

Improving Snow Plow Design: Highway Maintenance Concept

Vehicle Phase V

**Prepared for the
Clear Roads Program**

Prepared by



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Improving Snow Plow Design: Highway Maintenance Concept Vehicle Phase V

A Clear Roads Research Project

1. INTRODUCTION

The U.S. economy is highly dependent on an efficient national highway system. More than 200 million cars and trucks use the national highway system and critical parts function at or near their maximum capacity much of the time (OFCM, 2003). Weather events reduce capacity and significantly impact efficiency. Weather is often the catalyst for triggering congestion, particularly for roads operating near capacity.

Weather also plays a critical role in highway safety. In the U.S. each year, approximately 7,000 highway deaths and 800,000 injuries are associated with poor weather related driving conditions. The economic toll of these deaths and injuries is estimated at \$42B per year (Lombardo, 2000). According to the Federal Highway Administration, weather plays a role in about 28% of the total crashes and 19% of the total fatalities.

The public's expectations of clearing winter roadways are high. Meeting the public's expectations is demanding for winter maintenance organizations. To meet these high expectations, this research project is to design a snow removal device that will clear the road surface in one pass, reduce the residue behind the plow, and operate at highway speeds.

The information in this paper is to provide the participating maintenance agencies and transportation officials a summary of improved winter maintenance technologies, identify areas for improvement, and learn about related experiences from other agencies.

2. WINTER MAINTENANCE TECHNOLOGY SUMMARIES

Advanced Snowplow Design

2.1 Driver Assistive Systems for Snowplows

Sponsoring Agency: Minnesota DOT Intelligent Vehicle Initiative

A comprehensive driver assistive system which utilizes dual frequency, carrier phase real time kinematic (RTK) differential global positioning system (DGPS), high accuracy digital geospatial databases, advanced automotive radar, and a driver interface with visual, haptic, and audible components has been used to assist specialty vehicle operators perform their tasks under these low visibility conditions. The system is able to provide a

driver with high fidelity representations of the local geospatial landscape through a custom designed Head Up Display (HUD). Lane boundaries, turn lanes, intersections, mailboxes, and other elements of the geospatial landscape, including those sensed by automotive radar, are projected onto the HUD in the proper perspective. This allows a driver to safely guide his or her vehicle in low to zero visibility conditions in a desired lane while avoiding collisions. Four areas of research are described herein: driver assistive displays, the integration of a geospatial database for improved radar processing, snowplow dynamics for slippery conditions, and a virtual bumper based collision avoidance/gang plowing system. (Gang plowing is the “flying in formation” of snowplows as a means to rapidly clear multilane roads.) Results from this research have vastly improved the performance and reliability of the driver assistive system.

Source: University of Minnesota Department of Mechanical Engineering ITS Institute Intelligent Vehicles Lab Minneapolis, MN <http://www.lrrb.gen.mn.us/PDF/200313.pdf>, 2003

2.2 Advanced Vehicle Control Systems (AVCS) for Maintenance Vehicle Applications

Sponsoring Agency: Federal Highway Administration

Within the context of highway maintenance operations, this study explores opportunities for AVCS-based snow removal and work zone following vehicles. A description of these operations and their particular suitability for the application of AVCS is presented. For airport operations, the feasibility of AVCS-assisted snow removal and baggage movement is considered. Previous and on-going work related to vehicle automation for these operations is introduced, along with recommendations for the future, based on an assessment of technical feasibility of AVCS and the attitudes of the highway and airport maintenance communities towards this technology.

Source: FHWA Report DTFH61-94-C-00131, 1996

Author: Raytheon Systems

2.3 Advanced Snowplow Development and Demonstration: Phase 1: Driver Assistance

Sponsoring Agency: California ACHMT Program, University of California-Davis, California DOT

This final report documents the application of Intelligent Vehicle and Advanced Vehicle Control and Safety Systems (AVCSS) technologies to advance the safety and efficiency of snow removal. The system developed, known as the Advanced Snowplow (ASP), includes lane position indication, and lane departure warning, as well as forward collision warning system. The technology has been integrated onto a Caltrans 10-wheel 10-yard plow and tested through the winters of 1998 – 1999 in the California Advanced Winter

Maintenance Testbed on Interstate 80 near Donner Summit. The system was also tested for two weeks at a similar site on US 180 near Flagstaff, AZ. The report provides an introduction to the problem, an overview of the software, system hardware, a detailed discussion of the human – machine interface, the magnetic sensing system, and collision warning system, preliminary evaluation and finding and conclusions and recommendations for future research.

