

**Determining Recommended Language
for Speech Messages used by
Accessible Pedestrian Signals:**

Final Report

Accessible Design for the Blind

Billie Louise Bentzen, Ph.D.,
Janet Barlow, M.Ed., and
Lukas Franck, M.Ed.

Research supported in part by:

The Seeing Eye
American Council of the Blind
California Council of the Blind
Center for the Visually Impaired, Atlanta
U.S. Access Board

January 7, 2002

Acknowledgement

The authors gratefully acknowledge the contribution of Daniel Ashmead, Ph.D., Department of Hearing and Speech Sciences, Vanderbilt University Medical Center, to sections on speech intelligibility in noise.

Introduction

Accessible Pedestrian Signals (APS), to provide information to pedestrians who are blind, have been installed in some locations in the U.S. for over 30 years. Until recently, they have all been audible signals, with loudspeakers installed at the pedestrian signal head (ped head) that broadcast tones or messages across the intersection during the steady walk interval of the pedestrian crossing phase. The most commonly used signal, produced by several manufacturers, is one in which a repeating sound like “cuckoo” is used for crossings that run in a roughly north-south direction, and a repeating sound like “chirp” is used for crossings that run in a roughly east-west direction. A survey of orientation and mobility specialists conducted in 1998 by the Orientation and Mobility Division of the Association for Education and Rehabilitation of the Blind and Visually Impaired (Bentzen et al., 2000) and a parallel survey of pedestrians who are blind or visually impaired by the American Council of the Blind (Carroll & Bentzen, 1999) both indicated that this type of signal often provides ambiguous information.

Recently, APS that provide audible information from the pushbutton location have been introduced in the US. This type of signal has been used extensively in Europe and Australia for many years. It typically uses a rapidly repeating tone to indicate the walk interval, and a slower repeating tone during the “flashing don’t walk” and steady “don’t walk” intervals to indicate that the pedestrian should not initiate a crossing. This slowly repeating tone, or locator tone, alerts users to the need to press a button to request a walk signal, and helps users locate the pushbutton. Vibrotactile information is also provided in most of these signals. In the U.S., in some of these pushbutton integrated signals, speech messages are being used to indicate the walk interval information, as well as additional information when the pedestrian pushbutton is pushed during the “don’t walk” and “flashing don’t walk” intervals. A third type of APS provides a transmitted message, usually a speech message, from the pedestrian signal head to a receiver held by the traveler who is blind or visually impaired. This research focused on APS that provide directly audible speech messages, not transmitted messages.

At least five currently available accessible pedestrian signals in the U.S. offer the option of directly audible speech messages. APS manufactured by Polara Engineering, Inc., NOVAX Industries Corp., Prisma Teknik AB, Dick Campbell Co., and Bob Panich Consultancy Pty. Ltd. are all capable of having real time speech messages for the walk interval. All of these except the Panich signals are also capable of providing messages with additional information when the pedestrian pushbutton is pushed.

These speech signals are intended to be audible from 6-12 feet from the pushbutton pole, or to the building line, whichever is less, as stipulated in Guidance in the *Manual on Uniform Traffic Control Devices* (MUTCD 2000 4E.08). The speaker for these messages is located in the pushbutton unit, with the exception of the NOVAX signal, which also has a ped head mounted speaker. The signals are not intended to be heard from across the street. They are normally used in association with a quiet locator tone, repeating once a second, that informs approaching pedestrians that they need to push a button to request a pedestrian phase. This quiet tone also enables users to locate the pushbutton easily. In addition, a tactile arrow on the pushbutton unit

is aligned in the direction of travel of the crosswalk to provide tactile indication of the crosswalk that is controlled by the pushbutton.

Signals having speech messages are seen by many blind pedestrians as being very user friendly, and able to provide unambiguous information about which street has the walk sign. They are capable of providing both real-time and fixed descriptive information. Real-time walk signal information can be provided about the status of the pedestrian signal. Pushbutton messages can potentially include the name of the intersection and the street actuated by the pushbutton, the geometry and/or signalization of the intersection, and nearby landmarks such as transit stops or public buildings. The pushbutton message on the Polara and Campbell are typically activated by pressing the button for three seconds or more; the Prisma message is activated immediately when the button is pushed. The NOVAX signal has the capability of providing pushbutton messages, but it has not yet been used in this fashion.

During the deliberations of the Public Rights-of-Way Access Advisory Committee (PROWAAC) (Access Board, 2001), representatives of the National Federation of the Blind, the American Council of the Blind, the Council of Citizens with Low Vision, the Association for Education and Rehabilitation of the Blind and Visually Impaired, and The Seeing Eye all supported the use of APS having speech messages to reduce possible ambiguity about which crosswalk has the walk signal at some intersections. PROWAAC was established by the U.S. Access Board in 1999 to provide recommendations for minimum guidelines and requirements for implementing the Americans with Disabilities Act in public-rights-of-way.

There currently is minimal standardization of either walk messages or pushbutton messages for APSs, however, therefore message content, length, and structure vary from one APS installation to another. The only existing standard for the wording of APS speech messages is contained in The Millennium Edition of the *Manual on Uniform Traffic Control Devices* (MUTCD 2000 4E.06). This standard requires that where verbal messages are provided during the walk interval, “the verbal message . . . shall be the term ‘walk sign,’ which may be followed by the name of the street to be crossed,” and the “verbal message . . . when the walk interval is not timing . . . shall be the term ‘wait.’” As an option “Accessible pedestrian signals that provide verbal messages may provide similar messages in languages other than English, if needed, except for the terms “walk sign” and “wait.” The specification of the terms “walk sign” and “wait” was based on research conducted for The Smith-Kettlewell Eye Research Institute (Myers, Bentzen & Crandall, 1996).

This research on speech messages for APS was undertaken to develop recommendations based on data from stakeholders to form the basis for the establishment of recommended practice for the structure and content of walk messages and pushbutton messages for directly audible accessible pedestrian signals.

