TECHNICAL MEMORANDUM 3

to the

NATIONAL COOPERATIVE HIGHWAY RESEARCH

PROGRAM (NCHRP)

on

Project 20-68C

from

Lori Rosenkopf, Ph.D.

DRAFT

April 4, 2012

Acknowledgements

This study was conducted for the Domestic Scan Panel with funding provided through the National Cooperative Highway Research Program (NCHRP) Project 20-68C (Research on Innovation Networks – Domestic Scans). The NCHRP is supported by annual voluntary contributions from the state Departments of Transportation. Project 20-68C is intended to fund assessments of Domestic Scan impact on behalf of the Domestic Scan Panel. The report was prepared by Lori Rosenkopf, Batia Wiesenfeld and Nicole Rosenkranz. The work was guided by the Domestic Scan Panel. The project was managed by Andrew Lemer, NCHRP Senior Program Officer.

Summary of Research Objective

Our research team is analyzing how domestic scans completed as part of NCHRP 20-68A affect DOT effectiveness. By examining several innovations which have received varying levels of attention in scans, we can evaluate both how scans shape broader innovative activity at state DOTs, and how scans compare to alternative methods of diffusing innovations. By targeting innovations in the maintenance function, our survey is intended to provide the oversight panel with information about effectiveness not only from scan participants and hosting site participants, but also from the relevant third parties responsible for implementing or evaluating such innovation initiatives in their DOTs.

Methodology

Our team began by interviewing members of the NCHRP 20-68 Panel to understand their perceptions of effective innovation activities, and by examining published scan reports to seek an effective domain to study specific innovations that may have been influenced by a scan. We chose scan 07-03 (Winter Maintenance) and interviewed experts in the maintenance domain to choose three specific innovations to study their diffusion patterns: Maintenance Decision Support Systems (MDSS), TowPlow (TP) and Automated Pothole Patcher (APP).

We developed a survey pilot and then endeavored to secure the cooperation of each state DOT via a presentation at the AASHTO SCOM meeting in Louisville (July 2011) as well as requests from each state DOT head of maintenance. 34 states agreed to participate, and we reviewed and refined the survey questions with each state's contact. Respondents to the survey (341 out of 612, for a 57% response rate, after being corrected for invalid responses) spanned both central and district offices, and they indicated their individual attitudes toward innovation, their assessment of their state DOT culture and structure supporting innovation, their self-reported network contacts for innovation, and their assessment of the status of each of the three innovations under study. A listing of the participating states and their response rates may be seen in Appendix 1.

Completed activities since delivery of TM-2 (1Q12)

- Finalized hand-coding of write-in data and performed more detailed analyses of all data.

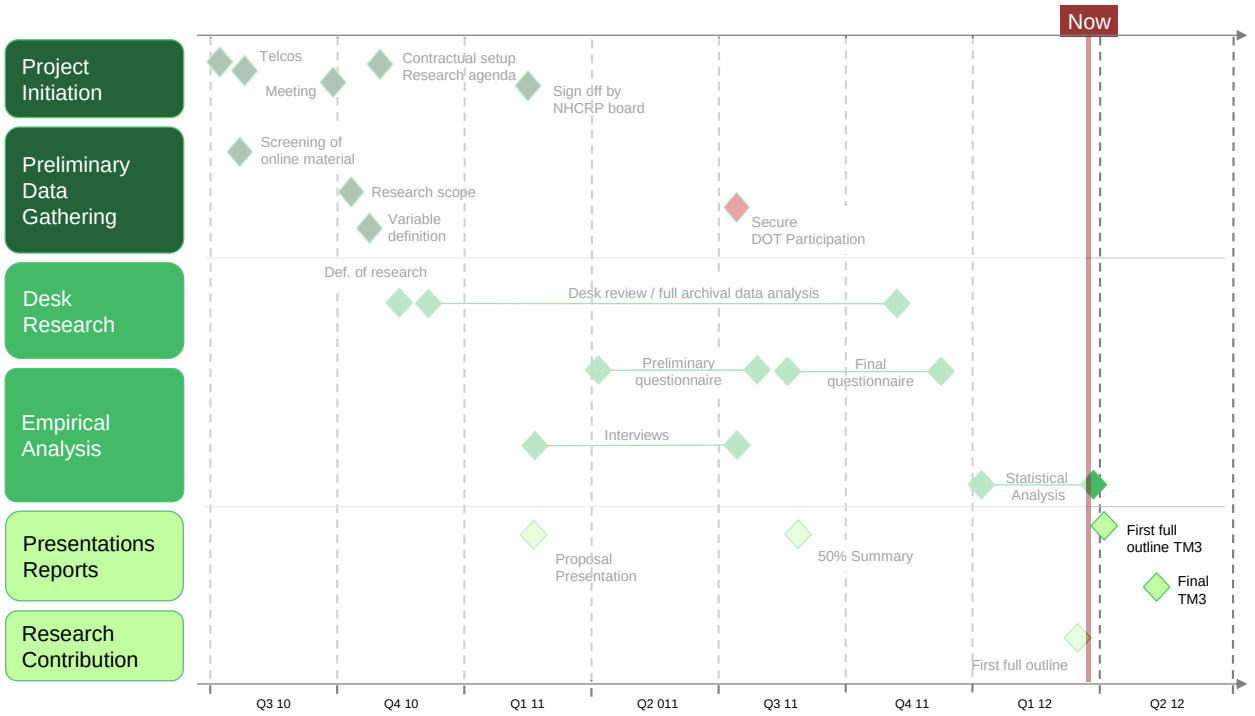
- Generated and distributed individual and state reports for survey respondents comparing their ratings to the average values in their state and overall (see sample reports in Appendices 2 and 3). By increasing awareness of innovative activities by their own and the sponsoring organization, receiving these reports may increase attention and motivation regarding innovation and networking.

- Conducted prize lottery. Two winners notified who will receive their prizes upon completion of paperwork.

- Committed to participate in June 6 teleconference with Domestic Scan Panel members to review findings.

Project Time Line

NCHRP 20-68C - Research on Innovation Networks



Survey Results

Appendix 4 provides a screen-by-screen depiction of the online survey instrument, a brief interpretation of the question and responses, a tabulation of the aggregate responses to each question item, and identification of high- and low- scoring states on relevant attributes. Additionally, Appendix 5 summarizes the key variables and their ranges of scores in a single-page format. Highlights of these analyses include:

1) Sources of knowledge about innovations

- Innovations can be classified as more or less complex and uncertain. A Management Decision Support System (MDSS) represents the most complex and uncertain innovation in this study, because it needs to be integrated with other technology and it is still evolving as a relatively new technology. In contrast, the Automated Pothole Patcher (APP) is the least complex and uncertain, because it is stand-alone and a mature technology. The TowPlow (TP) is moderate because it is stand-alone (low complexity) but is much newer than APP (higher uncertainty). Greater complexity and uncertainty demands knowledge flow that can transmit richer information, which is easier in the case of reciprocal knowledge flow than with broadcast (i.e., one-way) knowledge flow. The information sources generating reciprocal knowledge flows are direct contact with peers, piloting, and internal DOT communication. In contrast, the information sources generating broadcast (one-way) knowledge flows are vendors, meetings, conferences and print sources. Note that scans can serve both as reciprocal sources (for participants) and broadcast sources (for readers of reports) and thus were not included in the calculations below. The results indicate that as the complexity of an innovation (or the uncertainty associated with it) increases, respondents rely more on reciprocal flows of information to learn about the innovation.

Innovation	Complexity/ Uncertainty	Reliance on reciprocal flows	Reliance on broadcast flows
APP	lowest	29%	64%
TP	medium	38%	54%
MDSS	highest	60%	32%

- The average value of scans as sources of innovation among *users* of scans was rated 5.1 (on a scale of 1=not valuable at all to 7=extremely valuable). This rating is nearly comparable to other more general and ubiquitous sources of innovation such as printed reports, websites, association meetings, other group meetings and personal contacts. It is worth noting that 80% of the scan users did not participate directly in scans as team members or hosts, suggesting that scan findings are diffusing beyond the selected participants. At the same time, only 64% of respondents reported using scans, while other sources are used by significantly more respondents (over 90%), suggesting opportunities for further penetration.

2) Network contacts

- 174 of our respondents provided information on their network contacts that help them learn about innovations. Scan participants reported higher numbers of contacts on average (7.1) than non-scan participants (5.3). While only one of the 174 respondents attributed scan team activity as the initial source of a network contact, we found that the 07-03 scan team members were listed as contacts by 11 respondents, suggesting some additional opportunities for scan information to diffuse. A further extension of this "scan potential" is

the fact that over 33 respondents (spanning 15 states) cited network contacts that were either in the same state as a scan team traveler or a host state for these travelers.

- Each of the 174 respondents providing network contact data could be identified as either headquarters (41 people or 24%) or district-level personnel (133 people or 76%) within their state. The number of reported contacts per respondent is higher for those in HQ (5.7) than in districts (5.1), but the HQ respondents' contacts are significantly more likely to be out-of-state and involved in scans than those of the district personnel. Specifically:

    - Out-of-state contacts comprised 38% of the network contacts reported by HQ respondents, but only 14% of those reported by district respondents. This is consistent with the image of a network of HQ personnel connected to their internal people and to their peers in other states. So HQ personnel serve a critical role in the flow of information about innovations; it is conceivable that they could serve as either innovation catalysts or innovation bottlenecks.

    - Scan participants comprised 41% of the 241 network contacts reported by HQ respondents, but only 9% of the 637 network contacts reported by district respondents (some contacts are cited by more than one respondent, and these statistics include these multiple citations). This may mean that scan team composition reinforces existing networks when only HQ personnel are selected, and that there is an opportunity to include more varied perspectives and to reconfigure innovation networks by including more district-level personnel in scans.

    - Appendix 6 provides network graphs representing these trends.

3) Learning from scans

- Although two of the three innovations we studied were covered in scan 07-03, only one respondent reported learning about either of these innovations directly from the scan. This effect may result from a combination of several factors:

    - Competing sources of innovation information (TIG, pooled funds studies, etc.) may have generated awareness prior to the scan visits and subsequent scan report publication.

    - Scan team members have typically been DOT personnel located at state headquarters, who already have well-developed networks of contacts outside their state, so they are more likely to be aware of what is "in the air" and less likely to form new network contacts as a result. This raises the possibility that an effort to

increase participation by district office personnel may create more new network connections which can "cross-pollinate" across states. Such connections have the potential to decrease "information bottlenecks" around the key central office personnel.

4) State culture and practices that encourage or undermine innovation

- Appendix 7 summarizes the overall ratings of innovation orientation culture for each state.

- In corporate samples, both radical and incremental innovation is higher when organizations have more flexible structures and practices. Two of these flexibility dimensions stood out as most positively related to DOT orientation to innovation. Orientation to innovation was measured on a scale of 1=low to 5=high. We compared the top 25% of states to the bottom 25% on each flexibility dimension, and we also compared the perceptions of individual respondents who rated their organization in the top 25% on each flexibility dimension to respondents who rated their organization in the bottom 25%[1]. The three most notable flexibility dimensions were:

    - **Willingness to reconsider past practices**: States in the top quartile were more oriented toward innovation than those in the bottom quartile (top 25% of states mean = 3.6; bottom 25% mean = 2.3). This relationship also holds true at the individual level (top 25% of respondents mean = 3.9; bottom 25% of respondents mean = 3.2; correlation = .34)[2]

    - **Concentrating decision-making in those with expertise regardless of position:** Top 25% of states mean orientation to innovation = 2.9; bottom 25% mean = 1.9. Top 25% of respondents mean orientation to innovation = 3.7; bottom 25% of respondents mean = 3.2; correlation = .23.

- There was one notable exception to this trend. Flexibility with respect to low reliance on written rules and policy manuals tends to be positively related to innovation in corporate samples but is negatively related to orientation to innovation among DOT respondents. Those who rated their organization in the top 25% in flexibility on this dimension rated their organization as less oriented to innovation (top 25% of states mean orientation to innovation = 3.4; bottom 25% of states mean = 3.8; correlation = -.41).

- Respondents who observed a high reliance on external contractors to perform their maintenance function also viewed their organization as less oriented toward innovation

[1] Individual responses allow for more intra-state variation across districts, as typically one respondent would represent each district.
[2] All reported correlations are significant at a level of at least $p<.05$.

(respondents rating their organization in the top 25% on contracting out mean orientation to innovation = 3.4; bottom 25% mean = 3.7; correlation = -.18). This inverse relationship does not emerge at the state level, suggesting that the state average levels may mask variation across districts.