Source: AHMCT Research Report UCD-99-06-30-03

2.4 Needs Assessment and Cost-Benefits Analysis of the RoadView Advanced Snowplow Technology System

Sponsoring Agency: California Department of Transportation

The goal of this project was to determine the feasibility of implementing Advanced Vehicle Control and Safety Systems to enhance snow removal and to assess the benefits associated with utilizing Intelligent Vehicle technologies on conventional snowplows. The RoadView™ Advanced Snowplow (ASP) technology was developed by the Advanced Highway Maintenance and Construction Technology (AHMCT) Research Center at the University of California-Davis and the University of California-Berkeley's Partners for Advance Transit and Highways (PATH) Center. The system was designed to assist snow plow operators and improve safety and efficiency of snow removal operations. As follow-on research, this evaluation was designed to assess the magnitude of the challenges involved with clearing roadways of snow and ice, and to provide a needs assessment and a discussion of factors that could be utilized in a cost-benefit analysis.

Results indicated that the three methods most used by snowplow operators to maintain their lane position are visual, and that operators have a high perceived usefulness of technology that would assist in detecting obstacles and provide lane position information. The cost-benefit analysis indicated that the RoadView technology would be most beneficial on roadways with highway traffic volumes associated with significant road closures due to winter conditions.

Source: WTI, College of Engineering, Bozeman MT, Report UCD 02-06-30-02
Final Report June 2002 Authors: Eli Cuelho, David Kack Western Transportation Institute

2.5 Snowplow Operations and Resource Management

University of Minnesota-Duluth,

Sponsoring Agency: Minnesota Department of Transportation

The purpose of this research was twofold: to develop a simulation model of snowplow operations, and to develop a conceptual design for a predictive maintenance system.

The first portion of the research was concerned primarily with developing a simulation model of snowplow operations for selected routes in Virginia, MN. The purpose of this model is to assist managers with decisions related to route length, assignment of plows to routes, placement of reloading points, and the collection of labor and material cost based on “what- if” scenarios. Creating this model depended on input from experienced operators, internal management reports, and archived Road and Weather Information Systems (RWIS) data.

Source: www.cts.umn.edu/pdf/CTS-04-09.pdf June 2003

2.6 Evaluation of the Minnesota Department of Transportation’s Intelligent Vehicle Initiative Snowplow Demonstration Project on Trunk Highway 19 Winter 1998-1999

Sponsoring Agency: Minnesota Department of Transportation

Minnesota DOT began the demonstration phase of its IVI program through the initiation of the IVI Snowplow Demonstration Project during the 1998-99 winter. In an effort to address the many challenges and difficulties associated with plowing snow in adverse weather conditions, the SDP showcases two technologies to aid the operator: one to guide the snowplow and another to warn the snowplow operator of possible collisions.

Trunk Highway 19 between Winthrop and Fairfax in Sibley and Renville counties was chosen as the rural demonstration site. Plowing snow in rural areas is complicated by the combination of snow, blowing snow, fog, darkness, and lack of visual cues to locate the roadway. These less-than-favorable conditions create near zero visibility for the driver and produce a “snowcloud” around the snowplow, in effect hiding it from vehicles approaching from either direction.

The snowplow operator is typically under tremendous stress and faces a heavy workload. In a basic snowplow, the operator must control a large truck with plow blades extending into adjacent lanes while traveling on compacted snow, soft snow, or ice and often in poor visibility. The operator is also responsible for the dispersion of sand and de-icing chemicals.

The aim of the SDP during the 1998-99 winter was to test the lateral guidance and collision warning systems during regular operations. However, due to continual equipment calibration and an unusually low snowfall in Minnesota, only limited testing could take place.

