of those displays (e.g., solid Don't Walk). And there has not been any such observation in other studies where countdown signal were used.

Solid Walk

Majority of pedestrians do not seem to understand this display correctly as shown in figure 9. The same holds true for the before and after cases, although the "safer", more conservative understandings are better in the before condition. This finding is not reassuring. Result for each of the three groups and the individual locations are included in Appendix B

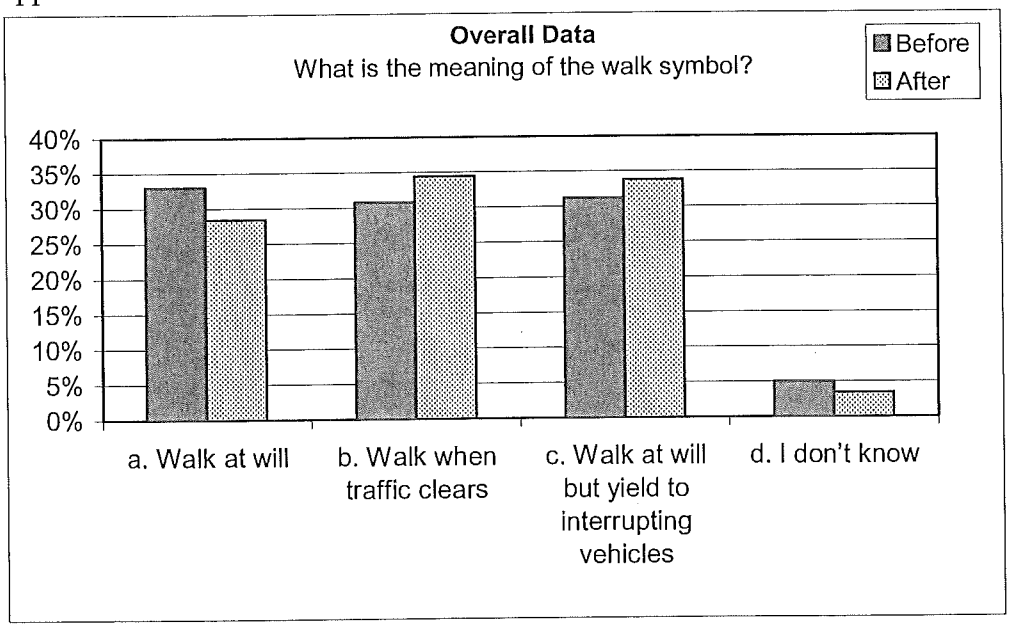

Figure 9 Understanding of the meaning of the "Walk" display, all locations

Flashing Don't Walk

Majority of the pedestrians understood what this display means both before and after the installation of the CDPS (the combination of responses c and d in figure 10). A significant percentage, however, did not understand the meaning of the display, or interpreted incorrectly. Result for each of the three groups, and for the individuals intersections within each group, echo those reflected in the figure. They are included in Appendix B.

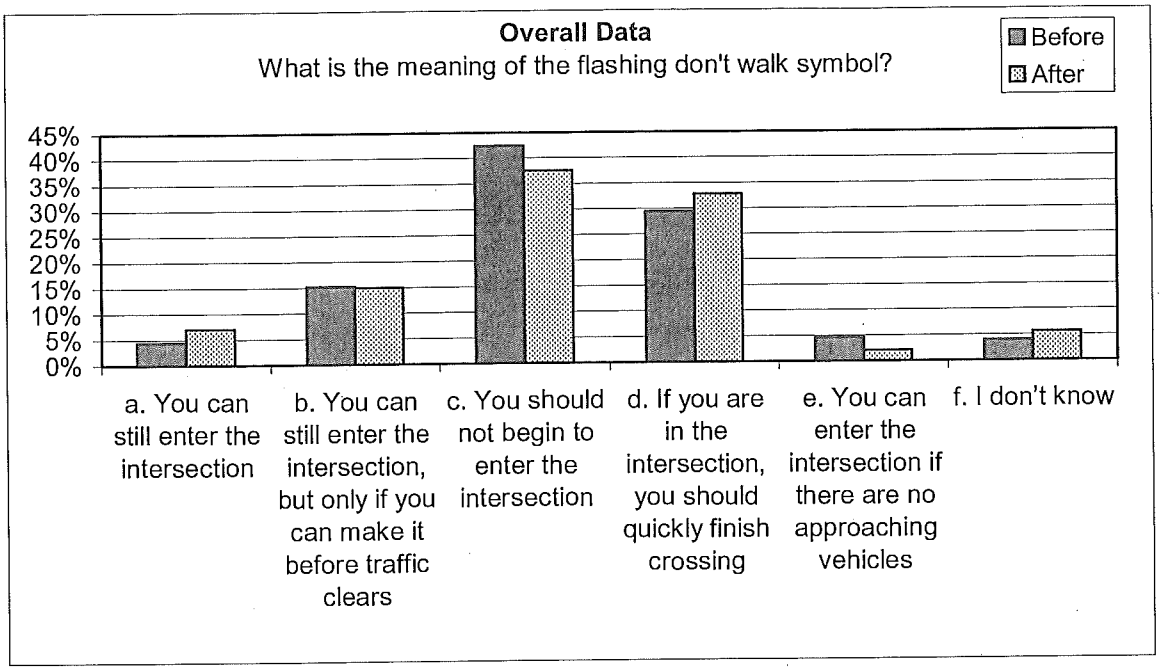

Figure 10 Understanding of the meaning of the flashing "Don't Walk" display, all locations

Solid Don't Walk

Most pedestrians understood the meaning of this display, as shown in figure 11. Results for each of the three groups and the individual locations are included in Appendix B. The trends in the group results and results at individual intersections follow the trend shown in figure 11.

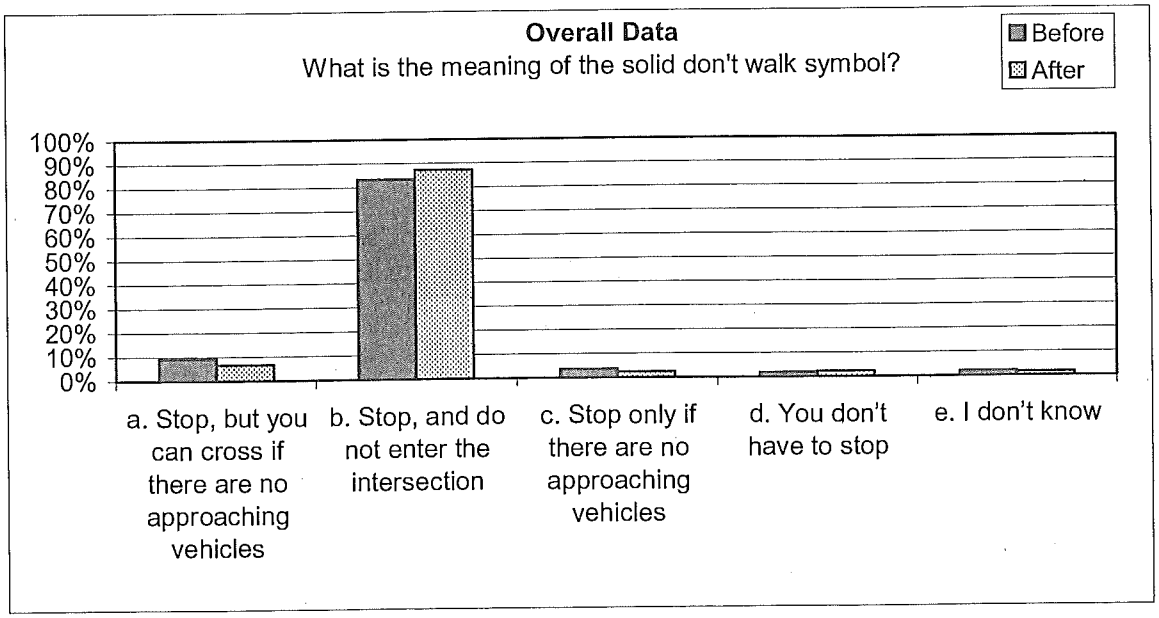

Figure 11 Understanding of the meaning of the solid "Don't Walk" display, all locations

Age of Surveyed Pedestrians

As the ultimate objective of this research is to accumulate enough knowledge and field experience to develop guidelines for installing CDPS, it was important that representative age distribution of pedestrians be use. Figure 12 shows the age distribution of the pedestrians surveyed in this study. Although different age groups are not equally represented in the samples, they all have meaningful representation in the observations. Results for each of the three groups, and the individual locations within each group, are included in Appendix C (for the after conditions). There, it is clear the some age groups are more dominant at some locations but when considered across all locations, all age groups are well represented.

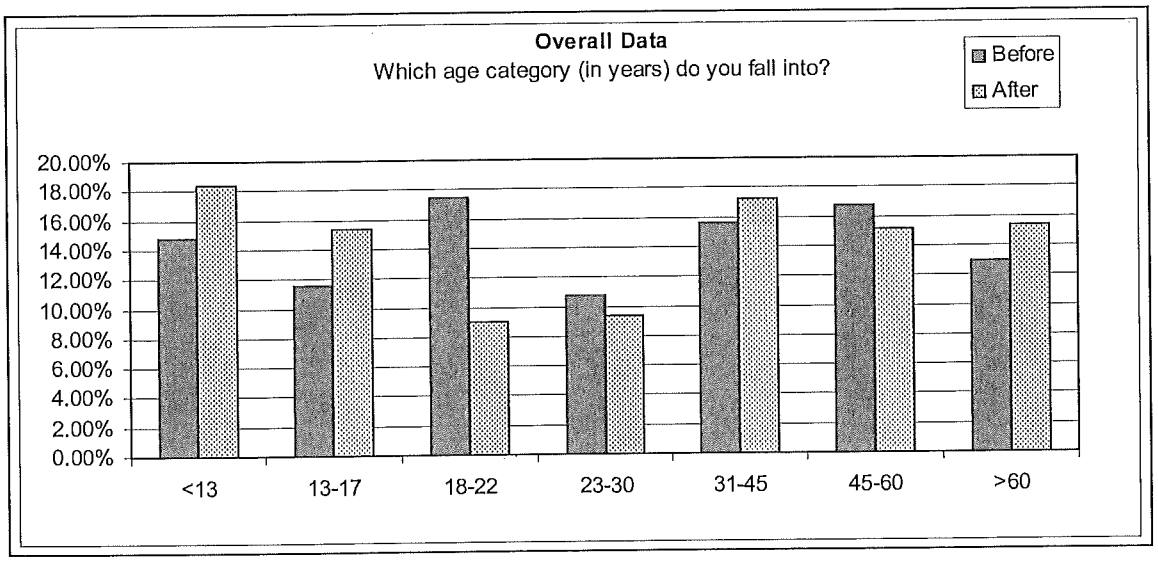

Figure 12 Age distribution of surveyed pedestrians, all locations

Pedestrian Compliance with Signal Indications

CDPS were well received by pedestrians. Although this may not directly translate into positive safety impacts, it is an indication of an overall likely positive impact of CDPS. While pedestrians may not be able to explain the exact reason for their positive perception, anecdotal evidence and some of the results of this study suggest that CDPS are more informative that traditional pedestrian signal heads.

Based on the results of the sixteen intersections of this study, the CDPS seem to have mostly positive effects on pedestrian compliance. In the few exceptions where compliance appears to have deteriorated, further analysis indicates that the apparent negative impacts are more a function of the specific measures of effectiveness adopted in this study rather than being an indication of something genuinely negative. For example, in some cases more pedestrians appear to start their crossing during the flashing Do Not Walk interval. However, pedestrians also appear to adjust their walking speed based on the CDPS display.

In other words, the specific number of seconds displayed appears to help pedestrian make more informative decisions, but the measure used in this study did not capture that. A more detailed—perhaps microscopic analysis, would be more suited. It was also noted at the intersection of Mission and Bellows near Central Michigan University in Mt. Pleasant, that pedestrians were seen to take clues from other crosswalks (and the corresponding countdown displays) to determine if they can cross safely although the signal indication dictated a "Don't Walk" choice be taken. The same thing was observed in an earlier study at three intersections near Michigan State University in East Lansing (7).

The following section summarizes results on pedestrian compliance for each of the measures of compliance noted above, namely:

1. Cleared before Solid Don't Walk indication,
2. Didn't clear before Solid Don't Walk, or
3. Started during Flashing Don't Walk
4. Crossing on Solid Don't Walk

Table 1 shows the results for all intersections combined for each of the above measures of compliance. The percentage of pedestrians who cleared before the solid Don't Walks and those who crossed on solid Don't Walk both went down, which is implies that the CDPS have had a positive impact. The percentages of pedestrians who did not clear before the solid Don't Walk and those who started during the flashing Don't Walks both increased (call those "exposed pedestrians"). However, as noted earlier, these results should be seen only in conjunction with the location of those pedestrian vis-à-vis the curb; this is shown in figure 13. Here for any given number of lanes remaining to cross when the solid Don't Walk appeared, the percentage of the exposed pedestrians is lower (or did not change) when CDPS were in use. There are two exceptions. First, the case of 3 lanes: this is for the most part due to pedestrians who did not clear but were on the islands of the intersection of Wyoming and 8 Miles. The other exception is for the case of 1.5 lanes. In this case the percentage of pedestrians exposed went up by only 0.3%. One last note on table 1: the percentage of pedestrians who started crossing on flashing Don't Walk went up slightly after the installation of the CDPS, but this does not say anything on whether those pedestrians adjusted their speed and hence cleared the intersection before the solid Don't Walk appeared.

Table 1: Summary of pedestrian compliance based on all 16 intersections

All 16 Locations Statewide, Michigan	BEFORE		AFTER	
	Amount	%	Amount	%
Cleared before Solid Don't Walk	13190	76.5%	12478	77.2%
Didn't clear before Solid Don't Walk	1312	7.6%	1375	8.5%
Started during Flashing Don't Walk	2220	12.9%	2553	15.8%
Crossing on Solid Don't Walk	2729	15.8%	2309	14.3%
Total Pedestrains	17231	100.0%	16162	100.0%

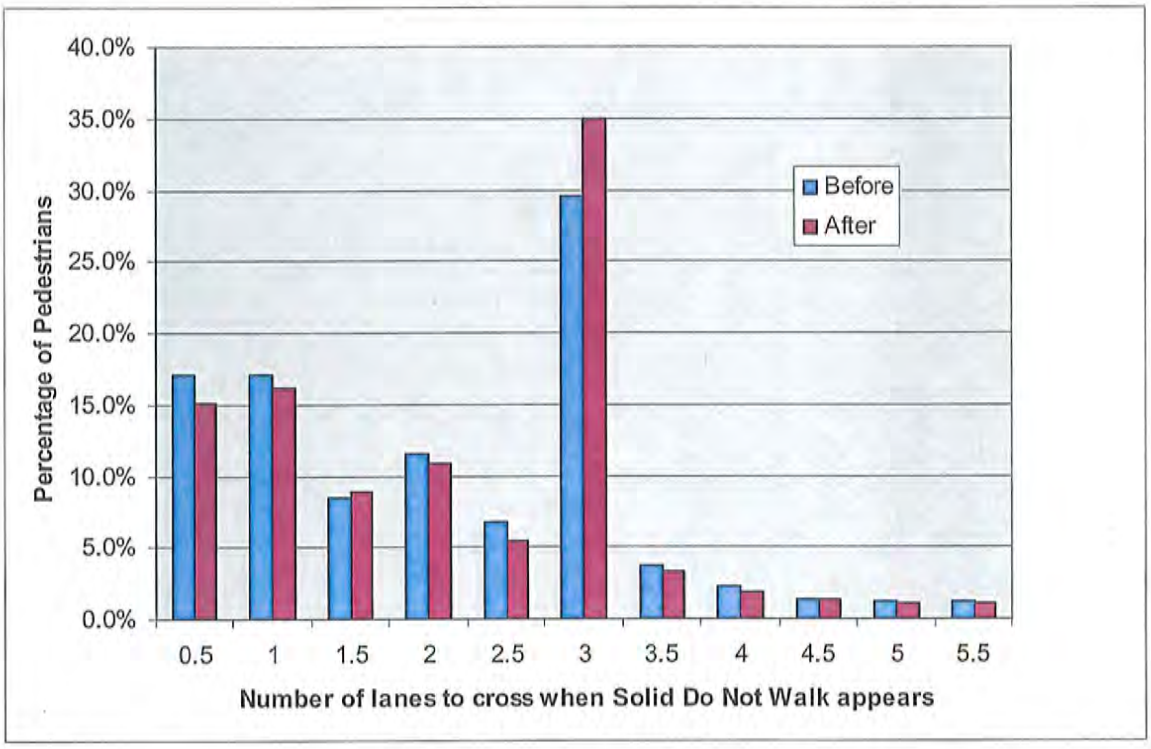

Figure 13 Change in percentages of pedestrians who had to cross the shown number of lanes when solid Don't Walks appeared

The equivalents of figure 13 for each of the study locations are included in Appendix D. Analysis of pedestrian compliance for individual intersections is as follows:

Cleared before Solid Don't Walk indication

Table 2 presents a comparison of the percentages of pedestrian who cleared the intersection before the solid Don't Walk. Positive change is desirable. In 12 of the sixteen intersections, the percentage of pedestrians who cleared the intersection before the solid Don't Walk appeared did increase, which is a desirable change. The percentages for the last four intersections (all in the City of Detroit) are based on small samples sizes (i.e., low pedestrian volumes).

