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SNOWPLOW SIMULATION TRAINING STUDY

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Research Report ICT-11-077

A report of the findings of
ICT-R27-SP15
Snowplow Simulator Training Study

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16. Abstract

This report evaluates simulation training of IDOT snowplow operators to improve IDOT snow and ice removal operations. Specifically, it assesses a drivers' evaluation of snowplow simulation training immediately after training in fall 2009 and again after the snow season in spring 2010. The report includes the supervisors' assessment of the simulator training after the snow season and a description of conventional training at the district level. Also included are an estimated cost analysis of the simulation training and the estimated cost of behind-the-wheel training, a review of the accident records of snowplow drivers who participated and who did not participate in the simulation training, and a review of reports from other states on simulator training. Results show favorable driver evaluations after the fall training but less positive evaluations after the snow season. Supervisor evaluation of simulation training was generally favorable. As presently conducted, simulation training appears more costly than conventional training. Finally, and consistent with most of the literature, no conclusive findings on driver performance were found when comparing drivers whose training included simulation to drivers whose training did not include simulation. Multiple reasons for this finding are provided in the report. Suggestions for future study are provided.

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Members of the Technical Review Panel from IDOT are the following:

Dave Johnson, Chair
Aaron Weatherholt
Harold Dameron
Richard Telford
Tim Peters

EXECUTIVE SUMMARY

This report includes:

- The results and analysis of the snowplow driver simulator training evaluation immediately after the training in Fall 2009.
- A follow-up of drivers after the snow season.
- The supervisor assessment of the simulator training after the snow season.
- A description of conventional training at the district level.
- An estimated cost analysis of the simulation training and conventional behind-the-wheel training.
- A review of the accident records of snowplow drivers who participated and did not participate in the simulation training.
- A review of reports from other states on simulator training.

The simulator training appears to be well planned and implemented. Review of the MPRI training materials indicated the curriculum is well conceived and consistent with sound educational principles. It appears that the instructors implemented the curriculum well. The driver evaluation immediately after the training was very positive as was drivers' performance on the simulator. One concern is that the time allotted may not be sufficient. Some lengthening should be considered. The training was a bit rushed to cover the material in time. This was noted by the trainees, evaluator, and instructors.

Although overall favorable, driver evaluations after the snow season were less favorable than immediately after the fall training. Results clearly show a lower post evaluation score in terms of course material and organization, acquisition of skills/content, instructor, and simulator training environment.

No significant correlations were found among driver evaluation of the simulator training, driver age, years driving for IDOT, or total years of snowplow driving.

Supervisor response to simulator training was quite favorable. Supervisors reported that simulation-trained driver performance improved relative to drivers not taking simulation training in terms of decision making skills, driving ability, and overall driver assessment. No supervisors reported their drivers as worse after the training.

The vast majority (89%) agreed that simulation training was effective, especially so (94%) for new hires and somewhat less but still favorable (61%) for veteran drivers. In addition, 82% agreed that drivers thought simulator training was worthwhile, and nearly two-thirds (63%) disagreed that simulation was a waste of time.

With respect to training at the district level, just over a half of the supervisors (53.8%) reported training 35 or fewer drivers, and nearly 70 percent (69.3%) had 45 or fewer drivers. The median number of hours-behind-the-wheel training was 8 hours; two thirds (66.7%) had 12 hours or less; and 83.3% had 16 hours or less behind-the-wheel training. The median number of miles driven was 95.

The median number of hours other than behind the wheel was also 8 hours, and only 11.8% had 16 or more hours of training.

No supervisor reported any accident, injuries, equipment damage, or damage to other property other than vehicles during any training.

With few exceptions overall, supervisor comments about simulation training were favorable and consistent with supervisor questionnaire responses as well as comments from drivers.

An estimated per-capita driver cost for simulator and conventional training was calculated. Per-capita driver cost for conventional behind-the-wheel training is significantly less

than simulation training. Although the differences are significant, an informed decision involves IDOT estimating the opportunity costs, benefits, and tradeoffs of conducting simulation training that doesn't require as much use of IDOT personnel and equipment for training; less exposure to accident, injury, or property damage; and the greater flexibility in scheduling simulation training that can be conducted at times other than the snow season. However, unless there is a compelling reason, it does not appear that simulation training, as conducted in this study, is cost effective compared to conventional behind-the-wheel training.

A review of IDOT snowplow driver recorded accidents and simulation driver reported accidents, injuries, and property damage during the past snow season did not evidence the merits of simulation training compared to conventional behind-the-wheel training. Because of multiple reasons identified in this report, including the absence of any significant driver caused accidents, injuries or property losses, there is no evidence to support the merits of either conventional behind-the-wheel or simulation-trained with respect to driver performance.

A review of the literature on snowplow driver simulation evidences that a number of studies, including the present Illinois evaluation, have indicated that simulator training has been well received by drivers and supervisors. However, it is also evident that strong empirical data of the effectiveness and cost effectiveness of simulation training using well accepted research design and data analysis is limited given the inherent difficulties associated with conducting scientific investigations in "real world" settings.

Other observations from the literature and this evaluation support the idea that simulator training should be viewed as a complement to on-the-road training rather than a replacement for it.

Results of this study are generally consistent with other reports indicating favorable driver evaluation of simulation training. But this study goes further to provide additional insight and adds to the current knowledge in several ways. While several previous studies evaluate simulator training immediately after training and before the snow season, nearly all that were reviewed do not include a post snow season driver evaluation of the simulation training. Nor do many previous studies include an evaluation of the simulation training by supervisors as this study does.

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INTRODUCTION

Illinois Department of Transportation (IDOT) maintenance operators are responsible for plowing federal and state roads. This activity often occurs under treacherous and stressful conditions. Additionally, drivers often have to operate several plows and spreaders simultaneously. Opportunities to provide comprehensive training under real-world conditions are limited and are inherently hazardous especially to novice drivers. There also may be limited opportunities for even experienced drivers to improve their skills, operate new equipment, and acquire new skills.

One training option is simulation. The use of simulators is not new. They have been used to assess how drivers would react to real-life situations that would be difficult or costly to replicate. Simulators have long been used for pilot training and are currently used for other vehicle training such as trucks, cars, including police cars, and emergency vehicles. In the past several years, several states have incorporated simulators into their training of snowplow operators.

Technological advancements have improved the fidelity of virtual reality environments in training. Simulators have several desirable advantages. Training can be conducted in a safe yet realistic environment and conducted anytime during the year especially when drivers are not as in demand for other critical activities. Also, simulators don't require or tie up vehicles and related equipment thus reducing vehicle operating cost including wear and tear.

Yet questions remain about using simulation to train snowplow operators. Is simulation effective and, if so, how effective? How do drivers respond to simulation training and would they recommend it for other drivers? Is it cost effective versus conventional training methods? Does it help to improve driver performance?

To answer these questions, this research evaluated simulator training of IDOT snowplow operators to improve IDOT snow and ice removal operations.

This report presents the results and analysis of:

(1) The snowplow driver simulator training evaluation after the snow season, based on a 36-item questionnaire completed by snowplow drivers that included both open- and closed-ended items. This survey was a follow-up to the snowplow driver simulator training evaluation conducted immediately after the simulation training during November 2009, before the snow season. The training was conducted by the firm MPRI for the Illinois Department of Transportation (IDOT) during the week of Monday, November 30 to Friday, December 4, 2009, in three locations: Ottawa on November 30 and December 1; Bloomington on December 2; and Collinsville on December 3-4. Eighty drivers were scheduled to participate. A previous report by the external evaluator presented the results of that evaluation.
(2) The supervisor assessment of the simulator training after the snow season and a description of conventional training at the district level.
(3) An estimated cost analysis of the simulation training and the estimated cost of behind-the-wheel training.
(4) A review of the accident records of snowplow drivers who participated and who did not participate in the simulation training.
(5) A review of reports from other states on simulator training.

Both the pre and post survey questionnaires were developed by the evaluator based on a review of other state snowplow evaluations, the simulator company manual, and in consult with IDOT staff. The IDOT contact person for the evaluator was Mr. David Johnson.

Mr. Johnson and Mr. Harold Dameron were helpful in responding to the evaluator's requests throughout the process. A 34-item questionnaire form was developed to take a driver evaluation immediately after the initial simulator training. The questionnaire consisted of five sections: course material and organization, acquisition of skills/content, instructor, simulator training environment, and driver demographic data. Driver-related items were the training site, primary type of route plowed, years of IDOT snowplow operator experience, total years of snowplow operator experience with IDOT and others, and driver age. A copy of the pre-survey report, including the questionnaire as well as the pre-training findings, is shown in Appendix A. For purposes of comparing pre to post-training results, the post-evaluation questionnaire included 36 items and utilized almost all identical items from the pre-training questionnaire. It also included a section on driver accident involvement during the 2009-2010 snow season. A copy of the post-training questionnaire is shown in Appendix B. The reader is encouraged to refer to that questionnaire when reviewing the findings.

RESULTS

DEMOGRAPHIC FINDINGS

Of the initial 77 drivers, 50 (65%) completed post training questionnaires. A higher response rate would have been preferable to reduce the likelihood of bias that is often associated with lower response rates. That is, the post-training respondents may not be representative of the initial participants. Because the responses were anonymous, there is no way to know which of the initial respondents completed the pre-training questionnaires.

Response bias could occur because:

(1) Some of the drivers could not be located for the post-training survey.
(2) Some supervisors stressed the importance of responding more than others.
(3) Drivers with more negative views were more likely to return a questionnaire than drivers with neutral or positive views.
(4) Some drivers needed more prodding to complete the questionnaire but only one mailing was conducted.

However, given that only one mailing was sent out with no follow up, a 65% response rate is excellent.

Drivers were asked to identify their primary route as either urban/suburban or rural. Results of the primary route identified by drivers are shown in Figure 1. Most drivers (72%) reported plowing rural routes. Some drivers circled both alternatives, and those are so identified. Quite likely the “both” category would be greater if that alternative had been provided.

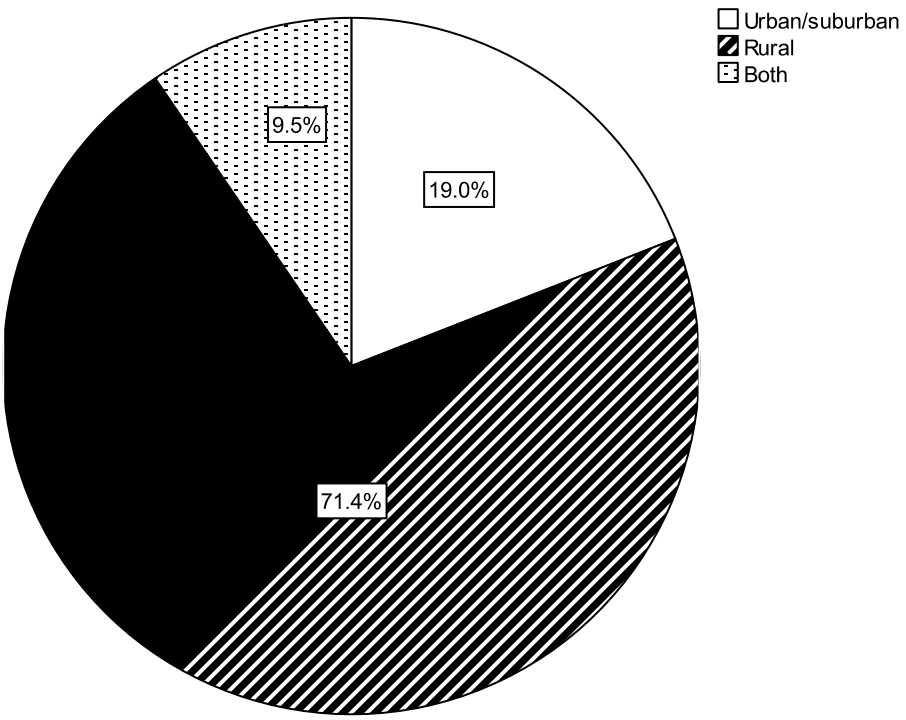


Figure 1. Q33 primary driver route.

With respect to total years of IDOT snowplow driving, a wide range (3 - 45 years) was found. IDOT drivers reported an average (mean) of 13.7 years and a median value of 10 years (middle point of all drivers where half drove more and half drove less). The median is often a better measure because, unlike the mean, it is not influenced by extremes at either end of the distribution range, such as drivers with very many or very few years of IDOT driving. Figure 2 depicts a histogram of the number of years drivers reported snowplowing for IDOT.

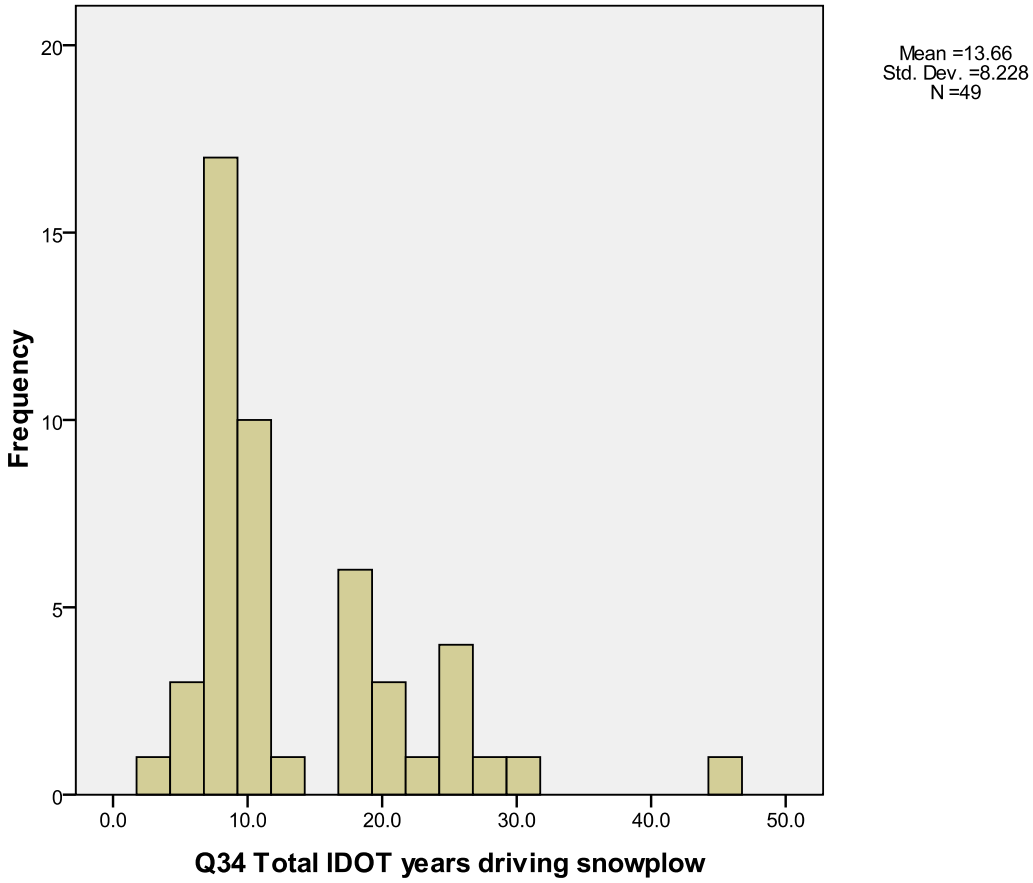


Figure 2. Q34 – Total IDOT years driving snowplow.

Further analysis of the data showed that most IDOT drivers (65%) had fewer than 13 years of service. Only 16% had more than 20 years, and only 6% had 25 years or more of service.

Figure 3 depicts the total number of years drivers reported plowing for IDOT and others. In terms of total years of snowplow driving experience (IDOT and others), the mean was 16.1 years and the median (middle value) was 13 years. The difference was due to 14 drivers having over 20 years of snowplowing experience. It is clear from these data that most driver experience is with IDOT.

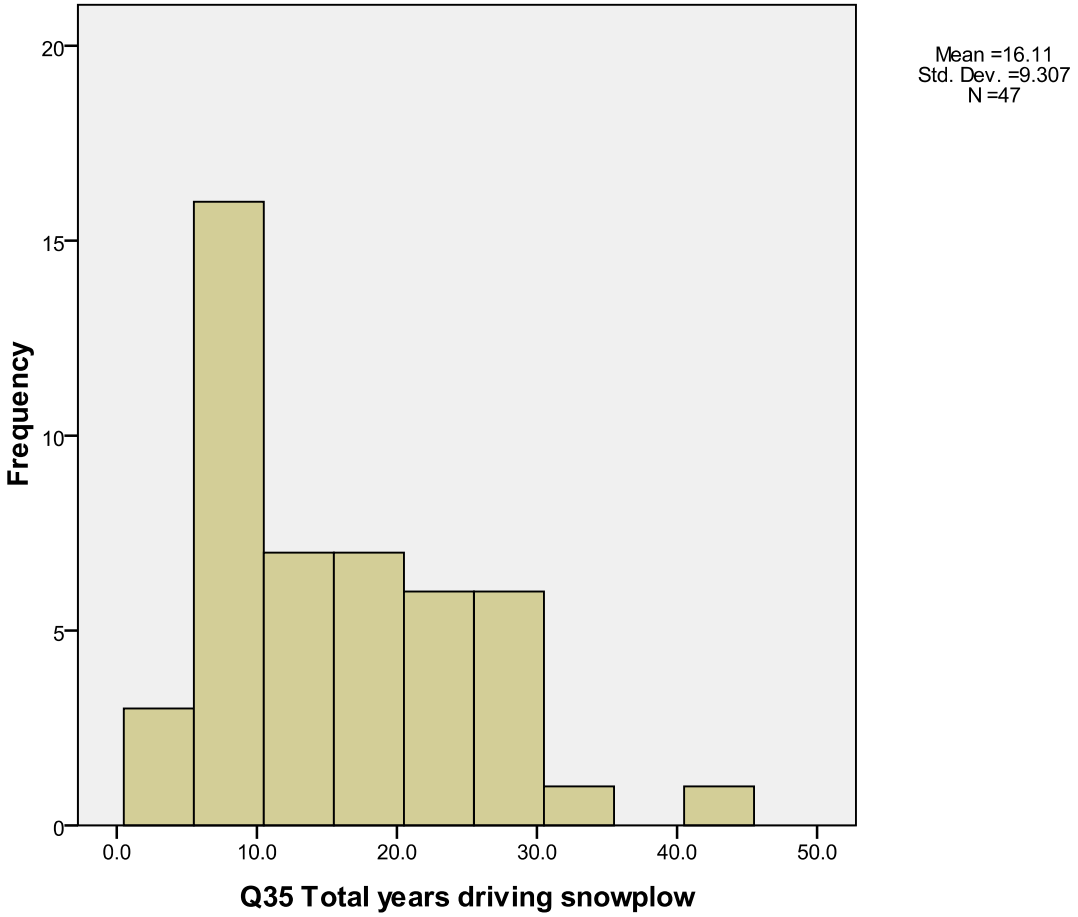


Figure 3. Q35 – Total years driving snowplow.

Figure 4 depicts driver age. The mean age (52.2) and median (52) are nearly identical. This indicates that driver age is somewhat normally distributed, with a wide range of ages (32 to 69). Nearly a quarter (24.4%) are over 60 years of age. This indicates that new drivers will be needed in the next few years.