Source: Evaluation of the Minnesota Department of Transportation's Intelligent Vehicle Initiative Snowplow Demonstration Project on Trunk Highway 19 Winter 1998-1999
Prepared by: Booz – Allen & Hamilton Co. McLean, VA October 27, 1999

2.7 Field Testing of Alternative Carbide Edge Snow Plow Blades

Sponsoring Agency: Maine Department of Transportation

The Maine Department of Transportation uses almost 2,500 carbide cutting edges on its fleet of highway snow plow trucks each winter. This represents almost 9,000 linear ft. of cutting edges and an annual expenditure of roughly \$150,000 each winter season. This does not include the number of regular steel or hardened steel blades used on other types of equipment such as graders, bucket loaders, etc. The number of replacement blades used in any particular season, and the annual costs for these blades, depend on the number and severity of winter storms and the condition of the roads. The expected life of a set of carbide edge blades is highly variable. Estimates range from 100 to 500 hours of plowing time per set. Longer lasting could lead to significant cost savings.

Problem Statement

Conventional carbide cutting edges are manufactured by placing small trapezoidal carbide inserts into a groove that is cut into the underside edge along the bottom edge of the steel plow blade. Carbide is a complex metal alloy of tungsten that is tougher and resists abrasion better than simple steel. The carbide, however, can be more brittle than steel. The severe shock loads experienced by plows hitting rough broken pavement, rocks, curbs, or other objects can crack and break the carbide edges, leading to rapid wear on the edge.

Preliminary results seem to indicate that the new blades do not last as long as regular stock blades. The new blades may perform well on concrete pavement. At this time, however, it is not clear if the new type blades will outlast the regular blades on the concrete pavement. Even if this proves to be true, Maine has few concrete roads. Another season of data collection is needed before the final results will be available. This research has shown that, so far, the new blades are not a cost-effective application for most Maine asphalt roads. The research has also established baseline performance data for conventional carbide blades; that data will be useful for future comparisons and evaluations.

Source: Maine Department of Transportation Technical Memorandum 03-11, March 2004

2.8 Evaluation Report Volume 2: Benefit Analysis Intelligent Vehicle Initiative Specialty Vehicle Field Operational Test

Sponsoring Agency: Minnesota Department of Transportation

The findings presented in this report are based on information that was gathered through an extensive literature review and a series of interviews. Interviews were conducted with state and county maintenance engineers and supervisors, equipment vendors, system integrators, equipment procurement personnel, and individuals involved in various aspects of risk management for transportation agencies.

The expected benefits of DAS on winter maintenance vehicles include the reduction in travel times, less disruption to routine travel behavior and improved safety for the traveling public during and immediately following winter weather events. The impact of winter weather on traveler safety, public agency budgets and regional economies is well documented. As part of this assessment, a literature review of related studies and reports was performed. Estimated impacts of winter weather on surface transportation are as follows:

Safety: The Federal Highway Administration (FHWA) estimates that adverse weather conditions cause 7,000 traffic fatalities and 450,000 injuries annually.

Maintenance Costs: State and local transportation agencies spend approximately \$1.8 billion annually on snow and ice control.

Economic Impact: The FHWA estimates that a one-day highway shutdown caused by snow in a major metropolitan area would cost between \$15 to \$76 million in lost time, productivity and wages.

Source: Minnesota DOT – US DOT Cooperative Agreement Task 7.5 of Cooperative Agreement DTFH61-99-X-00101, December 2002

2.9 DGPS Gang Plowing

Sponsoring Agency: Minnesota Department of Transportation

Gang plowing is one method used by the Minnesota Department of Transportation (Mn/DOT) to increase the productivity of snowplow operations. However, these gains in productivity often come at the expense of increased driver stress. These higher stress levels are the result of the low visibility caused by localized snow clouds created by the lead snowplow, and by anxious drivers trying to pass between the moving plows. To improve the gang plowing process, a DGPS-based gang plowing system has been

developed. This system uses advanced technology to allow a trailing snowplow to automatically follow a lead snowplow at an operator-specified lateral and longitudinal offset. The system is designed to improve both safety and productivity.

This report covers three areas. First, to improve driver visibility, an implementation of the virtual mirror to the left side of the trailing plow is described. Second, the lateral and longitudinal performance of a two-vehicle gang on Minnesota Trunk Highway 101 is described. Third, a system architecture for gangs of more than two vehicles is proposed, and its potential performance is documented through simulation. Finally, recommendations for further research and other potential applications are provided.