Appendix 1: Response Rates of Participating States, by Phase

Phase I (9/01 - 9/30)	California	24%
	Colorado	48%
Average response	Delaware*	100%
61%	Georgia	62%
	Illinois	58%
	Kansas	80%
	Louisiana	75%
	Missouri	83%
	Nevada	36%
	New York	44%
	North Carolina	50%
	Ohio	33%
	South Carolina	87%
	Tennessee	61%
	Washington	74%
Phase II (9/19 - 10/14)	Florida	44%
	Iowa	60%
Average response	Nebraska	35%
56%	North Dakota	54%
	Idaho	67%
	Kentucky	58%
	Minnesota	55%
	Mississippi	35%
	Wyoming	78%
	Arkansas	73%
Phase III (11/01 - 11/30)	Montana	100%
	Alabama	46%
Average response	Maryland	50%
65%	Arizona	63%
	Pennsylvania	60%
	South Dakota	70%
	Virginia	64%

* Only one participant

Appendix 2: Sample State Report

NCHRP - Project 20-68C State report - Alabama

Summary of Research Objective

Thank you for serving as the state contact for the NCHRP 20-68C survey designed to assess how practice improvements and innovative technologies move within and among transportation agencies and how that movement can be used to more effectively accelerate innovation. The survey was sent to maintenance function staff in 32 state DOT's, and we received responses from 341 people (60% response rate). The overall survey report is currently in preparation and will be available through NCHRP, but this document is a customized report providing you with information about your DOT's aggregated responses to the survey (from 12 respondents out of a possible 26, 46% response rate).

Respondent demographics:

Tenure (in years)

Overall: 22.9 Your DOT: 23.2

Education in % (High School / Undergrad / Grad)

Overall: 23.7 / 50.7 / 25.6

Your DOT: 9.1 / 54.5 / 36.4

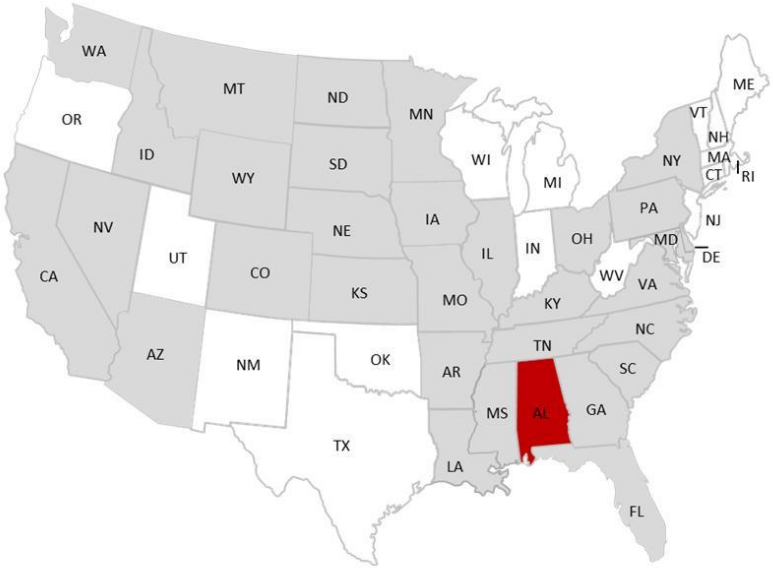
Domestic Scan (participant and host)

Overall: 44 Your DOT: 0

International Scan (participant)

Overall: 3 Your DOT: 0

Participating states



DOT Orientation towards Innovation

DOT's vary with respect to whether they resist or actively embrace new innovations. Stronger DOT orientation toward innovation involves searching for and being among the first to implement new innovative technologies. Values below 2.5 indicate resistance to innovation while values 4 and above indicate positive orientation toward innovation.

Overall Sample: Mean: 3.5, Std.Dev.: 0.8 (Min: 1.3 / Max: 5.0)

Your DOT: Mean: 3.5, Std.Dev.: 0.7 (Min: 2.5 / Max: 4.5)

State DOT's also vary with respect to their belief that they can learn from other DOT's, which indicates how receptive the state is to innovations implemented in other DOTs. Values below 2.5 indicate resistance (i.e., "not invented here" syndrome) while values 4 and above indicate willingness to learn from other DOT's.

Overall Sample: Mean: 4.6, Std.Dev.: 0.7 (Min: 1.0 / Max: 5.0)

Your DOT: Mean: 4.6, Std.Dev.: 0.7 (Min: 3.0 / Max: 5.0)

Items of the questionnaire

1. My DOT actively seeks information about technological changes.
2. My DOT is among the leaders in our industry in detecting technological changes.
3. My DOT generally responds quickly to technological changes.
4. My DOT makes substantial efforts to exploit new technologies.
5. Despite differences between states, one DOT can usually learn from another.

DOT Structure and Culture

Organizations vary with respect to the extent to which their structure, processes, and culture are more rigid or more flexible, with greater flexibility generally associated with an increased likelihood of implementing innovative technologies. Values above 3 indicate relatively greater flexibility in DOT structure and culture.

Overall Sample: Mean: 2.7, Std.Dev.: 0.5 (Min: 1.3 / Max: 4.4)

Your DOT: Mean: 2.3, Std.Dev.: 0.5 (Min: 1.4 / Max: 3.0)

Items of the questionnaire

No use of contractors ---------- Contracting out of all maintenance
Policy manual with clear rules ----------Very few written rules
Communicate through manager ---------- Free communication across organizational
Centralized organization structure ---------- Decentralized organization structure
Decision authority is based on position -------Decision authority is based on expertise
Jobs are clearly distinct ----------Jobs are not clearly specified
Emphasis on tried and true practices ---------- Adapting to changing circumstances
Follow formal and specific procedures ---------- Getting things done
Tight formal control of most procedures -------Informal relationships and cooperation

Employee Engagement in Innovative Activities

Innovative activities can be differentiated with respect to the extent to which they reflect a more radical departure from existing practice or offer relatively more limited and incremental improvement that builds upon existing activities. Both are valuable forms of innovation. Values of 4 and above indicate a high level of engagement in innovative activities of these different types. The spider graphs to the right provide responses to each of the four individual innovation activities that make up the measure.

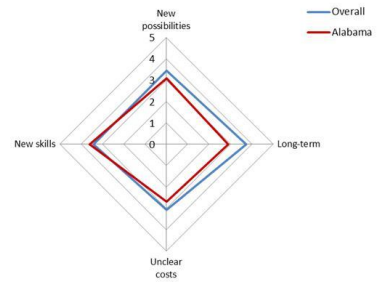
Radical innovation:

Overall sample:

Min: 1.3
Max: 5.0
Mean: 3.4
Std.Dev.: 0.6

Your DOT:

Min: 2.5
Max: 3.8
Mean: 3.1
Std.Dev.: 0.4



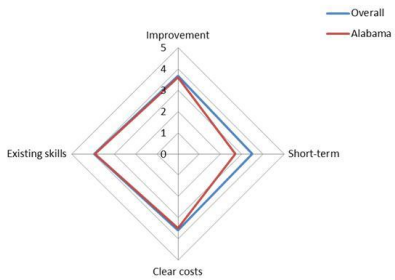
Incremental innovation:

Overall sample:

Min: 2.0
Max: 5.0
Mean: 3.7
Std.Dev.: 0.5

Your DOT:

Min: 2.8
Max: 4.3
Mean: 3.4
Std.Dev.: 0.4



Support for Specific Innovations

Our survey addressed three innovations that are all related to winter maintenance and that have received attention across DOTs. These innovations are Maintenance Decision Support Systems (MDSS), TowPlow, and Automated Pothole Patcher. DOT's and individual respondents differed with respect to their level of awareness of each innovative technology, how supportive they were of each innovative technology, and the extent to which the innovative technologies were being implemented. Support and implementation scales range from 1 to 5 with higher values being more positive.

Summary

	MDSS	TowPlow	Pothole Patcher
Technology Awareness Level			
Overall sample:	1.4	1.4	1.4
Your DOT:	1.9	1.9	1.6
DOT Support			
Overall sample:	3.6	3.2	3.2
Your DOT:	3.7	2.7	3.1
Individual Support			
Overall sample:	3.8	3.6	3.7
Your DOT:	3.4	2.6	2.9
Implementation			
Overall sample:	3.4	3.0	3.1
Your DOT:	3.0	2.0	3.4

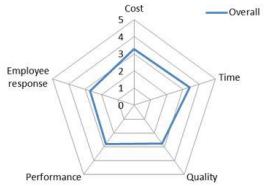
Innovation Contribution to DOT Effectiveness

For DOT's that have implemented each of these innovative technologies, perceptions of the extent to which the technologies contributed to DOT effectiveness (along dimensions such as savings in time and money) varied. Values below 3 indicate that benefits fell short of expectations while values of 4 or higher indicate that benefits exceeded expectations on that dimension. The spider graphs provide responses to each of the five individual performance measures that make up the compound measure. State information regarding how innovations contributed to DOT effectiveness was only obtained when states indicated that the innovation was currently being used.

MDSS:

Overall sample:
Min: 1.6
Max: 4.0
Mean: 3.0
Std.Dev.: 0.4

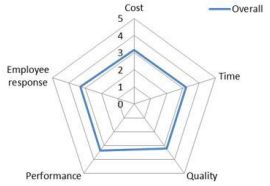
Your DOT:
Min: -
Max: -
Mean: -
Std.Dev.: -



Towplow:

Overall sample:
Min: 1.0
Max: 5.0
Mean: 3.3
Std.Dev.: 0.8

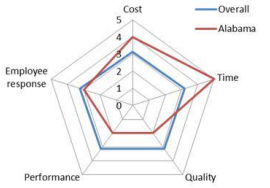
Your DOT:
Min: -
Max: -
Mean: -
Std.Dev.: -



Pothole Patcher:

Overall sample:
Min: 2.0
Max: 5.0
Mean: 3.2
Std.Dev.: 0.5

Your DOT:
Min: 3.2
Max: 3.2
Mean: 3.2
Std.Dev.: -



Social Networks Supporting Innovation

Ideas and innovations spread across people and organizations via their social networks – the personal contacts they have with others inside and outside their own organization. Respondents varied with respect to the size (that is, number of contacts) and content (percent of contacts that are external to their DOT) of their social networks. Out of the 12 respondents from your state, 2 (16.7%) provided network information. Averages on network contacts were only calculated based on the 174 survey responses that reported network data. Larger social networks, and social networks that bridge across organizations, expose people to more new innovations.

Number of contacts reported

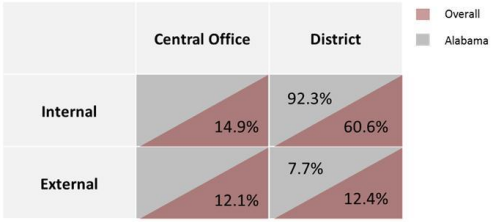
Average in overall sample: 5.2

Average in your DOT: 6.5

Percent of recorded contacts outside own state

Overall sample: 19.4%

Your DOT: 16.5%



Relationship with DOT Organization and Profession

People vary with respect to how important certain professional groups are to them. For some people, belonging to their DOT or the engineering profession is a central part of who they are as people. The survey assessed both the strength of respondents' relationship with their DOT and with the engineering profession.

Relationship with DOT

Overall sample: Mean: 4.3, Std.Dev.: 0.6 (Min: 1.0 / Max: 5.0)

Average in your DOT: Mean: 4.1, Std.Dev.: 0.5 (Min: 3.5 / Max: 5.0)

Relationship with Engineering Profession

Overall sample: Mean: 3.8, Std.Dev.: 0.8 (Min: 1.0 / Max: 5.0)

Your DOT: Mean: 4.0, Std.Dev.: 0.2 (Min: 3.5 / Max: 4.5)

Research Team

Lori Rosenkopf is the Simon and Midge Palley Professor at the Wharton School of the University of Pennsylvania, where she teaches at the undergraduate, MBA, doctoral and executive levels. She received her Ph.D. from Columbia University (1994), M.S. from Stanford University (1986), and B.S. from Cornell University (1984). Lori's award-winning research on innovation networks in high-tech industries has been published in the top management journals, and she is now applying these concepts to the study of public institutions. Lori serves as a Senior Editor at the journal Organization Science, and she recently completed a term as the Chair of the Technology and Innovation Management Division of the Academy of Management.

Batia Mishan Wiesenfeld, Professor of Management at the Leonard N. Stern Schools of Business, New York University, is the David Margolis Faculty Fellow. She received her Ph.D. in Management and Organizational Behavior from the Columbia University Graduate School of Business. Her teaching and research interests focus on the management of organizational change. She also studies virtual work, online communities and the careers of top executives and directors. Her work has been published in numerous academic journals, as well as manager-oriented journals such as Harvard Business Review. She serves as a Senior Editor of the journal Organization Science.

Nicole Alexandra Rosenkranz, PostDoc and Lecturer at the Wharton School of the University of Pennsylvania, where she conducts research in innovation management driven by inter-firm collaboration. She teaches at the undergraduate level and has previously managed executive education at Columbia University Graduate School of Business. She received her Ph.D. from the University of St.Gallen (2011), MBA and B.S. from the European Business School (ebs). Nicole serves as a reviewer to diverse journals, amongst which Organization Science and the Academy of Management Review.

