What Do We Know About Signal Countdown Timers?

THE PAPER IS A BRIEF INTRODUCTION TO THE SIGNAL COUNTDOWN TIMER AND PRESENTS PAST PRACTICAL EXPERIENCE ON ITS TRAFFIC EFFECTS POST-INSTALLATION. THE DEVICE IS A WARNING ENHANCEMENT SYSTEM WITHIN THE TRANSITION PHASE OF A TRAFFIC SIGNAL AND ALLOWS DRIVERS TO ANTICIPATE AND IDENTIFY THE EXACT POINT OF THE SIGNAL CHANGE—GREEN TO RED OR RED TO GREEN—WITHIN A FIXED-TIME PLAN.

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INTRODUCTION

Pedestrian countdown signals have been widely used and accepted by many state and local agencies in the United States. Positive effects have been reported on pedestrian safety and operations as a result of the implementation of these devices. In fact, the results have been so dramatically positive that countdown pedestrian indications are currently planned to be mandated for all future pedestrian signals.[20, 21, 24]

However, signal countdown timers have not been approved for implementation in the United States, even though these devices are widely used in many other countries. As a result, the real impacts of signal countdown timers are presently unknown to many transportation professionals. This paper summarizes some current international practices vis-à-vis signal countdown timers.

SIGNAL COUNTDOWN TIMER

Signal control systems are intended to regulate traffic passing through intersections safely and efficiently. Though conventional signal systems play an important role in controlling traffic flow, they do experience significant lost time, and hence capacity reduction, at the transition points. The transition points, where the signal light turns from green to red and from red to green, are necessary to allow drivers to respond to changes in right-of-way assignment. Because the actual transition point is completely unpredictable in many conventional signal locations, drivers that are caught in the dilemma zone may make judgment errors about whether they should go or stop. Therefore, intersection safety and capacity could potentially be enhanced among drivers by providing additional warning about the onset of the transition.

Signal countdown timers are widely used in East Asian countries and have provided some useful operational and safety benefits; however, the application of the device in North America is minor. The purpose of this paper is to provide a concise summary of the practical experience on the use of signal countdown devices. Past research, projects and papers were reviewed with an emphasis on signal design features and effects on traffic, as well as strengths and weaknesses associated with the use of signal countdown timers. Finally, we present conclusions and recommendations for future research improvements.

Signal countdown devices are designed to provide drivers with the remaining time before status change (e.g., yellow to red) on conventional vehicular signal indications. The basic assumption is that drivers will apply this information to make better decisions on the proper time to enter the intersection. The device is used in conjunction with conventional traffic signal indications as an auxiliary part of the whole signal control system. Figure 1 shows two photos of deployed red and green countdown devices, and the logical connection of the device is illustrated in Figure 2. The countdown time display panel is under the control of a countdown controller that runs in step with the signal controller. When a signal is counting down for a specific phase, the countdown control system shows the remaining time for that phase.

DESIGN PURPOSE OF SIGNAL COUNTDOWN DEVICES

The countdown devices are intended to provide safety and operational benefits by

- improving capacity of signalized intersections by reducing lost time;
- helping drivers better understand traffic flows;
- enabling drivers to make decisions on the remaining time left on the green or red phase; and
- reducing the crash frequency of the intersections.

The device can only be installed in the fixed-time signal, since if the signal timing is actuated, the green and red times change for each cycle, dependent on detected traffic volumes. The device therefore cannot predict the time left for the green and red phases. This condition has greatly limited the utilization of these devices because actuated time plans are more widely used than fixed-time plans, especially in North America. However, many East Asian countries such as China, Malaysia and Singapore have deployed signal countdown devices and have experience in the application of the device. A case in Shanghai shows a number of benefits, such as energy conservation, reduction in environmental pollution, travel-time savings, improved efficiency and a reduced potential occurrence of crashes.[1]

EFFECTS OF SIGNAL COUNTDOWN DEVICES BASED ON PAST STUDIES

The purpose of applying the device is clearly that to auxiliary drivers the current state of signal control. However, the application of the countdown device has also brought some attention to its safety and operational characteristics. Some big cities in China, such as Shanghai, Beijing and Guangzhou, installed countdown systems approximately five years ago.[1,2,3] However, they are now planning to uninstall the devices from the current signal control systems due to four operational problems that have been identified.

