

CHAPTER 2: PHASE I SUMMARY

The objectives of Phase I were to identify the desired functionality of winter maintenance vehicles and enlist private sector partners to join the consortium. Work began with a review of literature related to winter highway maintenance activities.

LITERATURE SEARCH

The goal of the literature search was to identify subject materials related to state-of-the-art technologies and research results regarding snow and ice removal. The search was carefully organized and documented to facilitate ease of both presentation and retrieval of materials.

The search discovered several research activities in progress and many documents describing completed projects. The more important references are described in Table 2-1. The study team was interested in focusing on successful ventures and determining their potential application for this study. Many of the sources found were used to focus the scope of the project in the early stages, when direction for the study was being established. The least documented subject was economic evaluations of technology applications by either public or private entities.

The greatest value derived from the literature search was the identification of technologies already developed for applications other than highway maintenance that held promise for implementation on the concept highway maintenance vehicle.

Table 2-1 Selected literature

Ref. No.	Source	Subject
1	Roads and Bridges	International study tour sponsored by the FHWA brings both easy and complex solutions to domestic snow control problems.
2	NCHRP Research Results Digest	An NCHRP digest of the findings and recommendations of an international winter maintenance scanning tour conducted under the auspices of the FHWA's international programs and NCHRP Project 20-36, Highway Research and Technology - International Information Sharing.
10	TRB Maintenance Management Conference Proceedings 5	Automating maintenance scheduling and reporting including voice recognition software, pen based computers, bar-code scanners, and communication technologies.
25	Michigan Technology University	Explores new techniques of disbonding ice including pavement surface compositions, electromagnetic radiation, air and liquid jets, and acoustics waves.

TABLE 2-1 Selected literature (continued)

Ref. No.	Source	Subject
29	Washington DC University Trans. Centers	Enhance the value of data received by the maintenance foreman for making decisions regarding winter highway maintenance using a microcomputer-based decision support system (DSS).
32	WELS Research Corp.	Development of user-friendly, artificial intelligence-supported weather prediction software. Seeks to integrate historical and current local weather information.
47	Better Roads	A discussion of salting and anti-icing techniques including temperature-measuring devices attached to moving vehicles.
209	Better Roads	Cost reductions resulting from the Wisconsin Winter Weather System (WWWS) which allows for less use of salt by delaying applications until they are required for deicing activities.
233	South Dakota DOT	Snowplow light visibility and snow cloud reduction by using a variable angle snowplow.
242	Scranton Gillette Communications, Inc.	This report looks into how snow removal has moved from the mode of snow removal to that of prediction and prevention. There have been new developments in chemicals, equipment, and techniques, many of which are described.
247	Bundesministerium fur Wirtschaftliche Angelegenheiten	New snowplow configurations that are hydraulically controlled for quick connect and disconnect features.
317	Stadden-K	This article discusses nationwide mobile messaging systems for trucking fleets. Mobile communications in trucks make drivers' lives easier, impress customers, and improve management efficiency.
342	Bristol Company	A press release for the SYN/CON FPS-1000-M Road Sensor that is truck mounted and displays the temperature of the liquid on the road and the freezing temperature of materials.
343	Traffic Technology International	An international review of road condition sensors, visibility sensors, thermal mapping, route optimization, pavement sensors, and variable message signs.
344	Traffic Technology International, Autumn 95	Pre-salting is effective where there is access to highly accurate road weather forecasts.
354	MNDOT	This paper discusses how reductions in roadway departure accidents can be achieved by integrating emerging sensing and control technologies into guidance control systems.
361	Finnish National Road Administration	This paper describes the principles of winter maintenance quality and road standards that the FinnRA has established.
363	Commonwealth of Pennsylvania, DOT	Field test performed in Pennsylvania of Tyler Ice's zero velocity spreader. Material savings and increased performance were documented.

DESIRED VEHICLE FUNCTIONALITY

A critical step in the early stages of this study was to develop and prioritize the desired winter maintenance vehicle functionality.

Process

The process used to identify and prioritize the functionality was similar to a one used by private industry to develop new products. The process, which focuses on the needs of the end users (and which is described thoroughly by L. P. Sullivan in the June 1986 issue of *Quality Progress*), is called Quality Function Development (QFD). QFD requires defining the customers' desires, or "the voice of the customer." Once the customers' expectations have been defined, a prototype model is assembled, tested, evaluated, and modified to meet the customers' needs before production of the first manufactured models begins. By applying the QFD process, CTRE was able to identify the desired vehicle functionality using focus groups, affinity diagrams, and relations diagrams. For this project, the consumers are the people who work with maintenance vehicles as a part of their everyday jobs: maintenance equipment operators, mechanics, and maintenance supervisors. See Figure 2-1 for the three-step process CTRE utilized to capture the "voice of the customer."