Table 2: Comparison of the percentage of pedestrians who cleared before the solid Don't Walk

Intersection	Percentage cleared before solid Don't WALK		Change in Percentage from Before to After. Positive change is desirable
	Before	After	
Saginaw/Capitol, Lansing	75.8%	76.5%	0.92%
Michigan Ave/Larch, Lansing	73.6%	77.7%	5.57%
Saginaw/Pennsylvania, Lansing	75.6%	76.0%	0.53%
Dexter/Washington, Ionia	86.8%	92.5%	6.57%
Michigan/Rose, Kalamazoo	80.4%	82.7%	2.86%
Bridge/Jefferson, Grand Ledge	86.5%	91.1%	5.32%
Genesee/Washington, Saginaw	84.0%	81.6%	-2.86%
VanDyke/10 Mile, Centerline	89.0%	93.0%	4.49%
Wyoming/8 Mile, Detroit	42.2%	40.5%	-4.03%
Mission/ Bellows, Mt Pleasant	68.3%	62.4%	-8.64%
Beach/5th, Flint	75.3%	77.8%	3.32%
Michigan/ Ann Arbor, Saline	91.6%	84.5%	-7.75%
Gratiot/Filbert, Detroit	47.4%	62.65%	32.17%*
Gratiot/Outer, Detroit	43.3%	58.2%	34.41%*
Gratiot/Hickory, Detroit	60.2%	67.1%	11.46%*
Gratiot/Linhurst, Detroit	57.1%	58.9%	3.15%*

* Based on small sample size

Didn't clear before Solid Don't Walk

Table 3 presents a comparison of the percentage of pedestrians who did not clear the intersection before the solid Don't Walk. Negative change is desirable. Except for the intersection of Wyoming and 8 Miles, the percentages in both the "before" and "after" conditions are very low hence the change appears artificially high. In short, the results in table 3 do not indicate much change between the before and after conditions since the percentages of those who did not clear before the solid Don't Walk were small in both the before and after conditions. The high percentages at Wyoming and 8 Mile include pedestrians who did not clear the intersections but were waiting on the islands.

Table 3: Comparison of the percentages of pedestrians who did not clear before the solid Don't Walk

Intersection	Percentage did not clear before solid Don't WALK		Change in Percentage from Before to After. negative change is desirable
	Before	After	
Saginaw/Capitol, Lansing	2.7%	2.8%	3.70%
Michigan Ave/Larch, Lansing	2.6%	3.3%	26.92%
Saginaw/Pennsylvania, Lansing	7.1%	8.9%	25.35%
Dexter/Washington, Ionia	1.8%	0.7%	-61.11%
Michigan/Rose, Kalamazoo	7%	6.2%	-11.43%
Bridge/Jefferson, Grand Ledge	2.4%	1.7%	-29.17%
Genesee/Washington, Saginaw	4%	5.3%	32.50%
VanDyke/10 Mile, Centerline	4.8%	0.8%	-83.33%
Wyoming/8 Mile, Detroit	48%**	51.2%**	6.67%
Mission/ Bellows, Mt Pleasant	1.3%	2.8%	115.38%
Beach/5th, Flint	4.5%	4.4%	-2.22%
Michigan/ Ann Arbor, Saline	3%	6.5%	116.67%
Gratiot/Filbert, Detroit	11.1%	6.5%	-41.44%

GUIDELINES

The following guidelines for use of pedestrian countdown signals (CDPS) have been developed based on the results of the extensive study described in the previous sections of this report along with the results of a previous study conducted at four signalized intersection at the perimeters of Michigan Stat University in East Lansing, Michigan. In addition, field crews and research assistants who collected the field data, watched the video recordings. and reduced the data were formally interviewed and asked for any observations that may not have been captured by the video recordings. The guidelines provided here, therefore, are based on the knowledge acquired from the field observation as captured in the video tapes and other information provided by field crews and data reduction teams.

The following situations warrant the use of CDPS, with the qualifications noted:

1. Crossings with high pedestrian volumes. However, if vehicular traffic volumes are low, or sufficient gaps exist in the vehicular traffic stream, CDPS may not be as effective.

2. School areas. For use near schools, consideration of slower walking speeds should be considered. This should be determined based on the age distribution of pedestrians.

3. Areas with special use establishments such as retirement homes, hospitals, and other places whose clients may be disproportionately senior citizens or physically-challenged. In these cases default crossing speeds may need to be changed to best meet the needs of the pedestrians in question.

4. Locations with a history of pedestrian/vehicle accidents. In this case, causes of the pedestrian/vehicle accidents should be investigated to ensure that other deficiencies are not causing the accidents.

5. Locations with high vehicle traffic levels that may be hazardous to pedestrian crossing.

6. Wide width crossings. These are crossing that require long clearance intervals (~15 seconds or more, although this number may be different depending on the pedestrians age distribution and their physical condition).

7. Mid-block pedestrian crossings with high pedestrian volumes.

The following are findings that should be considered in conjunction with the above guidelines:

1- Speeds did not seem to influence pedestrian behavior and level of compliance and hence it should not be a deciding factor in installing CDPS.

2- There is no evidence that drivers approaching signalized intersections take cues from the countdown clocks to gauge their chances of crossing safely (and adjusting their speed accordingly). If later this proves to be the case, louvers or other similar devices may need to be used on the CDPS heads to limit their visibility only to relevant pedestrians.

3- Socioeconomic characteristics of surrounding areas appear in some cases to play a role in determining the pedestrians' levels of compliance.

4- There is evidence that pedestrians, particular young adults, take cues from the countdown heads of other crossings to determine if the can cross on a solid Don't Walk and still be safe.

5- Where CDPS are installed, higher type pavement crosswalk markings should be considered.

CONCLUSIONS

From all observations and information obtained directly from pedestrians at the study locations, it appears that CDPS have an overall positive impact on the understanding of pedestrian signal operations. Analysis of pedestrian behaviors before and after installation of the CDPS supports that. It appears that the CDPS have given pedestrians more information to better understand what the different signal displays mean, and the time needed to cross. This can only improve pedestrian safety. The results of the pedestrian survey clearly showed that pedestrians at the locations included in this study understand the meaning of the CDPS displays, and have a positive impression of them. Although the results on the specific compliance measures may give the impression that more pedestrians initiated more inappropriate crossing maneuvers after the CDPS were installed, this should be seen in the proper context of the study locations and the other, related measures of compliance. There are two reasons to believe this conclusion is not appropriate: 1) other measures of compliance indicate positive change, and 2) pedestrians were observed to take clues from the countdown clocks of the perpendicular crosswalks to make a determination of whether or not they can initiate an inappropriate crossing maneuver and complete it safely. For a given number of lanes yet to be crossed before the solid Don't Walk appears, there were fewer such pedestrians after the CDPS were installed.

The outcome of the study shows that to the extent the 16 intersections studied in this research are representative enough of other intersections, countdown pedestrian signals (CDPS) can be used in lieu of traditional pedestrians signals. There is no clear evidence to indicate that CDPS should not be used. The expected benefits, however, will likely vary by the level of discipline of pedestrians. Younger adult pedestrians appeared to be more willing to start the crossing process when they are not supposed to, although that does not mean they did not clear the intersection before the release of conflicting traffic; with the display of the time remaining for the crossing process, pedestrians seem to adjust their speed. CDPS may not make much difference in areas where pedestrians are less disciplined and/or exhibit disorderly behavior.

Acknowledgement:

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APPENDIX A:

Survey and data reduction forms

Grand River and Abbott

Pedestrians that clear before solid don't walk		Peds that don't clear before solid don't walk	
Total =		Total =	

Peds That started crossing during flashing don't walk	Peds crossing on Solid Don't Walk
Total =	Total =

Distance across intersection (1/2 lane)

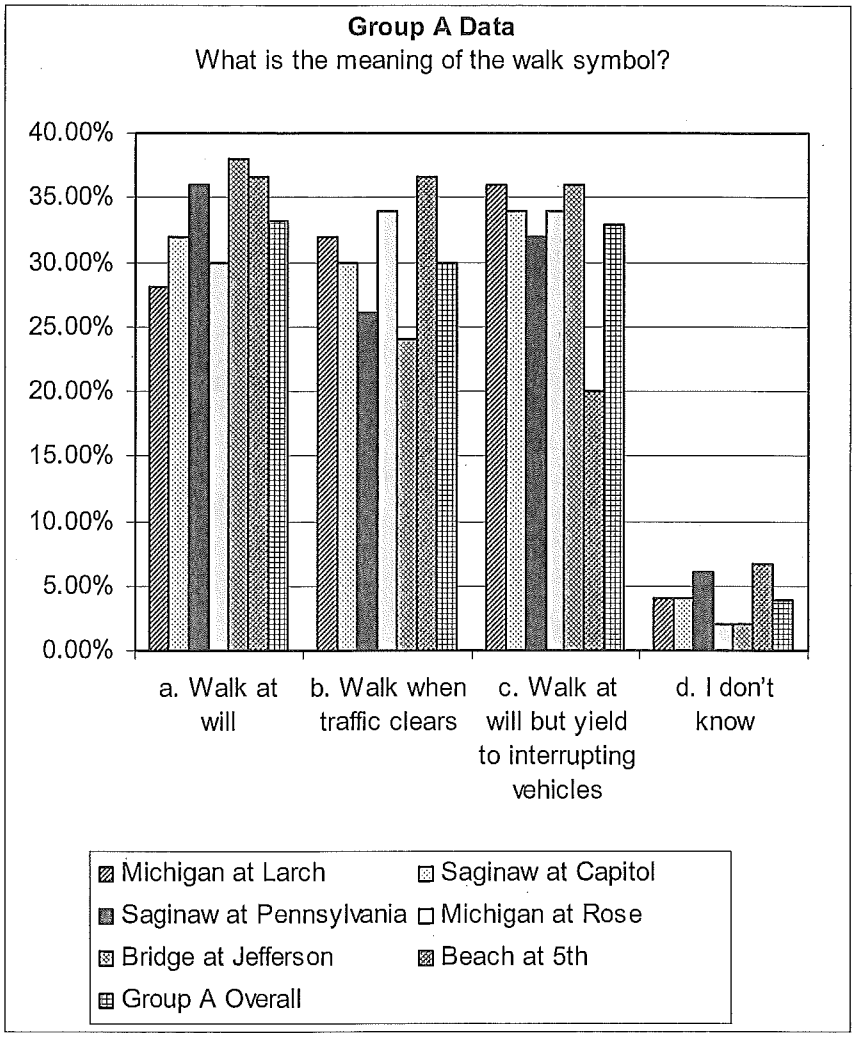
How far from clearing the intersection were the pedestrians in half lane distances

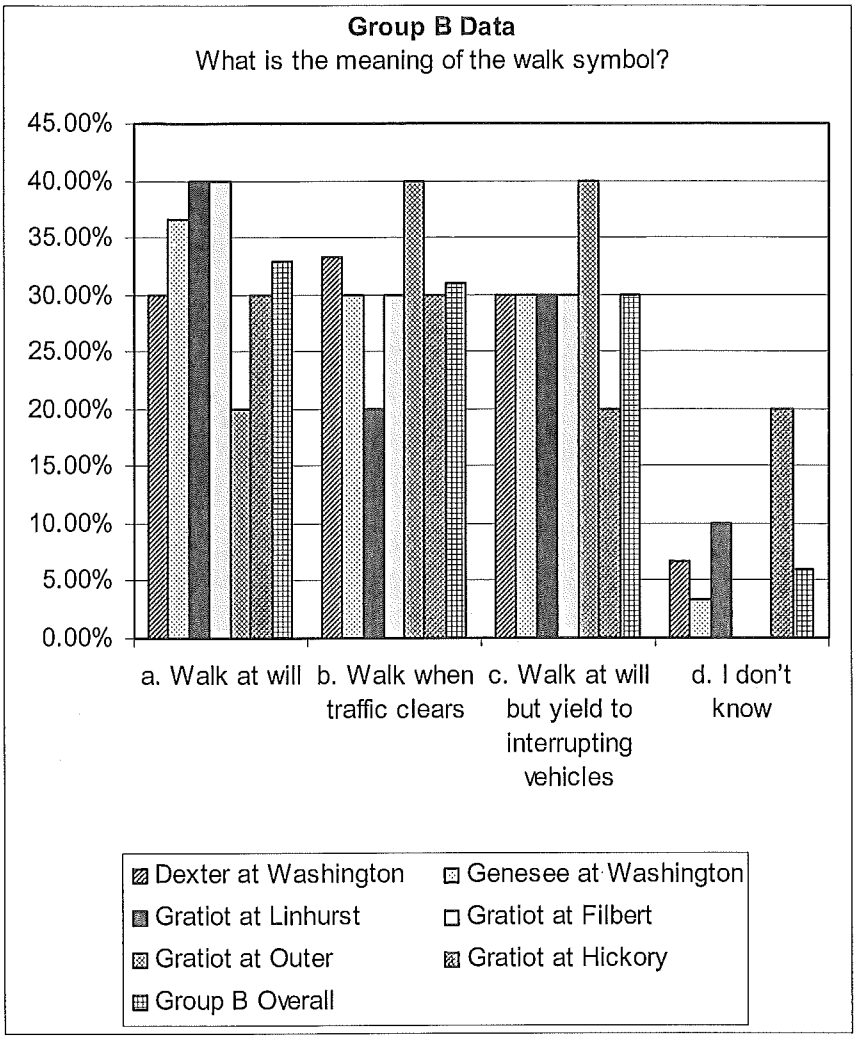
		1/2
		1
		1-1/2
		2
		2-1/2
		Island
		3-1/2
		4
		4-1/2
		5
		5-1/2

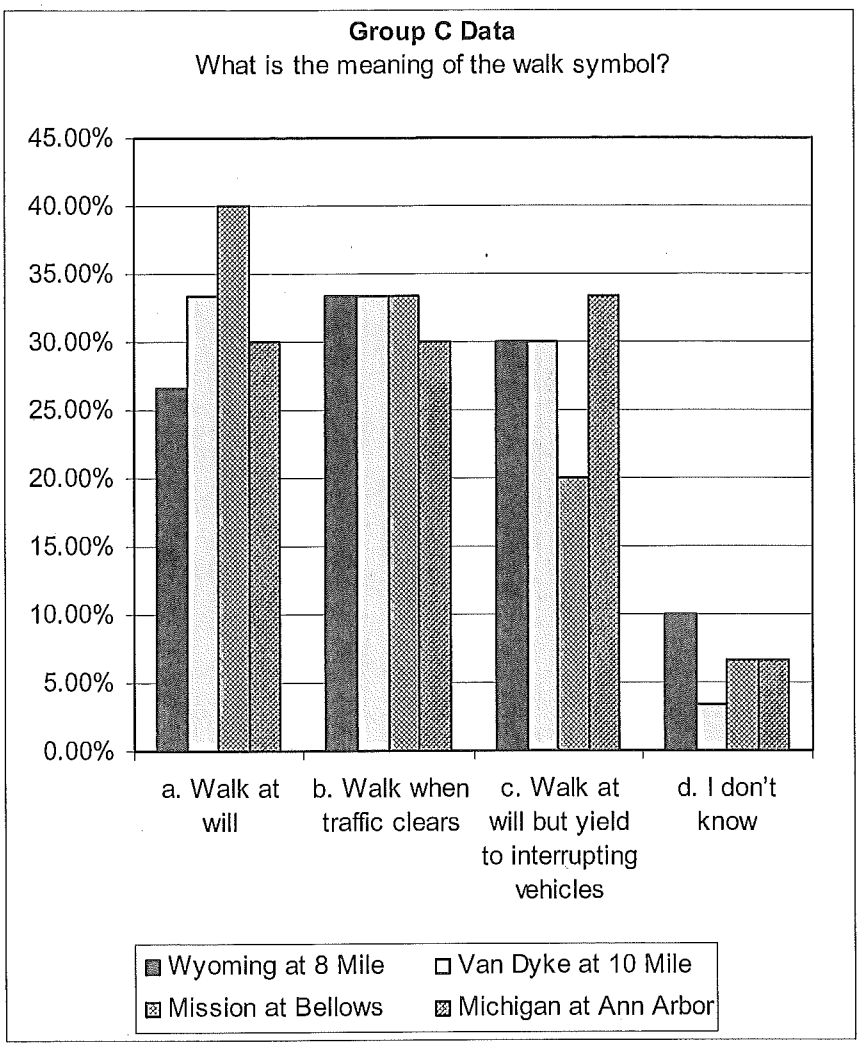
APPENDIX B:

Understanding of pedestrian signal head displays

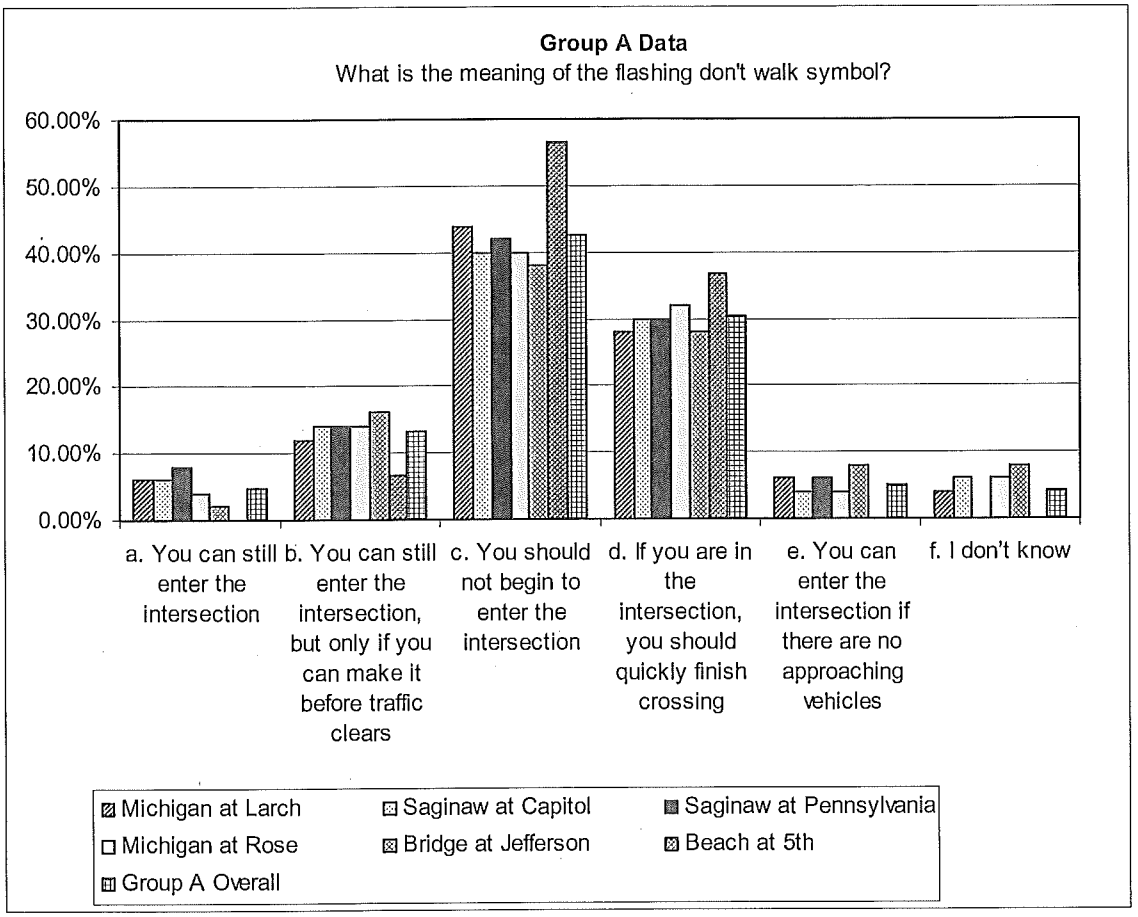
Walk

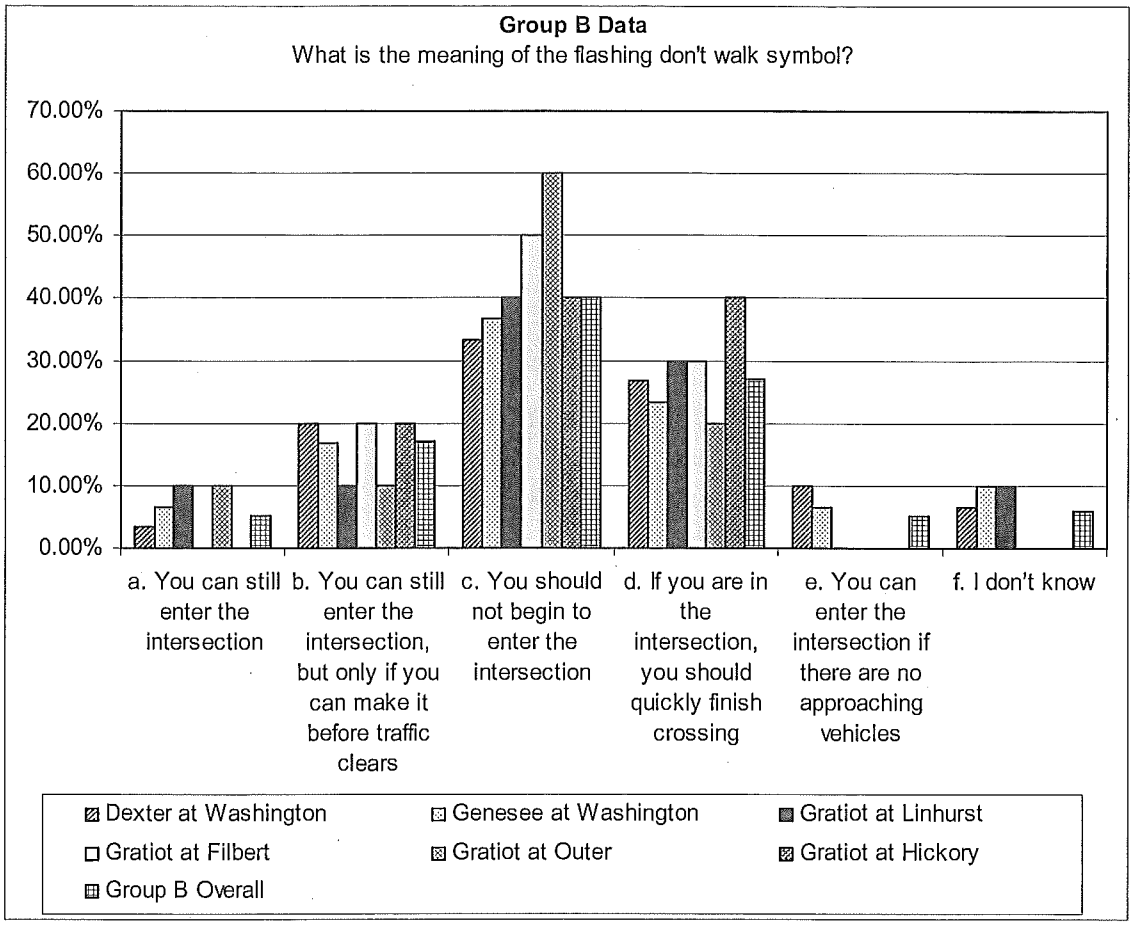

Group A Data
What is the meaning of the walk symbol?
40.00%
35.00%
30.00%
25.00%
20.00%
15.00%
10.00%
5.00%
0.00%
a. Walk at will
b. Walk when traffic clears
c. Walk at will but yield to interrupting vehicles
d. I don't know
Michigan at Larch
Saginaw at Capitol
Saginaw at Pennsylvania
Michigan at Rose
Bridge at Jefferson
Beach at 5th
Group A Overall

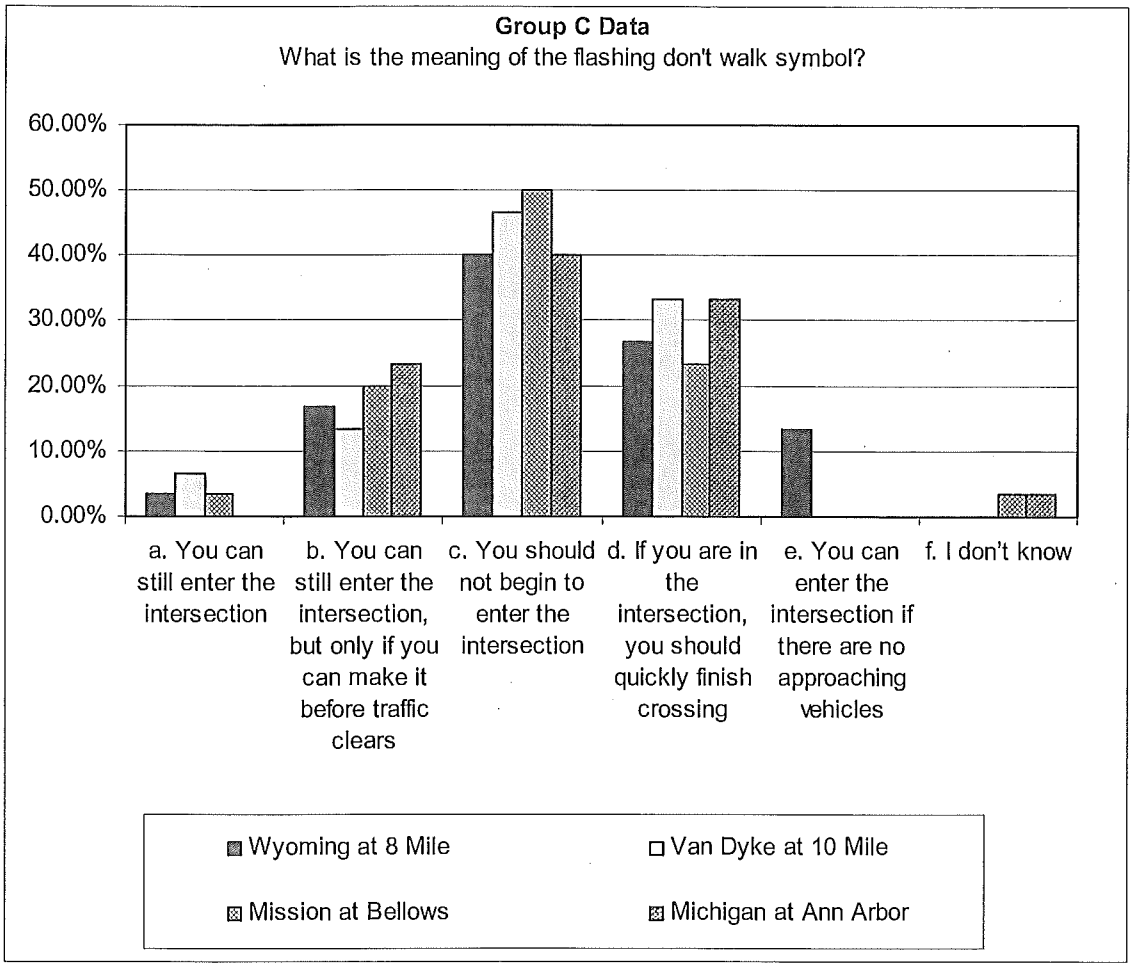

Group B Data
What is the meaning of the walk symbol?
45.00%
40.00%
35.00%
30.00%
25.00%
20.00%
15.00%
10.00%
5.00%
0.00%
a. Walk at will
b. Walk when traffic clears
c. Walk at will but yield to interrupting vehicles
d. I don't know
Dexter at Washington
Genesee at Washington
Gratiot at Linhurst
Gratiot at Filbert
Gratiot at Outer
Gratiot at Hickory
Group B Overall


Group C Data
What is the meaning of the walk symbol?
45.00%
40.00%
35.00%
30.00%
25.00%
20.00%
15.00%
10.00%
5.00%
0.00%
a. Walk at will
b. Walk when traffic clears
c. Walk at will but yield to interrupting vehicles
d. I don't know
Wyoming at 8 Mile
Van Dyke at 10 Mile
Mission at Bellows
Michigan at Ann Arbor

