Human Factors Analysis of Real-Time Rail Crossing Information Signs

Smahel, T., CCPE, Human Factors North Inc.
Ng, H., TransLink
Chu, S., TranLink

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ABSTRACT

The Roberts Bank Rail Corridor (RBRC) is a vital east-west link for the movement of goods by rail to the west coast ports and terminals as well as eastern destinations. The RBRC travels through several at-grade crossings in the City of Langley, the City of Surrey, and the Township of Langley where motor vehicle traffic is impacted by travel delays due to trains occupying these crossings. With increasing Asia-Pacific trade the frequency and length of trains will grow over time, and so too will travel delays.

In order to help mitigate the compounding traffic congestion and safety issues associated with more trains travelling through Langley, TransLink proposed installing a Rail Crossing Information System (RCIS) in order to detect trains and predict train arrival times at the at-grade crossings in Langley, and installing nine (9) Motorist Advisory Signs (MAS) to encourage drivers to detour to grade-separated crossings when trains are blocking the at-grade crossings ahead.

The study was designed to assess the design of MAS based on human factors research and current guidelines and evaluate the comprehension of the MAS with a representative sample of road users.

Over 10 recommendations were made to improve the design of the MAS. The comprehension test determined that, depending on the complexity of the task presented to study participants, the rate of comprehension was in the range of 82% to 93%.

LITERATURE REVIEW

Legibility

Legibility refers to the distance at which a sign can be read. Drivers move towards signs quickly and long messages must be legible at a distance that allows the driver to read the entire message prior to reaching the sign. If drivers must carry out a maneuver based on information received from the sign, then the legibility distance must allow the driver to read the sign and make a comfortable and safe maneuver or else advance signing must be used.

Legibility is determined by the characteristics of the driver, the environment, the sign, and the sign lettering. The driver characteristics include their visual acuity and familiarity with the area; the environmental characteristics include ambient light level, illumination, and weather condition; the sign characteristics include the reflectivity of the sheet, colour,

and contrast of letters with the background; the lettering characteristics include letter height, font and font characteristics (stroke-to-height ratio, spacing between letters, etc.).

Driver Characteristics and Legibility

A driver with 20/20 vision can, under ideal circumstances, just barely read lettering that is 10 cm tall at 57 m, equivalent to a legibility index of 5.7 m/cm. A driver with 20/40 vision can read the same letter height at half the distance, at 28.5 m, equivalent to a legibility index of 2.9 m/cm.

About three-quarters of the driving population have 20/20 vision (or corrected vision) and drivers with 20/40 are allowed to drive without corrective lenses. Older drivers, even those with normal 20/20 vision, have shorter legibility distances due to issues related to contrast sensitivity.

One of the earliest legibility studies determined that a 30 cm sign would be legible at a distance of 183 m, equivalent to a legibility index of 6 m/cm. This was later determined to be equivalent legibility of an observer with visual acuity of 20/23 (1). In order to accommodate drivers with 20/30 vision the current standard for font legibility is 4.8 m/cm (1). This encompasses the needs of 75 to 85% of older drivers and 95% or more of younger drivers both at night and during the day (2).

Letter Characteristics and Legibility

Letter characteristics that affect legibility include font (or letter style), letter height, letter width, letter spacing, mix of upper and lower case, and observer familiarity with the word(s).

Short, fat letters are more legible than tall, narrow letters. For example, warning and regulatory signs that use Series C and Series D fonts are less legible than guide signs, which use Highway modified font. However, warning and regulatory signs are much more familiar to drivers, and drivers can generally predict, based on colour, shape, and sign placement, what the sign will say. Familiarity can as much as double legibility distance.

In 1994 a new font (Clearview) was developed especially for use on highway signs. The rationale was the belief that the current Series E modified thick stroke width font design, together with its small interior letter spaces, when created with high-brightness materials and viewed by older drivers, resulted in an irradiation effect that compromised legibility. Garvey et al. carried out a legibility study with older drivers to compare the current Series D and Series E (modified) Interstate fonts, which are used on most Canadian and U.S. signs, with Clearview (3). Signs used for testing had 5 in. (12.7 cm) white letters on a green background (see Figure 1). No differences were found for daytime legibility of Clearview as compared to E (modified). However, the Clearview font had a legibility distance 22% greater with high intensity retro-reflective sheeting and 11% greater legibility with VIP retro-reflective sheeting at night.

Spacing between letters impacts legibility. Mace et al. tested the impact on legibility of 100%, 140% and 200% spacing using standard Highway Series E modified font (2). Wider spacing improved legibility, but by less than 5%. Garvey et al. tested legibility distance with the new Clearview font at its standard spacing at 100%, as well as at

106%, 112%, 118% and 124% of the standard spacing (3). Reaction times were generally fastest for the 118% and slowest for the 100% spacing, but results were mixed, depending on the experiment. Field studies comparing the 100% and 112% spacing showed greater legibility distance for the latter spacing. At 100% spacing, Clearview and Series E modified, the font currently used on Canadian and U.S. guide signs, had equivalent legibility. However, Clearview lettering took up to 12% less sign space.

In 2004 the U.S. Federal Highway Administration granted Clearview interim approval, and individual states have begun replacing their old typefaces with this newer font. The following jurisdictions are in the process of adopting Clearview system-wide on freeways: British Columbia, Ontario, Yukon, Texas, Pennsylvania, Michigan, and Florida. According to the U.S. Federal Highway Administration, an additional 19 states have been granted approval for using Clearview fonts. In each of these jurisdictions guide signs with old typefaces are being phased out gradually with new signs that use Clearview font. During this transition, it is not uncommon to have some guide signs with Clearview and other signs with old typefaces.

