APPENDIX A
Forward Visibility in Snowplow Operations Survey
Forward Visibility in Snowplow Operations

The 3M Company and the University of Iowa are conducting this survey in cooperation with the Iowa DOT and Minnesota DOT.

This survey will ask about your knowledge and experience with factors affecting forward visibility and lane position during snowplow operations. The goal is to understand operational issues and operator practices in low-visibility conditions.

Filling out this survey is voluntary. We want your answers to be anonymous, so please do not put your name on the survey. When you have completed the survey, please fold it and place it in the postage-paid envelope and drop it in the mail.

If you have any questions or additional comments, please contact:

Mr. Daniel McGehee
University of Iowa
227 South Quadrangle
Iowa City, IA 52242-1192
1-800-710-8891 8AM-5PM (toll free)

Please return the completed survey in the enclosed postage-paid envelope.

Thank you very much for your assistance in completing this survey!
**INSTRUCTIONS**

We are interested in finding out about your experience with snowplow operations. Please answer each question to the best of your knowledge and as precisely as possible. If you have any comments or additional information you wish to provide, do not hesitate to write in the margins. If you feel uncomfortable answering a question, or part of a question, feel free to skip to the next question.

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### Some Background Information

1. Which maintenance facility do you work for?
   - 1 Iowa DOT
   - 2 Minnesota DOT
   - 3 Other: ___________________________

2. How many winter seasons have you worked as a snowplow operator: ______ winters

### Your Snowplow Vehicle(s)

*These questions ask about characteristics of the snowplow vehicles that you drove this winter.*

3. How many different snowplow vehicles did you typically drive during the current (98-99) winter season?
   (Do not count vehicles that you used because your primary vehicle was unavailable due to maintenance)
   - 1 One (1)
   - 2 Two (2)
   - 3 Three (3)
   - 4 More than three (3)

4. What is the year, make, model, and axle type of the snowplow vehicle you drove most frequently this current (98-99) winter season? *(if known)*
   a. Year: _______
   b. Make: __________________________
   c. Model: __________________________
   d. 1 Single-axle  2 Tandem-axle

### Your Snow Route

*The next questions ask about the route(s) that you plowed this winter season.*

5. In the current (98-99) winter season, how many different routes did you plow during an average snowstorm?
   - 1 One (1)
   - 2 Two (2)
   - 3 Three (3)
   - 4 More than three (3)

6. What was the approximate length of your primary route this current (98-99) winter season (not including deadheading):
   (If you plow more than one route, choose the route that you drove the most frequently this winter season)
   _____ lane miles

7. Approximately how many lane miles of each type of roadway do you plow in your current primary route (not including deadheading):
   a. _____ lane miles of ramps
   b. _____ lane miles of city driving
   c. _____ lane miles of two-lane undivided highway driving
   d. _____ lane miles of ‘super two-lane’ highway driving
   e. _____ lane miles of two-lane divided highway driving
   f. _____ lane miles of two-lane divided interstate driving
   g. _____ lane miles of multi-lane (3 or more) divided interstate driving
   h. _____ lane miles of other roadway driving. Please describe:

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Snowplow Lane Awareness System: Operator Interface Design and Evaluation
The University of Iowa
8. Thinking about your snowplow operations during the current (98-99) winter season:
   a. What was your **average** driving time: ______ hours per shift
   b. What was your **maximum** driving time: ______ hours per shift

9. Thinking about your snowplow operations during the current (98-99) winter season:
   a. What was your **average** driving speed while plowing? ______ mph
   b. What was your **minimum** driving speed while plowing? ______ mph
   c. What was your **maximum** driving speed while plowing? ______ mph

10. During the current (98-99) winter season, what percentage of time, on average, did you use each of these **plows or systems**? (Circle the number that best represents the percentage of time you used this plow or system)