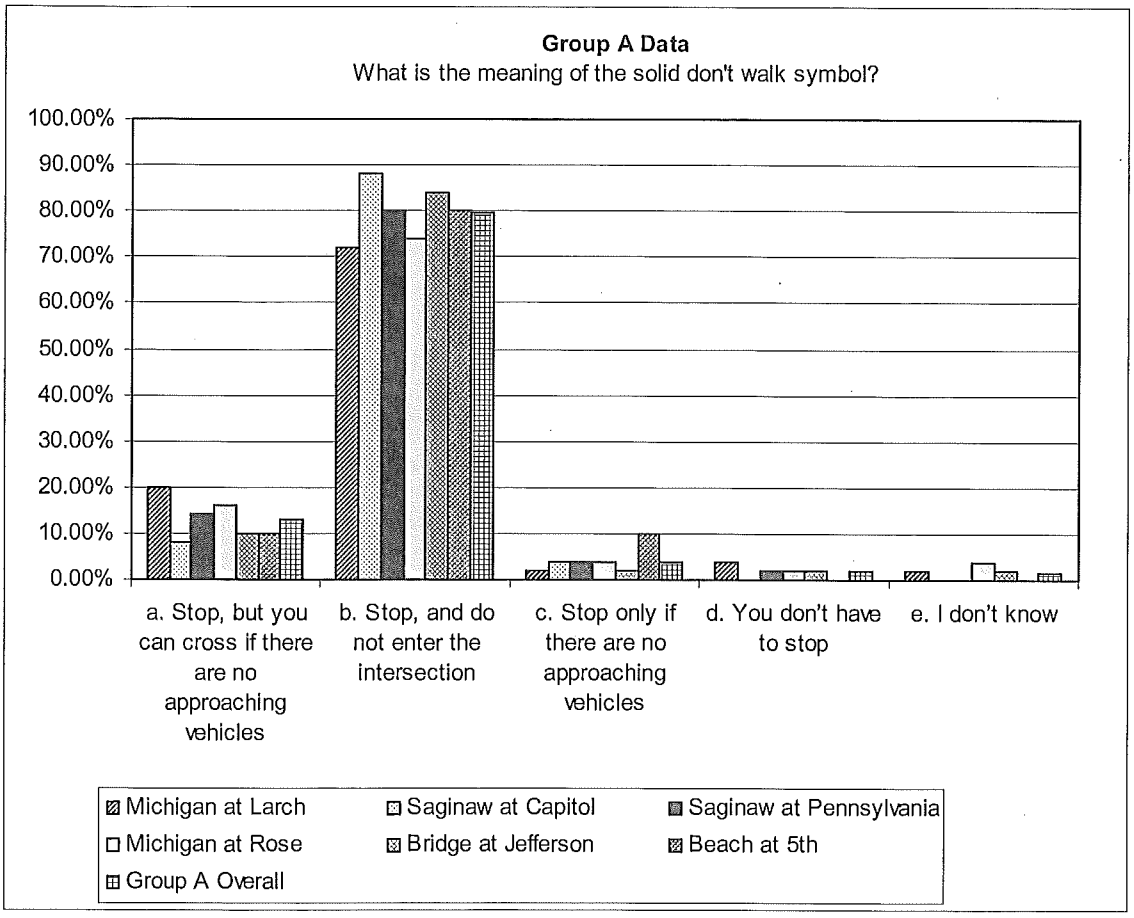
Flashing Don't Walk

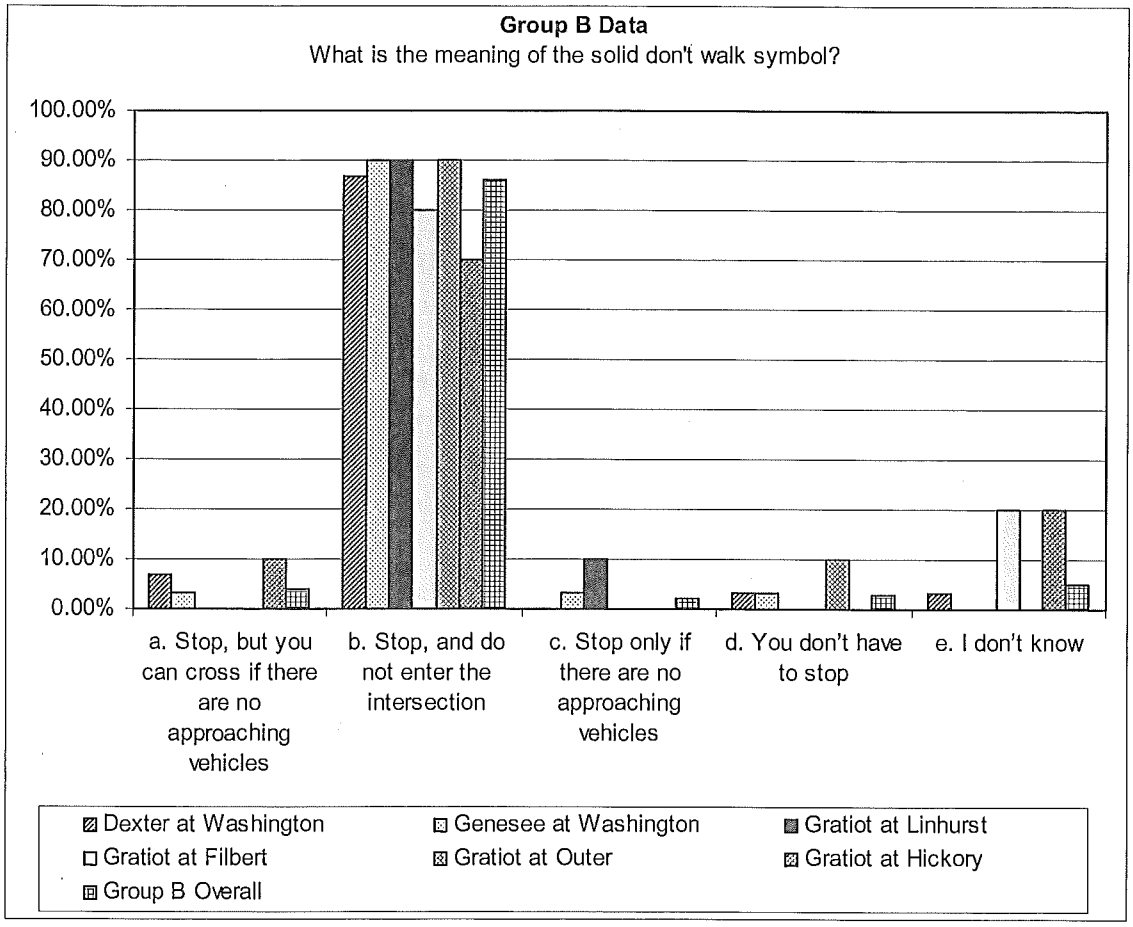


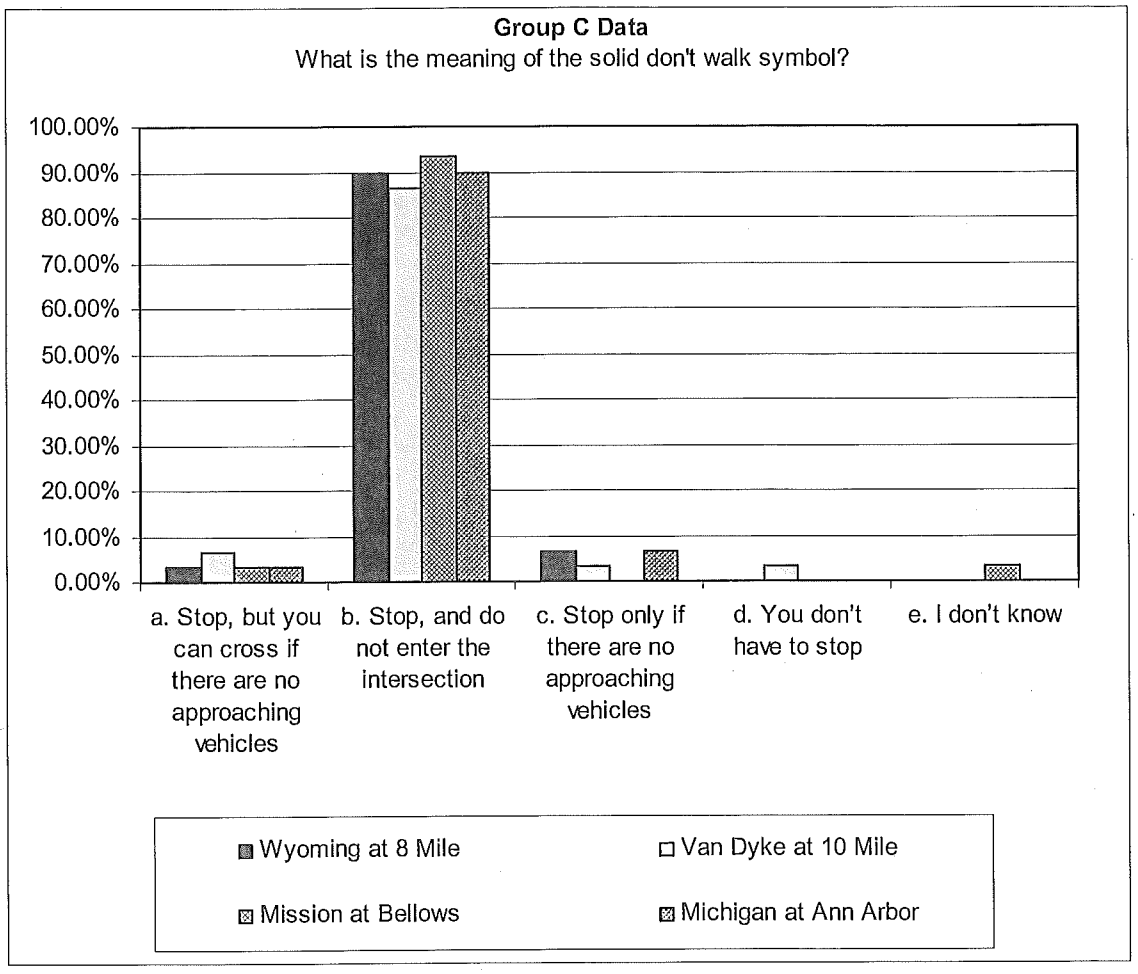

Group B Data
What is the meaning of the flashing don't walk symbol?
70.00%
60.00%
50.00%
40.00%
30.00%
20.00%
10.00%
0.00%
a. You can still enter the intersection
b. You can still enter the intersection, but only if you can make it before traffic clears
c. You should not begin to enter the intersection
d. If you are in the intersection, you should quickly finish crossing
e. You can enter the intersection if there are no approaching vehicles
f. I don't know
Dexter at Washington
Genesee at Washington
Gratiot at Linhurst
Gratiot at Filbert
Gratiot at Outer
Gratiot at Hickory
Group B Overall


Group C Data
What is the meaning of the flashing don't walk symbol?
60.00%
50.00%
40.00%
30.00%
20.00%
10.00%
0.00%
a. You can still enter the intersection
b. You can still enter the intersection, but only if you can make it before traffic clears
c. You should not begin to enter the intersection
d. If you are in the intersection, you should quickly finish crossing
e. You can enter the intersection if there are no approaching vehicles
f. I don't know
Wyoming at 8 Mile
Van Dyke at 10 Mile
Mission at Bellows
Michigan at Ann Arbor

Solid Don't Walk

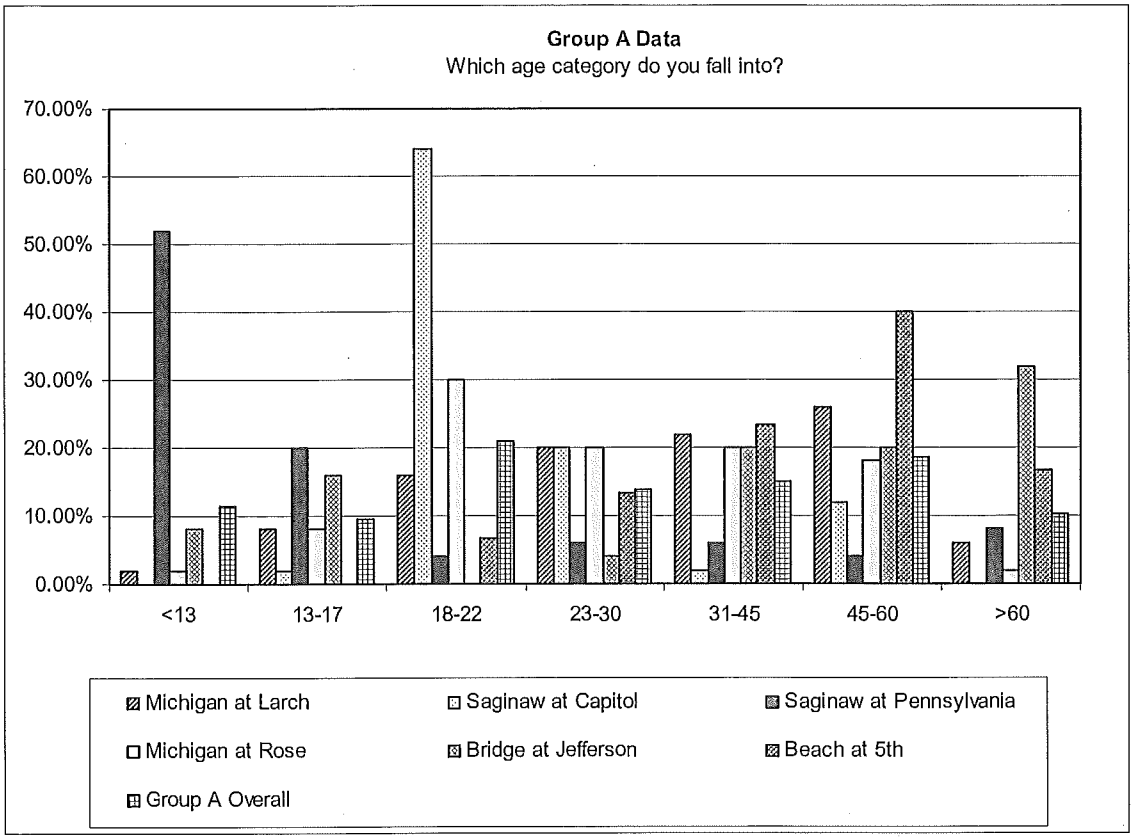


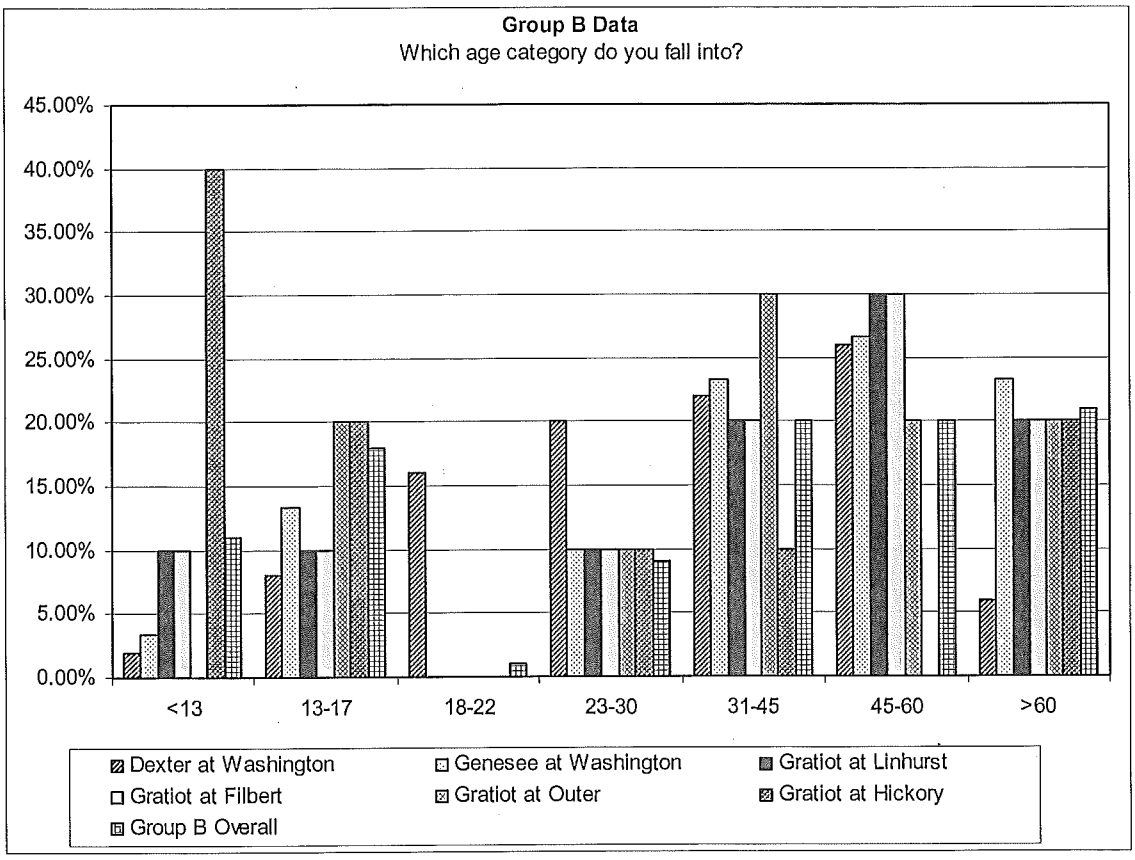

Group B Data
What is the meaning of the solid don't walk symbol?
100.00%
90.00%
80.00%
70.00%
60.00%
50.00%
40.00%
30.00%
20.00%
10.00%
0.00%
a. Stop, but you can cross if there are no approaching vehicles
b. Stop, and do not enter the intersection
c. Stop only if there are no approaching vehicles
d. You don't have to stop
e. I don't know
Dexter at Washington
Genesee at Washington
Gratiot at Linhurst
Gratiot at Filbert
Gratiot at Outer
Gratiot at Hickory
Group B Overall

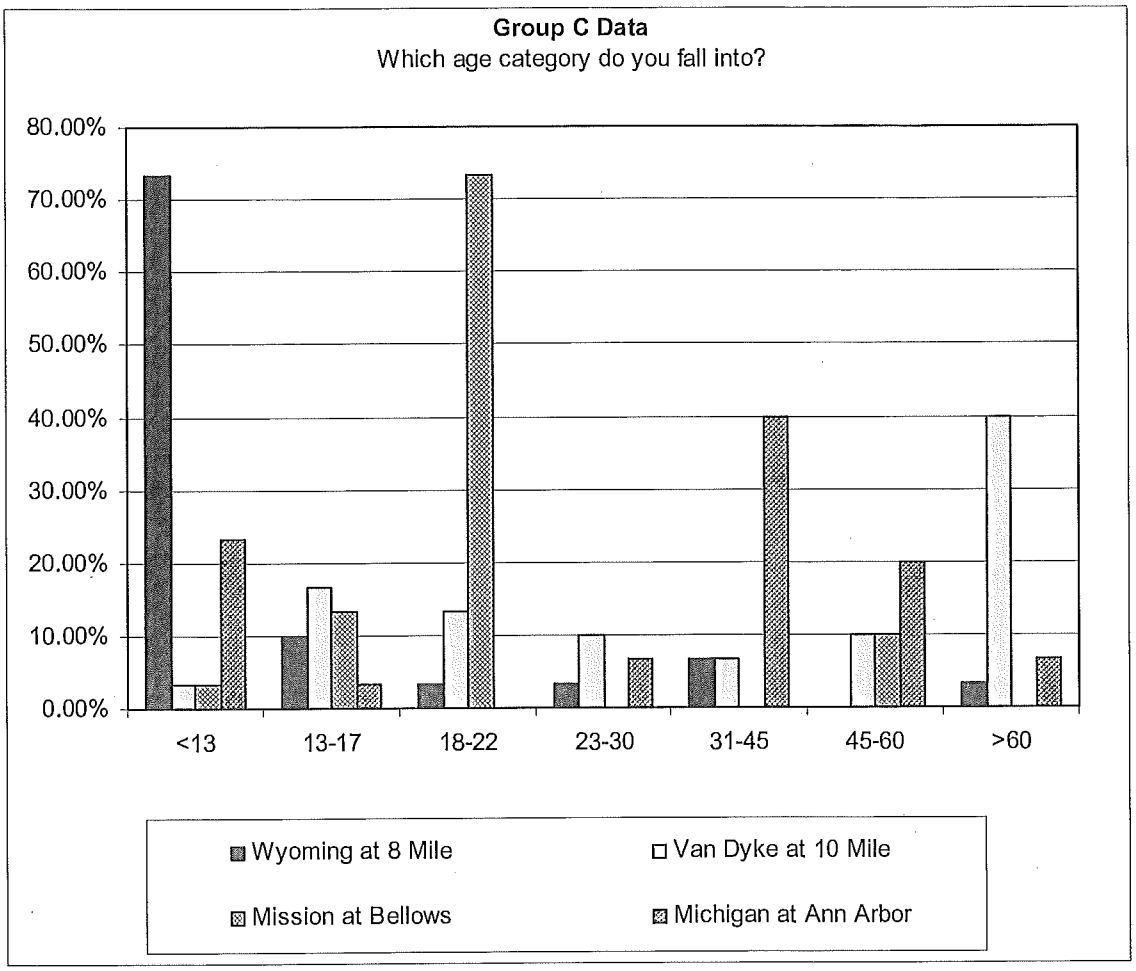

Group C Data
What is the meaning of the solid don't walk symbol?
100.00%
90.00%
80.00%
70.00%
60.00%
50.00%
40.00%
30.00%
20.00%
10.00%
0.00%
a. Stop, but you can cross if there are no approaching vehicles
b. Stop, and do not enter the intersection
c. Stop only if there are no approaching vehicles
d. You don't have to stop
e. I don't know
Wyoming at 8 Mile
Van Dyke at 10 Mile
Mission at Bellows
Michigan at Ann Arbor