Source: Intelligent Vehicles Lab Department of Mechanical Engineering University of Minnesota Minneapolis, MN 55455 <http://www.lrrb.org/PDF/200518.pdf>

2.10 NCHRP Report 526 Snow and Ice Control: Guidelines for Materials and Methods

This report presents a realistic set of guidelines for selecting roadway snow and ice control strategies and tactics for a wide range of climate, site, and traffic conditions found in the United States. These guidelines apply to both state and local highway agencies. The term “roadway” used in this document refers to any highway, road, street, or other paved surface that carries motor vehicles.

The guidelines were developed from appropriate existing documentation plus data collected from field testing of selected snow and ice control strategies and tactics over three winters. In the general sense, a strategy is a careful plan or method directed at achieving a specific goal or goals. Tactics, on the other hand, are the systematic employment of available means or resources to accomplish a desired end condition of a strategy. For purposes of these guidelines, strategies and tactics refer to the combination of material, equipment, and methods, including both chemical and physical, that are used in snow and ice control operations to achieve a defined level of service.

The various roadway snow and ice control strategies used in winter maintenance operations in the United States can be classified into four general categories:

- Anti-icing
- Deicing
- Mechanical removal of snow and ice together with friction enhancement, and
- Mechanical removal alone

Mechanical removal alone is a strategy that involves the physical process of attempting to remove an accumulation of snow or ice by means such as plowing, brooming, blowing, and so on, without the use of snow and ice control chemicals. This strategy is strictly a physical process that has some merit during and/or after frozen precipitation has occurred at very low pavement temperatures, say below 15°F, and on very low volume and unpaved roads.

Source: NCHRP Report 526: Snow and Ice Control: Guidelines for Materials and Methods, Transportation Research Board, Washington DC 2004

2.11 Visibility Improvements with Overplow Deflectors during High-Speed Snowplowing

This paper explained how windtunnel and field experiments are presented to quantify visibility improvements with deflectors that were placed over the top of snowplow blades and were designed to reduce airborne debris. Windtunnel measurements provide the influence of overplow deflectors on the distribution of debris around the truck. Road tests

on airport taxiways and highways show that the visible area of the plow truck increases by about 50% for following traffic and that snow debris, which blows over the top of the plow, is eliminated with trap angles less than 50°.

Source: JOURNAL OF COLD REGIONS ENGINEERING / SEPTEMBER 2002

Authors: Brian E. Thompson and Hany K. Nakhla

2.12 Improved Cutting Edges for Ice Removal

Strategic Highway Research Program SHRP-H-46

Laboratory tests were performed with a hydraulic ice-cutting rig to determine the effects of the geometry of the cutting edge of a snow plow blade on the force required to remove ice from a highway pavement surface. Test results indicated that the most important parameter was the clearance angle, and the associated flat width. Using this information, a prototype cutting edge was designed and fabricated for field testing during the winter of 1991-92. Three different cutting edges were tested: the prototype cutting edge, and two commercially available cutting edges. The results indicated that the prototype cutting edge cut more ice (i.e., took a deeper cut at a given velocity) and did so with less downforce than either of the other two blades. The field tests did not address the issues of blade wear or shock resistance. The prototype cutting edge was shown to be clearly superior to the other two edges, cutting more ice with less downforce and thus resulting in greater vehicle control.

Source: Strategic Highway Research Program, National Research Council Washington DC 1993. Author: Wilfrid A. Nixon, University of Iowa

2.13 Ice-Pavement Bond Disbonding-- Surface Modification and Disbonding

Strategic Highway Research Program SHRP-H-644

Current techniques to remove ice and compacted snow from pavement surfaces are costly because they needlessly crush or melt most of the ice layer. Also, in many cases they do not accomplish disbonding or clear the ice to the pavement interface. In addition, deicing chemicals currently in use (salts) are environmentally objectionable. More efficient alternatives to current physical and chemical methods are needed which will apply energy selectively to the ice - pavement interface to accomplish disbonding and which are environmentally acceptable.

This research program has explored new techniques of disbonding ice. Pavement modifications included differences in surface texture or composition; one example being a rubber additive to create a more flexible pavement surface to facilitate disbonding under traffic loads. Non-contact methods included electromagnetic radiation, abrasive air and liquid jets, acoustic waves, and application of pressurized deicer directly to the ice

pavement interface. Contact techniques included analyses and experiments to develop a more energy efficient cutting edge for snow plows which may include auxiliary force augmentation.