Symbol Characteristics and Legibility

The legibility of a symbol depends on the smallest critical detail in the symbol that needs to be resolved in order that the symbol is understood (i.e., not necessarily the smallest detail). Legibility is difficult to determine without testing. Legibility distances were measured for 85 symbols in the U.S. Manual for Uniform Traffic Control Devices (MUTCD) in a laboratory study by Dewar et al. and varied greatly, from 94 metres for a PAVEMENT ENDS sign to 324 metres for an ADDED LANE symbol (4). Consequently, the guidelines that can be given as to symbol legibility are estimates only. Legibility distance is approximately 24 m/cm of symbol width.

Sign Characteristics and Legibility

Sign legibility is dependent on the contrast between the lettering and its background. During the day colour contrast is critical, while at night, the difference in luminance will determine how far away a sign will be read.

During the day colours reflect different amounts of light. In order to increase contrast the background must reflect much more light than the lettering, or vice versa. For example, red against blue offers very poor contrast during the day whereas white against black offers maximum contrast. Dudek and Huchingson recommend a minimum contrast of 50% for signs to be useful at night as well as during the day (5). The ADA recommends a colour contrast of 70%.

At nighttime, when only a small amount of light is available, luminance contrast is determined by the type of sheeting and the degree of retro-reflectivity. For regulatory and warning signs, higher grade retro-reflective sheeting can increase legibility from 3.6 m/cm up to 4.8 m/cm (2).

Sign Message Comprehension

Comprehension refers to driver understanding of the meaning of the message, and any symbols or abbreviations used. Lack of driver comprehension may be due to numerous reasons including:

- Unfamiliar or unintuitive symbols
- Ambiguous or unclear text messages
- Need for driver to deduce route from other destinations on sign
- Different use of same sign in jurisdiction with which driver is familiar

The Transportation Association of Canada guidelines for comprehension recommend a comprehension rate of 75% for non-critical regulatory signs and all warning, guide and information, and temporary signs (6).

ASSESSMENT OF VISUAL ELEMENTS

Visual Elements Assessment Criteria

The primary goal of the design of the visual elements of the MAS is to optimize the legibility of the sign. The human factors analysis included an assessment of the following elements:

- Sign sheeting (e.g., engineer grade, high intensity grade, diamond grade, etc.)
- Sign background colour
- Sign characteristics (e.g., static and dynamic text)
- Font
- Font case (e.g., mixed-case versus all capitals for static and dynamic text)
- Font colour (e.g., use of colour to differentiate crossing state for dynamic text)
- Letter height
- Message content (e.g., number of crossings shown on sign, integration of static and dynamic message elements
- Design of the train symbol
- Text to designate crossing occupied by train (i.e., “train” or “closed”)

Analysis of Visual Elements

The initial design of the MAS proposed 20 cm letter height using in Interstate or Clearview font. Clearview is the preferred font to enhance legibility and/or reduce sign size. The variable message portion of the sign will be double density (e.g., letters will be capitalized 10 pixels wide x 14 pixels tall, as compared to single density, which is 5 pixels wide x 7 pixels tall); letter heights will also be 20 cm. The type of sign sheeting was not specified; sheeting with very high retroreflectivity (e.g., High Intensity sheeting) will increase legibility distance at night.

An initial assessment was carried out with three individuals not familiar with the project and who had never been to the City of Langley. These individuals were shown an image of the initial design of MAS_01 for a brief period of approximately five seconds, and were then asked what the sign message was (Figure 2, top image). Participants recalled that the sign had something to do with railway crossings but were unable to provide a more detailed response. Participants were then shown the initial design of MAS_01 again and asked to describe in what order they read the information on the sign. It was noted that the sign reads as three distinct horizontal bands with a title band, road names, and then dynamic information. It was noted that it was difficult for participants to associate the

crossing status (TRAIN or OPEN) with the road names. This is likely due to the lack of clear vertical alignment between the road names and the crossing status. The train symbol was well understood. Similarly, the chevrons were understood to indicate the direction the train was travelling. It was not clear from the sign whether the railway crossing status was referring to the current condition versus the condition that would be expected upon arrival at the crossing.

A series of mock-ups were created in order to strengthen the visual relationship between the road names and the crossing status. This was done by: (1) adding blue vertical dividers to buffer the crossing status for adjacent crossings, (2) centering road name above the crossing status, and (3) adding a horizontal divider to separate the crossing status from the train and direction symbols. Next, the title used all capital letters to make RAILWAY CROSSING STATUS more visually distinct and legible at a greater distance than the road names. Several versions of these mock-ups were created, and then printed affixed to a wall surface for viewing.

Different fonts were used on the mock-ups, including FHWA E-Modified (a surrogate for Interstate) and UK Transport (a surrogate for Clearview). Observations were made at a distance where the signs were barely legible (e.g., threshold legibility). Based on these observations further refinements were made to the sign layouts. The current train symbol was maintained but the number of directional chevrons was reduced in order to enhance their legibility at a distance.

A comparison between the initial design of MAS_01 and the modified design MAS_01 is shown in Figure 2. The modified version of the sign is the same height but approximately 15% narrower than the current sign, while maintaining the same letter heights (20 cm). A similar series of modifications were made to a sign with the status of three railway crossings.

The modified sign layouts were recommended for comprehension testing.