Sohum Doshi and Patrick Wingo, Research Assistants at the Wharton School of the University of Pennsylvania provided support in the data analysis and reports.

Disclaimer

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Appendix 3: Sample Individual Report

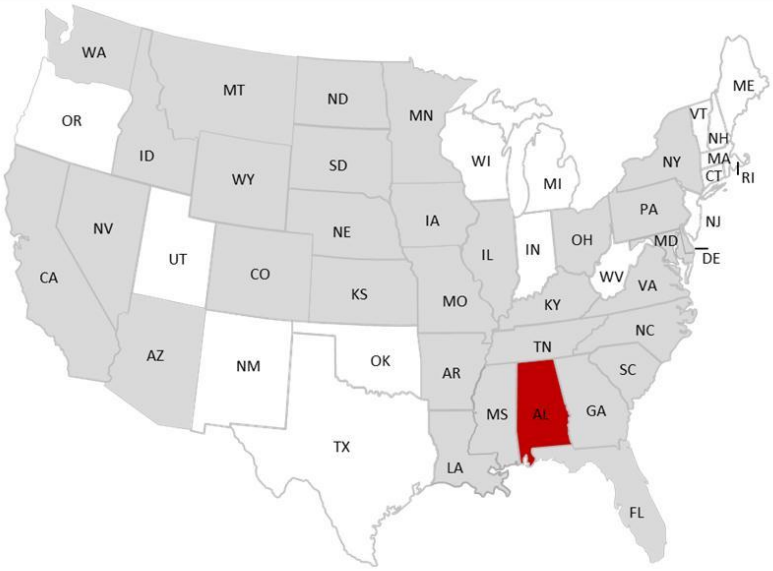
NCHRP - Project 20-68C
Alabama - Individual Report

Summary of Research Objective

You participated in a survey as part of NCHRP 20-68C designed to assess how practice improvements and innovative technologies move within and among transportation agencies and how that movement can be used to more effectively accelerate innovation.

The survey was sent to maintenance function staff in 32 state DOT's, and we received responses from 341 people (60% response rate). The overall survey report is currently in preparation and will be available through NCHRP, but this document is a customized report providing you with information about your own and your DOT's responses to the survey because you elected to receive an individual report.

Participating States



DOT Orientation towards Innovation

DOT's vary with respect to whether they resist or actively embrace new innovations. Stronger DOT orientation toward innovation involves searching for and being among the first to implement new innovative technologies. Values below 2.5 indicate resistance to innovation while values 4 and above indicate positive orientation toward innovation.

Overall Sample: Mean: 3.5, Std.Dev.: 0.8 (Min: 1.3 / Max: 5.0)

Your DOT: Mean: 3.5, Std.Dev.: 0.7 (Min: 2.5 / Max: 4.5)

Your response: 3

State DOT's also vary with respect to their belief that they can learn from other DOT's, which indicates how receptive the state is to innovations implemented in other DOTs. Values below 2.5 indicate resistance (i.e., "not invented here" syndrome) while values 4 and above indicate willingness to learn from other DOT's.

Overall Sample: Mean: 4.6, Std.Dev.: 0.7 (Min: 1.0 / Max: 5.0)

Your DOT: Mean: 4.6, Std.Dev.: 0.7 (Min: 3.0 / Max: 5.0)

Your response: 4

Employee Engagement in Innovative Activities

Innovative activities can be differentiated with respect to the extent to which they reflect a more radical departure from existing practice or offer relatively more limited and incremental improvement that builds upon existing activities. Both are valuable forms of innovation. Values of 4 and above indicate a high level of engagement in innovative activities of these different types.

Radical innovation:

Overall sample: Mean: 3.4, Std.Dev.: 0.6 (Min: 1.3 / Max: 5.0)

Your DOT: Mean: 3.1, Std.Dev.: 0.4 (Min: 2.5 / Max: 3.8)

Your response: 3

Incremental innovation:

Overall sample: Mean: 3.7, Std.Dev.: 0.6 (Min: 2.0 / Max: 5.0)

Your DOT: Mean: 3.4, Std.Dev.: 0.4 (Min: 2.8 / Max: 4.3)

Your response: 3.5

Support for Specific Innovations

Our survey addressed three innovations that are all related to winter maintenance and that have received attention across DOTs. These innovations are Maintenance Decision Support Systems (MDSS), TowPlow, and Automated Pothole Patcher. DOT's and individual respondents differed with respect to their level of awareness of each innovative technology, how supportive they were of each innovative technology, and the extent to which the innovative technologies were being implemented. Support and implementation scales range from 1 to 5 with higher values being more positive.

Summary

	MDSS	TowPlow	Pothole Patcher
Technology Awareness Level (%)			
Overall sample:	60	65	60
Your DOT:	8	8	42
Your response:	n/a	n/a	n/a
DOT Support			
Overall sample:	3.6	3.2	3.2
Your DOT:	3.7	2.7	3.1
Your response:	n/a	n/a	n/a
Individual Support			
Overall sample:	3.8	3.6	3.7
Your DOT:	3.4	2.6	2.9
Your response:	n/a	n/a	n/a
Implementation			
Overall sample:	3.4	3.0	3.1
Your DOT:	3.0	2.0	3.4
Your response:	n/a	n/a	n/a

Social Networks Supporting Innovation

Ideas and innovations spread across people and organizations via their social networks – the personal contacts they have with others inside and outside their own organization. Respondents varied with respect to the size (that is, number of contacts) and content (percent of contacts that are external to their DOT) of their social networks. Averages on network contacts were only calculated based on the 174 survey responses that reported network data. Larger social networks, and social networks that bridge across organizations, expose people to more new innovations.

Number of contacts you reported

Average in overall sample: 5.2

Average in your DOT: 1.1

Your response: 3

Percent of contacts you reported outside your state

Overall sample: 19.4%

Your DOT: 16.5%

Your response: 33.3%

Relationship with DOT Organization and Profession

People vary with respect to how important certain professional groups are to them. For some people, belonging to their DOT or the engineering profession is a central part of who they are as people. The survey assessed both the strength of respondents' relationship with their DOT and with the engineering profession.

Relationship with DOT

Overall sample: Mean: 4.3, Std.Dev.: 0.6 (Min: 1.0 / Max: 5.0)

Average in your DOT: Mean: 4.1, Std.Dev.: 0.5 (Min: 3.5 / Max: 5.0)

Your response: 5

Relationship with Engineering Profession

Overall sample: Mean: 3.8, Std.Dev.: 0.8 (Min: 1.0 / Max: 5.0)

Your DOT: Mean: 4.0, Std.Dev.: 0.2 (Min: 3.5 / Max: 4.5)

Your response: 4

Research Team

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Batia Mishan Wiesenfeld, Professor of Management at the Leonard N. Stern Schools of Business, New York University, is the David Margolis Faculty Fellow. She received her Ph.D. in Management and Organizational Behavior from the Columbia University Graduate School of Business. Her teaching and research interests focus on the management of organizational change. She also studies virtual work, online communities and the careers of top executives and directors. Her work has been published in numerous academic journals, as well as manager-oriented journals such as Harvard Business Review. She serves as a Senior Editor of the journal Organization Science.

Nicole Alexandra Rosenkranz, PostDoc and Lecturer at the Wharton School of the University of Pennsylvania, where she conducts research in innovation management driven by inter-firm collaboration. She teaches at the undergraduate level and has previously managed executive education at Columbia University Graduate School of Business. She received her Ph.D. from the University of St.Gallen (2011), MBA and B.S. from the European Business School (ebs). Nicole serves as a reviewer to diverse journals, amongst which Organization Science and the Academy of Management Review.

Sohum Doshi and Patrick Wingo, Research Assistants at the Wharton School of the University of Pennsylvania provided support in the data analysis and reports.

Disclaimer

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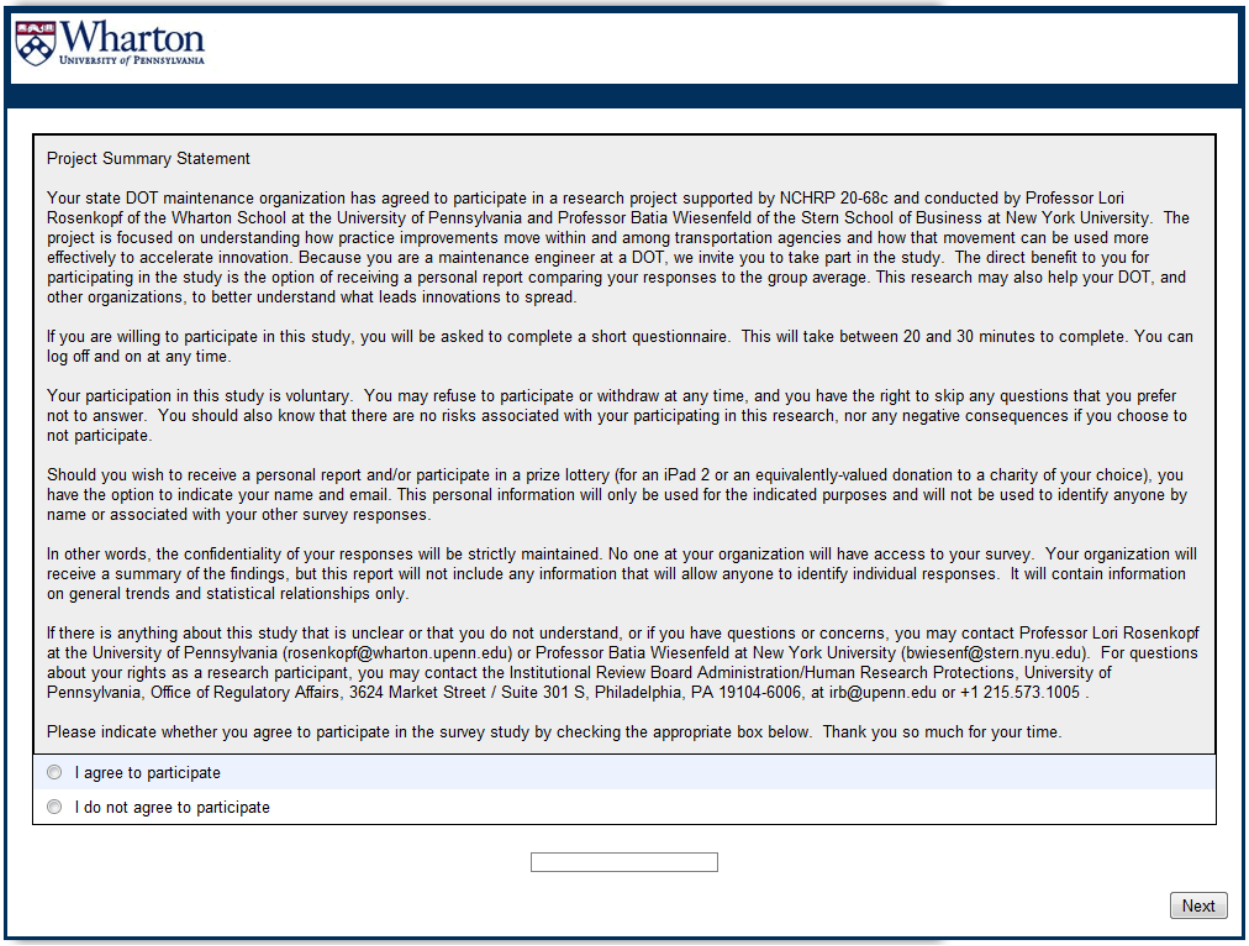
Appendix 4: Questionnaire screenshots and response summaries



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Project Summary Statement

Your state DOT maintenance organization has agreed to participate in a research project supported by NCHRP 20-68c and conducted by Professor Lori Rosenkopf of the Wharton School at the University of Pennsylvania and Professor Batia Wiesenfeld of the Stern School of Business at New York University. The project is focused on understanding how practice improvements move within and among transportation agencies and how that movement can be used more effectively to accelerate innovation. Because you are a maintenance engineer at a DOT, we invite you to take part in the study. The direct benefit to you for participating in the study is the option of receiving a personal report comparing your responses to the group average. This research may also help your DOT, and other organizations, to better understand what leads innovations to spread.

If you are willing to participate in this study, you will be asked to complete a short questionnaire. This will take between 20 and 30 minutes to complete. You can log off and on at any time.

Your participation in this study is voluntary. You may refuse to participate or withdraw at any time, and you have the right to skip any questions that you prefer not to answer. You should also know that there are no risks associated with your participating in this research, nor any negative consequences if you choose to not participate.

Should you wish to receive a personal report and/or participate in a prize lottery (for an iPad 2 or an equivalently-valued donation to a charity of your choice), you have the option to indicate your name and email. This personal information will only be used for the indicated purposes and will not be used to identify anyone by name or associated with your other survey responses.