It was concluded that several of the techniques have potential for highway use but need further development. In the pavement modifications area, changes in surface texture or geometry did create greater shear forces under traffic loads than smooth surfaces, however insufficient to disbond ice. Microencapsulation of deicers for release during icing conditions using interracial polymerization techniques was not possible. The addition of coarse rubber aggregate to asphalt pavement surfaces to create a deformable surface for disbonding indicated good potential for ice release. However, further investigation of pavement integrity and increased rolling resistance is necessary.

In the contact area, improved geometry of cutting edges, particularly provision of a 15 to 30° rake angle, results in significant energy savings in cutting ice from pavement surfaces. The use of pretreatment such as rolling the ice surface to create cracks results in additional energy savings.

Source: Strategic Highway Research Program, National Research Council, Washington DC 1993 Author: Albert F. Wuori Michigan Technological University

2.14 An Improved Displacement Snowplow

Strategic Highway Research Program SHRP-H-673

This report describes the research on improving the design of snowplows, as well as design, fabrication and test of plows incorporating improvements. The project included a variety of features which were intended to promote technology transfer. These efforts are also documented. Finally, a recommended design for an improved reversible plow is presented.

The primary goal of the research was to decrease the energy consumption during plowing by twenty percent. Secondary goals included increasing the cast performance, improving visibility for the operator and the motoring public, and improving the safety of the plow especially on impact with hazards found on and along roadways.

The report suggests tall moldboards with large-radius upper moldboard sections. Field tests of the experimental plows and observation of plows engaged in routine snow removal operations in many environments indicated that speeds of 10 to 15 m/s (20 to 30 mph) are required to keep snow from falling off the moldboard for a wide range of reversible plows currently in operation. In situations where plowing is conducted at lower speeds there is considerable rehandling of the snow regardless of the plow geometry. Energy consumed in rehandling the snow dominates all aspects of the plow geometry. The large radius upper moldboard suggested providing sufficient flow distance to allow the snow from the toe to reach the exit also influences the aerodynamic flow in the

neighborhood of the plow. These large-radius units tend to decrease blowby over the plow thereby improving visibility for the operator and motoring public.

Source: Strategic Highway Research Program, National Research Council, Washington DC 1994 Author: Kynric M. Pell University of Wyoming

2.15 Final Report of Snow Plow Cutting Edge Test and Evaluation (T & E) Program

Sponsoring Agency: Federal Highway Administration

During the winters of 1996-97 and 1997-98, as part of an FHWA Test and Evaluation Program, two front mounted plows and two underbody plows have been instrumented so that the snow and ice scraping loads could be measured. These plows were used during standard snow and ice clearing operations. Three different cutting edge types were tested: One standard cutting edge and two cutting edges designed according to the guidelines developed under SHRP Project H-204A. The two SHRP cutting edges are distinguished by the hardness of their carbide inserts. One has a carbide insert with a regular hardness (Rockwell A 87.5 to 89.0), while the other insert is somewhat softer than normal (Rockwell A 87.0 to 88.0). During each storm event, two different cutting edges were to be tested, so as to give direct comparisons. Information on plow routes, weather conditions, and operator observations were recorded for each plowing event.

Two trucks were instrumented with the intent of measuring scraping forces for both front-plow and underbody plows in full deployment. Due to equipment and data acquisition failures, no successful and complete load measures were made, and thus it is not possible to directly analytically compare the three cutting edges. To achieve useful information in studies of this nature, it is important that sufficient time be allowed in the project. In this case, two winter seasons were insufficient to develop a novel instrumentation method, work out the difficulties of using the new method, and then gather useful field data. This time factor should be a major consideration in future field studies.

Source: FHWA DTFH71-96-TE028-IA-43

Authors: Wilfrid A. Nixon, YingChang Wei, University of Iowa February 1999

3. Design Charrette

What is a charrette? The American Institute of Certified Planners (AICP) defines a charrette in this manner.

