

Snow plowing goes high tech



A LOT OF SNOW PLOW OPERATORS are talking to themselves these days—because they're all alone in the cab. With tight staffing budgets in many local transportation agencies, an increasing number of operators drive solo. And, as anyone who has done it knows, singlehandedly maneuvering a 25-ton truck and all its ancillary equipment in a snowstorm on snow-packed or ice-slicked roads is challenging, to say the least.

One way to ease the burden on operators while helping them work more efficiently and safely is to modify the snow plow truck itself. Last year the Iowa, Michigan, and Minnesota state departments of transportation sat down with people who operate and maintain snow plow trucks and asked them what would make their work easier and more effective. Then, based on the recommendations they heard, the DOTs embarked on a project to design, assemble, and test an advanced-technology highway maintenance vehicle.

Innovative approaches in design, construction, and even public and private collaboration have made this project one that promises significant benefits for road maintenance programs and their operators.

Special technologies

For the prototype vehicle, each of the three DOTs provided a new, 25-ton snow plow truck equipped with underbody blade, front and wing plows, box for salt/sand, and state-of-the-art material application systems. Then the project team added some off-the-shelf technologies. A friction meter from Norway was added under the box and special temperature sensors from Oregon attached to the driver-side rearview mirror. These instruments collect detailed information about the roadway's friction and the air and pavement temperatures. On-board global positioning systems (GPS) equipment from Iowa was installed on the back of the cab to collect position data.

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public input into system planning and programming." Often, public feedback adds a practicality to the technicality of transportation engineering.

Some World Wide Web sites devoted to ISTEA include:

- The U.S. Department of Transportation's page at <http://www.dot.gov/ost/govtaffairs/istea/>
- The Federal Highway Administration's page at <http://www.fhwa.dot.gov/reauthorization>
- The Congressional Record of the bill's proceedings at <http://thomas.loc.gov/home/r105query.html>

In addition, the Office of the Assistant Secretary for Policy can be contacted c/o Elizabeth Parker, Office of the Secretary, U.S. Department of Transportation, Washington, DC 20590. ■



It started as a wish list: the advanced technology maintenance vehicle. Photo courtesy of the Iowa DOT.

For this first phase of the project these data are relayed to the truck operator, via an on-board computer. This real-time information will take much of the guesswork out of operators' road maintenance decisions. In later phases the truck computer will automatically fine-tune the application of sand, salt brine, and chemicals according to the current road and weather conditions. Eventually the data collected by the on-board technologies will be relayed to the truck's base station, allowing agencies to respond quickly to weather changes, stranded vehicles, and other emergencies. When all the technology is in place, the real-time road condition data may also be made available to the public so travelers can make informed decisions about changing routes or postponing trips.

High-tech safety features have also been added to the prototype vehicles. Heavy, slow-moving snow plow trucks themselves can present a hazard to motorists in a snowstorm, but each prototype truck is specially equipped to reduce the danger.

High intensity, fiber optic warning lights, distributed in Iowa and installed above the cab, will penetrate a greater distance in blowing snow and fog. A unique engine power booster using an alcohol-based fuel system, manufactured in Iowa and tucked into free space behind the truck cab, will give the truck extra horsepower for accelerating quickly into traffic, reducing the need for motorists to brake on slippery roads. A 900-gallon brine tank (compared to 100 gallons or less on older plows) will allow operators to cover more miles before stopping to reload. And three special sensors, manufactured in Canada, will warn the operator and automatically apply the brakes if the truck is backing up when a car or other object is behind the truck (see photos on page 6).

Designing with the user in mind

A unique aspect of this project has been the active involvement in the vehicle's design of the eventual "consumers"—a bottom-up approach. At five focus group meetings in the three states, snow plow operators, mechanics, and highway maintenance supervisors—the vehicle end users—identified approximately 600

features they would like in the ideal snow plow truck. Participants were encouraged to dream, and their wishes ranged from hovercraft units that don't touch the roadway, to systems for monitoring operators' vital signs, to automatic washing systems to prevent vehicle corrosion.

The features identified at the five meetings were later incorporated into a database and categorized (administrative, pre-operative, post-operative, and at-rest features; features pertaining to infrastructure and roadway systems). Similar features were combined and then prioritized. Then the private sector was called on to provide existing, off-the-shelf technologies—as is or modified for the snow plow truck—that match features the users asked for.

Private sector partners

The involvement of vendors from the private sector was a critical aspect of this project. The contributions of vendors not only made the prototype vehicles possible but also opened avenues for eventual private production of additional vehicles.

