SNOW PLOW TRUCKS - SPECIFICATIONS FOR THE TWENTY-FIRST CENTURY

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ABSTRACT

As the world of highway maintenance moves though the 1990's to the year 2000, the way highway and transportation agencies conduct business will continue to change at a rapid pace. Contracting of many functions, increased dependence on part time and hourly workers, and changing methods of performing critical maintenance functions will impact on the specification and purchase of vehicles and equipment handled by fleet managers. Nothing better exhibits this changing environment than the work horse of every snow belt state, the snow plow truck.

"More with Less" is the battle cry of the public sector. Every corner of the public sector hears and feels the growing demand from the public for better and more efficient services. Shrinking budgets demand better management and innovative approaches. Reducing full time staff cuts costs, but also often reduces the overall skill level of the work force. To counteract, managers are turning increasingly to the application of new technologies for greater efficiency, longevity and safety. This paper explores the past, present and future application of new technology to the public service of snow and ice control, and the equipment used to accomplish the task.

INTRODUCTION

Only with the coming of the industrial revolution and the mechanical mobilization of man has snow fall become an unacceptable hindrance to the general population. Even today snow is accepted in many places in the world as a routine occurrence left in most part to come and go as nature decrees. This is far from the case in the populated snow belt areas of the United States. The railroads were the first to find that snow fall handicapped their ability to remain on schedule. As such they were the first to use mechanized devices, plows and then blowers, to displace snow from the tracks.

Streets in large cities soon became the next target for mechanized snow removal. While men with shovels and horses with wagons had been used to clear streets and sidewalks after large accumulations for years, the arrival of the automobile and the motor truck demanded a more efficient clearing of snow. The snow plow truck was born in the early 1920's out of need and mechanical application of the tools of the day. Soon public officials discovered the cost to commerce and to public safety when snow storms crippled movement on the streets of the cities and the highways connecting the cities for extended periods. By the 1950's snow removal, keeping roads and streets always passable, become a public service with high priority. As the service got better, the expectation, in fact the demand, from the public grew.

While public expectations vary by location, frequency of storms and historical level of removal service, it is not at all uncommon for most of the public living in the snow belt to expect to travel during and after the storm as if the snow were not there. Many of today's drivers view snow on the road as "here today gone tomorrow." Anything less is most often seen as a lack of service by the responsible public agency. Public agency accountability is today linked to public expectations through the various news media. The application of the latest technology in the coverage of media events means public agency managers must respond instantly to each inquiry. Major snow storms frequently become major media events. Removing snow appears to most people to be a simple mechanical task. Just push or melt it away. "If I can clear my driveway, why can't the state transportation people clear the roads?" Unfortunately the simple notion has become more complex today and will become more complex in the future.

COMPLEXITY OF THE TOOLS

Pushing, plowing and hauling by application of mechanical technology in the form of a truck or other self propelled piece of equipment has been and remains today the principle method of displacing snow from streets and highways. Primary improvements have come in the prime mover, the truck. Motor trucks of the medium-duty size have and continue to be the base component of what the public calls a "snow plow." Evolutionary improvements in these trucks, from engines to transmissions, from tires to safety devices, have resulted in a better truck for plowing operations. Yet these are largely inherited gains. Few if any

technological improvements in the medium-duty truck are a result of snow plowing needs. The market share for snow plow trucks is too small. Snow plow users generally take what the bigger customer markets demand and make the best of it.

The plowing equipment attached to the truck is only just beginning to change from the early first designs. Plow shapes and sizes have remained essentially the same since the 1930's. Improved fabrication practices have helped improve the reliability and life of the product and the application of hydraulics in the 1950's, to raise and reverse the angle of plows, has made them easier to use. Only recently has consideration been given to plow design research and the application of materials other than traditional fabricated steel.

Early treatment of packed snow or ice consisted of application of abrasive materials, such as sand, slag or ash, to improve tire traction. Use of chemicals in snow and ice control was limited to the treatment of abrasives. Increasing efficiency of snow removal by adding chemicals, principally salt, to supplement and lessen the time required for removal compared with the purely mechanical approach began in the late 1930's. The application of rock salt, first manually, then through modified spreaders adopted from agricultural markets, soon became a basic part of many agencies' snow fighting arsenal.

Like the snowplow, the salt or aggregate spreader evolved quickly in early use only to become stagnate in terms of technological improvement. The two common designs, hopper and under-the-tailgate for dump trucks, became the industry standards. Improvements, for the most part came in drive systems where hydraulics replaced direct mechanical and independent engine systems. In recent years the use of stainless steel in fabrication has become more common to prevent corrosive failure.

