Transportation Northwest at the University of Washington
Research Project Descriptions
Year 16: September 1, 2003-August 31, 2004

Identifying Number	62-8989
Project Title	Implementation of AVL Vehicles as Speed Probes for Traffic Management and Traveler Information in Addition to Performance Monitoring
Principle Investigator	Daniel J. Dailey
Institution	University of Washington
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PI's E-mail address	dan@its.washington.edu
External project contact, address, telephone number	Pete Briglia WSDOT University District Building, Suite 535 1107 NE 45th Street Seattle, WA 98105-4631 206-543-3331
Project objective	1. Refine the methodology to automatically use transit coaches as probe vehicles to estimate freeway and arterial speed and travel time for traffic and traveler information, traffic management, as well as performance monitoring. 2. Deploy a set of components to provide real-time travel time and speed measures widely available to researchers nationwide. 3. Improve public access to virtual sensors over a large geographical area of metropolitan King County by improving the user interface for a web application. ▪ Publish peer-reviewed results describing the effectiveness and confidence levels of data created using a transit fleet management system to create virtual sensors.

Abstract

Previously funded joint WSDOT/ TransNow projects began the development of technology and software to use Metro's AVL-equipped fleet as a set of probe vehicles on both freeways and arterials. Those projects created the ability to capture AVL data on the fly and to measure individual transit vehicle travel times as well as estimate speeds on freeways.

It is now possible to create an SDD data stream that contains speed estimates for virtual sensors located on a variety of arterials and freeways. Past work demonstrated that the speed estimates, for the transit vehicles, compare favorably with speed estimates from inductance loop data where such loop data are available. In this project, the speed and travel-time estimates on arterials will be validated against floating car data and, in parallel, the real-time data will be placed in the WSDOT Traffic Management System to be evaluated for use as part of the overall North West Region Traffic management effort. In addition, an improved user interface for traveler information containing both speeds at virtual sensors and corridor travel times will be created. These additional virtual sensors and corridors will be focused on areas where presently there is little or no installed sensing capability. This project will provide additional sensing capability without incurring the expense of installing additional loops and the communications infrastructure necessary to support real-time use of the loop data.

WSDOT will benefit by gaining additional sensing capabilities for traffic management without the additional installation and maintenance costs of cabinets, loops, and communications. The traveling public in Metropolitan Seattle will benefit from having additional traveler information on arterials that are alternatives to freeway travel. Publication of the results validating the techniques used to derive virtual sensors from transit probe vehicles will have a national impact especially in the increasing number of cities where transit fleet management systems are in use.

Task Descriptions and Milestones

Task 1. Develop algorithms to estimate speed and travel time for freeway corridors using AVL data. Record AVL data to be used for algorithm verification.
Task 2. Validate assumptions about observed data properties to ensure validity of algorithms developed.
Task 3. Identify promising arterials and a freeway segment on which to estimate speed.
Task 4. Construct mapping between roadway segments and spatial transit schedule information.
Task 5. Use recorded transit position information to make optimal estimates of the statistical parameters of the models.
Task 6. Implement speed estimation filters in software.
Task 7. Implement SDD transmitter for speed estimates.
Task 8. Implement connection to WSDOT TMS
Task 9. Validate selected arterial speeds and travel times
Task 10. Refine the prototype graphical user interface for regional speed/travel-time data.
Task 11. Develop recommendations for the use of speed/travel-time estimates.
Task 12. Prepare manuscript for publication. Respond to reviewers to ensure publication.
Task 13. Write the final report.
Task 14. Respond to comments on the final report.

Project Start and End Dates	September 1, 2003 – August 31, 2004
Current year budget	$41,000
For two-year project, total budget and start and end dates	
Modal orientation of the project	Transit
Student involvement (thesis, assistantships, paid employment)	Graduate Assistantship

Relationship to Other Research Projects

Previously funded joint TransNow/WSDOT projects began the development of technology and software to track Metro's AVL-equipped fleet and to use them as a set of probe vehicles on both freeways and arterials. Those projects created the ability to capture AVL data from the freeway, measure individual transit vehicle travel times, estimate individual vehicle speed, and make a prototype virtual sensor web page. In past work, several techniques and technologies have been used to estimate travel time, each of which has various strengths and limitations. For this reason, "data fusion," the principled integration of multiple data sources, is seen as a desirable way to estimate travel conditions. The fusing of data from both WSDOT and Metro will allow the development of the techniques necessary to truly use transit vehicles as

probes. Further, this project will make the results from past projects available within the North West Region's TMS for evaluation as a traffic management tool.