Other concerns regarding speech messages

Other concerns regarding speech messages for APS, in addition to standardization of message content and structure, include the following.

- It is important that messages are understandable by all users.
- It is not likely to be possible to make speech signals understandable in all ambient noise situations, such as loud traffic.
- It is easy for listeners to miss or mistake parts of messages in loud ambient noise situations.
- Non-English speakers and non-native English speakers are likely to have difficulty understanding speech messages.
- To be understood, speech messages must be carefully recorded, in a clear voice, with excellent diction, and moderate pacing.
- Replacement of signals having speech messages necessitates custom recording rather than off-the-shelf substitution of components.

Research on intelligibility of speech in noise is also relevant to the general consideration of the use of speech messages in APS. A number of speech-in-noise tests have been used by audiologists and hearing scientists. In most of these tests the information is sound from loudspeakers. Typically the background noise on these tests consists of pre-recorded conversational babble from multiple speakers (like “cocktail party” noise). The listener’s task is to listen to speech samples and report the word or sentence which was spoken. The measure is percentage of utterances reported correctly. The test is usually done at several different signal-to-noise ratios.

A recent report by Killion (1999) provides an example of the findings. Listeners with normal hearing required a signal-to-noise ratio of +2 dB to get 50% of sentences correct, and +5 dB to get 90% correct. Listeners with hearing impairments required signal-to-noise ratios of +8 dB for 50% correct and +15 dB for 90% correct. These findings suggest that a signal-to-noise ratio of +5 dB or more is required for good speech intelligibility by persons with normal hearing, in listening situations where the listener is not able to see the speaker. However a large majority of persons with visual impairments are over the age of 60 and thus can be expected to have age-related hearing loss, particularly for higher frequencies. Thus, speech messages in APS may need to be equal to or greater than 15 dBA above ambient traffic sound to be intelligible to many persons with visual impairments.

Speech-in-noise tests of the sort represented by the Killion (1999) study have some limitations in terms of generalization to audible pedestrian signals. One is that the background noise was conversational babble, which has the same spectral composition as the speech signals. However, traffic sound has most of the energy concentrated in the lower frequencies (Wiener et al., 1997). Persons with visual impairments who have normal hearing may be able to understand APS speech messages better in the context of ambient traffic sound than conversational babble because of the difference in spectral composition. However, the majority of persons with visual impairments who are likely to have age-related hearing loss can be expected to have more difficulty hearing the higher frequencies in speech than the predominantly lower frequencies in traffic noise. Therefore the results of tests such as that of Killion (1999) may underestimate the

amount by which APS speech messages need to exceed the intensity of traffic noise in order to be intelligible to older blind pedestrians.

It may not be possible to provide APS with intelligible speech messages that are not so loud as to have the potential for causing hearing loss. The MUTCD says that the maximum volume of APS should be 89 dB, and APS should be no more than 5 dB louder than ambient sound (4E.06). The 89 dB upper absolute limit was set by the Federal Highway Administration to comply with OSHA standards. The 5 dB upper limit relative to ambient sound was based on research that found that an 880 Hz square wave tone used as an APS locator tone was more readily perceived and localized by blind persons from distances of up to twelve feet when it was 2-5 dB above ambient vehicular sound along an eight lane artery than when it was 10 dB above that ambient sound Bentzen et al, 2000).

Another limitation in generalizing to APS the results of Killion (1999) and related research is that the background noise levels tend not to be as high as in traffic situations. Mean traffic noise for traffic accelerating at the onset of 20 walk intervals on a four-lane street was measured at 94 dBA from the position at which a pedestrian who is visually impaired would be standing while waiting to cross the street (Wiener et al., 1997). The microphone of an APS which senses ambient sound level may be located up to 12 feet, (or sometimes more), from the position of pedestrians waiting to cross, and hence measure a lower sound level. It may then control a signal output which is, for example, 5 dB louder than the ambient sound at the APS, but this sound, measured from the position of the person waiting to cross the street, may not even be as loud as the vehicular noise heard from that position. In order to make the speech loud enough to be intelligible by a pedestrian waiting to cross, it might have to be objectionably loud when heard by a person standing close to the APS.

This research does not address the above issues, which should be considered in any installation of APS using speech messages. This research only provides recommendations regarding the structure and content of walk messages and pushbutton messages, when speech messages are used on APS.

Method

An Expert Panel met by teleconference to develop a survey to be given to stakeholders, including pedestrians who are visually impaired, orientation and mobility specialists, transportation engineers, and accessible pedestrian signal manufacturers. The Expert Panel was comprised of the three co-principal investigators (authors, all Certified Orientation and Mobility Specialists), and one representative familiar with speech equipped APSs from each of the following groups: transportation engineers, APS manufacturers, Council of Citizens with Low Vision, and the American Council of the Blind.¹ The National Federation of the Blind declined the invitation to participate in this research.

¹ Julie Carroll, Environmental Access Committee, American Council of the Blind
Patricia Beattie, Council of Citizens with Low Vision
John McGaffey, Polara Engineering
Julie Gonzalez, Senior Transportation Engineer, Cal-Trans District 5.

The Expert Panel developed sample walk interval and pushbutton messages that were applicable to different intersection geometries and signalization patterns, and that varied in message content, length, and structure. Each message approved by the Expert Panel was required to have consensus that it could be appropriate in content and structure. Appropriate messages were those that were judged by most Expert Panel members to be unambiguous, and to clearly convey the minimum necessary information.

The Expert Panel discussed several issues of message content and wording extensively and made the following recommendations:

- The words “walk sign” and “crossing” should not be used in the pushbutton message; “to cross” was considered acceptable in the middle of a phrase.
- Landmark information, such as location of public buildings and transit stops, should be prohibited from pushbutton and walk signal speech messages.
- Construction information should be prohibited from pushbutton and walk signal speech messages.

Therefore these wordings and types of information were not included in the sample messages developed by the Expert Panel. (For explanation of the rationale for these recommendations, see Results and Discussion.)