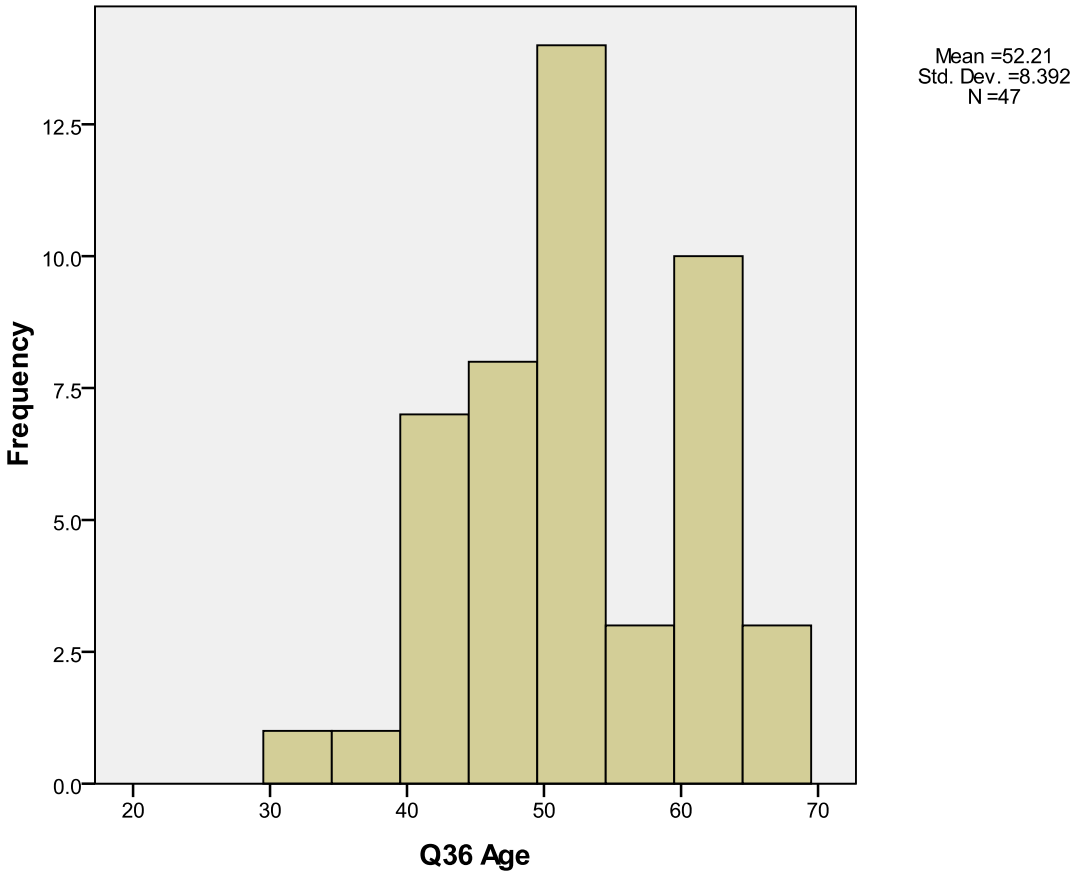


Figure 4. Q36 – Age composition of snowplow drivers.

DRIVER EVALUATION OF TRAINING

The next several tables report the findings of the other four sections of the questionnaire (see Appendix B): Course Material and Organization (10 items), Acquisition of Skills/Content (12 items), Instructor (6 items), and Simulator Training Environment (3 items).

Each item was scored on a 1 (strongly disagree) to 5 (strongly agree) scale. Thus, the highest score for an item was 5 and the lowest was 1. An item score of 3 would be in the middle or neutral position on the scale. Most items were worded in the affirmative where 5 (strongly agree) was the most positive response and 1 (strongly disagree) was the most negative. However, to maintain respondent attention and ensure reliability, three items were worded in the negative so that a positive opinion required responding “disagree” or “strongly disagree” (number 1). The three items were Q.6 (Not much was gained by taking the training), Q.26 (Some things were not explained very well), and Q.30 (The simulator made me nauseous). For analysis purposes, these three items were recoded when analyzing the data so that a response of 5 was the most positive and could be compared to other items.

COURSE MATERIAL AND ORGANIZATION

There were 10 items in the Course Material and Organization section of the evaluation questionnaire. Results for the Course Material and Organization section of the evaluation questionnaire are presented in Table 1.

Consistency was indicated by all but one item having mean scores between 3.2 and 4.0 on a five-point scale. That is, all scores but one were on the favorable side (3 or above) of the five-point scale.

Table 1. Course Material and Organization
(figures in percent form)

Statement	Strongly disagree	Dis-agree	Neither	Agree	Strongly agree	Mean*
1. I would take another training that is taught this way.	14	10	18	30	28	3.5
2. The training material seemed worthwhile.	8	16	12	40	24	3.6
3. Overall the training was good.	6	16	16	38	24	3.6
4. The training was well organized	4	0	22	40	34	4.0
5. The simulations were very useful.	18	10	12	40	20	3.3
6. Not much was gained by taking this training.	46	24	14	8	8	3.9
7. The driving simulations were realistic for the training objectives.	16	18	30	30	6	2.9
8. I practiced skills during the driving simulation part of the training that will be very useful on the road.	10	18	32	24	16	3.2
9. The time spent in the lecture portion was appropriate.	6	2	34	38	20	3.6
10. The time spent in the driving simulation portion was appropriate.	12	16	24	26	22	3.3

* On a scale of 1 to 5, where 1 = strongly disagree and 5 = strongly agree, except for Q.6 where the scoring was reversed.

However, the results of Table 1 were less favorable than the evaluation results immediately after the simulator training in November when all means for this section were between 4.1 and 4.4. Percentage results of several pre-post question comparisons showed significantly less favorable responses on the post evaluation. For example, with respect to agreeing, drivers reported they would take another training taught this way (Pre 84%; Post 60%), that the training was worthwhile (Pre 90%; Post 64%), that simulations were useful (Pre 92%; Post 60%), that simulations were realistic (Pre 77%; Post 35%) and would be useful on the road (Pre 80%; Post 39%). Finally drivers thought the time spent on the lecture portion was appropriate (Pre 85%; Post 59%) and thought the time spent on the driver simulation portion was appropriate (Pre 74%; Post 47%).

A wide variety of written comments were received from 15 drivers and are listed in Appendix C. The most frequent comment was that the training wasn't sufficiently realistic as evidenced by comments like, "Not the real deal," "Not nearly close enough to realistic driving," "More like a video game than a training tool," or "Not real word training." Several others mentioned that it was not worth the time and money. However, another driver noted, "We totally agree; this should be given to every highway maintainer every year."

ACQUISITION OF SKILLS/CONTENT

Findings of the 12 items covering Acquisition of Skills and Course Content are presented in Table 2. Mean scores ranged from 2.7 to 3.7. Only five items scored above the 3.0 midpoint of the scale. Most others were slightly below.

Table 2. Acquisition of Skills/Content
(figures in percent form)

Statement	Strongly disagree	Dis-agree	Neither	Agree	Strongly agree	Mean*
11. This training should be part of IDOT training for all snowplow operators.	24	16	20	18	21	2.9
12. The training helped prepare me for dealing with non-routine situations.	16	16	35	23	10	2.9
13. The training helped prepare me for situations involving blade catching.	18	18	29	29	6	2.9
14. The training helped prepare me for situations involving plow movement.	16	20	29	27	8	2.9
15. The training helped prepare me for situations involving passing cars.	16	16	37	23	8	2.9
16. The training helped prepare me for situations involving vehicles or pedestrians along the side of the road.	14	10	20	38	18	3.4
17. The training helped prepare me for situations involving plowing over structures.	16	22	31	23	8	2.8
18. This training explained why speed manage-ment is important for safe plowing.	10	6	25	38	21	3.5
19. This training explained why space management is important for safe plowing.	8	8	33	35	16	3.4
20. This training explained why good communication is important for safe plowing.	10	12	27	33	18	3.4
21. I would recommend this training for new snowplow drivers.	14	12	10	16	47	3.7
22. I would recommend this training for experienced snowplow drivers.	29	12	31	18	10	2.7

*On a scale of 1 to 5, where 1 = Strongly disagree and 5 = Strongly agree.

Consistent with the findings reported in the previous table, results of Table 2 were also less favorable than the evaluation results immediately after the simulator training in November when all means were for this section were between 3.7 and 4.4. For example, drivers thought the training should be part of IDOT training for all snowplow operators (Pre 85% ; Post 40%), that the training prepared them for dealing with non-routine situations (Pre 76% ; Post 33%), that it explained why speed (Pre 87%; Post 59%) and space management (Pre 88%; Post 50%) as well as good communication (Pre 84%; Post 50%) are important for safe plowing.

In the pre-training evaluation, 84% of drivers strongly recommended (4.4 on a 5-point scale) this training for other snowplow drivers. In the post evaluation, this question was divided into two components – new and experienced snowplow drivers. Much different results were noted. Specifically, on the post evaluation, 63% of drivers were in agreement that they would recommend this training for new drivers, but only 29% would recommend it for experienced snowplow drivers.

A wide range of written comments was also received from 15 drivers. Their comments are listed in Appendix C. Most commonly expressed was that the training should be focused on new employees: “Only for new employees,” “Training for new hires and 6 month temps,” “Recommend for new drivers but not those plowing over 8 years,” and “Useful for rookies. Not sure veterans would be very interested in.”

INSTRUCTOR

Findings of the seven items from the instructor section of the evaluation form are presented in Table 3. All items were scored favorably at 3.8 or higher on a 5-point scale.

Table 3. Instructor
(figures in percent form)

Statement	Strongly disagree	Dis-agree	Neither	Agree	Strongly agree	Mean*
23. I think the training was taught quite well.	0	6	20	43	31	4.0
24. The trainer had a good understanding of the material.	2	2	16	41	39	4.1
25. The trainer worked well with the drivers.	0	4	12	37	47	4.3
26. Some things were not explained very well.	42	23	17	10	8	4.0
27. The trainer understood your needs and issues.	4	6	21	48	21	3.8
28. The trainer gave very useful feedback.	4	0	23	46	27	3.9

* On a scale of 1 to 5, where 1 = Strongly disagree and 5 = Strongly agree, except for Q.26 where the scoring was reversed.

However, the same pattern of lower post evaluation scores emerged when comparing pre to post training evaluations except that the differences were not as large. For example, drivers reporting that the training was taught well (Pre 95%; Post 75%), that the trainer had a good understanding of the material (Pre 96%; Post 80%), worked well with the drivers (Pre 96%%; Post 83%), understood their needs and issues (Pre 90%; Post 69%) and gave very useful feedback (Pre 93%; Post 73%).

Eight written comments were received and reflected a range of opinions (see Appendix C). “Very good understanding of our issues,” “Very helpful,” “Good guys,” and “He was knowledgeable.” In contrast several comments were received about the instructor’s lack of experience, “Instructor has no experience operating snowplow. Should have previous experience” and “Instructor has never been in real situations.”

SIMULATOR TRAINING ENVIRONMENT

Findings from the three items from the Simulator Training Environment segment of the evaluation are presented in Table 4. All items were scored favorably.

Table 4. Environment
(figures in percent form)

	Strongly disagree	Dis-agree	Neither	Agree	Strongly agree	Mean*
29. The simulator facility was adequate.	4	0	24	48	24	3.9
30. The simulator provided a good learning experience.	8	14	18	36	24	3.5
31. The simulator made me nauseous.	70	8	6	4	12	4.2

* On a scale of 1 to 5, where 1 = Strongly disagree and 5 = Strongly agree, except for Q.31 where the scoring was reversed.

The same pre-post evaluations trend with lower post evaluation scores was noted. Specifically, drivers considered the facility adequate (Pre 86%; Post 72%) and that the simulator provided a good learning experience (Pre 90%; Post 60%). Similar pre-post results were found for the simulator making them nauseous (Pre 19%; Post 26%).

Eight drivers provided written comments (see Appendix C) and included favorable, unfavorable, and constructive suggestions. No primary theme was noted.

SUMMARY OF EVALUATIONS

Table 5 presents a summary of the pre-post simulation training evaluation means for each of the four sections of the driver evaluation. Results clearly show a lower post evaluation score for all sections and the overall mean. In contrast to the pre evaluation with each section receiving a very favorable score of 4.1 or higher on a 5-point scale with an overall mean across all sections of 4.3, the post evaluation means, although overall favorable, were lower in every instance.

Table 5. Summary of Driver Training Evaluations*
(figures in percent form)

Topic	Pre Mean*	Post Mean*
Course Material & Organization	4.2	3.5
Acquisition of Skills/Content	4.1	3.1
Instructor	4.5	4.0
Simulation Training Environment	4.2	3.9
Overall Mean	4.3	3.6

*On a scale of 1 to 5, where 1 = Strongly disagree and 5 = Strongly agree

Several reasons may account for the lower scores. The response rate is certainly a consideration. Only 64% of the drivers who participated in the simulation training responded. In survey research, it is well known that people who feel strongly about the topic are more likely to respond, and intensity is often more likely to be negative than positive.

Also, the initial evaluation came immediately after completing the training while the post evaluation came after drivers had time to reflect during and after a snow season. During this period drivers were likely to discuss the training with other drivers and may have been influenced. Finally, drivers may have been less likely to remember/recall the training seven months later. Most likely, all these factors as well as others may have contributed to the lower post evaluations. In any event, the drivers were favorable after the initial evaluation and overall favorable, but less so, after the follow-up evaluation after the snow season.

CORRELATION FINDINGS

To obtain additional insight, several correlations were calculated. These included correlations between each of the four sections of the driver evaluation form (Materials & Organization, Skills/Content, Instructor and Environment). As background information, correlation values can be between +1.00 (that is, as the driver score for one section goes up or down it goes up or down at the same rate on the other section) and -1.00 (that is, as the driver score for one section goes up or down the score for the same driver goes in the opposite direction at the same rate on the other section). A .00 correlation means there is no relationship between driver scores on one section and scores on another.

Not surprisingly, results indicated that there was a positive significant relationship (p. <01) between driver scores on each of the four sections. To illustrate, Figures 5-7 present scatterplots for the correlations of the Materials and Organization section with each of the other sections. Each small circle represents one respondent. Each graph includes a line that reflects the “best fit” taking all scores into consideration. The more diagonal the line from lower left to upper right the stronger the correlation. Similar findings existed when other sections were correlated with each other.

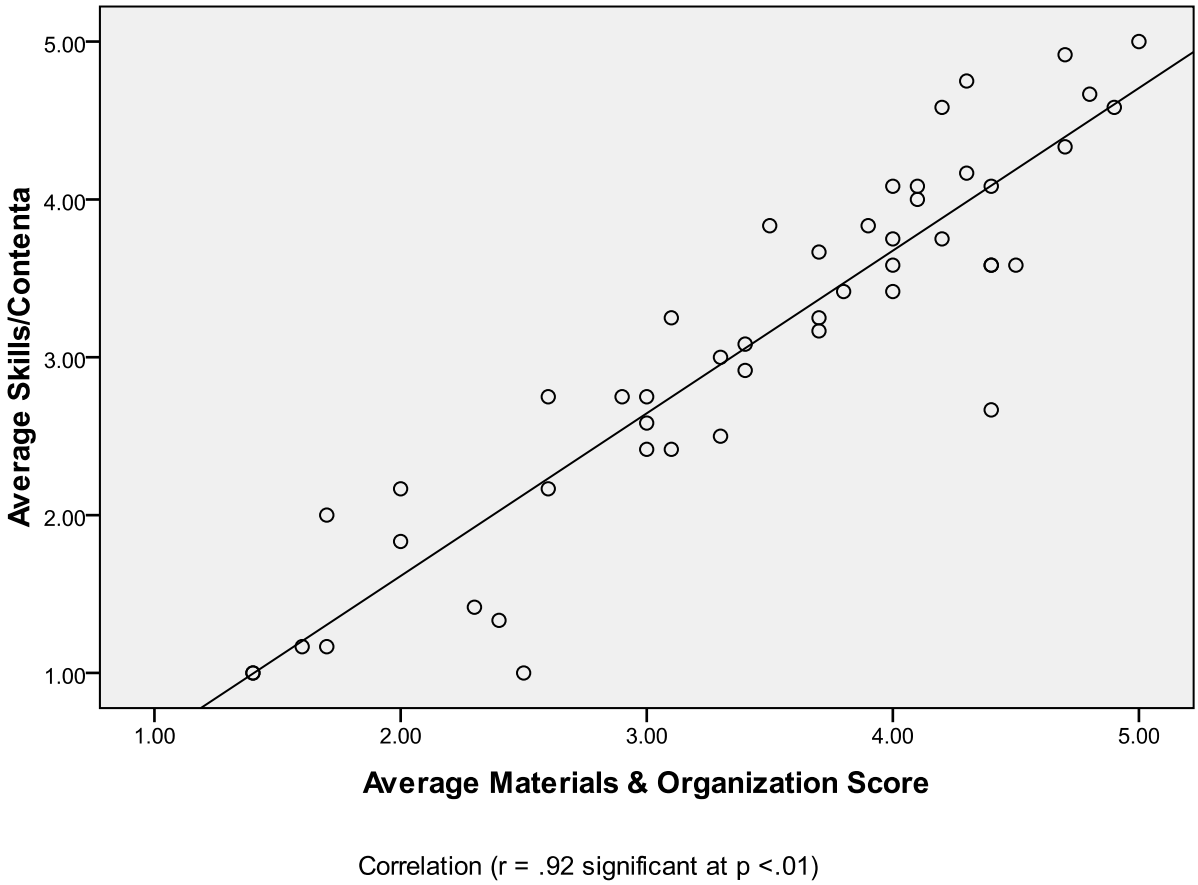
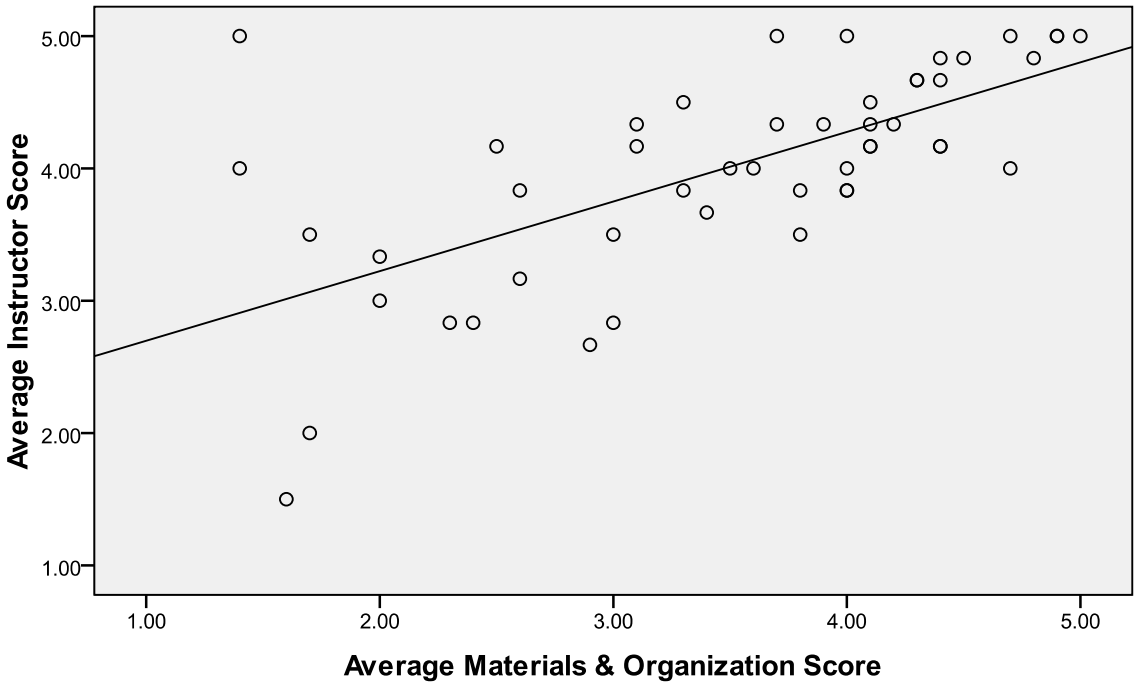


Figure 5. Correlation of driver materials and organization with skills/content scores.



Correlation (r = .67 significant at p <.01)

Figure 6. Correlation of driver materials and organization with instructor scores.

