Science on the Move:
Front-End Evaluation Report

Prepared for

OMSI

Everyday Encounters with Science

by

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Executive Summary

Overview

This report describes a multi-part evaluation study conducted to guide development of exhibit prototypes for *Science on the Move: Everyday Encounters with Science*, developed by the Oregon Museum of Science and Industry (OMSI), located in Portland, Oregon. This project, funded through an NSF Pathways grant, is intended to provide opportunities for adult transit users (particularly those without college degrees) to engage with exciting and personally relevant science concepts outside the walls of the museum. By working with TriMet (Portland's public transit provider) and Lamar (a marketing firm which works closely with TriMet to coordinate content placed at transit stops and on and in buses and trains), as well as the businesses and organizations along TriMet's routes, OMSI will develop prototypes for transit stops which surprise and engage transit users. Throughout the course of this project, a design-based research (DBR) approach will be employed; DBR encourages iteration, reflective assessment, and the development and refinement of context-contingent "small" theories (Brown, 1992; Cobb, Confrey, diSessa, Lehrer, & Schauble, 2003; Collins, Joseph, & Bielaczye, 2004; Sandoval, 2004).

Study Objectives

1. Identify techniques (marketing and otherwise) to successfully design and create the audience experience set forth in the project theory of action, with particular attention paid to strategies for engaging audiences in public spaces and to moving individuals from "noticing" to "approaching".
2. Determine unique characteristics of the target audience (adults without a college degree), as well as any perceptions and beliefs they might hold regarding science.
3. Draw upon current literature to construct a clear and functional operationalization of variables related to study impacts, particularly an "attitude of appreciation" that science is everywhere and personally relevant to audience members.
4. Develop a clear understanding of interpersonal and intrapersonal bus stop/transit center dynamics, as well as specific interventions which tend to foster conversation and interaction between transit users.
5. Identify topics or themes which are interesting and personally relevant to the target audience and bus riders more generally, while also remaining connected to both immediate and local contexts.

Methods

To address the evaluation objectives, the team conducted structured interviews with 96 adults recruited at three TriMet transit stations in March 2013. In addition to primary data collection, evaluators and other team members engaged in secondary analysis of existing datasets and a brief review of existing literature in the fields of marketing, exhibit design, education, psychology, and museum studies.

Summary of Findings

Interviews with TriMet users

- Among the TriMet riders interviewed by evaluators, the **overarching themes of nature, animals, and music** appeared most interesting and personally relevant.
- **Few differences in interview response were noted along demographic lines**, suggesting that the patterns of interest and perceived relevance are likely applicable to a diverse range of adult audience members.

Findings from prior research

- The concept of ***situational interest*** (Hidi & Renninger, 2006; Silvia, 2006) appears to provide both a promising approach to planning prototypes which capture and maintain individuals' attention and a meaningful and actionable avenue to conceptualize and assess the second project impact of an "attitude of appreciation."
- **Learning experience characteristics that trigger situational interest** include novelty, personal relevance, appropriate levels of challenge, hands-on activities and experiences, intensity, understandability, computers, social interaction, and individual choice.
- Successful exhibit interfaces tend to be **intuitive but engaging**, with no extraneous internal or external text.
- The **first moments of engagement** with an exhibit are crucial—successful exhibit experiences allow visitors to immediately feel engaged and excited, rather than intimidated or confused.
- Transit riders' perceived wait times are shorter if they have something to do, they are more likely to do something if they are sitting down, and their experiences of public transportation are influenced by the behavior of (and their interactions with) other riders.

Findings from secondary data analysis

- In contrast to primary data collection findings, data from the 2010 General Social Survey (GSS) indicate that individuals with lower levels of education are slightly less likely to be familiar with and interested in science topics and hold slightly less positive views of science in general. These differences were small, however, which may indicate either that such differences become apparent only across larger samples or that there is a slightly more science-friendly mindset among Portland-area transit users.
- **Design elements which produce positive psychological affect**, such as complimentary color palettes, may provide a useful and straightforward means to increase audience engagement with and enjoyment of prototypes.
- Both the general and specific location for placement of the prototype may be considered in order to capitalize on traffic patterns, visibility during day and (possibly) night, and the ability to create large-scale, attention-grabbing prototypes.
- Throughout the prototype development and evaluation process, mindfulness of cultural considerations which might impact the ways in which audience members interact both with the prototype and with other users is imperative.

Section 1: Overview

This report describes front-end evaluation activities conducted to contribute to the development of small, context-specific theories within a design-based research framework and to guide development of prototypes for the *Science on the Move: Everyday Encounters with Science* project, led by the Oregon Museum of Science and Industry (OMSI), located in Portland, Oregon. This project, funded through an NSF Pathways grant (DRL-1222659), is intended to provide opportunities for adult transit users (particularly those without college degrees) to engage with exciting and personally relevant science concepts outside the walls of the museum. By working with TriMet (Portland's public transit provider) and Lamar (a marketing firm which works closely with TriMet to coordinate content placed at transit stops and on and in buses and trains), as well as the businesses and organizations along TriMet's routes, OMSI will develop prototypes at transit stops which surprise and engage transit users. Throughout the course of this project, a design-based research (DBR) approach will be employed. DBR encourages iteration, reflective assessment, and the development and refinement of context-contingent "small" theories which may be adapted and implemented in future similar ventures (Brown, 1992; Cobb et al., 2003; Collins et al., 2004; Sandoval, 2004). In order to guide the development of the form and content of these prototypes, OMSI evaluators conducted in-person interviews with TriMet users at multiple transit centers; secondary data analysis and brief reviews of literature were also incorporated to ensure a sound theoretical and practical framework for prototype development.

The front-end evaluation and research phase immediately followed the planning phase and spanned approximately three months during Year 1 of the project, from February to May 2013. During the first weeks of this phase, the team discussed topic areas and research questions which should be answered prior to developing the prototype and content and began developing a first draft of the project's *theory of action*. A theory of action typically incorporates important inputs which influence the target impacts, promising support structures that might foster the impacts and objectives of the project, the desired outcomes of the impacts and objectives, indicators of these outcomes, and contextual factors that may potentially influence the outcomes (Cobb & Gravemeijer, 2008). Team members incorporated educational theories, previous empirical research, and previous experience to create the theory of action. The theory of action articulates specific characteristics of the prototype design, content design, and environmental context which the team believes will influence the project's impacts and objectives. (The current draft of the project's theory of action, including current articulations of the target impacts, is provided in Appendix A.)

While the theory of action serves as a valuable resource to guide the development and evaluation of the prototypes, it is also explicitly intended to be iterative and open to revision. For example, team members and project advisors may theorize that, based on previous experience and knowledge, a prototype with an audio component will be more successful at attracting users than a prototype without an audio component. Team members and project advisors may also hypothesize that certain locations will be more conducive to facilitating participation than others, or that certain phrasing of content may be more successful at increasing user appreciation of the personal relevance of science. A list of all of these inputs, support structures, objectives, indicators, and contextual factors was compiled into a single written document which comprises the project theory of action; however, if a posited relationship is not supported by empirical evidence at any point during the development and testing process, the theory of action will be revisited and adjusted as appropriate. This process of creating and recreating a theory of action will make the team's assumptions about the project explicit while also necessitating the continued questioning of these assumptions. Through such explication, each assumed relationship may be tested and revised during the subsequent "progressive refinement" evaluation phase.

Front-End Evaluation Objectives

The front-end evaluation activities were designed to achieve five objects, developed collaboratively with the project team:

1. Identify techniques (marketing and otherwise) to successfully design and create the audience experience set forth in the project theory of action, with particular attention paid to strategies for engaging audiences in public spaces and to moving individuals from "noticing" to "approaching".
2. Determine unique characteristics of the target audience (adults without a college degree), as well as any perceptions and beliefs they might hold regarding science.
3. Draw upon current literature to construct a clear and functional operationalization of variables related to study impacts, particularly an "attitude of appreciation" that science is everywhere and personally relevant to audience members.
4. Develop a clear understanding of interpersonal and intrapersonal bus stop/transit center dynamics, as well as specific interventions which tend to foster conversation and interaction between transit users.
5. Identify topics or themes which are interesting and personally relevant to our target audience and bus riders more generally, while also remaining connected to both immediate and local contexts.

The evaluation team accomplished these objectives through secondary research, secondary analysis of existing datasets, and in-person interviews with members of the target public audience. Because each of these data collection methods involved unique procedures, participants, and analyses, the following sections provide information regarding each individually. The primary research component of this study (interviews with public audience members) addressed objectives 2 and 5; these two objectives were further addressed through secondary data analysis, while secondary research was employed to address objectives 1, 3, and 4. The remainder of this report is divided into four sections, three of which present the findings of the studies described above and the last of which discusses the implications of these findings as a whole for the *Science on the Move* project.

Section 2: Public Audience Interviews

The primary data collection component of the front-end study consisted of interviews conducted with members of the project's target audience and other adults at local transit centers, with responses intended to address Study Objectives 2 and 5.

Methods

The following subsections outline the methods employed in the course of these public audience interviews, including the characteristics of participants and the data collection and analysis procedures.

Participants
In order to reach the project's target audience of adults without college degrees, evaluators chose to recruit front-end participants from among adult TriMet riders at multiple transit centers across the greater Portland area. Potential participants were selected on the basis of apparent age and activity at the transit center (individuals actively engaged in boarding or deboarding transit were not approached) and were recruited for inclusion in the study on the afternoons of March 19, 25, 26, and 27, 2013. A total of 153 individuals were approached for participation, with 55 declining to participate and two participants later removed from the study due to their age; this resulted in a response rate of 62.7% and a final analytic sample of 96 eligible individuals interviewed by evaluators during this period. As noted in the following pages, a subsample of 30 of these 96 individuals also participated in optional topic testing. This subsample did not differ significantly from the overall sample in terms of education or gender distribution, but topic testing participants were significantly older on average (M = 44.67, SD = 14.71) than those who did not participate in topic testing (M = 38.29, SD = 12.07), $t(86) = 2.18$, p = .032.

Study participants ranged in age from 18 to 73 with a mean age of 40.47. In terms of the project's target audience, the distribution of education levels supported the selection of data collection locations, as the majority of participants (65.7%, n = 63) fell within the category of adults without college degrees. Please refer to Table 1 for a complete overview of participant demographics.

Table 1: Demographic Characteristics of Interview Participants

Demographic Characteristic	*n*	%
Gender: Female	44	45.8%
Gender: Male	52	54.2%
Education: Less than high school	9	9.4%
Education: High school diploma or equivalent	23	24%
Education: Some college	31	32.3%
Education: Associate's or trade degree	9	9.4%
Education: Bachelor's degree or equivalent	11	11.5%
Education: Master's degree or equivalent	5	5.2%
Location: Clackamas Town Center Transit Center	12	12.5%
Location: Gateway Transit Center	39	40.5%
Location: Gresham Transit Center	45	46.9%

Sampling and Recruitment

Participants were recruited at local transit centers during each data collection day; specific location selection was based on recommendation by TriMet employees regarding ridership demographics and stop usage in order to maximize the inclusion of adult riders without college degrees. Due to determination by evaluators that the location was poorly-suited for data collection, fewer participants were recruited at the Clackamas Town Center Transit Center than at the Gateway or Gresham Transit Centers (see Table 2 for number and percentage of participants recruited at each location). Data collection took place over a period of nine calendar days, beginning on Tuesday, March 19, and concluding on Wednesday, March 27, with evaluators actively engaging in data collection on Tuesday, March 19, Monday, March 25, Tuesday, March 26, and Wednesday, March 27. Data were collected for approximately two and a half to three hours per day for four days during the data collection period for a total of 11 hours (22 person-hours) of data collection. (Hours and days of data collection at each of the three locations are provided in Table 2.)