The Expert Panel unanimously recommended the following order of information for pushbutton messages

- Intersection identification
- Intersection signalization (if remarkable)
- Intersection geometry (if remarkable)

In this order, the information necessary to the greatest number of users comes first.

Messages selected by the Expert Panel were developed into a survey instrument for obtaining data on preference for message types by blind pedestrians, orientation and mobility specialists, transportation engineers, and APS manufacturers. The survey also contained items to evaluate the understanding of various message types, and preferences for use of the pushbutton delay to actuate pushbutton messages.

The survey was mailed to 160 people who are actively involved in decision-making about pedestrian signals or in teaching pedestrians with visual impairments to recognize and interpret the geometric and signal information at intersections; these people represented the following categories of stake-holders: orientation and mobility specialists, APS manufacturers and distributors, and transportation engineers. The same survey was administered in Braille, large print, or orally to 170 pedestrians with visual impairments who were attending the convention of the American Council of the Blind during the first week of July 2001.

Of the 170 respondents with visual impairments, 84.2% were usually unable to read street signs, see traffic lights and see Walk/Don't Walk signs, and 15.8% were usually able to read street signs, see traffic lights and see Walk/Don't Walk signs. Respondents were asked to indicate the frequency with which they independently crossed streets with traffic lights; 72.5% reported that they independently crossed streets with traffic lights at least once a week, while 27.5% reported

that they independently crossed streets with traffic lights less often or never. Ages of respondents were: <40=23.5%; 40—54=50.0%; 55—69=21.8%; >69=8.8%. Respondents were not systematically asked to indicate what travel aid, (such as a long cane, dog guide, optical aid, or no aid) they typically use, however, 89 respondents were observed to be using a long cane and 62 were observed to be using a dog guide in traveling to the survey area.

The panel reviewed the survey results via a conference call and made recommendations based on the results and comments.

Results and Discussion

Expert Panel Decisions Prior to Conducting the Survey

Expert Panel members had extensive discussion of safety concerns related to the wording of the walk and pushbutton messages. It was considered essential that the walk message be worded as “Walk sign” or “Walk sign is on.” This is consistent with the MUTCD. The wording indicates the status of the signal; it does not give a command or imply that it is safe to cross.

There was concern that some messages that have been used on pushbutton messages, such as “Crossing Charles at State,” could be misinterpreted as a walk message by a pedestrian unfamiliar with such messages. This discussion led to the decision that the words, “crossing” and “walk sign” should not be included in the pushbutton messages. There was also discussion of the words “to cross.” The panel decided that “to cross” could be used as part of a phrase in the pushbutton message, but not at the beginning of the message. If used at the beginning of a message, if the word “to” is not heard or understood, pedestrians could mistakenly understand that “cross” means they should cross now.

The Expert Panel also decided that the word “wait” should be included in every pushbutton message, because pushbutton messages always come on during either the flashing or steady don’t walk intervals. This is consistent with the requirements of the MUTCD.

The Expert Panel discussed the types of information to be provided by the messages at length. While there was recognition that APS could provide landmark and construction information, the panel decided that APS should only be used to provide crossing and intersection information. That is, the APS should be a pedestrian signal only. The separation of traffic signal information from other types of information was considered a safety issue. The panel felt that other types of information should be provided by other means. Providing landmark or construction information was considered analogous to adding signs to the pedestrian signal head. In addition, the realities of maintenance, typical departmental structure of public works departments, and the necessity of deciding on a case by case basis what messages were included and how they should be worded were determined to be problematic. Therefore, the sample messages on the survey did not include this type of information.

The panel also discussed the fact that different messages might be understood differently by different stakeholders. In particular, the traffic engineering representative pointed out that a message such as “Howard Street, Walk Sign” would typically be understood in the traffic

engineering community to indicate that the walk signal was on to make a crossing parallel to Howard Street, while that message is currently being used on APS to indicate that the walk signal is on to cross Howard Street. This led to the inclusion of questions to determine the understanding of messages by the various groups.

Introduction to Survey Results

Surveys were completed by 170 pedestrians who were legally blind. The response rate for the 160 surveys mailed to the other stakeholders was 37.5%, comprised of 26 Orientation and Mobility Specialists, 29 Transportation Engineers, and 5 APS manufacturers or distributors.

In eight items designed to determine respondents' subjective evaluation to walk interval and pushbutton messages, respondents were asked to rate sample messages on a three point scale in terms of whether they were "good" messages, that is, messages they thought had the necessary information and that would be understood correctly. (1=poor; 3=good) The number of sample messages for each of these eight items, representing three situations in which walk messages were used and five situations in which pushbutton messages were used, ranged from two to eight. For these questions in which the response was a rating, means were computed for each sample message by groups, blind (totally blind and low vision), orientation and mobility (O & M) specialists, and transportation engineers, for the three large groups. Selected planned comparisons were then performed for the three items having six or eight sample messages, to determine whether observed differences in mean ratings between the highest rated sample message in each group and other messages in that group were significant; that is, whether there was less than .05 probability that the observed differences were attributable to chance. (Seven planned comparisons were performed for each of two items and five were performed for one item.)

In five items, respondents were asked to mark a choice that indicated their understanding of walk interval or pushbutton messages. There were three choices, a choice that the authors are calling the correct choice (that is, the way speech messages have typically been configured on APS), an incorrect choice, and "I'm not sure." Frequencies were computed, by major respondent group, for each of these questions.

Respondents were also asked whether they thought it was best to have the pushbutton message come on only after the button is pushed for a minimum number of seconds. Responses were "Yes," "No," or "No opinion." Frequencies were computed by major group, and Chi Square tests performed.

Respondents were given the opportunity to indicate particular wordings they thought were good or did not think were good, and to suggest alternative wordings.

Following statistical analysis, the Expert Panel convened by teleconference to interpret the results, combining the results for preference with those for accurate understanding of the message, respondents' additional suggestions, and their own expertise.