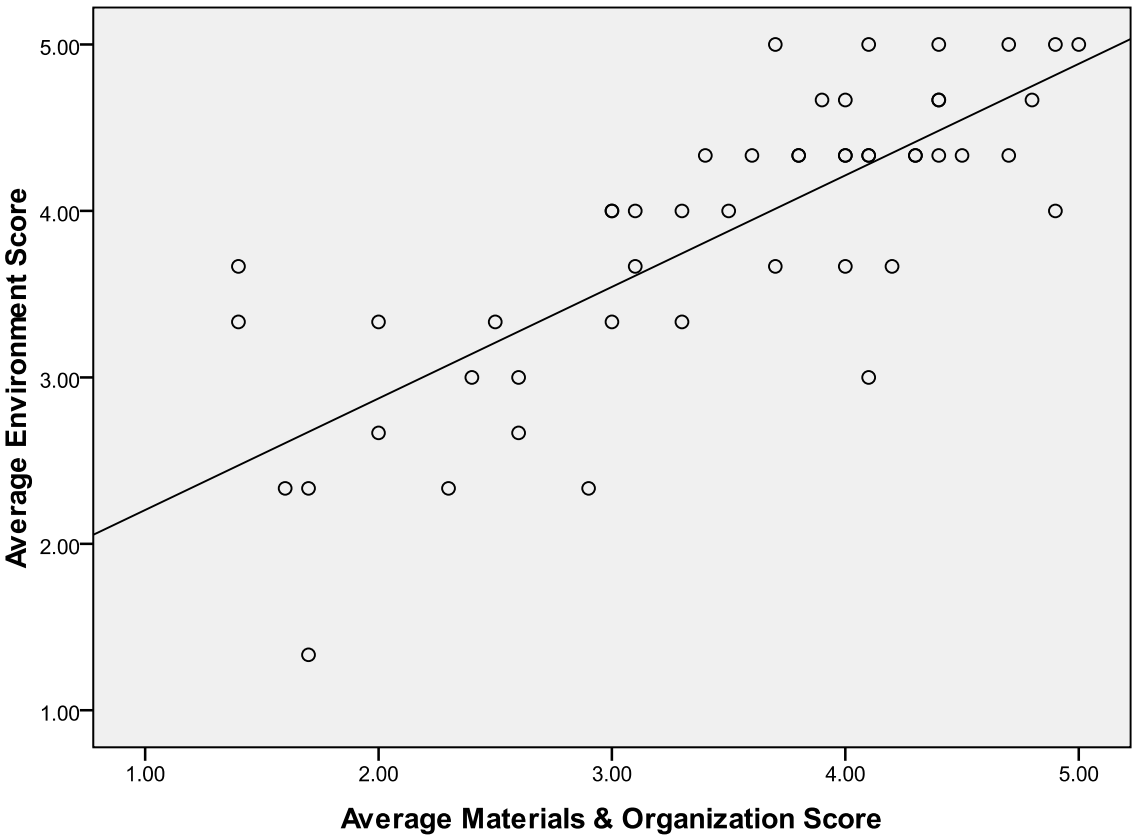
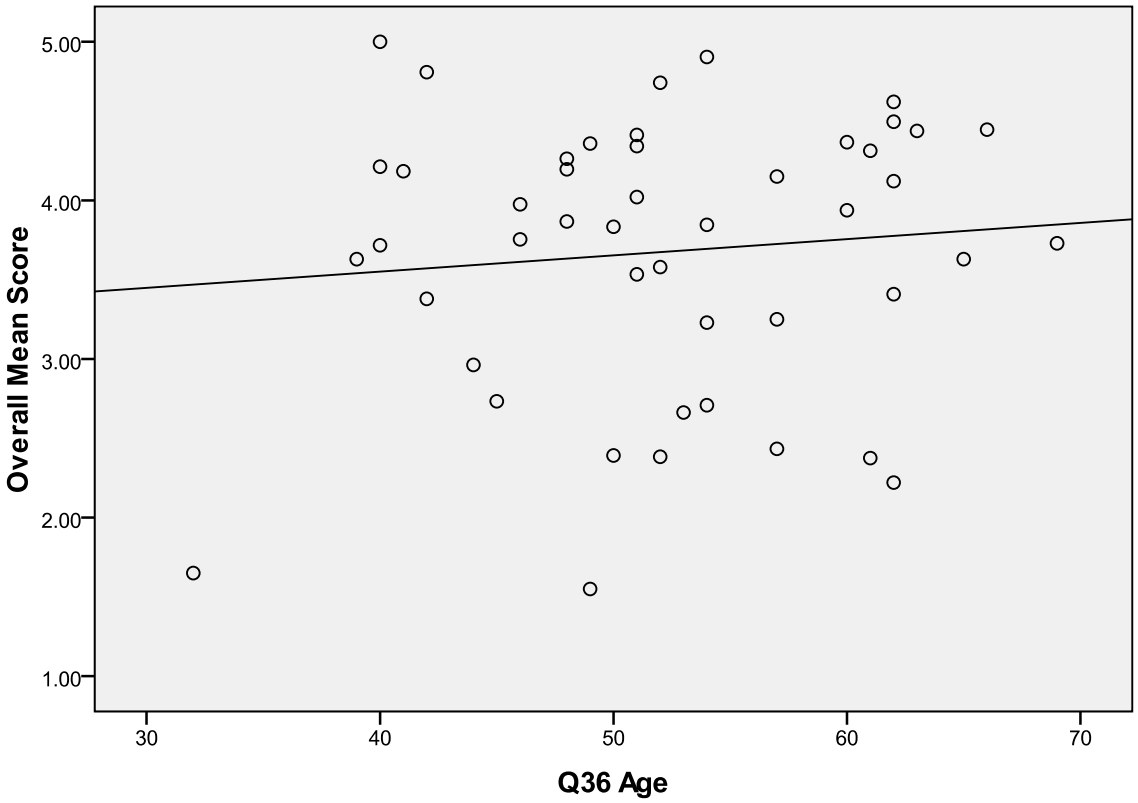


Figure 7. Correlation of driver materials and organization with environment scores.

OVERALL DRIVER EVALUATION SCORE AND AGE, YEARS WITH IDOT AND TOTAL YEARS OF SNOWPLOW DRIVING

Finally, correlation analysis was used to assess if driver training evaluation was related to either age, number of years as an IDOT snowplow driver, or total years of snowplow driving. To assess this, the overall mean driver score for all four sections of the evaluation questionnaire was correlated with age, number of years as an IDOT snowplow driver, and total years of snowplow driving. The results of the Figures 8 to 10 scatterplots are encouraging, as they fail to show any statistically significant relationship by age, years as an IDOT snowplow driver, and total years of snowplow driving.

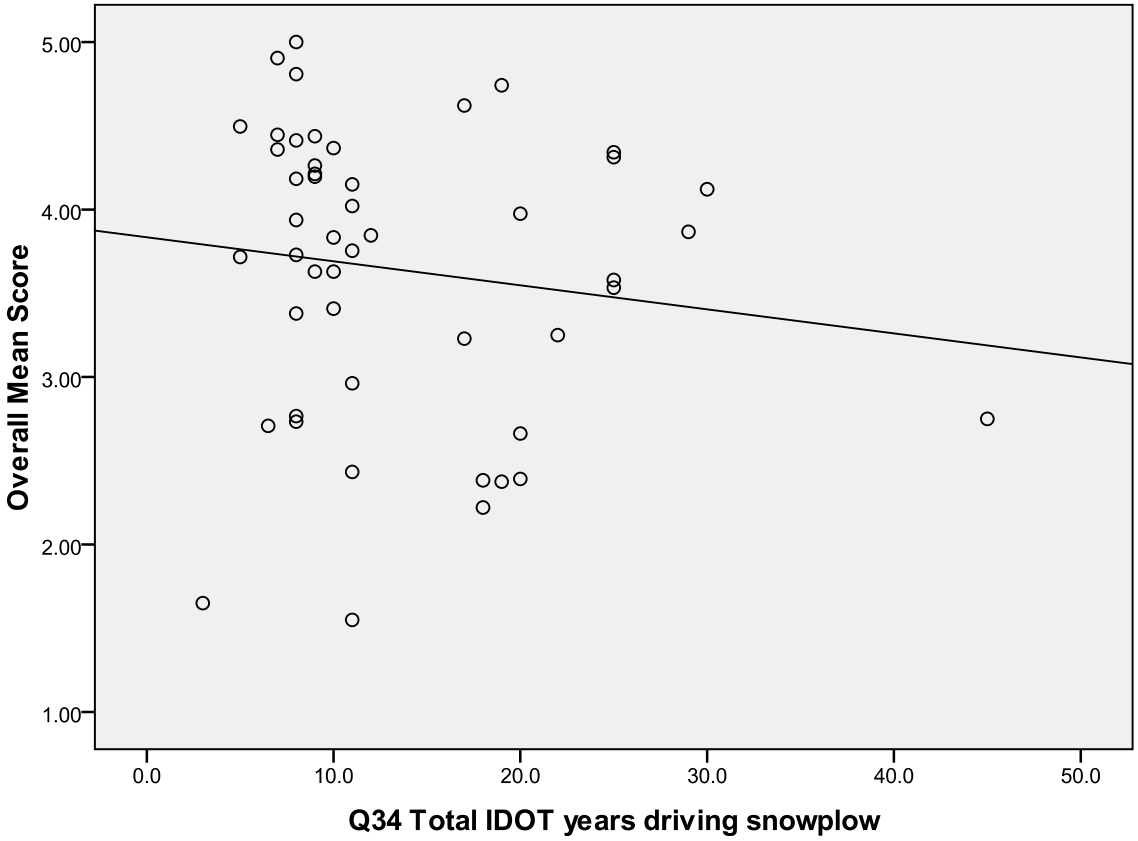
With respect to age (Figure 8), although there is a slight positive trend (more favorable scores as age increases), it is not significant. As the scatterplot shows, most drivers scored the training favorably (above a score of 3 on a 5 point scale) regardless of age.



Correlation (r = .10 not significant at p <.05)

Figure 8. Correlation of overall mean score with driver age.

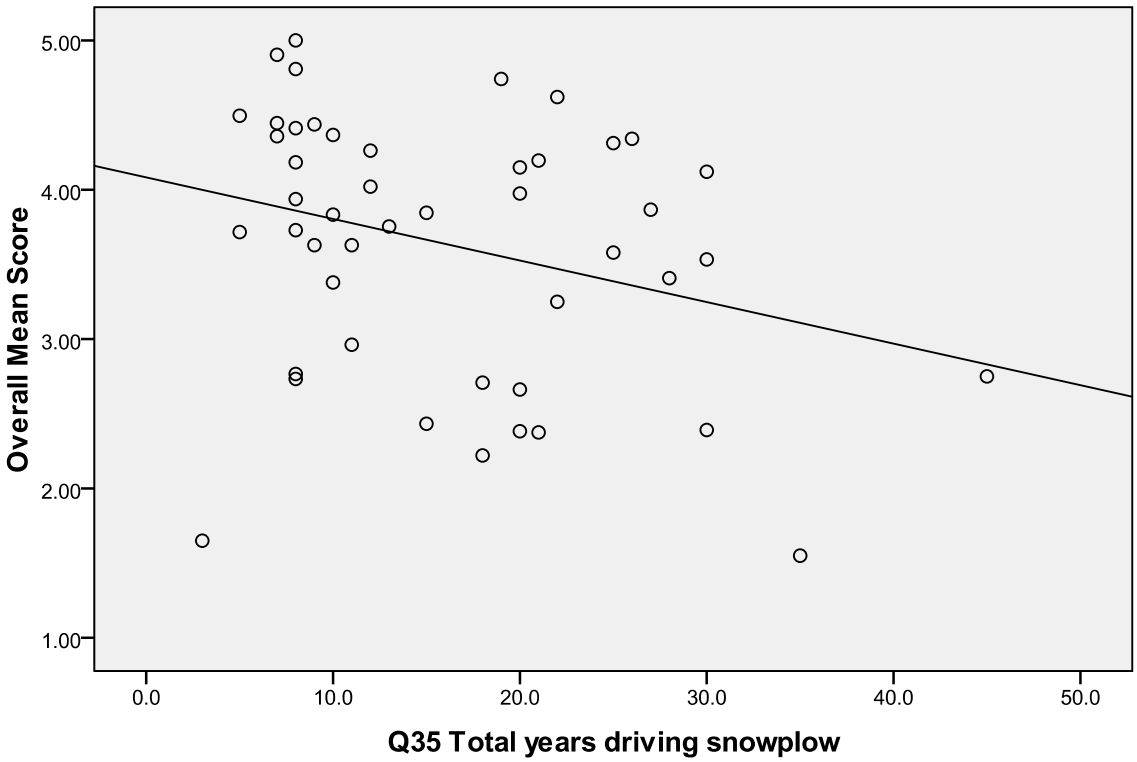
For Figure 9, there was a slight negative but overall favorable (above 3.0 on the 5 point scale) non-statistically significant correlation noted with the trend for average scores to be somewhat lower with increasing years as an IDOT driver.



Correlation (r = -.14 not significant at p <.05)

Figure 9. Correlation of overall mean score with years as an IDOT driver.

For Figure 10, there was a slight positive but overall favorable (above 3.0 on the 5 point scale) non-statistically significant correlation noted, with the trend for average scores to be somewhat higher with increasing total years as a snowplow driver.



Correlation (r = -.30 not significant at p <.05)

Figure 10. Correlation of overall mean score and total years driving a snowplow.

DRIVER ACCIDENT DATA

Four respondents (8%) reported being involved in an accident. None were involved in more than one accident. In three of the four cases, drivers reported they were at fault. In one case, the other driver was at fault. None of the accidents involved injury to any driver. Two respondents reported damage to their vehicle. One was for $400, when the other driver was at fault, and the other was for $2,000. There were two reports of other property damage, of $350 and $500, with the IDOT drivers at fault. Overall, there were no serious accidents reported either in terms of injury or property damage.

SUPERVISOR ASSESSMENT OF SIMULATOR TRAINING

Questionnaires were sent to supervisors in nine of the ten IDOT districts who sent one or more people to the simulation training. After the snow season, district supervisors were surveyed to assess their attitudes about the simulation and the performance of drivers who took the simulation relative to those who did not. Supervisors were also asked about the scope of their regular snowplow driver training. A copy of the district supervisor questionnaire is found in Appendix D at the end of this report. The reader is encouraged to review the questionnaire when reading this report.

Responses were received from 20 supervisors in seven districts (#2, 4, 5, 6, 7, 8, 9, and 411). Most supervisors (N = 10) reported sending two drivers from their district while three district supervisors reported sending four drivers. In one instance the respondent was not a driver but a “snowship leader” who attended the simulation, supervised the drivers, and reported sending no drivers. Fourteen (70%) of district supervisors who reported sending a driver to simulation training also reported that those drivers took the regular training.

Using a five-point scale where 1 = much better, 2 = somewhat better, 3 = about the same, 4 = somewhat worse, and 5 = much worse, supervisors were asked to assess how drivers who took the simulator training (as a whole, not individual drivers) performed as a group relative to drivers who did not take the simulator training. Percentages and a mean, with 1 being the highest score (much better) and 5 being the lowest score (much worse), were calculated for each item. Results are presented in Table 6.

Table 6. District Supervisor Assessment of Simulator Trained Snowplow Drivers Relative To Non Simulator Trained Drivers
(figures in percent form)

Item	Much better	Somewhat better	About the same	Somewhat worse	Much worse	Mean*
Driver decision making skills before the simulator training …….	0	16%	83%	0	0	2.8
Driver decision making skills after the simulator training…….	5	42	53	0	0	2.5
Driving ability before the simulator training……	0	11	83	6	0	2.9
Driving ability after the simulator training…….	5	37	58	0	0	2.5
Overall driver assessment…….	5	36	59	0	0	2.5

* On a scale of 1 to 5, where 1 = Much better, 2 = Somewhat better, 3 = About the same, 4 = Somewhat worse and 5 = Much worse.

As indicated by the percentages and mean scores (lower mean being a better score), results were positive, with supervisors reporting a trend that simulation-trained driver performance improved relative to drivers not taking simulation training. That is, lower means were reported for drivers after the training than before the training with respect to decision making skills and driving ability. Overall driver assessment was also positive, with 41% of the supervisors reporting that simulation driver respondents were either better or about the same. Also noteworthy was that no supervisors reported their drivers being worse after the training.

Next, supervisors were asked several questions about their thoughts and attitudes on simulator training, as they are in an influential position to support or not support this form of training. A four point Likert scale ranging from 1 (strongly agree) to 4 (strongly disagree) was used. Percentages and a mean were calculated for each item. For the means, 1 was the highest score and 4 the lowest score except for the “thought it was a waste of time” item where a higher score indicating disagreement was more positive. Results are presented in Table 7.

Table 7. District Supervisor Attitudes About Snowplow Simulation Training
(figures in percent form)

	Strongly agree	Somewhat agree	Somewhat disagree	Strongly disagree	Mean*
I think simulator training is effective …	22	67	11	0	1.9
I would recommend simulator training					
for new hires …….	72	22	6	0	1.3
for veteran drivers ……	17	44	33	6	2.3
for all drivers …….	17	44	22	7	2.4
Overall, drivers who took the simulator training thought it was worthwhile …….....	19	63	12	6	2.0
Overall, drivers thought the simulator training was a waste of time …	6	31	38	25	2.9

*On a scale of 1 to 4, where 1 = Strongly agree, 2 = Somewhat agree, 3 = Somewhat disagree, and 4 = Strongly disagree.

Overall, supervisor response was quite favorable. The vast majority (89%) agreed that simulation training was effective, especially so (94%) for new hires and somewhat less but still favorable (61%) for veteran drivers (also 61% for all drivers). In addition, 82% agreed that drivers thought simulator training was worthwhile. However, while nearly two-thirds (63%) disagreed that simulation was a waste of time, 37% did agree that it was a waste of time.

Next, district supervisors were asked about their regular snowplow training. Results are presented in Table 8.

Table 8. District Supervisor Reporting On Their Regular Snowplow Training

Item	Mean	Median	Range
Number of drivers trained ……	66.1	35.0	0-280
# of hours behind the wheel…….	10.9	8.0	0-32
# of hours other than behind the wheel	10.2	8.0	0-34
# of miles driven per driver.	117.8	95.0	0-450
Total # of accidents ……	0	0	0
Total # of injuries (drivers & others) …….	0	0	0
Estimated $ damage to IDOT vehicles ……..	0	0	0
Estimated $ damage to IDOT equipment other than vehicles ……	0	0	0
Estimated $ damage to other property other than vehicles ……	0	0	0

Results from Table 8 indicate a wide range of drivers trained, with one district supervisor having no drivers trained while another reported 280 drivers trained. In this and most other instances, the median (the middle score or 50th percentile) is usually preferable to the mean, since it is not influenced by extremes at either end of the range. Just over a half of the supervisors (53.8%) reported training 35 or fewer drivers and nearly 70 percent (69.3%) had 45 or fewer drivers. The median number of hours of behind-the-wheel training was 8 hours; two thirds (66.7%) had 12 hours or less; and 83.3% had 16 hours or less of behind-the-wheel training. The median number of miles driven was 95.

The median number of hours other than behind the wheel was also 8 hours and only 11.8% had 16 or more hours of training. Interestingly, one respondent reported having no behind the wheel or other driver training. No supervisor reported any accident, injuries, equipment damage, or damage to other property other than vehicles during any training.

Comments were received from 11 supervisors. Supervisors expressed overall support for training especially for new hires as indicated by comments such as," First priority for simulator training should be drivers with less than 5 yrs experience," "I strongly agree with this training. Needs to be required for all new hires and definitely snowbirds. Good course," "Think simulator training good for new drivers & temp help." These comments are consistent with other supervisor questionnaire responses as well as comments from drivers. With few exceptions, overall comments about simulation training were favorable. A listing of all supervisor comments is found in Appendix D.

COST OF SNOWPLOW DRIVER TRAINING

SIMULATION TRAINING COST

Using data and estimates provided by IDOT, an estimated per-driver capita cost for simulator training for 80 drivers was calculated. Elements in developing the cost of simulator training included the cost of the company (MPRI) providing the training, the salary costs (wages and benefits), as well the cost to transport drivers to and from the training site. Also included were the estimated IDOT legal and staff costs associated with negotiating and approving the MPRI contract and IDOT staff time associated with organizing and administering the training. It should be noted that we did not include any one time IDOT start-up costs that would not likely be incurred again for future trainings.

Total costs were then divided by 80 drivers to obtain a per capita driver cost for simulator training. In addition, a per capita cost for simulator training was calculated as if it were on site, not including transportation, as well as with and without fringe. Table 9 provides the items used in calculating the costs.

Table 9. Per Driver Simulator Training Cost*

Item	Amount	IDOT Fringe @ x118.52%	Total
MPRI	$20,000	$ 0	$20,000
80 Highway Maintainers (3 hours in transit) @ $31.13	7,471	8,855	16,326
18 vans (4.5 people per van) @ $7.50/hr for 3 hours)	405	0	405
80 Highway Maintainers (3 hours in training) @ $31.13/hr	7,471	8,855	16,326
5 Field Techs (ET V) @ 1 hour each @ $36.49	182	216	398
3 Operations Engineers (CE VII) @ 4 hours each @ $49.70	596	706	1302
1 Maintenance Engineer (CE VII) @ 16 hours @ $49.70	795	942	1,737
10 Field Techs (ET V) reports @ 1 hour each @ $36.49	365	433	798
Total cost	$37,285	$20,007	$57,292

Driver per capita cost including transportation = $37,285/80 drivers = $466 (no fringe)
Driver per capita cost without transportation = $29,814/80 drivers = $373 (no fringe)

Driver per capita cost including transportation = $57,292/80 drivers = $716 (with fringe)
Driver per capita cost without transportation = $40,966/80 drivers = $512 (with fringe)

Assumptions:
Average driving time of 1.5 hours each way to and from the training site.
4.5 drivers per van.
2 hours of training and 1 hour of time before and after the training for orientation and follow-up with instructors on driver simulator driving performance and evaluation.

BEHIND-THE-WHEEL TRAINING COST

Using data and estimates provided by IDOT, a per-driver capita cost for conventional behind the wheel snowplow driver training was calculated. It should be emphasized that, based on supervisor data, a wide range of conventional behind the wheel snowplow driver training was noted. The intent here is to provide a rough per capita driver estimate in order to compare conventional to simulator driver training costs while fully realizing that significant variation occurs across districts.