Evaluators employed a systematic sampling method with a sampling frame consisting of all adult TriMet public transit users present at three selected bus stops—Clackamas Town Center Transit Center, Gateway Transit Center, and Gresham Transit Center—during the periods of researcher observation. Based on the sample size and assuming an even distribution of responses within the target population, the 95% confidence interval for categorical data was ±10%.

Table 2: Data Collection Hours, Dates, and Number of Participants by Location

	Date	Hours	*n*	%
Clackamas Town Center Transit Center	Tuesday, March 19	4:00 PM – 5:30 PM	12	12.5
Gateway Transit Center	Tuesday, March 19	5:45 PM – 7:00 PM	15	15.6
	Tuesday, March 26	4:00 PM – 7:00 PM	24	25
Gresham Transit Center	Monday, March 25	4:15 PM – 7:00 PM	28	29.2
	Wednesday, March 27	4:15 PM – 6:45 PM	17	17.7

The project team was particularly interested in learning more about the target audience of adults without college degrees. While it could not be guaranteed that all participants in the study would fall within this category, the selection of research locations was be based upon data provided by representatives of TriMet regarding transit stops most frequently utilized by members of the target audience. To further ensure the selection of appropriate data collection sites, evaluators drew upon census data which provided a breakdown of resident education level and degree attainment by ZIP code (United States Census Bureau, 2013), resulting in the exclusion of the Beaverton Transit Center from data collection activities. As a final consideration, evaluators referred to OMSI data which indicated that Gresham residents are underrepresented in terms of museum membership and patronage, providing greater justification for the inclusion of the Gresham Transit Center in order to reach potentially underserved communities. In addition to taking these considerations into account, evaluators collected basic participant demographic information in order to provide the opportunity for analysis focused upon responses collected from target audience members. The protocol for the interviews conducted at these locations is described below, with a summary provided in Appendix B.

Before beginning an interview, evaluators filled out the first portion of a line on the tracking table provided in Appendix C (date, location, interviewer initials, and time). Upon arrival at the data collection location, evaluators walked along the transit waiting area, greeted the first adult to approach within four feet of their position, and began the recruitment script provided in Appendix C. Bearing in mind the prototype's target audience of adults without college degrees, only individuals who appeared to be 25 years of age or older[1] were approached and offered the opportunity to participate in a brief interview to share their thoughts about the city and the immediate and surrounding areas, as well as their general likes and dislikes. If the individual declined to participate, the evaluator marked their refusal and potential reason on that line of the tracking table before filling out the first portion of the next tracking table line and approaching another person. When an individual agreed to participate, the evaluator marked the consent on the tracking table and filled in their approximate age and gender, then continued on to the main interview questions.

[1] While evaluators approached only those individuals who appeared to be 25 years of age or older, several participants indicated that they were younger than this; as noted above, responses from these participants were still included in the study, provided they were at least 18 years of age.

Data Collection

A brief interview consisting of five open-ended questions and four closed-ended questions (described in greater detail below) was conducted with each individual included in the study sample. Additionally, participants who completed the interview in full were given the option of spending approximately ten more minutes to discuss ten "topic testing" cards presenting possible prototype topics which had previously been selected by team members for testing. While no incentives were offered for participation in the basic interview, all participants who completed the basic brief interview were offered the opportunity to provide topic testing input in exchange for two general admission tickets to OMSI; 31.2% (n = 30) of those interviewed chose to participate in topic testing.

All interviews were conducted in accordance with OMSI Evaluation & Visitor Studies guidelines, including informed consent statements provided to audience members describing research activities and verbal assent collected from interview subjects. An umbrella protocol providing of examples of the types of instruments and procedures which would likely be employed in the course of data collection was submitted to and approved by Portland State University's Institutional Review Board. All final data collection instruments, including the recruitment script and interview guide, are provided in Appendix C.

As noted above, the interview guide was divided into two sections, with the first section estimated to take five minutes to complete and the second section having an estimated completion time of ten minutes. In addition to five open-ended questions[2], the basic interview included four statements drawn from a questionnaire used in the Programme for International Student Assessment (PISA) designed to assess perceived relevance of science to individuals' lives (Organization for Economic Cooperation and Development [OECD], 2009). Responses on these items were assessed using a four-point Likert-style scale ranging from "Strongly Disagree" (coded as 1) to "Strongly Agree" (coded as 4), with higher scores corresponding to greater perceived relevance. Internal consistency for the four-item measure as assessed through Cronbach's α was acceptable at .86; this compared favorably with the internal consistency achieved during the original study (OECD, 2009), which ranged from .69 to .83 depending upon the country in which the survey was administered. Participant responses to these items were summed, resulting in an overall four-item scale with a possible range of 4 (strongly unfavorable views of perceived science relevance) to 16 (strongly favorable views of perceived science relevance).

The second, optional section of the interview guide used topic testing cards (Appendix E) to assess the level of interest and perceived relevance associated with 10 topics which might potentially be explored through subsequent exhibit development. These topics were selected through a process of brainstorming followed by iterative refinement by core project team members. Selections were made on the basis of perceived local and general appeal, suitability for

[2] It should be noted that the five open-ended interview questions were initially ordered slightly differently from that reflected in the final version (Appendix C), with the question "What are some things that you enjoy doing or ways you like to spend your time?" asked third rather than first. Based on the experiences of evaluators during this initial data collection shift, the questions were reordered to maximize participant comfort and alleviate feelings of distress or unpreparedness.

inclusion in a public, OMSI-branded exhibit, and potential connections to science, technology, engineering, and/or math (STEM) ideas and principles. Once the 10 candidate topics were identified, project team members collaboratively selected, discussed, and refined images to be associated with each, with the specific criteria of (a) clarity of topic being illustrated, (b) appropriateness and representativeness for diverse audiences, and (c) whenever possible, local (clearly Portland-based) imagery. In order to minimize confusion and support consistency across topic testing participants, in addition to the selected images, each card also included a verbal representation of the topic illustrated. Future similar studies may strengthen this method through the explicit inclusion of audience members or non-project staff in the selection of images and wording for topic testing cards.

After asking the basic interview questions, the evaluator thanked the participant, then offered them the option of continuing to share their thoughts for another ten minutes in exchange for two tickets valid for free general admission to OMSI. If the participant agreed, the evaluator explained the purpose of the topic testing questions before providing the ten topic testing cards and asking the participant to sort them based first on interest and then on perceived relevance; topic testing participants were also asked to provide some explanation for their choice in ordering the cards. After all topic testing questions were asked, the evaluator provided the participant with two tickets for free OMSI general admission.

Due to the nature of the data collection context, it was expected (and indeed the case) that some interviews would be incomplete, as participants occasionally needed to abruptly curtail conversation in order to board an arriving bus or light-rail car. In such cases, partial data collected was still included in analysis, *provided consent and demographic information had been collected*.

Data Analysis

Prior to the commencement of data analysis, all data were entered, cleaned, and double-checked. Evaluation of open-ended data was conducted through identification of persistent themes across participant responses. These codes were developed through an inductive process whereby an evaluator read through all responses to each interview question multiple times and made note of apparent themes (Patton, 2002; Shaw, 1999). As possible themes were identified, they were applied to the appropriate responses, after which the evaluator read each response again to ensure that the codes accurately and fully reflected what was expressed by participants. Interrater agreement was assessed through percent agreement across two evaluators who coded approximately 20% (n = 20) of participant responses to the five primary open-ended interview questions independently before comparing results. Interrater agreement scores during coding of these five questions ranged from acceptable (85%) to perfect (100%), with discrepancies discussed and adjustments made to the coding scheme to address any noted inconsistencies. Examples of responses recorded by evaluators during data collection are provided in the results section below to illustrate identified codes; however, it should be noted that while evaluators made every effort to record responses with as much detail as possible, those examples provided below are not necessarily verbatim.

Once themes were identified and coded, they were categorized and analyzed along with closed-ended responses using IBM SPSS Version 20, focusing upon descriptive and inferential statistics using independent samples *t* tests, one way analyses of variance (ANOVAs), Pearson product-moment correlations, and chi-square analyses. When data exhibited normal distribution and homogeneity of variance, parametric statistics were employed, with the equivalent nonparametric tests substituted in all other cases. For categorical variables and variables with distributions that differed substantially from normal, we report the median as the measure of central tendency, with confidence intervals calculated without distributional assumptions.

Only those statistical analyses which indicated both a statistically significant relationship ($p < .05$) and at least a medium effect size of .30 or higher as assessed through Cramér's V (Cohen, 1988) are reported below. Additionally, multiple evaluators assessed the results of each analysis to ensure consistency and accuracy (King, Keohane, & Verba, 1994).

Results

The following section outlines the findings from the public audience interviews described above, in addition to basic interpretation of statistical results. These findings are discussed in greater depth in the "Discussion and Recommendations" section at the end of this report.

Participant General Likes and Dislikes

The first question evaluators asked participants was: *"What are some things you enjoy doing or ways you like to spend your time?*" Responses to this question were read and coded by evaluators, with a total of 14 codes being identified; for this and all subsequent open-ended questions, multiple codes could be attributed to a given response. These codes and their distributions are provided in Table 3, while a full coding schema including definitions and examples for all codes is provided in Appendix D. For this and all subsequent open-ended questions, chi-square analyses were employed to assess the distribution of responses across interview locations and participant demographic categories (including age, gender, and level of education).

Table 3: Hobbies and Things Enjoyed

Code	*n*	%
Outdoor activities	43	46.7%
Reading	17	18.5%
Spending time with family/friends	16	17.4%
Watching movies/television	15	16.3%
Working/going to school	10	10.9%
Animals and plants	9	9.8%
Music	9	9.8%
Food/beer/wine	8	8.7%
Sports	7	7.6%
Shopping	5	5.4%
Arts/crafts	4	4.3%
Technology	4	4.3%
Other	4	4.3%
Traveling	3	3.3%
No response	4	--

Note: Percentages shown are out of the total number of participants who responded to this question (n = 92). Since responses could exhibit multiple codes, percentages do not total to 100%.

While the results of chi-square analyses indicated differences by education level in the likelihood of participants reporting answers related to certain codes, the expected counts for several cells did not meet the assumptions of minimum cell size established by Agresti (1990). There were no statistically significant differences with effect sizes greater than .30 based on age, gender, or data collection location.

Participant Likes about Area of Residence

Subsequent to responding to the question outlined above, participants were asked *"What are some of the things you like about the place where you live, whether it's Portland, Gresham, Beaverton, or anywhere else?*" Responses to this question were also read and coded by evaluators, with a total of 13 content-related codes identified; these codes and their distribution across responses are provided in Table 4, while complete definitions and examples of codes are provided in Appendix D.