<table>
<thead>
<tr>
<th>Plow or System</th>
<th>Never used this plow or system</th>
<th>Always used this plow or system</th>
</tr>
</thead>
<tbody>
<tr>
<td>a. Front-mounted one-way plow</td>
<td>0% 10 20 30 40 50 60 70 80 90 100%</td>
<td></td>
</tr>
<tr>
<td>b. Front-mounted two-way reversible plow</td>
<td>0% 10 20 30 40 50 60 70 80 90 100%</td>
<td></td>
</tr>
<tr>
<td>c. Front-mounted V-plow</td>
<td>0% 10 20 30 40 50 60 70 80 90 100%</td>
<td></td>
</tr>
<tr>
<td>d. Front-mounted snowblower</td>
<td>0% 10 20 30 40 50 60 70 80 90 100%</td>
<td></td>
</tr>
<tr>
<td>e. Under-body ice blade or plow</td>
<td>0% 10 20 30 40 50 60 70 80 90 100%</td>
<td></td>
</tr>
<tr>
<td>f. Left wing plow</td>
<td>0% 10 20 30 40 50 60 70 80 90 100%</td>
<td></td>
</tr>
<tr>
<td>g. Right wing plow</td>
<td>0% 10 20 30 40 50 60 70 80 90 100%</td>
<td></td>
</tr>
<tr>
<td>h. Material spreader</td>
<td>0% 10 20 30 40 50 60 70 80 90 100%</td>
<td></td>
</tr>
<tr>
<td>i. Salt-Brine sprayer</td>
<td>0% 10 20 30 40 50 60 70 80 90 100%</td>
<td></td>
</tr>
</tbody>
</table>

11. What plow configuration (front and wing only) did you use the **most frequently** this current (98-99) winter season? (Check only)
   - [ ] Front-mounted plow only
   - [ ] Front-mounted plow and left wing plow
   - [ ] Front-mounted plow and right wing plow
   - [ ] Front-mounted plow, left wing plow, and right wing plow, all together
   - [ ] Other: __________________________

12. The next question is about ‘backplowing.’ (By **backplowing** we mean operating the snowplow vehicle in reverse, with the plow(s) down (i.e. dragging).)
   As part of your snowplow operations, do you ever ‘backplow’?
   - [ ] No
   - [ ] Yes, how many times this current (98-99) winter season? __________times

13. What type of **mirrors** are in the snowplow vehicle you drove most frequently this current (98-99) winter season? (Check all that apply and indicate whether each mirror is heated or not)

<table>
<thead>
<tr>
<th>Mirror</th>
<th>Heated</th>
<th>NOT Heated</th>
</tr>
</thead>
<tbody>
<tr>
<td>a. Left-mounted rear-view mirror</td>
<td>[ ] 1</td>
<td>[ ] 2</td>
</tr>
<tr>
<td>b. Left-mounted, small convex mirror</td>
<td>[ ] 3</td>
<td>[ ] 4</td>
</tr>
<tr>
<td>c. Right-mounted rear-view mirror</td>
<td>[ ] 5</td>
<td>[ ] 6</td>
</tr>
<tr>
<td>d. Right-mounted, small convex mirror</td>
<td>[ ] 7</td>
<td>[ ] 8</td>
</tr>
<tr>
<td>e. Right front fender mirror</td>
<td>[ ] 9</td>
<td>[ ] 10</td>
</tr>
<tr>
<td>f. Left front fender mirror</td>
<td>[ ] 11</td>
<td>[ ] 12</td>
</tr>
<tr>
<td>g. Wing plow mirror</td>
<td>[ ] 13</td>
<td>[ ] 14</td>
</tr>
<tr>
<td>h. Front-mounted plow mirror</td>
<td>[ ] 15</td>
<td>[ ] 16</td>
</tr>
<tr>
<td>i. Other: ______________</td>
<td>[ ] 17</td>
<td>[ ] 18</td>
</tr>
</tbody>
</table>

**Vehicle Alarms and Devices**

The next questions ask about alarms & devices that your snowplow vehicle(s) might have.