Elements in developing the cost of the regular training included the salary costs of the drivers and staff time of a highway maintainer lead worker to conduct a three hour training at the site. Other costs were for hourly costs of the snow plow trucks as well as the costs for an operations engineer and field techs involved with organizing and administering the snowplow driver training. No cost of IDOT-caused accidents or vehicle and other property damage during training were included since none were reported.

Total costs were then divided by 80 drivers to obtain a per capita driver cost for the behind-the-wheel training with and without fringe. Table 10 provides the items used in calculating the costs. Table 11 presents a comparison of the cost of simulation to conventional behind-the-wheel training.

Table 10. Behind-the-wheel training Cost*

Item	Amount	IDOT Fringe @ x118.52%	Total
80 Highway Maintainers (3 hours in training) @ $31.13/hr	7,471	8,855	16,326
10 Highway Maintainer Lead workers @ 1 hour training @ $32.54	325	385	710
80 Snow Plow Trucks T-64 (3-Ton): @ 3 hours @ $25.75 per hour	6,180	0	6,180
1 Operations Engineer (CE VII) @ 4 hours @ $49.70	199	236	435
10 Field Tech (ET V) reports @ 1 hour @ $36.49	365	433	798
Total cost	$14,540	$9,909	$24,449

Driver per capita cost = $14,540/80 drivers = $182 (no fringe)
Driver per capita cost = $24,449/80 drivers = $306 (with fringe)

Assumptions:
Drivers trained on site by Lead worker.
That the Highway Maintainer Lead workers will supervise several workers on at least a 3 drivers to 1 trainer ratio.

Table 11. Comparison of Per Capita Behind-the-wheel training Cost To Simulation Training Cost

Includes	(A) Behind the wheel	(B) Simulation on site	(C) Simulation off site	% difference B to A	% difference C to A	% difference C to B
With fringe	$306	$512	$716	67%	134%	40%
Without fringe	182	373	466	105%	156%	25%

Simulation training on site is 67% higher than conventional behind-the-wheel training and 134% higher when off site if fringe costs are included. Without taking fringe costs into consideration, simulation training on site is 105% higher and simulation training off site is 156% higher. Finally, simulation training off site is 40% higher than simulation training on site if fringe is included and 25% higher if fringe is not included.

Results clearly show that per capita driver cost for simulation training is significantly higher than conventional behind-the-wheel training. Simulation training on site is estimated to be 71% higher than behind-the-wheel training when fringe is included and 139% higher when simulation training is conducted off site. Without taking fringe into consideration simulation training on site is 107% higher and 159% higher when simulation training is done off site. Finally, simulation training off site is 39% higher than simulation training on site when fringe is included and 25% higher when fringe is not included.

Although the differences are significant, an informed decision involves IDOT estimating the opportunity costs, benefits, and tradeoffs of conducting simulation training that doesn't require as much use of IDOT personnel and equipment as traditional training; involves less exposure to accident, injury, or property damage; and provides greater flexibility in scheduling simulation training that can be conducted at times other than the snow season. Although at higher costs, simulation training may free up equipment and other personnel that may be used more advantageously elsewhere. However, unless there is a compelling reason, it does not appear that simulation training, as conducted in this study, is cost effective compared to conventional behind-the-wheel training.

SNOWPLOW DRIVER PERFORMANCE

Snowplow driver performance during the 2009-2010 snow season was assessed based on IDOT records. During the season, there were approximately 2,800 snowplow drivers. A review of all snowplow driver records in the IDOT database was conducted. There were 41 reported accidents during the 2009 snow season. Reported accidents where an IDOT driver was determined not to be at fault were deleted. The remaining seven accidents where it appeared the driver may be at fault were analyzed in terms of accidents, injuries, and vehicle and equipment damage caused by the incident.

The seven reported accidents reflect an accident rate of rate of 2.5/1000 drivers (or .25% of drivers – one quarter of one percent) during the snow season. No deaths, significant injuries, or major damage to vehicles were reported. A rate per miles driven could not be calculated since exposure (total miles driven) was not available.

As previously mentioned in this report 50 (65%) of the initial 77 drivers who completed a questionnaire immediately after the fall simulator training also completed a post-training questionnaire. Four of the simulator-trained drivers reported being involved in an accident. None were involved in more than one accident. In three of the four cases, drivers reported they were at fault. This translated into a 6% of simulator drivers who responded who self reported an accident where it appears they may have been at fault. In one case, the other driver was at fault. None of the accidents involved injury to any driver. Two respondents reported damage to their vehicle. One was for $400, when the other driver was at fault, and the other was for $2,000. There were two reports of other property damage, of $350 and $500, with the IDOT drivers at fault. Overall, there were no serious accidents reported either in terms of injury or property damage.

While the incidence of accidents appears higher for simulation-trained drivers, any definitive conclusion comparing the simulation-trained to not-simulation-trained drivers can't be made for several reasons. These reasons include: the IDOT data records did not identify whether the driver was simulation-trained, and there is no certainty that the IDOT records contained all accidents. Some, especially minor accidents, may not have been reported. This may account for the apparently low number of possible driver-caused accidents from the IDOT records. Also, the low number of simulator drivers trained and the low number of accidents reported make any comparisons inconclusive. And the self-reported simulator driver accident findings are not comparable to the IDOT records. Finally, the short amount of training of just a few hours is not sufficient to assess the effectiveness of the simulation training. For all of these reasons, the results from this study, including the absence of any significant driver caused accidents, injuries, or property losses, there is no evidence to support the merits of either conventional behind-the-wheel or simulation training with respect to driver performance. To adequately compare the merits of each type of training would require a more rigorous design and data collection method as well as a longer time period.

OVERVIEW OF SNOWPLOW SIMULATOR TRAINING EVALUATIONS

A number of agencies, including state Departments of Transportation indicate simulator training provides benefits such as improved driver safety, fuel savings, and reduced wear and tear on plow trucks. While a number of studies, including the present Illinois evaluation, have indicated that simulator training has been well received by drivers and supervisors, it is also evident that strong empirical data of the effectiveness and cost effectiveness of simulation training that uses well accepted research design and data analysis is limited. For example, given the inherent difficulties associated with conducting scientific investigations in “real world” settings, hardly ever is there an experimental and control group with random assignment of drivers. Nor do most studies have a pre-post test measure. For example, a few studies report on snowplow driver evaluation of simulator training right after training and before the snow season, but unlike the current Illinois study, do not include a post snow season driver evaluation of the simulation training. Nor do many studies include an evaluation of the simulation training by supervisors as done in the Illinois study.

As seen repeatedly, in reviewing the literature on snowplow simulator training as described below, there is an absence of conclusive evidence of the effectiveness or efficiency of snowplow simulator training. However, these same studies fail to show any negative or detrimental evidence of simulator training. Most of these reports mention and caution that evidence of desired benefits is largely anecdotal and that they are in the early stages of quantifying the merits of snowplow simulator training. Again, the problem frequently cited is that challenges of the “real world” with respect to snowplow driving do not lend itself to rigorous experimental testing. This is summed up well by an Arizona DOT’s LTAP and Technical Training Director, who mentions that, “Intuitively, we know that simulator training has produced improvements in areas such as fuel usage and vehicle wear and tear,... It’s clear to see. The problem comes when you try to measure the benefits. It’s very difficult to isolate fuel usage and repair data for snowplow operations because the drivers and equipment are utilized in many other activities as well.”

Other observations from the literature seem to support the idea that simulator training should be viewed as a complement to on-the-road training rather than replacing it. Also, L-3 Communications, MPRI Division appears to predominate in the development and provision of snowplow simulation training and technology. Most users who have either purchased their simulator (L-3’s TranSim VS Series) or contracted with MPRI appear satisfied with their product or services.

The following highlights a summary of findings of reports and/or studies from several states (CTC & Associates LLC & WisDOT Research & Library Unit, 2008). The reader is encouraged to review the entire reports at the website or reference provided.

ARIZONA
(http://www.azdot.gov/TPD/ATRC/publications/project_reports/PDF/AZ635.pdf)

The Arizona Department of Transportation (ADOT) introduced simulator-based training in 2004, when maintenance crews in five rural districts received a third-party snowplow safety topics course on the L-3 TranSim VS III simulator. In early 2006, all of the district’s drivers took a Fuel Management Driving Techniques (FMDT) course on proper shifting techniques for better fuel economy . The goal of this study was to identify the benefits of simulator-based training in fuel economy and driveline repair costs for ADOT’s heavy vehicle fleet (College of Architecture and Environmental Design, 2007). The focus of

the study was to assess: (1) Potential improvements to fuel economy, recorded in the simulator training session, (2) Driver performance in the real-world environment, in terms of fuel economy, (3) Changes in fuel economy and repair costs related to proper driving/shifting skills. Three years of district fuel and repair histories were reviewed for periods before and after the 2006 training. Five significant “high mileage” work activity areas were studied. Results were mixed due to many variables, but the critical “snow and ice activity” category did show some improved fuel economy for early 2007. However, the records showed no clear reduction in driveline repairs for January-March ‘07, but noted that an additional cost of repairs is the time that trucks needing extensive work are out of service. This study used Kirkpatrick’s four-level evaluation model to assess if the training improved fuel economy in the Globe District. At the Reaction level, results are positive; crews say the training did increase awareness and change driving behaviors with regard to fuel efficiency. At the Learning level, results show some drivers improved but others did worse in post-testing. At the Performance level, the results are promising: drivers of manual-shift trucks achieved improvements in fuel economy. At the Results level, aggregate fuel economy figures also show a discernable difference in pre-training and post-training fuel efficiency for key winter maintenance tasks.

ARIZONA
(http://www.azdot.gov/TPD/ATRC/publications/project_reports/PDF/AZ585.pdf)

AZDOT’s primary focus was on driver response to simulator training and the effectiveness of that training in terms of public safety and potential cost savings (College of Architecture and Environmental Design, 2006). Clear quantitative results on this small scale have been limited, but two years of experience with simulator-trained snowplow operators in Arizona have resulted in optimism about the potential of simulators as an integral part of a comprehensive winter maintenance and driver skill training program.

IOWA (http://www.ctre.iastate.edu/reports/snowplow_simulator_final.pdf)

IDOT commissioned a study through Iowa State University to 1) assess the use of this simulator as a training tool and 2) examine personality and other characteristics associated with being an experienced snowplow operator (Center for Transportation Research and Education, 2007). The results of the study suggest that IDOT operators of all ages and levels of experience enjoyed and seemed to benefit from virtual reality snowplow simulator training. Simulator sickness ratings were relatively low, implying that the simulator is appropriate for training a wide range of Iowa DOT operators. Many reported that simulator training was the most useful aspect of training for them.

UTAH DOT

One of the better designed studies found in the literature is: The Development and Evaluation of a High-Fidelity Simulator Training Program for Snowplow Operators by the Department of Psychology, University of Utah (2004). In that study, a four hour customized training program incorporating high-fidelity simulation was developed for 40 snowplow operators in a collaborative research project with the Utah Department of Transportation, the University of Utah, and General Electric Driver Development. Four key areas were identified for training: space management, speed management, crew communication, and fuel management. Ratings of user acceptance of the training were very high, with drivers of all levels of experience indicating that the training helped them prepare for several issues critical to the safe and efficient operation of a snowplow. In the six-month period following

training, the investigators found that the odds of getting in an accident were lower for the group of drivers who received training compared with a matched control group who did not receive training, and the estimated cost associated with each accident was also lower for the drivers who received training. Data also indicated that fuel efficiency was greater for the trained drivers than for the control group. However, the report also mentions, “Unfortunately, several factors make it difficult to evaluate the effectiveness of simulator training on fuel management and maintenance costs in the current study. The major problem was that there was not a unique assignment of vehicles to drivers. On many occasions more than one driver would use a vehicle during a storm and in some regions vehicles would occasionally change stations during the season, making it difficult to associate specific vehicle parameters with a unique driver…. To complicate matters further, examination of the fuel records indicates that on many occasions the fuel card assigned to one vehicle was used to fill several vehicles (e.g., two vehicles in the same shed with the similar miles driven for a one-month interval would have vastly different fuel consumption rates i.e., 0 vs. 1137 gallons). In sum, neither the maintenance data nor the fuel data are of sufficient quality to afford a precise comparison between the study and control groups.”

ANECDOTAL REPORTS

The following three anecdotal reports are included in the 2008 publication Virtual Snowplow Training: State of the Practice and Recent Research Prepared for the Clear Roads Pooled Fund Study by CTC & Associates LLC and the WisDOT Research & Library Unit, 2008.

District of Columbia Department of Public Works, and Department of Transportation

The Department of Public Works and the District of Columbia Department of Transportation partnered on a contract for snowplow training from MPRI on the TranSim VS IV simulator. About 200 drivers of light and heavy snowplows were trained over the course of two weeks on software tailored for the District of Columbia. When asked about the benefits of the training, the administrator mentioned, “With regard to operator safety, I can tell you that this winter DPW has logged about 34,000 hours in the snow program, probably 90 percent of it driver time, and we haven’t had a single reported accident since the training. Those are pretty good numbers, even for clear pavement. We’re looking at putting the simulators to work for additional vehicles such as street sweepers and garbage packers.” Again, this highlights the anecdotal nature of many reports.

New Mexico DOT

According to the NMDOT Training Academy Director, “In terms of measurable benefits, I can tell you that I have not had one truck in the shop for transmission repair since we acquired our first simulator in August 2006. We used to have lot of the large trucks in for transmission repairs from teaching people how to shift the gears on big rigs out on the training runway. Now that students learn to shift on a simulator first, we don’t have them grinding gears and tearing up transmissions like they used to. Before we got the simulator, we needed to spend about two days on the runway just teaching the students how to shift a truck. Now we only need to spend a half day doing that, so we can get the students out on the road a little sooner for some real-world experience in the kinds of work they will be doing.”

Sauk County Wisconsin

According to the Safety/Risk Manager, “One the one hand, there’s no real way to simulate what goes on out there when the snow falls and you actually have to plow. But the unit does give our drivers some extra, valuable experience. For example, during an actual snow event, one of our drivers lost two tires on the Interstate, but was able to bring the truck under control and park it safely. He and the other drivers had prepared for these types of incidents on the simulator, which can replicate tire loss, tire blowouts, and other serious equipment malfunctions. We also use the machine to teach our operators a lot about defensive driving, because that’s basically what you’re doing when you’re plowing…Ninety percent of the feedback I get from the students is very positive….Some of their comments reveal a lot about the value of the training. I’ve heard this one more than once: ‘You know, I never really thought of driving that way before (using more observation skills)—I’m used to driving by feel. But when I left the training, I kind of found my eyes had opened up and I was looking around more, even in my own car.’ ”

SUMMARY

This report includes the results and analysis of the snowplow driver simulator training evaluation immediately after the training in the Fall 2009 and a follow-up of drivers after the snow season; the supervisor assessment of the simulator training after the snow season; a description of conventional training at the District level; an estimated cost analysis of the simulation training and conventional behind-the-wheel training; a review of the accident records of snowplow drivers who participated and who did not participate in the simulation training; and a review of reports from other states on simulator training.

Based upon a review of the MPRI training materials and observation of several training sessions, the training appears to have many features consistent with well-established educational principles (see Appendix A - Snowplow Pre Simulator Training Study - Report & Questionnaire). The training is a blend of instructor, computer-based training, and simulator-based training. The use of diverse methods is educationally sound. Each element seemed well developed and contributed to the overall learning. The instructors were prepared, knowledgeable, personable, helpful, and worked well as a team with each adding to the learning experience. The use of PowerPoint slides helped to augment lecture. Encouraging was the use of active learning by inviting trainee participation and the positive reinforcement throughout all course elements. Active learning was facilitated by shifting between lecture, simulation exercises, and computer-based training. It seemed that the training flowed well. This appeared to maintain attention and enhance learning. Trainees also received feedback of their performance and assistance by the instructors as needed. Driver evaluation of the training supported these observations.

One concern is that the time allotted may not be sufficient. Some lengthening should be considered. The training was a bit rushed to cover the material in time. This was noted by the trainees, evaluator, and instructors. This is not to say the training needs to be lengthened considerably, but an additional 30 minutes per training session appears to be needed. The training requires multiple moves from lecture to simulator or from lecture to computer-based training. Each takes a few minutes. At times, the training somewhat resembled a school hallway during recess – hurried and congested. This was particularly noticeable with the self-paced computer training and during the final simulation assessment. It was also apparent when the trainers printed out the final simulator assessment results, providing feedback as well as obtaining the trainee evaluation forms, all the while as the next group was ready to begin the next session. At least another 30 minutes may be needed to accomplish these tasks in a more satisfactory manner.

L-3 Communications, MPRI Division appears to predominate in the development and provision of snowplow simulation training and technology. Most users who have either purchased their simulator (L-3's TranSim VS Series) or contracted with MPRI appear satisfied with their product or services.

Although overall favorable, driver evaluations after the snow season were less favorable than immediately after the fall training. Results clearly show a lower post evaluation score in terms of Course Material and Organization, Acquisition of Skills/Content, Instructor, and Simulator Training Environment.

No significant correlations were found among driver evaluation of the simulator training and driver age, years driving for IDOT, or total years of snowplow driving.

Supervisor response to simulator training was quite favorable. Supervisors reported that simulation-trained driver performance improved relative to drivers not taking simulation training in terms of decision making skills, driving ability, and overall driver assessment. No supervisors reported their drivers being worse after the training.

The vast majority (89%) agreed that simulation training was effective, especially so (94%) for new hires and somewhat less but still favorable (61%) for veteran drivers. In addition, 82% agreed that drivers thought simulator training was worthwhile and nearly two-thirds (63%) disagreed that simulation was a waste of time.

With respect to training at the district level, just over a half of the supervisors (53.8%) reported training 35 or fewer drivers and nearly 70 percent (69.3%) had 45 or fewer drivers. The median number of hours of behind-the-wheel training was 8 hours; two thirds (66.7%) had 12 hours or less, and 83.3% had 16 hours or less of behind-the-wheel training. The median number of miles driven was 95.

The median number of hours other than behind-the-wheel was also 8 hours and only 11.8% had 16 or more hours of training.

No supervisor reported any accident, injuries, equipment damage, or damage to property other than vehicles during any training.

With a few exceptions overall, supervisor comments about simulation training were favorable and consistent with supervisor questionnaire responses as well as comments from drivers.

An estimated per-driver capita cost for simulator and conventional training was calculated.

Per capita driver cost for conventional behind-the-wheel training is significantly less than simulation training. Although the differences are significant, an informed decision involves IDOT estimating the opportunity costs and benefits, and tradeoffs of conducting simulation training that doesn't require as much use of IDOT personnel and equipment involved in conducting training, less exposure to accident, injury, or property damage, and the greater flexibility in scheduling simulation training that can be done at most times other than the snow season**.** However, unless there is a compelling reason, it does not appear that simulation training, as conducted in this study, is cost effective compared to conventional behind-the-wheel training.

A review of IDOT snowplow drivers' recorded accidents and simulation drivers' reported accidents, injuries, and property damage during the past snow season did not evidence the merits of simulation training compared to conventional behind-the-wheel training. Because of multiple reasons identified in this report, including the absence of any significant driver caused accidents, injuries or property losses, there is no evidence to support the merits of either conventional behind-the-wheel or simulation trained with respect to driver performance.

A review of the literature on snowplow driver simulation evidences that while a number of studies, including the present Illinois evaluation, have indicated that simulator training has been well received by drivers and supervisors, it is also evident that strong empirical data of the effectiveness and cost effectiveness of simulation training using well accepted research design and data analysis is limited given the inherent difficulties associated with conducting scientific investigations in "real world" settings.

Other observations from the literature and this evaluation support the idea that simulator training should be viewed as a complement to on-the-road training rather than a replacement for it.

Results of this study are generally consistent with other reports indicating favorable driver evaluation of simulation training and provide additional insight. This study adds to the current knowledge in several ways. While several existing studies report on snowplow driver evaluation of simulator training immediately after training and before the snow season, this study goes further to include a post snow season driver evaluation of the simulation training thus providing a pre-post training evaluation. This study also includes an evaluation of the simulation training by supervisors while most others do not.

IDEAS FOR FUTURE RESEARCH

The author makes the following suggestions for potential future study:

- Review and incorporate the input of drivers, supervisors, and the evaluator contained in this report and then evaluate the simulation training and driver performance before and after the snow season to assess if the simulation training improved driver evaluation and performance.
- Evaluate simulation-trained driver performance with a larger number of simulation-trained drivers over a three-year period. More cases are needed to determine any effectiveness.
- Consider a more controlled study with a few simulator and non-simulator trained drivers in only a few districts but where records of the type of truck, the drivers using the truck, the vehicle maintenance, and fuel usage are kept.
- While the report contains driver evaluation of the simulator training before and after the snowplow season, the absence of respondent identification did not allow for matched cases. Thus, it is not known how any individual evaluated the simulation. It would be preferable to use matched cases. In this case, we could assess if differences were due to many or few drivers. Having matched cases would answer this question. Differences between pre- and post- also could be assessed by age and years of driver experience.
- Given the apparent wide variation of district training, it would be useful to obtain a better understanding of what training is taking place across districts with the intent of improving the overall driver training process.