Today new materials, such as CMA and liquid deicers, combination systems and new anti-icing technology are creating new demands for chemical application technology in the snow and ice control industry.

An often over looked enhancement in the snow and ice efforts of public agencies in the 1960's was the application of two-way radio communication. With military roots, two-way radio first appeared in the public sector in the law enforcement arena. Later public works and highway maintenance agencies recognized increased labor efficiency and safety by providing remote communications between driver and supervisor. Basic two-way communications systems are common place in most snow and ice programs today. Used to direct operations, gather information and provide a safety link to the driver operating alone in hazardous conditions, the radio is an important if sometimes overlooked tool of the trade. It is in this area, radio frequency (RF) communications, where the future technologies hold considerable promise for the public agency goals for increased efficiency and "more with less."

The 1970's saw the first application of electronic devices other than two-way radio in the snow and ice arena. The growing demand for clear streets and highways prompted increasing use of salt as a deicer. Simultaneously the environmental impacts of chemical usage were creating a heightened level of public concern. For many agencies dealing effectively with the environmental issues of deicing salt meant improving mechanical control systems to lower cost by applying only what was needed when it was needed. Again drawing from the agricultural market, the automated spreader control was born. The device that monitored the truck speed and adjusted material flow rates proportionally removed a routine task and decision from the driver. A secondary benefit occurred when reducing salt usage helped to reduce the overall cost of services. New computer-based versions improve the reliability and accuracy of the controller and offer the added feature of collecting "management" information as the task is performed.

TRUCK CHASSIS TECHNOLOGICAL ADVANCEMENTS

Future Vehicle Design Considerations in "Medium Duty" Trucks

The sale of medium duty trucks (class 5, 6 and 7) is a highly cost competitive market. From the public sector perspective of efficiently purchasing trucks for snow plow applications, this is good because prices are competitive and reasonable. From an advancement perspective, this high cost sensitivity is bad because new technology lags behind heavy duty "class 8" equipment. From the manufacturers view, the technology must be salable to a highly cost conscious customer who wants a truck for basic functionality without the "bells and whistles." Though slower in the medium duty market, technology is coming. Electronic controls & monitoring systems will soon be standard on medium duty engines as they are on today's over the road rigs. Electronic "computer controlled" systems will permit variable horsepower engines designed to protect components and better match the engine to the task being done. Transmissions such as the Allison MD Series are already using electronic control systems to adjust shift patterns to load

and driving style. Computerized shifting of "manual" transmissions appears a near term reality. ABS braking systems, typical on today's automobiles and quickly gaining acceptance in heavy duty highway trucks, will appear in medium duty trucks in the next year or two. This technology along with traction control systems to automatically direct the right amount of power to the correct drive wheel should greatly increase safety and efficiency in the less than ideal condition of plowing snow.

Medium duty truck manufacturers and truck industry engineers see future emphasis on increasing driver visibility. The ability of the driver to see in all directions under all conditions is recognized as a major contributor to increased safety. For years snow plow operators have struggled with visibility problems caused by under designed heating systems, wiper systems and lighting systems. Today manufacturers are starting to hear these concerns and are researching heated windshields and cowls, modified special wipers for plow trucks, improved cab air intake systems, and improved instrument visibility. Another area of improvement long recognized for increased attention by plow drivers and agency safety managers is the need for improving driver entry and egress. Manufacturers are hearing the need and working to make future trucks safer to enter and exit in all weather conditions.

Of interest to those plowing snow in urban environments, all manufacturers are actively working on increasing maneuverability and creating tighter turning angles. Front axles with 45 degree turn angles should appear on the market soon. Alternative fuels and reducing vehicle waste by the increased use of synthetic lubricants can also be expected in future medium duty truck designs. Increasing truck service life is of interest to the customer in any market. To this end, manufacturers promise future trucks with better component parts, heavier non-reinforced frames and increased corrosion protection. All of which are welcome improvements to the fleet managers working to keep their snow plows running with a shrinking replacement budget.

In all but the rarest of cases today's plow truck looks just like any other truck rolling off the truck assembly line. The bare cab and chassis, sometimes with a few special features, heads for final assembly by an allied equipment supplier and/or the end user agency. It is here where a marriage of many unique and diverse component parts join with the bare truck to create a multi-functional tool for the war against snow and ice.

Snow Plow Advancements

As stated previously, snow plow designs have remained largely unchanged until recent years. A simple mechanical device with a limited market potential, the snow plow has generally been built by regional enterprises with the facilities to cut, bend and fabricate steel. Designs were based on the practical knowledge of the fabricator and the user with little more than trial and error testing of prototypes in the field. Users in various geographic areas determined the designs that worked best for them and developed relationships with suppliers who met their needs. Thus, the plows of New England differ from those in the Midwest that differ from those of the West.