Table 4: Things Liked about Area of Residence

Code	*n*	%
Nature/environment	26	27.1%
Easy to get around	23	24.0%
Quiet/secluded	20	20.8%
People	13	13.5%
General positive comments	11	11.5%
General complaints	8	8.3%
Things to do	7	7.3%
Weather	6	6.3%
Diversity	5	5.2%
Neighborly/feels like home	4	4.2%
Safety	4	4.2%
Politics	2	2.1%
Other	6	6.3%

Note: Percentages shown are out of the total number of participants who responded to this question (n = 96). Since responses could exhibit multiple codes, percentages do not total to 100%.

The results of chi-square analyses indicated differences by data collection location in the likelihood of participants reporting answers related to certain codes; however, the expected counts for several cells did not meet the assumptions of minimum cell size established by Agresti (1990). No statistically significant differences with effect sizes of .30 or greater were noted based on participant age, gender, or level of education.

Participant Interests in Immediate Vicinity

As a more specific follow-up question to the previous inquiries regarding general likes and things enjoyed about participants' areas of residence, evaluators then asked *"Take a moment to look around the area where we're standing. Are there any places or things around here that you think are interesting or that you'd like to know more about?*" Again, responses to this question were also read and coded by evaluators, with a total of eight content-related codes identified (Table 5). Complete definitions and examples of these codes are provided in Appendix D.

Table 5: Things of Interest in Immediate Vicinity

Code	*n*	%
Art installations	15	16.3%
Natural/environmental features	12	13%
Nearby Businesses	11	12%
History of area	9	9.8%
Architecture/built environment	9	9.8%
Other general comments	8	8.7%
Know the area well already	6	6.5%
Nothing (reason not stated)	32	34.8%
No response	4	--

Note: Percentages shown are out of the total number of participants who responded to this question (n = 92). Since responses could exhibit multiple codes, percentages do not total to 100%.

As with the previous questions, the vast majority of tests indicated no statistically significant disparities which also exhibited sufficiently large effect sizes. However, a chi-square analysis comparing location and interest in nearby art installations did indicate significant unexpected differences in response distribution, χ^2 (2, N = 96) = 8.24, p = .016, Cramér's V = .293. Participants at the Gresham Transit Center tended to mention art installations more frequently (80% of responses, n = 12) than did participants at other locations (20% of responses, n = 3). While this effect size remains just below Cohen's (1988) threshold for medium effect sizes, this finding is arguably still worth noting, as this discrepancy was undoubtedly due to a prominent art installation in the center of the Gresham Transit Center, a "living room set" constructed from durable outdoor materials such as cement and sheet metal. It seems possible, based on this, that aesthetically engaging outdoor installations may be successful at drawing the attention of TriMet riders.

Perceptions and Opinions of Science

Following these questions probing participants' general and area-specific interests and opinions, each participant was read the four statements described earlier designed to assess perceived relevance of science to individuals' lives. The participant mean for the summed responses was 13.29 (SD = 2.07, min. = 8, max. = 16) with a possible range of 4 to 16, which compares favorably with the mean of 11.42 observed among United States students responding to equivalent student questionnaire items during the 2006 PISA survey (OECD, 2006). This mean score appears to indicate a moderate to high level of perceived science relevance, although it must be noted that the evaluator-administered nature of these interviews may well have influenced participants and caused them to respond in a way which they believed to be more contextually desirable. Interestingly, no significant differences were noted in mean scores on this measure based on location or gender; likewise, age and perceived science relevance were not found to be significantly correlated.

As a follow-up question to the four closed-ended questions described above, participants were next asked "*Thinking about your answers to those last four statements, what makes you feel the way you do about science?*" As with the previous questions, responses were read and coded by evaluators, with a total of 12 content-related codes identified (Table 6). Complete definitions and examples of these codes are provided in Appendix D.

Table 6: Why Participants feel as they do about Science

Code	*n*	%
Science is everywhere/part of everyday life	16	20%
Helps to explain things/satisfy curiosity	15	18.7%
Studying/studied in school/college	12	15%
Generally interested	11	13.7%
Related to hobbies/interests	9	11.2%
Science relates to my kids/family	8	10%
Related to profession	6	7.5%
Science makes sense/tells the truth/is definite	5	6.2%
Grew up with science	5	6.2%
Issues with/distrust science	5	6.2%
Previously disliked science, but like it now	5	6.2%
Mentioned OMSI	4	5%
No response	16	--

Note: Percentages shown are out of the total number of participants who responded to this question (n = 80). Since responses could exhibit multiple codes, percentages do not total to 100%.

Again, the results of chi-square analyses indicated differences by education level in the likelihood of participants reporting answers related to certain codes; however, the expected counts for several cells did not meet the assumptions of minimum cell size established by Agresti (1990). There were no statistically significant differences with effect sizes greater than .30 based on age, gender, or data collection location.

Interesting Science Topics
The final question asked of participants during the basic interview was "*Are there any science topics you're interested in or you'd really like to learn more about*". Responses to this question were, again, read and coded by evaluators, with a total of 12 content-related codes identified; the names and distribution of these codes are presented in Table 7. Complete definitions and examples of these codes are provided in Appendix D.

Table 7: Science Topics of Interest to Participants

Code	*n*	%
Natural sciences	34	40.5%
Physical sciences	19	22.6%
Astronomy/space science	14	16.7%
Technology and engineering	10	11.9%
Social sciences	10	11.9%
Anything at all/nothing in particular	20	23.8%
No response	12	--

Note: Percentages shown are out of the total number of participants who responded to this question (n = 84). Since responses could exhibit multiple codes, percentages do not total to 100%.

While the results of chi-square analyses indicated differences by education level in the likelihood of participants reporting answers related to certain codes, the expected counts for several cells did not meet the assumptions of minimum cell size established by Agresti (1990). However, the distribution of responses indicating no particular area of interest varied significantly based on location, χ^2 (2, N = 96) = 8.89, p = .012, Cramér's V = .30, with participants at the Gresham Transit Center being more likely than expected to provide such responses (30% of responses, n = 6) compared to participants at other locations (70% of responses, n = 14). No statistically significant patterns in response distribution with effect sizes of .30 or greater were noted based on participant age or gender.

Topic Testing Responses
As described earlier, after participants completed the basic interview, they were offered the option of participating in topic testing in exchange for two general admission tickets to OMSI. Thirty of the 96 participants chose to engage in topic testing; this involved reading through ten cards which were each clearly labeled with an image and a caption related to a topic which the team had previously identified as having some relevance to the Portland area (available for review in Appendix E). After participants had read through the cards, they were asked to first sort them based on which topics seemed *most interesting* to them, and then to sort them based on which topics seemed *most relevant to their lives*. The results of topic testing are provided in Tables 8 and 9; for each participant, topics were coded from 1 for "most interesting" or "most

relevant" to 10 for "least interesting" or "least relevant," with the result being that lower mean scores for a given topic equate to a more favorable assessment by participants.

Table 8: Topic Testing Results, **Interest**

Topic	M	SD
Nature	3.07	2.30
Animals	3.73	2.39
Music	3.97	1.63
History	4.30	2.51
Weather	5.73	2.72
Food, Beer, and Wine	5.93	2.49
Personal Technology	6.20	2.68
Bikes	7.20	2.70
Cars	7.33	2.43
Sports	7.53	2.58

Table 9: Topic Testing Results, **Perceived Relevance**

Topic	M	SD
Nature	3.90	2.72
Animals	4.10	2.53
Weather	4.10	2.69
Music	4.34	2.36
Personal Technology	4.93	2.79
Food, Beer, and Wine	5.34	2.42
History	5.69	2.21
Bikes	6.90	2.57
Cars	7.59	2.20
Sports	8.10	2.42

Evaluators and other team members were eager to determine whether these topic testing results varied based on participant characteristics; interestingly, while a few statistically significant correlations were observed, these correlations tended not to have a substantial impact on the overall order of topic preference. Participant age was significantly correlated with lower perceived relevance of music, $r(27) = .502$, $p = .005$, and with lower perceived relevance of food, beer, and wine, $r(27) = .436$, $p = .018$. Additionally, participant scores on the PISA science relevance scale were significantly correlated with both lower interest in cars, $r(27) = .437$, $p = .018$, and lower perceived relevance of cars, $r(27) = .413$, $p = .029$. It is worth emphasizing that with the possible exception of the correlation between age and decreased relevance of music, none of these statistically significant relationships pertain to the topics which were considered most interesting or relevant by participants. Furthermore, and of particular importance, there were no significant differences observed in topic testing response based on level of education or participant degree acquisition.

Section 3: Secondary Research

Secondary research for this project was conducted through the identification and review of existing studies and publications, with the overall goal of addressing Study Objectives 1, 3, and 4.

Methods

The following paragraphs outline the selection of sources included in secondary research, as well as the process by which evaluators and other team members conducted this element of the front-end study.

Sources
Sources to be reviewed were drawn from literature in the fields of marketing, visitor studies, education, museum studies, and psychology. Examples of sources included books, refereed journal articles, unpublished manuscripts, and theses and dissertations. Particular attention was devoted to specific studies or theories recommended for review by project team members, partners, and advisors, both internal and external.

Procedure
Drawing upon partner and stakeholder recommendations in addition to review of related bibliographies, evaluators and other team members first identified a selection of relevant sources, particularly those pertaining to audience or viewer attraction and engagement and those which included descriptions of previously established operationalizations of "appreciation." Once a sufficiently representative selection of sources was compiled, Evaluation and Exhibit Research & Development team members divided these sources and engaged in a deep review of the resources, including the creation of annotated bibliographical entries for each source. At the conclusion of the review, evaluators and R&D staff synthesized their findings in order to provide recommendations on which the team may base their ongoing theory of action and prototype development.

Results

The following section outlines the findings from the secondary research described above, as well as basic interpretation of these findings. Based on an assessment of the data likely to be provided by primary research (i.e., interviews with adult transit users) and the existing datasets available for analysis (described in the following section), secondary research efforts were focused on riders' behavior at transit stops. A good deal of secondary research was also dedicated to exploring the concept of situational interest, a potentially promising construct for understanding an "attitude of appreciation." The findings are further considered in the subsequent "Discussion and Recommendations" section. In addition to the concepts and sources discussed in the following pages, a supplemental review of two articles discussing best practices in exhibit design was also conducted. The findings from these articles should not be considered a conclusive and comprehensive survey of established design practices, but may provide suggestions for consideration during prototype development. Due to the limited scope of this secondary research component, the findings are not incorporated below; the review of these articles, however, is provided in Appendix F.

Situational Interest

Perhaps the single most pressing goal of the secondary research conducted for this project was the determination of possible means of conceptualizing and assessing an "attitude of appreciation" which could both draw upon and contribute to existing theories of appreciation and engagement. In order to address this goal, evaluators explored the concept of *situational interest*, a phenomenon which has previously been assessed both within informal learning environments and other contexts. Although a range of perspectives on interest exists within the literature (Renninger & Hidi, 2011), scholars generally agree that situational interest is an emotional response to conditions, characteristics, or stimuli in a specific situation which motivates attention and effort (Dohn, 2011; Hidi & Renninger, 2006; Renninger & Su, 2012; Rotgans & Schmidt, 2011; Silvia, 2006). For example, Hidi and Renninger (2006) defined situational interest as "focused attention and the affective reaction that is triggered in the moment by environmental stimuli" (p. 113). Brain research has linked the emotional state of interest with the evolutionarily adaptive seeking and curiosity systems in humans and animals (Hidi & Renninger, 2006; National Research Council [NRC], 2009, p. 59; Renninger, 2010). Research suggests that situational interest is distinct from but closely related to enjoyment (Silvia, 2006), with the two often combined under the umbrella of positive affect (Hidi & Renninger, 2006).