The French word, "Charrette" means "cart" and is often used to describe the final, intense work effort expended by art and architecture students to meet a project deadline. This use of the term is said to originate from the École des Beaux Arts in Paris during the 19th century, where proctors circulated a cart, or "charrette", to collect final drawings while students frantically put finishing touches on their work.



The charrette combines the creative, intense work session with public workshops and open houses. The Charrette is a collaborative planning process that harnesses the talents and energies of all interested parties to create and support a feasible plan that represents transformative community change.

Who uses Charrettes?

- Planners and Designers
- Architects
- Public Officials and Organizations
- Planning and Community Development Directors
- Public and Private Developers and Land Owners
- Citizen Activist Groups
- Non-Governmental Organizations

Charrette Project Types

Though Charrettes can be used virtually any time a product needs to be created or designed, the Charrette model results in feasible plans for:

- Regional Planning
- Comprehensive Planning
- Rewriting Development Codes
- New Community Master Planning
- Specific Planning
- Redevelopment Projects
- Affordable Housing Developments
- Buildings

Elements of a Charrette

Trust – Dynamic Planning promotes trust between citizens and government through meaningful public involvement and education.

Vision – Dynamic Planning fosters a shared community vision and turns opposition into support.

Feasibility – Dynamic Planning increases the likelihood of getting projects built by gaining broad support from citizens, professionals, and staff. And, it creates a better plan through diverse input and involvement

Economy – Dynamic Planning avoids costly rework and utilizes highly productive work sessions.

4. Other Improvements

The next sections of this report include snow removal equipment from other countries.

Notes from an earlier meeting. Please note the comment from Jim Dowd.

Dennis Burkheimer and Dennis Kroeger (from CTRE – Center for Transportation Research and Education) started the meeting by informing the committee there was funding left over from the concept vehicle project that ended about two years ago. They were going to see if the funding could be used to help the committee develop a new concept for removing snow from the roadway. **Jim Dowd related a story where The CEO from ATT walked into a meeting and told the group the telephone system had been wiped out and no longer existed. They were then instructed to design, a new communications system with the features that were needed in today's society.**

The Committee was then instructed to use this philosophy to brainstorm ideas of removing snow from the roadways by any means possible.

The following ideas were mentioned:

Heated air – melt the snow

Blow the snow off

Blade/Scrap snow off but use a lighter weight device

Roller – Wheels – to break up hard packed snow

Rotating Auger – made from light weight material

Chemicals to melt it off

Geo-Thermal pavement heater

Heat pavement with solar or electrically

Built in liquid system with troughs to allow chemical to be dispensed and traffic to track chemical down roadway – possibly wind powered.

The discussion then switched to what goals do you want a snow removal device to accomplish.

The committee came up with the following list:

Clean pavement fast

Remove snow at high speed to reduce speed differential with traffic

Remove as much snow and ice as possible the first pass

Conform to road surface

Keep snow off front of truck and windshield

Put snow where you want it

Maintain safety for operator

Reduce snow cloud for public

Minimal weight but still be effective at removing snow/ice

Able to handle different types of snow/ice

Easy to work on – KISS method of design

Attach and detach easily
Use minimal recourses of truck – hydraulics / electrical system
Minimal cost
Reduce vibration
Reduce noise in cab
Alternate methods – blowing snow off
Eliminate, if possible other equipment
Disc type – to work snow off to side
Durable – Strong – Must push deep snow

The committee also added items that would help improve snow removal:

Slow traffic down

Seem to be always behind the weather – not able to keep up with heavy snow – plow runs take to long (some 1 ½ - 2 hours some as long as 2 – 3 hours) for round trip and snow accumulates on road faster than they can plow it off.

4.1 Active Blade Adapter System (ABAS)

The Active Blade Adapter System was invented in Finland and is used extensively throughout both Finland and Sweden. The same adapters have been on the same plows for 9 years.

This system was introduced into Canada and the USA in 2002. Since then units have been installed at DOT's in the USA including Iowa, Illinois, Kansas, Nevada, New York, Minnesota, Michigan, North Dakota, Virginia, Wisconsin, South Dakota, Maine, and Missouri with several other States showing great interest.

In Canada we have adapters in Alberta, Saskatchewan, Manitoba, Ontario, and soon to be in New Brunswick. There are several plowing contractors that use the ABAS system in the Greater Toronto area plowing some of Canada's busiest highways like the 400,401, 407, and 427.