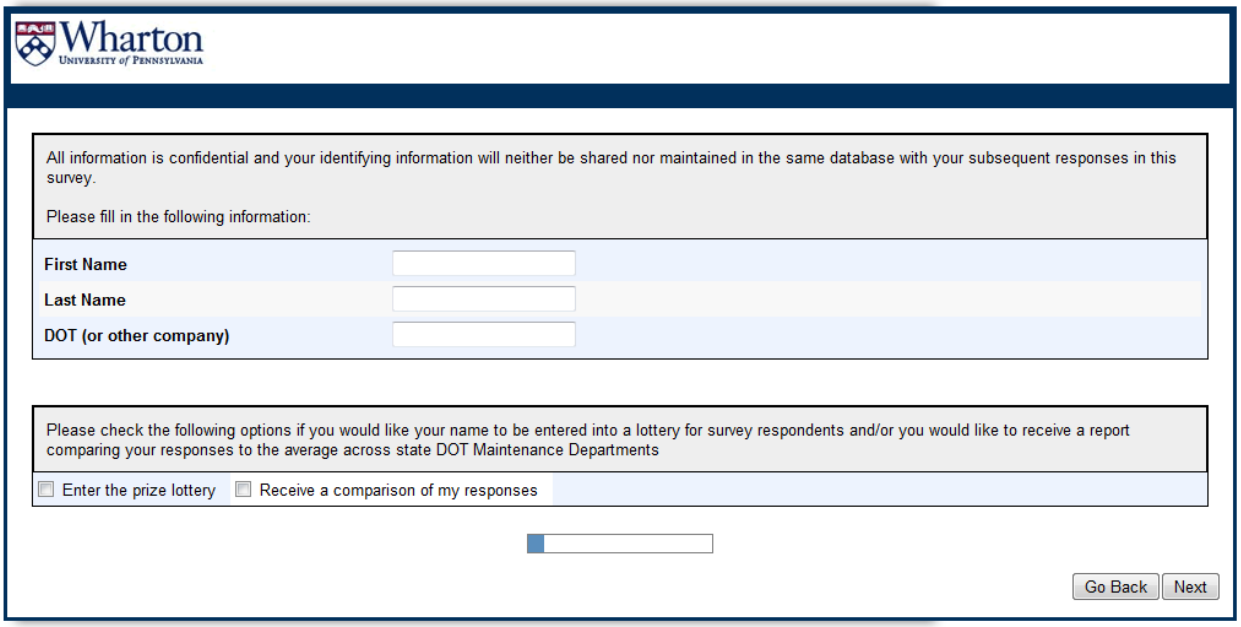
In other words, the confidentiality of your responses will be strictly maintained. No one at your organization will have access to your survey. Your organization will receive a summary of the findings, but this report will not include any information that will allow anyone to identify individual responses. It will contain information on general trends and statistical relationships only.

If there is anything about this study that is unclear or that you do not understand, or if you have questions or concerns, you may contact Professor Lori Rosenkopf at the University of Pennsylvania (rosenkopf@wharton.upenn.edu) or Professor Batia Wiesenfeld at New York University (bwiesenf@stern.nyu.edu). For questions about your rights as a research participant, you may contact the Institutional Review Board Administration/Human Research Protections, University of Pennsylvania, Office of Regulatory Affairs, 3624 Market Street / Suite 301 S, Philadelphia, PA 19104-6006, at irb@upenn.edu or +1 215.573.1005 .

Please indicate whether you agree to participate in the survey study by checking the appropriate box below. Thank you so much for your time.

- ○ I agree to participate
- ○ I do not agree to participate

Next



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All information is confidential and your identifying information will neither be shared nor maintained in the same database with your subsequent responses in this survey.

Please fill in the following information:

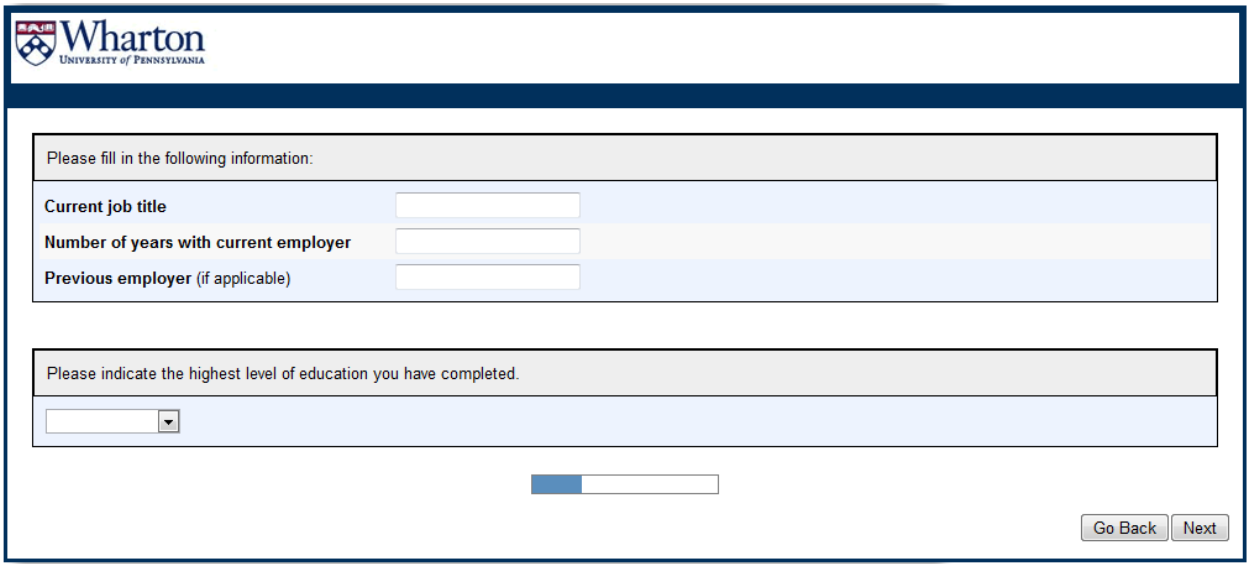
First Name	
Last Name	
DOT (or other company)	

Please check the following options if you would like your name to be entered into a lottery for survey respondents and/or you would like to receive a report comparing your responses to the average across state DOT Maintenance Departments

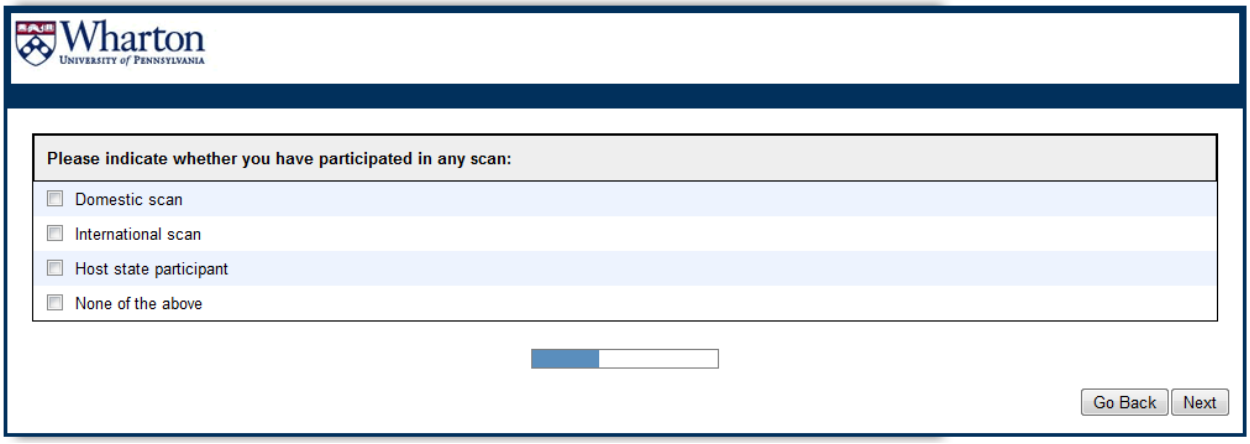
☐ Enter the prize lottery ☐ Receive a comparison of my responses

Go Back Next

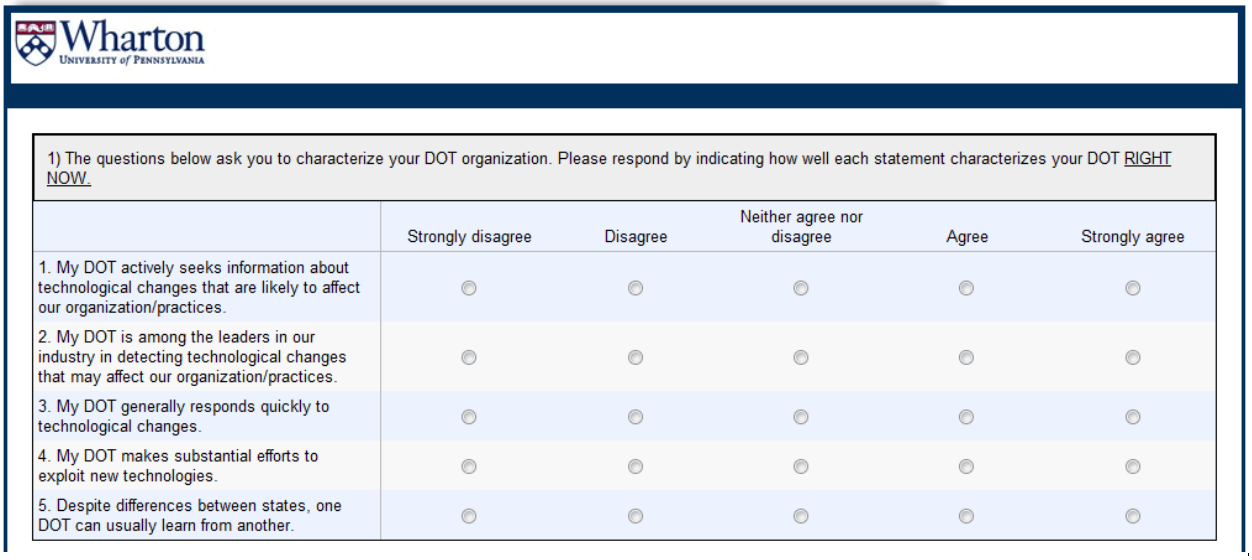
172 respondents entered the lottery, and 253 elected to receive a comparison of their responses



Education		
High School	Total	80
Undergrad	Total	170
Graduate	Total	86



Scan Participation		
Domestic Scan	Total	31
Host State	Total	22
International Scan	Total	3
None	Total	288



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1) The questions below ask you to characterize your DOT organization. Please respond by indicating how well each statement characterizes your DOT RIGHT NOW.

	Strongly disagree	Disagree	Neither agree nor disagree	Agree	Strongly agree
1. My DOT actively seeks information about technological changes that are likely to affect our organization/practices.					
2. My DOT is among the leaders in our industry in detecting technological changes that may affect our organization/practices.					
3. My DOT generally responds quickly to technological changes.					
4. My DOT makes substantial efforts to exploit new technologies.					
5. Despite differences between states, one DOT can usually learn from another.					

Respondents exhibited the highest and most uniform level of support for the item assessing their willingness to learn about innovations from other state DOTs (Item 1.5), suggesting support for innovation diffusion mechanisms such as domestic scans which create opportunities for states to learn from one another. In addition, states varied somewhat with respect to respondents' ratings of how supportive and oriented toward innovation they were perceived to be).

ID	Min	Max	Mean	StD
Seek information	1	5	3.92	0.77
Detecting tech. change	1	5	3.58	0.93
Response to tech. change	1	5	3.17	0.93
Exploit tech. change	1	5	3.43	0.92
Learn from other DOTs	1	5	4.55	0.66

Highest states	Mean	Lowest states	Mean
Florida	4.38	South Carolina	3.09
Minnesota	4.32	Maryland	2.88
Iowa	4.14	Illinois	2.79

2) Please indicate the extent to which you engaged in the following innovation activities in the past year:					
	Not at all	Rarely	Once in a while	Often	Always
1. Searching for new possibilities with respect to products/services or processes	○	○	○	○	○
2. Activities which clearly serve long-term goals	○	○	○	○	○
3. Activities for which the associated benefits or costs are currently unclear	○	○	○	○	○
4. Activities requiring you to learn new skills or knowledge	○	○	○	○	○
5. Improving existing activities with respect to products/services and processes	○	○	○	○	○
6. Activities which clearly serve short-term goals of existing business	○	○	○	○	○
7. Activities for which the associated benefits, costs and outcome are clear and measurable	○	○	○	○	○
8. Activities which you can properly conduct by using your present knowledge	○	○	○	○	○

Innovative activities can be differentiated with respect to the extent to which they reflect a more radical departure from existing practice (reflected in items 1-4) or offer relatively more limited and incremental improvement that builds upon existing activities (reflected in items 5-8). While respondents reported slightly greater propensity to engage in incremental than radical innovative activities, an exception was the relative focus on long-term rather than short-term-focused innovation (items 2 vs. 6).