In their influential four-phase model of interest development, Hidi and Renninger (2006) describe situational interest as an important initial step in the development of more enduring, individual interest. The model distinguishes between triggered situational interest and maintained situational interest, with triggered situational interest being associated with short-term changes in affective and cognitive processes and maintained situational interest extending over a longer time period or reoccurring. Other scholars have described these two phases as the "catch" and the "hold" (Linnenbrink-Garcia et al., 2010, p. 648). In the context of classroom learning, Linnenbrink-Garcia and colleagues (2010) argued that triggered situational interest relates to affective reactions to the *presentation of materials*, while maintained situational interest relates to affective and value reactions to the *material itself*. The four-phase model of interest development posits that situational interest is a critical first step in the development of more enduring, individual interest (Hidi & Renninger, 2006; Renninger & Hidi, 2011).

Relevance to Science on the Move

Interest in general, and situational interest specifically, is generally acknowledged as an essential component of learning and education (Renninger & Hidi, 2011). Situational interest has been positively associated with attention and focus, persistence, goal-setting and self-regulation, comprehension and cognitive processing, memory and recall, and use of effective learning strategies (NRC, 2000, 2009; Kang, Scharmann, Kang, & Noh, 2010; Lewalter & Scholta, 2009; Renninger & Su, 2012). For example, as part of an investigation of conceptual change with 483 seven graders in Korea, Kang et al. (2010) found that situational interest sparked by a science activity was positively and significantly related to both students' short-term conceptual understanding and long-term conceptual recall and that this relationship was due to students' increased attention and effort during the activity.

Situational interest triggers
There is almost no research on the factors related to situational interest in informal learning environments. Based on studies of reading and classroom learning (Dohn, 2011; Hidi & Renninger, 2006; Lewalter & Scholta, 2009; Palmer, 2004; Renninger, 2010; Renninger & Hidi, 2011; Rotgans & Schmidt, 2011), commonly cited factors which help to trigger and maintain situational interest are as follows:

- **Novelty**, including variety, suspense, originality, and unusual or discrepant information;
- **Personal relevance**, including meaningfulness, connections with prior knowledge or interests, familiarity, personal identification, and involvement;
- **Appropriate levels of challenge**, including puzzles;
- **Hands-on activities** and experiences;
- **Intensity**, including actions, imagery, and feelings;
- **Understandability**, including coherence, completeness, ease of comprehension, and appropriate levels of complexity;
- **Computers**, including attractive software design;
- **Social interaction**, including group work; and
- **Individual choice**, including autonomy support and opportunities for self-direction.

There is also some evidence that positive feelings are critical for sparking and maintaining interest and that personal relevance and meaningfulness are particularly important for sustaining situational interest (Hidi & Renninger, 2006; Renninger, 2010). Additionally, in one of the few studies conducted in an informal learning environment, Dohn (2011) used a qualitative approach, including observations and interviews, to identify five factors (social involvement, hands-on experiences, surprise, novelty, and knowledge acquisition) which appeared to trigger situational interest for high school students visiting an aquarium in Denmark.

Renninger (2010) argued that, relative to later stages of interest development, individuals experiencing situational interest need external support, appreciation of their efforts, respect for their ideas, and concrete and simple instructions and suggestions in order to maintain interest. Individuals at this stage are unlikely to have strong self-efficacy, personal identification with the focus of interest, or motivation or ability to reengage.

How has situational interest been measured?
In general, research on interest and interest development is in its infancy (Palmer, 2004; Renninger & Su, 2012; Rotgans & Schmidt, 2011) and relatively few approaches have been developed to measure interest, especially in informal learning environments (Dohn, 2011; Kang et al., 2010; Linnenbrink-Garcia et al., 2010). Most studies of situational interest have relied on self-report measures (NRC, 2009; Renninger & Hidi, 2011; for examples, see Palmer, 2004; Rotgans & Schmidt, 2011; Linnenbrink-Garcia et al., 2010).

Researchers have emphasized the importance of assessing situational interest using both self-report and observational measures because individuals may not be consciously aware that their interest has been triggered (Renninger & Su, 2012; Renninger & Hidi, 2011) and because beliefs and motivations may only be relevant to the degree that they are manifested through behaviors (Rotgans & Schmidt, 2011). In the field of informal science education, researchers have investigated the related concepts of engagement, positive affect, interest, excitement, motivation, and comfort through analysis of facial expressions, open-ended questions, semantic differential questions, Likert-type scales, physiological measures, discourse analysis, and general measures of length and level of engagement (NRC, 2009, pp. 60–61).

Bus Stop Behavior

A fair amount of attention has been devoted to understanding the dynamics of bus stop and transit center use, with several findings having definite implications for *Science on the Move*. Based on observations of public transit users, approximately 50% of individuals at bus stops tend to be "just waiting" (not engaging in any observable activity other than sitting or standing), with the remaining 50% doing something such as reading, smoking, texting, or talking with other riders (Ohmori, Hirano, Harata, & Ohta, 2004). While it seems likely that the increasing ubiquity of smartphones and tablets may have resulted in shifts in these trends, similar observations were recently made by Russell et al. (2011). In their study of bus and train riders, these researchers noted that once on board public transit, 65.3% of the individuals observed tended to simply look straight ahead or out the window, while approximately 20% read a book or magazine and the other passengers engaged in activities such as listening on headphones, texting, talking, or sleeping.

While the increasing availability and use of smartphones and other devices to engage in real-time tracking of buses and trains has provided riders an unprecedented degree of control over their public transit experience, the final amount of time spent waiting remains largely outside the influence of the individual rider due to traffic, accidents, and other unforeseeable circumstances. It should hardly be surprising, then, that individuals might experience varying degrees of irritation, with several factors identified as playing a role in mitigating or exacerbating the pleasantness or unpleasantness of the public transit experience (Hutchinson, 2009; Psarros, Kepaptsoglou, & Karlaftis, 2011). As an example of these dynamics, individuals' age, trip purpose, and trip time period appear to impact perceived wait time. Specifically, those on education or work trips tend to perceive themselves as experiencing longer waits (leading to an overestimation of actual time spent waiting), while transit riders' perceived waiting time tends to decrease during morning time periods. Furthermore, the responses from transit users in five different age groups (18 and under, 18—30, 31—45, 46—55, and 56 or over) indicated a steady increase in the ratio of perceived wait time to actual wait time, with older individuals perceiving longer wait times in relation to their actual wait time (Psarros et al., 2011). The findings of these studies are particularly intriguing in that they appear to illustrate both an increased perceived wait time and simultaneously lower levels of irritation among older transit users, indicating that older riders may feel less "robbed" of time even when their perceived wait is greater. In sum, the findings of these studies provide evidence that transit riders' perceived wait times are shorter if they have something to do, they are more likely to do something if they are sitting down (Ohmori et al., 2004), and their experiences of public transportation are strongly influenced by the behavior of (and their interactions with) other riders (Hutchinson, 2009).

Although waiting time is to some extent outside the control of the public transit rider, when wait times are expected to be long, certain strategies tend to be used to ensure as short a wait as possible. An examination of the arrival patterns of transit riders at various transit stops indicated that "an 11-min vehicle headway [marked] the transition from practically random to less random passenger arrivals, and all transit users can be regarded as coordinated arrivals after 38-min bus headway" (Fan & Machemehl, 2009, p.169). In other words, if the bus or train arrived every 11 minutes or less, riders tend to show up randomly with minimal concern for likely wait time. For buses or trains with regular arrival times between 11 and 38 minutes, there tends to be a combination of random arrivals and riders who have planned ahead and arrive at a certain time in order to catch a specific bus or train. If the regular arrival time of a bus or train is greater than 38 minutes, however, nearly all riders plan their arrival to minimize wait times. These strategies have definite implications for *Science on the Move*, as they indicate that we should expect an average wait time of no more than 11 minutes among target audience members and should plan the prototype experiences to capitalize on this timeframe.

Section 4: Secondary Data Analysis

Secondary data analysis for this project was conducted through the identification and manipulation of a large existing national dataset, with the overall goal of addressing Study Objectives 2 and 5.

Methods

The following paragraphs outline the selection and analysis of an existing dataset to better understand the science attitudes of US adults, including those without a college degree.

Sources
Data were analyzed from the General Social Survey (http://www3.norc.org/gss+website/), a nationwide survey conducted biennially by the National Data Program for the Sciences (The National Data Program for the Sciences, n.d.). Participants for the survey consist of adults living in the United States, with each participant responding to up to three consecutive surveys over the course of four years. Over the course of its history, the GSS has accumulated a total of more than 5,500 variables, resulting in a tremendous number of possible datasets from which to choose. Due to the nature of the current project, evaluators focused particularly upon those datasets relating to public beliefs and perceptions regarding science and its role in society. The data which were analyzed for *Science on the Move* were collected during the 2010 GSS; detailed information regarding survey development, sampling, and data collection procedures for this and other GSS iterations is provided in the National Data Program for the Sciences appendices (http://www3.norc.org/GSS+Website/Publications/Documentation/).

Procedure
Evaluators first searched through the multitude of datasets available for download from the GSS to determine which would yield useful information to provide the project team with guidance regarding the target audience. A total of 13 questions were chosen for analysis, with 12 of these relating to knowledge, beliefs, and opinions regarding science and one being a general demographic question assessing participants' highest level of education complete. (These questions, as well as the associated response categories, are provided in Table 10.) The next step was to determine the statistical analyses most likely to yield information facilitating the successful resolution of these questions, followed by data analysis and compilation of results. At the conclusion of secondary data analysis, evaluators synthesized the information collected into recommendations on which the team may base their ongoing prototype development activities.

Table 10: 2010 General Social Survey questions chosen for secondary data analysis

GSS Survey Item	Response Categories
"I am going to name some institutions in this country. As far as the people running these institutions are concerned, would you say you have a great deal of confidence, only some confidence, or hardly any confidence at all in them?" ("Scientific community)	Great deal of confidence / Only some confidence / Hardly any confidence
"Here are some things that have been said about science. Would you tell me if you tend to agree or disagree with them?" ("One trouble with science is that it makes our way of life change too fast.")	Agree / Disagree
"Here are some things that have been said about science. Would you tell me if you tend to agree or disagree with them?" ("Because of science and technology, there will be more opportunities for the next generation.")	Agree / Disagree
"Even if it brings no immediate benefits, scientific research that advances the frontiers of knowledge is necessary and should be supported by the federal government."	Strongly Disagree / Disagree / Agree / Strongly Agree
"People have frequently noted that scientific research has produced benefits and harmful results. Would you say that, on balance, the benefits of scientific research have outweighed the harmful results, or have the harmful results of scientific research been greater than its benefits?"	Intended as Harmful results greater / Benefits greater, but "About equal" responses were allowed if volunteered by participants.
"Would you say that the balance has been strongly in favor of the benefits, or only slightly?"	Strongly in favor / Only slightly in favor
"Would you say that the balance has been strongly in favor of the harmful results, or only slightly?"	Strongly in favor / Only slightly in favor
"When you read news stories, you see certain sets of words and terms. We are interested in how many people recognize certain kinds of terms. First, some articles refer to the results of a scientific study. When you read or hear the term scientific study, do you have a clear understanding of what it means, a general sense of what it means, or little understanding of what it means?"	Clear understanding / General sense / Little understanding
Issues about new scientific discoveries. (Are you very interested, moderately interested, or not at all interested?)	Not at all interested / Moderately interested / Very interested
Issues about the use of new inventions and technologies. (Are you very interested, moderately interested, or not at all interested?)	Not at all interested / Moderately interested / Very interested
Issues about space exploration. (Are you very interested, moderately interested, or not at all interested?)	Not at all interested / Moderately interested / Very interested
Do you have any college degrees? (IF YES: What degree or degrees?)	Less than high school / High school / Associate

	/ Junior College / Bachelor's / Graduate

Results

The following section outlines the findings from the secondary data analysis described above, in addition to basic interpretation of statistical results.