It was not until the recently completed Strategic Highway Research Program (SHRP) efforts were undertaken that any significant engineering study of snow plow design occurred in the United States. This program produced two important projects related to plowing and plow design which combine practical knowledge with scientific techniques to address improved casting, scraping and weight issues to reduce fuel requirements. Yet, these projects just begin to scratch the surface of plow design. Future research needs include refinements in all these areas and matching the plow to the variety of snow conditions found in the different regions of the country.

The construction equipment industry has recognized and adopted modern state-of-the-art load sensing hydraulics for improved efficiency and fuel economy. Today this technology is slowly working its way into the snow plow truck. Though more complex than the old "open center" systems used on plow trucks for years, these systems offer many options for improved driver or automated control thus allowing plows, spreaders, scrapers and dump boxes to operate independently in their most effective pressure and flow ranges. The adoption of pulse width modulated control valves and integral speed sensors in hydraulic motors permit easy integration of electronic computerized control systems for operating systems automatically or at the touch of a driver's finger. Not only are these systems growing in ability and sophistication, they also offer increased reliability in the field.

GENERAL SAFETY ADVANCEMENTS

Always recognized as a critical area of concern, snow plow truck lighting and visibility to vehicles approaching and overtaking the truck continues to evolve. Strobe lighting and other warning light systems continue to be evaluated by industry and users alike. The lack of some motorists concern for conditions and speed during snow storms continues to make the snow plow truck and its driver a slow-moving target for inattentive high speed drivers. While many states have undertaken in-house studies to develop lighting systems, no comprehensive independent scientific study has been made. Most

product changes come from the manufactures whose principal business encompasses all types of public safety vehicles. Users have made changes to date based on trial evaluations and driver comment. Just as "being seen" is important to the snow plow driver, so is the need to see. Improved plowing lights are an important consideration for operations that frequently continue around the clock. SHRP Project H-206 addressed reduction of the "snow cloud" created by the plow as a major visibility benefit of a new plow design. The National Cooperative Highway Research Program (NCHRP) has recently released a request for proposals (RFP) for research on snow plow visibility issues. Vehicle lighting technology has improved in the general automotive area. Constructive research and testing are likely to bring improvements in snow plow lighting in the not to distant future. Only in the last few years have complete three-point seat belts become a part of the medium duty truck. Yet, in the not to distant future, these same vehicles may catch up to the automobile industry with air bags and other collision mitigation devices. SHRP research and testing have even broken ground for truck mounted attenuators (TMA's) for snow plows as a further aid in protecting motorist and plow driver alike.

Electronics - RF Communications Devices

While truck industry sources predict a some what slower application of technology to the medium duty truck market and highway agencies work with various suppliers to adapt new ideas to the mechanics and hydraulics of snow plows and spreaders, the communications environment for the public sector appears poised for rapid changes into the next century. Already private sector trucking firms are adapting and applying state-of-the-art communications to allow data and voice communication between truck and terminal, to pin point the locations of trucks and their contents, and to monitor the operational performance of the various component and systems. What five years ago seemed to many to be "star wars" is today part of the routine of doing business for many parcel and freight carriers worldwide.

IVHS - Smart Cars Meet Smart Plow Trucks

Work continues in several parts of the country on various approaches to the Intelligent Vehicle Highway System/ Intelligent Transportation Systems (IVHS/ITS). Much of this work involves the combination on smart cars with onboard data collection management and information systems communicating via land based or satellite based systems to highway management centers and occasionally other similarly equipped vehicles. While debate continues about how and when the various aspects of IVHS/ITS will become a reality, it is good bet that this technology will exist in some form early in the next century. Some parts, such as automatic vehicle monitoring (AVM) and location monitoring systems (LMS), are already in field use with the freight tracking systems.

Logical application of IVHS/ITS technology in snow plow trucks includes the use of collision-avoidance systems to help prevent snow plow/motorist collisions in poor visibility conditions, the use of snow plow trucks to gather traffic flow/congestion data during storm periods to update travel times, and routings and AVM technology to monitor truck operating systems and unit operating safety.

Global Positioning Systems (GPS)

Many public safety operations are presently installing computer aided dispatch (CAD) facilities to improve communications throughput with fewer personnel. These CAD systems frequently use GPS to monitor and track the location of various fleet vehicles engaged in routine and emergency operations. GPS and CAD systems allow the dispatcher and supervisory personnel in the communications center to track movement and activity in great detail. While some may debate the need for designing the ultimate "war room" for the battle against winter snow storms, these systems will provide unrivaled monitoring of field operations while reducing use of critical radio communication "air time" by sending high speed data instead of voice-based information.