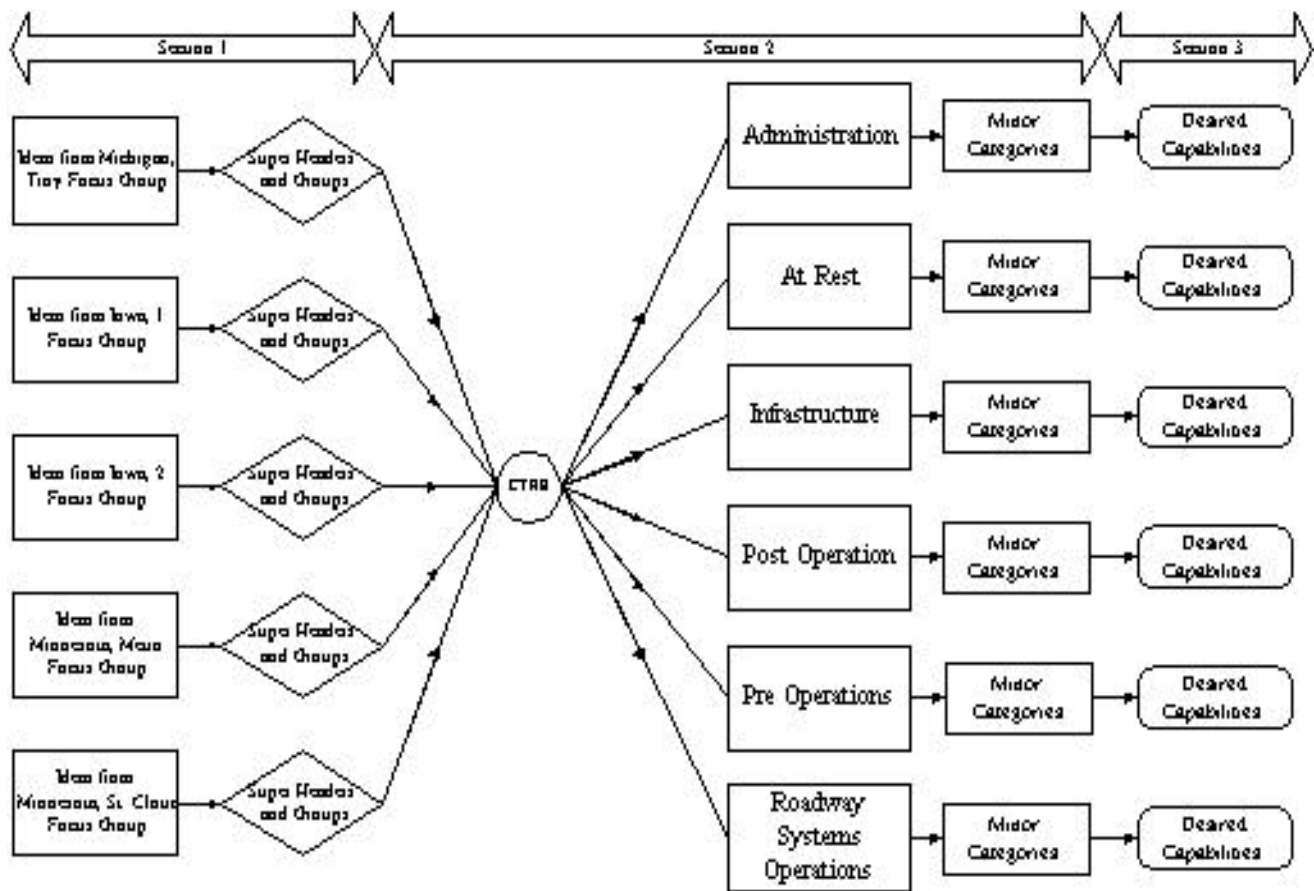


Figure 2-1 Three-step process flowchart

Focus Groups

To capture the “voice of the customer,” CTRE conducted a total of five focus group activities in the three consortium states in the fall of 1995. The groups consisted of DOT equipment operators, mechanics, equipment specification writers, maintenance managers, and maintenance supervisors. In addition, representatives from other professions with an interest in winter highway maintenance activities, such as law enforcement personnel and emergency responders, participated.