Technology Transfer Activities

1. An algorithm that uses Metro AVL data received over the ITS backbone to estimate speed and travel time of transit vehicles on validated arterial roadways.
2. An SDD Transmitter that can provide real-time speed information on a variety of roadways using Metro Transit vehicles as probes.
3. A graphical display of the speed on a variety of freeway and arterial roadway links.
4. A connection to the WSDOT NW Region TMS to deliver virtual speed sensor data to the TMS.
5. A set of virtual sensors that meet the needs of the traffic management personnel and augment the existing inductance loop system.
6. A report that:
   a) describes the AVL speed/travel-time algorithm
   b) describes comparative analysis of various estimates and measurements
   c) recommends methodologies for data fusion of various estimates and measurements
   d) recommends future ITS development strategies to make travel times and speeds more available, accurate, and useful.
7. A paper to be submitted for presentation at the TRB'04 Annual Meeting and a manuscript to be submitted to a peer-reviewed journal.

Potential Benefits of the Project

The groups who will benefit from this work will range from DOT operations personnel to planners and transit operators. DOT operations personnel will benefit from the creation of a new sensor to measure traffic conditions on both freeways and arterials. Planners will benefit from the availability of corridor information for both reporting and planning. In addition, transit operators will benefit from increased ability to monitor the impact of congestion on schedules. This project's numerous benefits include:

1. leveraging additional key benefits from Metro/WSDOT/TransNow's existing investment in both ITS Backbone and AVL related research projects
2. increasing the effectiveness of performance monitoring efforts by:
   a) enhancing the accuracy of estimated travel times and speeds
   b) creating the technology for a new tool that can be used to do performance evaluation
3. making available better travel time and speed estimates for a variety of ITS applications by fusing two different travel-time data sources
4. making current travel-time and speed data available for archiving and manipulating
5. creating algorithms for travel time and speed estimation that can be used with any methodology that collects sets of positions as a function of time (e.g., GPS-equipped vehicles)
6. implementing virtual speed sensors for use by the NW Region
7. producing a report that describes the algorithms and statistics of travel time and speed estimates when using probe transit vehicles for performance monitoring.

TRB Keywords

Automatic Vehicle Location System, Probe Vehicles, Kalman Filtering, Speed Measurement, Travel Time

Identifying Number	62-8990
Project Title	Virtual Training Tools for Transportation Infrastructure Construction
Principle Investigator	Joe Mahoney
Institution	University of Washington
PI's telephone number	206-685-1760
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External project contact, address, telephone number	David Newcomb
Project objective	This project's ultimate goal is to bring cost-effective interactive 3D training environments to contractors and state agencies. This will be accomplished by developing and testing a second version of the XPactor training simulation software. While the original XPactor simulator focused exclusively on a single compactor operator in a single paving scenario, the proposed enhancements will expand the capabilities of the current system and work towards creating a virtual hot mix asphalt (HMA) paving construction site. This site will allow multiple users to interact with one another and assume a variety of key construction roles including paver operator, multiple types of compactor operators, site coordinator, and even public motorist. The virtual site will be configurable to present users with a rich set of construction projects, such as paving different geometries like multilane, curved, and inclined roads, and paving under different environmental conditions including weather, time of day (night), and traffic patterns. As with the current version, the trainer will be able to set these parameters at runtime in order to customize training.

Abstract

The goal of this project is to develop and test an interactive 3D virtual training environment for pavement construction in order to bring realistic and cost-effective training to contractors and state agencies. This project builds on earlier work that developed the XPactor virtual hotmix compactor. The main features of the proposed simulator include:

- A virtual hot mix asphalt (HMA) paving construction site. The virtual site will allow multiple users to interact with one another and assume a variety of key construction roles including paver operator, multiple types of compactor operators, site coordinator, and even public motorist.

- Software agents. In a single-user simulation running on a single machine the simulator will provide autonomous bots enacting the other construction site roles and interacting with the user. These bots will also be utilized for roles not occupied by a trainee in multi-user simulations running over a local area network.

- Rich paving scenarios. The virtual site will be configurable to present users with a rich set of construction projects such as paving different geometries like multi-lane, curved, and inclined roads as well as paving under different environmental conditions including weather, time of day (night), and traffic patterns.

- Performance evaluation. The simulator will provide users with feedback on their performance including assessments of mat compaction, paver speed and operation, work zone safety, etc.

Task Descriptions and Milestones
Three development tasks will be performed as part of this project.

