KIRKLAND'S EXPERIENCE WITH IN-PAVEMENT FLASHING LIGHTS AT CROSSWALKS[1]

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Introduction

Located in the Puget Sound region, Kirkland, Washington is a suburb of Seattle and has a population of approximately 50,000. The Kirkland City Council recognizes pedestrian safety and "walkability" as key components in the livability of the City, and "pedestrianism" has been a theme of the City for some time. The In-Pavement Flashing Lights Crosswalk Warning System ("Flashing Crosswalk") is a series of flashing light units installed just below the pavement surface along the crosswalk lines and facing traffic. Its purpose is to warn drivers of the presence of a pedestrian about to cross or already in the crosswalk at uncontrolled intersections. In an effort to increase pedestrian safety, the first two flashing crosswalks installed outside of California were installed in fall of 1997, at mid-block locations in Kirkland

This paper describes Kirkland's experience with flashing crosswalks, including how the system works and how it is installed, effectiveness, response from the public and application criteria. In general, the flashing crosswalks are considered to be a success both in terms of their effectiveness in causing vehicles to respond to pedestrians and in terms of their public support. In fact, at the time of this writing, Kirkland is receiving bids for an additional 14 systems.

History

In 1993, in response to an unusually high incidence of pedestrian/vehicle collisions resulting in a significant number of pedestrian fatalities and injuries, the City of Santa Rosa, California introduced a new concept in proactive pedestrian warning systems for uncontrolled crosswalks, known formally as an In-Pavement Flashing Lights Crosswalk Warning System.

The idea for the system originated with a private citizen who is a pilot and believed that the strobe lights used on runways to help pilots land their planes might be useful in providing greater protection for pedestrians at crosswalks.

The California Traffic Control Devices Committee allowed the City of Santa Rosa to test the device at selected locations; and the California Office of Traffic Safety granted funds to the City

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[1] This paper was prepared for TRB's 6th National Conference on Transportation Planning for Small and Medium-Sized Communities (September, 1998; Spokane, WA) under the title *Success in Redesigning Main Streets for Pedestrians*.

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to study the effectiveness of the device. In 1994-95, the system was installed at three locations in Santa Rosa and between 1996-97 at locations in the California cities of Fort Bragg, Lafayette, West Hollywood, Willits and Orinda, and two locations in the City of Kirkland, Washington. Funding to evaluate the effectiveness of the device in Kirkland was provided through the Federal Highway Administration *Pedestrian Facilities Program* which is being conducted by the University of North Carolina Traffic Safety Research Center.

The City of Kirkland first became aware of the device through a communication by the State of Washington Traffic Safety Commission (WTSC) which knew of the City's interest in pedestrian safety innovation. Based upon conversations with the manufacturer (LightGuard Systems, Inc., Santa Rosa, CA) and other user cities, along with materials provided by those parties, we decided to propose to our City Council that we experiment with the device. WTSC generously offered to provide $10,000 toward the installation costs.

System Description

The flashing crosswalk systems installed at Kirkland consist of heads imbedded in the pavement, a controller and push-button activation devices, as shown in Figure 1. Heads were installed at seven locations perpendicular to the crosswalk across both approaches and across all lanes to increase visibility and command attention. LED banks in each head provide illumination, which sit behind a clear lens. At the recommendation of the manufacturer, the heads are mounted at varying low angles to the roadway centerline, and aim at points 250, 300 and 350 feet down the roadway and at various positions across the traveled way (see Figure 1).

Earlier California devices used plastic heads to contain the LED units; snow plowing considerations in Kirkland required design of a snow plow resistant head. This requirement caused the manufacturer to develop a more durable aluminum head, which bolts to a recessed plate. Recently, an even lower profile head has been developed. The winter of 1997-1998 was a relatively mild one in the Puget Sound and the devices were not rigorously tested. Even in the worst weather years, Kirkland does not see much snow plowing and rubber bladed plows are used. All new locations will use heads with a lower profile which will minimize the effects of snow plowing.

A solid state controller unit mounted in a standard type NEMA housing controls the device. The controller is capable of flashing the LEDs for a variable amount of time, counting the number of pedestrian activations, and dimming the displays; a time clock can initiate a constant activation or allow the head to burn steadily. Because it is designed to work from a 9-volt power supply, the cabinet also contains a back-up battery, which can power the crosswalk for several hours of operation.

