CHAPTER 3: PROOF OF CONCEPT

The primary objective of Phase II was to conduct "proof of concept." Proof of concept is simply a process that proves that an idea, or concept, is possible. The concept of this study is that advanced technologies, developed for other applications, can be adapted for use on snowplow vehicles to improve maintenance operations for operators and managers. The study team required proof of this basic concept before proceeding with full-scale field evaluation of the prototype vehicles in Phase III.

Proof of concept for the add-on technologies was conducted at two levels, installation and performance. Proof of concept for each add-on technology answered these questions:

- Can the technology be securely and relatively conveniently installed and operated on a winter maintenance vehicle?
- Once installed, does the technology perform as expected?

INSTALLATION

Installing some of the technologies on the prototype vehicles was straightforward. Installation of the high-intensity lights, for example, required little special fabrication. The lights proved sturdy and easily accessible for installation and maintenance.

Installation of other technologies, however, was more challenging. As described in Chapter 8, Minnesota and Iowa experimented with installing the ROAR friction meter in different locations. Iowa's installation resulted in interference with the underbody blade; Minnesota's installation resulted in excessive whipping and bouncing of the ROAR friction meter and subjection to salt and sand from the spreader. The ROAR friction meters on both prototype vehicles didn't stand up well to bumps and potholes and required special heavy-duty shock absorbers and other significant retrofitting. The ROAR friction meter would not fit on Michigan's prototype vehicle; the Michigan DOT installed it on a separate pick-up class truck.

Even these significant installation problems, however, did not disprove the concept of incorporating a friction meter on the prototype vehicles. Rather, they provided the impetus for Roadware Corporation to develop a newer, smaller, lighter, more rugged, and less expensive friction meter—the SALTAR, which is expected to be ready for installation and field evaluation in Phase III.

Installation procedures—including difficulties and successes—are discussed in detail in Chapters 5 through 11. The friction meter provided the greatest installation challenge of all the add-on technologies and in fact was not installed on Michigan's prototype vehicle. In general, however, as described in Chapters 5 through 11, Phase II activities proved the feasibility of incorporating and operating all the desired technologies on winter maintenance vehicles.

PERFORMANCE

Installing and operating the new technologies, however, is only half the proof. Once the technologies were on the vehicles, they had to perform as desired and expected. Again, determining that some of the add-on technologies worked as expected was fairly straightforward. For example, the backup sensors were observed to automatically apply the vehicle's brakes if the vehicles approached an object too closely while backing up, as expected. The PlowMaster display showed plow positions, temperature measurements, and other data collected from other onboard technologies, as expected.

Again, however, proving that some add-on technologies were performing as expected was more challenging. Primarily, these technologies included those that measured environmental conditions: the air/pavement temperature sensors, the friction meter, and the onboard global positioning system (GPS). To prove that these technologies were performing as expected or desired, it was not sufficient to determine that these technologies were collecting data; it was important to determine that they were collecting reasonable data.

For proof of concept, CTRE compared data collected by add-on technologies to known data to confirm that the data from the vehicle technologies were reasonable. For example, latitude and longitude data from the onboard GPS were translated to milepost locations and compared to known milepost and latitude/longitude data provided by the Iowa DOT (see Chapter 13). Data collected by the friction meters were graphed and the slopes compared to data collected by ASTM E-274 friction measuring devices (see Chapter 8). Air and pavement temperatures recorded by the temperature sensors were compared to temperature data provided by RWIS (see Chapter 9).

Performance of the various technologies—successes and difficulties—is discussed in detail in Chapters 5 through 11. Collecting enough winter-related data from vehicle sensors to compare to known data was a significant challenge, given the mildness of the 1997-1998 winter and CTRE's limited control over prototype vehicle operators' activities. Generally, however, as described in Chapters 5 through 11, Phase II proved that the add-on technologies could perform as expected during winter maintenance operations.

PROOF OF CONCEPT SUMMARIES

Table 3-1 lists the technologies installed on the prototype vehicles, the results of proof of concept for each technology, and suggested modifications. Proof of concept of real-time communications was not conducted during Phase II.

Table 3-1 Proof of concept results

Function and Chapter	Subsystem	Passed Proof of Concept	Modification for Phase III
Measure Pavement Surface Condition (8)	Friction Meter	Yes	Newer model
Measure Ambient Conditions (9)	Air and Pavement Temperature	Yes	None
Automatic Vehicle Location (7)	Global Positioning System	Yes	Implement DGPS
Improve Engine Performance (10)	Power Booster	Yes	None
Apply Various Materials (5)	Materials Applicators	Yes	Coordinate material applications with roadway conditions
Improve Vehicle Visibility (11)	Fiber Optic Lights	Not conducted	None
Rear Obstacle Alarm (12)	Backup Sensors	Not conducted	None
Data Processing (6)	Onboard Computer	Yes	Format data for reports
Data Communications (Real Time)	Data Communications	Not conducted	Provide communication linkage to garages