Task One – Rich Paving Scenarios
Task Two – Multiple Worksite Roles
Task Three – Robust Evaluation of Performance

Project Start and End Dates	September 1, 2003 – August 31, 2004
Current year budget	$40,159
For two-year project, total budget and start and end dates	
Modal orientation of the project	Highway
Student involvement (thesis, assistantships, paid employment)	Thesis/RA

Relationship to Other Research Projects
The proposed project builds on our previous success developing XPactor, the virtual HMA compactor simulator. The main features of XPactor include:

- A drivable roller compactor, controlled by user input within a simulated construction environment.
- Realistic simulation of HMA mat (the freshly paved material) cooling physics (through the use of the MultiCool software). Users must employ proper techniques and strategies in order to adequately compact the hot mix before its cessation temperature (temperature below which no further compaction is possible) is reached.
- Visually rich feedback mechanisms for evaluating user performance
- Configurable paving conditions, set by the trainer.

Technology Transfer Activities
The implementation plan contains three elements. Following completion of the prototype virtual site simulator, trial implementation will be done within three types of organizations: universities, state DOTs, and a contractor-oriented paving association (NAPA). At the University of Washington, we will introduce the simulator to both senior and graduate students and obtain student feedback on its effectiveness, realism, and ability to convey critical field construction operations. State DOTs will be targeted for trial implementation including Washington and Maryland. These states together with California, Minnesota, and Texas have formed a consortium that enables collaboration on pavement-related issues. The research directors and chief pavement engineers for these DOTs meet on a regular basis. They have stated that tools, such as the virtual pavement construction site simulator, are needed for training their personnel, and are motivated to assist with implementation. Finally, the National Asphalt Paving association will identify one or more of its member contractors that the research team will collaborate with

for trial implementation. With high employee turnover, construction-related training is a constant and critical contractor need.

Potential Benefits of the Project
The virtual construction site simulator addresses issues related to the placement of asphalt concrete. This will help fill an immediate need in the hotmix industry – a more knowledgeable cadre of personnel in agencies and contracting companies. The simulator will provide cost-effective training to field personnel. It will help to make them aware of timing, communication, and safety issues essential to the success of paving projects. This will assist in educating students about the systems and processes of pavement construction in a compelling, visually rich, interactive, "game-like" environment.

TRB Keywords
pavement, simulation, software, construction

Transportation Northwest at the University of Washington
Research Project Descriptions
Year 16: September 1, 2003-August 31, 2004

Identifying Number	62-8992
Project Title	Improving Dual-Loop Truck (and Speed) Data: Quick Detection of Malfunctioning Loops and Calculation of Required Adjustments
Principle Investigator	Nancy L. Nihan/Yinhai Wang
Institution	University of Washington
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PI's E-mail address	nihan@u.washington.edu / Yinhai@u.washington.edu
External project contact, address, telephone number	Mark Hallenbeck TRAC UW Box 354802 Seattle, WA 98195 206-543-8690
Project objective	▪ Develop an algorithm that calculates the difference in sensitivity of any two single loops that form a dual-loop detector and calibrates the sensitivities of single loops; ▪ Develop a system that can tune up dual-loop detectors by incorporating the algorithm as its core component.

Abstract
The Washington State Department of Transportation (WSDOT) has made an enormous investment in the installation of loop detectors in the Seattle metropolitan area freeway network. The real-time traffic data collected by loop detectors are a primary data source for automated traffic monitoring or information systems, such as Advanced Traffic Management Systems (ATMS) or Advanced Traveler Information Systems (ATIS). However, previous research found that the WSDOT dual-loop detection system was not consistently reporting accurate truck volumes. More than 80 percent of the dual-loop detectors had significant under-count errors due to the large difference (>10%) of vehicle on-times measured by the two single loops that form a dual loop detector. Fixing the sensitivity problems is an emergency task for reliable truck and speed data collection. Here we propose a system that uses loop event data for malfunctioning loop identification and reparation.

Task Descriptions and Milestones
1. Develop a portable loop event data collection system.
2. Develop a loop detector tune-up system by incorporating a tune-up software package to the portable DEDAC system.
3. Test the loop tune-up system.
4. Finalize the loop detector tune-up system. Write a user manual.
5. Write project report for review and dissemination.

Project Start and End Dates	September 1, 2003 – August 31, 2004
Current year budget	$40,321
For two-year project, total budget and start and end dates	
Modal orientation of the project	Highway
Student involvement (thesis, assistantships, paid	Xiaoping Zhang, RA

employment)	

Relationship to Other Research Projects
This project will conduct follow-up research of two previous research projects entitled "Evaluation of Dual Loop Data Accuracy Using Video Ground Truth Data" and "Investigating Causes of Dual Loop Miscount and Misclassification Using Loop Event Data", respectively. The achievements to be made in the proposed research project will benefit some other ongoing projects in the State of Washington.