First, the critical problem of the device is that it can only accurately display the time remaining for a particular phase in intersections with fixed-time traffic signals.

Second, the countdown device has been phased out among domestic big and medium-sized cities. Traffic-actuated or traffic-responsive signals, which are able to change time according to relevant traffic, are employed in more and more in these cities. For example, about two-thirds of the 194 signals in the city of Fuzhou had installed intelligent adaptive signal control systems by the end of 2006. Based on the first limitation, Beijing, Guangzhou, Shenzhen and other large and medium cities in China decided to no longer install countdown devices.

The third problem is that the countdown device increases the risks of potential

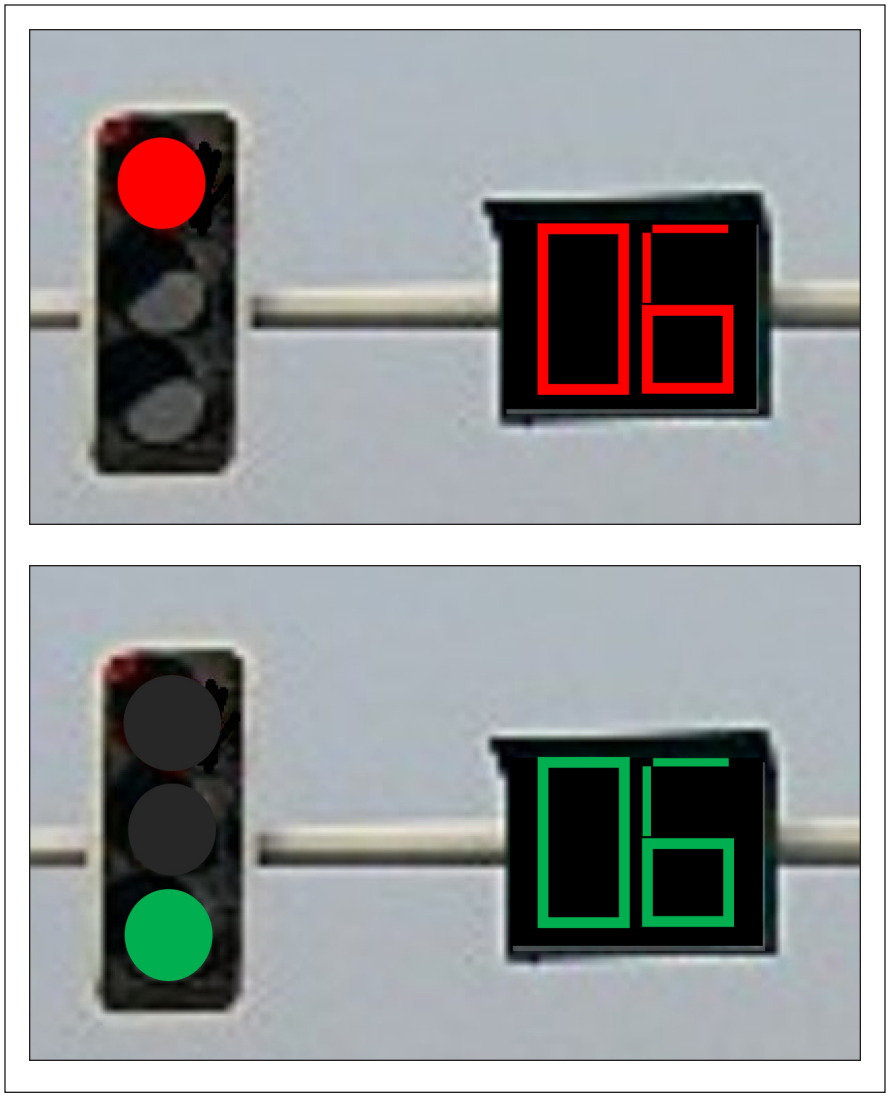

Figure 1. Countdown timers in action.