APPENDIX C:

Age distribution of pedestrians at stud locations ("after" conditions)


Group A Data
Which age category do you fall into?
70.00%
60.00%
50.00%
40.00%
30.00%
20.00%
10.00%
0.00%
<13
13-17
18-22
23-30
31-45
45-60
>60
Michigan at Larch
Saginaw at Capitol
Saginaw at Pennsylvania
Michigan at Rose
Bridge at Jefferson
Beach at 5th
Group A Overall


Group B Data
Which age category do you fall into?
45.00%
40.00%
35.00%
30.00%
25.00%
20.00%
15.00%
10.00%
5.00%
0.00%
<13
13-17
18-22
23-30
31-45
45-60
>60
Dexter at Washington
Genesee at Washington
Gratiot at Linhurst
Gratiot at Filbert
Gratiot at Outer
Gratiot at Hickory
Group B Overall


Group C Data
Which age category do you fall into?
80.00%
70.00%
60.00%
50.00%
40.00%
30.00%
20.00%
10.00%
0.00%
<13
13-17
18-22
23-30
31-45
45-60
>60
Wyoming at 8 Mile
Van Dyke at 10 Mile
Mission at Bellows
Michigan at Ann Arbor

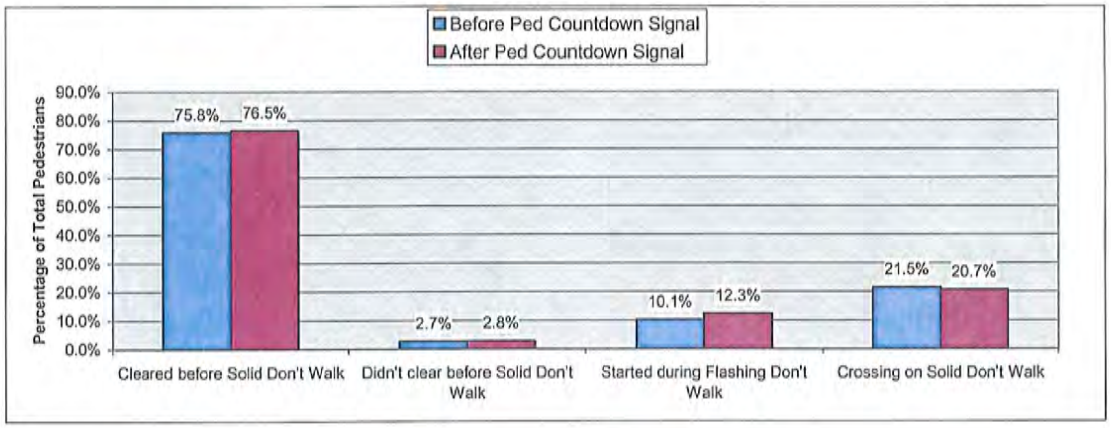
APPENDIX D:

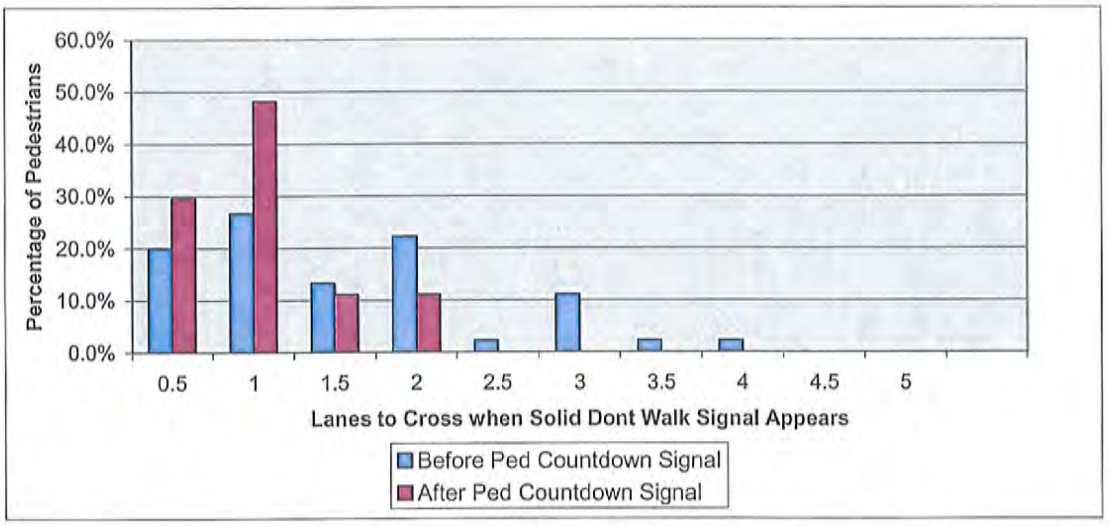
Pedestrians' compliance at individual intersections

Saginaw at Capitol
Lansing, MI

	BEFORE		AFTER	
	Amount	%	Amount	%
Cleared before Solid Don't Walk	1282	75.8%	1093	76.5%
Didn't clear before Solid Don't Walk	45	2.7%	40	2.8%
Started during Flashing Don't Walk	171	10.1%	175	12.3%
Crossing on Solid Don't Walk	364	21.5%	295	20.7%

Distance Across Intersection (1/2 Lane)											
lanes	0.5	1	1.5	2	2.5	3	3.5	4	4.5	5	
before	9	12	6	10	1	5	1	1	0	0	
before %	20.0%	26.7%	13.3%	22.2%	2.2%	11.1%	2.2%	2.2%	0.0%	0.0%	
after	8	13	3	3	0	0	0	0	0	0	
after %	29.6%	48.1%	11.1%	11.1%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	

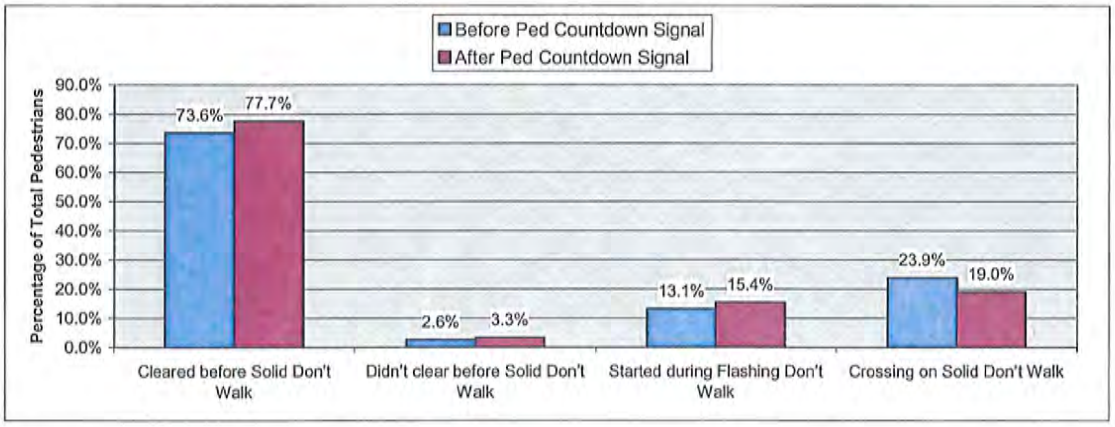


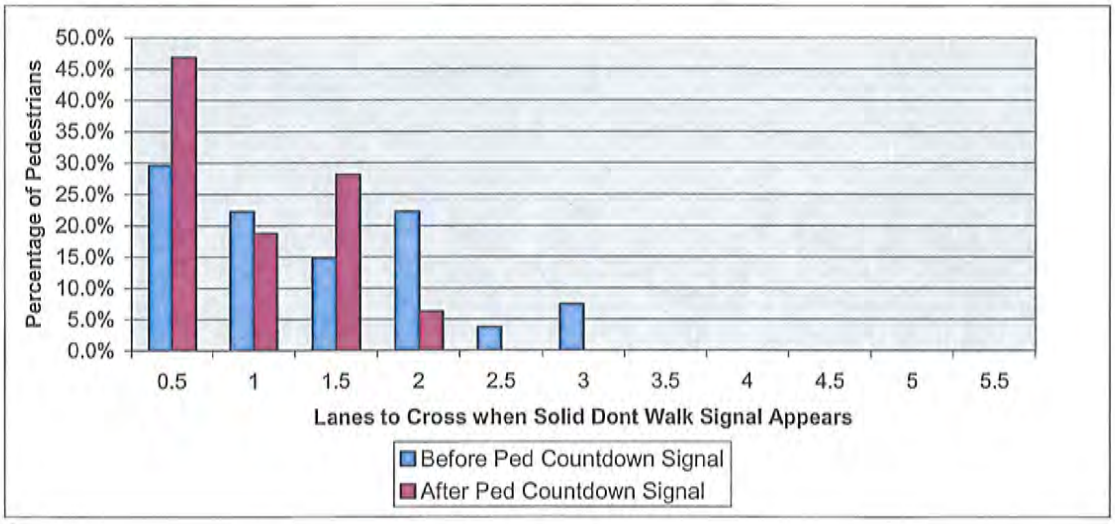


Michigan at Larch
Lansing, MI

	BEFORE		AFTER	
	Amount	%	Amount	%
Cleared before Solid Don't Walk	774	73.6%	779	77.7%
Didn't clear before Solid Don't Walk	27	2.6%	33	3.3%
Started during Flashing Don't Walk	138	13.1%	154	15.4%
Crossing on Solid Don't Walk	251	23.9%	191	19.0%

Distance Across Intersection (1/2 Lane)											
lanes	0.5	1	1.5	2	2.5	3	3.5	4	4.5	5	5.5
before	8	6	4	6	1	2	0	0	0	0	0
before %	29.6%	22.2%	14.8%	22.2%	3.7%	7.4%	0.0%	0.0%	0.0%	0.0%	0.0%
after	15	6	9	2	0	0	0	0	0	0	0
after %	46.9%	18.8%	28.1%	6.3%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%

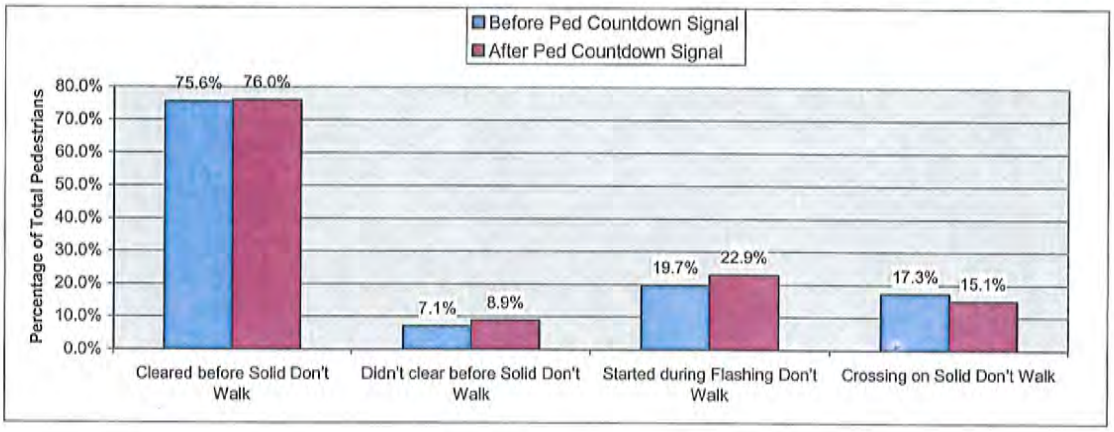


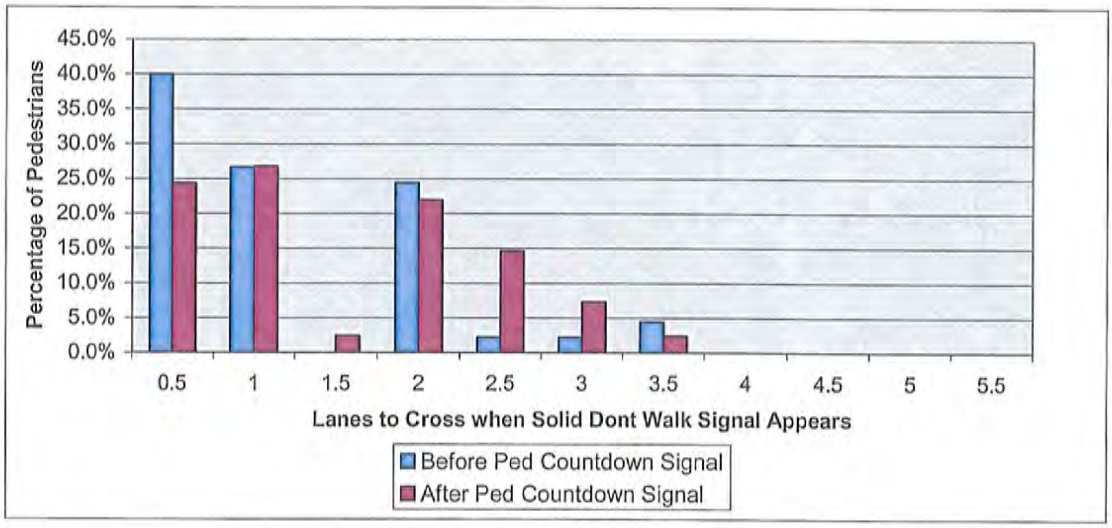


Saginaw at Pennsylvania
Lansing, MI

	BEFORE		AFTER	
	Amount	%	Amount	%
Cleared before Solid Don't Walk	530	75.6%	352	76.0%
Didn't clear before Solid Don't Walk	50	7.1%	41	8.9%
Started during Flashing Don't Walk	138	19.7%	106	22.9%
Crossing on Solid Don't Walk	121	17.3%	70	15.1%

Distance Across Intersection (1/2 Lane)											
lanes	0.5	1	1.5	2	2.5	3	3.5	4	4.5	5	5.5
before	18	12	0	11	1	1	2	0	0	0	0
before %	40.0%	26.7%	0.0%	24.4%	2.2%	2.2%	4.4%	0.0%	0.0%	0.0%	0.0%
after	10	11	1	9	6	3	1	0	0	0	0
after %	24.4%	26.8%	2.4%	22.0%	14.6%	7.3%	2.4%	0.0%	0.0%	0.0%	0.0%

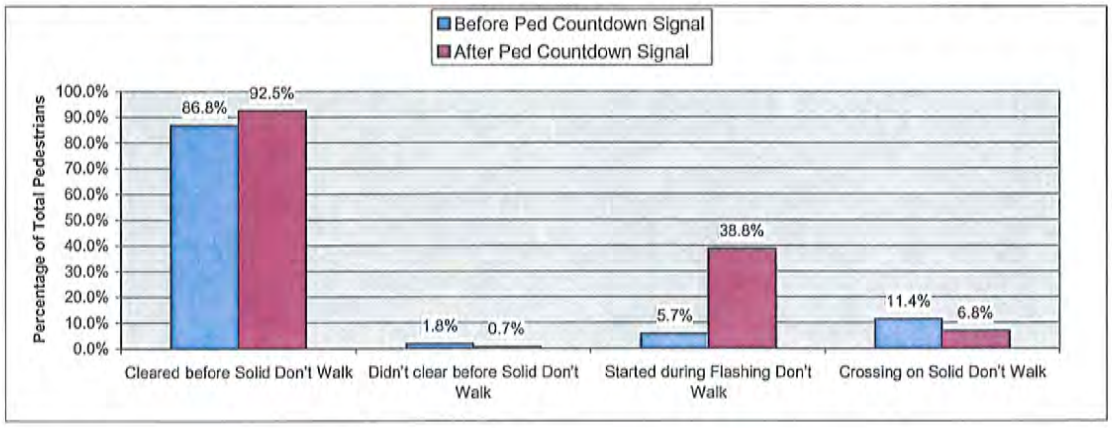


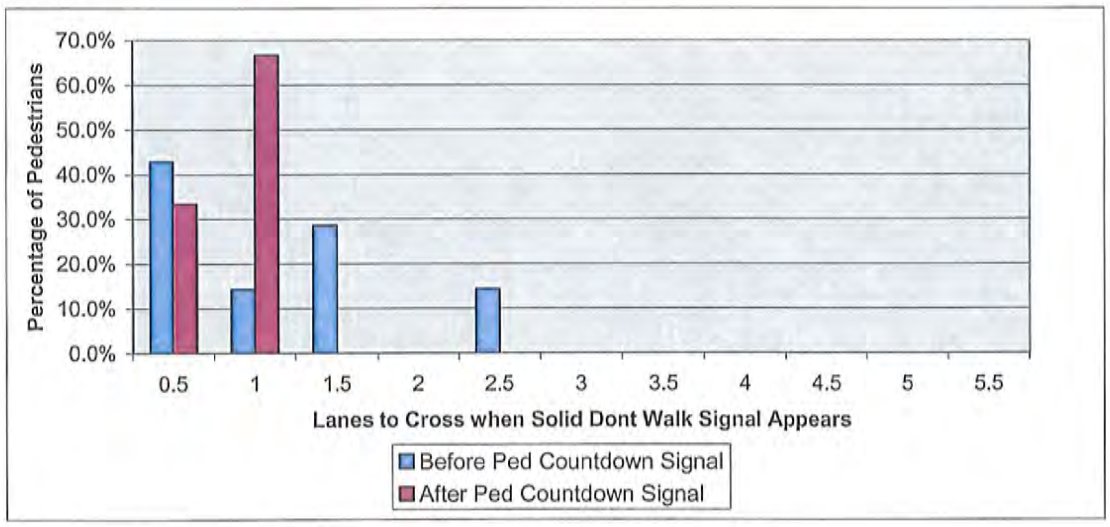


Dexter at Washington
Ionia, MI

	BEFORE		AFTER	
	Amount	%	Amount	%
Cleared before Solid Don't Walk	335	86.8%	284	92.5%
Didn't clear before Solid Don't Walk	7	1.8%	2	0.7%
Started during Flashing Don't Walk	22	5.7%	119	38.8%
Crossing on Solid Don't Walk	44	11.4%	21	6.8%