Ideas generated by the focus groups were recorded in a format called an affinity diagram. After all ideas were generated, they were grouped into logical categories and labeled by the participants. A relations diagram was then used to determine relationships between categories. A relations diagram looks at cause and effect between categories and quantifies which of the categories exerts an influence on others, and which categories are influenced by others. Actions are most effective if they derive from categories that exert the most influence on other categories.

The relations diagram is an effective prioritizing tool. With a relations diagram, functions that exert the most influence are most effective and therefore have the highest priority for implementation. Using effectiveness as the criterion, then, all of the focus groups identified driver safety and snowplowing functions as the highest priorities. As a result of these activities, each partner state’s DOT developed a prioritized list and a detailed description of the desired concept vehicle functionality.

Generally, the prioritized lists included the following functions:

1. Record and download vehicle activities.
2. Sense roadway friction conditions.
3. Sense roadway surface and air temperatures.
4. Improve fuel economy.
5. Carry multiple types of materials.
6. Distribute multiple types of materials.
7. Provide adequate horsepower for the vehicle.
8. Provide removable salt/salt brine dispensing system.
9. Sense obstacles behind the vehicle utilizing backing sensors/monitors.

PRIVATE SECTOR PARTNERS

To generate private sector interest and participation in the project, the study committee invited a large number of companies from various industries involved in snow and ice control to attend a workshop in Detroit, Michigan, in April 1996. Forty-nine industry representatives attended. The workshop began with an overview of the progress to date and a presentation of the results of the focus group activities. Then attendees participated in one of three discussion sessions—vehicle manufacturers, communication/technology providers, and equipment vendors—to define the technologies available for prototype evaluation in the participating states.

The workshop provided the consortium DOT maintenance engineers and research engineers an opportunity to meet with equipment providers and discuss the potential for advanced technologies on highway maintenance vehicles. The discussion sessions allowed private sector attendees to provide direction to the consortium DOTs. Furthermore, the technology and equipment providers were enticed by the opportunity to hear what the DOT equipment operators defined as improved vehicle and equipment capabilities, or functionality.

At the conclusion of the workshop, representatives from private organizations were given “partnership interest” forms asking them to indicate the level of participation that they could supply in terms of time, equipment, technology, and funding. Responding private sector partners were assigned to one of the state teams according to the technology and equipment they could provide, their geographical proximity, and their familiarity with each state’s DOT. Figure 2-2 shows the 10 initial private sector partners grouped into state teams following receipt of partnership interest forms after the Detroit workshop.

Additional companies expressed interest in the project after the initial private sector assignments were made. These companies were asked to complete partnership interest forms, updated on the progress of the project, and invited to attend the next project workshop. Completing this step in the study assured the valuable backing of a variety of private sector partners.



Figure 2-2 Initial prototype teams for winter 1996-1997

DETERMINING ACTUAL VEHICLE FUNCTIONALITY

In cooperation with private sector partners, the state DOT partners collaborated to define the systems, subsystems, and budget for the initial prototype vehicles—one in each state—to be developed. These decisions were based on the functionalities identified in the focus groups and

the technologies available from participating vendors. Discussion and consensus-building during a July 1996 meeting in St. Paul, Minnesota, and subsequent conference calls assured participating private sector partners that the concept maintenance vehicle was worth the investment and convinced all partners to proceed with assembly of the prototype vehicles. At this point, the consortium members knew the equipment that would be on the vehicles, the technology that would be implemented, the funding available, and the extent of participation from private sector partners

PRODUCTION TIMELINES

An objective of the St. Paul meeting was to establish a reasonable timeline for assembly of the three prototype vehicles. Consideration was given to existing production schedules and commitments of manufacturers who were contributing resources to the project. For many of the technology providers, the time frame for planning and assembling the vehicles was their busiest time of the year. Private sector partners provided direction about product availability and valuable insight into industry practices and the commitments that could be formalized. The first prototype vehicles were scheduled to be fitted with new technology and equipment and ready for use by November 1996. The state DOTs were to make the vehicles available in August 1996.

PRODUCTION TEAM AND LOCATION

The production elements, associated costs, desired technology, and production timelines had been defined at this point. The consortium then designated two production teams for assembly of the vehicles. Iowa and Michigan were scheduled to have their plows and spreaders installed on their prototype vehicles at Monroe Trucking in Monroe, Wisconsin. Minnesota planned to have its assembly done at Tyler Ice in Benson, Minnesota, with whom it had cooperated on previous research projects. The steering committee conducted project meetings at each location and toured each of the facilities. Both Monroe Trucking and Tyler Ice were fully equipped to accomplish the equipment assembly and to overcome the unpredictability of installing prototype equipment.