2010 General Social Survey (GSS)

The primary question explored through the analysis of data collected in the GSS was that of the varying perceptions of science among individuals with different levels of education. In order to explore this question, chi-square analyses were conducted to compare the distribution of participant responses to various science-related questions based across education levels. Table 11 provides a complete list of the questions assessed, as well as the significance levels and effect sizes.

Table 11: Chi-Square Analysis of Distribution of Responses to General Social Survey Questions, By Education Level

GSS Survey Item	*N*ǂ	df	χ^2	*p*	V
Confidence in scientific community	3,135	8	185.56	< .001*	.172
Science and technology give more opportunities to the next generation	1,398	12	34.38	.001*	.091
Science makes our way of life change too fast	1,398	12	108.24	< .001*	.161
Scientific research is necessary and should be supported by the federal government	1,370	12	64.42	< .001*	.125
The benefits of scientific research outweigh the harmful results	1,318	8	92.43	< .001*	.187
Scientific research is strongly in favor of benefits	972	4	41.90	< .001*	.208
Scientific research is strongly in favor of harmful results	120	4	2.93	.570	.156
Participant has a clear understanding of scientific study	1,429	8	282.12	< .001*	.314**
Interested in new scientific discoveries	1,445	8	78.97	< .001*	.165
Interested in technologies	1,445	8	61.98	< .001*	.146
Interested in space exploration	1,446	8	35.94	< .001*	.111

*Significant *p* value
**Cramér's V meets Cohen's (1988) .30 standard for medium effect size
ǂDue to administration of varying versions of the GSS questionnaire across overall survey sample, the total number of respondents for each questionnaire item can vary widely.

While chi-square analyses cannot contribute to the establishment of linear relationships between variables, the distribution of responses illustrated by these statistical tests consistently indicated that individuals with lower levels of education rated themselves as less interested in and informed of scientific topics, perceived fewer benefits from scientific endeavors, and possessed a less favorable view toward science in general. While the effect sizes for these findings (as assessed through Cramér's V) remained generally very low, the consistency of the results and the high degree of statistical significance appear to indicate small but pervasive trends in public beliefs, perceptions, and knowledge regarding science.

Section 5: Discussion and Recommendations

In order to provide the *Science on the Move* project team with guidance regarding next steps for theory of action and prototype development, the following section synthesizes the front-end evaluation and research findings detailed above within the context of the six study objectives.

Objective 1*: Identify tested and proven techniques (marketing and otherwise) to successfully implement the audience experience set forth in the project theory of action, with particular attention paid to strategies for engaging audiences in public spaces and to moving individuals from "noticing" to "approaching" a stimulus.*

Based on the interviews conducted with TriMet riders, it appears that art installations located at transit centers are at least somewhat effective at drawing attention, perhaps due to the relative emptiness of the transit center environment. If this is indeed the case, audience members at these locations may well be eager to engage with the prototypes developed for *Science on the Move*. This should not, however, be interpreted as meaning the team's work is done and the prototypes will be successful regardless of their implementation. In order for the relative emptiness of the transit center setting to become an opportunity rather than a risk, **the team must be mindful of both the general and specific location for placement of the prototype and attempt to capitalize on traffic patterns, daytime visibility (at least), and the possibility of creating large-scale experiences**.

In regards to the design and interface of the prototypes themselves, based on the findings of secondary research, we recommend that every effort be made to remember that **the interfaces should be intuitive but engaging, with no extraneous internal or external text**. It is also worth emphasizing the importance of first impressions—**the initial moments of engagement with a prototype are crucial, and visitors should immediately feel engaged and excited, rather than intimidated or confused** (Gammon, 1999a).

Objective 2*: Determine unique characteristics of target audience (adults without a college degree), as well as any perceptions and beliefs they might hold regarding science.*

The responses provided by public audience interview participants support the idea that Portland public transit users, both those within and outside the project's target audience, tend to have positive views regarding science and perceive science as highly relevant to themselves and their lives. Among the analyses which suggested a statistically significant difference in participants based on level of education, perhaps the most relevant to this project was the finding that individuals with lower levels of educational attainment are less likely to provide specific areas of interest with regards to science compared to those with higher levels of education.

Evaluators were able to draw upon data collected during the 2010 General Social Survey (GSS), an analysis of which indicated that individuals with lower levels of education are increasingly likely to identify as unfamiliar with and uninterested in science topics and to hold less positive views of science in general. While effect sizes for these findings were low, they nonetheless provide an interesting counterpoint to the more micro-level interview data collected by evaluators which indicate that TriMet riders with and without college degrees perceive science to be moderately to highly relevant to their lives. Given the substantially greater number of individuals sampled by the GSS, these results appear to suggest one of two possible explanations. First, and arguably most likely, it is certainly possible that trends such as those indicated by the GSS data do in fact exist among the larger population, but these trends are so small that they only become apparent when responses are compared across very large sample sizes. Second, it may also be the case that the individuals included in this front-end study's sampling frame may possess certain characteristics which genuinely differentiate them from the larger U.S. population with regards to perceptions of and interest in science. Further inquiry is necessary to determine whether one, both, or neither of these explanations might hold true.

Objective 3*: Draw upon current literature to construct a clear and functional operationalization of variables related to study impacts, particularly an "attitude of appreciation" that science is everywhere and personally relevant to audience members.*

Based upon a thorough review of relevant current literature, it appears that **the concept of *situational interest* may provide a meaningful and actionable avenue to conceptualize and assess the intended project impact of "engagement."** Furthermore, it may also contribute to the conceptualization of an "attitude of appreciation" that science is everywhere and personally relevant. Characteristics of learning experiences which have been shown to trigger situational interest include novelty, personal relevance, appropriate levels of challenge, hands-on activities and experiences, intensity, understandability, computers, social interaction, and individual choice (Dohn, 2011; Hidi & Renninger, 2006; Lewalter & Scholta, 2009; Palmer, 2004; Renninger, 2010; Renninger & Hidi, 2011; Rotgans & Schmidt, 2011).

While this theoretical construct has been assessed in various ways, several researchers have stressed the importance of **employing multiple data collection methods (e.g. observation and post-use surveys) to measure situational interest**. Another consideration to bear in mind is that situational interest may be expressed not only by those audience members who interact directly with the prototypes, but also by those who observe such interactions taking place. Bearing this in mind, **the operationalization of situational interest should permit the tracking and assessment of indirect engagement and interest** through such indicators as interpersonal conversation, physical signs of attentiveness, and the use of photo and video capturing technology by audience members who are observing or engaging with the prototypes.

Objective 4*: Develop a clear understanding of interpersonal and intrapersonal bus stop/transit center dynamics, as well as specific interventions which tend to create the impetus for conversation and interaction between transit users.*

Based upon the findings of several studies addressing individuals' behaviors at and reactions to transit centers and bus stops, **transit riders' perceived wait times are shorter if they have something to *do*** (Ohmori et al., 2004). Additionally, they are more likely to engage in an activity of some sort if they are sitting down, although the frequent dearth of benches and other seating areas often renders this impossible. Lastly, **individuals' experiences and perceptions of public transportation are influenced not only by the built transit center environment, but also by the behavior of (and their interactions with) other riders** (Hutchinson, 2009).

Objective 5*: Identify topics or themes which are interesting and personally relevant to our target audience and bus riders more generally while also remaining connected to both immediate and local contexts.*

Among the TriMet riders personally interviewed by evaluators, **the overarching themes of nature, animals, and music appeared most interesting and relevant**, with nature being mentioned with overwhelming frequency across nearly all interview questions. Outdoor activities constituted the most popular pastime among interview participants, environmental features and natural surroundings were frequently cited as things which they enjoyed about the areas in which they lived, and **stated interest in specific science content centered strongly upon the natural sciences**. Interestingly, when participants were asked to elaborate on what caused them to choose nature, animals, and music as either interesting or personally relevant, certain reasons tended to emerge. Participants often alluded to the belief that **nature connects us all, that it impacts everyone, and that it is outside human control**. Similarly, **music was a constant part of many individuals' daily lives, and was also perceived to bring people together** (with several participants making statements like "Who doesn't love music?"). **Animals, too, were frequently described as being universally appealing and connected to everyone's lives**, although a few participants also mentioned that they chose "Animals" as a topic because they believed their child or children would enjoy them.

Because few differences in interview responses were noted along demographic lines, it appears likely that **a prototype which is relevant to and engaging for our target audience (adults without college degrees) will also be enjoyable for general audience members**. While this should not be construed as indicating that the project team no longer needs to attend to the particular needs and interests of our target audience, it does mean that in doing so, they will not be simultaneously unappealing to other potential audience members. On a related topic, team members should be mindful of cultural considerations which might impact the ways in which audience members interact both with the prototype and with other users. While the only underserved audience explicitly addressed by this project is that of adults without college degrees, the fact remains that these prototypes will be highly visible within the public eye, and it would be truly regrettable for such an exciting opportunity to result in the perception of OMSI as falling short in terms of cultural sensitivity.