Walk Signal Messages

In each of the first two questions, respondents were asked to rate each of eight sample messages intended to convey that the walk sign was on to cross the street in front of them (the perpendicular street). In the first question, respondents were to rate sample messages for their use at a crossing where it would be obvious from the location of the pushbutton, or the nature of the intersection, such as a mid-block crossing, which crosswalk would have the walk signal when a walk message was heard. In the second question, respondents were asked to rate the same eight sample messages for use at a corner where it might not be obvious which of two crosswalks had the walk signal when a walk signal came on, such as when there are two pushbuttons mounted on the same pole, serving two different crosswalks. Mean responses of those participants who rated all eight messages in each group can be seen in Table 1.

Table 1. Mean ratings of sample walk signal messages for locations where it would be obvious which crosswalk had the walk interval and for locations where it would not be obvious which crosswalk had the walk interval. The highest mean rating for each situation, for each respondent group, is indicated by an asterisk. Means in bold type did not differ significantly from the highest mean for that situation and group.

Sample Walk Messages	Blind	O&M Specialists	Engineers
	Mean	Mean	Mean
At a signal where it is obvious which crosswalk has the walk signal.	N=135	N=26	N=25
Walk sign.	1.70	1.65	1.44
Walk sign is on.	1.99	1.73	1.68
Howard Street, Walk sign.	2.33*	2.35	1.64
Walk sign is on to cross Howard Street.	2.24	2.12	2.52*
Howard Street, Walk sign is on.	2.29	2.39*	2.08
Walk sign, Howard Street.	2.13	2.19	1.96
Walk sign on, Howard Street.	2.14	2.15	1.92
Howard Street, Walk sign on.	2.25	2.35	1.96
At a signal where it is not obvious which crosswalk has the walk signal.	N=131	N=24	N=24
Walk sign.	1.18	1.13	1.21
Walk sign is on.	1.35	1.08	1.25
Howard Street, Walk sign.	2.25	2.42*	1.71
Walk sign is on to cross Howard Street.	2.44	2.13	2.58*
Howard Street, Walk sign is on.	2.47*	2.29	1.96
Walk sign, Howard Street.	2.12	2.00	1.83
Walk sign on, Howard Street.	2.22	2.13	1.83
Howard Street, Walk sign on.	2.44	2.38	1.88

For both types of intersections, respondents in all groups rated walk messages that included the name of the street to be crossed higher than messages that did not include the street name. There

was a tendency across blind respondents and orientation and mobility specialists to rate messages beginning with the street name higher than messages beginning with “Walk sign,” although most differences were not statistically significant. Traffic engineers rated the message that was the most complete grammatical sentence significantly higher than all other messages.

Regardless of preferences for message types, it is essential that walk signal messages correctly convey to users which crosswalk has the walk signal. APS are required by the MUTCD (4E.06) and the recommendations of PROWAAC (X02.5.2.2A) to provide unambiguous information about which crosswalk has the walk interval. Respondents were therefore asked two questions to determine the relative importance to understanding the walk signal message, of complete phrasing versus more concise phrasing. Frequency of responses to each question can be seen in Table 2.

Table 2. Understanding of sample walk interval messages. Number of respondents in each group who provided each response. The meaning the APS message would be intended to convey to pedestrians (the correct response) is indicated in bold print.

Sample Messages, and Responses	Blind	O & M Specialist	Engineer
Mess: “Walk sign is on to cross Howard St.”			
Resp. A. Howard St. is the street parallel to the crossing.	5	0	0
Resp. B. Howard St. is the street to be crossed.	155	26	29
Resp. C. I'm not sure.	7	0	0
Mess: “Howard St. Walk sign.”			
Resp. A. Howard St. is the street parallel to the crossing.	9	0	2
Resp. B. Howard St. is the street to be crossed.	135	23	17
Resp. C. I'm not sure.	23	3	10

For the walk message “Walk sign is on to cross Howard St., 92.8% of blind respondents correctly understood that Howard St. was the street to be crossed. For the walk message “Howard St. Walk sign,” only 80.8% of blind respondents correctly understood the message to mean that Howard St. was the street to be crossed, that is, the street for which the walk sign now says WALK.

Twelve respondents spread across all groups stated that more concise messages are better, however one blind respondent stated that the best messages were “more phrase like.” This expressed preference for more concise messages does not correspond with the preference ratings or the data on understanding messages, however.

In considering the walk interval messages, the Expert Panel recognized that despite comments to the contrary, participants not only rated the more completely phrased messages more highly than the more concise messages, but were also more likely to understand the more completely phrased messages correctly. However, Expert Panel members were concerned that 7.2% of blind

respondents interpreted the most accurately interpreted message incorrectly or found it ambiguous.

Another reason Expert Panel members preferred the more fully phrased walk signal message was that it was consistently interpreted by traffic engineers in the same way as it was intended to be interpreted by pedestrians who are visually impaired. Having this agreement in interpretation will facilitate correct installation of APS having speech messages.

Additionally, Panel members were strongly of the opinion that the street name should come first in the message. This is because users are primed to hear “Walk sign,” and may incorrectly assume that the street they desire to cross is the one that has the walk sign, and begin their crossing without waiting to be sure which street is being signaled. Users who are familiar with speech signals at a particular intersection will not be delayed in their crossing by having the name of the street first, and users who are unfamiliar with speech signals at a particular intersection, or who are careless at a particular time, will have the information first that is critical to life safety. This is consistent with the high ratings given by blind respondents and orientation and mobility specialists to sample messages in which the street name comes first.

Therefore Panel members concluded that the recommended wording for walk messages should follow the model “Howard. Walk sign is on to cross Howard.” They recommended that the designations “Street,” “Avenue,” etc. should not be used unless necessary to distinguish between roadway names that are similar in a particular geographic area.