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APPENDIX A: PRE-SNOWPLOW SEASON SNOWPLOW SIMULATOR TRAINING STUDY - REPORT & QUESTIONNAIRE

SNOWPLOW PRE SIMULATOR TRAINING EVALUATION REPORT

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January 2010

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INTRODUCTION

This report presents the results and analysis of (1) the snowplow driver evaluation and (2) "behind the wheel" driver assessment from the snowplow driver training conducted by MPRI for the Illinois Department of Transportation (IDOT) and 3) evaluator observation of the training. The training was conducted during the week of Monday, November 30 to Friday, December 4, 2009 in three locations: Ottawa on November 30 and December 1, Bloomington on December 2, and Collinsville on December 3-4. Eighty drivers were scheduled to participate. To obtain a first-hand perspective of the simulator training, the external evaluator attended several classes at the Bloomington training site. His comments are included in this evaluation.

Results of the snowplow driver evaluation will be presented first, followed by the findings of the "behind the wheel" driver assessment. A 34-item questionnaire form was developed to assess driver evaluation of the simulator training. The questionnaire was developed by the evaluator based on a review of other state snowplow evaluations, the simulator company manual, and in consult with IDOT staff. The evaluator's IDOT contact person was Mr. David Johnson, who was helpful in responding to evaluator requests throughout the evaluation process.

The questionnaire consisted of five sections: Course Material and Organization, Acquisition of Skills/Content, Instructor, Simulator Training Environment and driver demographic data. Driver-related items were the training site, primary type of route plowed, years of IDOT snowplow operator experience, total years of snowplow operator experience with IDOT and others, and driver age. A copy of the questionnaire is shown in Appendix A.

RESULTS

DEMOGRAPHIC FINDINGS

Demographic findings are presented first, followed by the results of each of the four sections assessing driver evaluation of the simulator training.

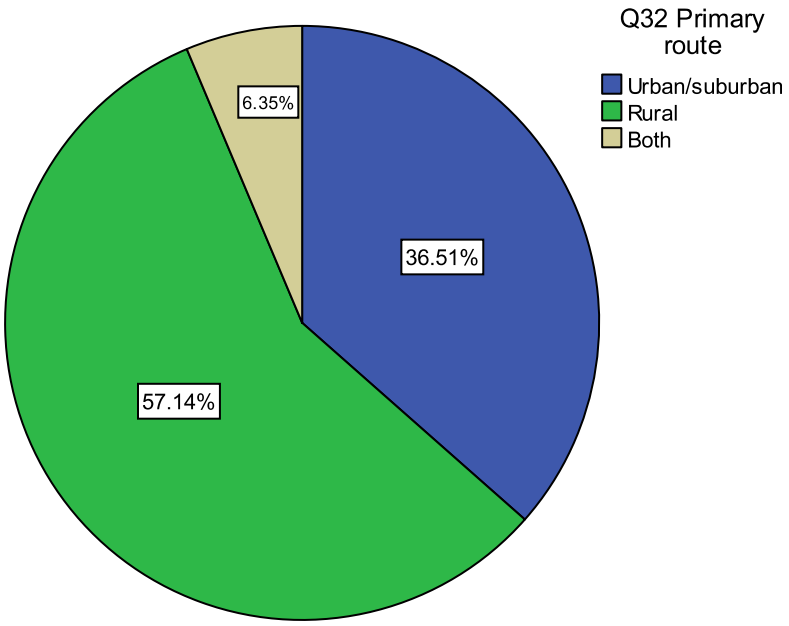
As shown in Table 1, 77 driver training evaluation forms were received: 30 from Collinsville, 17 from Bloomington, and 30 from Ottawa.

Table 1. Q31 - Training Site

		Frequency	Percent
Valid	Collinsville	30	39.0
	Bloomington	17	22.1
	Ottawa	30	39.0
	Total	77	100.0

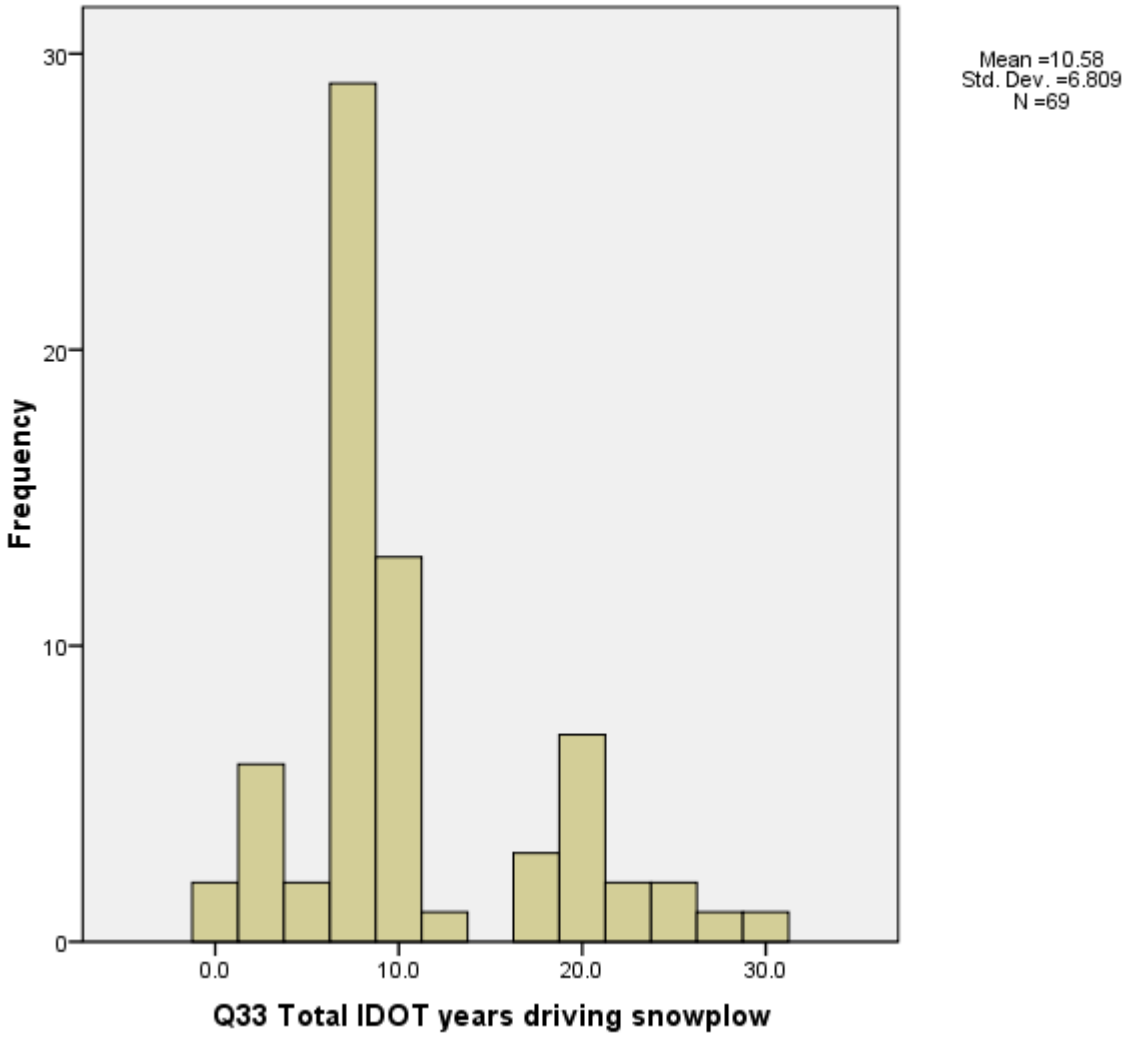
Drivers were asked to identify their primary route as either urban/suburban or rural. Results of the primary route identified by drivers are shown in Figure 1. Some drivers circled both alternatives and those are so identified. Quite likely the “both” category would be greater if that alternative had been provided.

Figure 1 Primary Driver Route



With respect to total years of snowplow driving, a wide range (0-29 years) was found. IDOT drivers reported an average (mean) of 10.6 years and a median value of 8 years (middle point of all drivers where half drove more and half drove less). The median is often a better measure because, unlike the mean, it is not influenced by extremes at either end of the distribution range, such as drivers with very many or very few years of IDOT driving. Figure 2 depicts (a histogram) of the number of years drivers reported snowplowing for IDOT.

Figure 2 Total IDOT Years Driving Snowplow



The histogram clearly shows that IDOT drivers are in two groups. Again, and not surprisingly, a wide range from 2 to 29 years was reported. Half have approximately 10 years of service and the others approximately 20 years or more of service.

Figure 3 depicts the total number of years drivers reported plowing for IDOT and others. In terms of total years of snowplow driving experience (IDOT and others), the mean was 12.5 years and the median (middle value) was 9.5. It is clear from these data that most driver experience is with IDOT.

Figure 3 Total Years of Driver Expereince

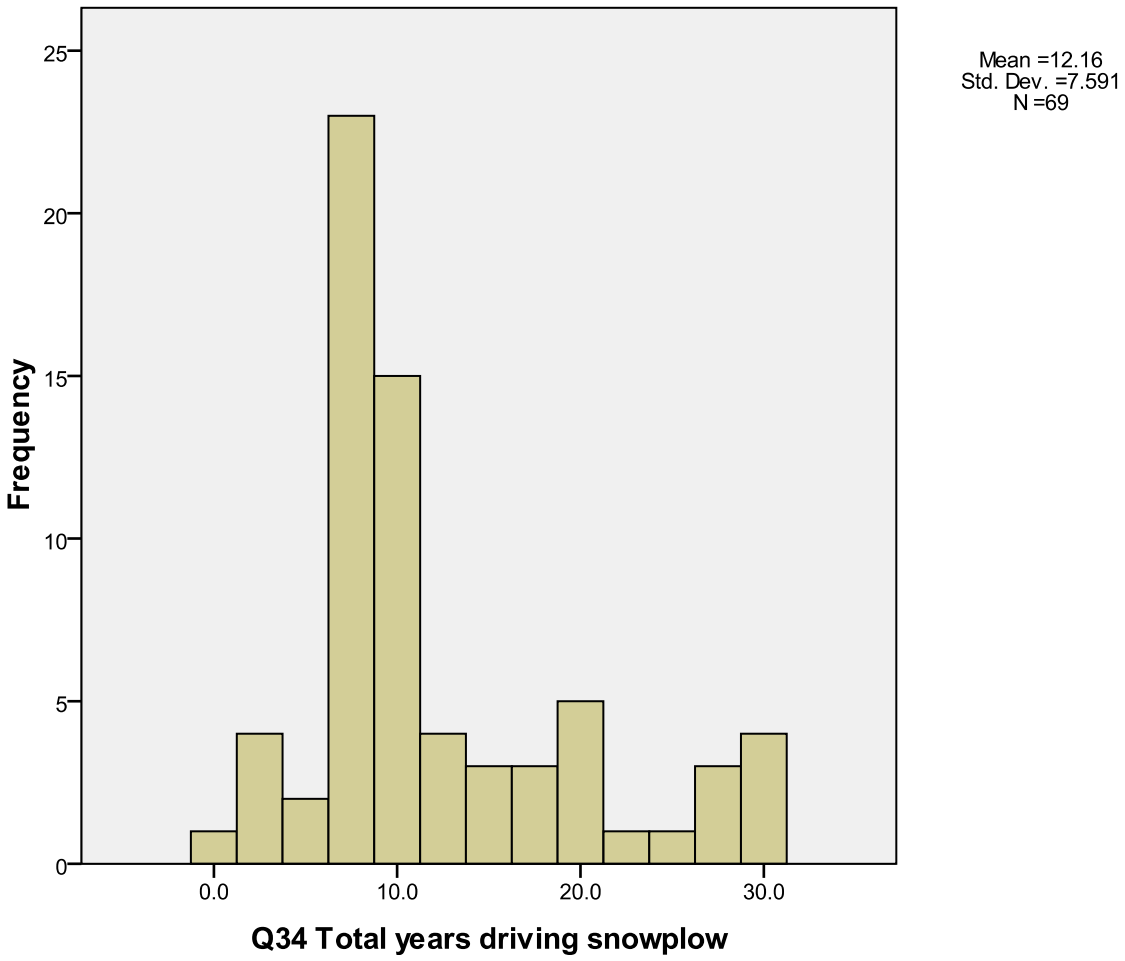
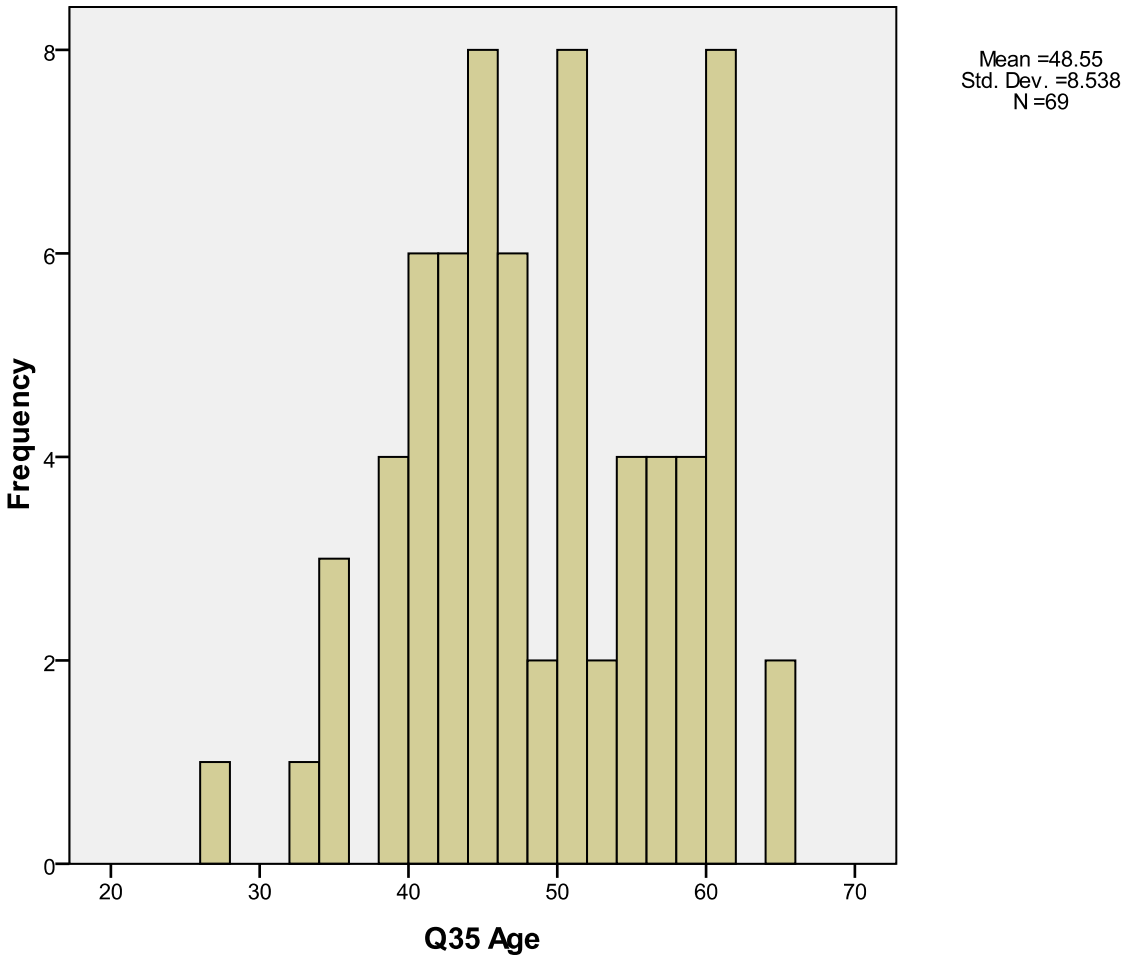


Figure 4 depicts driver age. The mean age (48.6) and median (47) are close. This indicates that driver age is fairly normally distributed, although there is a wide range of ages (27 to 65). While the mean age is less than 50, one fifth of drivers (20%) are 58 or older. Given that no driver is 65 or older, this indicates that new drivers will be needed in the next few years.

Figure 4 Age Composition of Drivers



DRIVER EVALUATION OF TRAINING

The next tables report the findings of the other four sections of the questionnaire: Course Material and Organization, Acquisition of Skills/Content, Instructor, and Simulator Training Environment.

COURSE MATERIAL AND ORGANIZATION

There were 10 items in the Course Material and Organization section of the evaluation questionnaire. Each item was scored on a 1 (strongly disagree} to 5 (strongly agree) scale. Thus, the highest score for an item was 5 and the lowest 1. An item score of 3.0 would be in the middle or neutral position on the scale. Most items were worded in the affirmative where 5 (strongly agree) was the most positive response and 1 was the most negative. However, to maintain respondent attention and ensure reliability, three items were worded in the negative so that a positive opinion required responding disagree or strongly disagree (number 1). The three items were Q.6 (Not much was gained by taking the training), Q.25 (Some things were not explained very well), and Q.30 (The simulator made me nauseous). For analysis purposes, these three items were recoded so that a response of 5 was the most positive and could be compared to other items.

Results for the Course Material and Organization section of the evaluation questionnaire are presented in Table 2. Results show that all items received a favorable mean score of 4.1 or higher on a five-point scale The overall mean for all items in this section was 4.2, indicating a very favorable response.

Consistency was indicated by all items having mean scores between 4.1 and 4.3 on a five-point scale. Review of the percentage results showed almost all items received about an 80% favorable rating. Overall, drivers reported they would take another class taught this way (84%), that the training was worthwhile (90%), that simulations were useful (92%), that simulations were realistic (77%) and would be useful on the road (80%). Finally drivers thought the time spent on the lecture portion was appropriate (85%) and 74% thought the time spent on the driver simulation portion was appropriate. The overall range for driver scores was from 5 to 2.1. The low score should be considered an outlier because only three drivers evaluated the training less than the scale midpoint value of 3.0.

Table 2. Course Material and Organization
(figures in percent form)

Statement	Strongly disagree	Dis-agree	Neither	Agree	Strongly agree	Mean*
1. I would take another training that is taught this way.	3	4	9	26	58	4.3
2. The training material seemed worthwhile.	0	4	6	38	52	4.4
3. Overall the training was good.	1	4	7	26	62	4.4
4. The training using the simulator for optimal shifting was very useful. (NOT APPLICABLE)						
5. The simulations were very useful.	2	3	3	42	50	4.3
6. Not much was gained by taking this training.	56	31	8	3	2	4.4
7. The driving simulations were realistic for the training objectives.	1	6	16	30	47	4.1
8. I practiced skills during the driving simulation part of the training that will be very useful on the road.	1	4	15	33	47	4.2
9. The time spent in the lecture portion was appropriate.	3	4	8	34	51	4.3
10. The time spent in the driving simulation portion was appropriate.	2	7	17	29	45	4.1

* On a scale of 1 to 5, where 1 = strongly disagree and 5 = strongly agree, except for Q.6, Q.25 & Q.30 where the scoring was reversed.

ACQUISITION OF SKILLS/CONTENT

Findings of the 11 items covering Acquisition of Skills and Course Content are presented in Table 3. All items were scored favorably ranging from 3.7 to 4.4. Most were at or above 4.0. Overall, drivers thought the training should be part of IDOT training for all snowplow operators (85%), that the training prepared them for a dealing with non-routine situations (76%), that the training prepared them for a variety of specific situations, that it explained why speed (87%) and space management (88%) as well as good communication (84%) are important for safe plowing. Finally, 84% of drivers strongly recommended (4.4 on a 5 point scale) this training for other snowplow drivers. The overall mean score for all 11 items was a favorable 4.1 with a high of 5 and a low of 1.9. That low score should be considered an outlier since it was the only one below the scale midpoint value of 3.0.

Table 3. Acquisition of Skills/Content
(figures in percent form)

Statement	Strongly disagree	Dis-agree	Neither	Agree	Strongly agree	Mean*
11. This training should be part of IDOT training for all snowplow operators.	4	4	17	21	54	4.2
12. The training helped prepare me for dealing with non-routine situations.	1	7	16	33	43	4.1
13. The training helped prepare me for situations involving blade catching.	5	13	16	36	30	3.7
14. The training helped prepare me for situations involving plow movement.	1	13	27	29	30	3.7
15. The training helped prepare me for situations involving passing cars.	2	11	23	32	32	3.8
16. The training helped prepare me for situations involving vehicles or pedestrians along the side of the road.	0	12	16	33	39	4.0
17. The training helped prepare me for situations involving plowing over structures.	0	7	29	36	28	3.9
18. This training explained why speed management is important for safe plowing.	1	1	11	37	50	4.3
19. This training explained why space management is important for safe plowing.	0	4	8	37	51	4.4
20. This training explained why good communication is important for safe plowing.	0	4	12	36	48	4.3
21. I would recommend this training for other snowplow drivers.	3	1	11	26	59	4.4

*On a scale of 1 to 5, where 1 = strongly disagree and 5 = strongly agree, except for Q.6, Q.25 & Q.30 where the scoring was reversed.