The flash rate of the LEDs is a proprietary rate consisting of, in simple terms, two quick "on's" followed by a longer “on” followed by a long “off.” This flash cycle is approximately 3 seconds long and was designed to maximize the effects that attract viewer's attention while not causing negative side effects to those sensitive to flashing lights. Kirkland sets the flasher to remain active for a time interval in seconds equal to the number of feet of the crossing divided by 3. Observations show that this time is reasonable for most pedestrians. Optimally, the time would be long enough to protect the pedestrians but not long enough to show vehicles flashing heads when no pedestrians are present. Pedestrians activate the device, wait for traffic to clear the crosswalk or come to a stop, and then begin to walk across the street. Studies in Kirkland show that the 85th percentile walking speed is considerably more than 3 feet per second so that the extra time allowed for in the crossing interval used for vehicles to stop is compensated for by the walking speed.

Practitioners in different areas have used several methods for activation. The most straightforward of these methods uses a push button similar to those used in standard traffic signal installations and are used in Kirkland. The buttons used in Kirkland's installations include

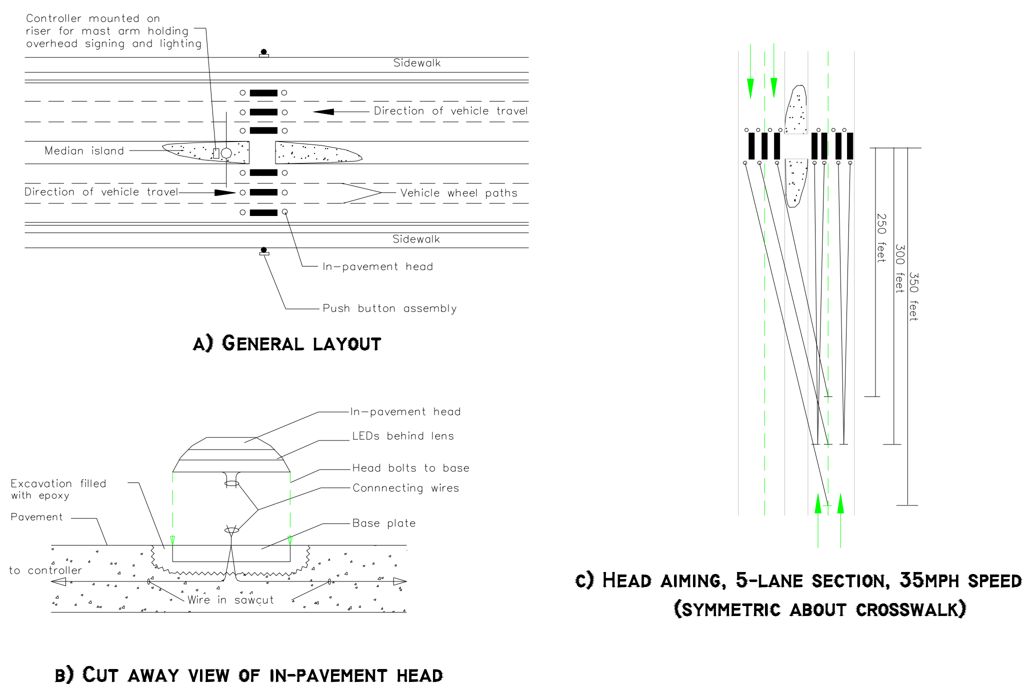

FIGURE 1: SCHEMATIC OF TYPICAL KIRKLAND FLASHING CROSSWALK

an array of LEDs on the button mounting housing that flash when the in-pavement heads flash. Pushing the button while the crosswalks is flashing causes the timer to reset and a fresh timing interval to begin. Observations in Kirkland have not shown that pedestrian buttons cause a "false sense of security" as evidenced by caution pedestrians use after they push the activation button.

Activation schemes that are passive to the pedestrian are used following the assumption that pedestrians will exercise more caution if they do not know the crosswalk is flashing. In other cities, microwave detectors have been used with limited success; the devices were not able to detect 100% of pedestrians. Video detection as used in traffic signals has been used with more reliability. LightGuard Systems, Inc. has developed a bollard system that activates the heads when a pedestrian passes between the bollards. Whitlock & Weinberger[3] indicate that an automatic detection system is more appropriate than a push button system.

