Research Section
555 13th Street NE
Salem, OR 97301

ph: (503) 986-2700
fax: (503) 986-2844

OREGON DEPARTMENT OF TRANSPORTATION

SPR Quarterly Progress Report

October 1, 2016 through December 31, 2016

Date December 21, 2016

TO: Technical Advisory Committee Members:

Jarvis Pennington ODOT TMM Region 3, Jarvis.G.PENNINGTON@odot.state.or.us
Eric Standley, ODOT TMC Region 3, Eric.S.STANDLEY@odot.state.or.us
Tyson Lindekugel, ODOT Safety/Wellness Manager Region 2, Tyson.LINDEKUGEL@odot.state.or.us
Ron Larson, ODOT PM Region 1; Ronald.LARSON@odot.state.or.us
Justin King, ODOT Work Zone Standards Engineer, Justin.S.KING@odot.state.or.us
Nick Fortey, FHWA Safety Engineer; nick.fortey@fhwa.dot.gov
Scott McCanna; ODOT Work Zone Engineer, Scott.M.MCCANNA@odot.state.or.us
Dean Chess, ODOT Product Evaluation Coordinator, Dean.M.CHESS@odot.state.or.us

Friends of the Technical Advisory Committee:

Travis Brouwer, ODOT Assistant Director, Travis.BROUWER@odot.state.or.us
Other representative from industry – possible Association of General Contractors

1. Project

Title: Work Zone Intrusion Alert Technologies: Assessment and Practical Guidance
SPR # 790

2. Project Investigator

Name: John Gambatese
Title: Professor
Agency: Oregon State University
Address: 101 Kearney Hall, Corvallis, OR 97331
Phone #: (541) 737-8913
Email: john.gambatese@oregonstate.edu

Name: Hyun Woo (Chris) Lee
Title: Assistant Professor
Agency: University of Washington
Address: 120 Architecture Hall, Box 351610, Seattle, WA 98195
Phone #: (206) 616-4937
Email: hyunwlee@uw.edu

3. Project Coordinator

Name: Jon Lazarus, Research Coordinator
Phone: (503) 986-2852
E-mail: Jon.M.Lazarus@odot.state.or.us

4. Key Dates

Project start date: July 30, 2015
Project completion date: March 31, 2017

First Fiscal Year: [year]
Final Fiscal Year: [year]
[List revised dates and corresponding amendment numbers]

5. Project Status (Completed by project investigator)

Task 1: Documentation of Technologies
Deliverable Due Date: 11/1/2015
Literature on currently available technologies and technologies that have high potential for preventing injury due to work zone intrusions will be collected and reviewed. To collect the literature, the researchers will conduct a comprehensive search of archival publications and the Internet using on-line search engines. All documents found that are germane to the research topic will be accessed and reviewed. Task 1 will lead to the creation of a catalog of the technologies for use during the research and in the future by ODOT. The catalog will contain a description of each technology along with associated benefits, limitations to its use, and summaries of findings from prior research on the technology.

Percent completed reported in last quarterly report: 100%

Task 2: Survey of Current Practice
Deliverable Due Date: 11/1/2015
Task 2 is to conduct a survey of state DOTs, construction and traffic control contractors, equipment vendors, and automobile manufacturers. The survey will aim at documenting current and recommended practices, barriers, enablers, and impacts associated with work zone intrusion alert technologies. To conduct the survey, a questionnaire will be developed that addresses the aims listed above. The TAC will be asked to review the questionnaire and provide feedback. The questionnaire will be revised to incorporate the TAC's input, and then distributed by the researchers to the entities listed above. The survey sample will be developed based on input from the TAC, the researcher's personal contacts, and the companies and organizations identified in Task 1. Task 2 will lead to the identification of the status quo of the construction industry and its current best practice in terms of preventing work zone intrusion crashes.