Distance Across Intersection (1/2 Lane)											
lanes	0.5	1	1.5	2	2.5	3	3.5	4	4.5	5	5.5
before	3	1	2	0	1	0	0	0	0	0	0
before %	42.9%	14.3%	28.6%	0.0%	14.3%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%
after	1	2	0	0	0	0	0	0	0	0	0
after %	33.3%	66.7%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%

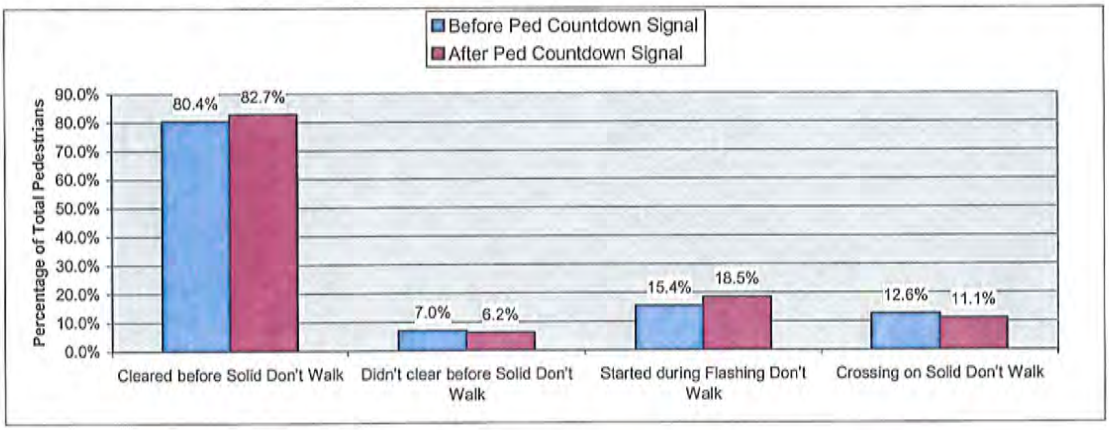


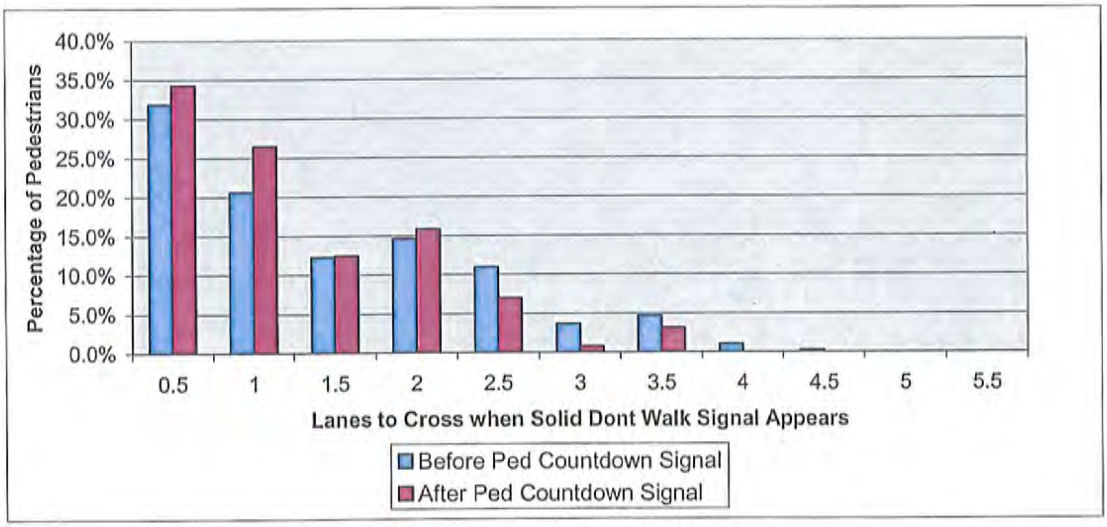


Michigan at Rose
Kalamazoo, MI

	BEFORE		AFTER	
	Amount	%	Amount	%
Cleared before Solid Don't Walk	5568	80.4%	5169	82.7%
Didn't clear before Solid Don't Walk	483	7.0%	387	6.2%
Started during Flashing Don't Walk	1067	15.4%	1158	18.5%
Crossing on Solid Don't Walk	871	12.6%	693	11.1%

Distance Across Intersection (1/2 Lane)											
lanes	0.5	1	1.5	2	2.5	3	3.5	4	4.5	5	5.5
before	122	79	47	56	42	14	18	4	1	0	0
before %	31.9%	20.6%	12.3%	14.6%	11.0%	3.7%	4.7%	1.0%	0.3%	0.0%	0.0%
after	132	102	48	61	27	3	12	0	0	0	0
after %	34.3%	26.5%	12.5%	15.8%	7.0%	0.8%	3.1%	0.0%	0.0%	0.0%	0.0%

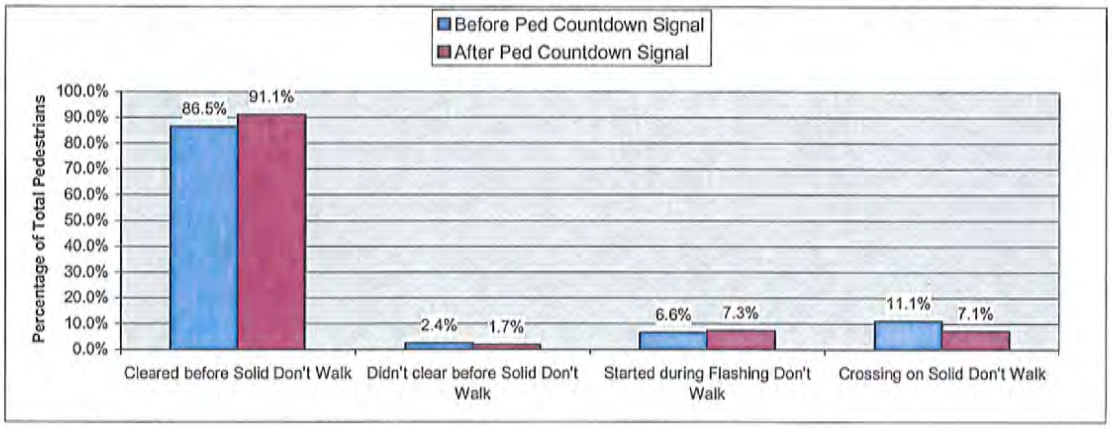


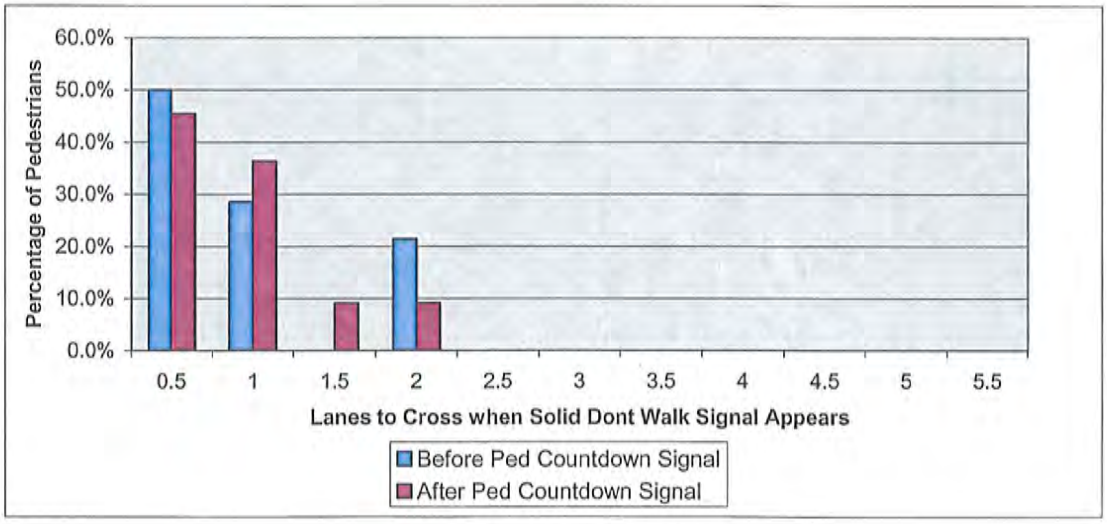


Bridge at Jefferson
Grand Ledge, MI

	BEFORE		AFTER	
	Amount	%	Amount	%
Cleared before Solid Don't Walk	498	86.5%	574	91.1%
Didn't clear before Solid Don't Walk	14	2.4%	11	1.7%
Started during Flashing Don't Walk	38	6.6%	46	7.3%
Crossing on Solid Don't Walk	64	11.1%	45	7.1%

Distance Across Intersection (1/2 Lane)											
lanes	0.5	1	1.5	2	2.5	3	3.5	4	4.5	5	5.5
before	7	4	0	3	0	0	0	0	0	0	0
before %	50.0%	28.6%	0.0%	21.4%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%
after	5	4	1	1	0	0	0	0	0	0	0
after %	45.5%	36.4%	9.1%	9.1%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%

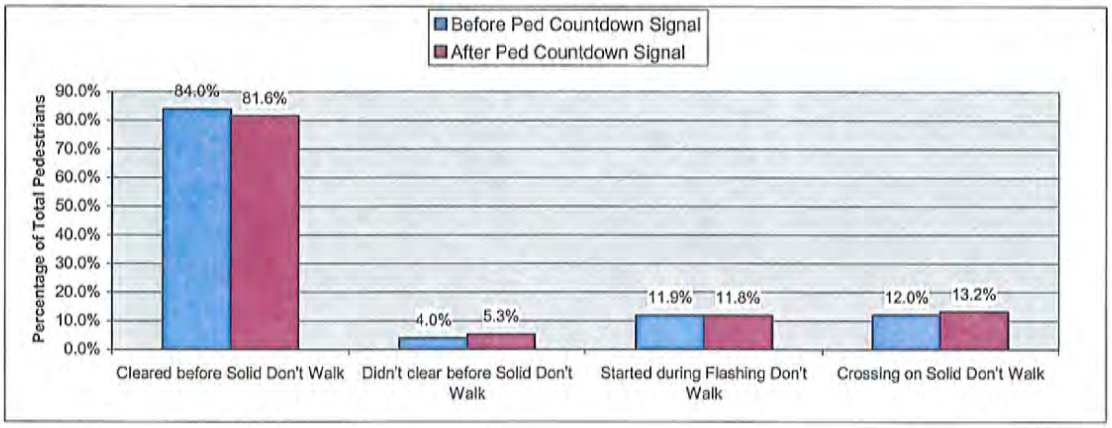


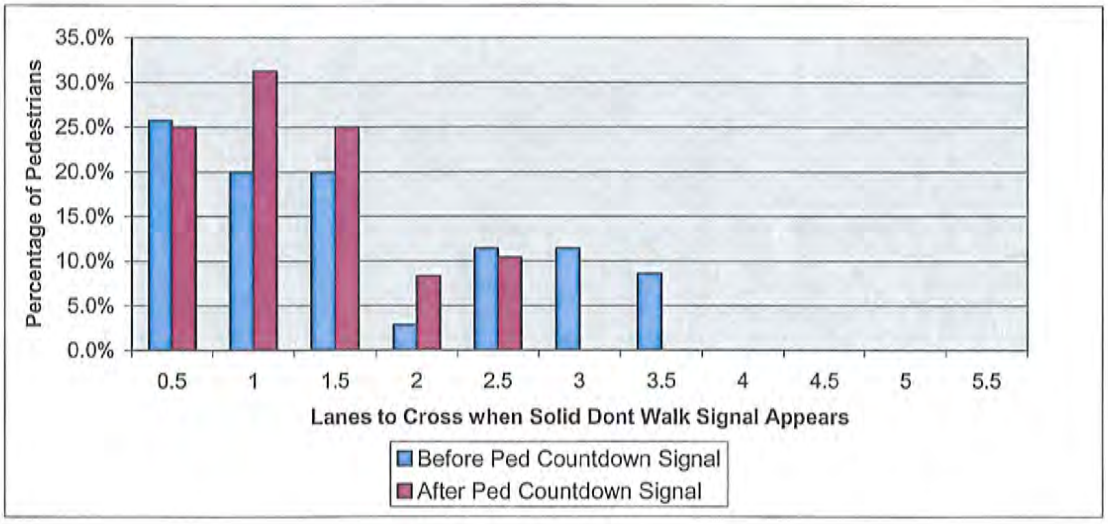


Genesee at Washington
Saginaw, MI

	BEFORE		AFTER	
	Amount	%	Amount	%
Cleared before Solid Don't Walk	697	84.0%	744	81.6%
Didn't clear before Solid Don't Walk	33	4.0%	48	5.3%
Started during Flashing Don't Walk	99	11.9%	108	11.8%
Crossing on Solid Don't Walk	100	12.0%	120	13.2%

Distance Across Intersection (1/2 Lane)											
lanes	0.5	1	1.5	2	2.5	3	3.5	4	4.5	5	5.5
before	9	7	7	1	4	4	3	0	0	0	0
before %	25.7%	20.0%	20.0%	2.9%	11.4%	11.4%	8.6%	0.0%	0.0%	0.0%	0.0%
after	12	15	12	4	5	0	0	0	0	0	0
after %	25.0%	31.3%	25.0%	8.3%	10.4%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%