COMPREHENSION TEST

Study Participants

The target audience of the MAS was local drivers who are familiar with the area, including commuters and/or local shoppers. Participants were recruited from the *TransLink Listens* panel. The screening criteria required that they drive a vehicle and drive across one of the railway crossings in the City of Langley at least once a week.

In December 2012 a total of 298 Panelists from Surrey and Langley were asked to complete a “pre-screen” survey in order to determine how many panelists qualified for the survey. This “pre-screen” survey was carried out in order to determine if a sample of 75 to 100 participants would qualify to participate in the survey. In total, 182 TransLink Listens panelists met the screening requirements.

In January 2013 the 182 pre-screened panelists were invited to participate in the Comprehension Test and 123 individuals completed the survey for a participation rate of 68%. Of the 123 participants 52 individuals (42%) also completed the 2011 TransLink Signage Evaluation and would have been exposed to MAS design concepts similar to the ones shown in this comprehension test.

Experimental Design and Procedure

At the start of each survey participants were asked a few questions regarding their driving frequency at the railway crossings in Langley and then they were shown a map of Langley illustrating the locations of at-grade crossings as well as the location of overpass (Figure 3).

Participants were then given six (6) scenarios including two (2) practice and four (4) test scenarios. Three test scenarios involved a train event on the road ahead and one test scenario involved a train event but not at the crossing ahead. For each scenario participants were shown a map and told: (1) where they are starting from, (2) what road they are on, and (3) where they are going (Figure 4). They were then shown an illustration of a road scene with the MAS included in the road scene for a display interval of 6.0 seconds (Figure 5). Note, in the 2011 TransLink Listens Signage Evaluation the display interval was 10 seconds, which is likely longer than the sign would be legible to drivers travelling at the posted speed limit. The 6.0 display interval was selected based on the maximum legibility distance of the proposed MAS design at the posted speed limit. In addition, during testing of the TransLink Listens online survey platform, it was determined that the slides showing the MAS within the roadway context took approximately up to 1 second to fully load, resulting in an effective display interval of approximately 5 seconds.

After seeing each of the four test signs participants were asked a few questions including, (1) whether the crossing ahead was open or closed, (2) whether they would continue driving straight ahead or choose another path, and either (3a) why they would continue driving straight or (3b) what detour path they would take.

Participants were assigned to one of four orders. Orders were counterbalanced to ensure that each of the four test messages was observed an equal number of times at the beginning, middle, and end of the survey.

Performance of the message in each scenario was assessed based on the accuracy of their response to the state of the crossing ahead (i.e., open or closed) and the proportion of drivers who would detour based on the presence of a Motorist Advisory Sign.

At the end of each session participants were asked questions about the level of difficulty of extracting particular pieces of information from the sign. The survey took approximately 10 minutes to complete.

RESULTS

Demographics

Age and Gender

A total of 123 individuals from the TransLink Listens panel participated in the survey. The participant sample included a gender split of 56% male and 46% female. The age distribution of participants is shown in Table 1 alongside the distribution of the general population. The participant sample was under represented in the middle age group (age

35-54 years) and over-represented in the older age group (age > 55 years) compared to the general population in Langley (Statistics Canada, 2011).

Education

A comparison between the education of study participants and that of the population of Langley based on census data is shown in Table 2. The number of participants who received a university degree (46%) was much greater than the general population (15%) and the number of participants who did not finish high school (2%) was much less than the general population (23%).

Driving Experience in the City of Langley

The target audience of the MAS was drivers who were very familiar with driving through the City of Langley. Therefore it was required that participants drove into or through the City of Langley a minimum of once a week. As shown in Table 3, most of the participants drove through the City of Langley several times a week (53%) or daily (22%).

Participants were asked how often they drove across each of the at-grade railway crossings in the City of Langley. Overall, they were more likely to use the Fraser Highway (70% at least once a week) and 200 Street (71% at least once a week) crossings and less likely to use the 56 Avenue (37% at least once a week) and 192 Street (20% at least once a week) crossings (Table 4).

Participants were asked, on average, how long they have to wait for a train. Overall, most participants reported average wait times of at least 3 minutes (82%) including nearly one-third who wait 5 minutes or longer, on average (Table 5).

Participants were asked if they had ever taken a detour when they saw traffic backed up ahead due to a train at one of the crossings in the City of Langley. Overall, 57% said they had taken a detour. Of those that said they had detoured, most detoured once a month or less (53%) (Table 6).

For those participants who said they have never detoured, the most common reasons were (1) wait times were not that long usually (41%), (2) no detour options possible (32%), and (3) not sure of detour route (23%) (Table 7).

Message Comprehension

Message A – Train Event When South on 200 Street

Participants were shown a map indicating they were on the north side of Langley and instructed they were going south on 200 Street towards the south side of town (Figure 6). They were subsequently shown the modified design of MAS_03 within the roadway context for 6 seconds and then asked if the 200 Street crossing was open. Overall, 82% of participants correctly indicated that the 200 Street crossing was closed. A chi-square test was used to compare performance to the comprehension benchmark defined by the Transportation Association of Canada (75%); there was a trend towards higher comprehension than the 75% benchmark ($p=.068$).

Participants were then asked, based on information on the sign they just saw, would they continue driving straight on 200 Street or choose another path. Of the 101 participants who said the crossing was closed, 28% said they would continue straight and 72% said they would choose another path.

Of the 28 participants who said they would continue straight even though they knew the 200 Street crossing was closed, the most common reasons were that they don't mind waiting at a closed crossing (n=9) and the other crossing might be closed (n=5) (Table 8).

Of the 73 participants who said they would choose another path 78% said they would choose the 204 Street overpass and 8% would take the Langley Bypass.