The ABAS patented system is the only technology of its kind in North America.

So the question is "what is the ABAS system, how does it work, and what are the advantages gained when using it.

The basic concept of the system is that it converts your present rigid plowing system into a free floating system.

A good explanation would be if you currently have a plow with a front mold board of say 12' you are probably using three 4' carbide blades bolted on. Even though you have 3 separate blades you in theory have one 12' long blade. This will act as one blade so if you have uneven roads or a crown in the road only one point of that 12' blade will be in contact with the road surface at that point and because the other points on the blade will be raised above the road surface snow will be left behind and therefore making driving conditions unsafe, and also more salt and sand will be needed once remaining snow freezes.

In the above mention example we would provide you with our adapters that would come in 2' lengths along with 2' carbide blades. You would remove your 4' blades and bolt our adapters onto the same holes in your front mold board and bolt the 2' carbide blades to our adapters.

Our adapters will now allow each of the 2' carbide blades to be able to move up and down about 1/2" individually and independently from the others. So now you will have six 2' blades able to move to the contour of the road surface, over manholes, joints in bridges, or any other obstacles in the road surface.

Due to the design of the adapters having rubber pads as the main focus this will also greatly reduce if not eliminate noise, shock and vibration when plowing as all plow operators have testified too.

Other advantages gained by using the ABAS system:

1. Less noise and vibration when plowing resulting in reducing overall plow maintenance.
2. Extending blade life by absorbing shock when plowing over obstacles in the road surface like Raised Pavement Markers.
3. Prolong life and reflectivity of painted road lines with glass beads.
4. Decreased amount of salt and sand used over the season because of better snow and packed ice removal especially on uneven road surfaces.
5. Increased environment benefits (ground water, air pollution in urban areas: dust, pm 10 and 2.5 particles) and traffic safety.
6. More effectiveness and safety in high-speed plowing.
7. Less wear and tear on equipment.
8. No damage to airport runway lights, or sprinkler heads on bridges for de-icing purposes.
9. No damage to RPM's (Raised Pavement Markers)

The main purpose of the adapters is to increase the effectiveness of removing snow from the road surface compared to plowing with a rigid system and that is exactly what the ABAS system does.

Brian Lazich

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4.2 Blade from Boone Iowa Garage

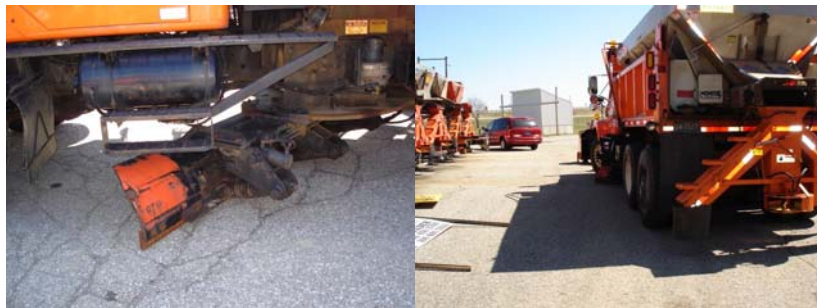
This apparatus is a “squeegee” blade added to the snow plow. The “squeegee” follows the blade to remove the debris left by the first plow and blade.





4.3 Michigan Snowplow

The following pictures are of a snowplow presently used in Michigan.
Photos courtesy of Dave Budd.





4.4 Japan Snowplow

This is a heavy duty snowplow from the Haikaido district.