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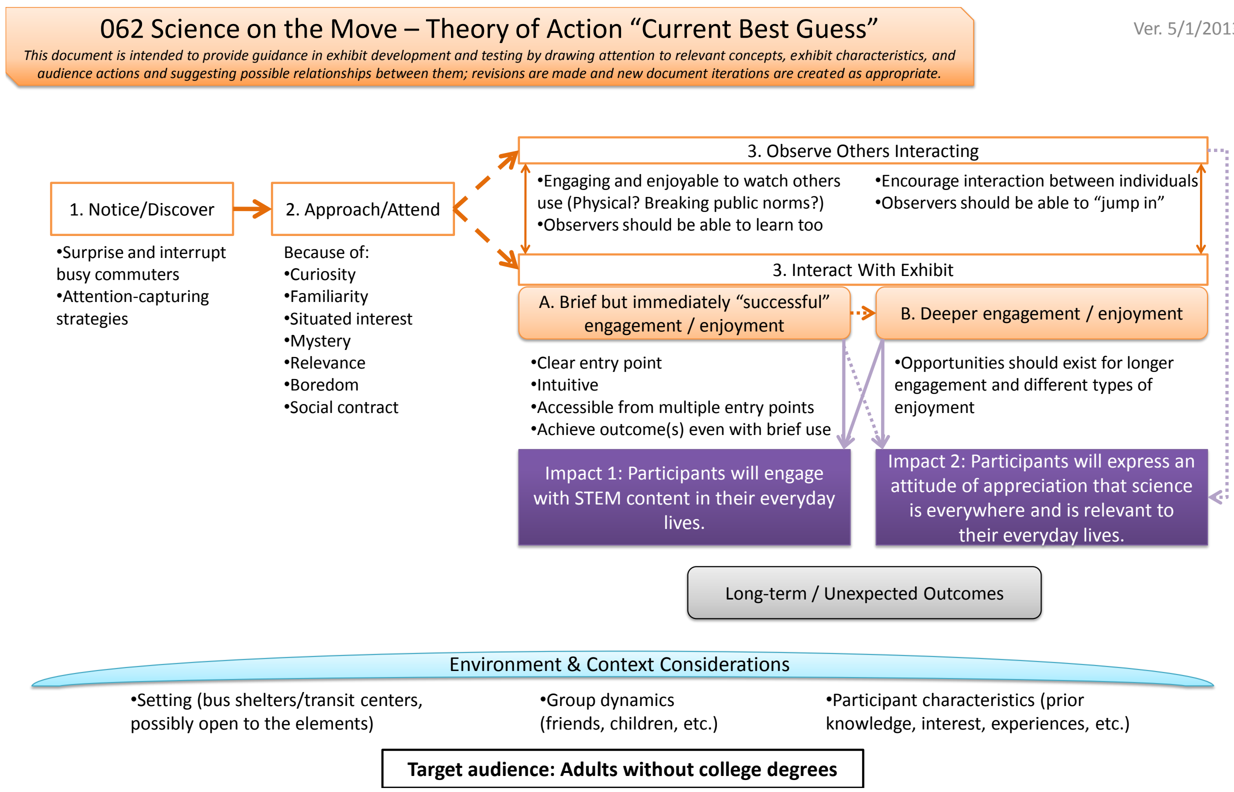
Appendix A: Current Project Theory of Action



Appendix B: Interview Protocol

Front-End Objectives Addressed:

- Identify topics or themes which are interesting and personally relevant to our target audience and bus riders more generally, while also remaining connected to both immediate and local contexts.
- Begin preliminary assessment of possible community business partners, including potentially salient backgrounds and characteristics.

Things you should bring with you to the transit shelter:

- Clipboard
- Sufficient number of copies of the survey instrument
- Two sets of topic testing cards
- Five pens or pencils
- Folders for completed interviews
- Letter of permission to conduct study from Tri-Met
- OMSI business cards
- OMSI brochures
- Tickets for free general admission to OMSI

You should wear OMSI-identified clothing and a name badge. Be cheerful and friendly in your approach.

Steps:

1. Fill out the first portion of a line on the tracking table (date, location, interviewer initials, and time)
2. Upon arrival at the data collection location <u>and at the conclusion of each interview</u>, begin walking along the transit waiting area, greet the first ***adult*** (preferably 25+, at least 18+) to approach within four feet of your position, and recruit using the script at the bottom of Page 2.
    - If they say no, mark the refusal and potential reason on that line of the tracking table. Then, using the same sheet, approach another person.
    - If they say yes, mark the consent on the tracking table and fill in their approximate age and gender, then continue on to the main questions (starting on Page 3).
3. Ask the main questions (Section 1). Try to balance *taking verbatim notes* of the participant responses (ask the participant to slow down and/or repeat themselves as necessary) and *building rapport* with the participant (making eye contact, making agreeing noises, etc).
4. After asking the main questions (Section 1), *thank the participant*, then offer them the option of continuing to share their thoughts for another ten minutes in exchange for two tickets valid for free general admission to OMSI.
5. If the participant agrees, ask the supplemental questions (Section 2), *providing the topic testing cards as appropriate*. After all questions have been asked, provide the participant with two tickets for free OMSI general admission.
6. Step away and go back over your notes on the interview instrument and try to flesh out your notes regarding what the participant said or did. It is important that you do this immediately after the interview before you forget. Feel free to include your impressions of the interviewee and their thoughts, but clearly mark what notes are your impressions and what notes are verbatim participant responses.
7. Put the finished interview guide in your “Completed Interviews” folder.

Start with a new interview guide after every successful interview.

Appendix C: Public Audience Interview Guide

Recruitment and Consent

Approach TriMet rider who appears to be waiting (not boarding or de-boarding transit).

1. "Hi, my name is ____________________ and I'm here from the Oregon Museum of Science and Industry (OMSI). We're doing a survey of adult TriMet riders to help us build an exhibit to be put in bus stations around the Portland area. Would you be willing to talk to me for a few minutes and share your thoughts?"

    a. *If definite no:* "No problem. Thanks very much for your time anyway, and have a nice day." *Mark refusal on tracking sheet and begin approach again.*

    b. *If yes:* "Great, thank you so much! OMSI is working with TriMet to create some interactive displays in transit shelters for adult riders like you to use while waiting for a train or bus. We're hoping to get input from riders to help inform the activities we're developing. It should only take about five minutes and you can quit at any time."

    c. *If participant appears unsure:* "I'd *really* appreciate hearing your thoughts and input – it won't take long at all, and you can absolutely leave in the middle if you need to! What do you say? *(Proceed as directed above for "yes" or "no" responses.)*

Interview Number: ___________ *(Scott start at 1, Chris start at 201, Steve start at 401)*

Main Questions (Section 1)
(Throughout the following section, please feel free to ask open-ended probing questions as appropriate to increase the depth and clarity of participants' responses. For example, "What makes you feel that way?" or "Why might that be?"

Okay, first I'm going to ask you a few questions about your thoughts and opinions regarding the area and how you might spend your time. There are no wrong answers, so feel free to say as much or as little as you want about whatever you'd like.

1. What are some things that you enjoy doing or ways you like to spend your time? *(If needed, prompt with "Hobbies, sports, activities, anything like that.")*

2. What are some of the things that you like about the place where you live, whether it's Portland, Gresham, Beaverton, or anywhere else?

3. Take a moment to look around the area where we're standing. Are there any places or things about here that you think are interesting or that you'd like to know more about? *(If needed, prompt with "Any businesses or activities or places right nearby that you think are really cool or interesting?")*

4. I'm going to read a few statements regarding science – I'd like you to imagine yourself saying each one, and then tell me how much you agree or disagree with each one, either "Strongly disagree," "Disagree," "Agree," or "Strongly agree." And don't worry, you won't offend me if you say you disagree!

Statement	Response
"I find that science helps me to understand the things around me"	
"There are many opportunities for me to use science in my everyday life"	
"Some concepts in science help me to see how I relate to other people"	
"Science is very relevant to me"	

   a. Thinking about your answers to those last four statements, what makes you feel the way you do about science?

   b. Are there any science topics you're interested in or you'd really like to learn more about?

5. Would you mind telling me your age?

6. What's the highest level of education that you've attained?

   a. *If college or above, ask* What is (or was) your major?

7. What's the ZIP code where you live?

End of Main Questions (Section 1)
Thank you so much for your time! I really appreciate you talking to me. I don't want to keep you any longer if you have to get going, but if you'd be interested in spending another ten minutes or so looking at some cards I have here and telling me what you think, I'd be happy to give you a couple of coupons that'll get you free admission to OMSI on your next visit. Would you be interested? It's actually pretty fun!

- □ *If YES, check this box, then proceed to Section 2*
- □ *If NO, thank them again, then check this box and refer to the instructions on Page 1 for post-interview procedures*

Topic Testing Questions (Section 2)
That's fantastic! All right, I don't want to take up any more of your time than I have to, so let's get started! Basically, I'm going to give you these eight cards with various pictures and captions *(show participant topic testing cards)*, then I'll ask you a few questions one at a time, and what I'd like you to do is to take a minute to order the cards based on those questions. Each of the cards has to do with a topic we're thinking about using for a new exhibit, and I'd like to hear what you think of them. You can let me know if you'd like some clarification or if there are any questions you're not comfortable answering, okay? *(If participants appears unclear regarding instructions, say "Don't worry, it'll make more sense once you hear the questions!") (If participant provides indication of acquiescence:)* Great, here you go! *(Hand participant topic testing cards.)*

a. First off, looking at the things on these cards, please take a minute to organize them from the one you think is most interesting to you to the one you're least interested in.

1.	6.
2.	7.
3.	8.
4.	9.
5.	10.

    a. Great! Can you tell me a little bit about what you were thinking as you were putting the cards in this order?

b. Perfect, thanks! Next, go ahead and take the same cards and take a few minutes to sort them again, but this time, sort them based on how relevant you feel like they are to you and your everyday life.

1.	6.
2.	7.
3.	8.
4.	9.
5.	10.

    b. Can you tell me a little bit about what you were thinking as you were putting the cards in this order?

End of Topic Testing Questions (Section 2)

Thank you again for taking all this time to talk to me. Everything you've said will really help us make the best exhibits we can. As promised, here are your OMSI tickets – *(hand participant two GA tickets)* – and did you have any questions for me?

Record participant questions here

Here's a card with my contact information, if you think of anything else you'd like to ask. *(Hand participant a business card.)* Again, thanks so much – have a great rest of your evening!

End of Interview

Post-Interview Reflection

After the interview, please use this space to record any thoughts or concerns you might have.

Appendix D: Interview Coding Scheme

Question	Codes	Definition	Examples
1. What are some things you enjoy doing or ways you like to spend your time?	1. Reading	Reading of any type; it should not be assumed that "Studying" includes reading unless explicitly stated	"**Read - that's about it**"
	2. Watching movies/television	Watching movies and/or television, either at home or in theaters	"Reading, **watching TV**"
	3. Outdoor activities	Any activities which are performed primarily or entirely outdoors (e.g., hiking, skateboarding, camping, gardening, going to the beach); also includes enjoyment of nature in general	"**Camping, rafting, being in the outdoors. Love to "flag" [some type of outdoor activity]**"
	4. Working/going to school	General comments regarding work or school, or specific mention of type of work done	"**Work full time, go to school full time.** Narcotics anonymous."
	5. Spending time with family/friends	Time spent or activities shared with family and/or friends in general or with specific members of family (children, grandkids, etc.)	"Travel, beach, casinos, **five grandkids - spend time with them**"
	6. Traveling	Individual uses the words **"travel"** or **"traveling"** - this does not include mention of specific places, such as the beach or the casino	"Studying, **traveling,** nature"
	7. Shopping	Shopping online or offline - this does **not** include window shopping, which is coded as "4"	"**Shop,** go for walks and hikes, read, go online"
	8. Food/beer/wine	Includes cooking, baking, brewing, eating, and drinking, as well as specific foods (e.g., doughnuts)	"**Cook and bake**"
	9. Music	Either listening to or making music, including singing and DJing	"**Music, play guitar**"
	10. Animals and plants	Animals or plants in general (including going to the zoo) and/or specific types of animals (birds, squirrels, cats, dogs, etc.)	"Watching movies, shopping online, **playing with my cats**"
	11. Sports	Play or watch sports, in person or on television (this includes non-traditional sports, such as rock climbing)	"**Swim** and shop, mostly"
	12. Arts/crafts	Crafts (such as knitting or sewing) and visual arts (such as painting and photography)	"Music, **sewing, crafts,** and hiking"
	13. Technology	Robotics, computer, video games, and other high tech-related topics (television and movies are **not** included)	"Being outdoors, hiking, scenery, **computers**"
	14. Other	Various other activities (relaxing, talking to people, etc.)	"**Talking to people, helping people; everything - what's not interesting?**"
	99. No response		