Message B – No Train Event When East on 56 Avenue

Participants were shown a map indicating they were on the west side of Langley and instructed they were going east on 56 Avenue towards the east side of town (Figure 7). They were subsequently shown the modified design of MAS_01 within the roadway context for 6 seconds and then asked if the 56 Avenue crossing was open. Overall, 93% of participants correctly indicated that the 56 Avenue crossing was open. A chi-square test was used to compare performance to the 75% benchmark; the level of comprehension was significantly higher than the 75% benchmark ($p<.001$).

Participants were then asked, based on information on the sign they just saw, would they continue driving straight on 56 Avenue or choose another path. Of the eight (8) participants who said the crossing was closed, three (3) said they would continue straight and five (5) said they would choose another path.

Message C – Train Event When North on 200 Street

Participants were shown a map indicating they were on the south side of Langley and instructed they were going north on 200 Street towards the north side of town (Figure 8). They were subsequently shown the modified design of MAS_08 within the roadway context for 6 seconds and then asked if the 200 Street crossing was open. Overall, 89% of participants correctly indicated that the 200 Street crossing was closed. A chi-square test was used to compare performance to the 75% benchmark; the level of comprehension was significantly higher than the 75% benchmark ($p<.001$).

Participants were then asked, based on information on the sign they just saw, would they continue driving straight on 200 Street or choose another path. Of the 110 participants who said the crossing was closed, 46% said they would continue straight and 54% said they would choose another path.

Of the 51 participants who said they would continue straight even though they knew the 200 Street crossing was closed, the most common reason was that they don't mind waiting at a closed crossing (Table 9).

Of the 59 participants who said they would choose another path 84% said they would take the 204 Street overpass.

Message D – Train Event When East on Fraser Highway

Participants were shown a map indicating they were on the west side of Langley and instructed they were going east on Fraser Highway towards the east side of town (Figure 9). They were subsequently shown the modified design of MAS_02 within the roadway context for 6 seconds and then asked if the Fraser Highway crossing was open. Overall, 93% of participants correctly indicated that the Fraser Highway crossing was closed. A chi-square test was used to compare performance to the 75% benchmark; the level of comprehension was significantly higher than the 75% benchmark ($p<.001$).

Participants were then asked, based on information on the sign they just saw, would they continue driving straight on Fraser Highway or choose another path. Of the 115 participants who said the crossing was closed, 36% said they would continue straight and 64% said they would choose another path.

Of the 42 participants who said they would continue straight even though they knew the Fraser Highway crossing was closed, the most common reason was that they don't mind waiting at a closed crossing (Table 10).

Of the 73 participants who said they would choose another path 55% said they would take the Langley Bypass and 31% said they would take the 204 Street overpass.

Debrief Questions

After the responding to the test messages participants were asked a few debrief questions including the level of difficulty of using the new signs. The vast majority of participants (88%) said it was either somewhat or very easy to determine whether the crossing ahead was open or closed (Table 11). About half of participants (53%) said it was somewhat easy or very easy to determine what detour options were available and about two-thirds of participants said it was either somewhat easy or very easy to determine whether the detour options were likely to be open or closed.

Participants were asked, based on the information on these new signs, how likely were they to detour when a train is blocking the road ahead. Table 12 shows a comparison between those who said they had previously detoured to those who said they had never detoured. Of particular interest, of those participants that had never detoured previously, 49% were either more likely or much more likely to detour based on these signs.

Participants were shown the sign shown in Figure 10 and asked, "imagine that you saw this sign while driving on Fraser Highway towards the railway crossing and were about one minute of travel time from the crossing. Do you think the Fraser Highway crossing will be open when you get there?"

Most people responded that the crossing would be closed (59%) and only 15% thought the crossing would be open. The remaining 26% did not know if the crossing would be open or closed. The correct answer is that the crossing would be open as the real time information is intended to account for the travel time between viewing the sign and reaching the crossing.

DISCUSSION

The target audience for the MAS is drivers familiar with driving in and around the City of Langley as these signs provide only passive detour information. A sample of 123 individuals representative of the target audience was recruited who drive at least once a week across the at-grade railway crossings in Langley. Most participants encountered a train at least once a week on 200 Street and on Fraser Highway, and about one-third of wait times were estimated to exceed five minutes in duration. Just over half of all participants had detoured during a train event in the City of Langley (57%).

In terms of familiarity with the MAS and completing a similar online survey, less than half (42%) of the participant sample also completed the 2011 TransLink Signage Evaluation.

In terms of age and level of education, the participant sample was slightly older and more educated than the general population in Langley.

Three of the four test scenarios involved a MAS message indicating that a train was blocking the road ahead. These signs had a very high rate of comprehension with respect to participants determining whether the crossing ahead was open or closed (82%, 89%, 93%). For these scenarios most participants said they would choose another path rather than continuing straight to the blocked crossing based on the information presented on the MAS (72%, 54%, 64%). For those participants who indicated that they would continue straight, the most common reason was they did not mind waiting at a closed crossing. For the scenario where two of the four crossings were closed, but the crossing ahead was open, the vast majority of participants correctly indicated that the crossing ahead was open (93%).

Overall, participants were able to use the MAS to determine whether the crossing ahead is open or closed with a very high rate of accuracy. Sign performance met the recommended comprehension threshold of 75% (1 test sign) or exceeded it by a statistically significant margin (3 test signs).