ID	Min	Max	Mean	StD
New possibilities	1	5	3.46	0.77
Long-term goals	1	5	3.73	0.74
Unclear benefits	1	5	3.07	0.79
New learned skills	1	5	3.43	0.76
Existing activities	1	5	3.67	0.75
Short-term goals	1	5	3.50	0.79
Measureable benefits	1	5	3.59	0.78
Existing knowledge	1	5	3.92	0.56

Radical Innovation

Highest states	Mean	Lowest states	Mean
Minnesota	4.02	Illinois	3.04
Ohio	3.92	Delaware	3.00
Maryland	3.88	South Carolina	2.85

Incremental Innovation

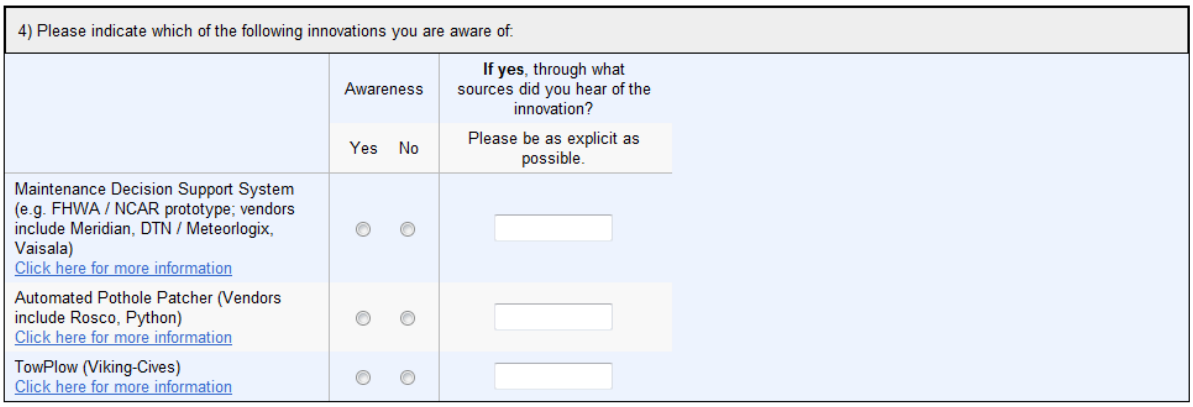
Highest states	Mean	Lowest states	Mean
Missouri	4.08	New York	3.36
Iowa	3.86	North Dakota	3.34
Pennsylvania	3.86	Wyoming	3.32

3) Please indicate which information channels you used (if any) to learn about innovative technologies and processes.									
	Not at all valuable	Not valuable	Of little value	Neither valuable or not valuable	Moderately valuable	Very valuable	Extremely valuable		Not used
Scan related (e.g., meetings, scan reports, domesticscan.org)	○	○	○	○	○	○	○	○	○
Printed resources (e.g., journals, reports, department noticeboard)	○	○	○	○	○	○	○	○	○
Websites (e.g., MyStateDOT, TRB.org, vendor website, best practices database)	○	○	○	○	○	○	○	○	○
Professional/Trade Association sponsored events (e.g., conferences, trade shows, workshops, webinars)	○	○	○	○	○	○	○	○	○
Other meetings (e.g., regional forums, liaison exchange, within-state events)	○	○	○	○	○	○	○	○	○
Personal communications (e.g., informal discussions with university collaborators, consultants, DOT team, vendors)	○	○	○	○	○	○	○	○	○

Scans were assessed as valuable, on average, by users of scans (mean = 5.08). This rating is nearly comparable to other more general and ubiquitous sources of innovation such as printed reports, websites, association meetings, other group meetings and personal contacts.

ID	Min	Max	Mean	StD
SCAN	2	7	5.16	0.59
PRINTED	2	7	5.23	0.32
WEBSITES	2	7	5.42	0.42
PROF/TRADE	2	7	5.61	0.40
OTHER	2	7	5.70	0.36
PERS COMM	2	7	5.70	0.38

	Highest state	Mean	Lowest state	Mean
SCAN	Nevada	6.25	Kansas	3.75
PRINTED	Maryland	6.00	South Dakota	4.64
WEBSITES	Maryland	7.00	Florida	4.50
PROF/TRADE	Maryland	7.00	Georgia	4.80
OTHER	Maryland	6.50	Ohio	5.00
PERS COMM	Florida	6.50	Arkansas	4.90



4) Please indicate which of the following innovations you are aware of:

	Awareness		**If yes**, through what sources did you hear of the innovation?
	Yes	No	Please be as explicit as possible.
Maintenance Decision Support System (e.g. FHWA / NCAR prototype; vendors include Meridian, DTN / Meteorlogix, Vaisala) Click here for more information	○	○	
Automated Pothole Patcher (Vendors include Rosco, Python) Click here for more information	○	○	
TowPlow (Viking-Cives) Click here for more information	○	○	

Approximately 2/3 of respondents were aware of each innovation.

Innovations	Yes (%)
MDSS	60
POTHOLE	60
TOWPLOW	65

MDSS

Highest states	**Yes (%)**	**Lowest states**	**Yes (%)**
Colorado	100	Delaware	0
Idaho	100	Georgia	0
Maryland	100	Louisiana	0

Pothole

Highest states	**Yes (%)**	**Lowest states**	**Yes (%)**
Delaware	100	Alabama	42
Pennsylvania	89	Georgia	38
Kansas	88	Washington	35

Towplow

Highest states	**Yes (%)**	**Lowest states**	**Yes (%)**
Delaware	100	Alabama	8
Pennsylvania	100	Louisiana	0
Wyoming	100	Georgia	0

5) A maintenance decision support system can incorporate several components, listed below. For each component, please indicate where your DOT stands from awareness to full implementation of the technologies:

	Aware	Considering	Testing	Implementing		n/a
1. RWIS (remote sensors)	○	○	○	○	○	○
2. GPS / AVL	○	○	○	○	○	○
3. Vehicle cameras	○	○	○	○	○	○
4. Weather reporting systems	○	○	○	○	○	○
5. Live traffic reporting	○	○	○	○	○	○

In the questions that follow, 'Maintenance Decision Support System' refers to a fully integrated system which may contain any or all of the components listed.

States were more advanced in implementing remote sensor information and weather reporting systems than other components of MDSS, with vehicle cameras being the least commonly integrated component of MDSS systems.

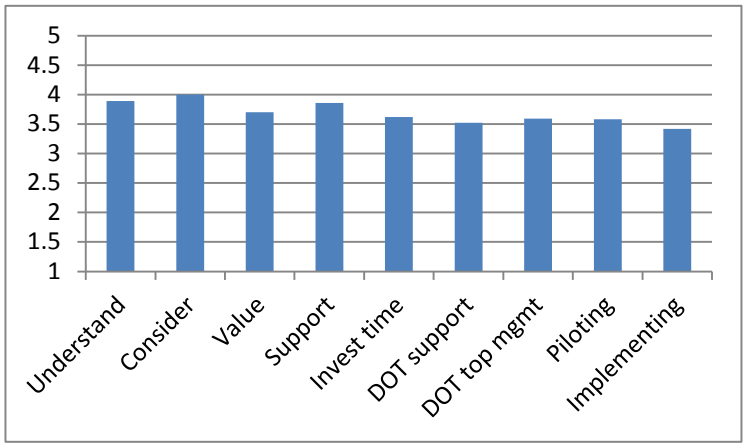
ID	Min	Max	Mean	StD
RWIS	1	4	3.56	1.02
GPS/AVL	1	4	3.11	1.12
VEH CAM	1	4	2.39	1.38
WEATHER	1	4	3.30	1.17
LIVE TRAF	1	4	2.96	1.43

6) Please indicate the degree to which you agree with the statements below.

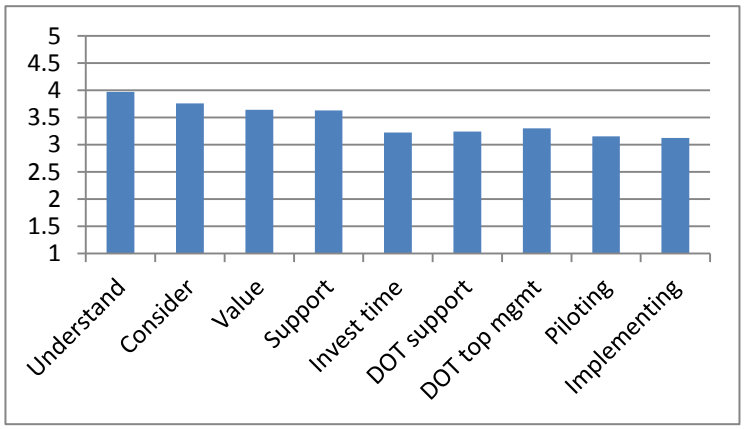
	Maintenance Decision Support System					Automated Pothole Patcher					TowPlow				
	Strongly disagree	Disagree	Neither agree nor disagree	Agree	Strongly agree	Strongly disagree	Disagree	Neither agree nor disagree	Agree	Strongly agree	Strongly disagree	Disagree	Neither agree nor disagree	Agree	Strongly agree
I fully understand this innovation	○	○	○	○	○	○	○	○	○	○	○	○	○	○	○
I am considering/have considered the applicability of this innovation to my DOT	○	○	○	○	○	○	○	○	○	○	○	○	○	○	○
The value of this innovation for my DOT is clear.	○	○	○	○	○	○	○	○	○	○	○	○	○	○	○
I support the implementation of this innovation at my DOT.	○	○	○	○	○	○	○	○	○	○	○	○	○	○	○
I intend to invest my time in implementing this innovation at my DOT.	○	○	○	○	○	○	○	○	○	○	○	○	○	○	○
	Strongly disagree	Disagree	Neither agree nor disagree	Agree	Strongly agree	Strongly disagree	Disagree	Neither agree nor disagree	Agree	Strongly agree	Strongly disagree	Disagree	Neither agree nor disagree	Agree	Strongly agree
A sufficient number of people at my DOT are committed to implementing this innovation.	○	○	○	○	○	○	○	○	○	○	○	○	○	○	○
Top management at my DOT supports implementing this innovation.	○	○	○	○	○	○	○	○	○	○	○	○	○	○	○
My DOT is in the process of piloting this innovation.	○	○	○	○	○	○	○	○	○	○	○	○	○	○	○
Implementing this innovation is underway or nearly complete.	○	○	○	○	○	○	○	○	○	○	○	○	○	○	○

This question reflects the innovation adoption process; items are arrayed in order beginning with awareness (item 1) and progressing to full implementation (item 9). It is typical to find agreement decline with progressive items reflecting later stages in the innovation adoption process. This decline was less true of MDSS than of Towplow or Automated Pothole Patcher.

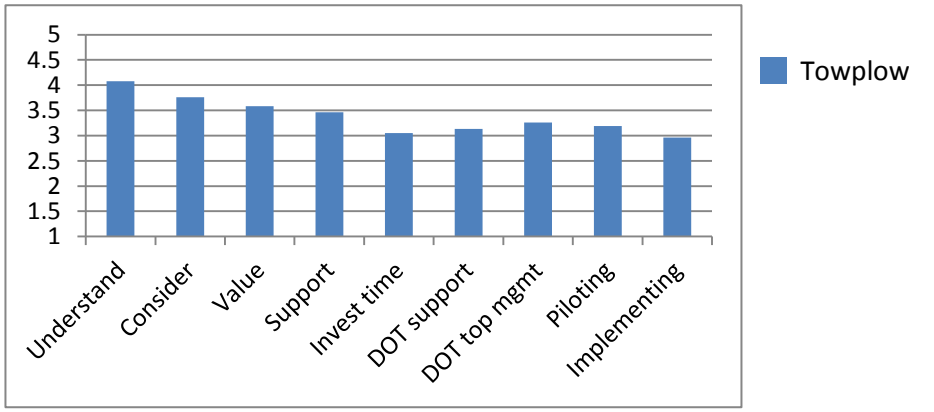
MDSS	Min	Max	Mean	StD
Understand	1	5	3.89	0.93
Consider	1	5	4.00	0.96
Value	1	5	3.70	0.94
Support	1	5	3.86	1.02
Invest time	1	5	3.62	1.06
DOT support	1	5	3.52	1.04
DOT top mgmt	1	5	3.59	0.96
Piloting	1	5	3.58	1.12
Implementing	1	5	3.42	1.18



Pothole	Min	Max	Mean	StD
Understand	2	5	3.97	0.82
Consider	1	5	3.76	0.99
Value	1	5	3.64	0.94
Support	1	5	3.63	1.01
Invest time	1	5	3.22	1.05
DOT support	1	5	3.24	0.96
DOT top mgmt	1	5	3.30	0.92
Piloting	1	5	3.15	1.03
Implementing	1	5	3.12	1.15



Towplow	Min	Max	Mean	StD
Understand	1	5	4.08	0.82
Consider	1	5	3.76	1.08
Value	1	5	3.58	1.07
Support	1	5	3.46	1.16
Invest time	1	5	3.05	1.21
DOT support	1	5	3.13	1.08
DOT top mgmt	1	5	3.26	1.03
Piloting	1	5	3.19	1.23
Implementing	1	5	2.96	1.30



Two measures were developed from the initial nine items. The first reflects the individual's attitudes and activities supporting the innovation and is a scale composed of items 1-5. The second measure reflects the DOT's activities supporting the innovation, captured by items 6-9.