2. What are some of the things you like about the place where you live, whether it's Portland, Gresham, Beaverton, or anywhere else?	1. Neighborly/feels like home	Individual identifies area as being or feeling like a neighborhood	"**The neighborhood-y feel**"
	2. General complaints	Complaints regarding transit, people, or general area (including complaints of boredom)	"Where I live? **Long transit - because I live in Vancouver and come here for work.**"
	3. General positive comments	Positive comments which don't fit any other code (such as general feelings of liking the area), as well as supplemental comments regarding specific topics not covered elsewhere (e.g., architecture)	"Lake Oswego - **Good place. No [in response to "anything else?"]**"
	4. Diversity	Comments regarding area having a good deal of variety and/or broad horizons	"Awesome. **Lots of diversity - cultural diversity**"
	5. Quiet/secluded	Includes the words "quiet," "remote," "secluded," and/or "rural"	"Home. **Live in wooded, secluded area - solitary [implying he likes the solitude]**"
	6. Weather	Anything related to weather or climate in general, as well as specific components thereof (lack of snow, etc.)	"Portland - **Rain, rain**"
	7. Easy to get around	Comments regarding places to walk, ease of getting places on foot or by bus/MAX, and general (positive) comments regarding transit system	"**Walkable. Take bus and walk everywhere**"
	8. Nature/environment	Scenery, trees, parks, and environmental features (ocean, rivers, lakes, etc). Does **not** include weather, which is covered by code 6	"Easy to get to places with public transit. **When it's green - I like** weather and **fresh air**"
	9. Safety	Safety and/or lack of crime in area	"Like the environment - **not a bad neighborhood, not too much crime.** Close to everything"
	10. People	Nice/friendly people, and/or lots of people around	"It's really nice here when it's sunny, **and there are cool people**"
	11. Things to do	General comments regarding things, events, or activities to do, as well as specific things (restaurants, Rose Parade, playgrounds, etc.)	"I like how easy it is to get around, there are lots of buses. **Good food and beer, too**"
	12. Politics	Politics in general and/or specific type of political views (e.g., liberal or conservative)	"I like how easy-going it is. It's neighborly and friendly, and **I like the politics** and the climate"
	13. Other	Comments about area being "home," as well as those with no positive or negative content	"I live in Gresham - **there's not a whole lot I like out there**"

3. Take a moment to look around the area where we're standing. Are there any places or things around here that you think are interesting or that you'd like to know more about?	1. Natural/environmental features	Trees, environmental features (such as rivers, mountains, and hills).	"**Used to be a cow field** - I've been here 60 years."
	2. History of area	History of the immediate area, local area, city, country, or general historical questions	"**History - roots, where we came from**; how come some people aren't happier"
	3. Businesses	Local businesses, including governmental institutions (Chamber of Commerce, court system, etc.)	"Not particularly - got here before bus - **convenient that grocery store is nearby**"
	4. Art installations	Local art in general, as well as the couch/living room set at Gresham and the wind thing on display at Gateway	"**I want to know why they put that couch there**"
	5. Architecture/built environment	Non-business-related aspects of local buildings, structures, etc. This includes fences, tunnels, roads, and questions or thoughts regarding the design or function of bus stops/transit centers	"**Who thought this up? This whole space?**"
	6. Know the area well already	Stated familiarity with the area, often including length of time here (this will usually, but not always, be the only code used for a statement)	"**I've been living here 15 years - I know everything**."
	7. Other general comments	Miscellaneous comments regarding things of interest not covered by above codes	"**Not really, like, interesting out here. The people, I guess**"
	8. Nothing (reason not stated)	Statements of non-interest in surrounding area	"**Nope, not around here**"
	99. No response		

4.a. Thinking about your answers to those last four statements, what makes you feel the way you do about science?	1. Science is everywhere/part of everyday life	Statements related to awareness of science's connection to everyday life and the world around us, as well as general statements of use not connected to specific activities	"Forever changing (science) - **it connects to animals, life, humans**"
	2. Helps to explain things/satisfy curiosity	Connections made between science and explanations of things around us	"**It helps me to understand the things around me**"
	3. Issues with/distrust science	Negatively-valenced statements regarding science, as well as those pertaining to lack of familiarity	"Touchy for me - stuff at OMSI is fun, **but other science doesn't work with my faith.**"
	4. Studying/studied in school/college	Statements directly referencing grade school and/or college classes	"**I'm studying to be a dental hygienist**"
	5. Science makes sense/tells the truth/is definite	Ways in which science backs itself up	"It explains the world around it. **It's truth, factual, not magic.**"
	6. Related to profession	Often includes reference to individual's specific occupation/profession, but may also be more general reference to job, as shown in example; in either case, participant must explicitly state that they are referring to their job/occupation/ profession, rather than "what they do" in general	"Interesting, **how to do job better,** use it in almost everything"
	7. Science relates to my kids/family	Individual includes **any reference** to family member(s) in their account of why science means what it does to them	"Way I was raised - **old man and me conserved on everything, grew our own garden**."
	8. Related to hobbies/interests	Statements which include broad (e.g., nature) or specific (e.g., quantum mechanics) interests or which tie science to individual's hobbies, including watching television shows	"I'm not a science guy, don't know much about it, **but I like hearing about space and other planets**"
	9. Grew up with science	Mentions of ways individual was raised or experiences during childhood, **not including** school-related experiences	"**Grew up with science.** I'm a veteran - 20 years as aviation mechanic. Now working in pharmacy field - science works all kinds of ways"
	10. Previously disliked science, but like it now	Responses indicating positive change in perception of science; often includes mention of poor school performance related to science	"**The OMSI exhibit on Einstein changed my life - really made it relevant to me. I hated science before**"
	11. Mentioned OMSI	Any mention made of OMSI	"Touchy for me - **stuff at OMSI is fun**, but other science doesn't work with my faith."
	12. Generally interested	Positively-valenced comments regarding science in general which do not fall within the above categories	"**I don't really know, it just seems to make sense to me**"
	99. No response		

4.b. Are there any science topics you're interested in or you'd really like to learn more about?	1. Technology and engineering	Computers, robotics	"**Robotics, artificial intelligence**."
	2. Astronomy/space science	Anything relating to space or astronomy **(astrophysics should be coded as both 2 and 4)**	"**Space travel - is that dying down?** Animals and wildlife, too. My daughter loves that."
	3. Natural sciences	Earth science, paleontology, biology, zoology, paleozoology, botany, oceanography, environmental science, planetary history	"Chemistry, **botany, biology.**"
	4. Physical sciences	Physics, chemistry, health science, human anatomy and physiology	"Don't really know, **stuff like with the body**."
	5. Social sciences	Psychology, sociology, anthropology, human history, spirituality	"Earth science, **biblical history**"
	6. Anything at all/Nothing in particular	Response without any specific content area identified	"**Not right now, no**"
	99. No response		

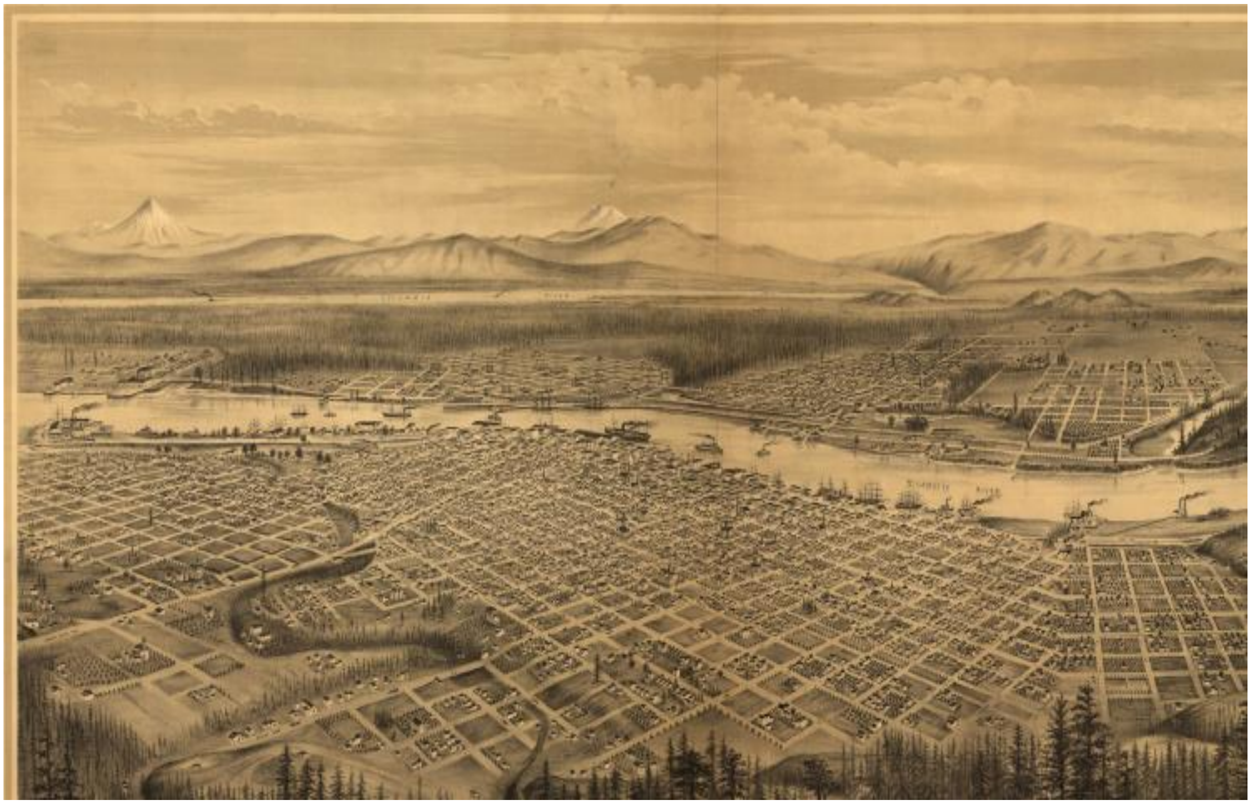
Appendix E: Topic Testing Card Images and Captions