Following the evaluation of the test messages the vast majority of participants indicated it was somewhat easy or very easy to use the MAS to determine whether the crossing ahead was open or closed (88%), and two-thirds of participants indicated it was somewhat or very easy to determine whether the detour options were likely to be open or closed (66%). Based on the information presented on the MAS, about half of the participants who reported never having detoured previously indicated that they were more likely or much more likely to detour during a train event (49%). Three-quarters of participants who had previously detoured said they were either more likely or much more likely to detour based on information presented on the MAS during a train event.

The majority of participants assumed that information on the MAS displayed real-time information without accounting for travel time from the sign to the crossing (57%). Only 15% correctly indicated that the crossing ahead would be open when the sign indicates the crossing is OPEN but a train is shown very close to the crossing (e.g., MAS shown on Fraser Highway shown below in Figure 11). The remaining 26% of participants did not know if the crossing would be open or closed.

CONCLUSIONS

With respect to the design layout of the MAS, the following modifications were recommended:

- Use high intensity sign sheeting to enhance sign legibility at night.
- Use white text on blue background or black text on white background
- Use all capital letters for the RAILWAY CROSSING STATUS title. This will increase the legibility of the title and help differentiate the title text from the crossing names.
- Use Clearview font to reduce text and sign width.
- Vertically stack all crossing names. This will emphasize the association between the crossing name and the at-grade crossing status below.
- Centre the crossing names above crossing status.
- Add vertical dividers to add a visual buffer between the statuses at each crossing.
- Add horizontal divider to add visual buffer between status at crossings and train direction.
- Reduce the number of chevrons by up to 50% and increase their height in order to enhance their legibility at a distance.
- Do not use yellow or amber colour text for OPEN message for crossings that are soon to be occupied by a train. A new colour will add to the visual complexity of the sign message and could create confusion as to whether or not the crossing will be open when drivers arrive at the crossing.
- It is not necessary to include a graphic element to indicate the name of the crossing ahead as most drivers will know what road they are on and this design element would add unnecessary clutter to the sign.

With respect to MAS comprehension:

- Based on the objective rate of comprehension (82% to 93%), and subjective ease with which participants felt they were able to determine if the crossing ahead is open or closed (88%), these signs are likely to be very effective at letting drivers know if the crossing ahead is open or closed.
- About half of the drivers who had never detoured in the past during a train event said they are more likely or much more likely to detour based on the information on these signs.
- Drivers are not likely to understand that the information presented on the signs take into account their travel time to reach the crossing. Only 1 in 6 participants thought the crossing ahead would be open when a train was shown close to the crossing but the crossing was identified as being open. Consideration should be given to having the information on the MAS be “real-time” rather than predicting the state of the crossing based on the estimated travel time from the MAS to the crossing. Alternatively, a comprehensive education campaign will need to be undertaken to teach drivers how the signs are intended to be used.

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TABLES

Table 1. Age Distribution of Participant Sample

	Participant Sample (n=123)	Langley (Statistics Canada*)
16-34	13%	11%
35-54	27%	48%
> 55	60%	41%

Table 2. Education Distribution of Participant Sample

	Participant Sample (n=123)	Langley (Statistics Canada*)
Some high school or less	2%	23%
High school	10%	29%
Community College	42%	32%
University	46%	15%

Table 3. Driving Experience in the City of Langley

	Participant Sample (n=123)
Daily	22%
Several times a week	53%
About once a week	25%

Table 4. Frequency Driving Across Langley At-Grade Crossings

	Daily	Several times a week	About once a week	2-3 times a month	Once a month	Less than once a month	Never
56 Avenue	5%	13%	19%	19%	10%	28%	6%
192 Street	4%	11%	15%	13%	11%	33%	14%
Fraser Highway	11%	32%	27%	17%	4%	6%	2%
200 Street	6%	38%	27%	13%	6%	8%	2%

Table 5. Train Wait Times in Langley

	Participant Sample (n=123)
Less than 1 minute	0%
1 to 2 minutes	2%
2 to 3 minutes	14%
3 to 5 minutes	51%
5 minutes or longer	33%

Table 6. Frequency of Taking Detour (For Those Who Have Detoured in the Past)

	Participant Sample (n=62)
Daily	3%
Several times a week	8%
About once a week	18%
2 to 3 times a month	18%
Once a month	24%
Less than once a month	29%

Table 7. Reasons for Not Detouring

	Participant Sample (n=53)
Prefer to wait	19%
Wait times not that long usually	41%
Detour would take too long	19%
Not sure of detour route	23%
No detour options possible	32%
Other	13%

Table 8. Message A – Reasons Choosing Not to Detour

	Participant Sample (n=28)
Don't mind waiting at a closed crossing	1
Not sure of other crossing options	9
Not sure how to get to other crossings	2
The other crossings might be closed	5
Other	9
Don't know	2

Table 9. Message C – Reasons Choosing Not to Detour

	Participant Sample (n=51)
Don't mind waiting at a closed crossing	21
Not sure of other crossing options	2
Not sure how to get to other crossings	2
The other crossings might be closed	2
Other	24

Table 10. Message D – Reasons Choosing Not to Detour

	Participant Sample (n=42)
Don't mind waiting at a closed crossing	17
Not sure of other crossing options	4
Not sure how to get to other crossings	4
The other crossings might be closed	2
Other	15

Table 11. Level of Difficulty Using the New Signs

	Very easy	Somewhat easy	Not easy or difficult	Somewhat difficult	Very difficult
Whether the crossing was open or closed	69%	19%	6%	6%	0%
What detour options were available	26%	27%	23%	18%	6%
Whether those detour options were likely to be open or closed	43%	23%	15%	13%	6%