MDSS

Individual support

Highest states	Mean	Lowest states	Mean
Idaho	4.55	Florida	2.90
Colorado	4.46	Arizona	2.87
Minnesota	4.40	North Carolina	2.75

DOT support

Highest states	Mean	Lowest states	Mean
South Dakota	4.41	Montana	2.60
Minnesota	4.36	Arizona	2.44
Maryland	4.33	North Carolina	1.00

Pothole

Individual support

Highest states	Mean	Lowest states	Mean
Minnesota	4.35	Ohio	2.90
Pennsylvania	4.28	Arkansas	2.83
South Dakota	4.25	Florida	2.67

DOT support

Highest states	Mean	Lowest states	Mean
Minnesota	4.33	Arizona	2.22
Pennsylvania	3.96	Idaho	2.22
Illinois	3.77	Florida	1.78

Towplow

Individual support

Highest states	Mean	Lowest states	Mean
Missouri	4.88	Washington	2.83
Nevada	4.68	Alabama	2.60
Delaware	4.60	South Carolina	2.00

DOT support

Highest states	Mean	Lowest states	Mean
Missouri	4.70	Kentucky	2.29
Pennsylvania	4.38	Mississippi	1.83
Minnesota	4.33	South Carolina	1.67

Percentage of districts utilizing innovations/years in use

7) Within my DOT, approximately what percentage of districts/regions that could be using the innovation are actually using it (e.g. 60%) and for how long (e.g. 3 years)?

There is no need to provide exact figures – please just provide your rough estimate without obtaining additional data.

	% of districts/regions	# of years
Maintenance Decision Support System		
Automated pothole patcher		
TowPlow		

Innovations	%	# years
MDSS	64.68	3.69
POTHOLE	54.71	5.13
TOWPLOW	35.95	2.09

Highest and lowest states with respect to percent of districts utilizing innovation and years in use

MDSS[3]

Highest states	%	Lowest states	%
Maryland	100	Virginia	20.00
Ohio / Iowa	100	Idaho	19.00
South Carolina	100	Kentucky	6.33

Highest states	Years[4]	Lowest states	Years
Tennessee	17.50	Pennsylvania	1.67
Iowa	12.50	Idaho	1.33
South Carolina	10.00	Maryland	1.00

Pothole

Highest states	%	Lowest states	%
Iowa	100.00	Louisiana	15.00
Kansas	100.00	New York	13.50
Wyoming	100.00	California	4.25

Highest states	Years	Lowest states	Years
South Dakota	10.00	Tennessee	2.67
South Carolina	9.33	Louisiana	2.00
Kansas	9.00	California	1.25

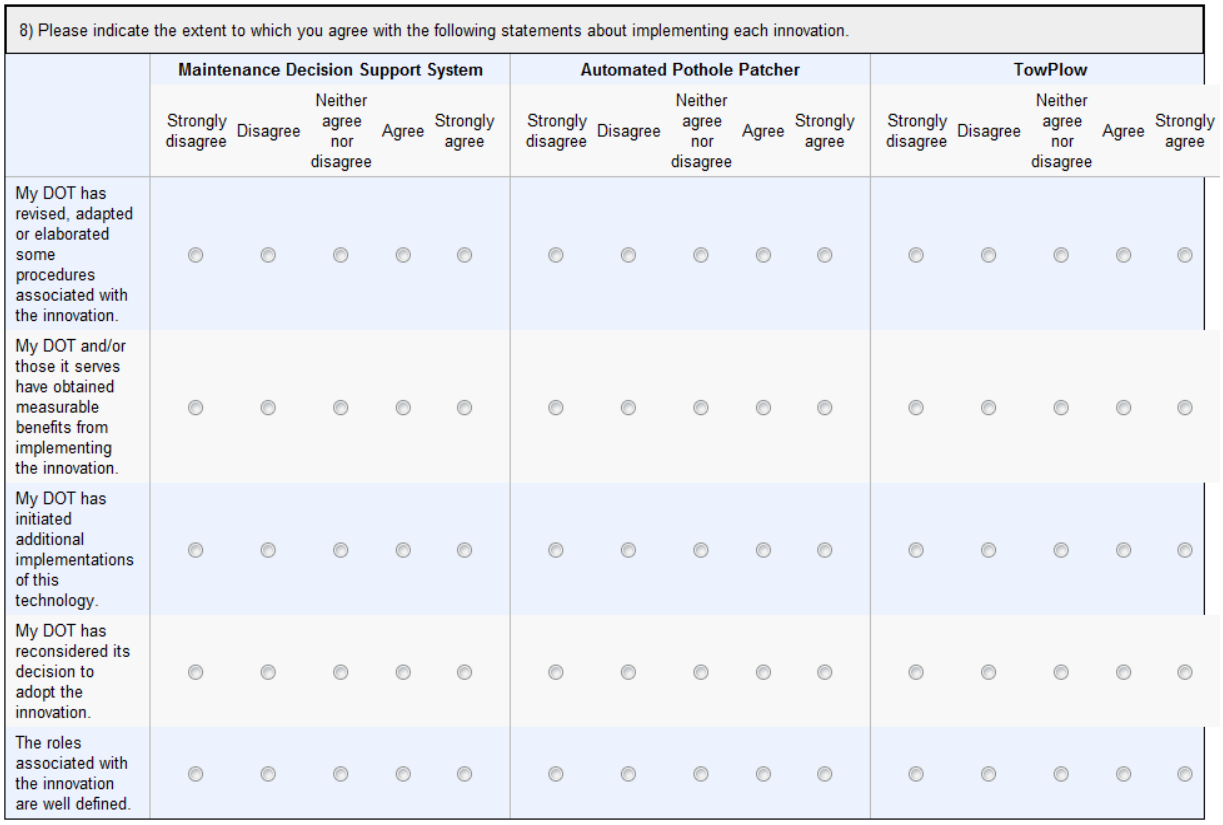
[3] Responses are limited to states indicating awareness of the particular innovation

[4] Year responses for MDSS are unreliable due to possible data entry errors by TN respondent

Towplow

Highest states	%	Lowest states	%
Pennsylvania	43.88	Maryland	14.50
Nevada	41.00	Colorado	12.50
Iowa	33.13	Ohio	8.10

Highest states	Years	Lowest states	Years
Missouri	4.75	Maryland	1.00
Minnesota	2.90	Colorado	1.00
Pennsylvania	2.00	Ohio	1.00



8) Please indicate the extent to which you agree with the following statements about implementing each innovation.

	Maintenance Decision Support System					Automated Pothole Patcher					TowPlow				
	Strongly disagree	Disagree	Neither agree nor disagree	Agree	Strongly agree	Strongly disagree	Disagree	Neither agree nor disagree	Agree	Strongly agree	Strongly disagree	Disagree	Neither agree nor disagree	Agree	Strongly agree
My DOT has revised, adapted or elaborated some procedures associated with the innovation.															
My DOT and/or those it serves have obtained measurable benefits from implementing the innovation.															
My DOT has initiated additional implementations of this technology.															
My DOT has reconsidered its decision to adopt the innovation.															
The roles associated with the innovation are well defined.															

Items revise, addimplement, and defroles reflect DOT efforts to elaborate and expand upon implemented innovations (i.e., revising the implementation, initiating additional implementations, and defining the roles associated with the innovation). Responses indicate moderate levels of such elaboration activities. Across the three innovations, there were moderate benefits reported from implementing the innovations, but little evidence that the decision to implement was reconsidered.

ID	Min	Max	Mean	StD
MDSS_revise	2	5	3.96	0.73
MDSS_benefit	1	5	3.62	0.88
MDSS_addimplement	1	5	3.65	0.90
MDSS_reconsider	1	5	2.78	0.95
MDSS_defroles	1	5	3.56	0.88
POTHOLE_revise	2	5	3.54	0.74
POTHOLE _benefit	2	5	3.86	0.76
POTHOLE _addimplem	2	5	3.39	0.79
POTHOLE _reconsider	1	5	2.62	0.88
POTHOLE _defroles	2	5	3.73	0.76
TOWPLW_revise	1	5	3.48	0.92
TOWPLW _benefit	1	5	3.73	0.84
TOWPLW _addimpl	1	5	3.57	0.95
TOWPLW _reconsider	1	5	2.41	0.94
TOWPLW _defroles	1	5	3.76	0.89

9a) To what extent did the implementation of your maintenance decision support system meet the following performance indicators?					
	Much less than expected	Less than expected	As expected	More than expected	Much more than expected
Cost	○	○	○	○	○
Time	○	○	○	○	○
Quality	○	○	○	○	○
Performance	○	○	○	○	○
Employee response	○	○	○	○	○

9b) To what extent did the implementation of Automated Pothole Patcher meet the following performance indicators?					
	Much less than expected	Less than expected	As expected	More than expected	Much more than expected
Cost	○	○	○	○	○
Time	○	○	○	○	○
Quality	○	○	○	○	○
Performance	○	○	○	○	○
Employee response	○	○	○	○	○

9c) To what extent did the implementation of TowPlow meet the following performance indicators?					
	Much less than expected	Less than expected	As expected	More than expected	Much more than expected
Cost	○	○	○	○	○
Time	○	○	○	○	○
Quality	○	○	○	○	○
Performance	○	○	○	○	○
Employee response	○	○	○	○	○

The three innovations were rated similarly and somewhat positively with respect to cost and time savings by those respondents who have piloted or implemented the innovations. However, MDSS was rated lower than TowPlow and Automated Pothole Patcher with respect to quality, performance, and employee response.

ID	Min	Max	Mean	StD
MDSS_COST	1	5	3.28	0.71
MDSS_TIME	1	5	3.41	0.74
MDSS_QUALITY	1	5	2.78	0.70
MDSS_PERFORM	1	5	2.80	0.78
MDSS_EMPLOY	1	4	2.72	0.75

ID	Min	Max	Mean	StD
POTHOLE_COST	2	5	3.13	0.64
POTHOLE_TIME	2	5	3.18	0.69
POTHOLE _QUALITY	2	5	3.14	0.71
POTHOLE_PERFORM	1	5	3.15	0.78
POTHOLE_EMPLOY	2	5	3.23	0.69

ID	Min	Max	Mean	StD
TOWPLOW_COST	1	5	3.16	0.73
TOWPLOW_TIME	1	5	3.19	0.66
TOWPLOW_QUALITY	1	5	3.22	0.69
TOWPLOW_PERFORM	1	5	3.36	0.74
TOWPLOW_EMPLOY	1	5	3.30	0.83

Overall performance (average across the five performance indicators) results are provided below.

MDSS

Highest states	Mean	Lowest states	Mean
California[5]	3.60	Ohio	2.80
Kentucky	3.33	Pennsylvania	2.77
North Dakota	3.23	Idaho	2.60

Pothole

Highest states	Mean	Lowest states	Mean
Kansas	3.60	Louisiana	2.93
Montana	3.50	Wyoming	2.80
South Dakota	3.40	North Dakota	2.56

Towplow

Highest states	Mean	Lowest states	Mean
Nevada	3.50	Nebraska	3.12
Missouri	3.50	Arkansas	3.00
Pennsylvania	3.34	Colorado	2.76

[5] Data for this state's answer in this category may be unreliable as only one respondent answered this question.

10) Please list up to 10 people whom you consider to be your most important contacts for successful innovation. These contacts may be from your own DOT or other organizations.

Names you provide will not be used for any purpose other than for your reference in later portions of the survey.

	First name	Last name	Employer/Organization	How did you first get to know this person?
1				
2				
3				
4				
5				
6				
7				
8				
9				
10				

10a) Now we would like to understand the specific ways in which these sources help you innovate.

Please check all that apply:

	Technical Expertise	New innovation opportunities	Financial support	Other
Lori Rosenkopf	☐	☐	☐	☐
Batia Wiesenfeld	☐	☐	☐	☐

10b) If there are any additional contacts who also provide technical expertise, new innovation opportunities or financial support, please list them in the space below.

Please check all types of support that apply.

	Identification				Type of Support		
	First Name	Last Name	Employer/Organization	How did you first get to know this person?	Technical expertise	New innovation opportunities	Financial Support
1					☐	☐	☐
2					☐	☐	☐
3					☐	☐	☐

The average number of contacts for the 15 scan participants (mean = 5.7) was slightly above the average number of contacts in the overall pool of 174 respondents providing network data (mean = 5.2). The scan participants' distribution was more polarized in that a larger proportion of scan participants reported 10 contacts than in the general sample of respondents. Contacts were categorized as either internal or external, meaning that respondents gathered information about innovations from fellow members of their own DOT or from people outside the state. States varied dramatically in the rates at which they reported external contacts.