Technology Transfer Activities
A final report detailing the achievements of the proposed project will be written and submitted to TransNow and to the WSDOT for review and distribution. The results of this research project will also be documented in two papers, which will be submitted for publication in the *Transportation Research Record* or the *Journal of the International Institute of Transportation Engineers*.

Finally, an easy-to-follow field manual will be developed for operators so that they can correctly adjust the sensitivities of malfunctioning loops as they are identified.

Potential Benefits of the Project
- Dramatically improved bin-volume data (and speed data) from the dual-loop detectors on the WSDOT freeway network.

- An easy-to-follow method for continuously monitoring and correctly adjusting the sensitivity of loop detectors in the field. (A field manual will be produced as part of the project outputs.)

TRB Keywords
dual-loop detection, truck volume data, freight mobility, ITS, vehicle classification, loop error, detector malfunction, event data, error correction

Transportation Northwest at the University of Washington
Research Project Descriptions
Year 16: September 1, 2003-August 31, 2004

Identifying Number	62-8991
Project Title	Documentation of User/Agency Benefits for Information-Based ITS Strategies
Principle Investigator	Scott Rutherford
Institution	University of Washington
PI's telephone number	206-685-4281
PI's E-mail address	scottrut@u.washington.edu
External project contact, address, telephone number	Pete Briglia WSDOT University District Building, Suite 535 1107 NE 45th Street Seattle, WA 98105-4631 206-543-3331
Project objective	The purpose of this research is to try to develop a way to measure ITS information strategies with information now available or easily collected. The following objectives should achieve this purpose: ▪ Document methods used to justify transportation or other information-based schemes. ▪ Develop a method for estimating the monetary benefits of transportation information technology. ▪ Implement the method developed for Objective 2 for an ITS transportation information system.

Abstract
No current research has found a reliable and defensible method for evaluating the benefits of information-based ITS strategies to users and agencies. These strategies include highway advisory radio systems; radio transmission of traffic information; PC-based Web sites such as the WSDOT freeway congestion Web site; and traffic information on Palm-type devices, real-time transit information at stops, on the Internet, and on mobile PDAs. Without information showing user and agency benefits, these projects will have difficulty obtaining transportation resources on a competitive basis with more traditional transportation projects such as highway capacity expansion or safety projects. It should be possible to measure how much time people spend on certain information devices such as freeway flow Internet sites and calculate the benefits. The purpose of this research is to try to develop a way to measure ITS information strategies with information now available or easily collected.

Task Descriptions and Milestones

Task 1 – Search the literature for similar analyses of Web-based information
Task 2 - Study procedures for measuring the use of information systems
Task 3 - Develop procedures for capturing usage data on ITS devices
Task 4 – Collect usage data
Task 5 - Analyze data to determine user/agency benefits
Task 6 - Make recommendations on how to incorporate the benefit calculations into the programming process
Task 7 – Produce final report and executive summary
Task 8—Final Report

Project Start and End Dates	September 1, 2003 – August 31, 2004
Current year budget	$15,007
For two-year project, total budget and start and end dates	
Modal orientation of the project	Multi-modal
Student involvement (thesis, assistantships, paid employment)	Taryn Kristof, RA Undergraduate TBN

Relationship to Other Research Projects

Two sets of literature will be explored for this effort. First, some work has already been done to valuate information systems. The Federal Highway Administration's IDAS computer program attempts to place value on information. The contractor who developed IDAS based it on a literature search, and this will be the basis for beginning of our search. Work is ongoing around the country, and Web-based searches of TRIS, the University Centers Program, state DOTs, and others will help establish the state of the art in the transportation information area.

The other set of literature will encompass economics, marketing, and business—areas in which information is bought and sold. This literature may yield new information not now in the transportation literature. Methods to valuate information in other fields may yield some insights for this project.

Technology Transfer Activities

This project will produce the following products:

1) technical memo on the literature review
2) method for measuring the benefits of ITS-based information systems
3) application of method described in 2 above
4) final report incorporating 1, 2 and 3.

Potential Benefits of the Project

The main benefit of this research will be to provide the WSDOT with a method for fairly evaluating the contributions of emerging ITS information technologies so they can be judged as a legitimate alternative for transportation programming.