INSTRUCTOR

Findings of the 7 items from the Instructor section of the evaluation form are presented in Table 4. All items were scored favorably, with most scored very high at 4.5 or higher on a 5-point scale. Overall, 95% said the training was taught well, that the trainer had a good understanding of the material (96%) and worked well with the drivers (96%). Only 18% felt that "Some things were not explained very well." In addition, 90% reported that the trainer understood their needs and issues and 93% said the trainers gave very useful feedback. The overall mean score for all 11 items was a very favorable 4.5 with a low of 1.2. The low score should be considered an outlier because only one driver evaluation was below the scale midpoint value of 3.0.

Table 4. Instructor
(figures in percent form)

Statement	Strongly disagree	Dis-agree	Neither	Agree	Strongly agree	Mean*
22. I think the training was taught quite well.	1	1	3	28	67	4.6
23. The trainer had a good understanding of the material.	1	0	3	22	74	4.7
24. The trainer worked well with the drivers.	1	1	2	19	77	4.7
25. Some things were not explained very well.	63	12	7	8	10	4.1
26. The trainer understood your needs and issues.	0	3	7	38	52	4.4
27. The trainer gave very useful feedback.	1	3	3	33	60	4.5

* On a scale of 1 to 5, where 1 = strongly disagree and 5 = strongly agree, except for Q.6, Q.25 & Q.30 where the scoring was reversed.

SIMULATOR TRAINING ENVIRONMENT

Findings of the 3 items from the Simulator Training Environment segment of the evaluation are presented in Table 5. All items were scored favorably. Drivers considered the facility adequate (86%) said that the simulator provided a good learning experience (90%). On the other hand, 20% reported that the simulator made them nauseous. When some driver discomfort was noted by the evaluator attending the Bloomington training, it should be noted that the discomfort was usually at the onset shortly after starting the simulator and was short lived. It did not appear to negatively affect driver performance on the simulator nor on the driver assessment at the end of the training session. The overall mean score was a very favorable 4.2 with a high of 5 and a low of 1.7. As with other sections of the evaluation, the low score should be considered an outlier since only one driver evaluation was below the scale midpoint value of 3.0.

Table 5. Environment
(figures in percent form)

	Strongly disagree	Dis-agree	Neither	Agree	Strongly agree	Mean*
28. The simulator facility was adequate.	1	4	9	32	54	4.3
29. The simulator provided a good learning experience.	1	0	9	33	57	4.4
30. The simulator made me nauseous.	56	10	14	9	11	3.9

* On a scale of 1 to 5, where 1 = strongly disagree and 5 = strongly agree, except for Q.6, Q.25 & Q.30 where the scoring was reversed.

SUMMARY OF EVALUATIONS

Table 6 presents a summary of the means for each of the four sections of the driver evaluation. Results were consistent with each section receiving a favorable score of 4.1 or higher on a 5-point scale with an overall mean across all sections of 4.3.

Table 6. Summary of Driver Training Evaluations*

Topic	Mean
Course Material & Organization	4.2
Acquisition of Skills/Content	4.1
Instructor	4.5
Simulation Training Environment	4.2
Overall Mean	4.3

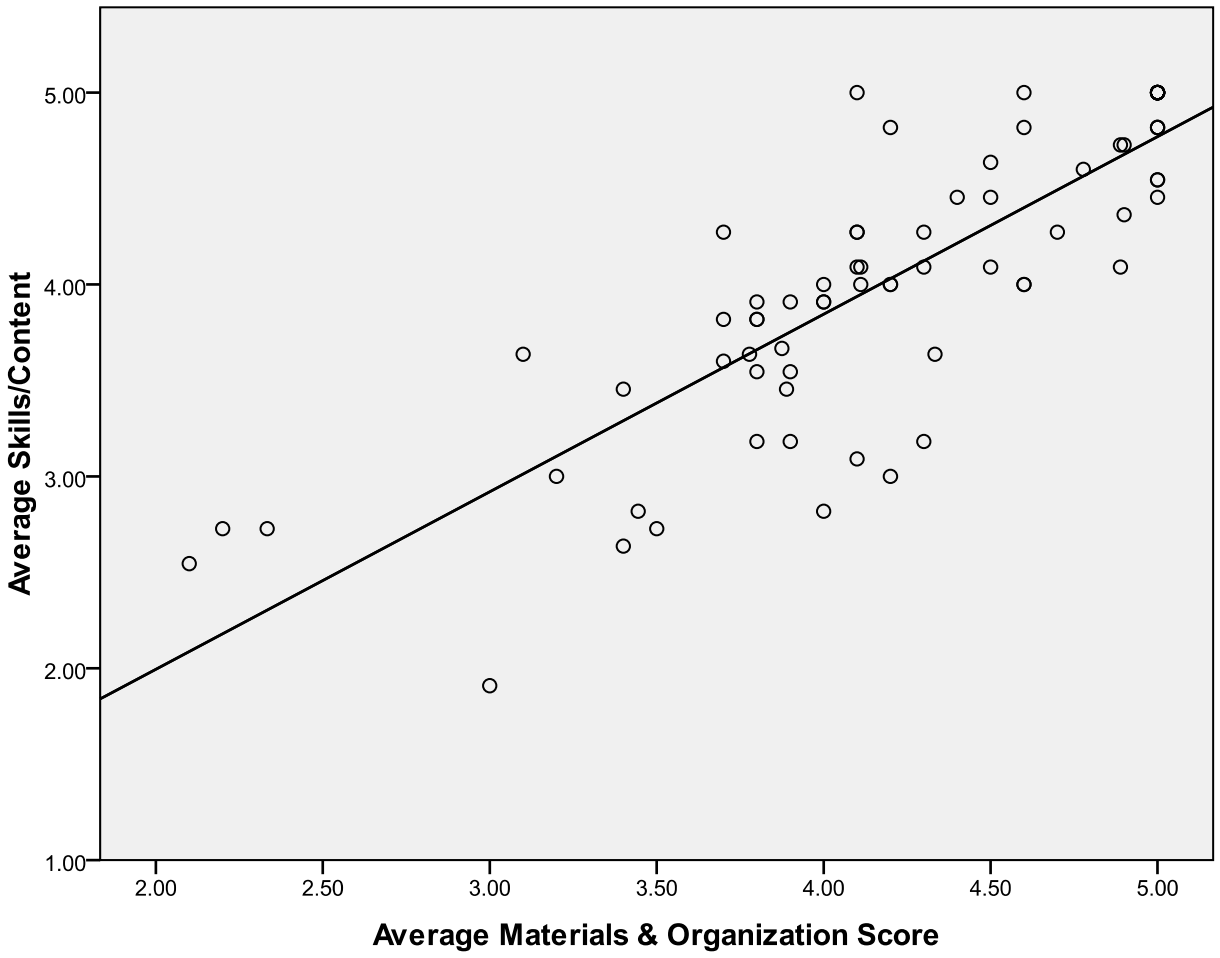
*On a scale of 1 to 5, where 1 = strongly disagree and 5 = strongly agree

CORRELATION FINDINGS

To obtain additional insight, several correlations were calculated. These included correlations between each of the four sections of the driver evaluation form (Materials & Organization, Skills/Content, Instructor and Environment). As background information, correlation values can be between +1.00 (that is, as the driver score for one section goes up or down it goes up or down at the same rate on the other section) and -1.00 (that is, as the driver score for one section goes up or down the score for the same driver goes in the opposite direction at the same rate on the other section). A .00 correlation means there is no relationship between driver scores on one section and scores on another.

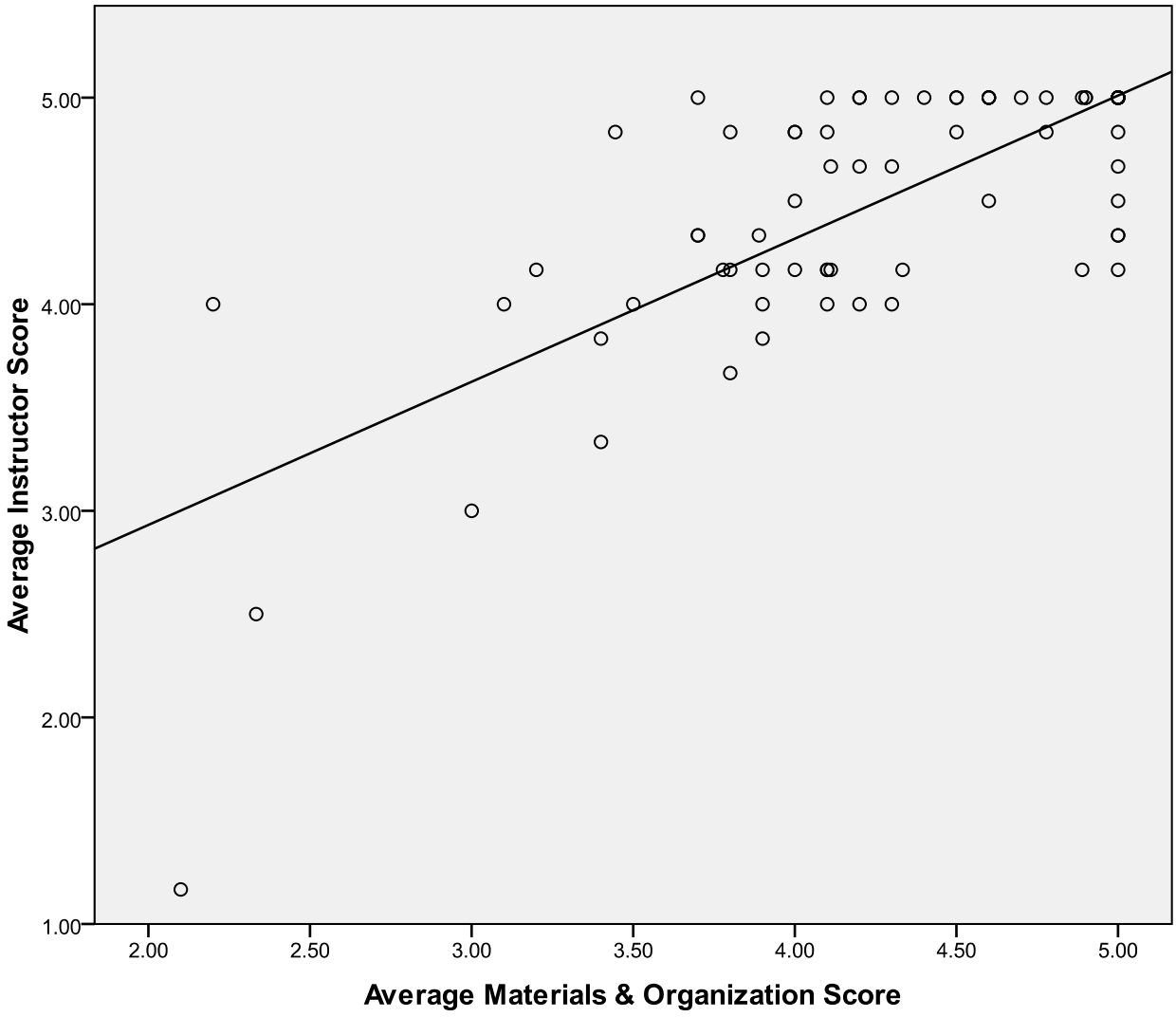
Results indicated that there was a positive significant relationship (p. <01) between driver scores on each of the four sections. To illustrate, Figures 5-7 presents scatterplots for the correlations of the Materials and Organization section with each of the other sections. Similar findings were found when other sections were correlated with each other. Each graph includes a line that reflects the “best fit” taking all scores into consideration.

Figure 5 Correlation of Driver Materials & Organization with Skills Content Scores *



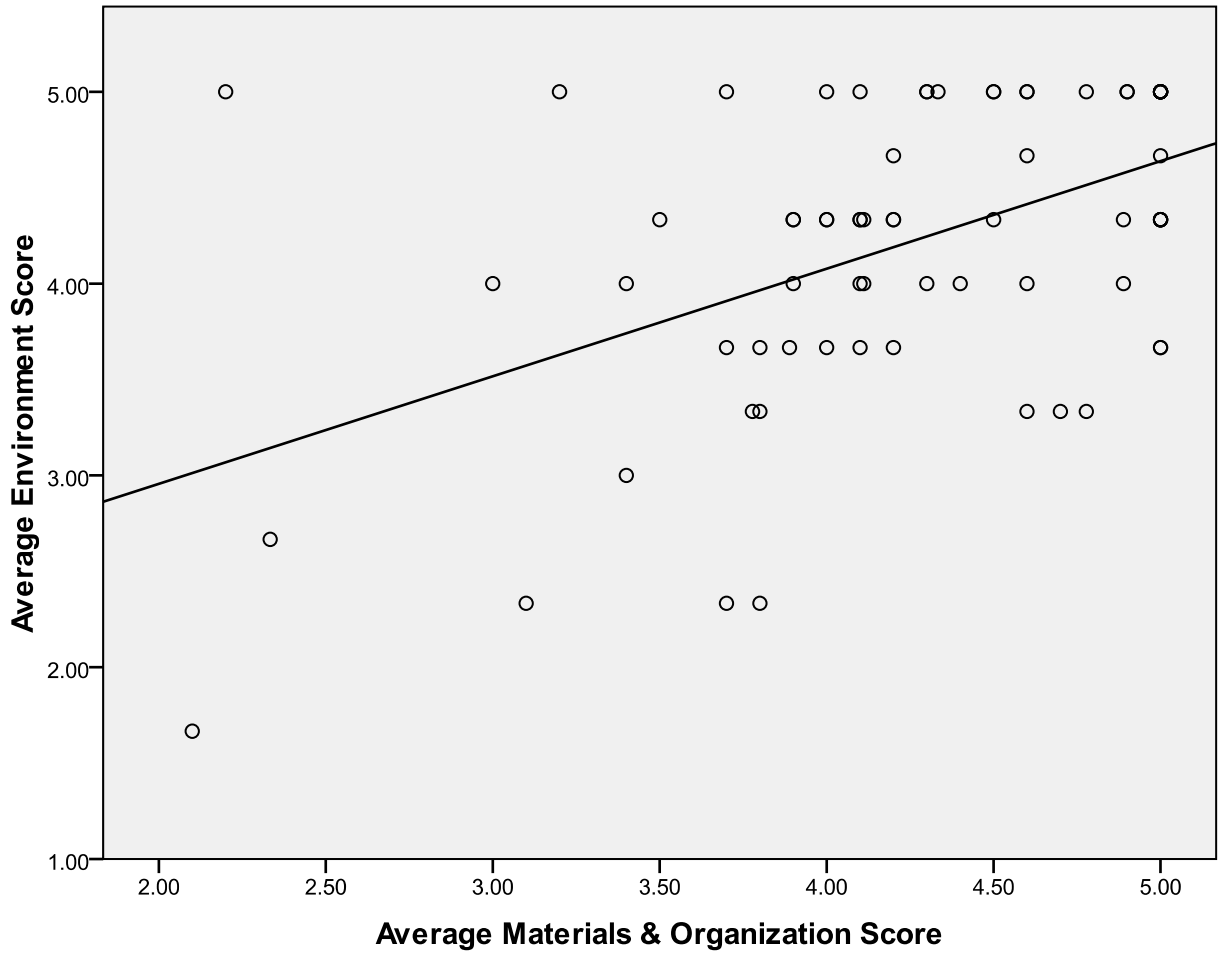
*Correlation (r = .84 significant at p <.01)

Figure 6 Correlation of Driver Materials & Organization with Instructor Scores *



* Correlation (r = .73 significant at p <.01)

Figure 7 Correlation of Driver Materials & Organization with Environment Scores *

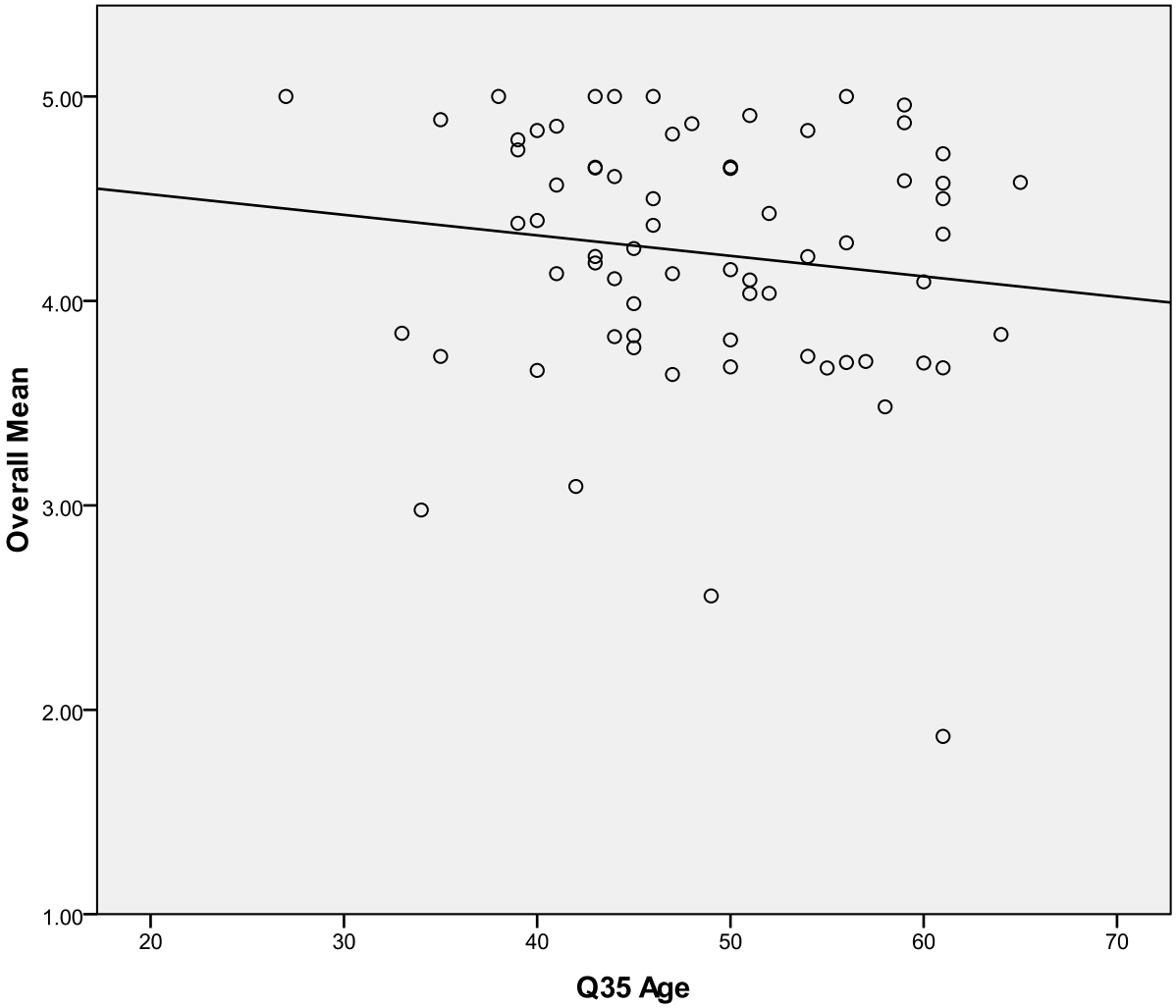


* Correlation (r = .50 significant at p <.01)

OVERALL DRIVER EVALUATION SCORE AND AGE

Finally, correlation analysis was used to assess if driver training evaluation was related to age. To assess this, the overall mean driver score for all four sections was correlated with age. Encouraging are the results of the Figure 8 scatterplot that fails to show any relationship. That is, although there is a slight negative trend in scores as age increases, as evidenced by the declining slope of the line from left to right, it is not significant. As the scatterplot shows, most drivers scored the training favorably regardless of age. Closer examination reveals that the trend would also be even less negative if not for one outlier driver who was 60 years old and who had a low training evaluation score.

Figure 8 Correlation of Age with Overall Mean Score



Correlation (r = -.06 not significant)

DRIVER ASSESSMENT FINDINGS

Each training consisted of two hours in which four drivers alternated between lecture and practicing on the simulator. There were two simulators available during each session with an instructor assigned to each simulator. During the simulation component, two drivers took turns practicing what was learned in lecture. The instructor provided feedback and encouragement throughout.