Percent completed reported in last quarterly report: 100%

Task 3: Pilot Testing of Technologies
Deliverable Due Date: 3/2/2016
Based on the results of Tasks 1 and 2, and input from the TAC, a sample of feasible technologies will be selected for pilot testing. Selection will consider technology availability, cost, ease of use, potential for improving safety, and potential for incorporating the technology in typical transportation control plans. Those selected for testing will be purchased, leased, borrowed, or if possible, acquired through a donation. Pilot testing will be conducted as initial testing of the selected technologies under controlled, off-roadway conditions. Each selected technology will be assessed to capture its capabilities, and record how it is implemented. The results of the pilot testing will be used to assess feasibility of use, capabilities, and limitations related to each technology under investigation.

Percent completed reported in last quarterly report: 100%

Task 4: Selection of Technologies for Live Testing
Deliverable Due Date: 5/1/2016
Following completion of the pilot testing and analysis of the results, Task 4 is to conduct focus group sessions with ODOT personnel and construction contractors to identify and select specific technologies to implement and test in an active work zone. The TAC will be asked to recommend focus group participants from within ODOT and construction companies. The researchers will plan, schedule, and conduct the focus group sessions. In each session, feedback on each of the technologies will be solicited. Those technologies that are deemed promising by the focus group participants, and fit within the research budget, will be selected. In addition, the researchers will work with ODOT to select construction and/or maintenance projects on which to conduct live testing of the technologies.

Percent completed reported in last quarterly report: 100%

Task 5: Implement and Test Selected Technologies
Deliverable Due Date: 10/1/2016
Task 5 involves implementing the selected technologies on each case study project. Depending on the case study projects selected, it is planned to apply the technologies under different work zone conditions (e.g., construction and maintenance, short-term and long-term, daytime and nighttime, and stationary and mobile). Each selected technology will be implemented during actual work operations. The researchers will monitor the technology installation, use, and removal. The researchers will videotape the operations and monitor vehicle speeds as needed to assess each technology. The testing results of each technology will be evaluated and compared based on a variety of criteria including, but not limited to: ease of implementation and use, ability to detect intrusions, ability to warn of intrusions, sensitivity to false alarms, impact on risk to worker safety, and implementation cost. Upon the completion of testing, feedback on each technology will be collected directly from the construction and maintenance workers involved in each case study project.

Percent completed reported in last quarterly report:70%
Percent completed after this quarter: 100%

Key Progress-To-Date

- The data collection is complete for the identified case study projects in the following three locations, as planned.
    1. US-30 Swedetown Road to Wonderly Road (Columbia County)
    2. I-84 Cascade Locks to Hood River
    3. I-84 Mosier to The Dalles

Specific Progress This Quarter

- The data collection at the third case study project was conducted over one night on October 1, 2016, targeting two 200-foot impact panels before and after a bridge on the eastbound lane.
- Due to the study's complex setup over one night, a group of six researchers took part in data collection to help improve the quality of data collected. Like the two previous projects, the three technologies were tested by setting them in the shoulder area and by using clickers for response collection.
- The paving crew involved in the project were almost identical as those on the second project, so it was decided to skip a demonstration session prior to live testing. However, post-live testing surveys were conducted as planned by asking a series of questions to the crew.

Problems

- Originally, the research team and the contractor agreed to use slow lane paving for data collection, as done in the two previous projects. However, at the last minute, the contractor changed the plan to paving of the impact panels. As a result, the work plan had to be adjusted to test the three technologies at the two impact panels before and after a bridge.

Work Planned for Next Quarter

- None; task already completed

Task 6: Data Analysis
Deliverable Due Date: 12/31/2016

The data collected from the case study projects will be analyzed to determine the feasibility, barriers, enablers, and impacts of each technology and develop guidance for future use of the technologies by ODOT. Where appropriate, multi criteria decision analysis will be applied to rank order the cost effectiveness of each technology. Such comparisons are expected to determine the relative benefits provided by each technology in preventing work zone intrusion crashes.