TRB Keywords

transportation information systems, ATIS, transportation cost/benefit analyses

Transportation Northwest at the University of Washington
Research Project Descriptions
Year 16: September 1, 2003-August 31, 2004

Identifying Number	62-8988
Project Title	Improved Truck and Speed Data Using Paired Video and Single-Loop Detectors
Principle Investigator	Yinhai Wang/Nancy L. Nihan
Institution	University of Washington
PI's telephone number	206-543-8255
PI's E-mail address	yinhai@u.washington.edu / Nihan@u.washington.edu
External project contact, address, telephone number	Mark Hallenbeck TRAC UW Box 354802 Seattle, WA 98195 206-543-8690
Project objective	The objective of this study is to develop a plug & play computer system that uses the image sequence captured by a video camera to collect real-time long-vehicle volumes by lane for roadways.

Abstract
Previous studies have found that the percentage of trucks in a traffic stream has significant effects on traffic capacity and safety. This indicates that vehicle composition information is important for almost all aspects of transportation planning and traffic management. This information is also needed to monitor and analyze our state's truck freight movements. However, such composition data are not available from locations without dual-loop detectors. In this proposal, we propose a computer system that uses the image sequence captured by an un-calibrated video camera to collect real-time long-vehicle volumes by lane for roadways. Then combine the truck volume data and single loop measurements to improve speed estimation accuracy. Since hundreds of surveillance video cameras have been installed along major freeways in Washington State, it will be very desirable if these un-calibrated video cameras can be used for long vehicle data collections.

Task Descriptions and Milestones
Task 1: Algorithm design
Task 2: System implementation
Task 3: System test and revision
Task 4: Documentation

Project Start and End Dates	September 1, 2003 – August 31, 2004
Current year budget	$40,321
For two-year project, total budget and start and end dates	
Modal orientation of the project	Highway
Student involvement (thesis, assistantships, paid employment)	Jianyang Zheng, PhD, RA

Relationship to Other Research Projects

The proposed project will provide an alternative solution for long-vehicle data collection for roadway sites where dual-loop detectors are not available. It is an extension of a current project, Developing Accurate, Real-Time Vehicle-Length Data Inputs to Improve WSDOT Video Speed Sensor Accuracy, funded by the WSDOT. In this ongoing project, a computer system will be developed to separate long vehicles (LVs) from short vehicles (SVs) and output vehicle-length information to the WSDOT.

Technology Transfer Activities

A final report detailing the achievements of the proposed project will be written and submitted to TransNow and to the WSDOT for review and distribution. The results of this research project will also be documented in two papers, which will be submitted for publication in the Transportation Research Record or the ASCE Journal of Transportation Engineering.

Finally, an easy-to-follow field manual will be developed for operators so that they can correctly adjust the sensitivities of malfunctioning loops as they are identified.

Potential Benefits of the Project

- An algorithm for vehicle classification using video images;
- A portable plug & play computer system for real-time long-vehicle data collection.

TRB Keywords

video imaging and detection, truck volume data, freight mobility, ITS, vehicle classification, uncalibrated camera, vehicle length

Transportation Northwest at the University of Washington
Research Project Descriptions
Year 16: September 1, 2003-August 31, 2004

Identifying Number	922927, Task 7
Project Title	Urban Commodity Flow Data Collection and Analysis Using Global Positioning Systems
Principle Investigator	Thanit Puthpongsiriporn
Institution	Oregon State University
PI's telephone number	(541) 737-4505
PI's E-mail address	Thanit@orst.edu
External project contact, address, telephone number	Susie Lahsene Port of Portland 121 NW Everett Portland OR 97209 Tel: (503) 944-7517 Fax: (503) 944-7466 lashes@portptld.com
Project objective	To collect and analysis urban commodity movement data using Global Positioning System (GPS) receivers and evaluate advancing intelligent transportation systems (ITS) technologies as data collection tools that could supplement freight planning and modeling needs, through improved freight movement data attributes.

Abstract
Global Positioning System (GPS) receivers will be used to collect detailed urban commodity movement data. The additional detailed truck route and commodity flow data to be collected during the pilot test will improve the accuracy and hence enhance the urban commodity flow model developed by Portland Metropolitan Planning Organization (MPO). In addition, the project research team will reevaluate and update the role and capability of Global Positioning System (GPS) receivers as a tool for freight truck movement data collection in metropolitan areas.