Each session concluded with each driver independently taking a final driver assessment performance by driving a route of approximately 1.45 miles not previously seen. While two drivers took their performance evaluation, the other drivers sat out of view of the performing drivers and completed a training evaluation form (results shown in the previous pages). The roles were then reversed. When each driver completed their driver assessment performance, they received a computerized score sheet that provided an overall score out of 100 as well as the number of violations and warnings during the route. For each violation a s point deduction was made. They also received a detailed assessment of their performance on four driving components - Space Management, Speed Management, Startup Procedure, and Turning. Results of the overall driver performance, as well as each of the four components, are presented in Table 7.

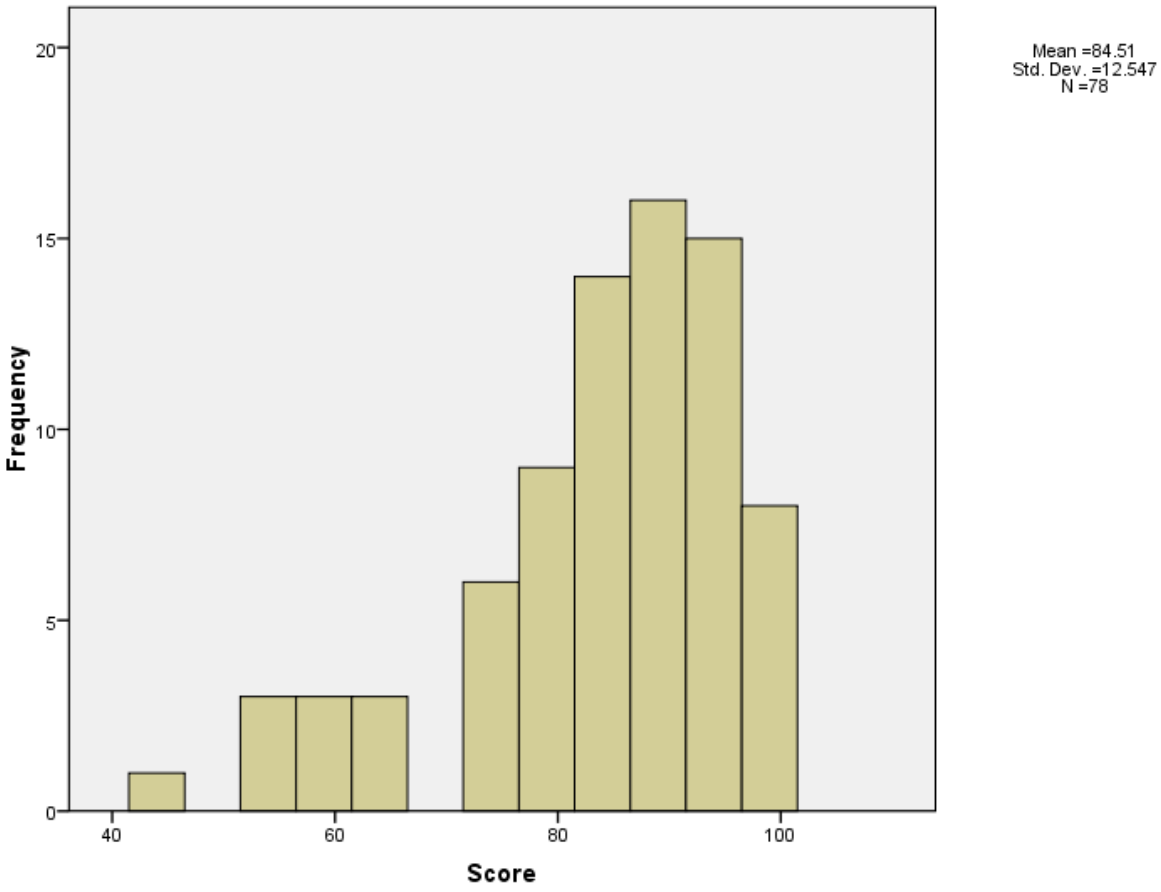
Table 7. Driver Assessment Performance
(N = 75 drivers)

Component	Mean	Median	High	Low
Overall score	84.5	86.5	100	44
Violations	2.9	2.5	10	0
Space Management	96.8	100	100	81
Violations	0.5	0	3	0
Speed Management	93.1	95	100	70
Violations	1.4	1	6	0
Startup Practice	97.1	100	100	73
Violations	0.4	0	2	0
Turning	97.6	100	100	85
Violations	0.5	0	3	0

Results from Table 7 indicate satisfactory performance. The overall mean was 84.5 and the median at 85. The similarity of both these measures indicated that scores were fairly normally distributed. The scores depicted an average of three violations at five points per violation. However, that data were not normally distributed with just a few drivers have many more violations. That is 27% had no violations and another 32% had only one violation. Overall 83% of drivers had two or less violations. At the other end, 12% of the drivers had 7 or more violations. Scores for each of the components were high with each showing a score above 90. Of the average of nearly three violations per driver most (1.4) were for Speed Management primarily Maximum Speed Limit Exceeded, Failed to Stop in Zone and Hard The remaining violations equally distributed over the other three components.

To get a better perspective of the results, Figures 9-13 present the driver performance scores in graphic form.

Figure 9 Overall Driver Assessment Scores



Results from Figure 9 clearly show most drivers scored well above 80 and there was only one outlying low score of 44.

Figure 10 Space Management Scores

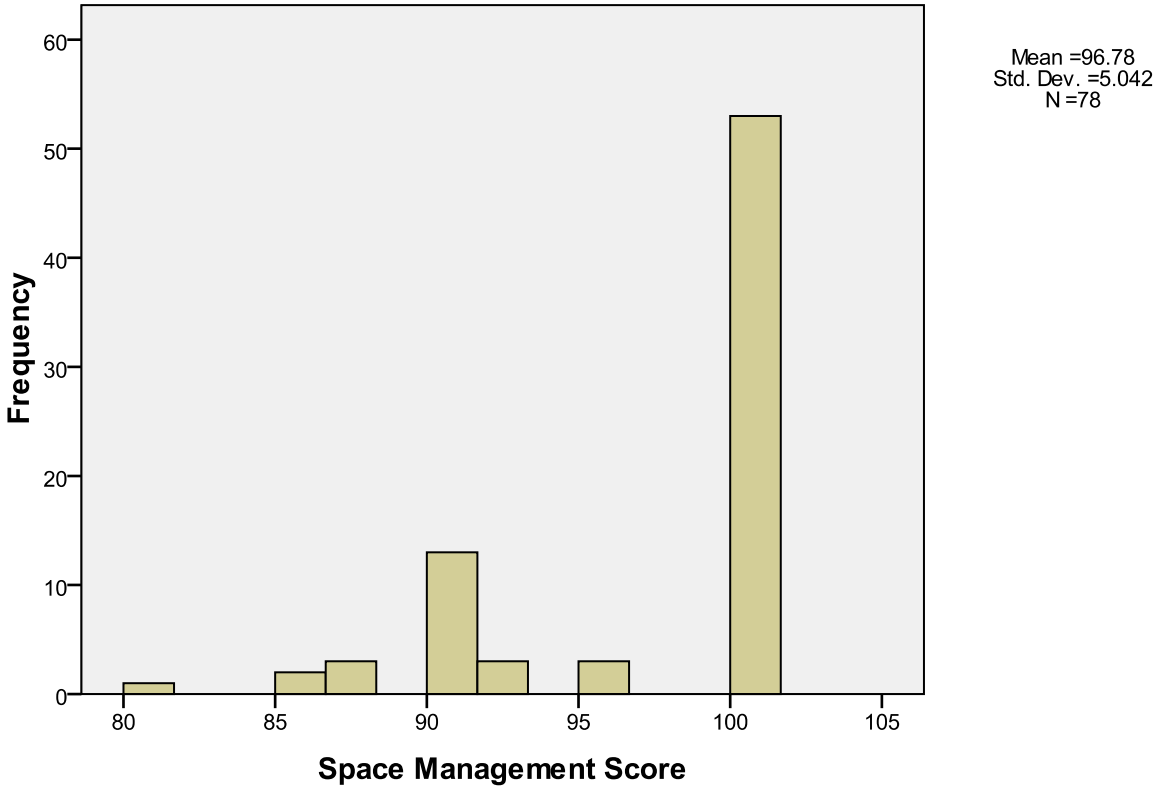


Figure 11 Speed Management Scores

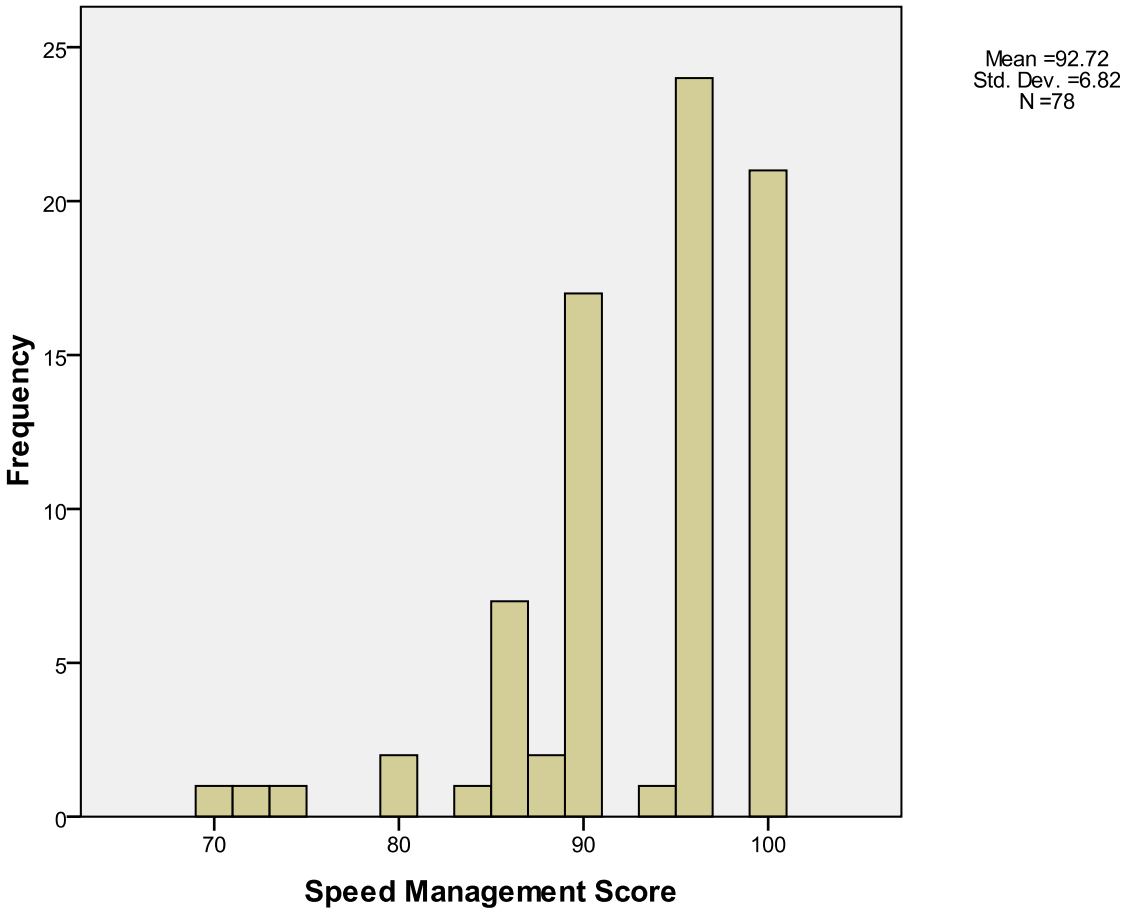


Figure 12 Startup Procedure Scores

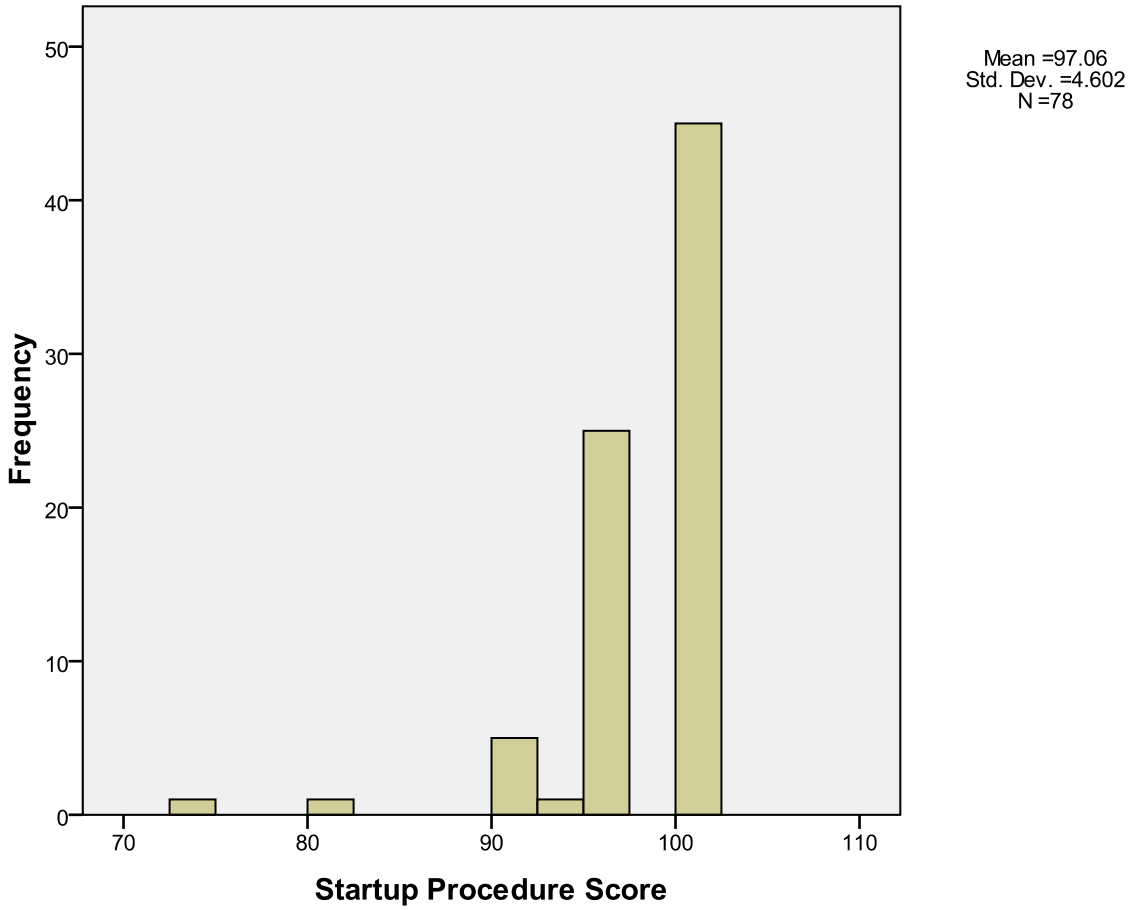
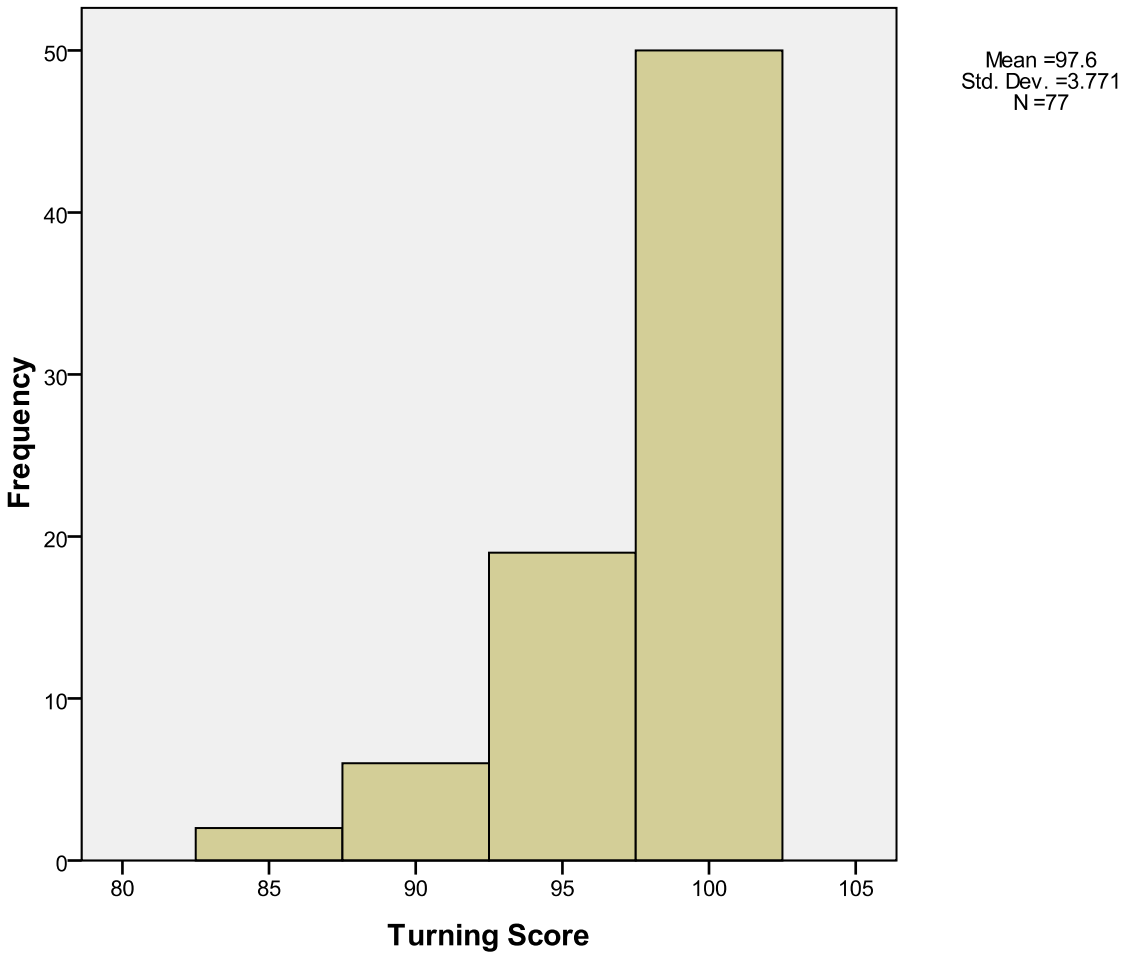


Figure 13 Turning Scores



For all four components shown in the figures above, a similar pattern was noted. In all instances most drivers performed above the average with only a relatively few drivers having lower scores.

EVALUATOR ASSESSMENT OF CLASSROOM TRAINING

The following is an assessment by the evaluator of the MPRI classroom training. The assessment is based on a review of the MPRI website and MPRI materials. The evaluator required several materials from MPRI and they always responded in a timely manner. The assessment is also based on direct observation of several training sessions at the Bloomington site on December 2, 2009. The MPRI materials and site observation provided sufficient information to provide the following comments. The evaluation will be divided into two parts. The first is a brief description of the training. The second will be the evaluation.

DESCRIPTION OF TRAINING

The two Bloomington morning training sessions were conducted in the MPRI mobile van by MPRI trainers Jay Stevens and Joe Fernandez. Eight students were scheduled for each session. Each instructor led one training session of approximately two hours, with the other actively involved throughout using a team teaching approach.

The training curriculum package was a blending of three elements: (1) Instructor Led Training (ILT), (2) Computer Based Training (CBT), and (3) Simulator Based Training (SBT). The ILT consists of information provided by the instructor based mainly on a PowerPoint presentation and information delivered during the simulation driving element. The CBT element consists of a self- paced coverage of training specific materials. The SBT pairs students on each simulator and performs driving scenarios specific to the principles presented and cumulative progress toward course objectives.

The lead trainers for each session began by introducing themselves and their backgrounds for the training. The IDOT drivers introduced themselves and told where they came from. Then the MPRI trainer clearly mentioned why they were here today. They were not here to teach how to drive in terms of physical skills but rather the emphasis was on improving the decision-making process and becoming skilled at recognizing and managing risk while driving and plowing, with a focus on space and speed management. Using a PowerPoint presentation, the trainer then outlined what would be covered in the training session, including a useful decision-making process and reference to “best practices” driving.

Drivers were then introduced to the simulator and given an opportunity to get a “hands on” feel of the simulator. There were two simulators in the van with one at each end of the van and with an instructor at each simulator. The driver group was divided into two groups of four. One driver was at each simulator while others observed the driver going through a simulation. Each driver took turns with others observing with the scenario changing.

After an introduction to the simulator trainers mentioned “best practices” but within the context of existing driver policies and procedures based on the Maintenance Policy Plan for plowing speeds, handling emergencies and radio communications. Also discussed was the important element of fatigue and handling fatigue.