Table 12. Likelihood of Detouring During Train Event Using New Signs

	Much more likely	More likely	No difference	Less likely	Much less likely
Have previously detoured (n=70)	26%	47%	27%	0%	0%
Have never detoured (n=51)	14%	35%	49%	2%	0%

FIGURES

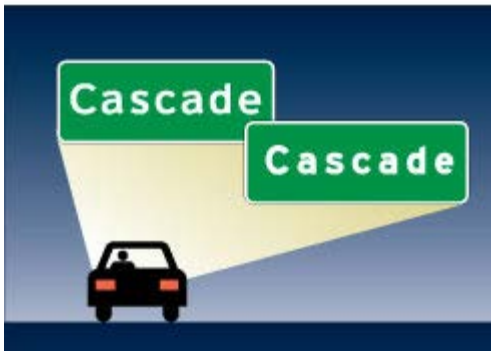

Figure 1. Comparison between Clearview (left) and Series E modified (right)

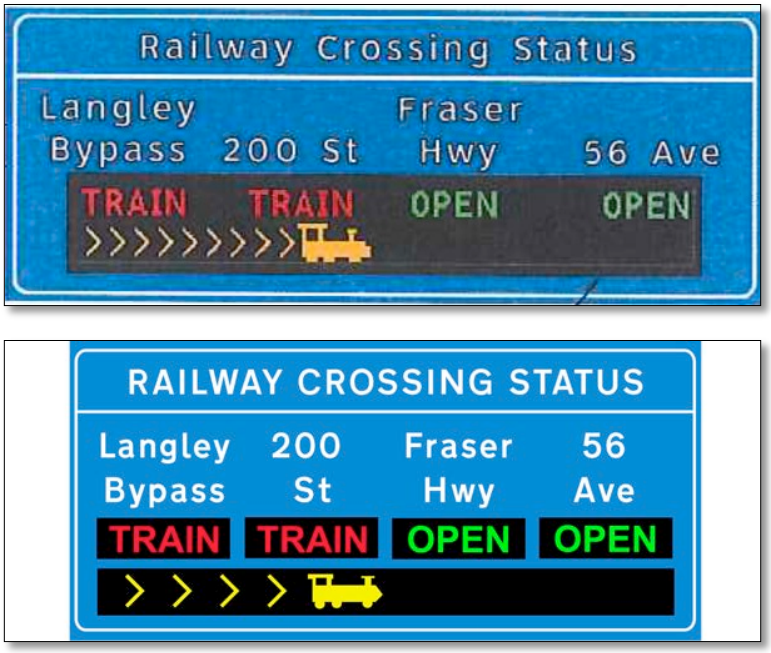

Figure 2. Initial design of MAS_01 (top) vs. modified design (bottom)