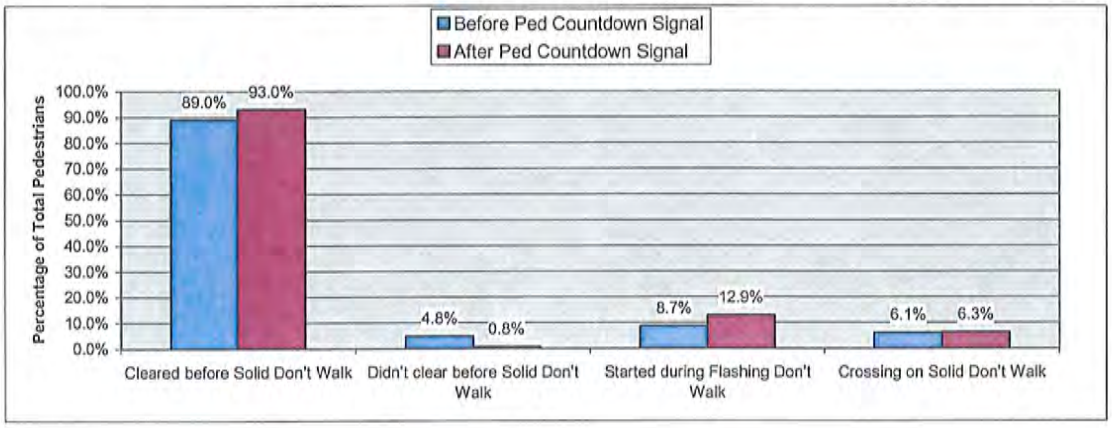


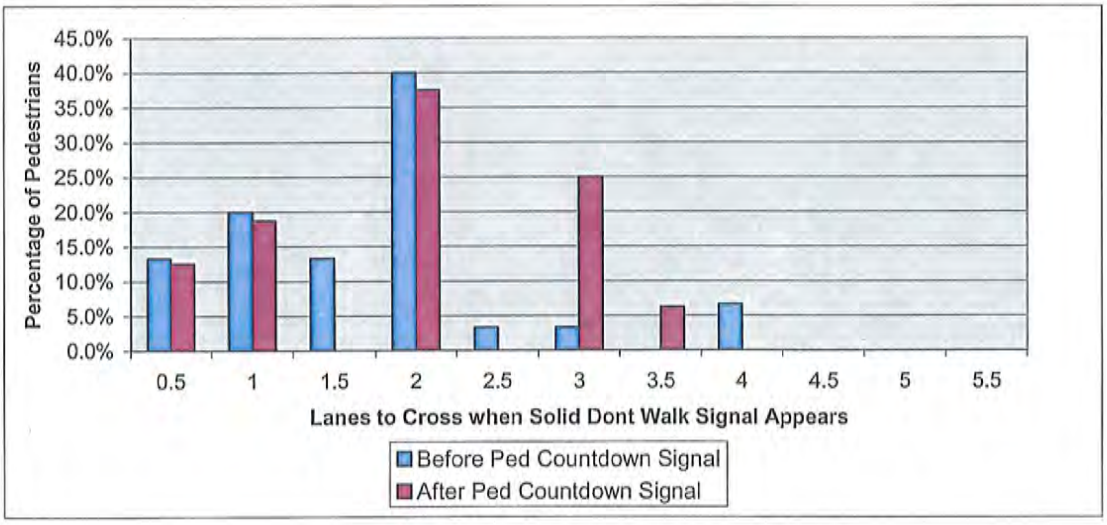


VanDyke at 10 Mile
Center Line, MI

	BEFORE		AFTER	
	Amount	%	Amount	%
Cleared before Solid Don't Walk	739	89.0%	742	93.0%
Didn't clear before Solid Don't Walk	40	4.8%	6	0.8%
Started during Flashing Don't Walk	72	8.7%	103	12.9%
Crossing on Solid Don't Walk	51	6.1%	50	6.3%

Distance Across Intersection (1/2 Lane)											
lanes	0.5	1	1.5	2	2.5	3	3.5	4	4.5	5	5.5
before	4	6	4	12	1	1	0	2	0	0	0
before %	13.3%	20.0%	13.3%	40.0%	3.3%	3.3%	0.0%	6.7%	0.0%	0.0%	0.0%
after	2	3	0	6	0	4	1	0	0	0	0
after %	12.5%	18.8%	0.0%	37.5%	0.0%	25.0%	6.3%	0.0%	0.0%	0.0%	0.0%

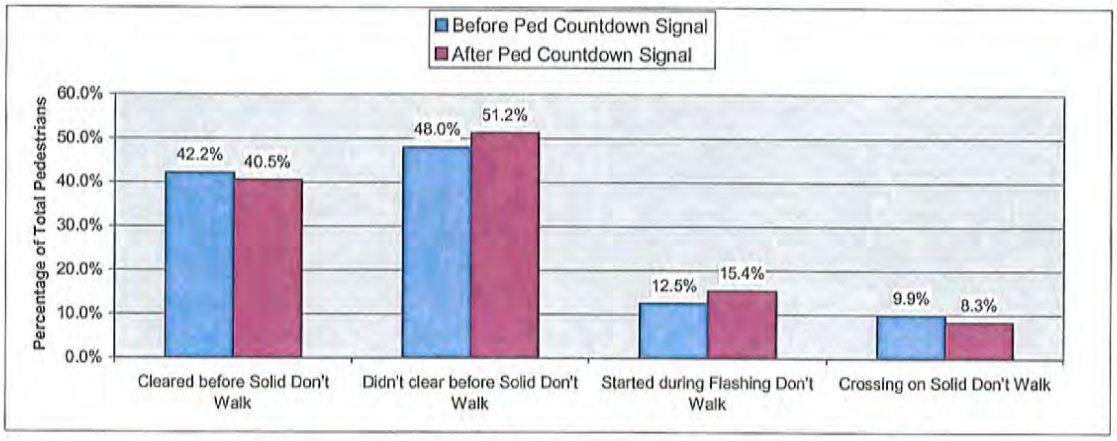


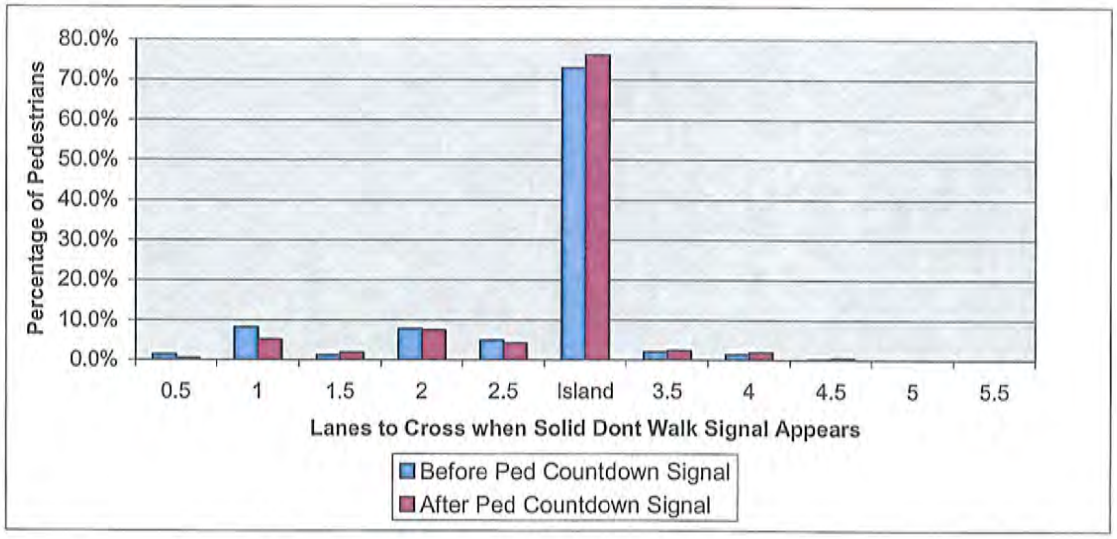


Wyoming at 8 Mile
Detroit, MI

	BEFORE		AFTER	
	Amount	%	Amount	%
Cleared before Solid Don't Walk	419	42.2%	498	40.5%
Didn't clear before Solid Don't Walk	477	48.0%	630	51.2%
Started during Flashing Don't Walk	124	12.5%	189	15.4%
Crossing on Solid Don't Walk	98	9.9%	102	8.3%

Distance Across Intersection (1/2 Lane)											
lanes	0.5	1	1.5	2	2.5	Island	3.5	4	4.5	5	5.5
before	7	40	6	38	24	358	10	7	1	0	0
before %	1.4%	8.1%	1.2%	7.7%	4.9%	72.9%	2.0%	1.4%	0.2%	0.0%	0.0%
after	3	33	12	48	27	489	15	12	3	0	0
after %	0.5%	5.1%	1.9%	7.5%	4.2%	76.2%	2.3%	1.9%	0.5%	0.0%	0.0%

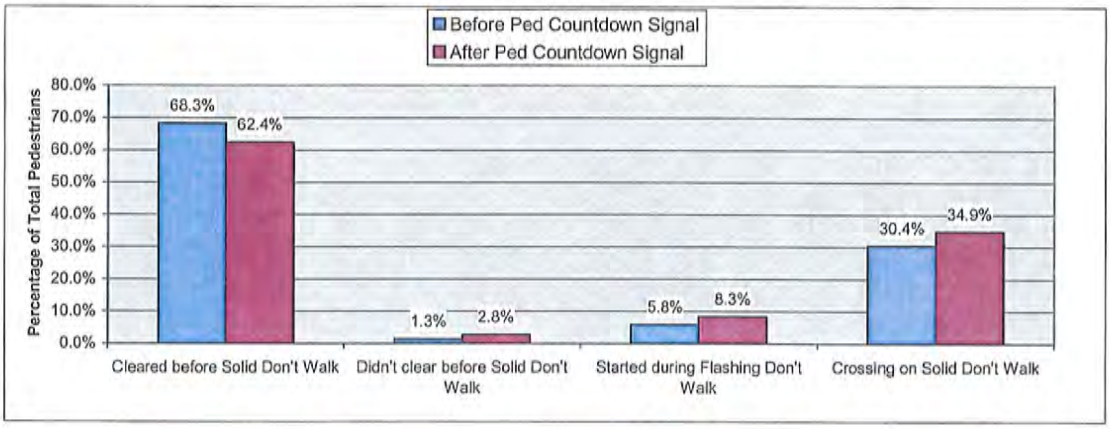


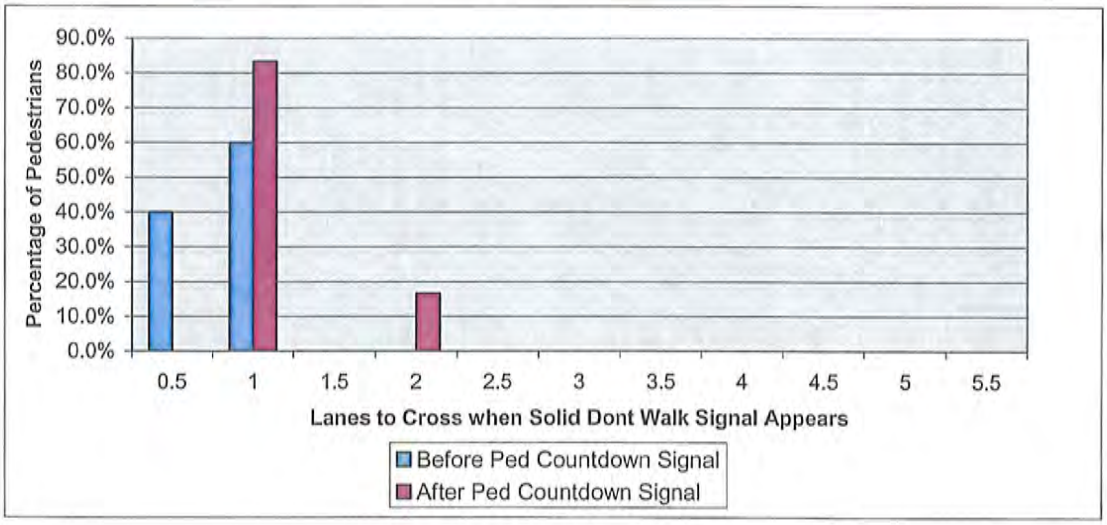


Mission at Bellows
Mount Pleasant, MI

	BEFORE		AFTER	
	Amount	%	Amount	%
Cleared before Solid Don't Walk	258	68.3%	136	62.4%
Didn't clear before Solid Don't Walk	5	1.3%	6	2.8%
Started during Flashing Don't Walk	22	5.8%	18	8.3%
Crossing on Solid Don't Walk	115	30.4%	76	34.9%

Distance Across Intersection (1/2 Lane)											
lanes	0.5	1	1.5	2	2.5	3	3.5	4	4.5	5	5.5
before	2	3	0	0	0	0	0	0	0	0	0
before %	40.0%	60.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%
after	0	5	0	1	0	0	0	0	0	0	0
after %	0.0%	83.3%	0.0%	16.7%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%

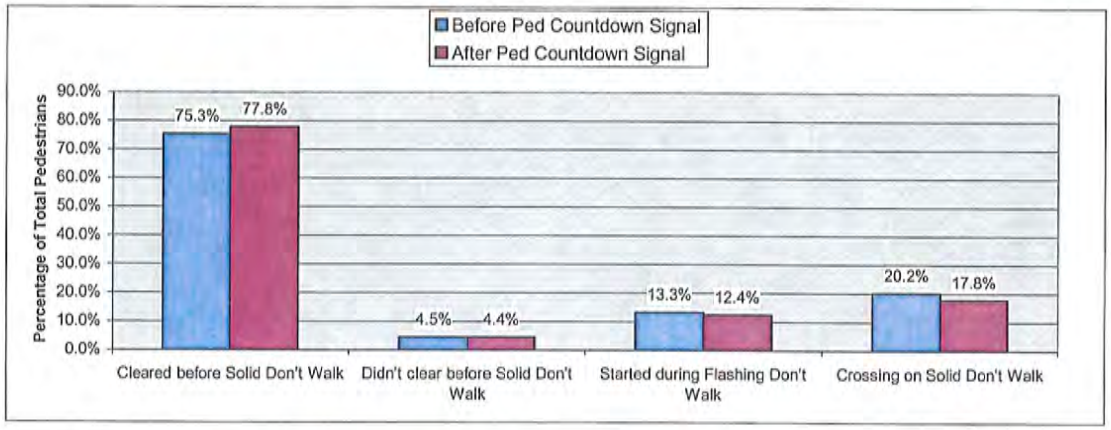


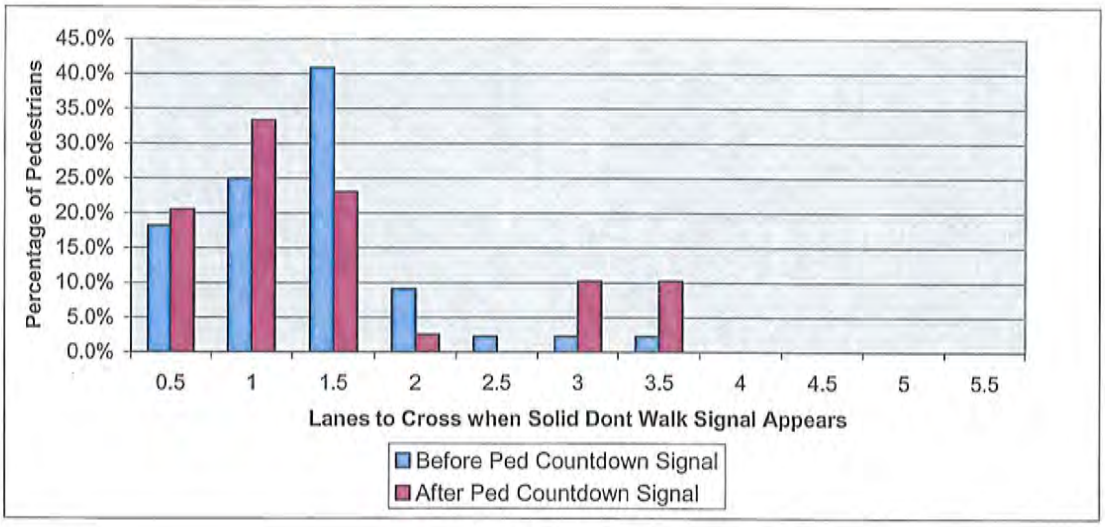


Beach at 5th
Flint, MI

	BEFORE		AFTER	
	Amount	%	Amount	%
Cleared before Solid Don't Walk	738	75.3%	647	77.8%
Didn't clear before Solid Don't Walk	44	4.5%	37	4.4%
Started during Flashing Don't Walk	130	13.3%	103	12.4%
Crossing on Solid Don't Walk	198	20.2%	148	17.8%

Distance Across Intersection (1/2 Lane)											
lanes	0.5	1	1.5	2	2.5	3	3.5	4	4.5	5	5.5
before	8	11	18	4	1	1	1	0	0	0	0
before %	18.2%	25.0%	40.9%	9.1%	2.3%	2.3%	2.3%	0.0%	0.0%	0.0%	0.0%
after	8	13	9	1	0	4	4	0	0	0	0
after %	20.5%	33.3%	23.1%	2.6%	0.0%	10.3%	10.3%	0.0%	0.0%	0.0%	0.0%