Pushbutton messages

Respondents were asked to rate six sample pushbutton messages which could be available from a speaker at the pushbutton during the don’t walk and flashing don’t walk intervals. The messages were intended to identify the intersection and to identify the particular street whose walk signal would be actuated by the pushbutton. PROWAAC recommends requiring (X02.5.1.4 A) that unambiguous information be provided at pushbuttons indicating which walk signal is requested by that pushbutton. The MUTCD says that unambiguous information should be provided (MUTCD 4E.08). PROWAAC (X02.5.1.4 C) also recommends requiring intersection identification information at each APS. Mean ratings of those participants who rated each of the six sample messages in this item are presented in Table 3.

Table 3. Mean ratings of sample pushbutton messages providing intersection identification. The highest mean rating for each group is indicated by an asterisk. Means in bold type were not significantly different from the highest mean for that group.

Sample Pushbutton messages Providing Intersection Identification	Blind	O&M Specialists	Engineers
	N=118	N=26	N=25
	Mean	Mean	Mean
Pushbutton for Howard St. at Grand Ave. Wait.	1.98	2.08	1.72
Requesting Howard St. at Grand Ave. Wait.	1.92	1.62	1.40
Request for Howard St. at Grand Ave. Wait.	1.97	1.81	1.48
Request to cross Howard St. at Grand Ave. Wait.	2.44	2.23	2.20
Wait to cross Howard St. at Grand Ave.	2.54*	2.54*	2.28
Requesting to cross Howard St. at Grand Ave. Wait.	2.14	2.00	2.36*

Both blind respondents and orientation and mobility specialists rated the message “Wait to cross Howard St. at Grand Ave.” the highest, but not significantly higher than “Request to cross Howard St. at Grand Ave. Wait.” Most messages that began with “Request” or “Requesting,” or that did not contain the words “to cross,” were rated lower. Traffic engineers again rated most highly the message that was the most grammatically complete, but this was not significantly different from the ratings of the two messages most highly rated by blind respondents and orientation and mobility specialists.

Respondents were also asked to respond to three items to determine their understanding of the intersection identification messages. Regardless of preference for a particular wording, if many people misunderstand the wording or are unclear about its meaning, it is not a good message. Frequency of response to each item is shown in Table 4.

For the message “Wait to cross Joy St. at Central Ave.” 82.8% (135) of blind respondents correctly understood the message to mean they had pushed the button to cross Joy St. For the message “Requesting Central Ave. at Joy St. Wait.” 70.6% (120) of blind respondents correctly understood the message to mean that they had pushed the button (put in a request to the signal controller), to cross Central Ave. For the street identification message “Pushbutton for Joy St. at Central Ave. Wait.” Only 70.4% (119) of blind respondents correctly understood the message to mean that they had pushed the button to cross Joy St.

Table 4. Understanding of sample pushbutton messages providing intersection identification. Number of respondents in each group who provided each response. The response designated as correct is indicated in bold print.

Sample messages, and responses	Blind	O & M Specialist	Engineer
Mess: “Wait to cross Joy St. at Central Ave.”			
Resp. A. You have pushed the button to cross Central Ave.	14	0	1
Resp. B. You have pushed the button to cross Joy St.	135	26	27
Resp. C. You don't know.	14	0	1
Mess: “Requesting Central Ave. at Joy St. Wait.”			
Resp. A. You have pushed the button to cross Central Ave.	120	24	15
Resp. B. You have pushed the button to cross Joy St.	19	0	2
Resp. C. You don't know.	31	2	12
Mess: “Pushbutton for Joy St.at Central Ave. Wait.”			
Resp. A. You have pushed the button to cross Central Ave.	16	0	0
Resp. B. You have pushed the button to cross Joy St.	119	22	18
Resp. C. You don't know.	34	3	11

“Wait to cross Joy St. at Central Ave.” was the only sample message that was not considered ambiguous by a large percentage of traffic engineers. The traffic engineer member of the Expert Panel pointed out, prior to administration of the survey, that to traffic engineers, phrases such as “Requesting Central Ave.” and “Pushbutton for Central Ave.” would commonly be interpreted as requesting to cross parallel to the named street.

Three respondents, (1 O & M specialist, 2 traffic engineers) mentioned that beginning the statement with the word “pushbutton” might be interpreted as meaning “Push the button,” resulting in repeated pushing of the button.

In considering the intersection identification portion of the pushbutton message, the Expert Panel recognized that the sample message “Wait to cross Joy St. at Central Ave.” had a higher mean rating by blind respondents and O & M specialists than other samples, and its rating by engineers was not significantly different than the rating of the most highly rated sample. Additionally, it was correctly understood by more than 10% more respondents than the other two samples for which this information was obtained. Finally, in the opinion of the Expert Panel, it is essential that the first word of the message heard during either the don’t walk or flashing don’t walk intervals should be “Wait,” so that if no other part of the message is listened to or understood, users will know it is not time to initiate a crossing. Expert Panel members were, however, concerned that more than 15% of blind respondents either incorrectly understood the best understood message or were uncertain of its correct interpretation. They concluded that standard pushbutton intersection identification messages should follow the model “Wait to cross Howard at Grand,” eliminating the street, road, etc. designation where this could not cause confusion.

Special Applications

Exclusive pedestrian phases. Respondents were asked to rate three sets of sample messages to be used at intersections having an exclusive pedestrian phase, that is, a signal timing in which all vehicular approaches have a red light during the walk and flashing don't walk intervals, sometimes called a Barnes dance or scramble crossing. One set of sample messages was for the walk signal, and two sets of messages were for pushbutton messages.

For three sample walk signal messages, respondents in all groups rated the message "Walk sign on for all crossings" highest. (See Table 5.) One blind respondent suggested the alternative message, "Walk sign, all crosswalks."

Table 5. Ratings of sample walk messages for intersections having exclusive pedestrian phases. The highest mean rating for each group is indicated by bold print.

Walk Message for Exclusive Pedestrian Phases	Blind N=170	O&M Specialists N=26	Engineers N=29
	Mean	Mean	Mean
All crosswalks, Walk sign.	1.92	1.78	1.98
All crossings, Walk sign on.	2.29	2.23	2.36
Walk sign on for all crossings.	2.67	2.74	2.67

The Expert Panel concluded that walk messages for exclusive pedestrian phases should follow the model "Walk sign is on for all crossings." This alternative was not offered in the survey, but differs from the highest rated alternative only in the addition of the word "is," which makes the message a full sentence. The standard walk message expressed as a complete sentence was better understood than the more condensed message. Therefore the Expert Panel concluded that the walk message where there is an exclusive pedestrian phase should also be a full sentence.

