

CHAPTER 16: NEW AND DEVELOPING TECHNOLOGIES

As this project has progressed, the study team members have expressed significant interest in investigating additional technologies for the prototype maintenance vehicles during the course of the study. The following examples illustrate the variety of opportunities for enhancing the technological capabilities of the vehicles, some of which may be implemented during Phase III.

TECHNOLOGIES CONSIDERED FOR PHASE III

Differential GPS

To determine vehicle location, the 1997-1998 prototype vehicles used conventional GPS, which has a potential range of error of 100 to 300 feet. Differential GPS (DGPS) offers much higher accuracy, with a potential range of error of only 2 to 5 meters. Real-time DGPS reports would provide highly accurate location information for the maintenance vehicles, which is especially important for identifying specific locations along the highway that require custom treatments (bridge approaches, culverts, etc). The existing onboard computers provided by Rockwell International already have DGPS receivers installed, and during Phase III DGPS will be used to determine vehicle location.

Chemical Sensor

A chemical sensor may be added to the prototype vehicles. The sensor would function like the chemical dilution sensor in RWIS, measuring the electrical conductivity between two points on the roadway and using the conductivity to estimate the amount of chemical present on the roadway surface. With such a sensor on their maintenance vehicles, operators would know the amount of chemical remaining on the roadway since the last maintenance pass, allowing them to make better-informed decisions about applying additional chemicals and abrasives.

Data Averaging

During Phase II, the PlowMaster recorded data concerning pavement temperature, air temperature, friction values, etc., as the respective sensors collected these data. In future phases, to improve the detection of trends and to remove unnatural “noise” from the data, some data may need to be averaged or smoothed. Specifications concerning how much averaging to perform and when to perform it need to be developed by the study team and CTRE.

Mapping Packages

During Phase II, data downloaded from the prototype vehicle were displayed in tabular, or spreadsheet, format. The study team desires to display data in graphic, or map, format for easier interpretation, eventually providing a “point and click” user interface. With such an interface, users can click on a point on the map and obtain a display of sensor output information

associated with that point on the road. Several computerized commercial mapping packages are available and are being evaluated for implementation during Phase III.

Cellular Telephone Communications Link

During Phase II, friction sensor outputs, pavement and air temperature sensor outputs, and GPS stamps were recorded on each prototype vehicle's PlowMaster and delivered to CTRE on PCMCIA cards. Although the cards transmit data satisfactorily, the study team is interested in pursuing avenues for providing "real-time" data to centralized locations to facilitate the decision-making process. CTRE is investigating two possible means for real-time data transmission, including cellular communications and radio communications.

Cellular communication is being used for data transfer in other applications, and its application on the prototype vehicles would be a step toward using a DOT radio system for data transmission (see the discussion of radio communications below). Cost is the biggest concern about using cellular connections on large-scale applications. Most of the expense involved in cellular communications is in the connect time (20-40 seconds) and disconnect time (20 seconds). Since cellular charges are billed in "round minutes," there is an incentive to keep the minutes to a minimum by having fewer call-ups. Fewer call-ups reduces the real-time value of data transmitted. However, for systems evaluation in Phase III on the three prototype vehicles, cellular communications links will be affordable and the real-time data transmissions adequate.

Each central office will be connected to and will forward data to a network server via a leased telephone line. Because other technologies may eventually be used to collect and transmit other data from the maintenance vehicles (see Chapter 17 on integrating additional data with DOT management systems), a special querying software application will be selected to query the resulting network database of outputs collected from many base stations. From the network server, weather data will be linked to the RWIS communication system for relay to weather forecasters; other data would eventually be linked to other management systems as appropriate.

TECHNOLOGIES BEING CONSIDERED BEYOND PHASE III

Radio Communications Link

Radio communications is less expensive than cellular for large-scale applications of real-time data transmission. Rockwell International has developed radio communications technology that can easily be adapted for use with the prototype maintenance vehicles. Each vehicle would have a radio receiver/ transmitter to transmit data to a base or repeater site. Ideally, the radio communications would be interfaced or "piggybacked" with the DOT's existing radio links and communications system but would remain separate in the event of radio communications system failure.

A frequency range of 800 to 900 megahertz (MHz) is recommended because of overpopulation on lower-end frequencies. Rockwell's chip technology would be used to transmit data, which presently are transmitted at around 4,800 baud.

Each maintenance vehicle would transmit data in real-time via radio to a base station, which may be located at a DOT maintenance garage. In the event the maintenance vehicle is out of range of a base station, sensor outputs would be stored until the maintenance vehicle is within range, then transmitted via a data “burst.” The number of base stations required in each state for statewide real-time communications would be determined using modeling software at Rockwell. Statewide radio coverage in Iowa, for example, would probably require six or seven base stations.

As with cellular communications between maintenance vehicles and base stations, each base station would be connected to a network server that would collect data from all base stations for query and use with various management systems.

A radio transmitter and receiver presently costs about \$500 to \$800 per vehicle, depending on desired transmission frequencies and radio communications features. Each radio base repeater unit costs about \$6,000 to \$8,000, and the computer to interface with the repeater costs about \$3,000. Thus each repeater installation would cost around \$10,000, for a total of \$60,000 to \$70,000 for six or seven repeater stations in the state of Iowa.

Collision Avoidance System

When winter maintenance vehicles are on the road, weather and driving conditions are often less than ideal. Blowing snow and heavy fog can reduce visibility to near zero, making stopped or stalled cars in or along the roadway a danger for maintenance equipment operators. To reduce maintenance vehicle collisions with stalled vehicles and other obstacles that might be in the roadway, CTRE suggests including a collision avoidance system on the prototype maintenance vehicles.

By incorporating a geographical information systems (GIS) based inventory of DPGS-established locations of guardrails, bridges, roadway medians, and other roadside features, the collision avoidance system could also help reduce maintenance vehicle collisions with these features. The system would alert drivers when they get dangerously close to a roadside feature and, eventually, display roadside features on the in-cab monitor as the vehicle travels down the roadway.

Additional Weather Data

Researchers in the FORETELL and FORETELL PLUS weather research project are interested in obtaining fine-scale weather observations for use in mesoscale weather forecasting models with FORETELL and the National Weather Service. The prototype maintenance vehicles may be a part of this fine-scale network of weather information. FORETELL researchers are interested in the pavement and temperature data already provided by the prototype vehicles and in relative humidity and wind speed and direction information that could be provided through additional add-on technologies.

If the study team directs it to do so, CTRE will pursue the possibility of placing relative humidity and wind speed and direction sensors on the prototype vehicles. Due to the movement of the vehicles, however, collecting wind speed and direction data may be a challenge. These

instruments may require input data about the truck's speed and heading to compensate for the movement of the truck.