Instantaneous Information Collection

Linking all these tools into a single on-vehicle device is the mobile data terminal (MDT) which today may be more aptly described as the mobile data computer. Quickly and quietly becoming a common tool of the law enforcement community, MDT's are bringing real time on-line access to computer data bases to personnel in the field. They provide a two-way link to send and receive information at anytime and anywhere, either by user interface with the device or automatically by connecting with various data collection devices onboard the vehicle. A MDT equipped snow plow vehicle could provide up to the minute status reports on work status, i.e., miles plowed, deicer or abrasives spread, hours worked, current pavement status, travel speeds, traffic volumes and even current weather conditions. In addition, drivers could monitor all systems and gather information from onboard pavement temperature sensors and, by remote link, connect to weather and pavement monitoring stations. Highway officials

continue to seek better more efficient ways to collect and distribute maintenance management data. *NCHRP Report 361*, "Field Demonstrations of Advanced Data Acquisition Technology for Maintenance Management," reviews many possible applications of GPS, MDT's and hand held computer devices in diverse area as roadway inventory, sign inventory and routine work activity reporting.

Preprogrammed Decision Making

It becomes reasonable to ask: for what practical purpose could this "Desert Storm Technology" be used in the simple task of removing snow and ice from the roadway? The answers are based on the benefit-to-cost comparison of delivering the service the public expects. Efficiency, "leaner and meaner" as some would say, is the ultimate driver of good public service from building roads to clearing the snow. Good snow and ice control programs are based on knowledge, history or experience, and current information. A skilled driver with years of plowing experience supervised by a person with equal or greater skill and experience, and the intuitive ability to predict the weather in any given storm, will have a high likelihood of success given the basic tools and materials of the trade. If all goes well and their decisions are not second guessed by the administration, the public, or the media; the storm will pass; an acceptable pavement condition will be maintained until cleared completely; and the public safety will be maintained.

Yet, as previously discussed, the overall skill levels and experience of public sector employees seem to be on the decline. More emphasis is placed on hiring part-time or hourly drivers. Experience of supervisors is drained as long time employees leave agency service under cost cutting early retirement incentive programs. New management is ever more sensitive to the power of criticism from the media and elected officials. Thus, drivers and first line supervisors of the future are not likely to be left alone to get the job done. Middle and upper managers will want to participate in the process and to be able to respond quickly to any concerns or criticism. To do this effectively will require that both history and current information be available anytime. New technology in snow plow operations will lessen the demand for the driver to decide, permit the delivery of deicing material based on exact conditions, and help coordinate route changes based on status throughout the affected area. In addition, systems can be expected to reduce unproductive operations and improve sequencing of shift changes and material reloading. The data gathered from various systems will promote modeling for future storms, provide documentation for accountability and better decision making, and most importantly increase safety for the plow driver and the motorist.

Driver Skills & Support

Building and maintaining a professional snow removal work team will become even more critical with growing sophistication of trucks and allied equipment. Commercial Drivers Licenses (CDL) have already contributed to minimum standards for professional skill levels. Yet, part-time drivers create potential conflict with the goals of increased driver skill and the demands of economically staffing highway maintenance organizations for the peak and valley demands of snow and ice removal. Given the limitations on training time with part-time staff, keeping the task of operating a snow plow simple and safe for driver and motorist may only be attainable with increased automation. The coming of the electronic age will place increased demands on the service technicians to provide maintenance and repair support, and equal demand on administrators to find and retain the skilled people to support the proliferation of electronic technology.

CONCLUSION

The simple notion of removing snow and ice from the public roadways has grown to be a significant annual public agency effort. The demands continue to grow and the costs continue to keep pace. The Illinois Department of Transportation alone estimates annual snow and ice removal costs at $25 million annually. This represents the single largest highway maintenance cost activity for the Department. Is new technology contributing to the increasing cost? While the simplistic answer could be yes, the increase in the technology used for snow and ice control will be driven not because "it is there," but, because there is a need to meet the demands and expectations of the traveling public. The cost of technology application to snow and ice will be repaid in more effective removal of snow and ice from the pavement and greater public satisfaction with the result.

The application of new technology, be it mechanical or electrical, is an evolutionary process. Not all public agencies will require or demand new technology at the same time. Will every snow plow truck be the sophisticated smart plow truck described above by the year 2000? Most likely they will not. Will some agencies be using some or all this technology by the year 2000? Yes some, if not several, will. Those fleet managers and specification writers responsible for the fleets of public agencies over the next 10 years will, without doubt, see the technology described here and more as they prepare specifications and purchase the snow plow trucks of the 21st Century.