Task Descriptions and Milestones
Task 1 Literature Survey
Task 2 Development of Technology and Functional Requirements for the Test GPS System
Task 3 Recruiting of Freight Transporter for Pilot Test
Task 4 Development of the Plan for Pilot Test
Task 5 Installation of the Test GPS Systems on Recruited Trucks
Task 6 Conducting of the Pilot Test of the GPS Systems
Task 7 Preparation of Reports

Project Start and End Dates	September 1, 2003 – August 31, 2004
Current year budget	$47,940
For two-year project, total budget and start and end dates	
Modal orientation of the project	Multi-modal
Student involvement (thesis, assistantships, paid employment)	RA and paid employment

Relationship to Other Research Projects

The proposed project builds on previous research that evaluated the implementation of Global Positioning Systems (GPS) automated data collection devices, the Truck Activity Data Collection and Analysis Using Global Positioning Systems study performed by Battelle in 1999. Also, the proposed project is an extension of the Truck Trip Data Collection Method Study sponsored by Oregon Department of Transportation in that it focuses on the use of GPS devices as a freight data collection methodology.

Technology Transfer Activities

The final report will be submitted to TransNow for review and distribution. The study results will be written into research articles and submitted to appropriate archival journal publications. The results of the study will also be presented at University Day 2005, the official OSU academic event to note the beginning of fall term.

Potential Benefits of the Project

The expected benefits of this project include:

1) Urban commodity flow data available to aid in freight planning and modeling. This data will be used as input to the Commodity Flow Model.
2) Utilization of this data may provide useful boundaries or at least narrow the scope of data collection strategies targeted at metropolitan and urban areas.

In addition, the proposed study will attract Industrial Engineering students in particular women and minorities into transportation and its related fields. The project will help students in the Department of Industrial and Manufacturing realize the research and career opportunity in transportation.

TRB Keywords

Intermodal, Traffic Flow Management, Comprehensive Transportation**,** Global Positioning System (GPS)

Transportation Northwest at the University of Washington
Research Project Descriptions
Year 16: September 1, 2003-August 31, 2004

Identifying Number	922910, Task 10
Project Title	Techniques for Mining Truck Data to Improve Freight Operations and Planning
Principle Investigator	Robert L. Bertini
Institution	Portland State University
PI's telephone number	503-725-4249
PI's E-mail address	bertini@pdx.edu
External project contact, address, telephone number	Barnie Jones Oregon Department of Transportation 200 Hawthorne SE, Ste. B-240 Salem, OR 97301-5192 503-986-2700
Project objective	The objective of this project is to build upon past and ongoing research in the area of identifying techniques for collecting freight transportation data by designing two specific data collection experiments using an existing ITS infrastructure and equipment. The objective will be met by carefully reviewing the literature, developing unique and comprehensive data sampling strategies, working with regional transportation agency partners to clearly define their data needs, and implementing a data collection experiment to demonstrate the capabilities of two existing ITS surveillance system for freight data collection.

Abstract

It is seen that congestion on the overall highway network is negatively impacting the efficient and effective freight movement, and that this is having a deleterious effect on our national and regional economies. Despite investments in intelligent transportation systems (ITS) in many regions, we still do not have a comprehensive understanding of how our freight transportation system operates. This is complicated by the presence of many private operators with complex needs traveling on publicly operated highways with a complex permitting and regulatory environment. There is a heightened need to improve our knowledge of freight flows in order to improve the overall transportation system, the freight component in particular, and to respond to new and emerging security concerns. The objective of this project is to build upon past and ongoing research in the area of identifying techniques for collecting freight transportation data by designing two specific data collection experiments using an existing ITS infrastructure and equipment. The objective will be met by carefully reviewing the literature, developing unique and comprehensive data sampling strategies, working with regional transportation agency partners to clearly define their data needs, and implementing a data collection experiment to demonstrate the capabilities of two existing ITS surveillance system for freight data collection. The results of the experiment will be documented and results will be disseminated via project reports, website outreach and presentation of results at regional and national conferences.

Task Descriptions and Milestones

Task 1 Literature Review
Task 2 Stakeholder Survey and Analysis
Task 3 Preliminary Data Analysis
Task 4 Sampling Plan
Task 5 Experimental Design

Task 6 Data Collection
Task 7 Data Analysis
Task 8 Reporting

Project Start and End Dates	September 1, 2003 – August 31, 2004
Current year budget	$58,235
For two-year project, total budget and start and end dates	
Modal orientation of the project	Highway
Student involvement (thesis, assistantships, paid employment)	Two master's students (one in civil engineering, one in statistics) plus student hourly (undergraduate and/or graduate).