- [ ] Left-mounted rear-view mirror
- [ ] Left-mounted, small convex mirror
- [ ] Right-mounted rear-view mirror
- [ ] Right-mounted, small convex mirror
- [ ] Right front fender mirror
- [ ] Left front fender mirror
- [ ] Wing plow mirror
- [ ] Front-mounted plow mirror
- [ ] Other: ______________
14. During the current (98-99) winter season, did the side windows of your snowplow vehicle ice up and reduce your visibility?
   q 1 No
   q 2 Yes, what percentage of the time? __________ percent

15. What visual displays and indicators are in the snowplow vehicle you drove most frequently this current (98-99) winter season? (Check all that apply)
   q 1 Material rate control
   q 2 Material spread width
   q 3 Salt spread over speed
   q 4 Salt-Brine control
   q 5 Under-body plow pressure
   q 6 Engine air filter restriction indicator
   q 7 Air temperature
   q 8 Pavement temperature
   q 9 Heated rearview mirror
   q 10 Rear axle differential lock
   q 11 Two-way radio channel scan
   q 12 Cellular phone status
   q 13 Other: __________________________

16. Of the visual displays and indicators listed in question #15 above, which one (if any) do you consider the most annoying during snowplow operations?
   _____ (Indicate the item number (1-13))

17. What alarms are in the snowplow vehicle you drove most frequently this current (98-99) winter season? (Check all that apply)

<table>
<thead>
<tr>
<th>Visual</th>
<th>Auditory</th>
</tr>
</thead>
<tbody>
<tr>
<td>a. High engine temperature</td>
<td>q 1</td>
</tr>
<tr>
<td>b. Hydraulic oil pressure</td>
<td>q 3</td>
</tr>
<tr>
<td>c. Loss of air pressure for brakes</td>
<td>q 5</td>
</tr>
<tr>
<td>d. Excessive speed while sanding</td>
<td>q 7</td>
</tr>
<tr>
<td>e. Material spreader 'off'</td>
<td>q 9</td>
</tr>
<tr>
<td>f. Box 'up'</td>
<td>q 11</td>
</tr>
<tr>
<td>f. Other: ______________________</td>
<td>q 13</td>
</tr>
</tbody>
</table>

18. Of the alarms listed in question #17 above, which one (if any) do you consider the most annoying during snowplow operations?
   _____ (Indicate the item letter (a-f))

19. In the snowplow operations you performed during the current (98-99) winter season, how much would you say each of these weather conditions reduced your ability to see in front of your snowplow vehicle?
   (Circle the number that best represents your experience with these weather conditions)

<table>
<thead>
<tr>
<th>Don't know</th>
<th>Never causes poor forward visibility</th>
<th>Always causes poor forward visibility</th>
</tr>
</thead>
<tbody>
<tr>
<td>a. Daytime with drifting snow and snowfall</td>
<td>0</td>
<td>1</td>
</tr>
<tr>
<td>b. Daytime with drifting snow only</td>
<td>0</td>
<td>1</td>
</tr>
<tr>
<td>c. Daytime with snowfall only</td>
<td>0</td>
<td>1</td>
</tr>
<tr>
<td>d. Daytime without snowfall or drifting snow</td>
<td>0</td>
<td>1</td>
</tr>
<tr>
<td>e. Nighttime with drifting snow and snowfall</td>
<td>0</td>
<td>1</td>
</tr>
<tr>
<td>f. Nighttime with drifting snow only</td>
<td>0</td>
<td>1</td>
</tr>
<tr>
<td>g. Nighttime with snowfall only</td>
<td>0</td>
<td>1</td>
</tr>
<tr>
<td>h. Nighttime without snowfall or drifting snow</td>
<td>0</td>
<td>1</td>
</tr>
</tbody>
</table>

Low-Visibility Operations

We are interested in identifying circumstances in which forward visibility is poor.