TECHNICAL REPORT

A technical report was not written to document the feasibility of developing the prototype vehicles. Because the study team members (including private sector partners as they were added to the consortium) worked together during the entire process, they had continuous reassurance that selected technology elements could be provided and had been successfully proven in other applications. The time to assemble the vehicles for the winter of 1996-1997 was very short. Considering the coordination and assembly time required, the study team committed all its time to the assembly task. In later phases of the study, as technology applications were considered for winter 1997-1998 prototype vehicles, more emphasis was placed on assisting the needs of the vehicle operators. It would be important in Phase II that the feasibility of the vehicle and additional technology applications be carefully documented and the relationship of this project with the state DOTs' business plans be established before moving into Phase III prototype vehicle evaluation or Phase IV fleet evaluation in each of the participating states.

SUMMARY

Phase I began with a literature review of materials related to winter highway maintenance activities, including state-of-the-art equipment, technologies, and research related to winter highway maintenance activities.

By utilizing focus group activities in each state, the desired functionality of a winter maintenance vehicle was identified. Approximately 600 ideas were combined and organized into five categories, and a prioritized list of functions was developed.

Private sector equipment and technology providers were asked to join the project. Several private partners committed to providing equipment and expertise for Phase II, which included producing three prototype vehicles for the winter of 1996-1997 and conducting proof of concept during the winter of 1997-1998.

The specific equipment and technology to be included on the three prototype vehicles for the winter of 1996-1997 was determined in cooperation with the three DOTs and the private sector partners. Phase I concluded by establishing that assembling the three prototype vehicles would be beneficial to the project and the three state DOTs, and it was agreed to proceed to Phase II: assembly and proof of concept. Figure 2-3 shows the private sector participants' contributions to the prototype vehicles as modified for proof of concept.

A complete discussion of Phase I can be found in the report, Concept Highway Maintenance Vehicle, Final Report Phase One, dated April 1997.

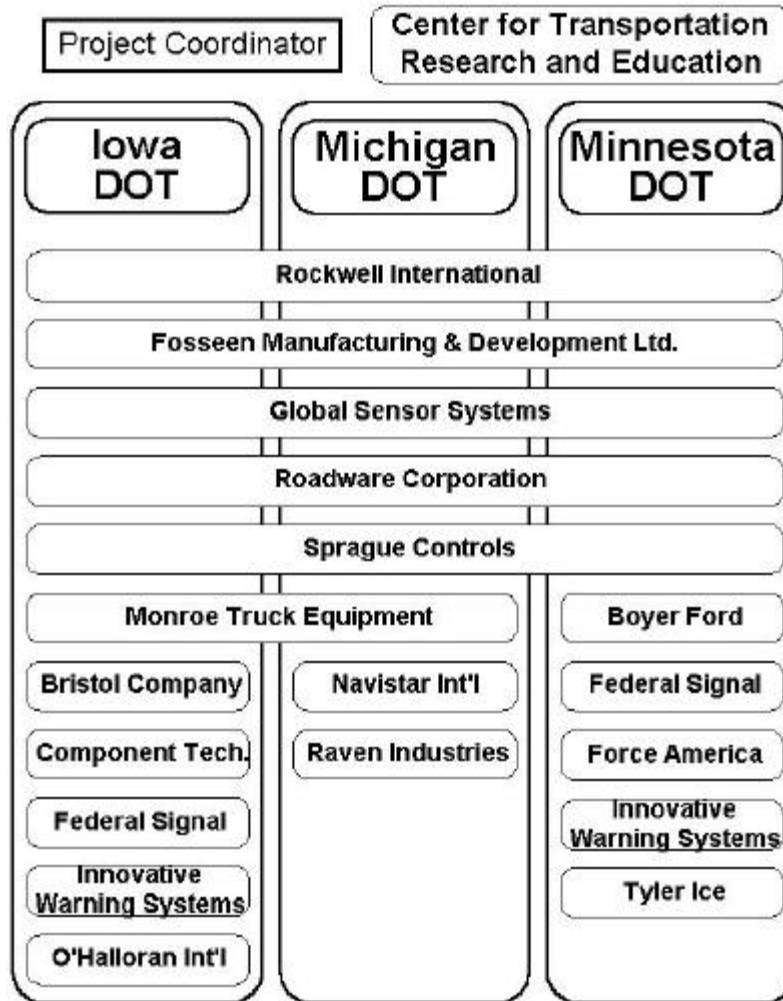


Figure 2-3 Relationship of the private sector participants to each concept vehicle at the end of Phase I