Relationship to Other Research Projects
This project builds on previous and on-going work in the Portland region. First, co-PI Bertini is completing a TransNow funded project that has investigated and used the freeway surveillance infrastructure to assess the ramp metering and incident response programs in the Portland metropolitan area. These projects have included components for validation of the loop detector data for use in counting collections of vehicles and estimating their speeds. Also, the Oregon Department of Transportation (ODOT) is currently completing an SPR project entitled, "Methods to Collect & Analyze Truck Trip Information," which is analyzing the effectiveness of transportation projects or polices on freight movements to help ODOT understand freight movements, characteristics and needed infrastructure. If successful, the methodologies, data and truck generation, distribution and routing relationships will be able to be quantified and to be incorporated into metropolitan models and the statewide transportation model. The proposed research will attempt to advance the possibility of obtaining vehicle count and classification data in the Portland metropolitan area, and twill thus benefit from and be performed in coordination with this past project. Finally, Co-PI Bertini is embarking upon a project funded by the National Science Foundation to mine the freeway and arterial surveillance systems in Portland toward improving the ways in which we monitor, model and evaluate transportation plans and improvements. The extension of those efforts to specifically address vehicle classification and freight movements will be very appropriate.

Technology Transfer Activities
We anticipate and specifically call for early and consistent involvement of our external project contact and external constituents at the Port of Portland, Oregon Department of Transportation and the City of Portland. The project results will be presented to our external project constituents, as well as being presented at the next Northwest Transportation Conference. We will also likely be able to present our results at local and statewide meetings of professional organizations such as Women's Transportation Seminar, Society of Women Engineers, American Society of Civil Engineers and the Institute of Transportation Engineers.

Two months prior to the project end date, the draft of the final report will be forwarded to TransNow for review and distribution. Results will also be disseminated through appropriate web-based media (e.g., the PSU and ITS laboratory website). The co-principal investigators and students will develop appropriate paper(s) for submittal to scholarly journals and major regional and national transportation conferences. The co-PIs will also work toward integrating project

results into their coursework. This is particularly timely as PSU begins to develop its first freight transportation operations graduate course to be taught in spring 2004. Early and continued involvement of the external project contact (as well as other stakeholders) will be maintained in order to ensure success.

Potential Benefits of the Project
With limited investment, taking advantage of past investments in freeway surveillance, a greater understanding of truck movement in the Portland area can be achieved. Establishing the volumes and type of trucks on the highway network with temporal and spatial dimensions will help planners understand through-trip and local trip truck trends. In addition, the continuous nature of the data could allow for validation of simulation models, such as TRANSIMS, and other truck models currently being applied in the Portland metro area and in the state of Oregon. By developing a program for systematically sampling truck types and flows over time and space, a robust definition of truck travel can be determined. This research could be used to capture and archive truck activity to better understand movements by time of day, season, direction, vehicle type, etc., and to track these trends over time. This will contribute toward the planning, design and operation of the freight transportation system in the state. Further, as Oregon moves to eliminate its Automatic Traffic Recorders (ATRs), the data processing system developed in this study could replace and augment the valuable vehicle classification data provided by the ATR system. Through technology transfer, practitioners will gain a better understanding of the impact of truck flows on the overall safety, efficiency and security of the transportation network. Also, students will gain hands-on experience working with truck flow data in the PSU Intelligent Transportation Systems laboratory, which will help them in their careers and increase the visibility for freight-related research to the many visitors to the laboratory and its web site.

TRB Keywords
freight, multimodal, data collection, sampling

Transportation Northwest at the University of Washington
Research Project Descriptions
Year 16: September 1, 2003-August 31, 2004

Identifying Number	740710
Project Title	An Analytical Model Supporting Intermodal/Port Facilities
Principle Investigator	Eric Jessup/Ken Casavant
Institution	Washington State University
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Project objective	The overall purpose of the research project is to develop and apply an empirical tool/model for examining alternative investment and operations scenarios as to their impact on port and intermodal performance and viability. To focus on the themes of TransNow (relating to urban and rural traffic operations and port, terminal and intermodal operations) specific objectives are designed to: -review the role of truck-rail, truck-barge and rail-barge facilities in providing transportation services. -review alternative models for providing infrastructure and investment decision information to policy makers. -develop an applied model that conceptually can show the impact on efficiency, effectiveness and, ultimately, viability of ports and intermodal facilities of alternative operations or investment policies. -test the model in several case studies to provide an evaluation of the sensitivity and applicability of the model to alternative scenarios. -recommend a model and methodology that can be used in evaluating policy decisions on infrastructure priorities and investment.