Animals

Bikes

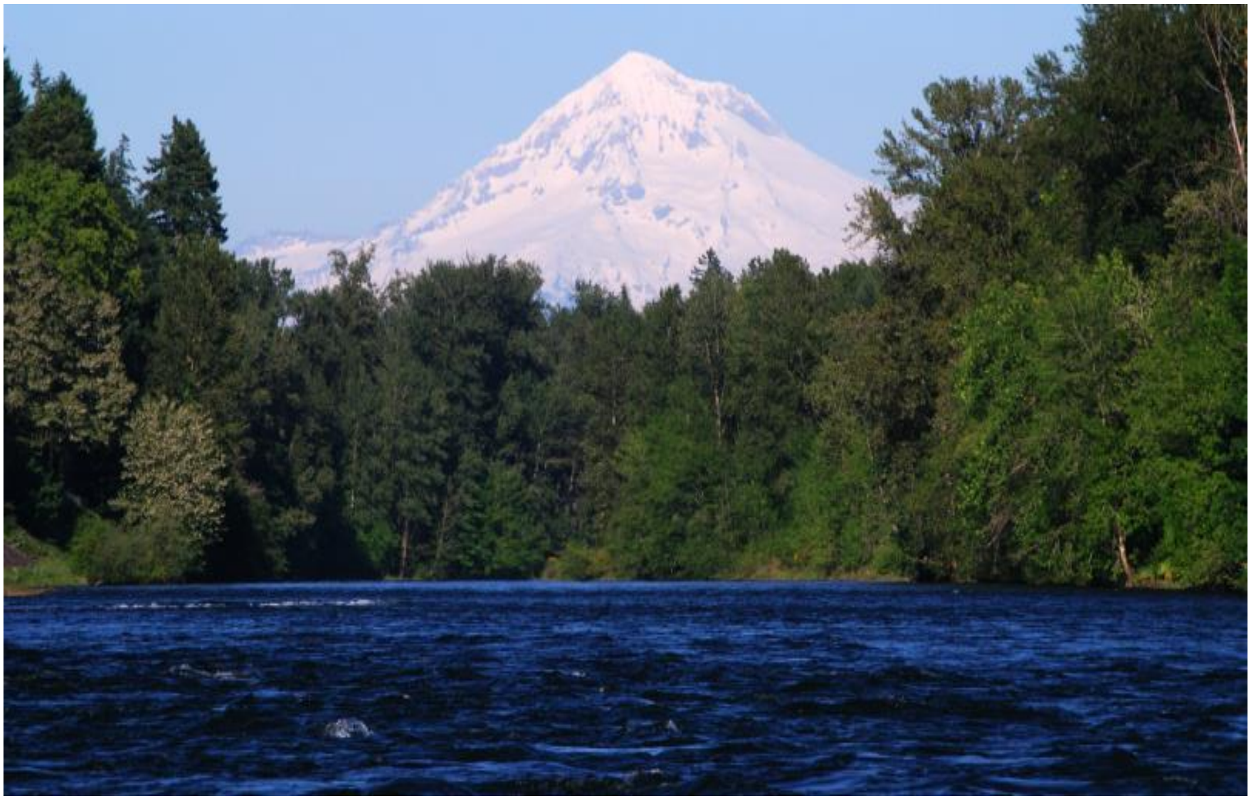
Cars

Food, Beer, and Wine



History

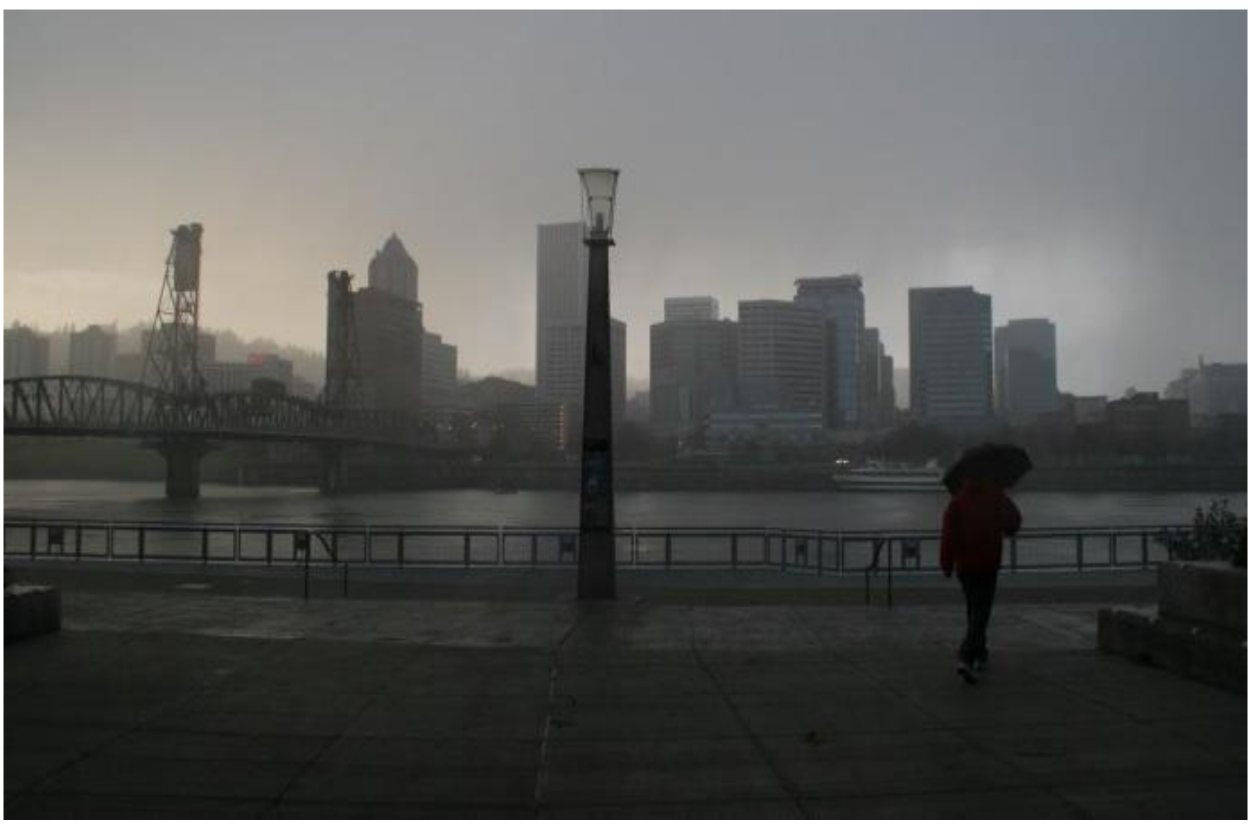
Music



Nature

Personal Technology

Sports



Weather

Appendix F: Supplemental Review of Secondary Literature

Interactive Design
The project's objective of placing a prototype outside museum walls poses an interesting challenge in that there is little professional or scholastic information regarding the success of interactive prototypes within public contexts. However, information from traditional museum and institutional exhibit design should still be considered relevant and can therefore be cautiously applied to an outdoor prototype. The articles explored during secondary research describe very specific, practical aspects of exhibit design as well as observations made of visitor behavior. Although not all information within these articles applied directly to the Science on the Move project, considering key concepts from museum interactive exhibit design should remain a valuable component of the team's decision making.

As stated above, this project's target audience has been identified as adults without college degrees, with a prototype context of transit centers outside the walls of the museum; bearing this in mind, it may be useful to consider the reasons why members of this audience may not have personal experience with museum or science center content. Based on Chang's (2006) discussion of psychographic variables, people do not visit museums because museums are perceived "to be formal, formidable places inaccessible to them because they had insufficient education to prepare them to read the *museum code*" (p. 173). It is also not uncommon for museums to be seen "as places that invoked restrictions on group social behaviors and on active participation" (p. 173). Based on findings such as these, "user-friendliness" could be considered a highly relevant component of successful interactive design, with the term "user-friendly" encompassing how easy the device is to use, how clear and productively the information is relayed, and how engaging the content/interaction is. With regards to creating user-friendly mechanical interactive exhibits, Gammon (1999a) draws upon his experiences as Head of Visitor Research at the Science Museum of London, to make several recommendations for consideration during interactive design, four of which are outlined below.

Good communication between exhibits and visitors is key
Feedback is a concept that is defined as the response of the exhibit to the actions of the visitor (e.g., aural, visual, tactile) and, as Gammon (1999a) states, is the most essential feature of interactive design. Ineffective feedback can lead to disengagement due to confusion or doubt that the machine is working properly. Feedback failure occurs when a response, even if a negative response, is not provided or is provided in an ambiguous or unnoticeable manner. It is also vital that a clear pattern of cause and effect be demonstrated for prototype users and that the designers attend to how the visitor will be physically oriented towards the display as information is presented; if information is not readily attainable, it will be detrimental to the rest of the experience.

The first few seconds of interaction with the exhibit are crucial
Akin to the concept of a "first impression," Gammon (1999a) argues that it is necessary for an exhibit to respond to a visitor within one to two seconds. This immediate response not only increases the likelihood of engagement, but also acts as a deterrent to inappropriate use of the exhibit. Suggestions for implementing this immediate responsiveness include the use of handles designed to turn both clockwise and counterclockwise, the removal or limitation of distractions

(by positioning and designing the prototype in a way that attention is unlikely to be distracted from the intended response), and an avoidance of machines which require visitors to push a button and then wait.

Visitors tend not to look up during exhibit use
Objects meant to be viewed from up high should be positioned to be viewed from a long distance so that viewers do not have to raise their heads too far for too long. Also, a mechanism (e.g., audio, movement) should be planned to draw attention to it (p. 7).

Labeling must be clear and concise. There must also be strong incentive to read it
Since people don't like to read and often like to start engaging with the exhibit right away it is crucial to design the prototype so that necessary instructions are given before one can continue with the interaction. Other observations made by Gammon (1999a) at the Science Museum of London include that large amounts of text or audio instruction displayed all at once will deter people from engaging, labels that direct attention to relevant parts of prototype through open-ended prompting questions tend to work best, and any part of the prototype which is pointed out on a label should be immediately visible from the perspective of the visitor looking at the label. Additionally, it was noted that the title or name of the prototype should be clearly visible on and explicitly tied to the prototype, as it is the single piece of text which visitors are likely to read. The name should describe the theme of the prototype, yet not be so overblown as to create unrealistic or inaccurate expectations among audience members.

Computer Exhibit Interfaces
As with those presented in the preceding section, these findings are drawn primarily from the work of Ben Gammon (1999b), head of visitor research at the Science Museum of London, who summarizes observations made about the use of computer exhibits culminating from five years of experience (1995-1999). Unlike mechanical interactives, Gammon argues that there is almost no average time a visitor will spend at a computer exhibit; engagement times vary widely depending on the comfort of the gallery space (e.g., whether seating is provided) and the quality of the interface itself.

Text on Screen
Based on his experiences with computer exhibit interfaces, Gammon (1999b) recommends adhering to a limit of 30-60 words on the screen at a time. In order to avoid intimidating or exhausting visitors, use more pages rather than cramming a large amount of text onto a single page; likewise, if at all possible, avoid the use of scroll bars. Interestingly, visitors tend to miss text which appears in the top third of the screen, as well as that which appears on the sides of the screen. It is therefore important to keep text in the center of the screen as much as possible, to clearly distinguish text from background images, and to make changes in text explicitly obvious, as subtle changes will likely go unrecognized. Gammon also warns that visitors tend to go straight to viewing the computer screen, and exhibit designers should not rely upon the effectiveness of printed text surrounding the screen.

Types of Computer Interface
Touch screens, Gammon (1999b) explains, are generally easy to use, and have the benefit of often being used by more than one visitor at a time; however, potential problems may arise if

users are unable to identify active areas, if the computer provides delayed responses, or if the screen’s active area is too small (less than 1cm square). To ensure the best possible audience experience with a touchscreen interface, active areas should clearly and dramatically stand out from non-active areas, with images and movement often providing useful indicators for the user that an area is active. Additionally, the computer should react within no more than one second of being touched to avoid confusion or misuse of the screen, either through direct transition to the following content or through the use of color changes, sounds, image movement, etc., to indicate that input has been received.

Trackballs and push buttons should always be different colors from the control panel in which they are installed, and movement of the trackball should correspond directly to the cursor on the screen. As with any cursor, the trackball cursor should be clearly visible at all times and not become easily camouflaged, regardless of its location on the screen. It’s also worth mentioning that trackballs work well for selecting active areas, but are subpar at best for click-and-drag functions.