% of external contacts

Highest states	Mean	Lowest states	Mean
Maryland	69.2%	Florida	0.00%
Georgia	60.0%	Nevada	0.00%
Idaho	50.0%	Nebraska	0.00%

11) Please indicate the degree to which you agree with the statements below:					
	Strongly disagree	Disagree	Neither agree not disagree	Agree	Strongly agree
1. I am very interested in what others think about my DOT.					
2. When I talk about my DOT, I usually say 'we' rather than 'they'.					
3. My DOT's successes are my successes.					
4. When someone praises my DOT, it feels like a personal compliment.					
5. I am very interested in what others think about the engineering profession.					
6. When I talk about engineers, I usually say 'we' rather than 'they'.					
7. The engineering profession's successes are my successes.					
8. When someone praises engineers, it feels like a personal compliment.					

Respondents' attitudes toward their DOT were more positive than their attitudes toward the engineering profession. Attitudes toward their DOT were similar to other U.S. corporate samples.

ID	Min	Max	Mean	StD
DOT - impression	1	5	4.22	0.68
DOT - 'we' vs. 'they'	1	5	4.37	0.65
DOT - success identification	1	5	4.19	0.73
DOT - personal compliment	1	5	4.22	0.68
Engineer - impression	1	5	3.95	0.83
Engineer - 'we' vs. 'they'	1	5	3.81	1.00
Engineer - success identification	1	5	3.65	0.92
Engineer - personal compliment	1	5	3.63	0.97

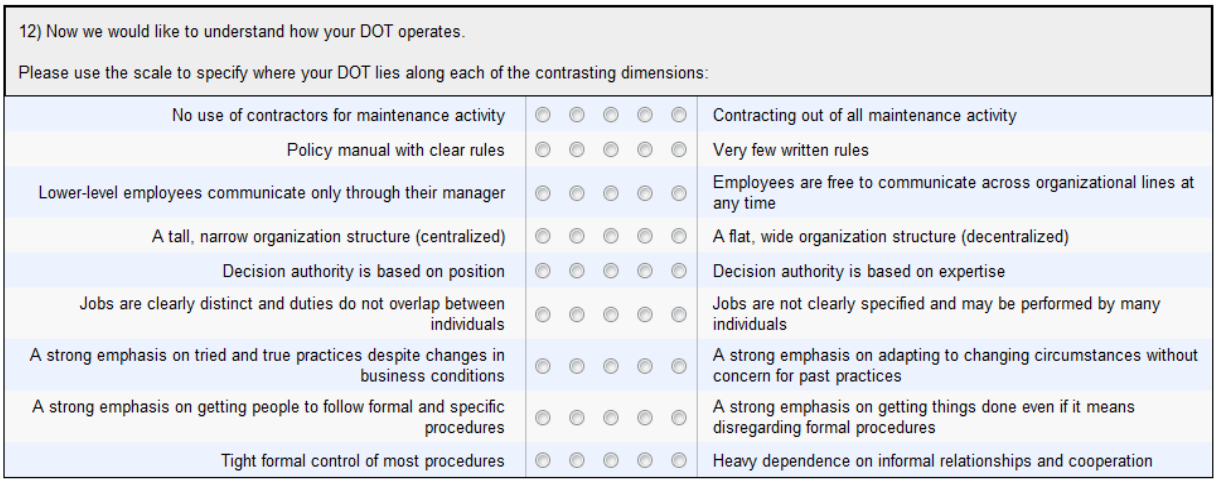
Overall identification (average of the four items for DOT and profession, respectively) are below.

DOT identification

Highest states	Mean	Lowest states	Mean
Ohio	4.75	Delaware	4.00
Florida	4.69	Nebraska	3.92
Colorado	4.66	Wyoming	3.86

Professional identification

Highest states	Mean	Lowest states	Mean
Mississippi	4.41	Nebraska	3.17
New York	4.25	Montana	3.06
Delaware	4.25	Iowa	2.58



12) Now we would like to understand how your DOT operates.

Please use the scale to specify where your DOT lies along each of the contrasting dimensions:

No use of contractors for maintenance activity	○ ○ ○ ○ ○	Contracting out of all maintenance activity
Policy manual with clear rules	○ ○ ○ ○ ○	Very few written rules
Lower-level employees communicate only through their manager	○ ○ ○ ○ ○	Employees are free to communicate across organizational lines at any time
A tall, narrow organization structure (centralized)	○ ○ ○ ○ ○	A flat, wide organization structure (decentralized)
Decision authority is based on position	○ ○ ○ ○ ○	Decision authority is based on expertise
Jobs are clearly distinct and duties do not overlap between individuals	○ ○ ○ ○ ○	Jobs are not clearly specified and may be performed by many individuals
A strong emphasis on tried and true practices despite changes in business conditions	○ ○ ○ ○ ○	A strong emphasis on adapting to changing circumstances without concern for past practices
A strong emphasis on getting people to follow formal and specific procedures	○ ○ ○ ○ ○	A strong emphasis on getting things done even if it means disregarding formal procedures
Tight formal control of most procedures	○ ○ ○ ○ ○	Heavy dependence on informal relationships and cooperation

Items 12.1-12.9 reflect DOT organizational structure and practices, with lower values reflecting a more formalized, bureaucratic structure and higher values reflecting a more flexible, informal structure. DOT respondents report that their organization is relatively more formalized and bureaucratic, with relatively few exceptions such as openness of communication.

ID	Min	Max	Mean	StD
Maintenance activities	1	5	2.47	0.88
Policies and rules	1	5	2.08	0.92
Communication channels	1	5	3.25	0.96
(De) centralization	1	5	3.03	0.99
Decision authority	1	5	2.35	1.04
Job definition	1	5	3.03	0.92
Practice and experience	1	5	2.96	0.93
Formal procedures	1	5	2.52	0.93
Control	1	5	2.66	0.93

The overall structure measure (an average of the nine structural indicators) is reported below.

Highest states	Mean	Lowest states	Mean
Missouri	3.23	South Carolina	2.41
Idaho	3.20	Pennsylvania	2.40
Delaware	3.00	Alabama	2.29

If you would like to share your experiences or suggestions regarding the diffusion of innovations within your DOT or other aspects of this survey, please write them down in the space below.

You have reached the end of the survey. Clicking "Next" will submit your responses to our database. If you would like to review your responses please click the "Go Back" button.

Thank you for completing this survey.

Go Back Next

Appendix 5: Descriptive statistics for key variables

Variable	Obs	Mean	Std.Dev.	Min	Max
Survey respondent located at HQ	315	0.231746	0.422619	0	1
years with DOT	340	22.86456	8.650876	1.5	50
Learning from other DOT	341	4.554252	0.6647563	1	5
Innovation culture excl. learning from other DOT	341	3.526628	0.7506907	1.25	5
Innovation culture incl. learning from other DOT	341	3.732258	0.6560357	1.2	5
Radical innovation	341	3.423021	0.5772205	1.25	5
Incremental innovation	341	3.668152	0.5293135	2	5
MDSS parts (i.e. RWIS)	203	3.181527	0.8442239	1	5.2
MDSS individual support	203	3.814433	0.7793232	1.8	5
MDSS DOT support	203	3.570887	0.8928696	1	5
Pothole Patcher individual support	202	3.646287	0.7964464	1.4	5
Pothole Patcher DOT support	202	3.238713	0.8567754	1	5
TowPlow individual support	213	3.59493	0.8742164	1.6	5
TowPlow DOT support	212	3.21	1.003951	1	5
MDSS performance (i.e. cost, time…)	116	2.997845	0.3765052	1.6	4
Pothole Patcher performance (i.e. cost, time…)	69	3.165942	0.4627676	2	5
TowPlow performance (i.e. cost, time…)	73	3.246575	0.5380216	1	5
Number of contacts	341	2.677419	3.389654	0	10
% of external contacts	173	0.1942775	0.2859626	0	1
Identification with DOT	317	4.249211	0.5492005	1	5
Identification with profession	317	3.758423	0.8288344	1	5
DOT Structure	314	2.706497	0.4839314	1.33	4.44

Appendix 6: Network graphs

Figure 6-1. Network of contacts for 174 respondents providing network data. An arrow from respondent i to respondent j indicates that i cited j as a contact for innovation. Some respondents show no links because they cited people who did not also provide network data (see Figure 6-2 for their inclusion). Note that several nodes of the network appear to be hubs that are cited by a greater number of respondents (for example, respondent 10081).

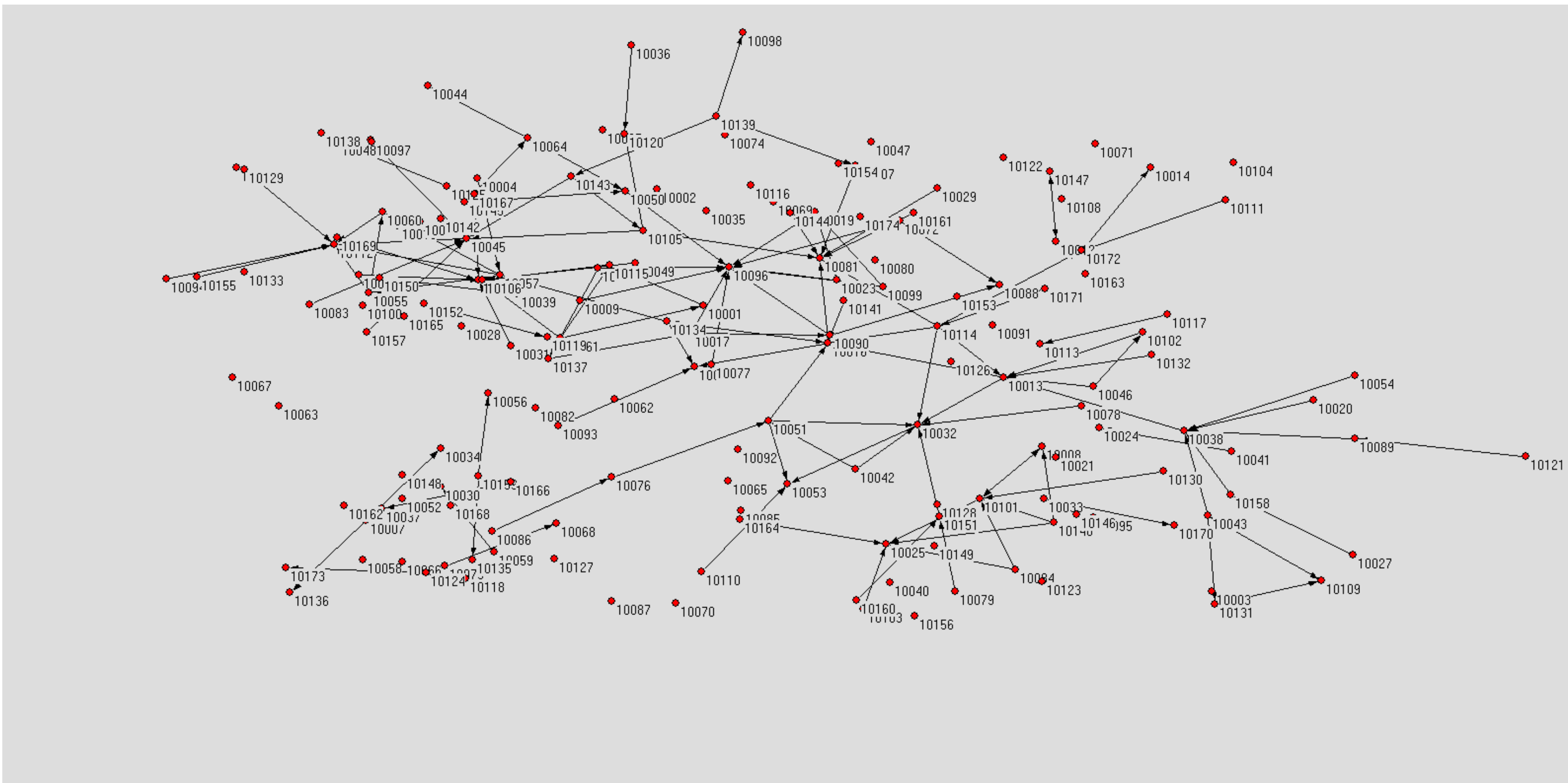


Figure 6-2. Overall network map. Map of all 800 unique people identified, including respondents providing network data, respondents not providing network data, and non-respondents cited by respondents. Note that the network has a similar quality to the prior one of the 174 respondents providing network data, and that the majority of network activity occurs among the more densely connected core of the network while the actors in the periphery are less networked.