Percent completed reported in last quarterly report: 0%
Percent completed after this quarter: 100%

Key Progress-To-Date

- Analysis for the data collected through the three case study projects is complete in the following areas:
    - Pre-live testing survey results
    - Live testing results

    - Post-live testing survey results

Specific Progress This Quarter

- Survey results are analyzed in the following criteria, as *subjectiv*e measures that represent the acceptance of the three technologies by the construction crew who participated in the testing:
    - Ease of use
    - Effectiveness of triggering mechanism
    - Effectiveness of alarm
    - Likeliness of use considering cost
    - Usefulness of technology
- Testing results are presented in the following formats, as *objective* measures for the effectiveness of the three technologies tested:
    - Equipment noise level evaluation
    - Participants' response rate on each project
    - Response rate by work role
    - Reaction time for each work role
    - Impact of location on response rate

Problems

- Due to unique setups and field conditions of each case study project, the three technologies were triggered at varying distances from the target paving operations. Thus, to maintain consistency, the analysis focuses on worker response rates recorded when the technology was triggered 100 feet and 50 feet away from the paving operation. It is because in all three case projects included the responses data at 50 and 100 feet away.
- For a similar reason, the paving crew were selected as the target subjects, because the research team was able to collect relatively reliable data from them, when compared to other workers such as roller operators or grinding crew.

Work Planned for Next Quarter

- None; task already completed

Task 7: Documentation and Dissemination
Deliverable Due Date: 3/1/2017

A draft final research report will be prepared and submitted to ODOT for review and comment. The draft report will present the findings of the research and provide recommendations to ODOT for implementation in practice. The draft final research report will be revised based on the comments received from ODOT, and a final research report will be prepared and submitted to ODOT for publication.

Percent completed reported in last quarterly report: 0%
Percent completed after this quarter: 100%

Key Progress-To-Date

- The development of a draft final research report is complete and ready for review of ODOT and TAC.

Specific Progress This Quarter

- By combining the previous interim reports with the results for Tasks 5 and 6, the research team has developed a draft final report. It encompasses not only the results for all research tasks that were originally proposed (Tasks 1 through 6) but also the suggested specification for future products.

Problems

- For some aspects of the specification, the research team was only able to make qualitative suggestions, mainly due to the practical limitations of the data collection methods implemented in this research. For example, the research team was not able to find conclusive data for visual and haptic alarms. As a result, the corresponding specifications are mainly based on the feedbacks collected from the research participants.

Work Planned for Next Quarter

- None; task already completed

6. **Project Coordinator's Comments** (Completed by ODOT)

Project final draft report sent via MoveIT in early January 2017, however, technology has not allowed us to view it. Report still pending for acceptance and distribution to the TAC. Additionally, there is a significant portion of the budget (~$40K) that was allocated for equipment purchases. The PIs have operated without purchasing this equipment and arranged to lease or borrow what they needed. This total will now not be realized and I've instructed the PI to have a remainder on the project (not bill to total contract amount).

7. **Finances** (Completed by ODOT)

SPR Project Summary

VENDOR	FY'16	FY'17	FY'18	FY'19	TOTALS
ORIGINAL BUDGET					$ -
WORK PLAN BUDGET	$167,824	$71,503	$ -	$ -	$ 239,327
REVISED BUDGET	**$86,707**	**$110,620**	**$ 6,673**	**$ -**	**$ 204,000**
EXPENDITURES - VENDOR	$ 88,719	$ -	$ -	$ -	$ 88,719
BALANCE	$ (2,012)	$ 110,620	$ 6,673	$ -	$ 115,281
ODOT	FY'16	FY'17	FY'18	FY'19	TOTALS
ORIGINAL BUDGET	$ 98,400	$ 98,400	$ 49,200	$ -	$ 246,000
REVISED BUDGET	**$ 10,000**	**$ 6,000**	**$ 1,327**	**$ -**	**$ 17,327**
EXPENDITURES - ODOT	$ 12,091	$ 4,272	$ -	$ -	$ 16,363
BALANCE	$ (2,091)	$ 1,728	$ 1,327	$ -	$ 964
PROJECT	FY'16	FY'17	FY'18	FY'19	TOTALS
ORIGINAL BUDGET	$ 98,400	$ 98,400	$ 49,200	$ -	$ 246,000
REVISED BUDGET	**$ 96,707**	**$ 116,620**	**$ 8,000**	**$ -**	**$ 221,327**
EXPENDITURES - PROJECT	$ 100,810	$ 4,272	$ -	$ -	$ 105,082
BALANCE	$ (4,103)	$ 112,348	$ 8,000	$ -	$ 116,245