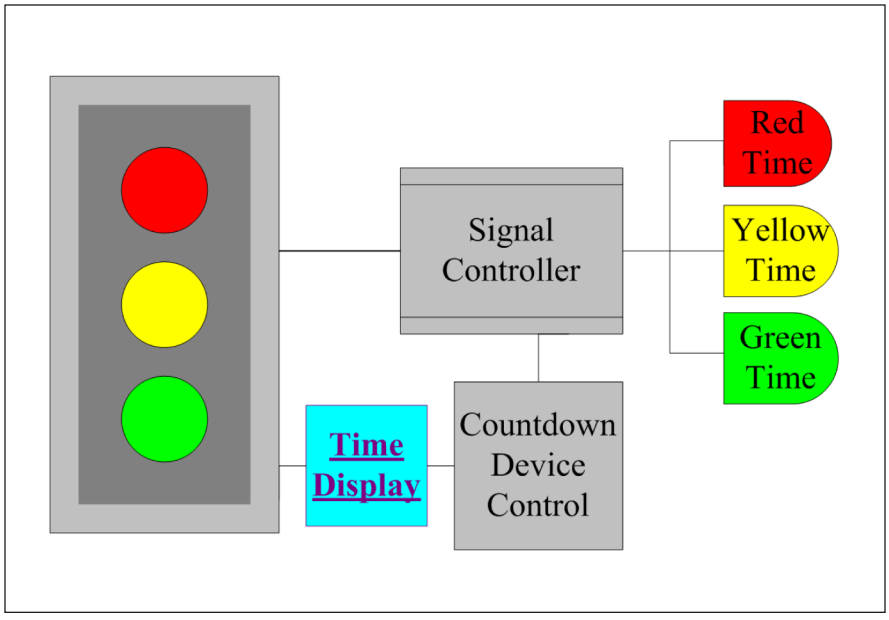

Figure 2. How countdown timers work.

crashes and thus decreases safety, which is not consistent with the original design purpose. Field observations have shown that drivers accelerate through the intersections at the end the green cycle even when the countdown time may be less than two seconds—or even one second.

Last but not least, recent research results showed that the regular "green flash" plus the yellow time is sufficient for drivers to make judgments to safely cross the intersections.[2] The "green flash" is generally three seconds long and signals the end of the green time and the upcoming red time, thus alerting drivers to slow down their vehicles.

A detailed study was conducted in the City of Taiwan.[5] The signal countdown device was installed at several intersections in 2004. Some intersections counted down the amount of time remaining until a green time turned yellow and then red, while others counted down the amount of time remaining before a red light turned green. Some intersections had both. However, a research institute within Taiwan's Ministry of Transportation has done a study on the safety of the countdown devices. Of the 187 intersections that had the timers installed, those locations that counted down the remaining time on green lights have double the number of reported crashes, with a 33 percent increase in the number of injuries. However, those sites counted down until a red light turned green have reduced by half both the number of total crashes and injuries. Intersections that had both red and green time have a 19 percent increase in reported crashes and a 23 percent increase in injuries.

Installing a red-time countdown device has a positive impact, while the green one increases the probability of crashes occurring at intersections. There could be several explanations; however, the main reason is diversion of the driver's attention from the intersection. When a driver decides to pass through a green light, he or she tends to focus more on the countdown time as opposed to what is happening on the road, especially during the last few seconds. For example, the driver in the previous vehicle might decide to slow down and stop at the intersection, while the trailing vehicle driver wants to speed up to pass through the intersection. Counting down the green time can increase the travel time and limit the traffic capacity. Fewer vehicles could jump the intersections during the fixed green time, and delay would increase largely, especially in peak hours. Because the green-time countdown device had negative effects on both safety and efficiency, the local police administration is considering dismantling or shutting off the devices in the near future. However, the installation of red-time countdown devices has some benefits. The observed driver behavior is different from the green countdown device. If a driver is at a red signal, more attention is paid to the road conditions than the signal indications. Also, it would help drivers to reduce delay time by knowing when to anticipate the beginning of green.