Respondents were asked to rate two sets of two sample pushbutton messages for intersections having exclusive pedestrian phases. The first set of messages was to be used at intersections at which right turns on red were prohibited. Mean ratings can be seen in Table 6. The ratings were based only on the second part of the message, that is, the part that provided information about the signal. All participant groups gave highest ratings to the message "Request for Howard St. and Grand Ave. Wait. Red light for all vehicles." However, four engineers, four orientation and mobility specialists, and one blind respondent expressed the concern that listeners could understand the message to mean that the red light for all vehicles was now on. Alternatives suggested were: "All vehicles will have red at the same time," "Wait for red light for all vehicles," "Walk all ways on red," "All cars stopped," "All crossings permitted," "Walk sign all crosswalks," "Full stop in all directions," and "All vehicles have red light at the same time."

Table 6. Mean ratings of sample pushbutton messages for an intersection where all cars have a red light during the pedestrian crossing time (exclusive pedestrian phase), with right turn on red prohibited. The highest mean rating in each set, for each group, is indicated by bold print.

Sample Pushbutton messages for Exclusive Pedestrian Phase with Right-on-Red Prohibited	Blind	O&M Specialists	Engineers
	N=170	N=26	N=29
	Mean	Mean	Mean
Request for Howard St. and Grand Ave. Wait. Red light for all vehicles.	2.50	2.46	1.96
Request for Howard St. and Grand Ave. Wait. All vehicles have red at the same time.	2.12	1.96	1.70

The Expert Panel concluded that the intersection identification information should follow the same model as the standard pushbutton message, followed by “Wait for red light for all vehicles.” This is similar to the highest rated “Wait. Red light for all vehicles,” but should be unlikely to be misunderstood as meaning that the red light is *now* on for all vehicles.

The second set of messages was to be used at intersections with a so-called exclusive pedestrian phase, but at which right turns on red are nonetheless permitted. Mean ratings for all groups were highest for the message “Request for Howard St. at Grand Ave. Wait. Red light for all vehicles; right turn on red permitted,” with the rating based on the part of the message providing information about the nature of the signal. (See Table 7.) There was also concern that some users could interpret this message to mean that the red light for all vehicles was on now. One respondent (engineer) suggested that there was no need to say “right turn on red permitted,” since this is usually the case. Another (blind) said that “right turn on red permitted” should precede “Red light for all vehicles,” as understanding that they needed to watch for turning vehicles was more important to the safety of blind pedestrians than knowing that there was a red light for all vehicles at the same time. One orientation and mobility specialist expressed that the amount of information in both messages could be confusing to blind pedestrians who were either children or elderly, and that both might choose to ignore the information.

Table 7. Mean ratings of sample pushbutton messages for an intersection where all cars have a red light during the pedestrian crossing time (exclusive pedestrian phase), with right turn on red permitted. The highest mean rating for each group is indicated by bold print.

Sample Pushbutton messages for Exclusive Pedestrian Phase with Right-on-Red Permitted	Blind	O&M Specialists	Engineers
	N=170	N=26	N=29
	Mean	Mean	Mean
Request for Howard St. and Grand Ave. Wait Red light for all vehicles; Watch for turning vehicles.	1.95	1.81	1.54
Request for Howard St. at Grand Ave. Wait. Red light for all vehicles; right turn on red permitted.	2.69	2.69	2.33

For intersections having exclusive pedestrian phase timing where right turns on red are permitted, the Expert Panel concluded that the intersection identification message should follow the same model as the standard pushbutton message, followed by the message “Wait for red light for all vehicles,” and a third component, “Right turn on red permitted,” based on the survey ratings.

Angled crosswalks. Respondents were asked to rate two sample pushbutton messages to be used at an intersection having an angled crosswalk on the street to be crossed. The beginning of the message identified the intersection and crosswalk. The rating was based solely on the second part of the message, that part describing the angled crosswalk. For all groups, the sample message receiving the highest rating was the same: “Request for Howard St. at Grand Ave. Wait.” (See Table 8.) However, there were numerous comments from blind respondents that they did not care for either message. Six blind pedestrians suggested using a clock analogy for expressing the angle of the crosswalk, for example “Crosswalk angles to 1:00 o’clock,” and five suggested simply “Crosswalk angles right.”

Table 8. Mean ratings of sample pushbutton messages for an intersection where there is an angled crosswalk on the street to be crossed. The highest mean rating for each group is indicated by bold print.

Sample Pushbutton messages Where there is an Angled Crosswalk	Blind	O&M Specialists	Engineers
	N=170	N=26	N=29
	Mean	Mean	Mean
Request for Howard St. at Grand Ave. Wait. Crosswalk angles 20 degrees right.	2.46	2.81	2.52
Request for Howard St. at Grand Ave. Wait. Crosswalk 20 degrees right.	1.81	1.38	1.79

Expert Panel discussion included a number of questions regarding the measurement of the angle of the crosswalk. Is the angle measured from the curb line at the crosswalk, which may be curved, or is it measured in relation to the approaching sidewalk? How does one get contractors to make accurate measurements? If the measurements are not accurate, may jurisdictions incur liability? Additionally, if angles are precisely measured and stated, for example, 3 degrees right or 1:45, may this precision be more likely to confuse pedestrians with visual impairments than to be of assistance? The Expert Panel concluded that the model for intersections where there is an angled crosswalk should be “Wait to cross Howard at Grand. Crosswalk angles right.”