18. Of the alarms listed in question #17 above, which one (if any) do you consider the most annoying during snowplow operations?
   _____ (Indicate the item letter (a-f))

19. In the snowplow operations you performed during the current (98-99) winter season, how much would you say each of these weather conditions reduced your ability to see in front of your snowplow vehicle?
   (Circle the number that best represents your experience with these weather conditions)

<table>
<thead>
<tr>
<th>Don't know</th>
<th>Never causes poor forward visibility</th>
<th>Always causes poor forward visibility</th>
</tr>
</thead>
<tbody>
<tr>
<td>a. Daytime with drifting snow and snowfall</td>
<td>0</td>
<td>1</td>
</tr>
<tr>
<td>b. Daytime with drifting snow only</td>
<td>0</td>
<td>1</td>
</tr>
<tr>
<td>c. Daytime with snowfall only</td>
<td>0</td>
<td>1</td>
</tr>
<tr>
<td>d. Daytime without snowfall or drifting snow</td>
<td>0</td>
<td>1</td>
</tr>
<tr>
<td>e. Nighttime with drifting snow and snowfall</td>
<td>0</td>
<td>1</td>
</tr>
<tr>
<td>f. Nighttime with drifting snow only</td>
<td>0</td>
<td>1</td>
</tr>
<tr>
<td>g. Nighttime with snowfall only</td>
<td>0</td>
<td>1</td>
</tr>
<tr>
<td>h. Nighttime without snowfall or drifting snow</td>
<td>0</td>
<td>1</td>
</tr>
</tbody>
</table>
20. In the snowplow operations you performed during the current (98-99) winter season, how much would you say each of these wind directions reduced your ability to see in front of your snowplow vehicle.  
(Circle the number that best represents your experience with these wind directions)

<table>
<thead>
<tr>
<th></th>
<th>Don’t know</th>
<th>Never causes poor forward visibility</th>
<th>Always causes poor forward visibility</th>
</tr>
</thead>
<tbody>
<tr>
<td>a. Head wind</td>
<td>0 1 2 3 4 5 6 7</td>
<td></td>
<td></td>
</tr>
<tr>
<td>b. Tail wind</td>
<td>0 1 2 3 4 5 6 7</td>
<td></td>
<td></td>
</tr>
<tr>
<td>c. Plowing the left lane with crosswind from the left</td>
<td>0 1 2 3 4 5 6 7</td>
<td></td>
<td></td>
</tr>
<tr>
<td>d. Plowing the left lane with crosswind from the right</td>
<td>0 1 2 3 4 5 6 7</td>
<td></td>
<td></td>
</tr>
<tr>
<td>e. Plowing the right lane with crosswind from the left</td>
<td>0 1 2 3 4 5 6 7</td>
<td></td>
<td></td>
</tr>
<tr>
<td>f. Plowing the right lane with crosswind from the right</td>
<td>0 1 2 3 4 5 6 7</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

21. Considering the road types where you performed snowplow operations during the current (98-99) winter season, how much would you say each of these driving situations reduced your ability to see in front of your snowplow vehicle.  
(Circle the number that best represents your experience with these driving situations)

<table>
<thead>
<tr>
<th></th>
<th>Don’t know</th>
<th>Never causes poor forward visibility</th>
<th>Always causes poor forward visibility</th>
</tr>
</thead>
<tbody>
<tr>
<td>a. Meeting passenger vehicles</td>
<td>0 1 2 3 4 5 6 7</td>
<td></td>
<td></td>
</tr>
<tr>
<td>b. Meeting trucks or buses</td>
<td>0 1 2 3 4 5 6 7</td>
<td></td>
<td></td>
</tr>
<tr>
<td>c. Being passed by passenger vehicles</td>
<td>0 1 2 3 4 5 6 7</td>
<td></td>
<td></td>
</tr>
<tr>
<td>d. Being passed by trucks or buses</td>
<td>0 1 2 3 4 5 6 7</td>
<td></td>
<td></td>
</tr>
<tr>
<td>e. Open fields on side of roadway</td>
<td>0 1 2 3 4 5 6 7</td>
<td></td>
<td></td>
</tr>
<tr>
<td>f. Other:</td>
<td>0 1 2 3 4 5 6 7</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