Several green-time countdown devices have been installed at intersections in Kuala Lumpur and other cities in Malaysia. The use of this device was to aid drivers in judging the amount of time left before the green signal as well as the amount of green time available to proceed across the intersection or to stop safely before the signal turns red. A research study done in Malaysia used six intersections, three with countdown timers and three without those timers.[8, 9, 10] The countdown timer has little effect on initial delay but does have a significant effect on headway. The discharge headway had a high variance for the same car positions in different cycles for several intersections; however, it has no significant effect on the travel time to stop line, especially for the first few vehicles.

The traffic signal violation rate for countdown versus no-countdown configurations was also compared. For the countdown case, the drivers crossed the stop line during red time in 24 out of 88 cycles. For the non-countdown case 22 out of 90 cycles were violated. Therefore, the rate of violation is 30 percent for countdown and 24 percent for non-count down.[9] The increased violation rate would certainly increase the chances of crashes occurring.

In 2003, Singapore Land Transport Authority collaborated with the Nanyang Technological University (NTU) to install a countdown timer along Rochor Road near Bugis Junction as a trial.[11] Over a period of one year, the number of vehicles running the red light was reduced during the first four months. The red-time countdown device had a positive influence on the safety performance. However, some motorists behave differently when they approach the intersections during the green countdown time. The countdown timer may result in a greater likelihood of rear-end collisions at traffic junctions. The result is consistent with the previous study done in Taiwan's Ministry of Transportation and those in China. The authority also mentioned fixed-timing traffic signals are not comparable to current adaptive traffic control systems. With actuated signals comprising the network, a countdown timer would not work with the established system.

The countdown devices also were tested over an eight-month period in Abilene, Texas, USA.[12] The results were not satisfactory, and the devices have been uninstalled for a long time.

EFFECTS OF PEDESTRIAN COUNTDOWN SIGNALS ON MOTOR VEHICLES

Several past research projects have focused on the impacts of the device on pedestrians as well as its influence on motorists.[13, 14, 21–25]

When vehicles approach the intersections, drivers could monitor the pedestrian countdown light to know the remaining time on both directions. On the associated directions, the green-time pedestrian countdown timer would show the left time for the approach. On the opposite directions, the red-time pedestrian timer shows the time as well, so the vehicles on the opposing approach could also know how much time is left. Several studies as listed above showed similar results. The pedestrian countdown devices did little improvement on the safety performance of motorist's behavior in the associated direction while the impacts on the vehicles in the opposing directions were insignificant.

One before-and-after study in San Jose, CA, USA, stated that the number of vehicles entering three intersections during yellow, red, or yellow and red phases, respectively, all decreased, ranging from 0.1 percent to 1.6 percent for the associ-

ated direction.[13] Though the proportion of violations decreased after the installation of the pedestrian countdown devices, the reduction is really insignificant. In 2005, another research study in Rockville, MD, USA, demonstrated that the pedestrian countdown devices appeared to change little on the violations for the associated direction as well.[14]

Table 1. Impacts of installing signal count-down device.

Countdown Time	Crashes	Travel Time	Capacity	Delay
Green	–	–	–	–
Red	+	–	–	+
Green and Red	–	–	–	–

Note: + for positive impact, – for negative impact.

CONCLUSIONS AND RECOMMENDATIONS

The signal countdown device is a warning enhancement system within the transition phase of a traffic signal and allows drivers to anticipate and identify the exact point of the signal change, green to red or red to green. The objective of the device is to inform driver's current signal status so that installing the device might have some effects on decreasing delays and increasing safety by reducing drivers' response time. It was long believed that the increased level of certainty would improve the drivers' decision-making ability, awareness and safety. However, based on real-world data, the anticipated safety and operational benefits were not realized. The device is also constrained so that it may only be installed in fixed-time signal systems. The configurations of signal countdown devices can be separated into three types: counting down green time, counting down red time and counting down both the green and red times. The effects of installing the signal countdown device are listed Table 1.

Based on the operational studies, only the red time countdown device has a positive influence on safety and delay but increases the travel time and decreases the capacity. The pedestrian countdown signal, however, has little improvements for both travel directions. ■

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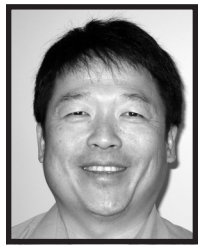

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