Crosswalks to Medians. Participants were asked to rate one set of three sample messages for use at crosswalks where there is a median with a pushbutton that must be pushed because pedestrian timing is too short for most pedestrians to cross the whole street at one time. Highest mean ratings for all groups, based on the portion of the message providing information about the intersection geometry and need to push a second pushbutton, were given to the message “Request for Howard St. at Grand Ave. Wait. Short walk phase; raised [or cut-through] median with second pushbutton.” (See Table 9.) This was the longest, most grammatically complete message. An alternative sample message was “Second pushbutton in median.”

Table 9. Mean ratings of sample pushbutton messages for a crossing having a median with a pushbutton that must be pushed because the pedestrian phase is too short for most pedestrians to cross the whole street at one time. The highest mean rating for each group is indicated by bold print.

Sample Pushbutton messages Where there is a Median with a Second Button Push Required	Blind N=170	O&M Specialists N=26	Engineers N=29
	Mean	Mean	Mean
Request for Howard St. at Grand Ave. Wait. Raised [or cut-through] median with button push required.	2.23	2.12	1.82
Requesting to cross to Howard St. median only. Wait.	1.66	1.31	1.67
Request for Howard St. at Grand Ave. Wait. Short walk phase; raised [or cut-through] median w/ 2nd pushbutton.	2.25	2.46	2.04

The Expert Panel concluded on the basis of survey ratings and the previously determined standard model for the intersection identification information, that the model pushbutton message for crossings having a short walk interval and a median with pushbutton should be “Wait to cross Howard at Grand. Short walk phase. Raised [or cut-through] median with second pushbutton.” The Expert Panel is aware that “walk phase” is incorrect terminology, however, it is terminology that is used colloquially, while “walk interval” is a technical term that is unfamiliar to most pedestrians.

Crosswalks to splitter islands. Respondents were also asked to rate one set of three sample messages for use at a crosswalk having a pushbutton to actuate a pedestrian signal for crossing to a right turn splitter island. Although in most cases, right turn lanes are unsignalized, they can be signalized. This question was intended to determine what pushbutton message would be most appropriate at such a crosswalk. Blind respondents and engineers gave the highest mean rating to the message “Requesting to cross right turn lane to island for Howard St. and Grand Ave. crosswalks,” the longest and most explanatory message. Ratings by orientation and mobility specialists were essentially equal for all three messages. (See Table 10.) Although there were no suggestions for alternate wording to be used for a crosswalk to a splitter island, numerous respondents who were blind indicated that this was a difficult concept to convey clearly, and that they would probably find all the sample messages confusing unless they were familiar with the intersection.

Table 10. Mean ratings of sample pushbutton messages for a crosswalk having a pushbutton to cross to a right turn splitter island. The highest mean rating in each set, for each group, is indicated by bold print.

Sample Pushbutton messages At Crosswalk to Right Turn Splitter Island	Blind	O&M Specialists	Engineers
	N=170	N=26	N=29
	Mean	Mean	Mean
Requesting crossing to island for Joy St. and Grand Ave.	1.94	2.15	1.56
Requesting to cross right turn lane to island for Howard St. and Grand Ave. crosswalks.	2.27	2.23	2.22
Requesting crossing to island for Joy St. and Grand Ave. crosswalks.	2.20	2.31	2.04

The Expert Panel adapted the message rated most highly by respondents who were blind and by traffic engineers, to make it more closely resemble the standard pushbutton message. The model recommended for crosswalks to right turn splitter islands is “Wait to cross right turn lane to island for Howard and Grand crosswalks.”

Crosswalks at “T” intersections. Respondents were asked to rate two sample messages to be used at crosswalks crossing from the top of a “T” intersection to a corner on one side of the stem. The highest mean rating for both blind respondents and orientation and mobility specialists, based only on the part of the message describing the geometry of the intersection, was for the message “Request for Howard St. at Grand Ave. Wait. Crossing from top of T to stem.” For engineers, the highest mean rating was for the message “Request for Howard St. at Grand Ave. Wait. T intersection of Grand Ave.” (See Table 11.)

Table 11. Mean ratings of sample pushbutton messages for crossing from the top of a “T” intersection to the stem. The highest mean rating for each group is indicated by bold print.

Sample Pushbutton messages for “T” Intersections	Blind	O&M Specialists	Engineers
	N=170	N=26	N=29
	Mean	Mean	Mean
Request for Howard St. at Grand Ave. Wait. Crossing from top of T to stem.	2.19	2.19	1.58
Request for Howard St. at Grand Ave. Wait. T intersection of Grand Ave.	2.05	1.92	1.77

Two blind respondents and one traffic engineer said that it was not important to provide the information that the intersection was T-shaped. One blind respondent suggested the alternate wording, “Crossing Howard St. to east side of Grand. Parallel traffic on left.” One engineer suggested the alternate wording, “Requesting to cross Howard at Grand. Grand ends here and all traffic turns onto Howard.”

The Expert Panel concluded that the only pushbutton message at T intersections should be intersection information, as additional information seemed to be more confusing than helpful to respondents who were visually impaired. Thus, the model “Wait to cross Howard at Grand” is recommended.

Pushbutton Delay

The pushbutton message from the pushbutton can come on as soon as the button is pressed, or with special actuation in which the button is depressed for a minimum number of seconds. Participants were asked to indicate whether they thought the pushbutton message should come on immediately, whether it should come on after a long button press, or they had no opinion on the matter. The number of subjects providing each response is shown in Table 12. While more respondents in each group indicated that the message should come on after a long button press than immediately, Chi Square tests revealed no significant differences within groups or in the total population of respondents.

Table 12. Respondent opinion, by group, regarding whether the pushbutton message from the pushbutton should come on only after the button is depressed for a minimum number of seconds, or the pushbutton message should come on immediately, each time the button is pushed. Number of responses in each group.

Message Timing	Blind	O&M Specialists	Engineers	Manufacturers	Total
Message should come on immediately	72	10	5	0	87
Message should come on after long button press	84	13	6	3	106
No opinion	11	3	5	2	21

Many participants provided reasons for their opinions on this issue. Reasons in favor of having the pushbutton message come on immediately were the following.