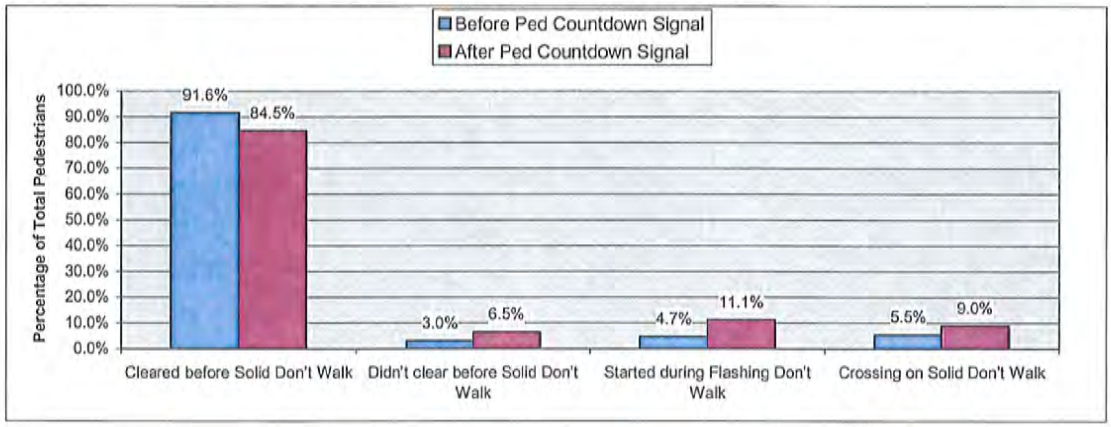


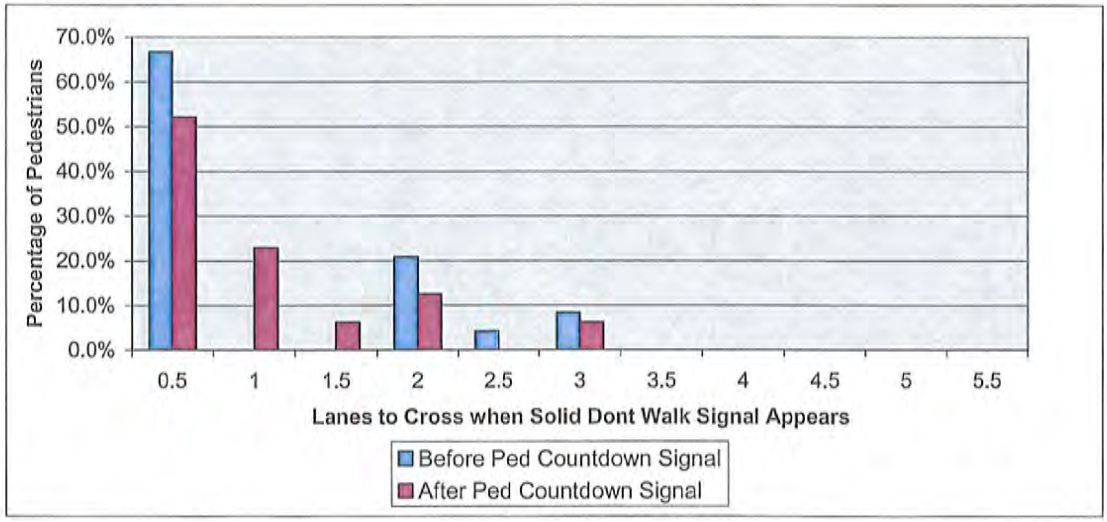


Michigan at Ann Arbor
Saline, MI

	BEFORE		AFTER	
	Amount	%	Amount	%
Cleared before Solid Don't Walk	739	91.6%	623	84.5%
Didn't clear before Solid Don't Walk	24	3.0%	48	6.5%
Started during Flashing Don't Walk	38	4.7%	82	11.1%
Crossing on Solid Don't Walk	44	5.5%	66	9.0%

Distance Across Intersection (1/2 Lane)											
lanes	0.5	1	1.5	2	2.5	3	3.5	4	4.5	5	5.5
before	16	0	0	5	1	2	0	0	0	0	0
before %	66.7%	0.0%	0.0%	20.8%	4.2%	8.3%	0.0%	0.0%	0.0%	0.0%	0.0%
after	25	11	3	6	0	3	0	0	0	0	0
after %	52.1%	22.9%	6.3%	12.5%	0.0%	6.3%	0.0%	0.0%	0.0%	0.0%	0.0%

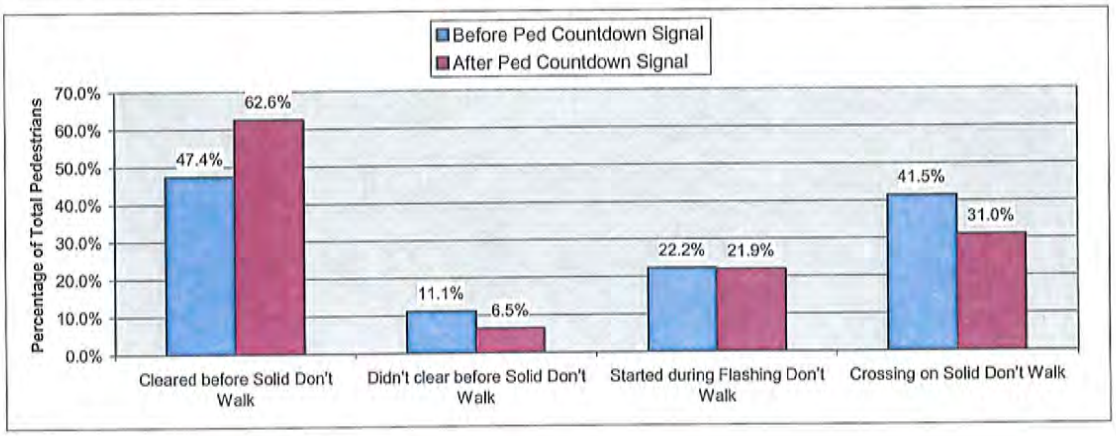


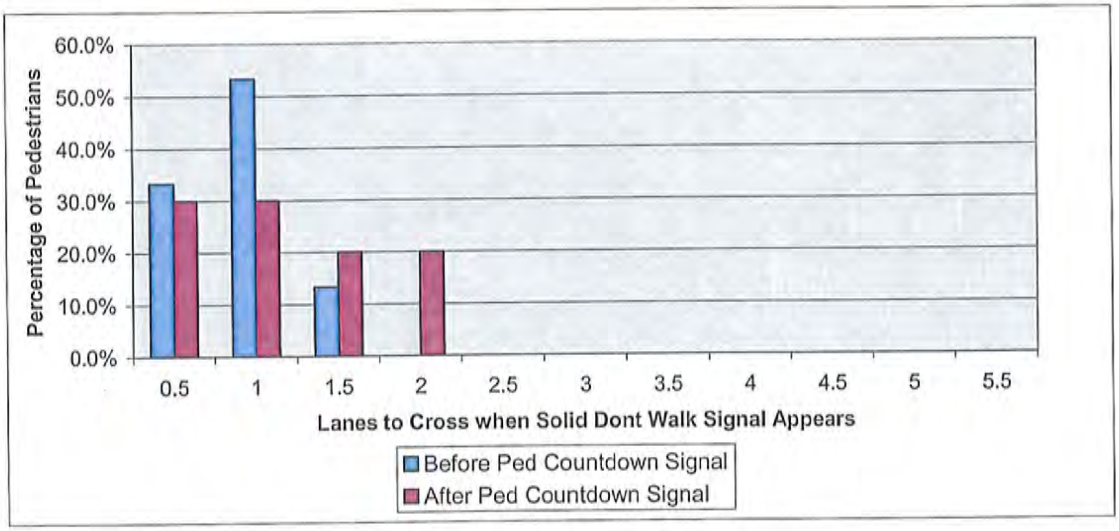


Gratiot at Filbert
Detroit, MI

	BEFORE		AFTER	
	Amount	%	Amount	%
Cleared before Solid Don't Walk	64	47.4%	97	62.6%
Didn't clear before Solid Don't Walk	15	11.1%	10	6.5%
Started during Flashing Don't Walk	30	22.2%	34	21.9%
Crossing on Solid Don't Walk	56	41.5%	48	31.0%

Distance Across Intersection (1/2 Lane)											
lanes	0.5	1	1.5	2	2.5	3	3.5	4	4.5	5	5.5
before	5	8	2	0	0	0	0	0	0	0	0
before %	33.3%	53.3%	13.3%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%
after	3	3	2	2	0	0	0	0	0	0	0
after %	30.0%	30.0%	20.0%	20.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%

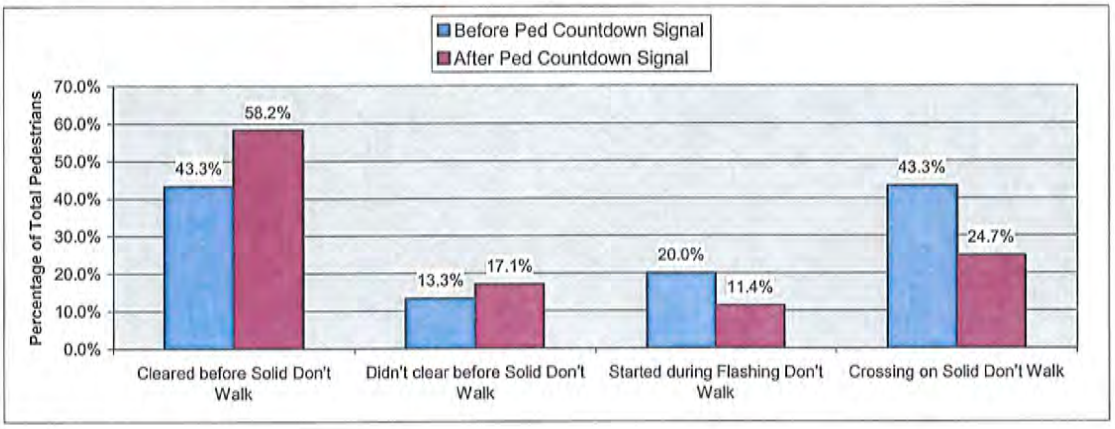


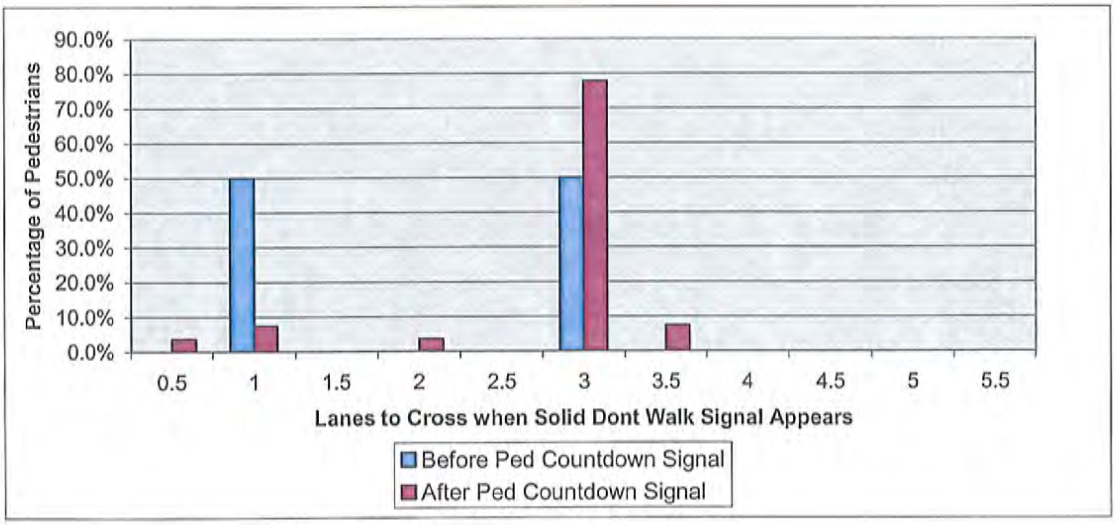


Gratiot at Outer
Detroit, MI

	BEFORE		AFTER	
	Amount	%	Amount	%
Cleared before Solid Don't Walk	13	43.3%	92	58.2%
Didn't clear before Solid Don't Walk	4	13.3%	27	17.1%
Started during Flashing Don't Walk	6	20.0%	18	11.4%
Crossing on Solid Don't Walk	13	43.3%	39	24.7%

Distance Across Intersection (1/2 Lane)											
lanes	0.5	1	1.5	2	2.5	3	3.5	4	4.5	5	5.5
before	0	2	0	0	0	2	0	0	0	0	0
before %	0.0%	50.0%	0.0%	0.0%	0.0%	50.0%	0.0%	0.0%	0.0%	0.0%	0.0%
after	1	2	0	1	0	21	2	0	0	0	0
after %	3.7%	7.4%	0.0%	3.7%	0.0%	77.8%	7.4%	0.0%	0.0%	0.0%	0.0%

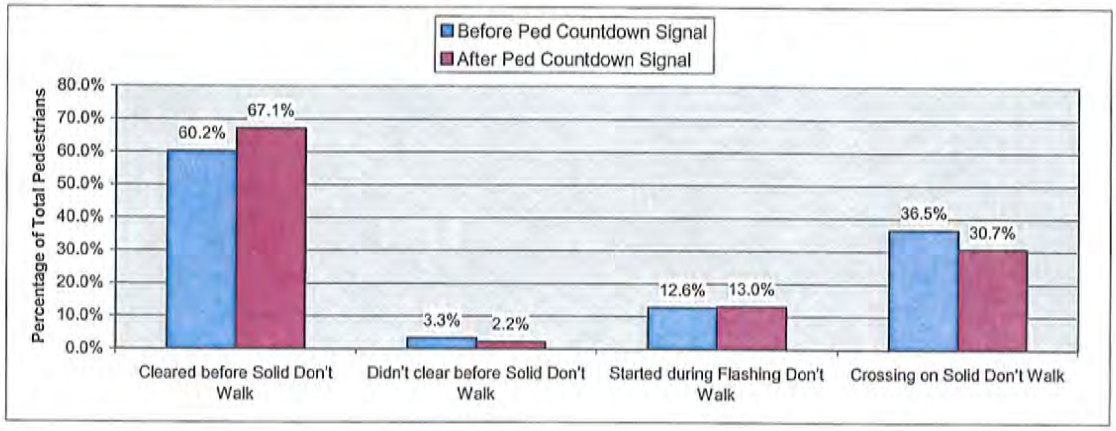


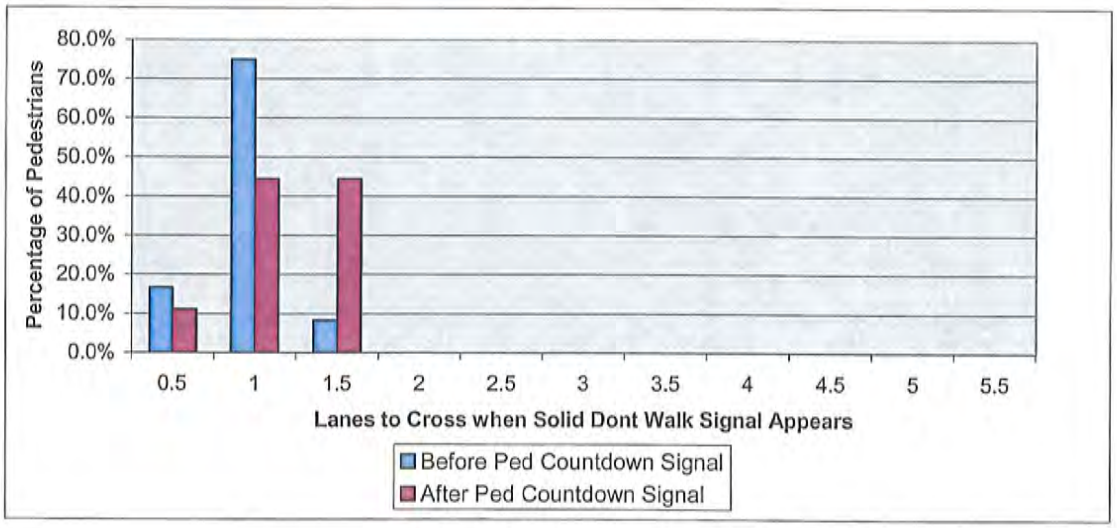


Gratiot at Hickory
Detroit, MI

	BEFORE		AFTER	
	Amount	%	Amount	%
Cleared before Solid Don't Walk	219	60.2%	278	67.1%
Didn't clear before Solid Don't Walk	12	3.3%	9	2.2%
Started during Flashing Don't Walk	46	12.6%	54	13.0%
Crossing on Solid Don't Walk	133	36.5%	127	30.7%

Distance Across Intersection (1/2 Lane)											
lanes	0.5	1	1.5	2	2.5	3	3.5	4	4.5	5	5.5
before	2	9	1	0	0	0	0	0	0	0	0
before %	16.7%	75.0%	8.3%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%
after	1	4	4	0	0	0	0	0	0	0	0
after %	11.1%	44.4%	44.4%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%





Gratiot at Linhurst
Detroit, MI

	BEFORE		AFTER	
	Amount	%	Amount	%
Cleared before Solid Don't Walk	317	57.1%	370	58.9%
Didn't clear before Solid Don't Walk	32	5.8%	40	6.4%
Started during Flashing Don't Walk	79	14.2%	86	13.7%
Crossing on Solid Don't Walk	206	37.1%	218	34.7%

Distance Across Intersection (1/2 Lane)											
lanes	0.5	1	1.5	2	2.5	3	3.5	4	4.5	5	5.5
before	12	18	3	0	0	0	0	0	0	0	0
before %	36.4%	54.5%	9.1%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%
after	7	10	14	6	0	0	0	0	0	0	0
after %	18.9%	27.0%	37.8%	16.2%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%