22. Describe any other weather or driving situations not listed in previous questions where you have experienced difficulty seeing in front of your snowplow vehicle.  
______________________________________________________________________________
______________________________________________________________________________
______________________________________________________________________________  

23. Based on your experience, how much would you say each of these plow configurations generates blowing snow and reduces your ability to see in front of your snowplow vehicle.  
(Circle the number that best represents your experience with these plow configurations)

<table>
<thead>
<tr>
<th></th>
<th>Don’t know</th>
<th>Never causes poor forward visibility</th>
<th>Always causes poor forward visibility</th>
</tr>
</thead>
<tbody>
<tr>
<td>a. Front-mounted one-way plow</td>
<td>0 1 2 3 4 5 6 7</td>
<td></td>
<td></td>
</tr>
<tr>
<td>b. Front-mounted reversible plow</td>
<td>0 1 2 3 4 5 6 7</td>
<td></td>
<td></td>
</tr>
<tr>
<td>c. Front-mounted V-plow</td>
<td>0 1 2 3 4 5 6 7</td>
<td></td>
<td></td>
</tr>
<tr>
<td>d. Front-mounted snowblower</td>
<td>0 1 2 3 4 5 6 7</td>
<td></td>
<td></td>
</tr>
<tr>
<td>e. Under-body ice blade or plow</td>
<td>0 1 2 3 4 5 6 7</td>
<td></td>
<td></td>
</tr>
<tr>
<td>f. Small left wing plow</td>
<td>0 1 2 3 4 5 6 7</td>
<td></td>
<td></td>
</tr>
<tr>
<td>g. Large left wing plow</td>
<td>0 1 2 3 4 5 6 7</td>
<td></td>
<td></td>
</tr>
<tr>
<td>h. Small right wing plow</td>
<td>0 1 2 3 4 5 6 7</td>
<td></td>
<td></td>
</tr>
<tr>
<td>i. Large right wing plow</td>
<td>0 1 2 3 4 5 6 7</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>
24. Is there a front-mounted plow type or model that, because of its design, generates more blowing snow and reduces your ability to see in front of your vehicle more than others?
   
   - Do not know
   - No
   - Yes, please describe:
     - Type (e.g., reversible): __________
     - Manuf.: ______________________
     - Model: _______________________
     - Height of plow: ______ inches
     - Curvature of plow:
       - Small barrel
       - Large barrel

25. In your opinion, what three (3) methods help you the most to maintain your lane position while plowing in poor forward visibility?

   (Choose only three (3) and rank their importance by using numbers 1 to 3)
   
   - Feeling the crown of the road
   - Feeling the rumbling strips on the shoulder
   - Feeling the slope of the shoulder
   - Evaluating distance from milepost delineators
   - Evaluating distance from fence line
   - Evaluating distance from grass line
   - Evaluating distance from center line
   - Evaluating distance from guardrails
   - Looking behind to evaluate distance from shoulder line
   - Looking ahead to evaluate distance from shoulder line
   - Following other vehicles’ tracks
   - Following your own vehicle’s previous tracks

26. Describe any other ways that you find successful in maintaining your lane position in poor forward visibility.

   __________________________________________________________
   __________________________________________________________
   __________________________________________________________

27. As part of your snowplow operations this current (98-99) winter season, did you intentionally cross into the other lane (oncoming or passing)?

   - Do not know
   - No → Go to question #30
   - Yes

28. When you intentionally crossed into either the oncoming or passing lane, how far did you typically move into the other lane during average-visibility conditions?

   - ______ feet into oncoming lane of a two-lane road (i.e., city, rural, or interstate)
   - ______ feet into passing lane of a four-lane road (i.e., divided interstate or highway)

29. When you intentionally crossed into either the oncoming or passing lane, how far did you typically move into the other lane during low-visibility conditions?

   - ______ feet into oncoming lane of a two-lane road (i.e., city, rural, or interstate)
   - ______ feet into passing lane of a four-lane road (i.e., divided interstate or highway)

30. As part of your snowplow operations this current (98-99) winter season, did you unintentionally (without meaning to) cross into the oncoming lane?