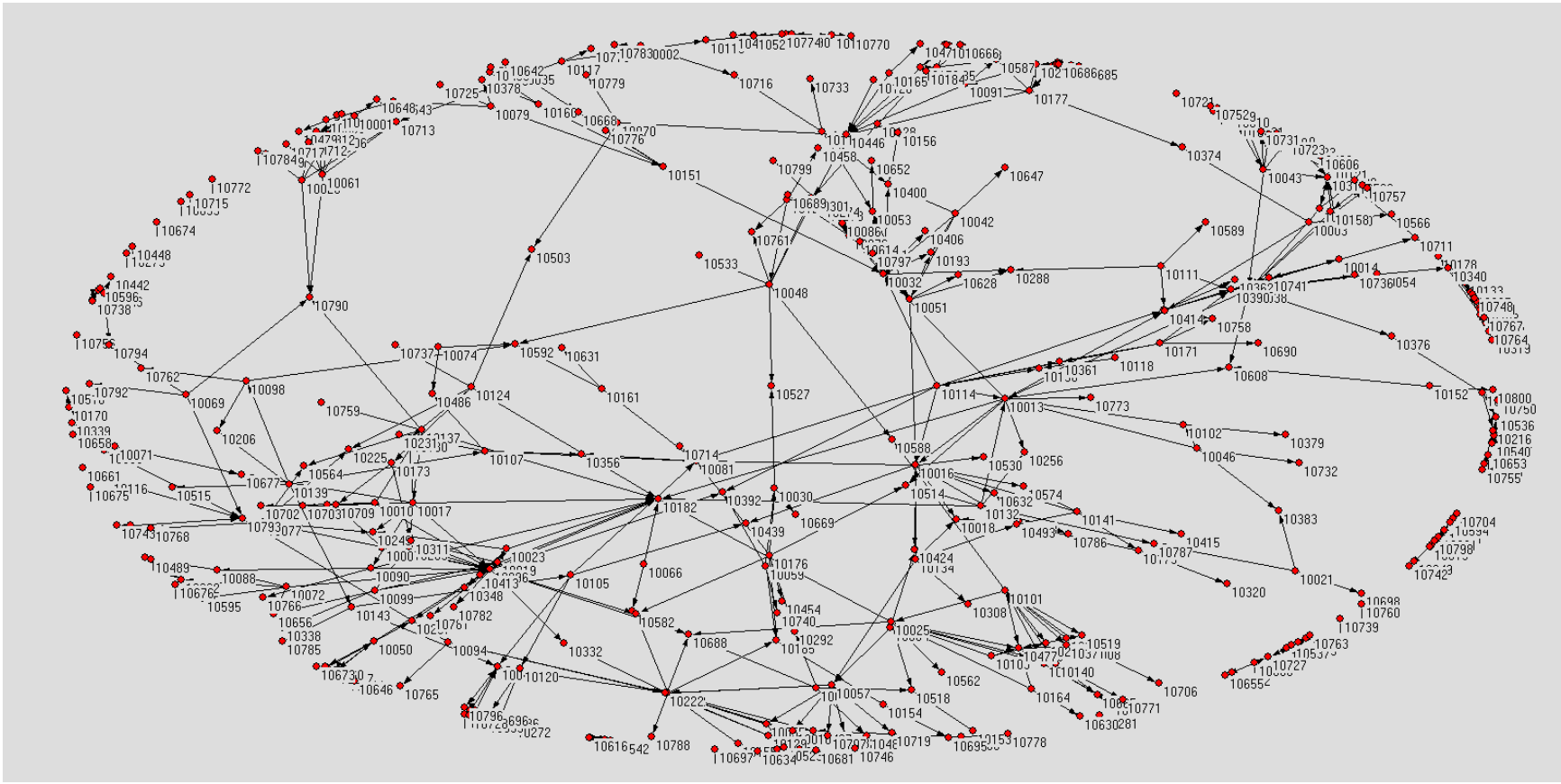
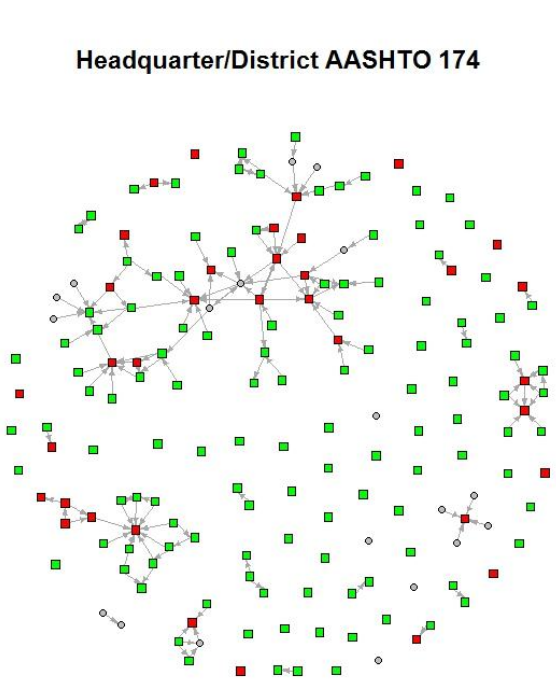


Figure 6-3. Headquarters personnel are more centrally positioned in networks. This set of graphs (and the two sets following in Figures 6-4 and 6-5) color code categories of interest so the viewer can see how people in those categories are positioned in the overall networks for 174 and 800 people. The categories are headquarters personnel (Figure 6-3), scan team participants (Figure 6-4), and scan team hosts (Figure 6-5). This figure shows how the networks of people located at headquarters (red) differ from those of people located in district offices (green). Note how headquarters personnel are more strongly networked than district personnel: the red nodes are located at the junctions of contacts.



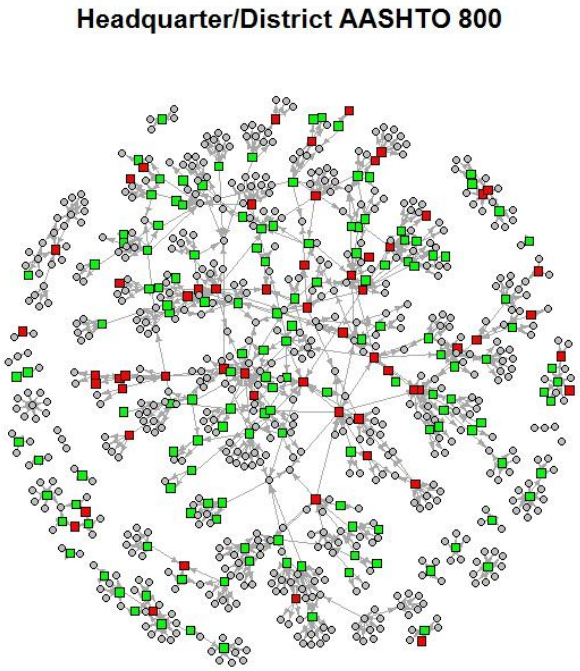
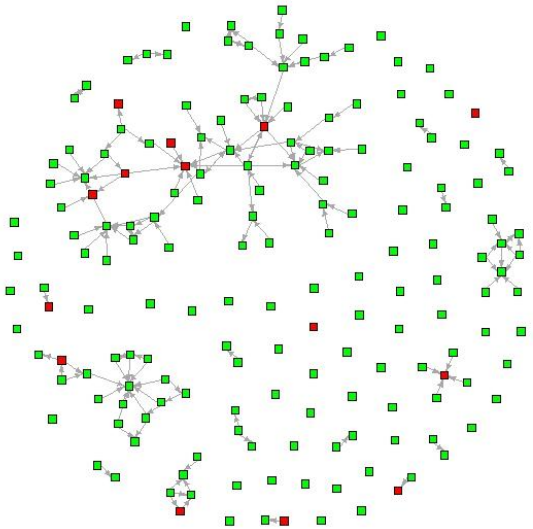


Figure 6-4. Scan participants are also more active in networks. This figure shows how the networks of people who participated on scan teams (red) differ from people who have not (green). Note how scan participants are more strongly networked than others: the red nodes are located at the junctions of contacts.



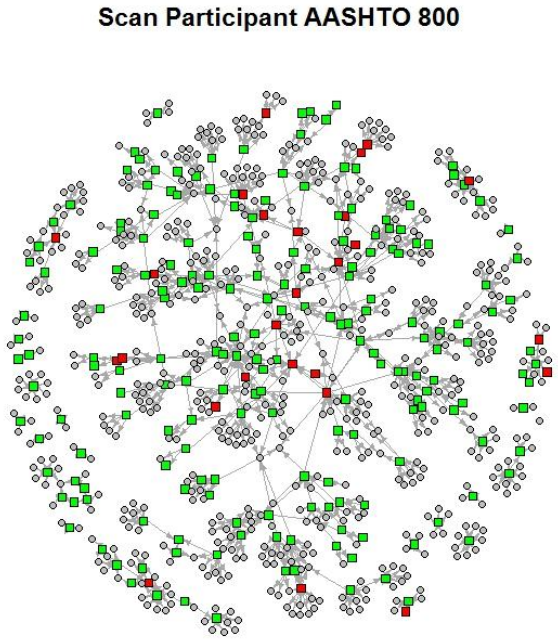
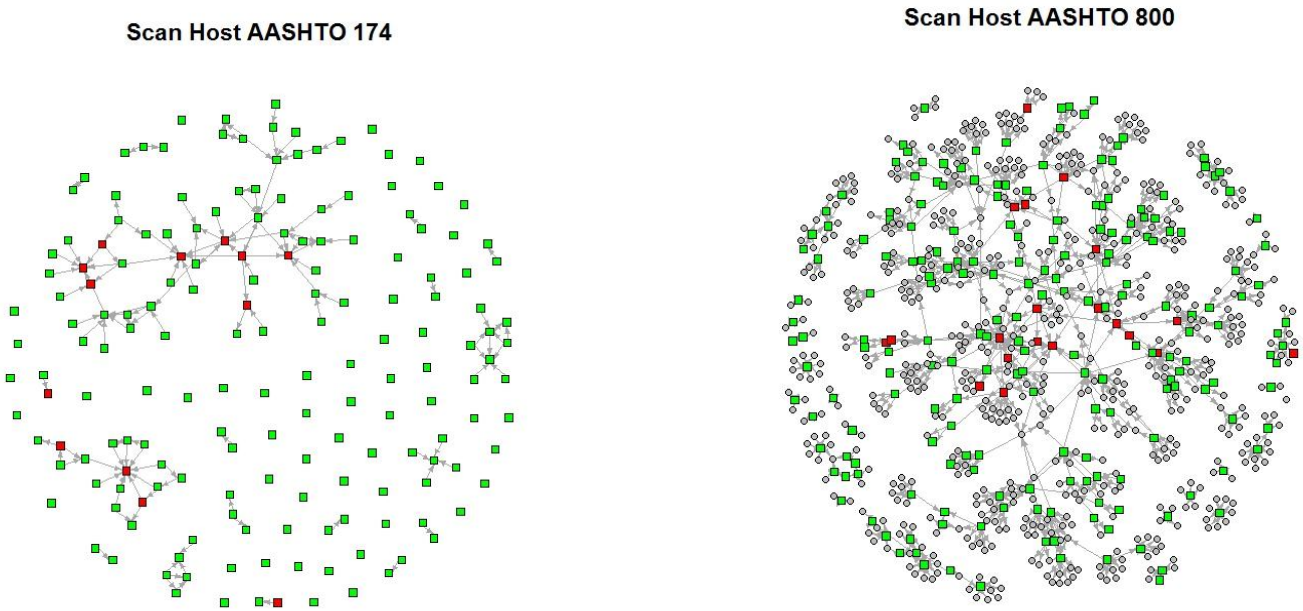


Figure 6-5. Scan hosts are also more active in networks. This figure shows how the networks of people who hosted scan teams (red) differ from people who have not (green). Note how scan hosts are more strongly networked than others: the red nodes are located at the junctions of contacts.



Appendix 7: State orientation to innovation (from Question 1)

	Learning from other DOTs (1 item)	Innovation orientation (other 4 items)
Alabama	4.58	3.46
Arizona	4.80	3.45
Arkansas	4.55	3.42
California	4.64	3.79
Colorado	4.70	3.41
Delaware	5.00	3.50
Florida	4.75	4.38
Georgia	4.75	3.41
Idaho	4.00	3.50
Illinois	4.37	2.79
Iowa	4.67	4.14
Kansas	4.75	4.13
Kentucky	4.45	3.10
Louisiana	4.67	3.53
Maryland	3.00	2.88
Minnesota	4.55	4.32
Mississippi	4.63	3.84
Missouri	4.70	4.00
Montana	4.78	3.86
Nebraska	4.71	3.39
Nevada	4.80	3.50
New York	4.55	3.32
North Carolina	4.58	3.35
North Dakota	4.36	3.13
Ohio	5.00	3.19
Pennsylvania	4.67	3.47
South Carolina	4.35	3.09
South Dakota	4.64	3.79
Tennessee	4.16	3.33
Virginia	5.00	4.00
Washington	4.59	3.94
Wyoming	4.71	3.21
Overall	**4.58**	**3.55**