The next element of the training was a brief lecture/discussion specific focus on the issue of space management. After discussing important elements of space management such as traffic density, road and weather conditions, speed and proving an example stopping time and distance, the importance of decision making to prevent accidents and property damage was introduced. The focus was on improving the decision-making process and recognizing and managing risk, with the instructors presenting and discussing the SIPDE decision making process (Scan, Identify, Predict, Decide and Execute) model.

Drivers then returned to the simulator with a focus on practicing using the SIPDE decision-making process, with each driver practicing while others observed. Trainers at each simulator provided guidance, feedback and encouragement throughout the simulation.

Next the lecture/discussion emphasized the importance of visibility (seeing and being seen, whiteouts, wipers icing, and blowing snow, as well as communicating with lights, horn and vehicle

position) and snowplow hazards (blade catching, manhole covers, railroad crossing, barriers, road debris, snow drifts, ice patches and freezing rain etc.).

Drivers then returned to the simulator for the third time to practice on information presented in lecture/discussion using the same format as previous described. Drivers received positive feedback and encouragement throughout the simulation.

This was followed by computer-based training. Each driver went to a computer terminal and was asked to first read relevant content based on previously presented information. Drivers were informed that at the conclusion they would be asked to answer several multiple choice questions. They were informed that throughout the content, links were provided if the driver wanted or needed additional explanatory information. Upon reading the information drivers responded to eight multiple choice items. After entering the items drivers received immediate feedback. If any item was answered incorrectly, drivers were directed to reread that section and were given one additional opportunity to get a correct answer. Each driver received a final score in percent format. The evaluator also took the exam.

For the final component of the training, each driver was asked to take a final simulator assessment. Drivers took the assessment without any other driver observing to prevent later drivers from benefitting from a “practice effect.” The final assessment was a culmination of the material covered and integrated in the lecture and computer-based training. After completing the simulated route each driver received an assessment of their performance which contained an overall score based on reductions for violations and a score for each of the main assessment components of Space Management, Speed Management, Startup Procedure and Turning. After receiving a printout of their performance scores, drivers received feedback from the trainers and suggestions for improvement based on any violations and warnings. Assessment results were previously presented. A copy of the assessment form is presented in Appendix A.

In reviewing that form it should be noted that much of the information such as average MPG, distance and time are irrelevant since elements like shifting techniques and fuel manage were not included in this training. Also, “passed” (True or False) is arbitrary depending on the score level desired by the client. In this case it was set at 65 out of 100, which is less than one would ordinarily consider passing. More useful for this training was the actual overall score reported on the form, as well as the scores for the four components included on the form (Space Management, Speed Management, Startup Procedure and Turning) that were reported earlier. For future reference, if desired, a specific passing score can be set by the client.

EVALUATOR’S OBSERVATIONS OF THE TRAINING

The training appears to have many features consistent with well-established educational principles. The training is a blend of instructor, computer-based training and simulator-based training. The use of diverse methods is educationally sound. Each element seemed well developed and contributed to the overall learning. The instructors were prepared, knowledgeable, personable, helpful and worked well as a team with each adding to the learning experience. The use of PowerPoint slides helped to augment lecture. Encouraging was the use of active learning by inviting trainee participation and providing positive reinforcement throughout all course elements. Active learning was facilitated by shifting between lecture, simulation exercises and computer-based training. It seemed that the training flowed well. This appeared to maintain attention and enhance learning. Driver evaluation of the training supported this observation.

The evaluator both observed and participated in this computer-based training segment. The computer-based training was well conceived. It covered the material. It was self-paced, which is beneficial for the driver, and also provided feedback and direction if the trainee answered a question incorrectly. In that case the driver was directed back to the appropriate topic and provided additional links if needed. Thus the trainee was provided with another opportunity to correct his answer before receiving a hard copy of their exam score. In essence, the training used the principle of mastery, where the goal is to facilitate learning and provide opportunities to do so.

Likewise, the simulator-based training appeared beneficial. The simulator cab was realistic as were the sounds. The dimensional qualities of the simulation screen provide a real life look and feel of actual driving. Simulator driving scenarios were appropriate and realistic for the training, with each building on the material provided by the instructors. The use of a final simulator assessment of driver performance was very beneficial as a cumulative learning experience. Upon completion of the assessment, the driver received a detailed hard copy of their overall performance score as well as specific scores for Speed Management, Space Management, Startup Procedure and Turning, as well as identifying any violations and warnings incurred. Trainees also received feedback of their performance and assistance by the instructors as needed.

One concern is that the time allotted may not be sufficient. Some lengthening should be considered. The training was a bit rushed to cover the material in time. This was noted by the trainees, evaluator and instructors. This is not to say the training needs to be lengthened considerably, but an additional 30 minutes per training session appears to be needed. The training requires multiple moves from lecture to simulator or from lecture to computer-based training. Each takes a few minutes. At times, the training somewhat resembled a school hallway during recess – hurried and congested. This was particularly noticeable with the self-paced computer training and during the final simulation assessment. It was also apparent in the trainers' printing out the final simulator assessment results, providing feedback as well as obtaining the trainee evaluation forms, all the while as the next group was ready to begin the next session. At least another 30 minutes may be needed to accomplish these tasks in a more satisfactory manner.

SUMMARY

Overall, the training appears to be well planned and implemented. Review of the MPRI training materials indicated the curriculum is well conceived and consistent with sound educational principles. It appears that the instructors implemented the curriculum well. Trainee evaluation was positive as was driving performance.

While the training evaluation seems encouraging, ultimate merits will need to be assessed after the snow season in terms of available data on variables such as accident reduction, reduced cost of accidents, and damage of vehicles while snowplowing and assessing the costs of simulation training to that of conventional training. Also helpful will be driver evaluation of simulator training after the snow season and the input of IDOT staff.

APPENDIX A

SIMULATOR TRAINING EVALUATION

Please help us evaluate this simulator training. The information you supply will be totally anonymous. Your name will not be connected to your responses.

Please answer each statement on a scale of from 1 to 5, with 1 for Strongly Disagree, 5 for Strongly Agree, and 2, 3, and 4 for attitudes in between. ***For each question please circle one number that BEST describes your response. There are no right answers or wrong answers.***

Course Material and Organization	Strongly disagree				Strongly agree
1. I would take another training that is taught this way. .	1	2	3	4	5
2. The training material seemed worthwhile	1	2	3	4	5
3. Overall the training was good.	1	2	3	4	5
4. The training using the simulator for optimal shifting was very useful.	1	2	3	4	5
5. The simulations were very useful.	1	2	3	4	5
6. Not much was gained by taking this training.	1	2	3	4	5
7. The driving simulations were realistic for the training objectives.	1	2	3	4	5
8. I practiced skills during the driving simulation part of the training that will be very useful on the road.	1	2	3	4	5
9. The time spent in the lecture portion of the was appropriate.	1	2	3	4	5
10. The time spent in the driving simulation portion of the training was appropriate.	1	2	3	4	5

Comments/Suggestions on Course Material and Organization:

Acquisition of Skills/Content	Strongly disagree				Strongly agree
11. This training should be part of IDOT training for all snowplow operators.	1	2	3	4	5
12. The training helped prepare me for dealing with non-routine situations.	1	2	3	4	5
13. The training helped prepare me for situations involving blade catching.	1	2	3	4	5
14 The training helped prepare me for situations involving plow movement.	1	2	3	4	5
15. The training helped prepare me for situations involving passing cars.	1	2	3	4	5
16. The training helped prepare me for situations involving vehicles or pedestrians along the side of the road.	1	2	3	4	5
17. The training helped prepare me for situations involving plowing over structures.	1	2	3	4	5
18. This training explained why speed management is important for safe plowing.	1	2	3	4	5
19. This training explained why space management is important for safe plowing.	1	2	3	4	5
20. This training explained why good communication is important for safe plowing.	1	2	3	4	5
21. I would recommend this training for other snowplow drivers.	1	2	3	4	5

Comments/Suggestions on Acquisition of Skills/ Content:

	Strongly disagree				Strongly agree
Instructor					
22. I think the training was taught quite well.	1	2	3	4	5
23. The trainer had a good understanding of the material.	1	2	3	4	5
24. The trainer worked well with the drivers.	1	2	3	4	5
25. Some things were not explained very well.	1	2	3	4	5
26. The trainer understood your needs and issues.	1	2	3	4	5
27. The trainer gave very useful feedback.	1	2	3	4	5

Comments/Suggestions on Instructor:

_____

_____

	Strongly disagree				Strongly agree
Environment					
28. The simulator facility was adequate.	1	2	3	4	5
29. The simulator provided a good learning environment.	1	2	3	4	5
30. The simulator made me nauseous.	1	2	3	4	5

Comments/Suggestions on Environment:

_____

_____

31. Training site (please circle one number)

Collinsville 1

Bloomington 2

Ottawa 3

32. What is your primary snowplow route?

Urban/suburban 1

Rural 2

33. Approximate number of years experience as an IDOT snowplow operator: _____ years

34. Approximate total number of years experience as a snowplow operator (with IDOT and others)

_____ years

35. In what year were you born? 19 _____

THANK YOU FOR YOUR PARTICIPATION

APPENDIX B: SNOWPLOW POST SIMULATOR TRAINING QUESTIONNAIRE

Illinois Department of Transportation stationery

Memorandum

To: Named Individual

From: David B. Johnson

Subject: Snowplow Simulator Training

Date: June 10, 2010

Last fall your district participated in snowplow simulator training. Immediately upon finishing the training, each participant completed an anonymous survey to evaluate that training. Now you have completed a snow season and we would once again like each participant to complete a post survey questionnaire about the simulator training.

The enclosed questionnaire should take less than 10 minutes to complete. You input is essential for us to evaluate the possible use of simulator training in the future. The survey is anonymous and results will be combined with all other drivers who took the simulator training.

After completing, please return the questionnaire to this office by June 30th. Again, your input about your simulator training will be used to determine future direction in this area. If you have any questions, please contact me.

Signed: David B. Johnson, Maintenance Operations Engineer

SIMULATOR TRAINING EVALUATION

Please help us evaluate this simulator training. The information you supply will be totally anonymous. Your name will not be connected to your responses.

Please answer each statement on a scale of from 1 to 5, with 1 for Strongly Disagree, 5 for Strongly Agree, and 2, 3, and 4 for attitudes in between. ***For each question please circle one number that BEST describes your response. There are no right answers or wrong answers.***

	Strongly disagree				Strongly agree
Course Material and Organization					
1. I would take another training that is taught this way. .	1	2	3	4	5
2. The training material seemed worthwhile	1	2	3	4	5
3. Overall the training was good.	1	2	3	4	5
4. The training was well organized.	1	2	3	4	5
5. The simulations were very useful.	1	2	3	4	5
6. Not much was gained by taking this training.	1	2	3	4	5
7. The driving simulations were realistic for the training objectives.	1	2	3	4	5
8. I practiced skills during the driving simulation part of the training that will be very useful on the road.	1	2	3	4	5
9. The time spent in the lecture portion of the was appropriate.	1	2	3	4	5
10. The time spent in the driving simulation portion of the training was appropriate.	1	2	3	4	5

Comments/Suggestions on Course Material and Organization:

_____

_____

Acquisition of Skills/Content	Strongly disagree				Strongly agree
11. This training should be part of IDOT training for all snowplow operators.	1	2	3	4	5
12. The training helped prepare me for dealing with non-routine situations.	1	2	3	4	5
13. The training helped prepare me for situations involving blade catching.	1	2	3	4	5
14 The training helped prepare me for situations involving plow movement.	1	2	3	4	5
15. The training helped prepare me for situations involving passing cars.	1	2	3	4	5
16. The training helped prepare me for situations involving vehicles or pedestrians along the side of the road.	1	2	3	4	5
17. The training helped prepare me for situations involving plowing over structures.	1	2	3	4	5
18. This training explained why speed management is important for safe plowing.	1	2	3	4	5
19. This training explained why space management is important for safe plowing.	1	2	3	4	5
20. This training explained why good communication is important for safe plowing.	1	2	3	4	5
21. I would recommend this training for new snowplow drivers.	1	2	3	4	5
22. I would recommend this training for experienced snowplow drivers.	1	2	3	4	5

Comments/Suggestions on Acquisition of Skills/ Content:

	Strongly disagree				Strongly agree
Instructor					
23. I think the training was taught quite well.	1	2	3	4	5
24. The trainer had a good understanding of the material.	1	2	3	4	5
25. The trainer worked well with the drivers.	1	2	3	4	5
26. Some things were not explained very well.	1	2	3	4	5
27. The trainer understood your needs and issues.	1	2	3	4	5
28. The trainer gave very useful feedback.	1	2	3	4	5

Comments/Suggestions on Instructor:

_____

_____

	Strongly disagree				Strongly agree
Environment					
29. The simulator facility was adequate.	1	2	3	4	5
30. The simulator provided a good learning environment.	1	2	3	4	5
31. The simulator made me nauseous.	1	2	3	4	5

Comments/Suggestions on Environment:

_____

_____

32. During the past snowplow season while snowplowing:

	Yes	No	
Were you involved in an accident?	1	2	If yes, how many? _____

Who was at fault? (Accident 1 & 2)

	Accident 1	Accident 2
You 1		1
Other driver .. 2		2
Both 3		3

Did you sustain an injury to yourself?	1	2	
Was another person injured?	1	2	
Was there damage to your vehicle?	1	2	If yes, approximate dollar damage $ _____
Was there other property damage?	1	2	If yes, approximate dollar damage $ _____

33. What was your primary snowplow route?

Urban/suburban 1

Rural 2

34. Approximate number of years experience as an IDOT snowplow operator: _____ years

35. Approximate total number of years experience as a snowplow operator (with IDOT and others)

_____ years

36. In what year were you born? 19 _____

THANK YOU FOR YOUR PARTICIPATION

APPENDIX C: POST EVALUATION DRIVER COMMENTS

DRIVER COMMENTS

COMMENTS ON COURSE MATERIALS & ORGANIZATION

We totally agree; this should be given to every highway maintainer every year.

It was interesting.

Not the real deal

Not nearly close enough to realistic driving.

Not real world training. Simulators outdated. Seemed like waste of taxpayers' dollars.

Material was info that lead workers & tech already taught me.

Would change blade control to compare more to snowplow truck.

Trainers ok but drivers need more time with hands on real vehicles.

Not worth the time & money.

Waste of 8 hrs. Bad. If I were 6 yrs old maybe it would help.

Simulator generator not working that day so training was delayed.

Truthfully a guy 60 yrs old like myself doesn't or probably wouldn't do as good as a 30-yr old.

Simulator seemed more geared for my 11-yr old son. More like a video game than a training tool.

Would highly recommend new hires with no plowing experience to participate in the training.

Simulation course could have been a little longer.

Needs to be aimed more to our policies and ways of plowing.

Would change blade control to compare more to snowplow truck.

COMMENTS ON SKILLS/CONTENT

My knowledge and skill was obtained through hands on training.

All questions 11-22 are good points that could be mentioned for all plow drivers

Idea of course is great but did not sharpen any skills. With IDOT less than 3 yrs. Was like prehistoric toy.

Training for new hires & 6-mo temps. Also for anyone having issues plowing snow.

Good reminder of things to do & look for.

More time should be spent for new hires in a real truck using trucks they will be plowing with.

Still very bad.

Older plow driver would benefit from training due to sight & hearing & reaction time!!

Recommend for new drivers but not those plowing over 8 years.

Only for new employees.

This training would be a total waste of money as far as simulator goes. Oral part all right but in house rookie training covers all of what they taught. Save your money.

Not agree with instructor about not plowing over railroad tracks. They said lift over tracks no matter how much snow on tracks.

Useful for rookies. .Not sure veterans would be very open to or interested in.

Training for new hires and 6 month temps. Also for anyone having issues plowing snow.

It just freshens your awareness.

COMMENTS ON INSTRUCTORS

Instructor has never been in real situations.

Instructors no experience operating snowplow. Should have previous experience.

Very good understanding of our issues.

Very helpful.

Good guys.

He was knowledgeable.

Again, oral part average. Material is nothing we don't go over in a snow meeting.

I didn’t see clearly the cross over I needed to do.

COMMENTS ON ENVIRONMENT

Every snow & ice storm different. Simulators can only do so much.

Not realistic. Boulders flying off mountains. Deer only moved when you did.

It was a big learning experience.

It’s a good thing. It just needs to be more life like.

No change.

The generator was broke so training was delayed. Class size good. More than 6 people would be bad.

Controls not responsive - blindspots with mirror arms. Break pedal unresponsive, hard to get "the feel" compared to real truck - but close. Younger person "game-board oriented" would do better than me

Would be a great Xmas present for kids!

APPENDIX D: POST EVALUATION SUPERVISOR QUESTIONNAIRE

Illinois Department of Transportation stationery

Memorandum

To: Named Individual

From: David B. Johnson

Subject: Snowplow Simulator Training

Date: June 10, 2010

Last fall your district took part in a Simulator Training. We are currently in the process of evaluating that training. We would very much appreciate the immediate supervisor's input. Their input is important and will be used along with the input of other supervisors.

Enclosed is a very brief questionnaire that is easy to fill out and should take less than 10 minutes to complete. After completing, please return the questionnaire to this office by June 30th.

All data are anonymous and your opinions will be combined with all other supervisors in the evaluation process. If you have any questions, please fee free to contact me.

Signed: David B. Johnson, Maintenance Operations Engineer

Attachments

SUPERVISOR ASSESSMENT OF SIMULATOR TRAINING

1. How many of your drivers did you send to Simulator training? _____ drivers

2. Of the drivers taking Simulator training, how many of them also took your regular snowplow training? _____

3. Now we would like your assessment of how drivers who took the Simulator training (as a whole, not individual drivers) performed as a group relative to drivers who did not take the Simulator training, with respect to the following:

For drivers who took the Simulator training, how was/were:

	Much better	Somewhat better	About the same	Somewhat worse	Much worse
Driver decision making skills before the simulator training …….	1	2	3	4	5
Driver decision making skills after the simulator training……	1	2	3	4	5
Driving ability before the simulator training……	1	2	3	4	5
Driving ability after the simulator training…….	1	2	3	4	5
Overall driver assessment…….	1	2	3	4	5

4. Now we would like to get your thoughts on a few other questions:

	Strongly agree	Somewhat agree	Somewhat disagree	Strongly disagree
I think simulator training is effective ……	1	2	3	4
I would recommend simulator training for new hires …….	1	2	3	4
for veteran drivers …….	1	2	3	4
for all drivers …….	1	2	3	4

	Strongly agree	Somewhat agree	Somewhat disagree	Strongly disagree
Overall, drivers who took the simulator training thought it was worthwhile ……	1	2	3	4
Overall, drivers thought the simulator training thought it was a waste of time ….	1	2	3	4

Finally, we would like to get some information about your regular snowplow driver training.

5. How many snowplow drivers in your district were trained during 2009-1010?

_____drivers

6. This past season, what would you estimate to be the average number of hours of training behind the wheel per driver? _____hours

7. What was the average number of hours of training other than behind the wheel (not including simulator training)? _____hours

8. Overall, would you say the total hours of snowplow training is too short, too long, or just about right?

Too short 1

Too long 2

Just about right . . 3

9. During your regular snowplow driver training:

a. What was the estimated average number of miles driven per driver? _____miles

b. What was the total number of accidents during training? _____accidents

c. What was the number of injuries (drivers and others) during training? _____injuries

d. What was the estimated dollar damage to IDOT vehicles? $_____

e. What was the estimated dollar damage to IDOT equipment other than vehicles? $_____

f. What was the estimated dollar damage to other property or vehicles? $_____

10. What is your District number: _____

Other comments you wish to make:

_____

_____

_____

THANK YOUR FOR YOUR COOPERATION

APPENDIX E: POST EVALUATION SUPERVISOR COMMENTS

SUPERVISOR COMMENTS

Experience is too novel to really evaluate effectiveness. Older drivers said it was like a "video game." Probably lends itself well to new hires/younger drivers.

First priority for simulator training should be drivers with less than 5 yrs experience.

I strongly agree with this training. Needs to be required for all new hires & definitely snowbirds. Good course.

Not happy with some evaluations by my guys. Don't believe they took the time to honestly evaluate. Some thought waste of time for experienced drivers but valuable for new hires. All agreed instructors were good.

Only lead workers went to training. They did not plow on regular basis if at all.

Overall, worth all the effort expended. Most drivers agree it was beneficial. Opened their eyes to situation they do & do not encounter. Some drivers did not agree mostly because it made them nauseous - possibly bi-focal issue. Also generator failed.

Questions were answered about fulltime employees only.

The guys who attended snowplow training felt they didn't get much out of the simulators. It felt like a video game, not a real truck.

Think simulator training good for new drivers & temp help.

Would like to have simulator training at yard location for all maintainers & operators. (Results given for "team section" not district.)