Abstract
The general purpose of this study is to develop an applied methodology, using a rigorous mathematical programming model, to empirically examine the impacts on intermodal efficiencies, effectiveness and performance/viability of alternative investment strategies or operations policy changes. Data from an ongoing study by these Principal Investigators will provide the structure of the case studies to be evaluated and a review of alternative stochastic and non-stochastic transportation models will be undertaken. Case studies, with differing operational and physical characteristics, of several port/intermodal facilities will be used to test the prototype model initially developed. Modifications and applications will be recommended.

Task Descriptions and Milestones

1. Review the literature on role of multimodal transportation systems, emphasizing the functions performed by intermodal/port facilities.

2. Review the analytical models and programming algorithms in the literature relative to the data needs and applicability to this type of economic transportation problem.
3. Develop a prototype model for empirical application to the case studies.
4. Test the model in the case studies where these case studies are chosen for having differing facility and competitive characteristics.
5. Recommend a model structure and corresponding applications.
6. Write report, review and rewrite.
7. Undertake technology transfer by submitting report to TransNow, to appropriate journals and submit papers for presentations at the TRB and the TRF, at a minimum.

Project Start and End Dates	September 1, 2003 – August 31, 2004
Current year budget	$42,000
For two-year project, total budget and start and end dates	
Modal orientation of the project	Multi-modal
Student involvement (thesis, assistantships, paid employment)	Quinton Pike, MS, RA Hodan Farah, Internship

Relationship to Other Research Projects

This research project is very timely because it will build on another project that is currently under way, lead by these same two Principal Investigators. The overall goal of that research effort is to identify the factors that contribute to, cause or guarantee economic viability of an intermodal facility. The output of the project is a list of attributes, necessary and/or sufficient, that identifies strengths and weaknesses of alternative proposals on facilities. That effort is fairly qualitative in nature but broad in coverage of existing port and intermodal facilities.

A need exists for a rigorous conceptual and mathematical model to detail specific impacts on efficiency and effectiveness, and ultimately viability, of existing and proposed intermodal centers. The focus of this project is to do exactly that, to the degree the project is successful. Data needs and availability will have been identified from the current study and the model applicability will use those data and data sources.

Other related studies are currently underway, but they do not focus on a model to determine impacts. The United States Department of Transportation, The Port of Benton, and the Hanford Investment Study have already been accomplished. The current project is looking at and studying the Stark County facility, the Port of Moses Lake/Port of Wenatchee, and the Northwest Container of Pasco, Moses Lake and Vancouver. The research findings of these studies will provide data and relationships among modes that will be very useful to this proposed project.

Technology Transfer Activities

The initial output of this research effort will be a report describing the model that was developed, its applicability and the results of the case studies chosen for the analysis. The report will be publicly available (PDF file format) on the TransNow home page, the WSDOT/TEP, the WSU/SFTA websites, as well as in printed form from the TransNow Center. Second, because the

research team will be working closely with WSDOT planning and policy personnel, as well as a Regional Administrator of the Department, as the research proceeds, some degree of results dissemination and implementation will be constantly forthcoming. Third, research results will be produced and presented to appropriate bodies and decision-makers, as decided in collaboration with TransNow and WSDOT personnel. Fourth, these principal investigators have a proven record of scholarly publications. Papers and presentations at regional and national transportation or economic conferences (PNWREC, TRB, TRF, AASHTO, etc.) and scholarly publications in journal are expected, given the unique scope of this research effort. Fifth, seminars within the Universities of TransNow are expected as well as faculty conferences in those and other academic outlets.

Potential Benefits of the Project
This project will have provided and described an applied methodology and analytical model to determine the impacts of alternative changes in intermodal/port operations and infrastructure. This will allow state, regional and local agencies to use the applied methodology as an initial screen to determine what priority should be given to what project and just what the relative benefits of such changes are. More benefits for shrinking public investment dollars will be realized. Such a tool will provide an unbiased framework for identifying public and private benefits of alternative changes, including shipper costs, road damage, intermodal facility volumes and composition, and even reduce congestion. Such information provided by this more rigorous methodology will provide a common basis for the development of public/private partnerships, if such arrangements are feasible and viable.

Decision makers at all levels should find this tool and methodology useful in their deliberations, whether it be a county commission, a regional planning authority or the state legislature itself. Since the literature on the specific impacts of changes in intermodal/port facilities is very sparse, this analysis and methodology contribution from the state of Washington would be a major contribution to the very general literature that does exist.

TRB Keywords
intermodal, port, infrastructure, model and planning