   - Do not know
   - Yes, how many times? __________

31. In the worst snowstorm this current (98-99) winter season, how often and for how long did you completely lose sight of the roadway and shoulders in front of your snowplow vehicle?

   - Number of times:
     - 0
     - 1–3
     - 4–6
     - 7–9
     - 10+

   - Longest duration (seconds):
     - 1–19
     - 20–29
     - 30–39
     - 40–49
     - 50+

   - Average duration (seconds):
     - 1–3
     - 4–9
     - 10–19
     - 20–29
     - 30+
32. During the current (98-99) winter season, did you ever have to stop because you could no longer determine your lane position?

- No
- Yes, number of times:
  
  0 1–3 4–6 7–9 10+

33. During the current (98-99) winter season, how many times did you have a ‘close’ call where you nearly ran off the entire road onto the soft shoulder? ________ times

34. During the current (98-99) winter season, did you ever hit an object (e.g., guardrail, bridge) because you could no longer determine your lane position?

- No
- Yes, how many times? _______
  
  What did you hit? ______________________

35. Have you or someone you know ever run off the road because of low visibility during snowplow operations?

- No → Go to question #37
- Yes

36. Considering the most serious occasion when you or someone else ran off the road because of low visibility:

a. What was the driving speed? ____ mph
b. What contributed to the low visibility?
   
   ________________________________
   ________________________________
c. Did anything else contribute to the vehicle running off the road?
   
   ________________________________
   ________________________________
   ________________________________

37. In your opinion, what are the three (3) most important safety concerns with regards to operating a snowplow vehicle?

(Choose only three (3) and rank their importance by using numbers 1 to 3)

- a. Ability to continuously see roadway in front of your vehicle
- b. Ability to be seen by a vehicle approaching from the front
- c. Ability to be seen by a vehicle approaching from behind
- d. Ability to identify your lane position at all times
- e. Ability to inform traveling public of your speed
- f. Ability to slow down traveling public
- g. Risk of being hit by another vehicle
- h. Amount of blowing snow generated by vehicle and plow configuration
- i. Amount of drifting snow generated by inadequate or insufficient number of snow fences
- j. Other: ________________________

38. If technology existed which could tell you your lane position, would you find it useful?

- No
- Yes
- Maybe

39. On which section of the road, would lane position information be most beneficial?

- Shoulder line
- Center line
- Center of lane
- Other: ________________________________

40. If there were a device that was able to detect obstacles in front of your vehicle while in motion, would you find it useful?

- No
- Yes
- Maybe
**About You**

41. What is your age: ______

42. What is your gender:
   - Q1 Male
   - Q2 Female

43. What is the highest grade or level of school that you have **completed**?
   - Q1 8th grade or less
   - Q2 Some high school, but did not graduate
   - Q3 High school graduate or GED
   - Q4 Some college or 2-year degree
   - Q5 4-year college graduate
   - Q6 More than 4-year college degree

44. Computer use:
   a. Do you use a computer at **work** on a regular basis?
      - Q1 No
      - Q2 Yes
   
   b. Do you use a computer at **home** on a regular basis?
      - Q1 No
      - Q2 Yes

45. Do you wear eyeglasses or contacts?
   - Q1 No → Go to question #47
   - Q2 Yes

46. If you wear eyeglasses or contacts, please indicate what type of eyewear:
   - Q1 Contacts
   - Q2 Regular eyeglasses
   - Q3 Bi-focal
   - Q4 Other: ___________________________

47. Do you wear sunglasses during daytime snowplow operations?
   - Q1 No
   - Q2 Yes

**Your Comments & Suggestions**

48. Please provide any additional comments or suggestions you may have for improving your ability to see in front of your vehicle and maintaining your lane position during low-visibility snowplow operations.

________________________________________________________________________________
________________________________________________________________________________
________________________________________________________________________________
________________________________________________________________________________
________________________________________________________________________________

Thank you again for your time!