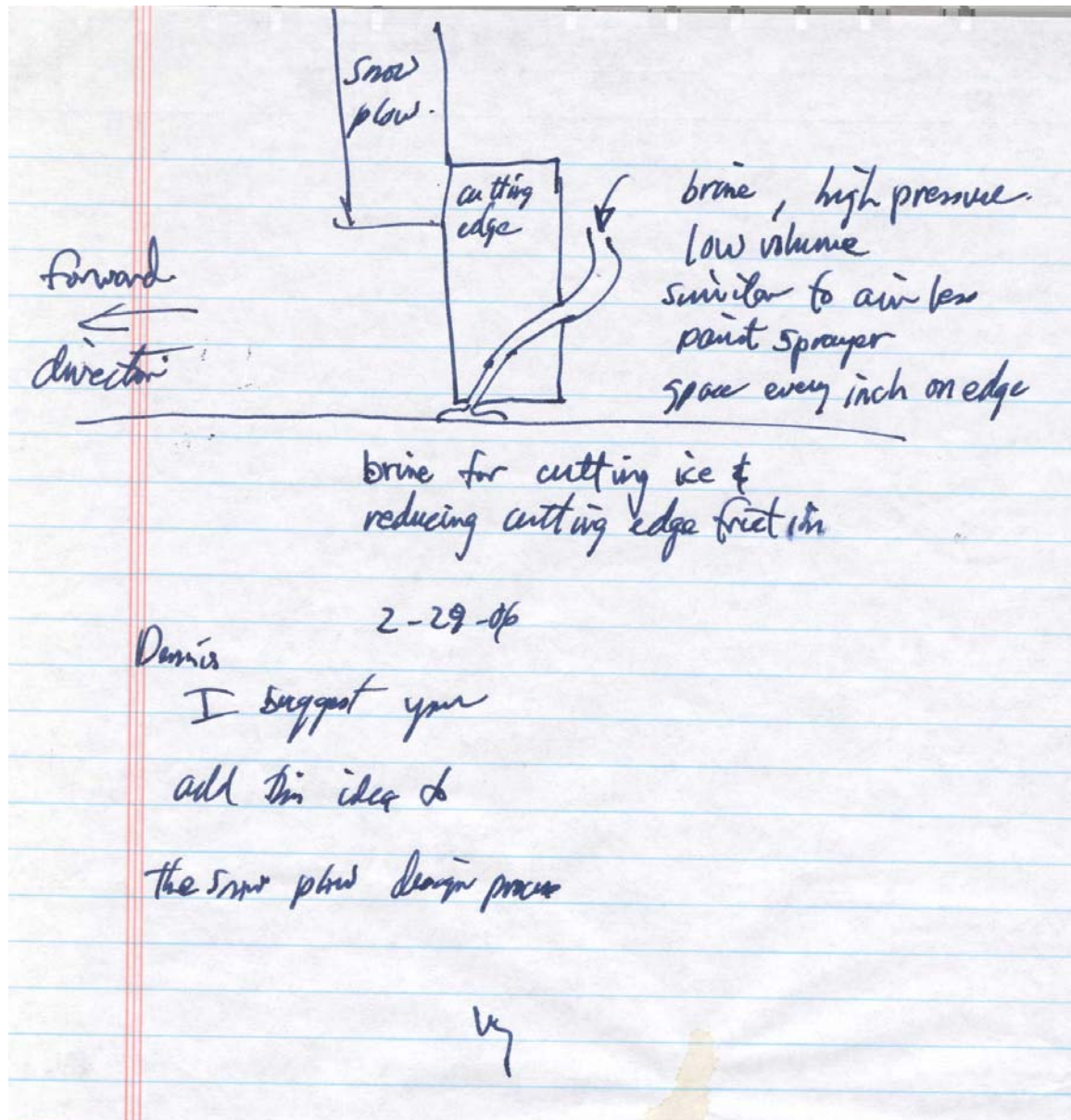


This picture is a snowplow with a dynamic message sign (DMS) on the rear, used in Japan.



4.5 Will's Design

The following idea is for injecting salt brine below the cutting edge.



4.6 High Mobility Multipurpose Wheeled Vehicle (HMMWV) Snowplow

This is the snowplow used by the US Army in Bosnia and Kosovo. CRREL designed the plow using commercial off the shelf technology (COTS) for the US Army European command.



Figure 2. M34 2-1/2-ton, 6 × 6 dump truck manufactured by the Reo Truck Company in 1952–53 mounting a cable/hydraulic Roadway model 1d single-blade non-reversible 12-foot snowplow. The plow was manufactured in the 1963–66 time frame and is still in use today.



Figure 3. 1966 M35 6 × 6, 2-1/2-ton truck mounted with an early German-built Schmidt Engineering 11-foot conventional, manually reversible snowplow manufactured in 1950. This plow was in service in Baumholder, Germany, with the U.S. Army for 43 years before being shipped to Task Force Able Sentry in 1994, where it continues in service today.