- “Because you need all the time to align for the crossing.” blind respondent.
- “I like it to come on immediately and then be repeated, especially if there is a lot of traffic.” blind respondent.
- “If it doesn’t come on immediately, people may miss valuable information.” O & M specialist.
- “If a long button push is required, blind pedestrians will need special training.” O & M specialist.
- “It should come on immediately, but the amount of information given should be limited to the identification of the intersection and crosswalk; more detailed information should be available after the long button press.” O & M specialist.
- “If it doesn’t come on immediately, how would the blind pedestrian know to keep the button pressed?” Engineer.
- “Why make blind pedestrians do something more than sighted pedestrians to get the same information?”

Reasons in favor of having the pushbutton message come on following a long button press were as follows.

- “It’s good to have the delay, but the delay should be shorter—maybe two seconds.” Two blind respondents.
- “All pedestrians have the option of hearing additional details.” Two O & M and one blind respondent.
- “It’s good to have the delay so that the signal is not irritating on every cycle.” Blind respondent.
- “Reduces neighborhood impact.” Engineer.
- “The long button press is good, but it requires universal education for blind pedestrians.” Engineer.
- “The long button press is good, but only if the button is large and easy to push.” Engineer.
- “The long button press is good, but children may always hold the button down to get the message.” Engineer.

The Expert Panel recognized that the lack of statistical significance for this question provided no basis for making a recommendation. However, they agreed unanimously that consistency in function throughout the United States is essential so that persons who would like to or need to use pushbutton information will be able to access it readily. They recommended that pushbutton messages come on following a long button press, (the amount of time to be standardized following research), preferring, since there was not statistically greater support for messages that come on immediately, to recommend a standard that results in less neighborhood impact.

Summary and Conclusions

An Expert Panel of stakeholders developed a survey instrument for obtaining data on preference for APS speech message structure and wording, by blind pedestrians, orientation and mobility specialists, transportation engineers, and APS manufacturers. The survey also contained items to evaluate the understanding of various message types by respondent groups, and preferences for use of a pushbutton delay feature to actuate pushbutton messages. The Expert Panel drew conclusions about the recommended structure and content of walk messages and pushbutton messages based on their own expertise and on the basis of the survey results from 170 pedestrians with visual impairments, 26 orientation and mobility specialists, 25 transportation engineers, and 5 APS manufacturers.

The following model messages are recommended for particular situations. Messages for actual installations should be developed on the basis of these models. The structure and content of actual messages should follow the models as closely as possible. Word order should not be changed. Where complete sentences are used in the models, they should be used in actual messages for the same situations. Where sentence fragments are used in models for other situations, they should be used in actual messages for those situations. In the model messages, such words as street, avenue and road are not used. In some locations they may be needed to avoid ambiguity.

SITUATION
MODEL MESSAGE

Walk Interval Messages

Model message for the walk interval, applicable to most intersections.

“Howard. Walk sign is on to cross Howard.”

Model walk message for intersections having an exclusive pedestrian phase.

“Walk sign is on for all crossings.”

Pushbutton Messages

Model message for pushbutton intersection identification information

“Wait to cross Howard at Grand.”

Model pushbutton message for intersections having an exclusive pedestrian phase with right turns-on-red prohibited.

“Wait to cross Howard at Grand. Wait for red light for all vehicles.”

Model pushbutton message for intersections having an exclusive pedestrian phase with right turns-on-red permitted.

“Wait to cross Howard at Grand. Wait for red light for all vehicles. Right turn on red permitted.”

Model pushbutton message for angled crosswalks.

“Wait to cross Howard at Grand. Crosswalk angles right.”

Model pushbutton message for crosswalks to medians where a second button push is required.

“Wait to cross Howard at Grand. Short walk phase. Raised [or cut-through] median with second pushbutton.”

Model pushbutton message for signalized crosswalks to splitter islands.

“Wait to cross right turn lane to island for Howard and Grand crosswalks.”

Model pushbutton message for crosswalks at “T” intersections.

“Wait to cross Howard at Grand.” [Not different from standard intersection identification message.]

Landmark information such as locations of public buildings and transit stops should not be included in either walk signal or pushbutton messages. Construction information should also not be included in either walk signal or pushbutton messages.

The order of information for pushbutton messages should be:

- Intersection identification;
- Intersection signalization (if remarkable); and
- Intersection geometry (if remarkable).

The Expert Panel concluded that pushbutton messages should come on after a long button press. Currently the length of this extended button press is about three seconds; this will be standardized in the future based on research.

While APS having speech messages may seem very user-friendly, especially when evaluated in an indoor setting, away from loud traffic sounds, and by people who are native English speakers, they will not solve all ambiguity problems that can occur with APS. It will not be possible to make speech messages from APS loud enough to be intelligible in all ambient traffic conditions by most people unless they are also loud enough to potentially cause hearing loss. In even moderate traffic conditions people who have age-related or other hearing losses, people who are not native English speakers, and people with cognitive disabilities are likely to miss hearing or to misunderstand some words, possibly resulting in misunderstanding entire messages.

APS speech messages are a fairly good way to provide pushbutton intersection identification, and signalization and geometry information. This information does not have to be understood by all users. This is additional, optional, information; it can be provided at a moderate sound level that may preclude its intelligibility by some potential users. However, tones or other methods may be a better way to provide real time information about the signal status, in situations where the signals can be installed to provide unambiguous information. The combination of the tactile arrow and careful location of the pushbutton may be more useful and certain in reducing ambiguity than a speech message during the walk interval.

If the decision is made to use APS with speech messages at a particular intersection or crosswalk, the messages should be worded carefully, according to the models above, or the nearest approximation to the special situations in which they will be used. The messages then must be recorded very carefully, in a clear, moderately pitched voice, with excellent diction and moderate pacing. For persons with unimpaired hearing, a female voice will be understood

somewhat better than a male voice because the frequency spectrum of the male voice is closer to that of traffic. However, for the large number of people who are visually impaired who also have age-related or other hearing loss, a female voice may not be as easy to understand as a male voice.

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