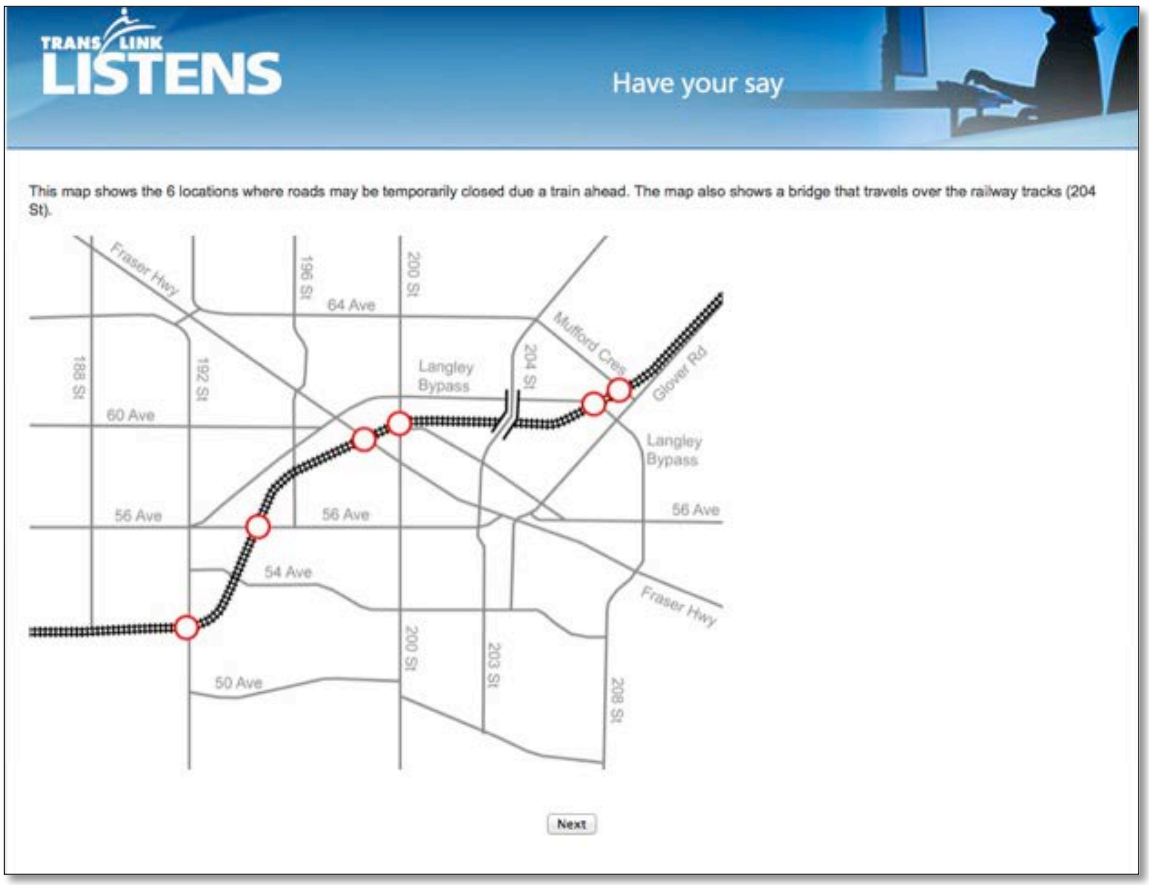

Figure 3. Map illustrating at-grade crossing locations and 204 Street bridge

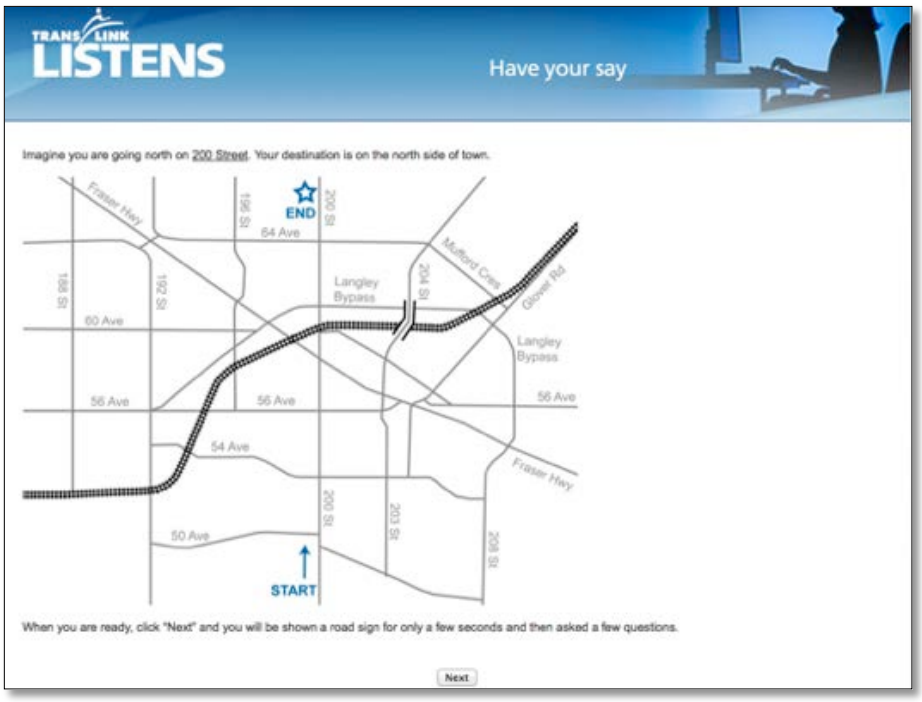

Figure 4. Map shown to participants at start of each scenario (practice scenario shown)

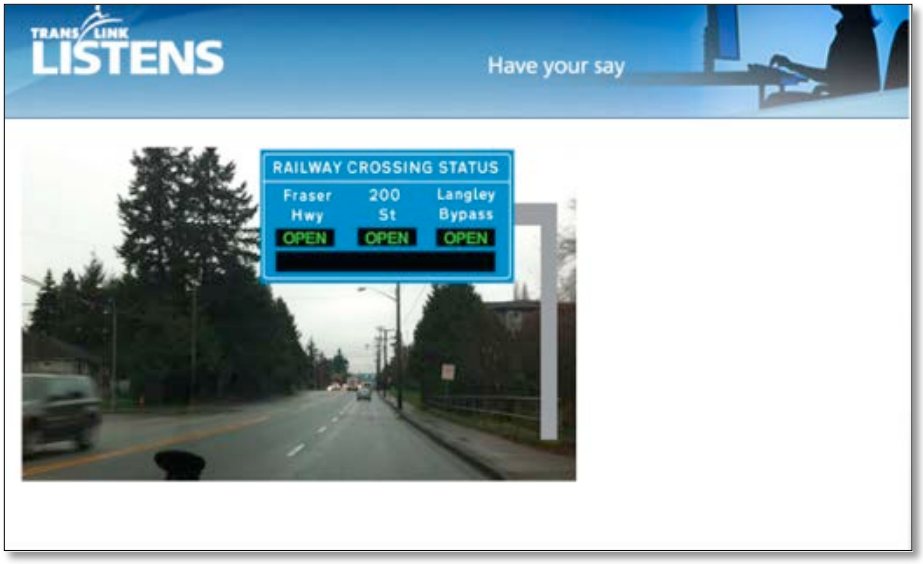

Figure 5. Mockup of sign shown in roadway context (practice scenario shown)