Costs

The first two systems in Kirkland were installed for $25,000 (plus $10,000 in grant funds from the Washington Traffic Safety Commission). The City purchased equipment from LightGuard, Inc. and City crews installed them. A recently bid road project had two flashing crosswalks (installed) and the low bidder submitted a unit cost of $18,000 each. The latest bids received on a project to install 14 crosswalks came in at $15,000 per location.

Installation procedures

Siting and installing the in-pavement heads is the most complicated portion of the installation procedure. In Kirkland the heads were aligned with the pavement markings of the existing zebra style crosswalk, the zebra stripes were laid out to be outside wheel paths (Figure 1A). Manufacturer's recommendations were followed for the number of heads to be used. Once the locations and number of heads were determined, alignment relative to the centerline was set again following manufacturer's recommendations. This was accomplished by stationing a person at the head and, another, then at the appropriate upstream location. Working after dark, a laser-leveling device was sited on the target and then rotated across the head location and the appropriate angle marked on the pavement. Simpler methods for aiming the heads can also be used satisfactorily.

At the location of each head, pavement was excavated by heating it with a torch and scooping it out using hand tools to make a hole just slightly larger than the base plate of the head (Figure 1 B). A narrow bar about a yard long was bolted to the base plate, and placed in the excavation so that the bar suspended the base plate in the hole and ensured that the head was properly aligned relative to the centerline and flush with the pavement. Fast curing epoxy poured around the base adheres it to the pavement. When the base is set, the flashing head is bolted to the base and connected to the wires coming from the base.

Wire from the pushbuttons and heads is run across the pavement in sawcuts and sealed in a manner similar to that used for inductive loops at traffic signals. Conduit carries the wires under the curbs from the pavement to the push button locations. At the first two Kirkland locations, overhead illuminated signing was already present in the median, and this made a convenient location for the cabinet installations and source for AC power. Because the system runs on a 9-volt power supply, solar power is an option, but since AC power was readily available, solar power was not used.

[3] Whitlock & Weinberger Transportation, Inc., *An Evaluation of a Crosswalk Warning System Utilizing In-pavement Flashing Lights*, April, 1998, p. 2

Before and After Study

Whitlock & Weinberger Transportation, Inc. (W-Trans) of Santa Rosa, California, under a contract with FHWA (through University of North Carolina Highway Safety Research Center) conducted before and after studies on the effectiveness of flashing crosswalks[4].

Data was collected using conflict/behavioral sampling techniques since collecting adequate accident data would take five to ten years of after experience. A staged "test" pedestrian was used to ensure consistency; driver reaction to the pedestrian both looking to cross the street and stepping into the roadway was measured using four variables:

- Approach speed (from 500 to 300 feet from the crosswalk).
- Travel time and deceleration (from 500 to 100 feet from the crosswalk)
- Braking distance (distance from the crosswalk where vehicles began to brake)
- Driver reaction (what did the driver do: yield to pedestrian, react but did not yield, did not yield)

Data was collected manually using stop watches and markers pre set at 100, 300 and 500 feet in advance of the crosswalk. Measurements were made both before and after flashing crosswalk installation in both daytime and nighttime conditions.

Table 1 summarizes the results of before and after studies at each location. The data suggests that the devices are effective in both increasing the number of drivers that yield to pedestrians and the distance from the crosswalk where drivers apply their brakes.

[4] ibid.

TABLE 1 Results of Before and After Studies on two sites in Kirkland

Location	Heading	Light	Before After	Distance from crosswalk when brakes applied (ft.)	Drivers yielding to Peds (Percent)
Central Way	East	Day	Before	200	62
			After	278	92
		Night	Before	115	16
			After	238	100
	West	Day	Before	192	59
			After	244	94
		Night	Before	175	27
			After	270	98
NE 124th Street	East	Day	Before	209	46
			After	214	85
		Night	Before	204	65
			After	244	93
	West	Day	Before	271	55
			After	312	92
		Night	Before	266	48
			After	304	97

Notably, the nighttime yielding percentage at Central Way in the eastbound direction went from 16 to 100 percent. In fact the lowest yielding after percentage at Central Way was 92 percent. Increases in braking distances were similar to the increases in yielding drivers. Results were similar but not as dramatic at the NE 124th Street location.