To solicit the involvement of private enterprise, over 200 potential partners, including maintenance engineers and research engineers from all the Snowbelt state DOTs, were invited to a workshop in which the project was introduced, progress to date described, and commitments for technology, equipment, and vehicle assembly solicited.

Initially 10 vendors committed to provide technology for the prototype vehicles, and more have since asked to participate. Add-on technologies are being provided by companies in Canada, Norway, and several states, including Iowa.

Testing the power booster

The Iowa prototype truck was tested in Des Moines on June 23 and 24, 1997. The tests focused on the engine power booster and increasing power on demand.

“When we were in the focus groups, one of the things operators said they needed was extra power, but only at certain times,” says Lee Smithson, deputy director of maintenance at the Iowa DOT. “One of the Iowa manufacturers said they could provide that capability through a new type of injector and manifold and with a booster fuel mixture of alcohol and water.”

The prototype truck was placed on a dynamometer and tested at three stages: first without any alteration to the truck, second with the installation of the new supplemental injectors and manifold but using only diesel fuel, and finally with the new parts and the alcohol/water mixture. The tests with the new parts and fuel mixture resulted in not only an

increase in engine horsepower but a drop in the exhaust gas temperature as well.

Smithson says similar testing is anticipated for the other two prototype vehicles. The tests that will show the most significant potential for the trucks, however, will be those conducted on their wheel horsepower. This is power as it is processed throughout a running vehicle, beginning with the engine and concluding at the wheels: the true, useable measure of how a truck moves. It is predicted that wheel horsepower of the specially-equipped trucks will demonstrate a 10 percent increase from a vehicle with a standard injector and fuel system.

“When you apply the gas, you don't expect the vehicle to jump out from under you like a muscle car,” Smithson says. “So measuring the wheel horsepower on the dynamometer is the real test.”

In the winter of 1997–98, the prototype vehicles (with some modifications) will be thoroughly tested and evaluated. Some of the new technologies have never been subjected to the harsh environment of snow and ice removal. One goal of the prototypes is to identify technology or equipment failures caused by the environment and make modifications to ensure future reliability.

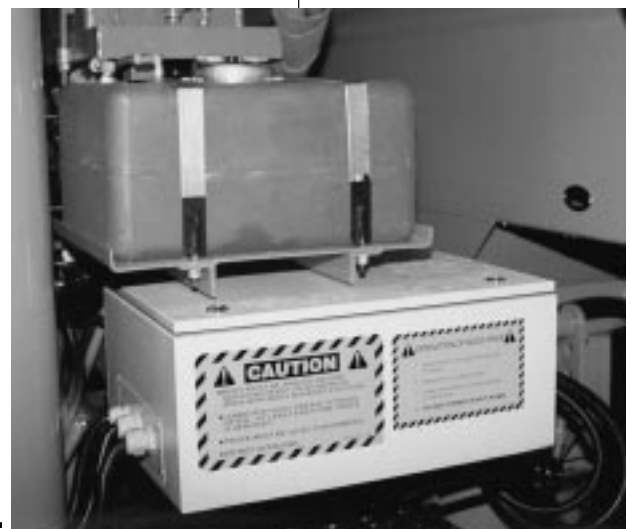
A report covering the testing and evaluation of the prototype vehicles will be issued in 1998.

Bottom line

The initial design phase of the project was funded by the three state DOTs, and the project partners are securing funds for the second phase of the project: developing, testing, and evaluating the prototype vehicles. A lump sum has been secured from the Federal Highway Administration's regional and national Priority Technology Program; the balance will be covered under a pooled-fund study. Invitations to participate in the pooled-fund study are being forwarded to all Snowbelt DOTs this year.

For more information about the project, contact Duane Smith, CTRE's associate director of outreach, 515-294-8103 (e-mail: desmith@iastate.edu). ■

The engine power booster and alternative tank automatically introduces a water/alcohol lubricant blend fuel additive into the engine injectors for extra horsepower when needed.
Photo courtesy the Iowa DOT.





high intensity warning lights
Tri-State Signing
Ontario, Canada



reverse obstacle sensors
Global Sensor Systems
Ontario Canada



global positioning system
Rockwell International
Cedar Rapids, Iowa



high-intensity warning lights
Tri-State Signing
New Hampton, Iowa

Iowa's prototype truck
O'Halloran International Inc.,
Des Moines, Iowa (truck vendor);
Bristol Company, Broomfield,
Colorado (material applicator)
Photos courtesy the Iowa DOT.



pavement friction measuring device
Roadware Corporation
Ontario Canada
and
Norsemeter Company
Rud, Norway



air/pavement temperature
sensor
Sprague Company
Canby, Oregon



engine power booster
and alternative tank
Fosseen Manufacturing
Radcliffe, Iowa