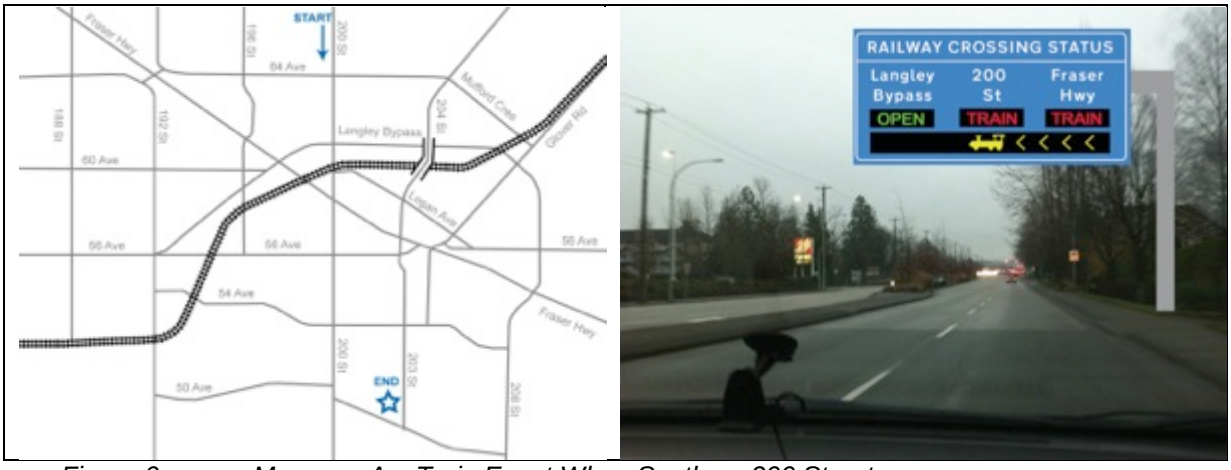

Figure 6. Message A – Train Event When South on 200 Street

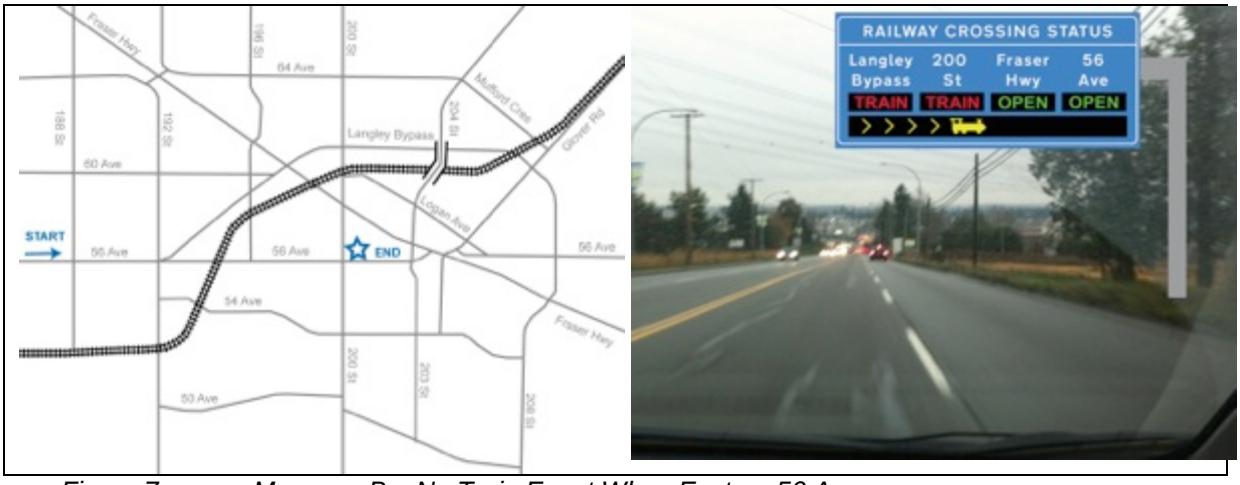

Figure 7. Message B – No Train Event When East on 56 Avenue

Figure 8. Message C – Train Event When North on 200 Street

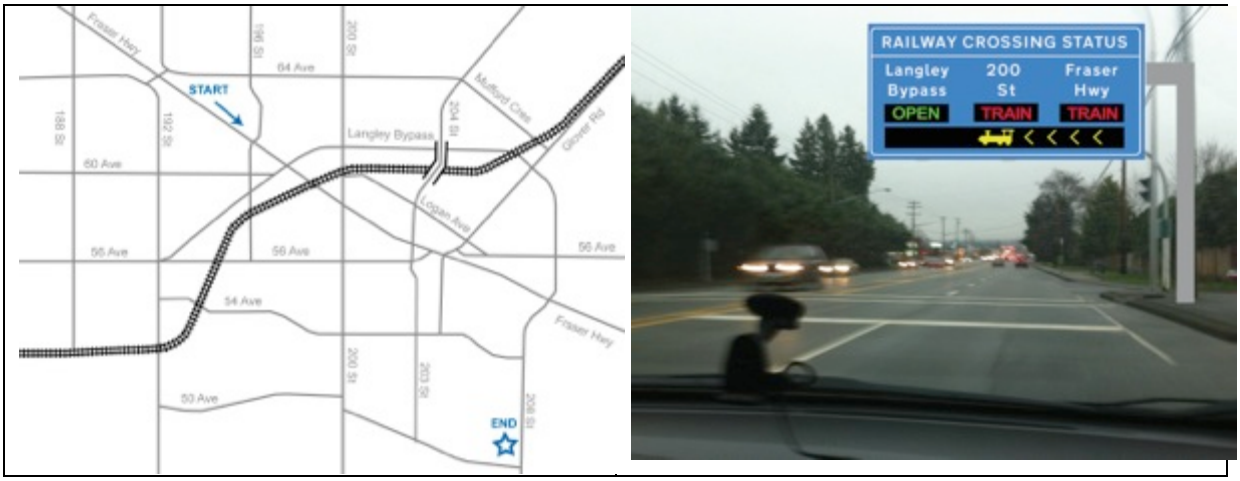

Figure 9. Message D – Train Event When East on Fraser Highway

Figure 10. Sample Sign Illustrating Train Approaching Crossing Ahead

Figure 11. Sample Sign Illustrating Train Approaching Crossing Ahead