The performance of the devices was similar at most of the other 10 locations covered in the W-Trans study. This led to their finding that "The concept of flashing amber lights embedded in the pavement at uncontrolled crosswalks clearly has a positive effect in enhancing a drivers awareness of crosswalks and modifying driving habits to be more favorable to pedestrians."[5]

Following installation of the two flashing crosswalks, and an article on the device which appeared in a City publication which is sent to all households, the City received many comments by phone, letter and in-person from the public. Almost all were highly favorable and supportive of additional installations. Specific statements included:

"I'm really impressed. I do a lot of walking...at least now you can get across the street...I'd like to see them all over town."

"We think they're great, especially when you can't see well, like in times of darkness. We love it for kids walking to school."

"They sure draw attention to the crosswalk. Now I feel more comfortable sending my son downtown and I feel more comfortable driving."

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[5] ibid.

The only negative comment came from a bicyclist that expressed concern over the possibility of striking a lightheaded while riding his bike. Lightheads were away from the wheelpath of a bicycle, and in future installations we will continue to work to avoid this potential conflict.

A more formal recognition of Kirkland's effort to improve the pedestrian environment came from WTSC, which presented the City with the first annual Community Excellence award for innovation in pedestrian facilities. With the award came a $1,000 grant.

Since the installation of the two flashing crosswalks, Kirkland has received numerous inquiries from other local government jurisdictions about the device. The City of Seattle has installed the system at a busy crosswalk near a private university campus; the City of University Place, Washington plans an installation as part of a roadway improvement project and we expect other localities to follow suit. The Institute of Transportation Engineers (ITE) has constituted a technical committee to develop application guidelines.

Installation Criteria

When the City Council contemplated construction of an additional set of flashing crosswalks, it became obvious that a system was needed to select and prioritize locations. Since the City had recently completed a system of ranking other Capital Improvement Projects, a similar process was envisioned for flashing crosswalk prioritization. A committee of citizens that had worked on the earlier priority ranking was reconvened to develop ranking criteria. City Staff prepared an initial set of criteria and then ranked a set of test locations to get an idea of how the criteria work.

A major point of discussion that is a sample of the types of discussion that took place was whether to give more points to locations that already have protective devices. One theory held that if a location has improvements such as medians and overhead signing, it is a good candidate for flashing crosswalks since the level of improvement reflects its validity as a location into which more improvements should go. The other philosophy said that flashing crosswalks at locations already benefiting from improvements should be delayed with improvements coming at less developed locations first. This second approach was adopted. Similar discussions took place around other issues with the criteria ultimately being approved as shown in Table 2.

TABLE 2 Criteria for Locating Flashing Crosswalks in Kirkland, Washington

I. Threshold criteria:

Location must have a marked crosswalk and stopping sight distance must be adequate for approach speed.

II. Engineering (30 points max)

Approach speed 85th percentile (MPH)

Speed	Points
<20 or >45	0
20-29 or 41-45	4
30-35	8
36-40	12

ADT (000)

Volume	Points
<5 or >30	0
>5-<15 or >25-<30	8
>15-<25	16

Cost

(Above standard costs)

Cost	Points
Other	0
Small or no additional cost	2

III Connections (35 points max)

00 of feet to nearest crosswalk

Distance	Points
<5	0
>5-<10	4
>10-<15	6
>15	9

What type of facilities does the crosswalk cross and/or continue? (Priority 1 and 2 Pedestrian facilities are defined in the Non-Motorized Plan.)

Points

Continues\Crosses	P1	P2	Other
P1	8	6	4
P2	6	4	2
Other	4	2	0

Is the crosswalk on school Walk Route?

Yes, 6 points

Is the crosswalk near schools, community facilities, etc.?

Activity Cntr.	Distance to Center < 1/4 mi.	<1/2 mi.
School	3 pts	2 pts
Com. Facility	2 pts	1 pt
Business Dist	2 pts	1 pt
Transit/HOV	1-2 pts	0.5-1 pt
Regional Cntr	1 pt	0.5 pt
Connect w/in Business Dist 1pt.		

IV Safety (35 points maximum)

Does the crosswalk serve a vulnerable population?

Yes 13 points

What is the accident history at the crosswalk?

Experience	Points
Less than Average	0
Average	6
More than Average	12

What improvements exist?

Improvements	Points
Striped crosswalk	10
Striped+Median or +O'head sign	6
Striped+O'head+Median	